

BIT

Bioeconomy in Italy

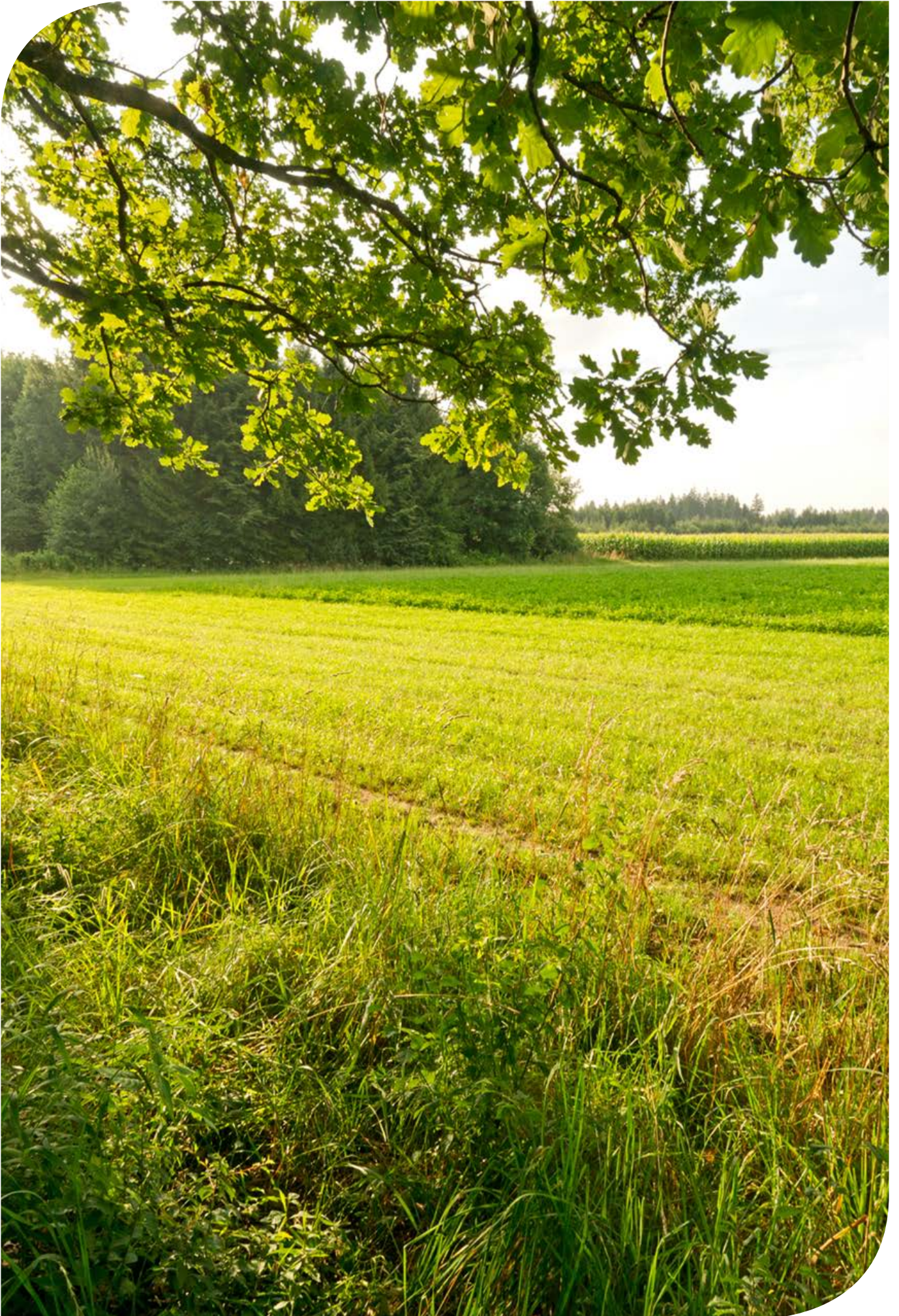


A unique opportunity to reconnect
the **ECONOMY, SOCIETY**
and the **ENVIRONMENT**



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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 a sustainable development that delivers strong communities by creating a flourishing economy that respects the environment. This is done 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 and leveraging on local diversities and traditions - in particular in the rural, coastal and industrial areas (including those that have been abandoned) - in line with the principles contained in the Juncker's Agenda for Jobs, Growth, Fairness and Democratic Change.

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

siders the potential of agricultural, forestry, and municipal (biogenic) wastes and residuals is also essential to enable the circular economy.

The Italian Bioeconomy means integrating the sustainable production of renewable biological resources and converting these resources and waste streams into value added products such as food, feed, bio-based products and bio-energy.

This strategy aims to provide a shared vision of the economic, social and environmental opportunities and challenges associated with the creation 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 the Mediterranean area.

The Bioeconomy strategy will be part of the implementation processes of the National Smart Specialization Strategy, focusing in particular on the areas of "Health, Food and Life Quality" and "Sustainable and Smart Industry, Energy and Environment". It will be implemented in synergy with the principles of the [Italian National Strategy for the Sustainable Development](#) for ensuring environmental sustainability and economic growth reconciliation.

A TRULY INTEGRATED ITALIAN BIOECONOMY ECOSYSTEM



Sustainable
agriculture and
forestry



Sustainable and
competitive agrifood
sector for a safe and
healthy diet



Aquatic living
resources and
marine and maritime
bioeconomy



Biobased
industries

EU level

Regional level

National level

INDUSTRY

CIVIL SOCIETY

RESEARCH

INSTITUTIONS

ITALIAN BIOECONOMY STRATEGY
Integrating sectors, systems, actors and institutions



EXECUTIVE SUMMARY



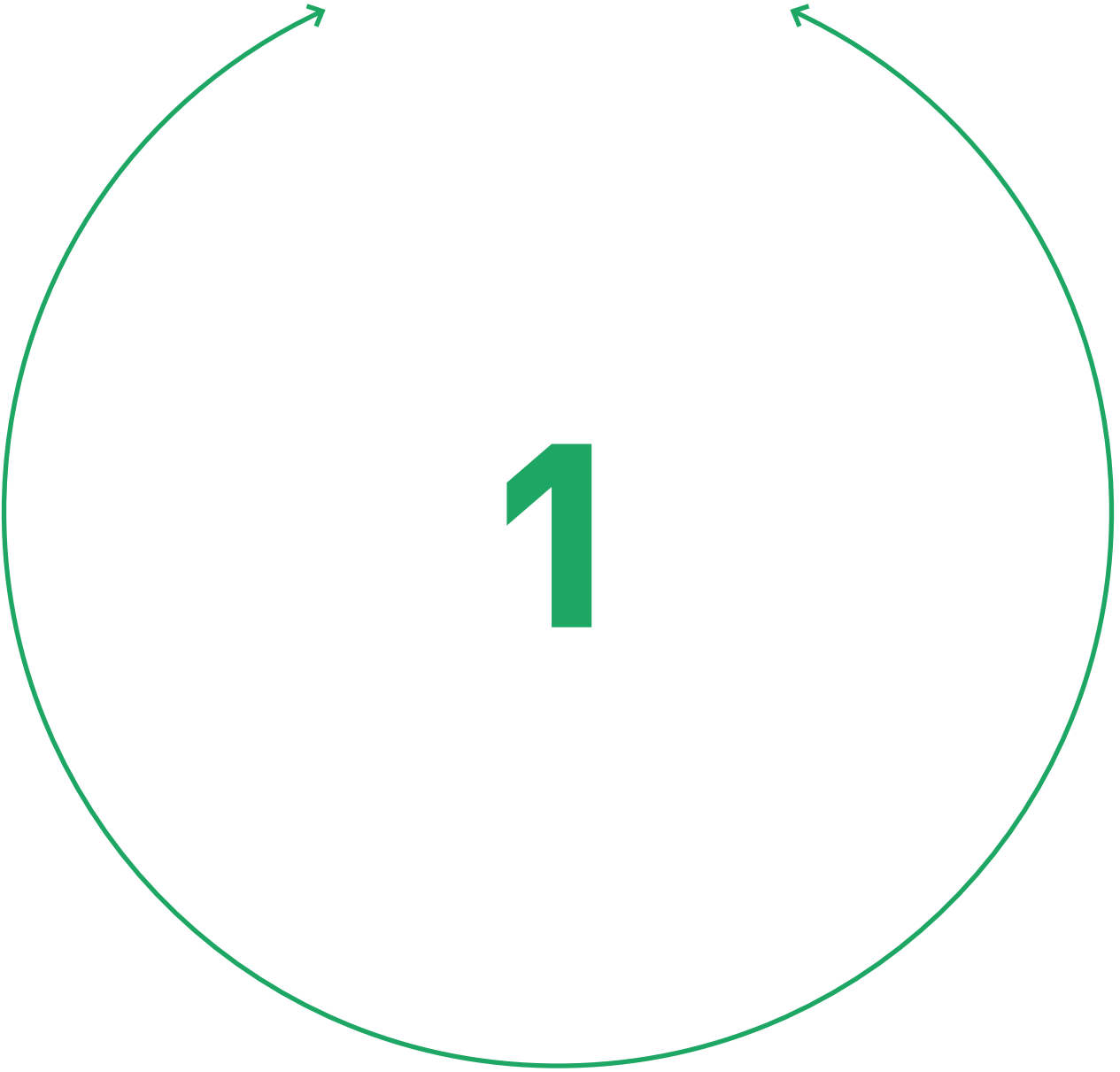
The **Italian bioeconomy** relies on all major sectors of primary production, i.e., agriculture, forestry, fisheries and aquaculture, those processing biological resources, such as the food and drink, wood and pulp and paper industries along with biorefineries, and parts of the chemical, biotechnological, energy, marine and maritime industries. It is currently making about EUR 255 billion/y of turnover and 1.7 million jobs.

The present Italian Bioeconomy Strategy (BIT) aims at achieving an increase of 20% in the current performance of the Italian Bioeconomy by 2030. This will be done by:

- a) Improving the sustainable production and quality of products in each of the sectors and interconnecting and leveraging the sectors more efficiently; allowing an effective valorization of national terrestrial/marine biodiversity, ecosystem services and circularity by creating longer and more locally routed value chains, where the actions of public and private stakeholders integrate across the board at the regional, national and EU level; regenerating abandoned/marginal lands and former industrial sites;
- b) Creating: i) more investments in R&I, spin offs/start-ups, education, training, and communication, ii) better coordination between regional, national and EU stakeholders/policies, iii) better engagement with the public, and iv) tailored market development actions.

The strategy also includes actions addressed to promote the bioeconomy in the Mediterranean area, mainly through an effective Italian participation in the BLUEMED and PRIMA initiatives for a greener and more productive region, wider social cohesion and greater political stability in the area.

The BIT R&I agenda and priority actions are accompanied by measures creating and guaranteeing the framework conditions required for its effective implementation. BIT will be part of the implementation processes of the National Smart Specialization Strategy, in particular the areas focusing on “health, food and life quality” and “sustainable and smart industry, energy and environment”, and it will be implemented 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 the use of agriculture, forestry, marine biological resources and inland waters, alongside the biobased industry, are among the most important elements influencing European society and the wider world.

The bioeconomy refers to the set of economic activities relating to the invention, development, production and use of biological products, services and processes across four macro-sectors¹:

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

This document proposes a transition towards a circular bioeconomy by integrating the bioeconomy and the circular economy models into a vision where the production and use of renewable bio-resources and their conversion into value added products is part of a circular system, that will make businesses more economically viable and sustainable in the long term².

A circular bioeconomy needs to build both on local resources and facilities and on the improved interaction and integration among the economic sectors concerned, public and private stakeholders, the civil society (especially NGOs) and existing policies at International, European and Member States level³.

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

1.1 IN THE GLOBAL AND EU CONTEXT

Currently, more than 40 nations worldwide are proposing actions and strategies to boost their bioeconomy, the economic dimension of which is steadily increasing: about US\$2 trillion 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].

1 Europe's Bioeconomy Strategy, European Commission, 2012

2 Closing the loop - An EU action plan for the Circular Economy, COM/2015/0614 final

3 Global Bioeconomy Summit 2015 Communiqué

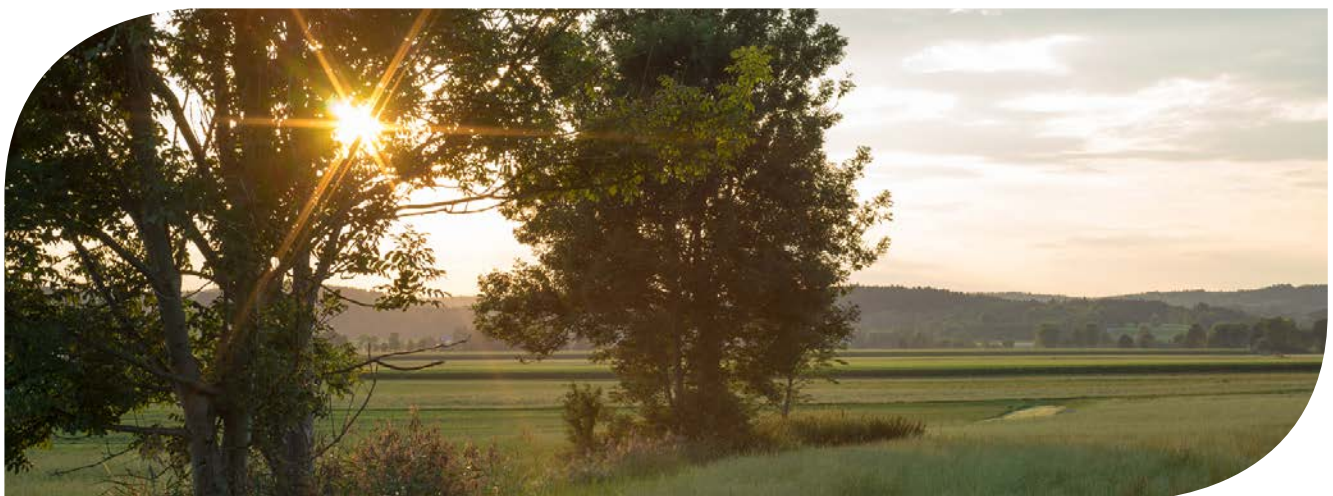
1. BIOECONOMY – AN INTRODUCTION

In Europe, the bioeconomy is already worth **EUR 2 trillion in annual turnover and accounts for more than 20 million jobs** (Strategy for “Innovating for Sustainable Growth: A Bioeconomy for Europe”, EC, 2012); it is expected to grow further, reaching a market value of EUR 40 billion and creating 90,000 new jobs by 2020 (“Growing the European bioeconomy” Third Bioeconomy Stakeholders’ Conference, Turin, EC, 2014). Furthermore, the food industry is the largest in the EU and there is still potential for growth, with new businesses and industries emerging in both traditional and novel food and non-food sectors. The EU Bioeconomy strategy, which is currently under revision, will unlock the potential of available bio-resources in the various bioeconomy and blue economy sectors in a sustainable and socially responsible way. The **European Circular Economy Package** will stimulate Europe’s transition towards a circular economy, boosting global competitiveness, fostering sustainable economic growth and generating new jobs. It establishes a

concrete and ambitious action programme, including measures that will contribute to “closing the loop” of product lifecycles through greater recycling and re-use, bringing benefits for both the environment and the economy.

