#127

DossierTècnic

Innovation and knowledge transfer

March 2024

Towards a circular bioeconomy in Catalonia

Generalitat de Catalunya

Rural Cat

David Mascort Subiranas
Regional Minister for Climate Action, Food and Rural Agenda

The bioeconomy is a circular and sustainable economic model based on the use of renewable and local biological resources to produce goods and services in all economic sectors. It is based on the maintenance of functional and healthy ecosystems and on a redefinition of the prevailing linear economy. The bioeconomy also makes it possible to address challenges related to sustainability, such as climate change, rural depopulation or the loss of biodiversity.

From the Government, we perceive the transition towards the bioeconomy as a great opportunity for the present and the future in the economic, social and environmental fields, especially for the sectors involved, and also to promote territorial development.

In this context, in 2021 we approved the Bioeconomy Strategy of Catalonia 2030 (EBC2030), to promote the sustainable development of the Catalan economy by promoting the production of biological resources and local and renewable processes.

The EBC2030 establishes a planning framework with a shared vision linked to the territory and aligned with European and country policies. The first 2022-2024 Action Plan identifies actions in four priority value chains: i) the use of forest resources; ii) resilient agroforestry landscapes and the sustainable provision of ecosystem services; iii) the valorisation of livestock manure and organic waste; and iv) the valorisation of by-products of the food chain.

Giving value and sustainability to agricultural, livestock and forestry production and fostering landscapes that are more resilient to socio-economic and environmental changes are two major challenges that lie ahead. The bioeconomy sector already has a significant weight in Catalonia. We therefore have the necessary economic fabric to carry out the transformation that must be able to emphasise our natural resources in a sustainable way. At the same time, it is necessary to ensure that the transition is fair and generates well-being and prosperity in the rural territories, which are the managers of a large part of the resources.

This change involves collaboration and complicity between public administration, academia, companies and civil society based on a shared vision. This is precisely the objective of the bioeconomy hub of Catalonia (BioHub CAT), an instrument that is to be established in 2023 within the territory, as a one-stop shop for promoting the bioeconomy in Catalonia.

The fact that the bioeconomy has multisectoral impacts that affect different areas and actors requires systemic approaches and new forms of governance that allow public policies to be linked with the challenges and needs of the territory in a more participatory, flexible and dynamic way, as well as ensuring that they encourage experimentation and learning.

In this whole process, citizens play a key role, with a change in life and consumption models, and making the demand that the other agents put the actions into practice. We must all take part in the transformation and we need to find the right formulas so that the projects that are developed in the territory have sufficient social consensus.

Finally, I would also like to highlight the BIT (Bioeconomy, Innovation and Technology) Congress, the showcase of the bioeconomy in Catalonia that has been consolidating itself as a meeting place, learning, exchange and positioning of the bioeconomy in Catalonia and that, like this edition of *Dossier Tècnic*, aims to contribute to the transition towards a bioeconomy.

Dossier Tècnic. No. 127
Towards a circular bioeconomy in Catalonia:
March 2024.

Publisher
General Directorate of Agri-Food Companies, Quality and Gastronomy.

Coordination and Production
Maria Josep de Ribot Porta, Imma Malet Prat, Annabel Teixidó Martínez and Míriam González Domínguez.

Language Correction and Advice
Lluís Piqueres Pla and Susanna Saval Costa

Graphics and Layout
Carlos Guzmán Lorente.

Printed by
EADOP

Legal deposit
B-16786-05.
ISSN: 1699-5465.

Department of Climate Action, Food and Rural Agenda.
Gran Via de les Corts Catalanes, 612-614, 08007 Barcelona (Spain)

More resources, links and electronic version:
https://ruralcat.gencat.cat
https://agricultura.gencat.cat/
e-mail: sia.daam@gencat.cat

Cover:
Author: Carlos Guzmán Lorente.

THE BIOECONOMY STRATEGY of Catalonia 2030

Examples of bioeconomy. Photo: Shutterstock image bank.

01. Introduction

The evidence that the prevailing model of globalised production and consumption causes negative impacts is numerous. From the climate crisis and its consequences in the form of drought, extreme weather episodes and large forest fires, to social or territorial economic inequalities, for example.

It is necessary to rethink and redesign this model recognising the need to have regenerated and healthy ecosystems and redefining economic activities to reduce the consumption of resources and to replace those that are fossil and non-renewable with new sources also based on the use of biologically-based resources and organic waste.

The bioeconomy aims to contribute to this transformation. It is conceived as a circular and sustainable economic model based on the use of renewable and local biological resources to produce goods and services in all economic sectors. It entails a change in the type of resources used, in their origin and the distances they travel. It involves taking into account the associated negative impacts and preventing them.

The bioeconomy covers all those areas based on renewable resources. It therefore includes agriculture, livestock, fishing and the food industry, forestry activity, bio-based products used in sectors such as textiles, chemicals, pharmaceuticals or paper, the management and treatment of livestock manure and organic waste and the energy utilisation of biomass.

In Catalonia, the economic contribution of the productive sectors that are related to it involved, on average, in the period 2016-2021 a production of €67,362.4 million (15.2% of the total) and 612,500 jobs (17.0% of the total).

02. EBC2030

The Bioeconomy Strategy of Catalonia 2021-2030 (EBC2030), approved in September 2021 (Government Agreement GOV/141/2021), is the roadmap of the Generalitat de Catalunya for the transition towards a sustainable bioeconomy and circular. Its drafting was promoted by the Department of Climate Action, Food and Rural Agenda, a body that integrates most of the policies closely linked to the bioeconomy. The different units of the Department participated in its design and are involved in its daily implementation. The Forestry Science and Technology Centre of Catalonia (CTFC) and the Food Research and Technology Institute (IRTA) were also involved in the preparation, collecting their specific scientific and technical knowledge.

Bioeconomy Strategy of Catalonia 2030. Source: DACC.

The EBC2030 is a strategy focused on the areas and activities of the bioeconomy that are less developed in Catalonia and that, therefore, need more institutional support through the implementation of specific measures.

The EBC2030 follows the guidelines of the European Bioeconomy Strategy, approved in 2012 and updated in 2018, which considers it essential to deploy local and regional strategies in the short term in order to take advantage of the potential to generate economic activity of the circular bioeconomy sector. It also takes into account the European Green Pact of the European Union and the Sustainable Development Goals of the United Nations.

It is a strategy focused on the areas and activities of the bioeconomy that are less developed in Catalonia and that, therefore, need more institutional support through the implementation of specific measures. It is complemented and coordinated with other strategic instruments of the Government. Among them, stand out the Strategic Food Plan of Catalonia 2021-2026 and the Maritime Strategy of Catalonia 2030, which deploy the lines of action associated with food, and the Circular Economy Roadmap of Catalonia 2030, which promotes the circularity of the entire production fabric.

The Bioeconomy Strategy aims to contribute to:

- Decarbonise the Catalan economy and make it more sustainable, circular, inclusive and resilient.
- Make use of renewable and local biological resources.
- Reduce dependence on external resources.
- Create new business opportunities, especially in the primary sector.
- Make use of the co-products and by-products of the food chain.
- Develop the rural world and promote territorial balance.
- Improve soil quality through agronomic practices that allow us to add more carbon.
- Promote the creation of landscapes that are more resilient to socio-economic and environmental changes.

The complexity of both the challenges and the type and number of agents involved or the formulation of actions make governance a key piece in the implementation of EBC2030. It is necessary to put into practice new more participatory and flexible models and methodologies that take into account the different administrations, but also the business sectors, research bodies and universities and civil society, throughout the territory, to define shared agendas and achieve weaving partnerships to build effective solutions.

03. Principles of EBC2030

The formulation of the EBC2030 starts from a series of principles that are taken into account in a transversal way in its deployment, among which stand out: contribute to curbing the loss of biodiversity and mitigation and adaptation to climate change, promote the link between the urban world and the primary sector, and develop those territorial areas with less economic activity:

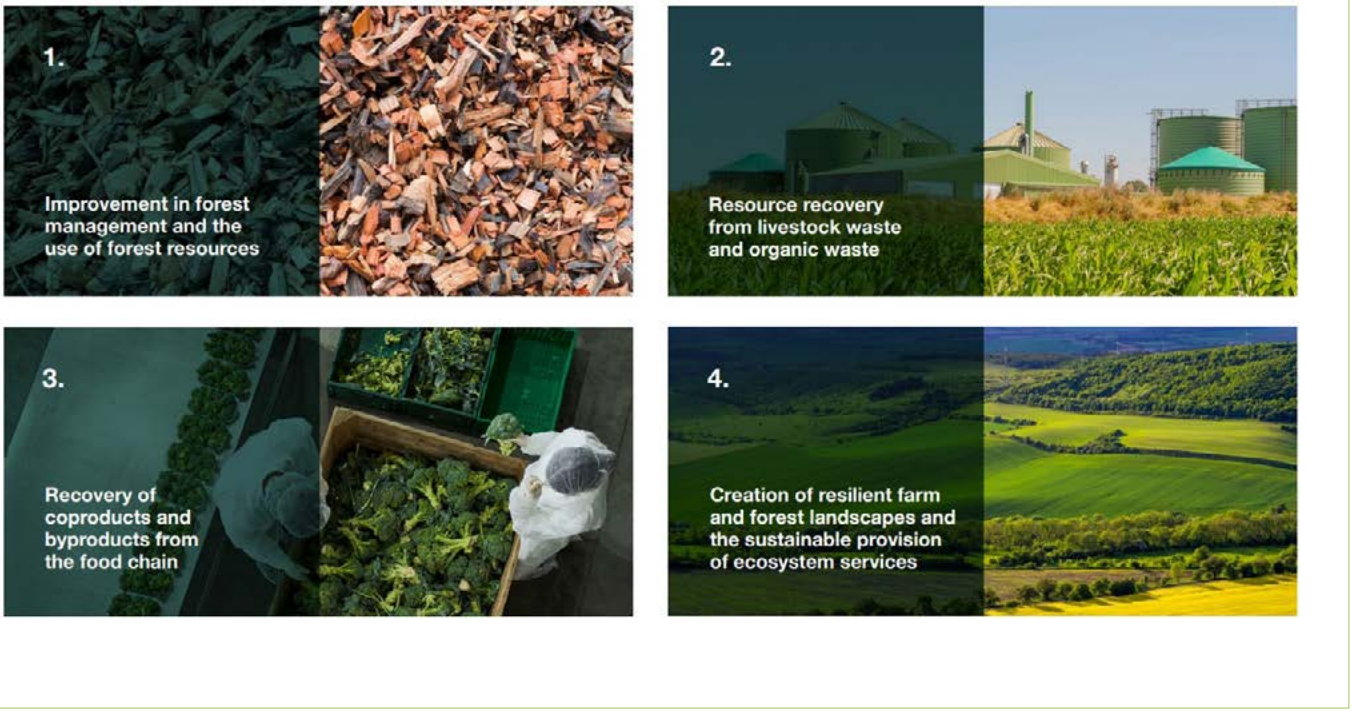
- Integrate and complement existing policies and strategies.
- Guarantee food security and sovereignty.
- Contribute to climate change mitigation and adaptation.
- Guarantee circularity and sustainability.
- Develop those territorial areas with less economic activity.
- Ensure the participation of all the agents involved.
- Contribute to slowing down the loss of biodiversity and to conserving natural heritage.
- Promote the efficient use of natural resources.
- Include the One Health paradigm.
- Promote the consolidation and incorporation of women.
- Strengthen the leadership of the Catalan agri-food sector and its international projection.
- Promote the link between the urban world and the primary sector.

04. Objectives

The mission of the EBC2030 is to promote the transition towards an economic model based on the optimal use of renewable and local biological resources to create products with more added value, while improving the competitiveness and sustainability of the sectors involved and, especially, of those less developed value chains by creating quality jobs and promoting the generation of knowledge as a driver of change, with special attention to the primary sector. The EBC2030 establishes 37 measures structured into seven strategic objectives:

1. Improve the use of Catalonia's biomass through characterisation, quantification, optimisation of management and distribution.
2. Develop a business fabric based on the circular bioeconomy throughout the territory, paying special attention to the primary sector.
3. Promote the use and consumption of bioproducts, bioenergy and biomaterials in the market.
4. Promote resilient agroforestry landscapes and the sustainable provision of ecosystem services in the context of the Catalan circular bioeconomy.
5. Position knowledge as a driver of the circular bioeconomy.
6. Strengthen the role of the Administration and adapt the regulatory and legal framework in a way that favours the circular bioeconomy in Catalonia.
7. Prepare Catalan society for the change towards the circular bioeconomy.

Objectives of the EBC2030. Source: DACC.



Value chains of the 2022-2024 Action Plan Source: DACC.

05. 2022-2024 Action Plan

In order to achieve the objectives of the EBC2030, and in line with the starting principles, the intention of this Strategy is to carry out a series of transformative actions that allow progress to be made on the circular bioeconomy in Catalonia. These are detailed in three-year action plans and are complementary to other actions promoted by the agents involved in the bioeconomy.

Thus, the first 2022-2024 Action Plan prioritises four value chains with need and potential for deployment in Catalonia and defines 15 transformative actions. Different departments of the Generalitat de Catalunya and different units of the Department of Climate Action, Food and Rural Agenda are responsible for its implementation, with an assigned schedule and budget.

The four value chains developed by the 2022-2024 Action Plan are put into practice through 15 transformative actions that have a total budget of more than of €200 million.