The Mediterranean area deserves a specific focus: it is characterized by high levels of hydric stress that, together with climate change, have a negative impact on agriculture. This has a negative influence on standards of living, with social and economic stress acting as a major cause of instability, which in turn contributes to migration, both internally, from rural to urban territories, and externally, in particular towards Europe. For food security reasons, a sustainable management of water provision and use and of food systems is required to provide clean water and affordable food for the region’s inhabitants. PRIMA⁴ is an initiative launched and coordinated by Italy, aimed at making water provision and food systems more ef-

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



1. BIOECONOMY – AN INTRODUCTION



efficient, cost-effective and sustainable, at helping solve bigger problems relating to nutrition, health and social wellbeing, and ultimately helping address mass migration trends.

The BLUEMED Initiative⁵ - also led by Italy - together with the EUSAIR and WEST MED regional initiatives, aims to create new 'blue' jobs and sustainable economic growth in the marine and maritime sectors in the area. The Mediterranean Sea is a basin with unique bio-geo-physical characteristics that contributes significantly to the EU economy by supporting 30% of global sea-borne trade. It has more than 450 ports/terminals, which host the world's second largest market for cruise ships, half of the EU's fishing fleet and a unique cultural heritage and natural patrimony. However, it is facing serious environmental challenges related to climate change, growing maritime traffic and pollution, the 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 the creation of jobs in areas that are currently underexploited. BLUEMED was initiated by the EU MS of the area as a way of addressing/implementing such challenges and opportunities via a common and shared vision and a Strategic R&I Agenda.

The bioeconomy could therefore contribute greatly to the regeneration, the sustainable development and the political stability of the area and, in turn, to a reduction in the migration phenomenon (for example with reference to the implementation of local investment projects with a high social and infrastructural impact, as outlined in the "Migration Compact" document proposed by the Italian Government) . Italy in particular, through the two initiatives it is coordinating, can play a key role in achieving this aim.

5 researchitaly.it

1. BIOECONOMY – AN INTRODUCTION

1.2 AT ITALIAN LEVEL

In Italy the entire Bioeconomy sector (including agriculture, forestry, fisheries, food and beverages production, paper, pulp and tobacco industries, textiles from natural fibers, leather, bio-pharmaceuticals, green chemistry, biochemicals and bioenergy) accounted for a total turnover of EUR 254 billion in 2015, and around 1.6 million employees. ¹

Estimates of the Bioeconomy as a whole are based on National Accounts for most of the sectors involved, while it is worth noting that biochemicals are not easily accounted for, since (with the exception of biofuels) they are not included in the current statistical framework. Estimates based on the Input/Output Table, following a different methodology, also indicate that chemicals based on renewable resources were worth around EUR 2.9 billion in 2015, i.e. 5.9% of total chemical production value.

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

Agriculture

Agriculture is an important economic sector in Italy, accounting for EUR 31 billion 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 in use. In 2015, the value of the production from agriculture, forestry and fisheries amounted to EUR 57.7 billion. 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. Various 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 food traditions. This is considered one of the most important distinguishing features of Italian agriculture and one of the main strengths of the sector in international competition on the agriculture/food markets.

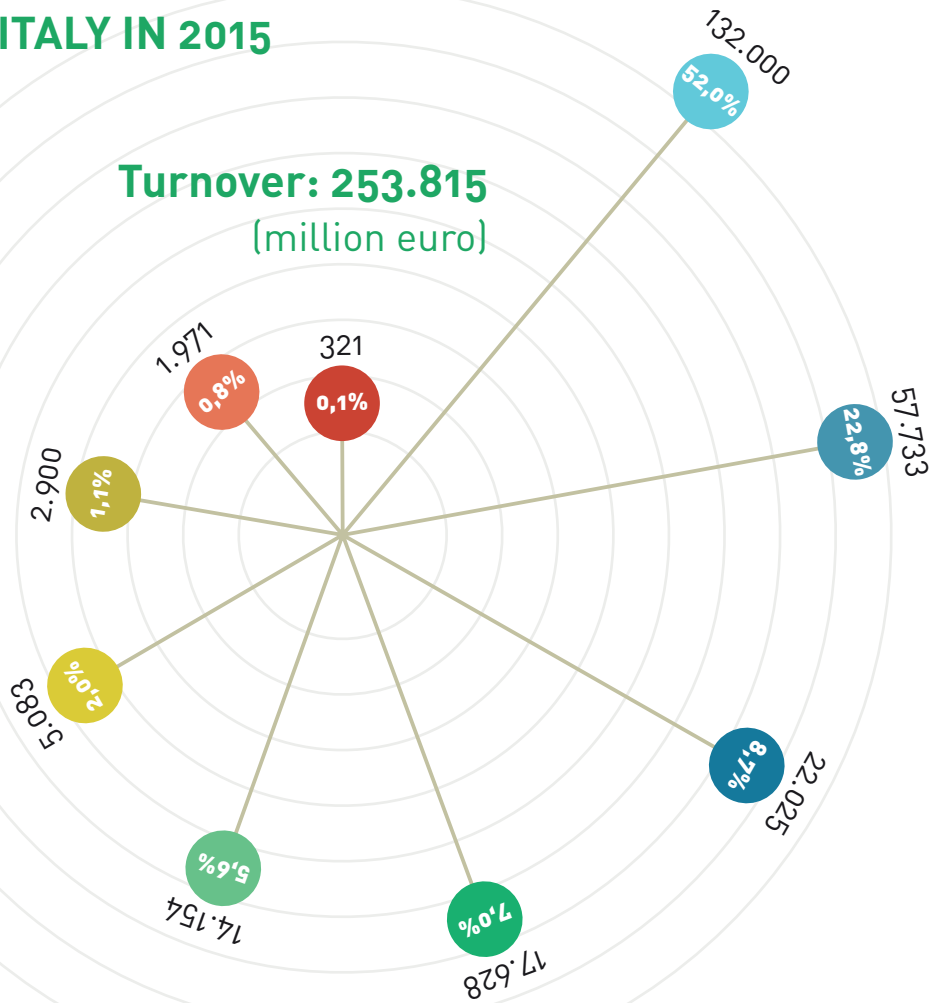
Agriculture and forestry have a vast potential in the context of the biobased and circular economy, ranging from the efficient management of resources, biodiversity, protection, soil and land sustainable management, production of ecological and social services, enhancement and re-use of residuals and wastes, as well as the production of bioenergy and bio-products through the adoption of sustainable production models and the efficient use of renewable resources.

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

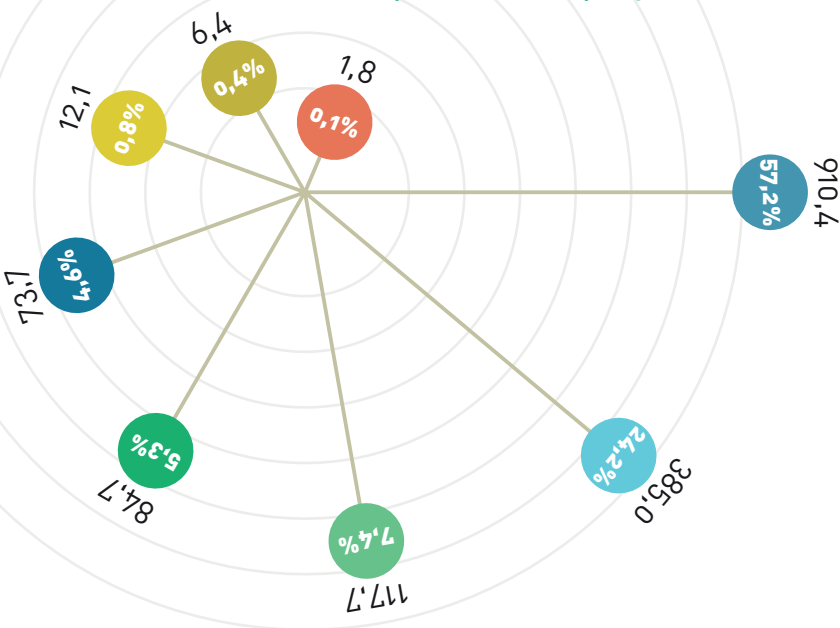
1 BIOECONOMY IN ITALY IN 2015

- 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: 253.815
(million euro)



Employment: 1.592
(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 EUR 132 billion (of which around 29 bn from exports - about 8.8% of Italy's total exports), 385,000 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 relies mostly on very small SMEs (over 85% of the companies have fewer than 9 employees) but, in spite of this, it has proved to be a resilient sector, capable of growing also during the economic crisis. This is due to its unique structure, especially based on the market success of Italian products worldwide, thanks to well-known trademarks and brands and also to the fact that the high value given by the social, cultural and environmental attention found in Italian products is protected by Geographical Indications (18% of EU products). **3**



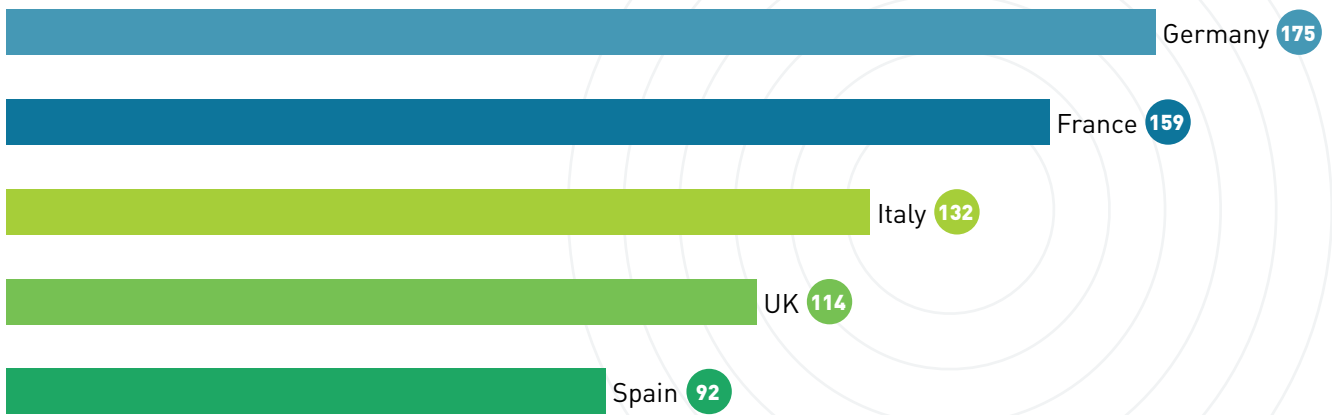
The Food Industry opens up huge opportunities for innovation and growth in the Bioeconomy sector. The National Agrifood Technology Cluster "CL.A.N."⁷, a multi-stakeholder network of the key national players of the agrifood chain, from companies to research centres, microbe collections and institutions, gave an important contribution on this matter through the drawing up of a Roadmap that identifies the most significant challenges and research priorities for the Food Industry with respect to the reuse of by-products. These include:

- Obtaining new foods and/or fodders for zootechnical purposes, innovative ingredients and/or bioactive compounds for developing health-giving foods 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.

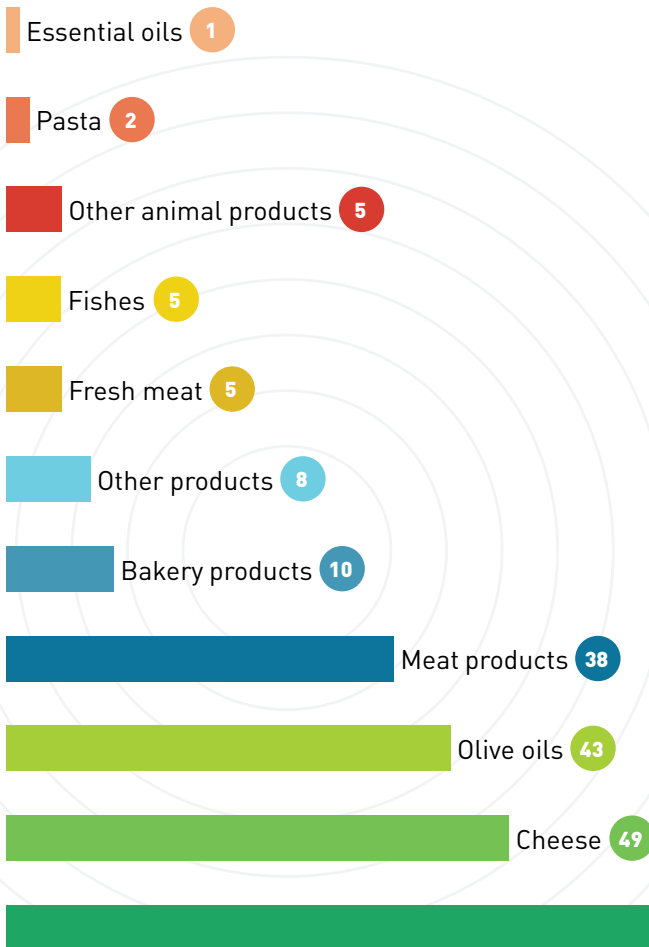
7 clusteragrifood.it

1. BIOECONOMY – AN INTRODUCTION

2 Europe's top five food industries



Source: FoodDrinkEurope – Turnover 2014 Bn €



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 energy 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 in the fresh-cut vegetables industry and valorization of wasted biomass. Within So.Fi.A., new technologies for reducing wasted biomass production using integrated drying processes and associated energy recovery devices are under study. In addition, composting and recycling waste into "on-farm" system is aimed at simplifying biomass management, reducing environmental impact.