05.01 Value chains

The four value chains developed by the 2022-2024 Action Plan are:

1. Improvement of forest management and the utilisation of forest resources.
2. Creation of resilient agroforestry landscapes and the sustainable provision of ecosystem services.
3. Valorisation of livestock manure and other organic waste.
4. Valorisation of co-products and by-products of the food chain.

05.02 Transformative actions

The 15 transformative actions included in the 2022-2024 Action Plan have a total budget of more than €200 million.

They collect activities that must allow the identification and characterisation of the biological resources available in Catalonia and facilitate access and management to take advantage of these resources. They plan to accompany the business system towards the bioeconomy by leveraging current and future knowledge and infrastructure and generating new business opportunities reinforced by appropriate professional profiles. They emphasise the streamlining of administrative procedures and targeting funding sources for the development of the bioeconomy. They want to promote the consumption of bioproducts, biomaterials and bioenergy. One of the areas for the substitution of fossil-based products is fertilisation, where the Plan's actions aim to strengthen organic fertilisation and improve soil quality. Finally, they promote the creation of resilient agroforestry landscapes and the sustainable provision of ecosystem services.

Code	Transformative actions	Value chain	Goal
TA 1	Bioeconomy Observatory	Cross-cutting	O1. Biomass utilisation
TA 2	Circular bioeconomy hub	Cross-cutting	O2. Business fabric
TA 3	Public purchase	Cross-cutting	O3. Consumption of bioproducts, bioenergy and biomaterials
TA 4	Citizen awareness-raising	Cross-cutting	O3. Consumption of bioproducts, bioenergy and biomaterials O7. Prepare society for change
TA 5	Circular Bioeconomy Research and Innovation Platform	Cross-cutting	O5. Knowledge as a driver
TA 6	New professional profiles and continuous training	Cross-cutting	O5. Knowledge as a driver
TA 7	Office of the Circular Bioeconomy	Cross-cutting	O6. Role of the Administration
TA 8	Circular Bioeconomy Co-Management Table	Cross-cutting	O7. Prepare society for change
TA 9	Energy utilisation of local biomass	Forestry, manure, food	O1. Biomass utilisation
TA 10	Access and management of biomass	Forestry, manure, food	O1. Biomass utilisation
TA 11	New business models based on the circular bioeconomy	Forestry, manure, food	O2. Business fabric
TA 12	Network of pre-industrial escalation plants	Forestry, manure, food	O5. Knowledge as a driver
TA 13	Organic-based fertilisation and improvement of soil quality	Manure, resilient landscapes	O4. Resilient landscapes and ecosystem services
TA 14	Pilot projects for the creation of resilient agroforestry landscapes	Resilient landscapes	O4. Resilient landscapes and ecosystem services
TA 15	Assessment of ecosystem services	Resilient landscapes	O4. Resilient landscapes and ecosystem services

Transformative actions of the 2022-2024 Action Plan. Source: own work.

To find out more

Bioeconomy Strategy of Catalonia 2030 https://ruralcat.gencat.cat/documents/20181/9735710/PA_EBC_CA_v4.pdf/d8bbfd1a-e857-4861-bf1f-a1b-7da11bb01

Action plan 2022-2024 of the Bioeconomy Strategy of Catalonia 2030 https://ruralcat.gencat.cat/documents/20181/9479472/EBC2030_EN.pdf/51d819d9-b139-4fb9-b297-278344bf72ea

European Commission Bioeconomy Strategy https://research-and-innovation.ec.europa.eu/research-area/environment/bioeconomy/bioeconomy-strategy_en

Authors

Míriam González Domínguez
Technical Office. DACC.
mgonzalezd@gencat.cat

Clara Solé Carbonell
Technical Office. DACC.
csolec@gencat.cat

IMPROVEMENT OF FOREST MANAGEMENT and the utilisation of forest resources of Catalonia

01. Current situation

Catalonia has 2,074,390 hectares of forest area (including forests, grasslands, thickets and wastelands, among others), which represents 65% of the total area. Of these hectares, 64% are forests (1.3 Mha). The average growth of these forests, obtained by comparing the third and fourth National Forest Inventory (IFN), is 2.24 m^3/ha·year for conifers and 1.74 m^3/ha·year for the plans. This growth represents 3.7 Mm^3/year in total. Of all this growth, only a third is used, which translates into an average utilisation of wood and firewood of around 1 Mm^3/year during the last 10 years.

In addition, the forest property in Catalonia is mostly private. Specifically, 75% is privately owned (1.56 Mha), while the remaining 25% is publicly owned (0.51 Mha). Additionally, not all Catalan forests have forest management plans, as only 39% of the public area (201,191 ha) and 30% of the private area (461,812 ha) are organised.

> The forestry sector in Catalonia is currently in a watershed and is heading towards a horizon where sustainability and the principles of the bioeconomy and the circular economy will be essential.

The forestry sector in Catalonia is currently in a moment of change, derived from the global situation itself and the need to adapt to a changing environment which at the same time is heading towards a horizon where sustainability and the principles of the bioeconomy and the circular economy will be essential. Forest management is also necessary to achieve some of the Sustainable Development Goals of the United Nations.

01.01 Valorisation of the forestry chain

Currently, the valorisation of the forestry chain has three main product lines (Table 1): wood for industry, chips and firewood. The last two are intended for the generation of bioenergy (190,270 m^3

Lines of work in the forest	Industrial destination	Roundwood (m^3)		Manufactured product (m^3)	By-products (m^3)			Total forest by-products (m^3)
		Import	Catalan		Woodchips	Sawdust	Bark	
Industry	Sawmills	133,838	454,993	214,335	190,192	95,980	88,325	374,497
	CLT	-	6,531	2,377	2,110	1,065	980	4,154
	Poles, lathed pieces, perches and stakes	27,454	99,271	81,104	20,276	7,604	17,742	45,621
	Shredding (export)	-	74,453	74,453	-	-	-	-
Chips for energy			190,270					190,270
Firewood			289,701					289,701
Total roundwood (m^3)		161,292	1,115,219		Total forest by-products (m^3)			904,243

Table 1. *Production within the forest chain in Catalonia (year 2022). Source: Forest utilisation statistics from the DACC and the IDESCAT Industrial Product Survey. To make the figures of the source data comparable, they are unified and simplified to m^3 counting densities 1t/m^3.*

and 289,701 m^3 respectively in 2022). Regarding wood for industry, the four destinations in Catalonia are: sawmills, the production of cross-laminated timber (CLT), the production of poles, perches and stakes, and shredding for export. Table 1 also specifies the origin of the roundwood used in the industry and distinguishes between imported (133,838 m^3) and that produced in the country (454,993 m^3), and also shows the final result of the industrial transformation, whether it is a finished product or the different types of by-products (chips, sawdust and bark).