Other important initiatives led by food companies: SUSTAINABLE FARMING for ITALIAN HIGH QUALITY DURUM WHEAT CULTIVATION – a landmark project aimed at shifting towards more sustainable durum wheat cultivation in order to improve production and soil efficiency through the optimization of operations and inputs, as well as to reduce soil degradation. It is followed up 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, such as packaging and agricultural materials.



1. BIOECONOMY – AN INTRODUCTION

Forestry

Forest surface in Italy covers 11 million hectares - approximately 37% of the national surface territory. Thanks to its Mediterranean positioning, together with its diverse landscape spanning from sea to high mountains, Italian forests host a wide variety of plant ecosystems. However, forest management needs to be improved, as does the accounting for its products and ecosystem services (INFC 2015). It is worth noting that carbon removals by managed forests covered 10% of the total national Kyoto target for CO₂ emission reduction and that there is a quite an active voluntary carbon sinks market. The whole wood/furniture supply chain in 2015 amounted to more than 80,000 companies, employing about 400,000 people, with an annual turnover of EUR 40 billion⁸, while the industry based on cellulose has an annual turnover of about EUR 22 billion, over 3,800 companies and over 20,000 employees. However, it should be noted that in such an important industry, 80% of the wood used is imported from other countries. Therefore, one of the primary objectives is to increase the degree of self-supply in this area.

Solid biomass fuels (among these wood) represent the main renewable source of energy on a national scale. The bioenergy sector has also shown strong growth during the last few years, becoming a very dynamic segment - including biomass producers and traders, stove producers, energy plant managers etc. - within

the forest-wood sector. Beyond the domain of wood-based products, non-wood (or wild) forest products and forest-related ecosystem services deserve to be mentioned. The former include a number of products - such as mushrooms, truffles, herbs, cork etc.- which often have a strong link to traditional knowledge, local economies and forest management practices. While in many cases economic activities related to these products remain largely informal, there is an increasing number of cases where wild product production has become more structured and more important than wood production in terms of direct and indirect income opportunities, job creation, visibility and rural development potential.

In addition, processed wood is converted into a few and traditional low value products while more room should also be made to expand the role of wood in the bio-construction industry. The current lack of integration and of efficient chains between the primary production and the wood processing industry is limiting both socio-economic growth and the international competitiveness of the whole value chain.

With regards to ecosystem services, although these are not (or are just marginally) included within official national accounting systems, they are increasingly recognised as an important component of forest ecosystems⁹.

8 FederlegnoArredo, 2016

9 The implementation of PES mechanisms is recalled by Art. 70 of the 2015 Budget Law (Collegato Ambientale alla Legge di Stabilità, 22nd December 2015) and related norms/regulations.

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, establishes 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 bio-char, biogases, and biobased products.
- B. Reverting disused industrial sites into next generation biorefineries.
- C. Maintaining and reinforcing Italian excellence in R&D in a global contest facing more and more aggressive policies developed by the major countries and the growing interest of the most important chemical companies.

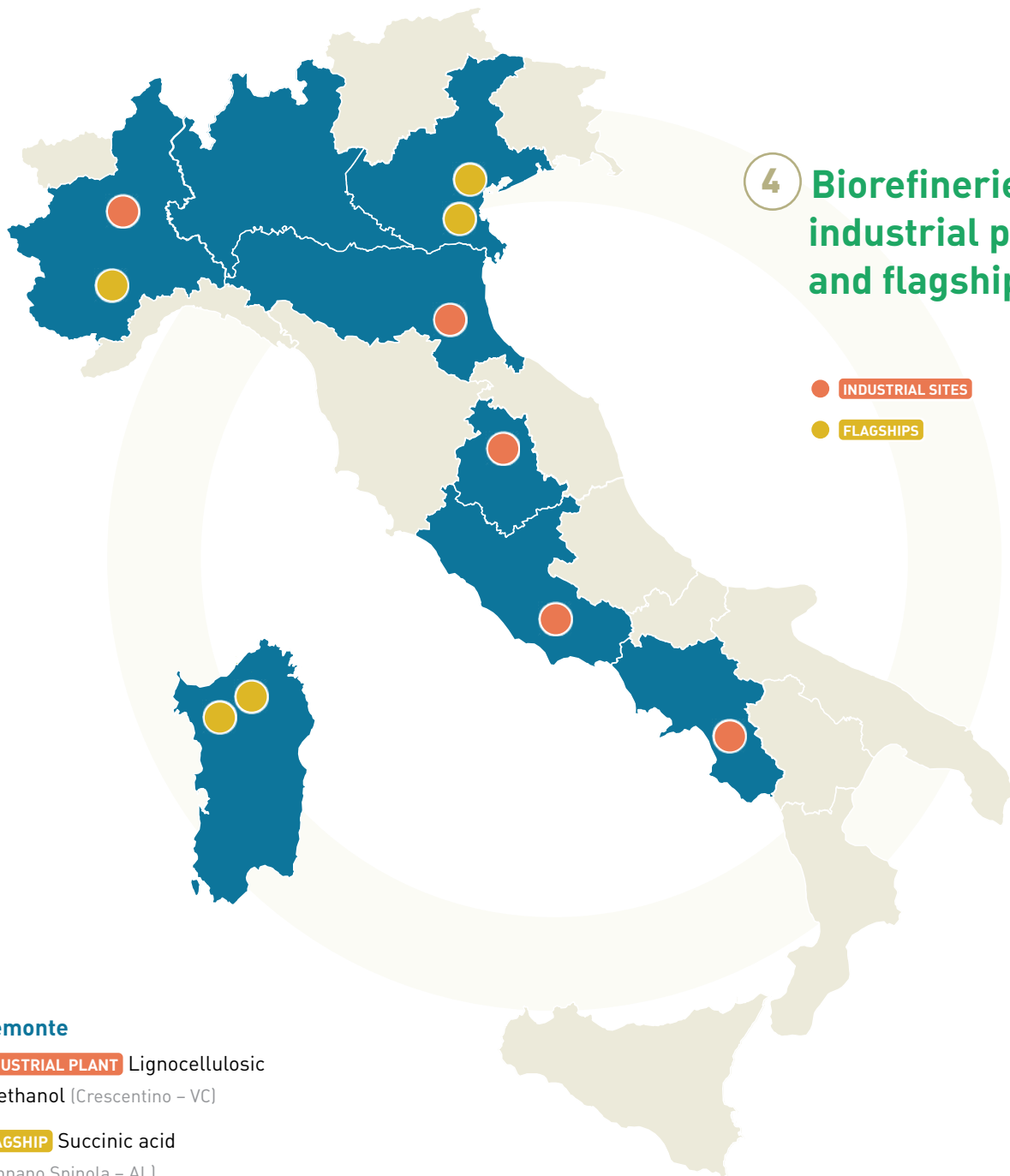
Bio-based industry

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. Hence it concerns industrial sectors which traditionally use biological resources as their main feedstock or catalysts (forest-based sector, bio-fuels/bio-energy, 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 through a number of proprietary technologies developed in the chemistry and industrial biotechnology sectors, the investments made, the range of products such as green catalysts and microbes, and the value chains available, Italy is playing a leading role in the bio-based industry.

This is a fundamental sector, as it supplies inputs and knowledge for promising technologies such as next generation bio-fuels and bio-plastics production, electricity and heating from biomass, bio-pharmaceuticals and bio-cosmetics. It is also important for the effective valorization of biological materials for residential buildings, bio-waste, urban, agricultural and industrial effluents/wastewater, the production of bio-methane, bio-fertilizers, bio-lubricants, and essential amino acids for feed production.

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



4 Biorefineries: industrial plants and flagships

- INDUSTRIAL SITES
- FLAGSHIPS

Piemonte

INDUSTRIAL PLANT Lignocellulosic bioethanol (Crescentino – VC)

FLAGSHIP Succinic acid (Cannano Spinola – AL)

Emilia Romagna

INDUSTRIAL PLANT based on vinification scraps and byproducts (Faenza - RA)

Veneto

FLAGSHIP 1,4 BDO from renewable raw materials (Adria – RO)

FLAGSHIP for the production of biofuels from vegetable oils biomass (Porto Marghera - VE)

Umbria

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)

Sardegna

FLAGSHIP Bases for biolubricants and bioadditives for rubber (Porto Torres – SS)

FLAGSHIP Azelaic acid and pelargonic acid (Porto Torres – SS)

1. BIOECONOMY – AN INTRODUCTION

Italian Flagships

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

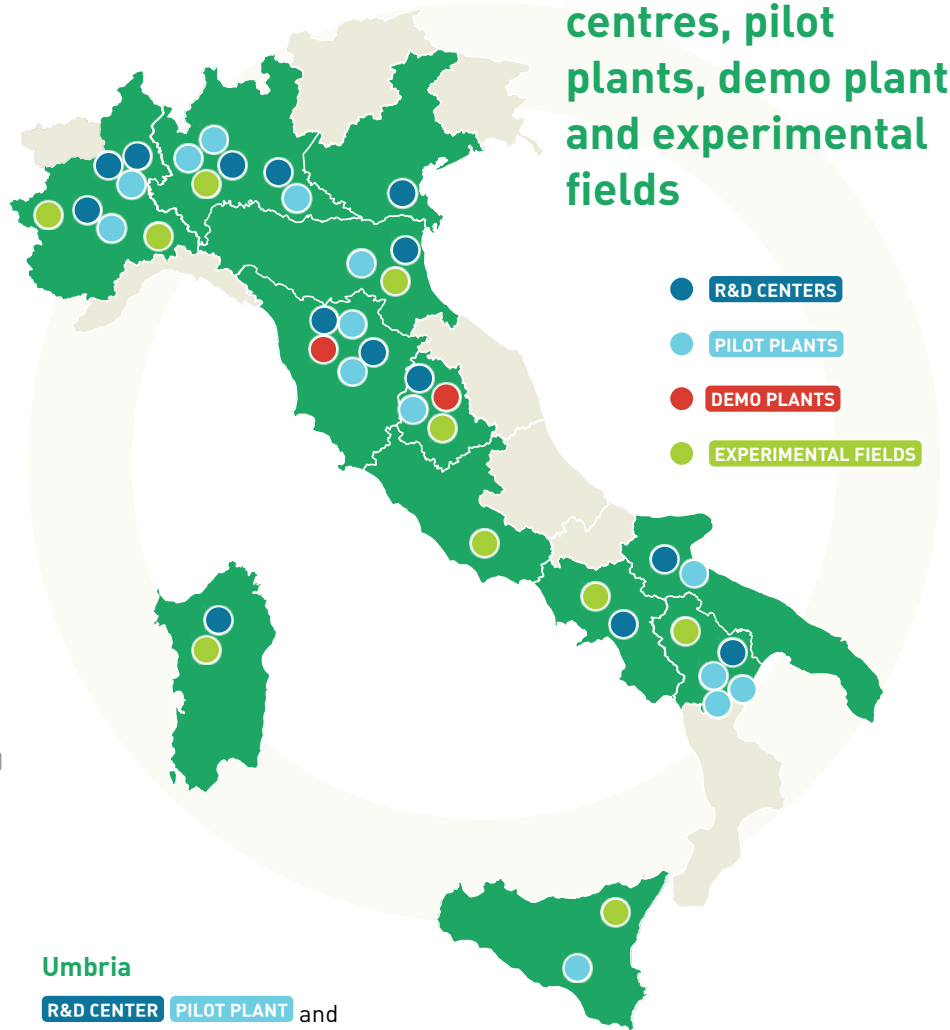
production of bio-products and bio-chemicals from renewable sources. Over a billion euros has already been invested in the re-industrialisation of decommissioned or no longer competitive sites of national importance and for the construction and launch of four flagship plants - the first of their kind in the world. (4) (5)

Notably, the Italian bio-based industrial sector is characterized 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. Italy is also the second EU country (after Germany) for the production of biogas and bio-methane with 1,924 installed plants and an energy production of 19,400 GWh (Terna, 2015).

There are other factors that have contributed to Italy's success in bio-based chemistry: the existence of the Cluster of "Green Chemistry" SPRING¹⁰, a national platform which brings together over 100 of the main stakeholders of the value chain, from farmers to entrepreneurial associations; it represents a proven, effective collaboration between public and private stakeholders, and research bodies with strong competences on the main value chains of the biobased industry; a network of large, medium and small-sized companies which work together (the main sectors represented are: bio-based chemicals, oleochemistry, bio-lubricants, cosmetics, wheat and corn wet-millers, bio-plastics, bio-methane).

¹⁰ clusterspring.it

5 Biobased R&D centres, pilot plants, demo plants and experimental fields



Piemonte

R&D CENTER Bioplastics and biochemicals from renewable raw materials (Novara)

R&D CENTER Chemistry from renewables (Novara)

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

PILOT PLANT Fatty alcohols (Rivalta Scrivia – AL)

PILOT PLANT Biomonomers (Novara)

EXPERIMENTAL FIELDS

Lombardia

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

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

PILOT PLANT for biobased butadiene (Mantova)

PILOT PLANT for biobased coatings (Cernusco sul Naviglio - MI)

PILOT PLANT for biomaterials from mycelia and scraps (Varese)

EXPERIMENTAL FIELDS

Veneto

R&D CENTER for new technologies development in the biotech-sector (Adria - RO)

Emilia Romagna

R&D CENTER Bioelastomers (Ravenna)

PILOT PLANT for PHA (Bologna)

EXPERIMENTAL FIELDS

Toscana

R&D CENTER and **PILOT PLANT** for biolubricants and biopesticides (Sesto Fiorentino - FI)

R&D CENTER **PILOT PLANT** and **DEMO PLANT** on bioenergy, biofuels and bioproducts (Scarperia e San Piero – FI)

Umbria

R&D CENTER **PILOT PLANT** and **DEMO PLANT** Oleaginous crops and biolubricants from local crops (Terni)

EXPERIMENTAL FIELDS

Lazio

EXPERIMENTAL FIELDS

Campania

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

EXPERIMENTAL FIELDS

Puglia

R&D CENTER to characterize biomass and biomaterials, organic waste and sludge, residues and agro-food byproducts (Foggia)

PILOT PLANT Anaerobic digester plant, pyrolysis/gasification plant, photobioreactors plant (Foggia)

Basilicata

R&D CENTER for green biotechnologies (Matera)

PILOT PLANT for conversion of non-food cellulosic biomass into cellulosic glucose (Rotondella - MT)

2 PILOT PLANTS for steam gasification of biomass (Rotondella - MT)

EXPERIMENTAL FIELDS

Sardegna

R&D CENTER for biochemicals from vegetable oils (Porto Torres – SS)

EXPERIMENTAL FIELDS

Sicilia

PILOT PLANT for cellulose extraction from citrus for textiles (Caltagirone – CA)

EXPERIMENTAL FIELDS

1. BIOECONOMY – AN INTRODUCTION

Marine bioeconomy

Italy is characterized by over 8000 km of coastline, 40% of whose jurisdiction space is under water. It can therefore count on remarkable sea-based resources (food, microbes, energy, materials, landscape). Currently, bioeconomy related activities are responsible for about 20% of the turnover and job opportunities of the present Italian blue economy, which were estimated at about € 43 Billion/y and 835,000 employees. These activities include fishery and marine aquaculture, the exploitation of marine algae, microbes, enzymes, and by-products

and biowaste of fishery and aquaculture products processing, biomonitoring and bioremediation of marine water/sediment systems. In particular, Italy is, respectively¹¹, the second biggest European fish producer and ranks fourth in Europe for aquaculture production. Nevertheless, about 75% of national consumption is covered by imports. Sea based tourism is responsible for 19.1% of the presences in the country and is the second contributor to the significant part of the Italian economy driven by foreign visitors. In addition to this, 64% of Italians choose marine locations for their vacations.



11 V rapporto sull'economia del mare, Unioncamere 2016

1. BIOECONOMY – AN INTRODUCTION

1.3 BIOECONOMY AT REGIONAL LEVELS

The availability of local competitive biological feedstocks is an important requirement for bioeconomy industries. Italian regions, at an individual level, have a high level of agricultural and natural landscape specificity linked to the biodiversity of cultivated plants, animals, related ecosystem services and their diverse cultural heritage.

A recent collaborative work for the drawing up of a Position Paper on Bioeconomy (6/129/CR08b/C11), developed by the Conference of the Italian Regions, monitored the strategic position of the regions with respect to three pillars of the Bioeconomy: Marine bioeconomy,

Agrifood, the Bio-based industry. The study paves the way to interregional cooperation in the bioeconomy, especially between neighboring territories, opening up also the necessary dialogue with national programs and strategies. **6**

The Italian regions are particularly motivated when it comes to keeping rural economies alive, putting into place regional economic cycles and supporting agro-industrial local projects with the strategic idea of using bio-resources in a more innovative and efficient way. Some of the initiatives carried out demonstrate the potential and the socio-economic impact of the development of the bioeconomy at a local level.

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)



1. BIOECONOMY – AN INTRODUCTION

The Agrifood sector is a priority in the strategic plans of all the regions, reflecting the value and importance of the sector linked to the quality and strong identity of the products. The agrofood system issues related to quality, sustainability and recovery of environmental value, and the relationship between food and health are central to the vision of the regions.

The regions see great potential in the development of the bio-based industry - the second sector in the strategic assessment. The potential is largely related firstly to the exploitation of food chain wastes, with the aim of reducing the environmental impact, and secondly to the development of industrial crops in marginal agricultural areas that do not compete with food production. Some

territories host important projects for the reconversion of de-industrialized sites into biorefineries for the production of bioproducts and biochemicals from local renewable sources, leading to positive impacts on employment, environment, product profitability and integration with regional agriculture systems.

The Italian regions are willing to establish a distributed bioeconomy system built on modular and multiple concepts, by building cross territorial links and interregional value chains. The key components of the Distributed Business Models are the distributed units and the modular nodes. Each module or production site is a node of its own, and is linked to several other nodes according to the needs and deliverables of each node.



EXAMPLE OF REGIONAL PROJECTS

✓ One recent example of an industrial reconversion is a new plan for the production of bio-butandiol at an old chemical site. The factory, which will produce 30 thousand tons of bio-butandiol per year, 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 rather than from fossil sources. This is done through a low-impact process and the co-products are completely reused. Some of these projects are coordinated by leading Italian players in bio-based industries sector and have been recognized as flagship initiatives in Europe by the BBI Joint Undertaking.

✓ Other interesting cases are focused on the possibility of using agricultural residues as a source of renewable energy - very common in several regions - thanks to the existence of public subsidies for investments. Agro-energy offers farmers the potential to earn extra income and often pushes for cooperation among farmers in order to aggregate the biomass needed to manage a bioenergy plant. The most accepted and widespread 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 this kind of initiative can be seen in the Veneto Region, where 14 farmers active in cereal production, cooperated in setting up a 1MW biogas plant fed with the waste of their production, creating a 2 million Eur/year turnover, making farm jobs more stable and creating new jobs for plant management and service.

✓ The Biopower project in Tuscany tackled the challenge of energy production by using renewable sources through a diffused network of small sized plants. The project involves 7 enterprises and has reduced the environmental pressure by saving 1,000,000 TEP, at the same time producing 17 new jobs.

✓ Another important initiative developed in Tuscany is related to the production of 20,000 tons of soil compost per year from local organic waste coming from the urban separate collection and treated in three industrial composting plants. The initiative provides a supplement to industrial fertilizer production lines, as well as organic fertilizer for farmers and public administrations. 30% of the 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 Italian regions where there is a high availability of water and sea coast. One of the objectives of aquaculture is to reduce energy consumption and minimize the environmental impact. One initiative developed and supported by the Veneto Region relates to the cultivation of mussels with a continuous rope and a biodegradable retention net. The projects led to a 50% in fuel reduction and waste, and an increase in production of up to 9,5 tons.

✓ Microalgae cultures have a strong potential for industrial developments thanks to the higher 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 the Liguria Region and the BIOFAT EU project. The industrial pilot initiative is developing rapidly, covering a 8,000 sqm greenhouse surface and employing 15 people, demonstrating the potential of producing oil and fine products for pharmaceutical and cosmetics.



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

From the environmental viewpoint, the bioeconomy raises both opportunities and challenges.

The opportunities are linked to the gradual shift in production processes from non-renewable to renewable resources in order to limit the environmental pressure on ecosystems. Higher value is placed instead on their conservation as, beyond their intrinsic or existing value connected to other services, they can provide important services for the economy, - including the strategic importance of finding nature-based solutions to cope with climate change and hydrological risks. Furthermore, the bioeconomy implies the possibility of decreasing dependence on resources not widely available in Italy. Producing more from renewables may ease the problem of waste management as these sources are more easily reabsorbed by the nature receptors.

However, the bioeconomy can also lead to a number of challenges. One necessary condition is the economic, environmental and social sustainability of products and processes. Especially in the food and fish industry, there are many examples of unsustainable management for both the environment and human health. The Value Added and utility for the society can be increased by improving the quality of products (i.e. agriculture).

Finally, it is important to reconcile economic and environmental needs: increasing the value added of the bioeconomy sectors should not be done by importing raw renewable materials from countries with less strict environmental regulations, as this could result in shifting the environmental damage abroad.

It is clear, therefore, that the opportunities and challenges in building a sustainable and flourishing Italian bioeconomy vary according to the source of biomass in the bioeconomy sectors, according to the need for “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 animal species not only supplies food, raw materials, energy, fresh water and medicinal products for human consumption, but represents overall the most significant part of the total value of our natural capital. The sustainable management of this stock offers other benefits to human society and the environment through a continuous flow of regulatory, supporting and cultural ecosystem services that are worth accounting for.

Agriculture based on sustainable practices responds to its primary function of food production while enhanc-

2. RAW MATERIALS SOURCES AND THE OPPORTUNITIES OF BIOWASTE

ing the correct management of natural resources (soil, water, air), biodiversity and contributing to genetic diversity conservation.

Between 1960 and 2000, the European countryside experienced a dramatic change in land use. Further land abandonment is forecast to continue until 2030¹², according to the Institute for European Environmental Policy and Eurostat survey. Estimates indicate an overall decrease in agriculture, grasslands and semi-natural habitats of more than 30 million hectares and an increase in urbanization. Activating synergies between agriculture, forestry, and the industrial sector in order to reuse residuals and waste for the production of bio-products and bioenergy, could help in bringing marginal and abandoned lands back into cultivation. Agriculture is already responding well today to the model of the circular economy - as in the case of the production of biogas and digestate, with positive impacts on organic soil matter.

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 raw fossil materials. It also has a wide variety of molecules and processes for synthesizing which are extremely interesting, yet until today, remain largely unexplored. As a consequence of energy-related and environmental problems arising from the use of fossil energy, renewable raw materials such as vegetable oils,

starch from corn and potatoes, cellulose from straw and wood, lignin and amino acids as well as the exploitation of algae are becoming increasingly important as industrial feedstocks. Through physical, chemical and biological processes these materials can be converted into fuel, chemical intermediates, polymers and specialties in general for which mineral oil has been used to date. We need to further valorize this potential of the agricultural sector within the circular economy.

Innovative, sustainable bioeconomy sectors should follow this general approach for the use of raw materials:

- **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), most suitable with respect to technical and environmental prerequisites in agriculture and biorefinery processes;
- **identification and use of marginal and/or contaminated lands**, in line with international policies on climate change and biodiversity, sustainable intensification policies, and in synergy with regional and local policies;
- **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);

¹² "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

- **construction of new supply chains integrated with agriculture forestry and the industrial sectors**, ensuring competitiveness and profitability for all participants in the value chain;
- **reliance on eco-labelled, 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 functioning of the marine ecosystem, as well as of the future livelihood itself of fisheries and marine bio-based economy. This is even 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, aquaculture can be a viable solution to the sustainable management of the fisheries industry and it is no coincidence that it is prioritized in the EU Blue Growth Strategy and BLUEMED Strategic Research and Innovation agenda. However, caution is required to mitigate potential negative impacts of intensive aqua-farming, through monitoring the release of nitrogen and phosphorous in the coastal zones.

The increasing use of **residuals and byproducts** for the production of materials and energy is at the foundation of a sustainable circular bioeconomy, reducing the pressure on raw renewable sources and dependence on 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 bio-residuals and waste from the primary food biomass processing and food making e.g. husks, hulls, shells, bagasse, etc. (about 15 million t/y). In addition, 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, representing about 43% of the total municipal organic waste produced after 2014¹³. Such residual streams are currently only partially and poorly valorized (mostly via biogas production) and mainly disposed of in landfills, with consequent high external costs and negative environmental impacts. Many of them, and in particular the agro-food industry by-products, waste and effluents, could be cheap and abundant sources of bio-based chemicals and materials, along with substrates for tailored biotechnological productions which, in turn, could enable the preparation of value-added bio-based fine chemicals, materials and bio-fuels.

However, the “end of waste” criteria, as well as a national revised regulation on waste and residuals, along with clear indications on the potential use of the products and on their quality assessment would contribute greatly to boosting the efficient and valuable exploitation of these forms of biomass.

13 ISPR; Rapporto Rifiuti Urbani, 2015).



3

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.



BIOGAS

Organic gas produced by the anaerobic digestion of biomass that can be used as fuel for the production of electricity and heat or as fuel as a result of a refining process biomethane.



PRODUCTS FOR FOODSERVICE

The use of biodegradable and compostable foodservice ware 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, extruded trays 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

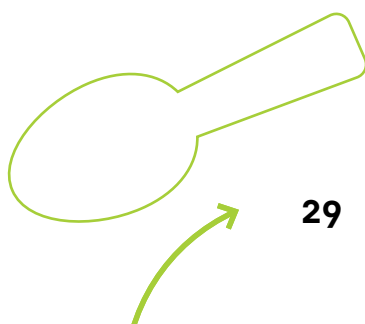
An innovative vegetable oil produced using olives and tomatoes only by mechanical processes.

- 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.



BAGS AND GLOVES FOR FRUIT & VEGETABLES

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.



3. BIOECONOMY IN EVERYDAY LIFE



COMPOSTABLE CAPSULES

Biodegradable and compostable capsules 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.



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.



CARBOXYLIC ACIDS AND COSMETICS

Carboxylic acids are the 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 as well as being used in the formulation of plant protection. Some carboxylic acids and their esters and glycerine are well-known products commonly used in cosmetics applications.



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.