As can be seen, 1 Mm^3/year of wood is extracted from Catalan forests, of which 57% enters the primary processing industry (mainly sawmills), 26% is used for firewood and the remaining 17% is turned into woodchips for energy uses.

In terms of industrial production, the largest proportion (41% of the total cut in Catalonia) goes to the production of sawn wood and to the secondary processing industry, mainly containers and packaging. In any case, the production of poles, lathed pieces, perches and stakes is also significant (9%), as well as the shredded wood that is exported for the production of paper and boards (7%). On the other hand, the manufacture of CLT currently only absorbs a discreet 0.6% of Catalan wood production, despite its great advantages as a construction material.

Regarding the by-products of wood processing, there are three types: chips, sawdust and bark, of which a total of 424,271 m^3 are generated that end up on the market as pellets, cattle litter, etc. This amount, added to the chips and wood for bioenergy, makes a total of 904,243 m^3 of forest by-products generated in Catalonia.

01.02 Non-carpentry products

Among the non-timber forest products, the most relevant in Catalonia are mushrooms, with production that varies greatly depending on the year. As an average, the production for the period 2018-2022 was 66.3 kg/ha. In terms of commercial production, 2,790 tonnes were traded in 2022, although the annual average for the 2018-2022 period was significantly higher, at 4,270 tonnes. It should be borne in mind that 2018 was a year of great mushroom production, with 10,710 tonnes.

The forestry chain has three main product lines: wood for industry, chips and firewood. In addition, the forest generates non-timber products: mushrooms, truffles, pine nuts and aromatic and medicinal plants.

As for other non-timber products, black truffle production in the 2022-2023 season was 2,850 kg, while the average annual production in the 2018-2022 period was 3,140 kg. The production of white pine nuts, understood as the dried fruit that is the seed of the fruit (pineapple) of the pine tree (*Pinus pinea*) was 28 tonnes in 2020, similar to the annual average of 26 tonnes in the 2014-2019 period. Regarding wild aromatic and medicinal plants, in 2020 the uses on public land were 22 tonnes of boixerola and 1.30 tonnes of medicinal plants. It should be borne in mind that non-timber products, with the exception of truffles, have a low economic impact in the forestry sector for various reasons such as, for example, pest infestation, poaching or the lack of a regulatory framework.

One of the main trends in the coming years in relation to these products will be the consolidation of the regulation and traceability of their marketing.

02. Main future challenges and opportunities

The Bioeconomy Strategy of Catalonia 2030, in line with what is also provided for in the Strategy to promote the energy utilisation of forest and agricultural biomass 2021-2027, proposes promoting a bioeconomy development scenario in which the Catalan roundwood production will increase by 30%, which means reaching an annual volume of 1.3 Mm^3. With this increase, compatible with the sustainable forest management criteria defined at the Forest Europe Lisbon Conference, it would ensure that it:

- Covers the needs of the Catalan packaging industry, while reducing its dependence on imports of roundwood. The growth of this industry is essential to stimulate forest management. Although there is a strong demand for pallets due to the high degree of exports of the Catalan industry, the growth of this sector is currently hindered by a lack of raw material originating from the Catalan forests.
- Have almost 100,000 m^3 of roundwood for the development of a second transformation forestry industry that valorises the highest quality wood for construction.
- Supply raw material to the Catalan furniture industry, with an annual turnover of €1,322 million, to cover part of its production with local wood.
- Maintain the activity of companies producing lathed pieces, poles, perches, etc.
- Guarantee the export commitments of some Catalan companies to external paper mills.
- Supply biomass to the current power generation plants and thermal boilers, and also provide the increase foreseen in the Strategy to promote the energy utilisation of forest and agricultural biomass 2021-2027.
- Continue with the current production of timber. No future increases are foreseen given that it has remained relatively stable in recent years.

03. Existing initiatives to promote the management of forests and the use of forest products

03.01 Industrial construction and wooden furniture

Building with wood allows a reduction in the use of materials, as it has greater thermal efficiency, as well as more efficiency in waste generation and installation time. In addition, every cubic metre built in wood fixes one tonne of atmospheric CO_2 and avoids the emission of two more tonnes compared to cement. Therefore, the development of new construction materials based on wood, as is the case of cross-laminated timber (CLT), represents an opportunity to increase energy efficiency, reduce emissions from the construction sector and increase the added value of wood.

CLT technology is effective for many design scales and is quickly penetrating the commercial construction industry as a fast and more sustainable alternative to steel or concrete superstructures. It uses highly precise digital manufacturing technology that allows for quick assembly and minimises the need for labour. It allows the forestry sector to capitalise on the natural resources of the territory and contribute to boosting the Catalan primary and secondary transformation industry.

In Catalonia, there is a company that has been working with this material using Pyrenean wood for years: Fustes Sebastia markets its CLT under the name SOLID CLT and also manufactures laminated beams.

Another initiative that will start production at the end of 2025 comes from the Boix Group, and will position it as the main producer of CLT in Catalonia with 20,000 m^3 annual, an expected investment of €30 million and employment of 20 people.

With the aim of accelerating the use and valorisation of local sawn timber, as well as supporting the aforementioned business initiatives, the Forest Science and Technology Centre (CTFC) is building the new Innovation and Technology Hub for the wood of Catalonia. This hub will have a testing unit and a prototyping plant where innovative products will be developed. It will serve to make prototypes, to carry out tests prior to the certification of products, both for own and third-party projects, and to accompany companies in the certification process through tests.

The Hub will also work to generate manufacture with the country's wood and quality material for furniture and carpentry. Currently, this sector imports almost all the wood it needs.

03.02 Particle boards

The Austrian multinational Kronospan, one of the world's leading particleboard producers, opened its first manufacturing plant based on recycled wood in Tortosa in 2021. In the summer of 2023, it signed an agreement with the Generalitat de Catalunya to invest €150 million in a new line of OSB boards that will use up to 300,000 tonnes of green wood annually. Its objective is to make Tortosa and Aldea into a centre of the lumber sector of the Peninsula.

This initiative will be a great upheaval for the valorisation of wood in the south of the country, which will give economic viability to many of the forestry treatments that are necessary in the districts of Tarragona and southern Lleida.

03.03 Forest biofuels

The promotion of heat production from forest fuels is the main objective of the Strategy to promote the energy utilisation of forest and agricultural biomass 2021-2027 and one

CLT from Catalan wood (forest hub). Photo: Marc Trilla

Catalan pine nuts initiative. Photo: Francesc Cano.

of the strategic objectives of the Bioeconomy Strategy of Catalonia 2030 It is also included in the Pyrenean Strategy, approved last April with Government Agreement 85/2023, which relates two of its eight main pillars to the forestry sector:

Pillar 3. Sustainable forest management, wood as a resource
Pillar 8. A Pyrenees area committed to renewable energies

Previously, in 2015, the Government Agreement was approved for the installation of 26 biomass boilers in buildings of the Generalitat de Catalunya in the regional capitals of the Alt Pirineu area to promote sustainable forest management.