BIOACTIVE COMPOUNDS FROM MEAT BY PRODUCTS

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



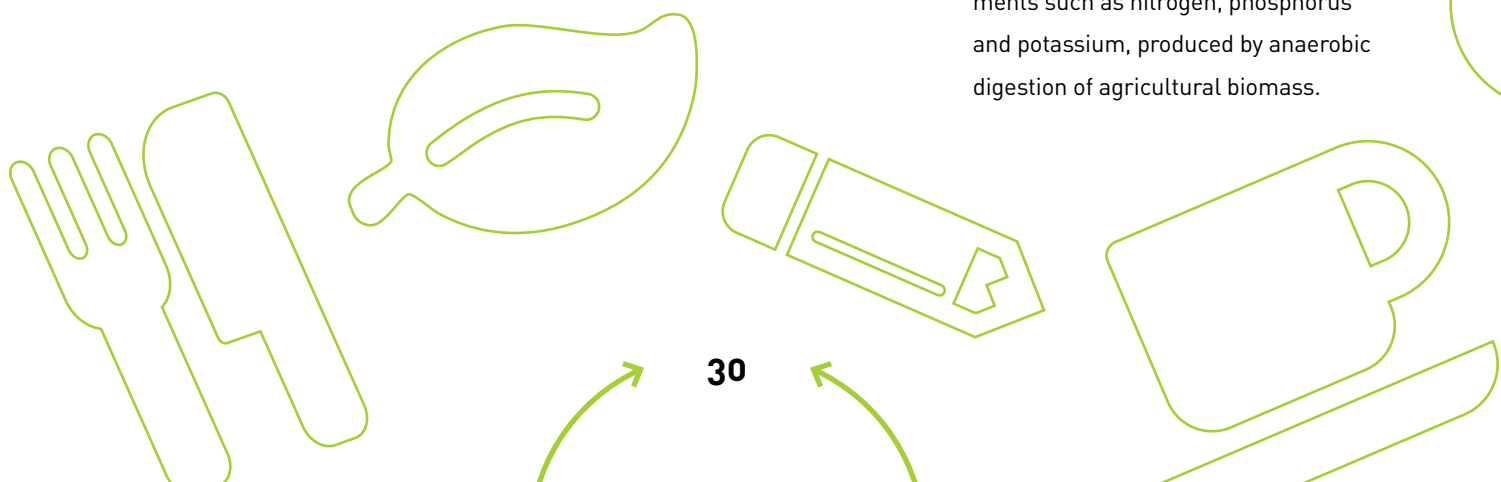
PLASTICIZERS

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



DIGESTATE PELLETS

Organic fertilizer rich in nutrient elements such as nitrogen, phosphorus and potassium, produced by anaerobic digestion of agricultural biomass.



3. BIOECONOMY IN EVERYDAY LIFE



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 and Omega 3 and 6).



INNOVATIVE PLASTER WITH LOW ENVIRONMENTAL IMPACT

- Support-tape made from bioresin-films; these substances are derived from potato starch (100% bio-compostable).
- Central pad containing no preservatives.
- Innovative adhesive solvent-free and without natural rubber latex.
- Packaging made of recycled cardboard.



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.



PORTABLE ELECTRONIC SYSTEMS FOR OLIVE OIL QUALITY CONTROL

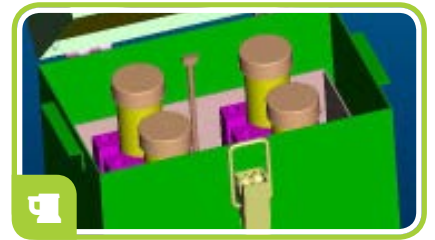
The portable electronic systems allow quick and in-situ analysis of olive oil quality (free acidity and total phenol content).

- 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).



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 allow an efficient control of weeds and the obtaining of equivalent agronomic yields in terms of quantity and quality.

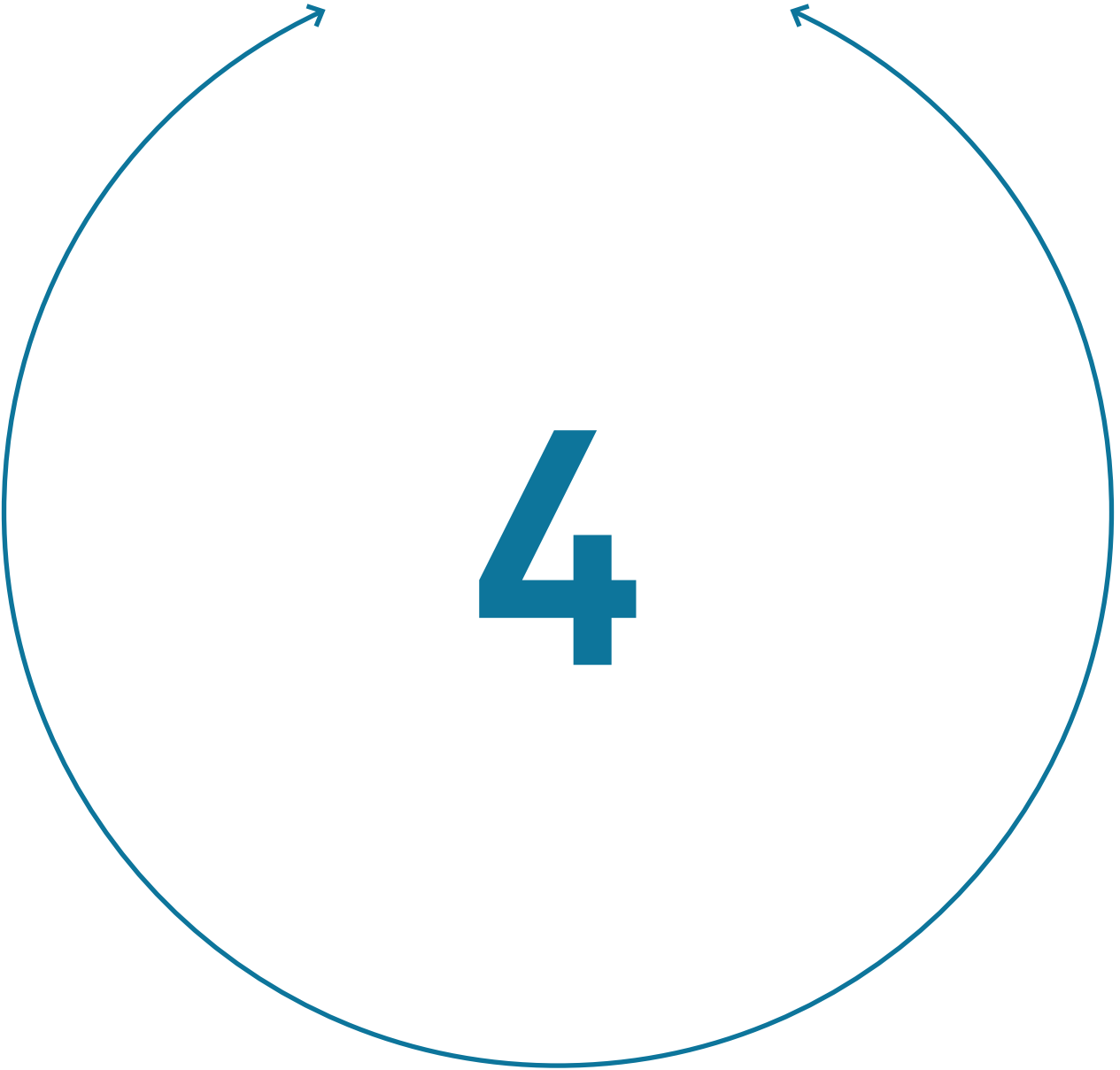


BIOSENSOR FOR BACTERIAL CONCENTRATION MEASUREMENT

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.





4

THE SOCIAL DIMENSION OF THE BIOECONOMY

To meet the bioeconomy challenge 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 does not mean simply integrating biological knowledge into existing technology.

To meet the 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 behaviour. Greater knowledge of what is being consumed - especially food products and processes - would lead to improvements in health conditions and lifestyle, stimulating a demand pull on sustainable innovation by companies. For this reason, it is crucial to further develop ecolabeling.

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

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

The bioeconomy, due to its intrinsic characteristics, has the potential to achieve a more profound integration between 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 the bioeconomy creates new economic value, jobs, relations and collaborations, it should also be clear that the bioeconomy is able to meet social needs and is aimed at improving human well-being, enhancing an individuals' capacity to act.

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





5

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 improve action plans and specific measures for the bioeconomy. In brief, the legislative and funding framework is composed as follows:

5.1 NATIONAL SMART SPECIALISATION STRATEGY

The Italian Bioeconomy Strategy is part of the implementation process of the [National Smart Specialization Strategy \(SNSI\)](#). The Smart Specialisation Strategy aims to identify priorities for investment in research, development and innovation that complement the resources and productive capacity of territories to build comparative advantage and sustainable growth path in the medium and long term. In the programming period 2014-2020, Research and Innovation Strategies for Smart Specialisation [RIS3] are an ex ante conditionality for the use of European Structural and Investment Funds' resources devoted to the thematic objective "strengthening research, technological development and innovation".

The SNSI is implemented through specific initiatives of the National Operational Programmes 2014-2020 for Research and Innovation (NOP R & I) and for Enterprise and

Competitiveness (NOP I & C) and through strategic plans funded by public resources from cohesion policy, national and regional ordinary funds, and private resources.

With reference to the Bioeconomy, two strategic plans have been defined: the Agrifood and Biobased economy, both of which are the pillars of this strategy. They derive from an interactive process of cooperation between the public sector and a private sector defined entrepreneurial discovery process.

The Italian Bioeconomy Strategy lays down the policy framework for these two action plans that are related to the main spheres where the bioeconomy and the biotechnologies have the greatest impact.

5.2 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"¹⁴ defining ambitious targets and a 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 industrial symbiosis, incentivizing other mechanisms to reduce future waste generation under

14 ec.europa.eu

5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

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) for 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 founded on sustainable development based on preserving and protecting marine biodiversity and finding solutions to current problems such as marine litter, pollution from contaminants, and the sustainability of fisheries.

Climate change strategy is a big challenge for the medium and long term future. In the meantime, it requires the transformation of the energy system in order to reduce GHG emissions into the atmosphere by increasing the share of clean and renewable energy, as well as the reduction of 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 Package¹⁵ by 2030, that strengthens the Paris agreement which entered into force in November 2016, as well as the 2050 Low-Carbon Economy¹⁶. With regards to the second pillar (adaptation), in 2013 the EU adopted the

European Adaptation Strategy¹⁷ that, among other objectives, promotes adaptation measures in key vulnerable sectors including green infrastructure and coastal zone management to increase the resilience of urban, rural and coastal areas.

5.3 ITALIAN LEGISLATION

The **Environmental Annex to the Stability Law 2014** «Measures for promoting the green economy and limiting the excessive use of natural resources»¹⁸ defines the important milestones for future Italian environmental strategies. The main focus is on the green economy and the 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.

15 ec.europa.eu

16 ec.europa.eu

17 eur-lex.europa.eu

18 gazzettaufficiale.it



5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

One of the most important aspects of the Environmental Annex is the update to the [Sustainable Development National Strategy](#), built upon the 2030 Agenda for Sustainable Development¹⁹ 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 the 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 reverse land degradation and halt biodiversity loss.

The [Green Public Procurement \(GPP\) National Action Plan \(NAP\)](#)²⁰ document outlines the strategy for the diffusion of GPP in Italy, the commodity categories, the reference environmental targets to be attained -both qualitative and quantitative - and the general methodological aspects.

Based upon the [Code of Public Contracts](#)²¹, the GPP NAP aims to spread and implement nationwide the adoption of sustainable purchases in Italy.

The above mentioned Environmental Annex established, from 2016, the compulsory commitment for the [Italian Public Administration to the Code](#). Italy thus became the first country in the world to adopt such an obligation. The new [Code of Public Contracts](#)²² has further reinforced the statement by defining more specifically the [Environmental Minimum Criteria \(EMC\)](#) for the eligibility of applicants to participate in public tenders. Since 2011, a number of Decrees from the Ministry of Environment, Land and Sea have been issued to define EMC by commodity category.

19 sustainabledevelopment.un.org

20 Approved through Interministerial Decree 11 April 2008 and updated with the Decree 10 April 2013

21 D. Lgs. 12 April 2006, n. 163

22 Decree 18/04/2016, n. 50

5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

With reference to waste, legislative decree 152/2006 sets the same 65% target on municipal waste as the EU within the Circular Economy package. The “[National Program for Waste Reduction](#)”²³ 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 minimizing food waste. Specifically, regarding composting, the recent Decree of Ministries Council Presidency on 7 March 2016²⁴ defines the requirements for the Italian regions in terms of organic waste to be treated through composting.

The updates 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 emission reduction and renewable energy share. In addition, Italy has adopted a “National Adaptation Strategy”²⁵ and is putting into place the “National Adaptation Plan”. The bioeconomy can play a significant 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.

The [National Biodiversity Strategy](#) (NBS), adopted in October 2010, aims to merge and integrate biodiversity conservation targets and the 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 (although in 2014 the EU Regulation 511/2014 “on compliance measures for users of the Nagoya Protocol Arising from their Utilisation in the Union” entered in force at EU level).

The [National Marine Strategy](#) D.lgs n. 190/2010 was enacted to transpose the Marine Strategy Framework Directive at national level and with the aim of achieving the Good Environmental Status for the Italian marine waters within a sustainable development perspective. [DM 17/10/2014](#) specifies the requirements and targets necessary to achieve the GES, whilst the [DM 11/02/2015](#) defines the indicators associated with the GES and regulates the drawing up of the monitoring programs necessary to evaluate it.

5.4 FUNDING PROGRAMMES

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

23 minambiente.it

24 gazzettaufficiale.it

25 minambiente.it

5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

This function should be performed by the Cohesion Policy Funds that make resources available along seven (plus three) year programming periods in thematic objectives and with investment priorities consistent with the bioeconomy development. Cohesion Policy Funds, according to their rules, are therefore allowed 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.

The European Agricultural Fund for Rural Development (EAFRD), for instance, 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 necessary inter-

face for agro-energy and bio-based industries. Regional EARDF programs identify also specific KETs (green biotechnologies and “omics”, precision farming, nanotechnologies) such as drivers for innovation and competitiveness of local systems.