Along these lines, the Project to transform the heat network with forest biomass at the Puig de les Basses Penitentiary Centre has been designed, financed from the Climate Fund.

All these initiatives seek to replace the fossil fuel that is now used for biomass obtained from the forest management of local forests. Not only does it involve a reduction in CO_2 emissions, but also the reduction in the risk of forest fire and the generation of wealth in the territory, contributing globally to the UN Sustainable Development Goals 7. Clean and affordable energy, 9. Industry, innovation and infrastructure and 13. Climate action

The existing innovation of the new, more efficient and cleaner heat networks, with the collaboration of the CTFC and the Catalan Energy Institute (ICAEN), will be incorporated into all the aforementioned initiatives of the Pyrenean Strategy.

03.04 Mechanisation and promotion of sustainable forestry close to natural processes

The mechanisation initiatives are driven by private wood utilisation and primary processing companies, the Administration and the CTFC. They seek to modernise and facilitate forest treatments with machinery adapted to our forests.

Close-to-nature silviculture has been decisively promoted in the Forestry Strategy of the European Union 2030 and in the Spanish Forestry Strategy Horizon 2050. Our country is closer to this type of management than other European countries, but it will be necessary to innovate and strengthen it with the support of the DACC units involved and the CTFC.

03.05 Non-timber forest products

Innovation in public-private collaboration must continue to advance and produce good results in truffle production. Also, the innovation and the provision of a necessary regulatory framework for the extractive activity must help to bring forth more wealth in the territory for the use of mushrooms and pine nuts. In this case, the registration of the “Pinyons catalans” (Catalan pine nuts) brand, the extension of cultivation with grafted plants (FCSA-CTFC) and the installation of a factory in the Empordà area will mean a new approach to production, as occurred in the past with the cultivation of the truffle.

03.06 Bioproducts

The construction of a pilot plant-scale biorefinery from wood and its by-products (sawdust, bark, etc.) to obtain bioplastics (University of Lleida, CTFC, Balaguer Municipal Council) and another at the Forest Technology Hub of the CTFC, in addition to the one currently existing at the CTFC, opens a new field of generation of new value chains from the by-products of the forestry sector will bear fruit in the coming years.

A similar process will take place with the new lines of work developed by the CTFC and EURECAT to produce sustainable textile fabric from cellulose from our forest species.

The new CTFC Technology Hub will also have demonstration and pre-industrial laboratories for the production of essential oils and other bioproducts from aromatic and medicinal plants, which together with alliances with companies in the perfumery, pharmaceutical and food sectors they will offer alternatives to traditional crops.

To find out more

Catalan Forestry Observatory www.observatoriforestal.cat

Forest hub of Catalonia https://blog.ctfc.cat/ca/en-marxa-el-hub-forestal-de-catalunya/

Authors

Josep-Salvador Blanch Roure
Forestry Engineer.
Forest Management Service.
General Directorate of Forests and Environmental Management.
DACC.
js.blanchr@gencat.cat

Jordi Tristany Trench
Forest Industries and Forest Bioeconomy Manager.
General Directorate of Forests and Environmental Management.
DACC.
jordi.tristany@gencat.cat

Neus Puy Marimon
Programme Manager for Bioeconomy, health and governance.
CTFC.
neus.puy@ctfc.cat

Francesc Cano Ibáñez
Deputy Director of Transfer.
CTFC.
francesc.cano@ctfc.cat

CREATION OF RESILIENT AGROFORESTRY LANDSCAPES and the sustainable provision of ecosystem services in Catalonia

Siarb Valley. Photo: Núria Aquilué (CTFC).

01. Resilient agroforestry landscapes as country policy

The social and cultural changes experienced since the Industrial Revolution have pushed our ecosystems and our primary sector to a reality in which there is a sharp decline in the quality of natural habitats, the biodiversity of species, the availability and quality of water and also primary production. The increasing pressure exerted on natural ecosystems and the increase in extreme environmental phenomena lead to scenarios of greater vulnerability with respect to fires, pests, droughts or climate change, to name a few. Additionally, changes in land use, the degradation of the productive and social fabric in mountain and rural areas, increasing urbanisation and social changes in the rural world pose new dynamics, pressures and risks for natural spaces and agro-livestock.

Catalonia's landscapes are bearing witness to this transformation. In the last 30 years, the country's wooded forest area has had an annual increase of close to 1%, reaching a current area of 1,331,906 ha (35% of the total area of Catalonia). Unfortunately, this increase has not been accompanied by more employment or greater industrial development in the forestry sector, but year after year this sector and, by extension, many value chains linked to the primary sector, has been decreasing and losing weight in the market.

In this context, the Bioeconomy Strategy of Catalonia 2030 (EBC 2030) was established, with the primary sector

and the sustainable management of the territory at the centre. The Strategy aims to favour the transition towards a more sustainable and circular economic model, based on the optimal use of renewable and local biological resources in order to create products with more added value and at the same time improve the competitiveness and sustainability of the sector and those less developed value chains that allow progress towards a more resilient, competitive and sustainable Catalonia. To promote these changes in the country, an integrated and cross-cutting forest and territory management at landscape scale is necessary, which increases socio-ecological resilience and impacts on the different points of the value chains, but also on the quality of life of people and their community.

The resilient agroforestry landscapes, developed as an objective of the EBC 2030, consist of implementing a new cross-cutting, multi-level and multi-stakeholder territorial management model. They must guarantee the persistence of forest masses, the conservation of natural spaces and the good management of biodiversity, while enabling the supply of forest resources and goods, and agro-livestock activity and preserve ecosystem services, both physical, biological as well as cultural.

There is significant potential to better align these different needs through good landscape-scale planning of clearing activities, agricultural and livestock management, timber and firewood extraction and habitat improvement and biodiversity conservation, with solutions adapted to local conditions and dynamics. This is why, since EBC2030, a methodology for resilient agroforestry landscapes is being developed based on integral and cross-cutting management, with local participation and emphasising the production and maintenance of ecosystem services.

It starts with the implementation of five pilot projects located throughout Catalonia: in Soriguera (Pallars Sobirà), in the Massif dels Ports (Baix Ebre), in the Camprodon Valley (Ripollès), in the Carme Valley (Anoia) and finally, on the north face and foothills of Cadí (Cerdanya), which aim to act as laboratories for the development of the policy of creating resilient landscapes. These pilots represent a wide variety of cases and problems, representative of those in which rural and mountain municipalities find themselves in relation to the availability of water, agro-livestock activity, forest area, ownership of forests, the lack of generational relief and the difficulties in forest management, among others.