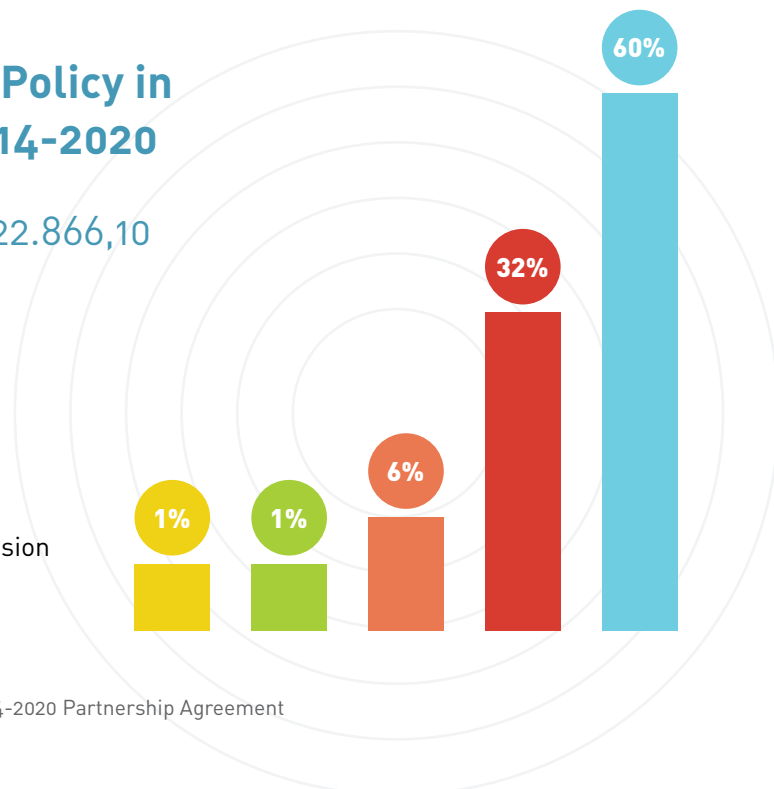
The table below illustrates the funding opportunities opened up by the Cohesion Policy resources for the bioeconomy in Italy. **7**

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](#) – which add

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

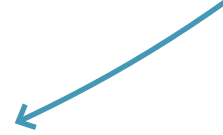
Total resources in million EUR 122.866,10
(EU and National contributions)

- 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



an important funding system (EUR 77.028 billion²⁶). 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 EUR 3.851 billion²⁷, in the period 2014–2020. Some priorities of the Bioeconomy are also supported by the societal challenge 3 and 5 and the NMPB pillar of Horizon 2020. Another part of the Horizon 2020 budget available for bioeconomy is implemented by one of the seven public private partnerships (PPPs) operating under Horizon: the Bio-Based Industries (BBI) Joint Undertaking. It aims to develop new bio-refining technologies to sustainably transform renewable natural resources (waste, agriculture residues) into bio-based products, materials and fuels.

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

At national level, the new Industry 4.0 plan²⁸ provides opportunities for enterprises of the Bioeconomy domain for enhancing research, innovation and compet-

itiveness. 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. The plan provides intense financial support to enterprises through hyper-depreciation and super-depreciation schemes (an increase in the 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 EUR 1 million in start-ups and innovative SMEs, 30% tax deduction for investments up to EUR 1 million 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 (Agrifood²⁹, Green Chemistry³⁰, Smart Factory³¹, Blue Growth and Energy (the latter two both under implementation) are priority areas of intervention in the framework of the National Research Plan.

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

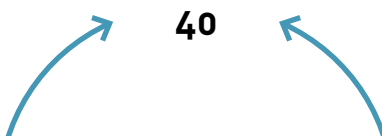
27 See note n. 19

28 sviluppoeconomico.gov.it

29 clusteragrifood.it

30 clusterspring.it

31 fabbricaintelligente.it



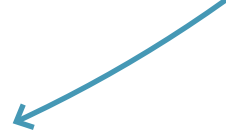
5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

MAJOR EUROPEAN R&I PROJECTS COORDINATED BY ITALY FUNDED IN THE FRAMEWORK OF H2020 (SOCIETAL CHALLENGES 2, 3, 5) IMPORTANT FOR THE BIOECONOMY

PROJECT TITLE	PROJECT ACRONYM	PROJECT SIGNATURE DATE	PARTICIPANT LEGAL NAME	PROJECT INSTRUMENT/ FUNDING SCHEME/TOPIC
Agricolus Decision Support System	Agricolus DSS	15/02/2016	TEAMDEV SRL	SME-1
A resource-efficient granulation process for advanced formulation of any compound in food and pharma production	AGS	17/12/2015	POLIBIOTECH SRL	SME-1
BIOSKOH's Innovation Stepping Stones for a novel European Second Generation BioEconomy	BIOSKOH	22/04/2016	BIOCHEMTEX SPA	BBI-IA-FLAG
BLUEMED	BLUEMED	27/09/2016	CONSIGLIO NAZIONALE DELLE RICERCHE	CSA BG - 13 - 2016
Cost-effective CO2 conversion into chemicals via combination of Capture, EElectrochemical and BI-ochemical CONversion technologies	CELBICON	04/02/2016	POLITECNICO DI TORINO	RIA ISIB-06-2015
COMPostable capSULE for instant coffee delivery based on an innovative chemical functionalization of biobased plastics	COMPSULE	28/10/2015	POINT PLASTIC SRL	SME-1
Valorisation of corn processing by-products into plastic bio-composites	CORNposite	27/02/2016	CORN VALLEY SRL	SME-1

*Data updated Dec 31st, 2016; partial 2016 results

5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES



PROJECT TITLE	PROJECT ACRONYM	PROJECT SIGNATURE DATE	PARTICIPANT LEGAL NAME	PROJECT INSTRUMENT/ FUNDING SCHEME/TOPIC
Optimum, sustainable solution for seed drying and conservation	DryCoolerSeeds	25/11/2015	MARCOLD GROUP	SME-1
Design of an agricultural greenhouse for intensive growing of microalgae in fresh / sea water with a syngas production plant and organic farming of chickens and pigs outdoors.	ECO-LOGIC GREEN FARM	22/07/2015	SOCIETA' AGRICOLA SERENISSIMA S.S.	SME-2
A feasibility study to investigate and verify the commercial and industrial viability of a wastewater processing solution to generate bioplastics from agri-food and municipal wastewater sources.	EggPlant	29/02/2016	EGGPLANT SOCIETA A RESPONSABILITA LIMITATA	SME-1
Food treatment process based on high voltage nanopulsed electric discharges in liquid phase	EMILK	20/08/2015	LASERLAM SRL	SME-1
Effective Management of Pests and Harmful Alien Species - Integrated Solutions	EMPHASIS	19/02/2015	UNIVERSITA DEGLI STUDI DI TORINO	RIA SFS-03a-2014
Flagship demonstration of an integrated biorefinery for dry crops sustainable exploitation towards biobased materials production	FIRST2RUN	10/06/2015	NOVAMONT SPA	BBI-IA-FLAG
Linking genetic resources, genomes and phenotypes of Solanaceous crops	G2P-SOL	05/02/2016	ENEA	RIA SFS-07b-2015

*Data updated Dec 31st, 2016; partial 2016 results

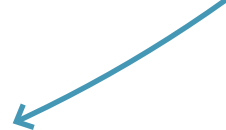


5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

PROJECT TITLE	PROJECT ACRONYM	PROJECT SIGNATURE DATE	PARTICIPANT LEGAL NAME	PROJECT INSTRUMENT/ FUNDING SCHEME/TOPIC
First industrial use of bio and ecocompatible geopolymers produced from metakaolin to manufacture tanks for wine, beer, vinegar and olive oil production and storage via 3D printing technology	GeoFood	21/05/2016	CIBAS DI POLI FABIO & C SAS	SME-1
Drone-based integrated monitoring system for early detection of crop pathology and pest control in high tech greenhouse agriculture.	GIDROM	26/08/2015	ABO DATA SRL	SME-1
Demonstration of solvent and resin production from lignocellulosic biomass via the platform chemical levulinic acid	GreenSolRes	29/07/2016	GFBIOCHEMICALS ITALY SPA	BBI-IA-DEMO
Jellyfish Barge - A floating greenhouse	JFB	20/05/2015	PNAT SRL	SME-1
Mobile wireless Device microcantilever-based biosensor to identify and measure the aflatoxin B1 in animal food and M1 in the milk-chain	MEDIuM	19/11/2015	INFORMATICA SYSTEM S.R.L.	SME-1
A sustainable organic solution to the decline of bees	MICRO4BEE	22/02/2016	MICRO4YOU SRL	SME-1
Integrated and innovative key actions for mycotoxin management in the food and feed chain	MycKey	09/02/2016	CONSIGLIO NAZIONALE DELLE RICERCHE	RIA SFS-13-2015

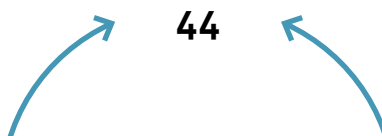
*Data updated Dec 31st, 2016; partial 2016 results

5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES



PROJECT TITLE	PROJECT ACRONYM	PROJECT SIGNATURE DATE	PARTICIPANT LEGAL NAME	PROJECT INSTRUMENT/ FUNDING SCHEME/TOPIC
Vegetable ozone therapy for the defence of greenhouse crops	O3MET	15/09/2015	MET s.r.l.	SME-1
Advanced solutions for ensuring the overall authenticity and quality of olive oil	OLEUM	08/07/2016	ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA	RIA SFS-14a-2014
From plants for plants: enhancing crop potential and resilience through reliable new generation biostimulants	Plants for Plants	04/12/2015	LANDLAB SRL	SME-1
Pest Organisms Threatening Europe	POnTE	29/10/2015	CONSIGLIO NAZIONALE DELLE RICERCHE	RIA SFS-03a-2014
Professional support to the uptake of bioeconomy RD results towards market, further research and policy for a more competitive European bioeconomy	ProBIO	16/02/2015	AZIENDA SPECIALE INNOVHUB - STAZIONI SPERIMENTALI PER L'INDUSTRIA	CSA ISIB-08b-2014
PROViding smart DELivery of public goods by EU agriculture and forestry	PROVIDE	27/05/2015	ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA	RIA ISIB-01-2014
Increasing grain quality through advanced oxidation treatment during storage	QUALIGRAIN	01/10/2014	LA SANFERMESE SpA	SME-1
Fermentation processes for functional foods from RAPeseed, Sunflower and Other EU matrices Devoted to Young animals. Zero-miles model boosting safety and competitiveness of livestock sector	RAPSODY	27/01/2015	METHODO CHEMICALS SRL	SME-1

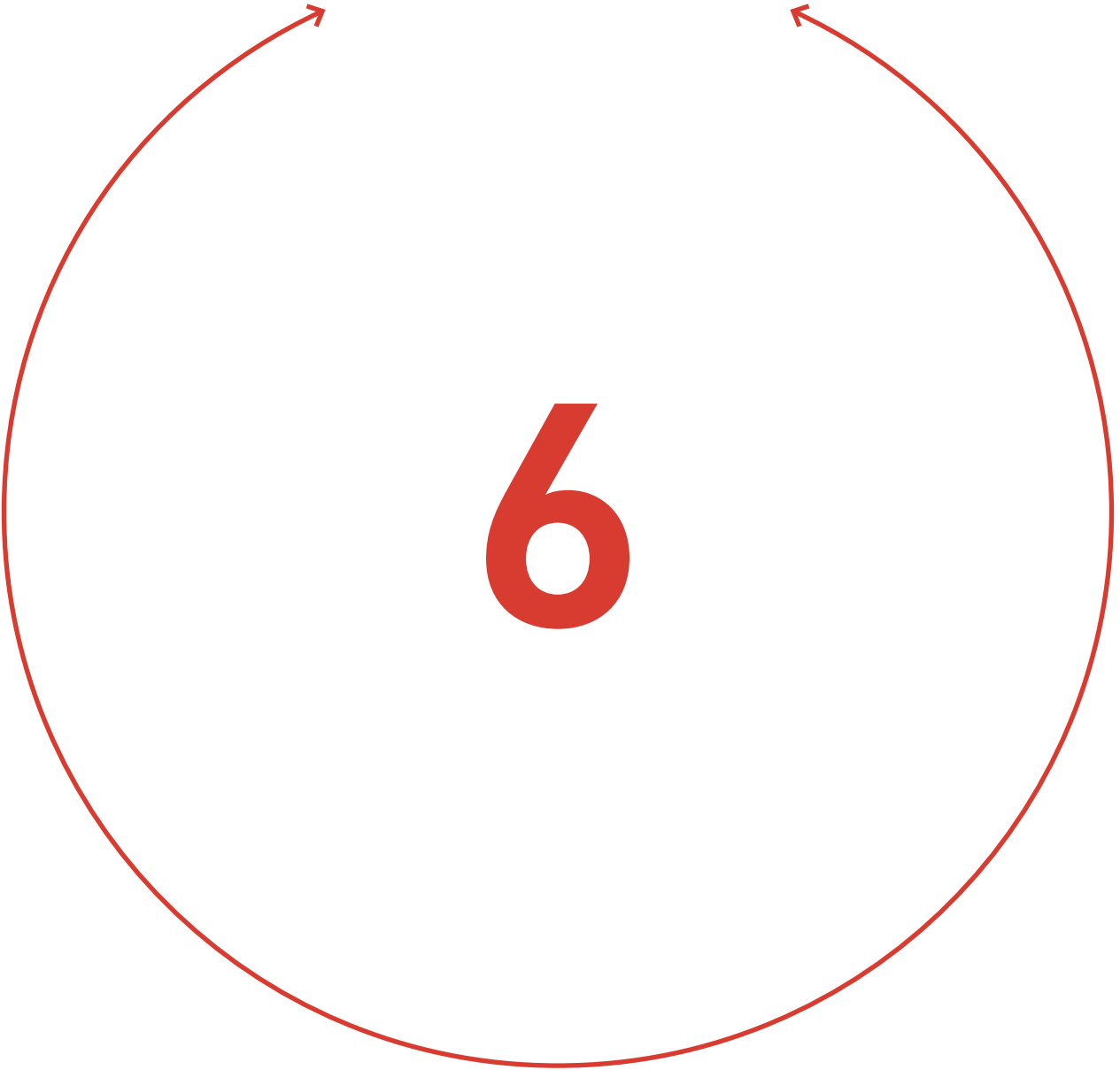
*Data updated Dec 31st, 2016; partial 2016 results



5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

PROJECT TITLE	PROJECT ACRONYM	PROJECT SIGNATURE DATE	PARTICIPANT LEGAL NAME	PROJECT INSTRUMENT/ FUNDING SCHEME/TOPIC
RESources from URban Blo waSte	RES URBIS	01/01/2017	Research Centre for Protection of Environment and Cultural Heritage, UNIVERSITÀ "LA SAPIENZA" DI ROMA	RIA CIRC 05-2016
Innovative oxygen-free wine bottling process	RiCaMo	22/06/2016	ENTER S.R.L.	SME-2
RLTProFood - Remote Lighting Technology for processing and production of food	RLTProFood	02/09/2015	IODA SRL	SME-1
Novel Ozone and Thermal Shock Conservation Process for Vegetables	SCHOCKO3	25/05/2015	FIORDELISI SRL	SME-1
A compact, unmanned, renewables-powered and self-sufficient vessel able to pick up marine litter and to treat it on board for volume reduction and energy recovery	Sea Litter Critters	12/02/2016	IRIS SRL	SME-1
Short supply chain Knowledge and Innovation Network	SKIN	23/09/2016	UNIVERSITA DEGLI STUDI DI FOGGIA	CSA RUR - 10-2016
Scale-up of low-carbon footprint material recovery techniques in existing wastewater treatment plants	SMART-PLANT	01/06/2016	UNIVERSITÀ POLITECNICA DELLE MARCHE	IA WATER 1b-2015
Submersible Tension Leg Fish Cage for Mariculture in Unsheltered and Offshore Areas	SubCage	17/12/2015	REFA MED SRL	SME-1

*Data updated Dec 31st, 2016; partial 2016 results



6

CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

The strategy aims at interconnecting the main bioeconomy sectors, creating longer, more sustainable and locally routed value chains.