The pilot projects must serve for the cohesive development of an integrated territorial management policy, based on consensus and local and scientific knowledge, but also a tailor-made policy with local needs at the centre. The project for the creation of resilient landscapes aims to be the instrument that structures the policies in terms of territorial management and brings to the fore and articulates all those local initiatives of territorial management and dynamism with a multifunctional perspective and emphasising the agro-silvopastoral mosaic focused on creating landscapes more cohesive and more resilient, allowing biodiversity to be preserved and agro-livestock, forestry, economic and social development to be promoted.

> The methodology of resilient landscapes promotes integrated and cross-cutting territory management at landscape scale, which increases resilience and has a positive impact on value chains and the quality of life of people and their community.

02. Description of the methodology for designing resilient agroforestry landscapes

To propose territorial planning that promotes resilient landscapes, it is necessary to characterise the current state of land cover distribution and describe the composition and structure of forest stands.

With a special emphasis on the importance of data, models, local community participation and decision-making tools, the key aspects of the methodology for co-designing resilient agroforestry landscapes are as follows:

- Characterise the landscape and forest ecosystems. The Spanish Forest Map 1:25,000 (MFE25) is used as the base cartography, which offers an updated view of the main land covers (forest, scrub, agricultural area, meadow/pasture and non-productive land) and an accurate segmentation of forest masses in stands.
- Apply forest dynamics and management models to simulate the evolution of forests under changing climate conditions and under different forest management alternatives.
- Estimating the provision of multiple ecosystem services such as blue water, potential livestock load or carbon stock in forests, as well as other key variables to guarantee the sustainability and functionality of agroforestry landscapes.
- Involve stakeholders in the participative process. This step is a key piece in the definition of management criteria and objectives, as it ensures that both the voices of the community and those of other experts involved are taken into account during decision-making and the definition of a consensual vision of the landscape to be achieved.
- Determine specific indicators related to the resilience and sustainability

of agroforestry ecosystems, which serve as a framework for evaluating the success of management strategies and which are weighted to prioritise actions and resources based on the most important needs.
- Use advanced tools, such as optimisation methods and multi-criteria analyses, to make decisions based on data and evidence from a solid and consensual basis.

In order to draw up a resilient agroforestry landscape plan based on global premises and including agreements regarding areas of overlap of priorities, an analysis and diagnosis work is developed that integrates physical, political, social and economic variables that converge in the study area. The result is a vision of a future resilient landscape, which is reached through sustainable management of the territory.

03. The Soriguera pilot project as a new public management model

03.01 Starting situation

Soriguera is a municipality of Pallars Sobirà with an average altitude of 1,258 m (oscillating between 596 and 2,438 m) above sea level. It has an area of 106.4 km^2 and a census population of 431 inhabitants in 2021, with an average density of 4 inhabitants per km^2. 75% of the municipality is within the Alt Pirineu Natural Park. Approximately 76 km^2 of forest are publicly owned, with a distribution that includes the Generalitat de Catalunya (44.8%), the municipality itself (40.6%) and decentralised municipal entities (14.6%). After categorising the land covers with the MFE25, it is observed that 72% of Soriguera is covered by wooded forest areas, while scrub areas represent 15%, and meadows and pastures 10%, with a small agricultural coverage of 2% (Fig. 1).

Based on an initial proposal for a resilient agroforestry landscape in Soriguera, derived from the optimisation process of the main ecosystem services, the territory's experts were consulted in different areas of action. The objective has been to characterise and identify those specific areas for the prioritisation of a certain activity that require special management measures or that may present restrictions with respect to the proposed changes. In this way, the aim is to design an action plan that leads the territory to be a resilient agroforestry landscape that respects, in a consensual manner, the priorities of each area. The specific areas according to expert criteria are, on the one hand, the areas with agro-livestock vocation, on the other hand, the priority areas for the conservation of biodiversity and, finally, the strategic areas for the prevention of large forest fires.

03.02 Proposals for specific areas according to expert criteria

To identify areas suitable for agro-livestock activity, 20th century land use information is used. Areas of past and present crops are grouped together, which add up to 1,497 ha, but restrictions are applied to guarantee their viability: they must be mechanised, with a slope ≤20%, with a distance ≤1,500 m from any urban centre, a surface >3,000 m^2 and be located at ≤1,500 m altitude. With these limitations, 221 ha are optimal for new crops and can double the current area dedicated to agricultural production. The areas that could potentially have a livestock vocation and could be grazed are those that were neither crops nor forest in 1956 and that are not currently cultivated either. And the areas with livestock vocation with south