As a consequence, it would allow Italy to increase its competitiveness and role in promoting sustainable growth in Europe and in the Mediterranean basin. It promotes the integration of research and innovation needs and opportunities, policy, business, and cultural attitude into a single systemic vision for the bioeconomy which is in line with the development model of the circular economy. A circular economy approach also fosters sectorial integration in a long-term perspective.

Looking at the overall long term objective, the strategy defines some guiding principles and specific targets in the vision; then presents an analysis of problems and opportunities for each sub-sector and, in particular, for the interconnections among them. As a result of this analysis, a research agenda, and some support measures to overcome obstacles are defined.

GENERAL OBJECTIVE

To increase current Italian bioeconomy turnover (currently about EUR 250 billion/y) and jobs (about 1.7 M) by 20% by 2030, while increasing the level of circularity in the economy.



6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

VISION

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

...by interconnecting effectively the main bioeconomy sectors, across sustainable value chains, embracing the production of bioresources (i.e., Agriculture, Livestock, Aquaculture, Forestry, Marine systems) their processing and valorization of final products (i.e. the food and drinks industry, wood, paper, leather, textiles, chemical and pharmaceuticals industries, and the energy sector), by leveraging traditional sectors deeply rooted in the territory, as well as the public and private stakeholders in local communities.

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

...by valorizing the marine and rural biodiversity across new values chains that will implement sustainable and circular production models, but also through the re-conversion of abandoned lands/industrial sites or the identification and exploitation of biowastes, effluents and civil wastewater.

c) TO MOVE *“from economy to sustainable bioeconomy”* ...

...by i) respecting natural harvest cycles and regeneration growth rates, ii) preserving ecosystem services also through compensation measures and the limitation of pollution and waste generation.

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

...via i) a more coherent political commitment towards the bioeconomy, ii) efficient alignment between regional, national and EU policies through coordination of relevant stakeholders via the national technology clusters, iii) investments in targeted programs for R&I education, training, iv) engagement in a public dialogue while increasing social awareness through the professional and efficient communication of the benefits of the bioeconomy, and v) tailored actions for market development.

e) TO PROMOTE THE *“Bioeconomy in the Mediterranean area”*...

...via the implementation of the PRIMA and BLUEMED initiatives (as well as the related macro-regional initiatives on blue growth of the area such as EUSAIR and WEST MED), aiming at a long-term coordination of European and non-EU countries of the area towards R&I activities in the field of bioeconomy. Such trans-national synergies and complementarities provide added value to regional, national and EU investments, while promoting Mediterranean primary production and industry within a perspective of enhanced social cohesion and political stability, a healthier environment and new occupational opportunities.

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

6.1 THE CHALLENGES

✘ PROBLEMS

- Abandonment of forests belonging to national and regional heritage with consequent biodiversity depletion;
- Ecosystem degradation due to climate change;
- Lack of strategies for the management, genetic improvement and valorization of autochthonous forestry production;
- Limited reliability and completeness of existing national statistics on forest resources, including a National Agriculture and Forest Sink register;
- National wood processing industry based on imported raw materials and the production of medium/low level products;
- High risks connected to possible imports of illegally or non-responsibly managed wood;
- Lack of education and training of forest company managers in new business opportunities and management.

✔ OPPORTUNITIES

- Increasing the surface area of forests managed according to independent Sustainable Forest Management schemes;
- Sustainable exploitation of valuable national raw materials according to the existing forest certification schemes, Life Cycle Analysis, etc., for the production of energy as well as added value products within the biorefinery concept and following a “cascade approach”;
- Development and production of high value certified new wood products, wood-based materials, composites and bioenergy from sustainably managed forests;
- Business innovation with local value chains deriving from forest products, like mushrooms, truffles, herbs, cork etc. as a contribution to rural development opportunities;
- Further development of chain of custody certification of forest-based value chains.

Agriculture

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY



✘ PROBLEMS

- High level of product counterfeiting and imitations;
- Weak connection with the primary production sectors;
- Low efficiency of food making chains with high resource consumption and excessive production of by-products/waste (≈15 M T/y);
- Inability to exploit by-products and production residues due to unsuitable terms and conditions set by national legislation;
- Small size and fragmentation of supply value chains.

✔ OPPORTUNITIES

- Valorization of “typical/quality” foods (DOP, IGP, STG, etc.);
- Creation of knowledge, technology and regulations for the production of food and feed ingredients from local fruit, vegetal and meat industry by-products;
- More extensive valorization of food waste with the production of valuable biobased chemicals, materials, energy, feed, fertilizers and compost;
- Promotion of networking among small industries for the development of novel, longer or more robust supply and value chains at regional or multi-regional level;
- Entering new markets created through the new international economic context - also embracing emerging and developing countries.

Food industry

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

✘ PROBLEMS

- Limited profitability of farms due to their small average enterprise size and low revenues (lack of policies to protect farmers' income in the current value chains);
- Abandoning of rural areas characterized by unsatisfactory living conditions and logistics services;
- Price volatility and increasing competition at worldwide level;
- Lack of innovation in agriculture to respond to climate change and alien pests/plants;
- Weak and poorly organized value chains in the face of a highly competitive international landscape;
- Depletion of soil organic matter and water scarcity;
- Soil and watershed pollution;
- Lack of effective communication, education and training of farmers about new business opportunities and innovation management.

✔ OPPORTUNITIES

- Diversification of rural incomes adding value to local production and products/food;
- Increased integration with other economic sectors;
- Discovering, protecting and valorizing the rich local biodiversity and agricultural ecosystem services through empowerment of local communities;
- Integrated land-use planning including abandoned, marginal and contaminated lands;
- Reuse or valorization of agricultural residues for the production of bioproducts, fertilizers and bioenergy;
- Digitalization for increasing productivity and big-data access for improving agronomic techniques;
- Use of adapted local crops/varieties to face climate change and promote low-input cultivations;
- Creation of new markets at global level to support Italian leadership in the sector;
- Setting up Italian bioeconomy business models and products as global benchmarks, as well as references for good practices;
- Increased the attractiveness of the agro-food sector for the new generations, thanks to novel professional and entrepreneurial opportunities within a bioeconomy perspective.

Forest and wood processing

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY



✗ PROBLEMS

- Unsustainable fishing and underexploited marine aquaculture;
- Sea productivity adversely affected by pollution (chemical pollutants, litter, etc.), invasive species and climate changes;
- Increasing import of fish from areas with low environmental regulation and monitoring;
- Lack of solutions to replace the use of fish oil and/or feeds of fish origin to feed farmed marine fish;
- Environmental pressure on coasts stemming from tourism and recreation activities and urbanization.

✓ OPPORTUNITIES

- Boosting environmental safe marine aquaculture (also offshore) and development of novel or more robust local aquaculture supply chains;
- Integrated exploitation of marine biological resources and fishery/aquaculture by-products and waste for producing pharmaceutical, cosmetic and nutraceutical products along with biobased chemicals, materials and fuels;
- Sustainable exploitation of deep sea biosystems and land/sea nexus;
- Promotion, conservation and sustainable valorization of the beauty of marine landscapes
- New business models for connecting tourism to ecosystem valorization.

Marine
bioeconomy

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

✘ PROBLEMS

- Limited and discontinuous availability of low cost sustainable feedstocks;
- Limited market for national biobased products, also due to their higher cost with respect to “traditionally or chemically synthesized” and/or “petrol-based” products;
- Lack of transparency and information on the real social and natural capital costs of the production and use of petrol-based products;
- Spread of products that do not comply to international standards and labeling on biobased and biodegradable products, and insufficient clarity/transparency in the labeling;
- Huge and risky investments needed for research and buildup of industrial flagship investment and infrastructure for the bioeconomy;
- Lack of regulations and specific end-of-waste criteria regarding industrial biowaste (need to enhance the knowledge of contaminants fate and to determine the criteria which have to be fulfilled for waste to be accepted by industry);
- Incentives with potential distorting effects on specific value chains.

✔ OPPORTUNITIES

- Availability of former oil refineries/ industrial sites that can be partially converted into biorefineries;
- Availability of efficient collection systems for organic waste and of large quantities of national biowaste (i.e., Food industry by-products and waste: ≈ 15 M T/y; agriculture residues: ≈ 10 M T/y; livestock effluents: ≈ 150 M T/y; Wastewater sludge: ≈ 3 M T/y; Municipal organic fraction: ≈ 6 M T/y);
- Availability of abandoned/marginal lands for the production of autochthonous or planted industrial biomass;
- Availability of successful case studies on biobased products developed in Italy (i.e. shopping bags) and price premiums for environmental sustainable products (Made green in Italy);
- Availability of prominent national microbial collections and of a large number of very creative and innovative research groups, start-ups, spin-offs working in the sector;
- Availability of a large network of biomethane producing facilities (mainly fed with biowaste) and wastewater purification plants that can be integrated into the system of biorefineries (possibility of enhancing existing and underutilized plants that can be renewed in a circular perspective).

Biobased industry

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY



✘ PROBLEMS

- Weak cooperation among European and non-Member States of the area with a limited integration of knowledge and efforts across sectors and countries;
- Inability of some local societies to provide affordable food, good quality water and to ensure healthy seas also due to adverse climate context, demographic trends and social, political and economic instability;
- Lack of financial resources for cross-border/transnational programmes providing actual sharing/joint exploitation of technologies, feedstocks and value chains.

✔ OPPORTUNITIES

- Availability of a large amount of valuable biomass and of by-products and waste streams from local agriculture, livestock production, forestry and food industry;
- Availability of the international cooperation program PRIMA and the BLUEMED Initiative addressed to improve the sharing and the joint exploitation of knowledge, technologies, capacities, and investments in the agrifood sector and marine bioeconomy to guarantee local food security and safety, employment and economic growth in line with the Migration compact and EU strategy for external action on migration;
- Advocacy for enhancing public understanding of the socio-economic and environmental value of the bioeconomy in the Mediterranean.

Contribution to the Euro-Mediterranean Bioeconomy



6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

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, resource-efficient and environmentally sustainable production processes able to guarantee improved supplies of new, safe and high quality foods and bio-based products and services - including bioenergy, via competitive and low carbon supply chains.

The bioeconomy embraces broad value chains, hence stronger interactions are necessary between public and private stakeholders, different sectors and disciplines from the harvest to the various final products. Furthermore, interconnecting the bioeconomy sectors also means facilitating cooperation among education providers, researchers, innovators, communicators and representatives of consumers in order to create the socio-economic and technological context for the effective implementation of the required cross-cutting interdisciplinary innovation.

The present strategy aims at producing new knowledge, technologies, services, capacity building, but also regulations and public awareness, and more specifically at:

- Increasing circularity in the economy;
- Boosting sustainable and locally routed economic growth by bridging gaps between research and economic sectors, including an emphasis on Small Medium Enterprises (SMEs);

- Supporting the alignment of EU, national, regional policies, regulations and coordination of local stakeholders
- Ensuring that the bioeconomy reconciles technological advances and progress without undermining environment conservation and the resilience of the ecosystems;
- Promoting knowledge-based economic activities and policy making;
- Supporting cross-disciplinary education and training for researchers as well as for technical careers;
- Catalyzing informal learning, tertiary education and technology/knowledge transfer to support the jobs in the wider bioeconomy domain;
- Promoting the Bioeconomy in the Mediterranean area via the implementation of PRIMA and BLUEMED initiatives addressed to improve Mediterranean primary production and bioindustry potential, thus creating new jobs, social cohesion and political stability in the area.

6.3 THE R&I AGENDA

The main R&I needs and opportunities for boosting the Italian Bioeconomy are reported below. The list is based on the results of the interactive process with the stakeholders followed for the preparation of “Agrifood” and “Biobased economy” action plans in the framework of implementation of National Smart Specialization Strategy.