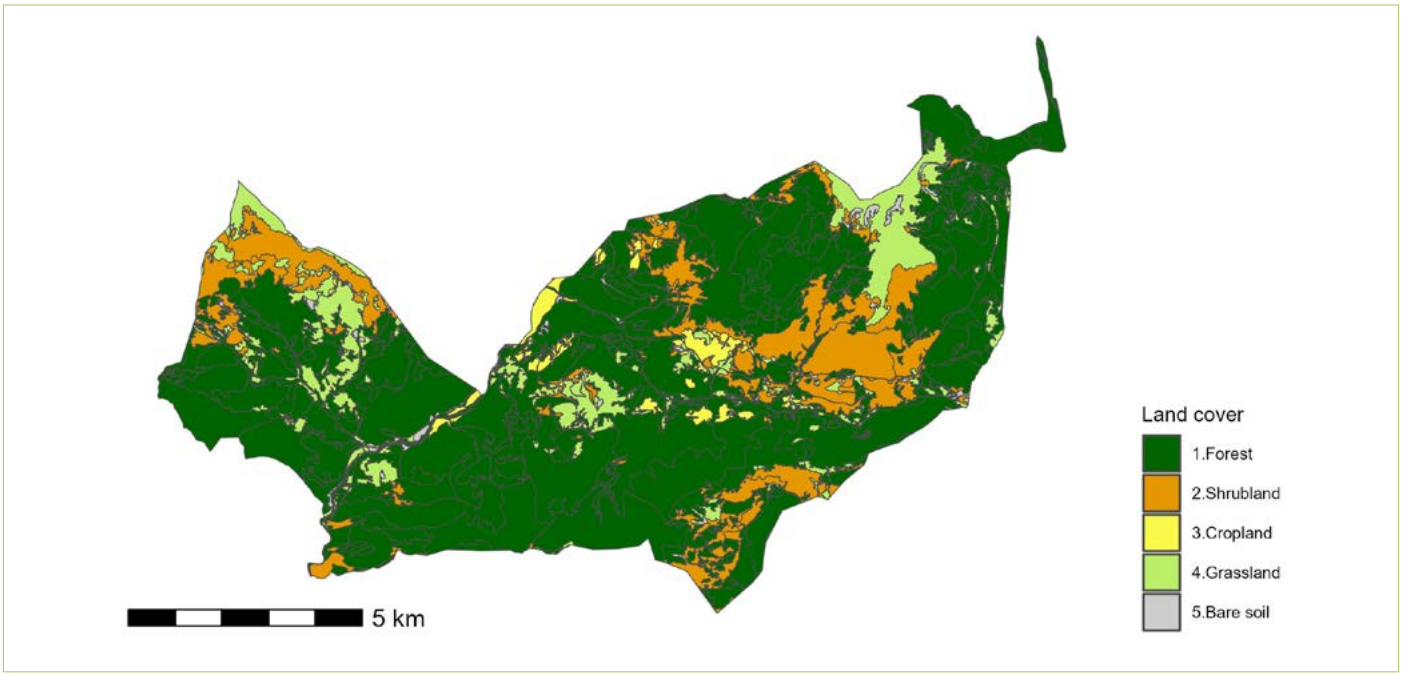


Figure 1. *Map of the current situation of Soriguera (2020). Source: CTFC's own work based on the MFE25 Spanish Forestry Map.*

or west orientation and slope ≤30% that allow mechanised maintenance are defined as viable. These areas would represent an extra 961 ha to be dedicated to livestock activity, either clearing the forest or creating new pastures.

There is a detailed map, provided by the technicians of the Alt Pirineu Natural Park, of the areas that require a prioritisation of biodiversity conservation due to their uniqueness and being the habitat of protected species.

And, finally, the Forest Actions Support Group of the Generalitat Fire Service has established strategic areas for the prevention of large forest fires. As a whole, a proposal for optimal conditions is drawn up, that is to say, with a series of tactically ideal actions to reduce the risk of fire but which respond to a situation of maximum capacity for action in the territory without considering other priorities. In these areas, the actions to be carried out are closely related to breaking the continuity of the large masses of fuel to minimise the potential of large forest fires and prevent them from spreading from one slope to another of the different massifs found within the municipality.

03.03 Forest management itineraries

On the other hand, three alternative forest management models have been proposed for the wooded areas of Soriguera, compared to the current approach. Each model has specific silvicultural prescriptions for the area's dominant forest species such as Scots pine, Black pine, European black pine, holm oaks and oaks, as well as their own characteristics and implications for biodiversity and functionality. of ecosystems.

- ORGEST model: involves regular management with a greater frequency of interventions. However, the basal area extraction is, depending on the species, between 5% and 15% lower than the current model.
- Naturalistic model or close-to-nature forest management: seeks to emulate the effects of low-intensity natural disturbances in forest stands. An attempt is made to take advantage of the arrangement of standing trees to regulate the shrub cover of the undergrowth in a natural way.
- Clearing: transforms forests into a meadow formation, which combines large-diameter trees with a grassy cover that can be used for grazing by herds.

03.04 Proposal for a resilient agroforestry landscape for Soriguera 2050

Taking into account the previous parameters, a proposal for a resilient agroforestry landscape has been developed for Soriguera until the year 2050, using spatial optimisation tools. This proposal is designed to meet global resilience premises and incorporate the priorities identified by experts in the co-design process. In the proposal, changes in land cover and alternative forest management models to the current ones have been taken into account. These changes have been designed to optimise the provision of ecosystem services while continuing to respect priorities in terms of biodiversity conservation, forest fire prevention and promotion of agro-livestock activity (Fig. 2).

The proposed land cover changes contemplate the transformation of scrub to forest through natural succession and the clearing or creation of new pasture areas to encourage livestock activity. The proposal also affects areas with a specific agricultural and livestock application, with the aim of enhancing the socio-ecological resilience of the landscape.

Routes in the Alt Pirineu Natural Park. Photo: Núria Aquilué (CTFC).

To understand and describe the future resilient landscape, projections of ecosystem services have been calculated in this context of socio-ecological resilience, including but not limited to water supply, surface fuel loading, forest biodiversity and the carbon stock in wooded areas. These projections have been compared with the current situation and current estimates of ecosystem services, both in a scenario that maintains the past socio-economic trend and in a scenario with measures to improve socio-ecological resilience in the face of global change (Table 1). This has provided a more detailed view of how the proposed management can influence the provision of ecosystem services in the future agroforestry landscape of Soriguera.

Aspects such as water supply, surface fuel load, forest biodiversity, carbon stock, agricultural and livestock production and wood production are taken into account to understand and describe the future resilient landscape.

03.05 Conclusions

The proposed agroforestry landscape in Soriguera in the framework of socio-ecological resilience offers positive results in a wide range of global indicators. The diversity of the new landscape mosaic contributes to the conservation of biodiversity in mountain areas, which counteracts the negative effects of rural abandonment. In the exhaustive prioritisation of conservation, especially areas of high ecological value and areas declared habitats of community interest, the attention paid to the key areas of the Natura 2000 network stands out.

There is a notable increase in the production of blue water, which improves the ability to use the water resource. Thus, active landscape and forest management improves resilience to the effects of climate change and drought. In addition, the reduction in fuel load and forest biomass decreases the risk of large forest fires. Likewise, landscape diversification helps reduce horizontal fuel continuity and increases safety in firefighting operations.

The promotion of agricultural and livestock activity emerges as a key piece to maintain local socio-economic vitality and ensure a dynamic and diversified landscape in the long term. The substantial increase in forestry mobilisation capacity boosts the local economy and contributes to the bioeconomy. It should be noted that, although the total carbon stock in standing forest biomass may be slightly lower, the assessment of the net balance of emissions requires the consideration of stocks in agricultural and forest soils.

Mobilised quality wood not only has a positive impact on the carbon balance, but can also be used as raw material for forest products with high added value. In this context, approximately half of this wood can be used for bioenergy, which contributes significantly to the mitigation of climate change by reducing emissions com-