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

PRIORITY

Sustainable agriculture and forestry

a. To boost sustainable and resilient primary production through actions and R&I aimed at:

- Implementing more effective models of agricultural and forestry production, such as climate smart agriculture and forestry, precision farming, ecological intensification, agroecology and regenerative agriculture to improve the productivity and resilience of animals and plants;
- Using biodiversity and modern genetic programs to improve the resilience of animals and plants to biotic and abiotic stresses; Boosting organic farming and livestock;
- Improving water use and management in and by agriculture;
- Exploiting the role of agriculture (including urban and peri-urban agriculture) and forestry in the circular bio-based society, and controlling contaminants.

b. To improve resource management and efficiency through actions and R&I aimed at:

- Developing “low input” agriculture practices in order to reduce water use, watershed and soil pollution;
- Improving strategies (sensor, networks, DSS, etc.) for rational water use in and by agriculture;
- Implementing agricultural, farming and forestry systems to prevent overexploitation of soil;
- Promoting connectivity along the product chain;
- Reducing gas emissions through decreasing the use of fertilizers;
- Increasing photosynthesis and carbon dioxide (CO₂) sequestration;
- Improving the understanding of role microorganisms on crops and exploiting beneficial effects of plant microbiota;
- Valorizing and reusing agricultural and forest residues, also for the production of bioproducts, bioenergy and biofertilizers;
- Exploiting valuable national forest raw material for the production of energy along with high value certified new products, materials and composites derived from wood.



6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

c. To improve multiple functions and benefits of land, rural and abandoned areas through actions and R&I aimed at:

- Boosting the link between the ecological and the socio-economic value of agriculture and forestry systems (e.g. by substantiating authenticity and traceability);
- Innovative use of abandoned and marginal lands also through multi-purpose nature-based solutions, preventing soil erosion and hydrogeological disasters;
- Creation of locally integrated agro and forestry industrial supply chains for a better valuing of product quality and a stronger contribution to rural development.

d. To improve human and social capital and social innovation through R&I/actions aimed at:

- Enhancing the skills, the human and social capital of farmers, foresters and other actors of the rural economy, also through education and digital based technologies;
- Involving young land managers in less favoured Italian regions in the adoption of good practices, thus creating possibilities for expanding farming and supporting knowledge sharing;
- Supporting a generation of entrepreneurs in the agri-food and forest-wood sectors in less favored Italian areas also through educational programs

and the transfer of good practices;

- Preserving and valorizing traditional knowledge for local management practices.

e. To contribute to improving the primary production in the Mediterranean area through R&I/actions, also promoted by the PRIMA initiative, aimed at:

- Preserving and implementing sustainable biodiverse crops and livestock, to offer a broad choice of genotypes addressing the needs of multi-ethnic societies in the Mediterranean basin;
- Developing molecular techniques and markers to facilitate the control and the selection of crop/livestock genotypes, including microbial companion (beneficial microbiomes), suitable for sustainable production in a changing Mediterranean environmental context;
- Designing a consumer-responsive Mediterranean agricultural production system, and raising consumer awareness towards its high standards, to promote consumption of healthy food endowed with intrinsic (e.g., absence of contaminants, improved taste and nutrient content) and extrinsic (sustainability, welfare, ethics, culture) quality attributes;
- Providing integrated pest management solutions, aided by novel control tools, to prevent diseases impacting on crops and livestock in the context of the Mediterranean climate change.

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

PRIORITY

A sustainable and competitive agri-food sector for a safe and healthy diet

a. To improve healthy diets and people's health through actions and R&I aimed at:

- Evaluating, educating and exploiting national consumer preferences, attitudes, needs, behaviour, lifestyle and education, and communication;
- Tackling obesity through food formulations/substitutions, changes in retail and catering practices, and changes in consumer behavior;
- Developing 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. metabolite tailored) nutrition solutions and health care;
- Further exploiting 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 promoting methods to defend their authenticity and traceability;
- Preventing, detecting and remediating biotic and abiotic contamination of food/feed products;

- Improving cultivation processes for the proxy personalized nutrition and increasing the nutritional quality of agri-foods;

- Exploiting alternative food sources (insects, algae etc.) and novel food microbes.

b. To improve food safety, security, defense, and integrity through actions and R&I aimed at:

- Developing rapid at-line or on-line detection tools for food and feed safety (vs pathogens, allergens, toxins, chemicals, nanomaterials, etc.) and integrating such tools in risk analysis protocols;
- Establishing the vulnerability of food and feed to fraud, counterfeiting or intentional contamination or adulteration in order to develop risk prevention, protection, and mitigation strategies for food business operators;
- Developing innovative packaging and smarter supply chains to support efficient delivery to consumers and prolonged shelf—life, reducing waste production;
- Developing tools (ICT, devices, apps etc.) for smart food utilization and domestic food management.



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c. To boost sustainable, competitive, and innovative food manufacture through actions and R&I aimed at:

- Improving the efficiency of the food making value chains (i.e., lowering raw material losses, by-products and waste production, and water and energy consumption and improving food preservation, distribution and logistics), by integrating them with Industry 4.0 tools and key enabling technologies solutions;
- Creating knowledge, technology and regulations for the production of food and feed ingredients from local fruit, vegetal and meet industry by- and co-products;
- Integrated exploitation of food (processing) waste with the production of added value bioactive products, biochemicals, biomaterials (packaging) and biofuels.

d. To boost food policies, supply chains, markets, and communities through R&I/actions aimed at:

- Promoting short local food chains for health and contrast non-market based networks of food provisioning;
- Developing food products and promoting ethno food marketing, taking account of migration and changing demographics in the country;
- Developing innovation support systems and net-

works for food SMEs, especially micro-SMEs and traditional food producers;

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

e. To contribute to improving food production and safety in the Mediterranean basin through R&I/actions, also promoted by PRIMA, addressed at:

- Adopting sustainable technologies to valorize low cost by-products of the Mediterranean agroindustry, with evidence based proved safety, as new ingredients for affordable tasty food with functional properties;
- Generating innovative food-grade nano-biotechnologies to preserve stability and improve bioavailability of bioactive molecules extracted by Mediterranean species and incorporated in functional food;
- Providing eco-innovations for efficiency and the valorization of side-products in Mediterranean agro-food value chains, by integrating different production systems, sharing infrastructures and logistic solutions, in order to maximize yields and reduce wastes;
- Designing innovative business models for quality and sustainability, at territorial level, involving food producers, services and tourism industry focused on the valorization of the Mediterranean culture.

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PRIORITY

Bio-based industries

a. To boost production of biobased products and biofuels in the framework of a circular economy through actions and R&I aimed at:

- Mapping the biomass supply - including novel and alternative feedstocks (biowaste, CO₂, marine biological resources) building on existing knowledge, approaches and tools;
- Boosting the valorization of organic waste and effluent organic matter to obtain high added value bioproducts;
- Exploring new, innovative, energy saving logistics and preservation/stabilization strategies for different types of biomasses/biowaste;
- Improving flexibility in terms of feedstock and products produced by bio and chemical processing integration, and downstream processing, of the current biorefining processes and schemes, schemes (including existing biomethane producing facilities);
- Using 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;

- Fostering 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;

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

b. To foster "Demonstration plants/test beds for cascading use of biomasses" through R&I and actions aimed at:

- Creating an optimal network of laboratories, microbial collections, etc. 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;
- Facilitating Spin-off/Start-up policies, Partners Integration, IPR policies and the access to Pilot plants and Demonstrators;
- Facilitating the use/conversion of former oil refiner-

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ies/industrial sites but also biogas/wastewater facilities for the implementation of novel biorefineries.

biorefineries (numbers and types) available in the whole Mediterranean basin;

c. To contribute to boosting a Mediterranean biobased Industry through R&I/actions aimed at:

○ Mapping: A - local biodiversity and biomass (types and volumes, including biowaste); B - logistics and biomass preservation/stabilization facilities; C -

○ Promoting cooperation between laboratories, infrastructures, biorefineries and key private and public stakeholders of the EU MS and non-EU countries of the area;

○ Promoting local education, training, information and communication in the biobased sector and on its potential in the area.

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY

PRIORITY

Aquatic living resources and marine and maritime bioeconomy

a. Boosting sustainable exploiting of marine resources through actions and R&I aimed at:

- Promoting the production and processing of seaweed, jellyfish and phytoplankton as possible sources of human edible proteins, fine chemicals, energy, bio-based materials, methane low ruminant feed stocks;
- Exploiting sustainably the large micro and meso plankton stocks for producing high value substances (e.g. pharmaceutical, cosmetic, nutraceuticals, etc.) and biobased products as well as enzymes for technological applications;
- Improving the resilience, ecological compatibility, robustness of the main aquatic production species using smart breeding programs based on genomics and precision phenotyping;
- Increasing the sustainability of fishery and marine aquaculture also including ethical and ecological aspects;
- Fostering fisheries as a recreational activity within an ecotourism approach also by strengthening

interactions with commercial fishery activity in remote coastal and rural areas;

- Exploiting marine biomass as well as by-products and waste deriving from fishery and aquaculture value chains within an integrated biorefinery scheme (e.g. for producing pharmaceutical, cosmetic and nutraceuticals);
- Exploiting the deep sea biosystems sustainably;
- Implementing new bioeconomy business models at the land/sea interface;
- Implementing multiple purpose offshore production sites, integrating bioresources and energy production into a “building with nature” approach.

b. To protect and valorize marine environment through R&I/actions aimed at:

- Promoting biomonitoring and bioremediation of existing plastics and microplastics, contaminated sediment systems, mitigation of new pollutants and development of marine degradable bio-based plastics to limit/prevent marine litter and pollution;

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY



- Analysing marine ecosystem resilience and regime shifts in relation to climate change and other natural or anthropic pressures, and develop mitigation strategies;
 - Promotion, conservation and sustainable valorization of the beauty of the marine landscapes;
 - Promotion and sustainable blue renewable energy production.
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- c. To contribute to boosting a MED marine bioeconomy through the BLUEMED R&I/actions aimed at:**
-
- Promoting an integrated, multi-disciplinary knowledge for better assessments and forecasts of the Mediterranean Sea ecosystem and biodiversity, and deeper understanding of its vulnerability, resilience and risks, as well as of the strategies for its preservation and sustainable valorization;
 - Turning the Mediterranean biodiversity into bio-based products for industry;
 - Pursuing the ecosystem based management of fisheries in a multispecies context impacted by climate change, to implement the Common Fisheries Policy also by means of a Geographic Information Systems-fishery system;
 - Supporting the innovation perspective in aquaculture identifying key species for farming, management strategies for platforms, feed design, diseases;
 - Addressing environmental fate and distribution of emerging pollutants to implement appropriate remediation actions;
 - Exploiting the bioeconomy potential of the land/sea interface and of the multiple purpose offshore production sites, integrating bioresources and renewable energy production.

6. CHALLENGES AND ACTION PLAN FOR THE ITALIAN BIOECONOMY



6.4 SUPPORT MEASURES

In order to unlock the innovation potential of the Italian Bioeconomy, it is fundamental that the above R&I Agenda is flanked by accompanying measures aimed at creating the framework conditions to boost it by creating competitiveness and productivity, alongside initiatives to increase corporate social responsibility and social awareness on the role of bioeconomy in a changing climate and ecosystem. Such accompanying measures will be adopted and implemented together with the R&I actions listed above. They are aimed at:

1. Ensuring strong coordination among the ministries, other public administrations, industries and firms and national technological clusters of the bioeconomy domain, in order to define a proper and coherent legislative framework, and minimize duplication and fragmentation. A permanent working group on bioeconomy composed of representatives of such organizations will be established with the task of:
 - a. monitoring the implementation of the bioeconomy strategy;
 - b. proposing new measures and actions to improve the bioeconomy system - also evaluating the social and environmental impact of subsidies on non-renewable resources;
 - c. implementing and coordinating international initiatives to boost the bioeconomy in the Mediterranean basin;
 - d. guaranteeing 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.
2. Exploring demand-side innovation policy tools such as standardization, to implement strict targets for the separate collection of organic waste, labelling, and public procurement. A life cycle thinking and ecodesign approach should steer the transition, in order to find the right balance between fossil based products (that give an important contribution in the 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 consumers to increase their awareness of 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 for bio-based products;



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4. Creating, through a cooperation with the stakeholders, a bioeconomy marketplace in order to match the demand and supply of biomass, technology, and 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. Revising academic and advanced-education programs in the context of new economic and productive scenarios while creating initiatives for the education and professional training of new bioeconomy specialists, through programmes for technical schools, academic courses and programmes, and executive masters on bioeconomy - also in partnership with private actors and industrial players;
6. Valorizing sustainable urban biowaste production by ensuring that separately collected urban biowaste is used for compost and/or anaerobic digestion, as well as valorizing biological wastewaters for the realization of high added-value products. Such measures would minimize the environmental impact (GHG emissions, local pollutants and discharge in water and land receptors) of waste management and allow a lowering in the costs of environmental services for citizens and for local administrations;
7. Involving local administrations in defining strategies to create organic waste and effluent organic matter value chains by promoting the adoption of integrated treatment processes that combine purification and valorization;
8. Promoting consumer empowerment through professional and pertinent information and communication of the impact and benefits of the bioeconomy;
9. Supporting corporate social responsibility by 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, and promoting voluntary labelling or other certificate schemes which are 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. The bioeconomy involves a wide number of different products, commodities, intermediate goods and technologies and it is an economy in evolution.

A great part of its future development will emerge from the convergence and transformation of markets and industries and from the creation of new markets, phenomena for which statistical data and indicators are currently unavailable. In addition to this, there is still a high rate of uncertainty on the constituents of the bioeconomy value chain.

However, it is possible to try to relate the overall objective to a tentative set of **EU key performance indicators (KPI)**³² to monitor the bioeconomy developments on the supply and demand side. These indicators refer to Eurostat and national data and allow for the implementation of benchmarking analysis once they become common indicators. **8**

Indicators have 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 the bioeconomy** in order to improve the social dialogue on these issues. They also refer to **EU initiatives**³³ for evaluating and monitoring the **EU bioeconomy**. **10**

32 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.

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



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	SUSTAINABLE 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 sustainably	Environmental/Social	Change in freshwater availability, Level of water pollution, Change in land use intensity, 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. The entities involved in its implementation are the:

- i) Ministry for Economic 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) Committee of Italian Regions
- vi) vi) Agency for territorial cohesion
- vii) Italian Technology Clusters for Green Chemistry Agri-Food and Bluegrowth

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

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

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