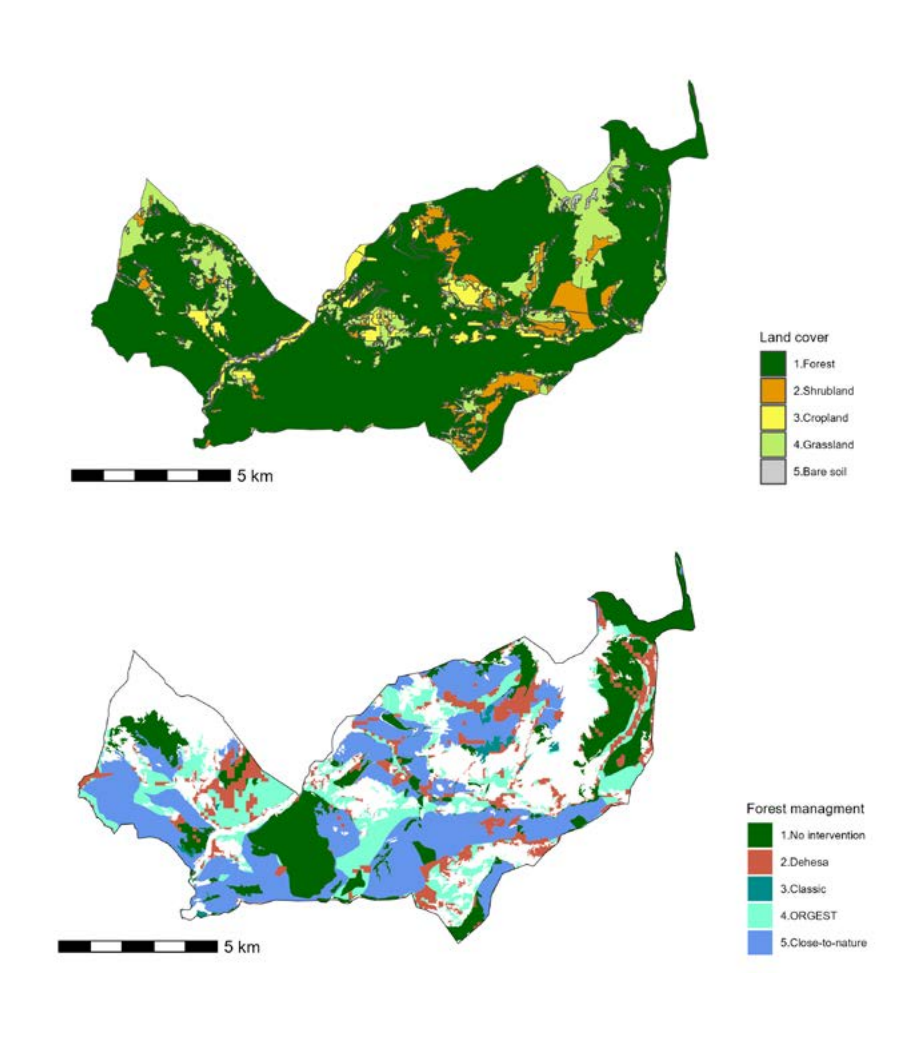


Figure 2. *Proposal for a resilient landscape for Soriguera by 2050. Shown are the land use change map (above) and the proposed forest management of the current wooded areas for the resilient agroforestry landscape (below). Source: CTFC's own work based on the MFE25 Spanish Forestry Map.*

Ecosystem service	Variables (units)	Current	Future if trend holds	Δ (%)	Resilient future	Δ (%)
Water	Blue water (Hm^3)	57.1	55.4	-3%	61.1	7%
Agricultural activity	Livestock density (UBG)	1464	1085	-26%	1783	22%
	Agricultural production (t)	3713	2747	-26%	4851	31%
Fire risk	Surface flammable density (Mg/ha)	10.8	12.2	13%	9.4	-12%
	Standing biomass (Mg/ha)	102	153	50%	82.2	-20%
Forestry activity	Wood production (m^3/year)	2517	2517	0%	14874	491%
Biodiversity	Coefficient of variation DBH (-)	0.52	0.43	-17%	0.48	-9%
	Volume of large trees (m^3/ha)	9.85	25.5	159%	32	220%
	Dead wood biomass (Mg/ha)	3.3	4.9	50%	4.2	33%
	Potential forest biodiversity index [0,1]	0.29	0.36	25%	0.43	48%
Climate change mitigation	Carbon stock / Standing biomass (-)	2.70	2.64	-2.0%	2.63	-2.5%

Table 1. *Comparison of the provision of ecosystem services in the municipality of Soriguera. Source: own work.*

pared to the current scenario of using fossil resources.

The results of this proposal highlight the multifunctionality and integration of a wide range of key landscape factors. This landscape-scale work methodology, which integrates the visions of all the actors, allows for an analysis of multiple criteria that is essential in the decision-making processes to project the landscapes we want for the future. Thus, this approach opens the doors to a new way of planning land management through the implementation of the bioeconomy and represents a meeting point to address the challenges, needs and concerns related to global change and land management.

To find out more

OFC - Catalan Forest Observatory https://www.observatoriforestal.cat/
FORMES – Projection system for multi-objective planning in Spain https://www.ctfc.cat/en/formes.php

Authors

Josep Milà Puigdomènech
Technical Office.
DACC.
josep.milap@gencat.cat

Núria Aquilué Junyent
Precision Forestry (PrecFOR) - New tools for forestry decision-making.
CTFC.
nuria.aquilue@ctfc.cat

Joana Camps Clot
Precision Forestry (PrecFOR) - New tools for forestry decision-making.
CTFC.
joana.camps@ctfc.cat

Neus Puy Marimon
Bioeconomy, health and governance programme manager.
CTFC.
neus.puy@ctfc.cat

Roser Maneja Zaragoza
Deputy Director of Research and Development.
CTFC.
roser.maneja@ctfc.cat

Francesc Cano Ibáñez
Deputy Director of Transfer.
CTFC.
francesc.cano@ctfc.cat

Antoni Trasobares Rodríguez
Director.
CTFC.
antoni.trasobares@ctfc.cat

VALORISATION OF LIVESTOCK MANURE and organic waste

01. Current situation

In Catalonia, a large amount and diversity of materials and organic waste is generated as a result of economic activity and society in general. These must be managed and valorised as material and energy resources, following the principles of the circular bioeconomy and the waste management hierarchy and bearing in mind that the resources we have are finite. In addition to its use, it is imperative to reduce emissions of greenhouse gases (GHG) and ammonia (NH_3) that are generated during its treatment.

Composting process. Photo: Catalan Waste Agency.

The most important organic materials in quantitative terms can be classified into large groups according to their origin: livestock manure, the organic fraction of municipal waste (FORM from its initials in Catalan) coming from selective collection or the remaining fraction, organic waste from the agri-food industry and sewage sludge. The main way of managing these materials is the recovery in agricultural soils, which are applied directly or after receiving a treatment. The most common organic matter treatments in Catalonia are composting and anaerobic digestion, and they have an important network of facilities spread across the territory. The materials, once processed, are a rich source of stable organic matter and/or nutrients with the ability to improve functional aspects of the soil such as fertility, water retention or carbon capture, all of which are of particular relevance in periods of drought and climate crisis.

Among these materials, cattle manure is the most abundantly generated in Catalonia. More than 12,000,000 tonnes of manure are produced a year, of which pig manure is the most abundant. About 10,600,000 tonnes are applied directly to the fields, while the rest are processed, mainly in composting and anaerobic digestion facilities, or simply separated into solid and liquid fractions. Despite the fact that manure has a high water content, they also contribute nutrients (N, P, K, S, etc.) to the soil. In addition, its buffer capacity (resistance to pH modification) favours its use in the anaerobic digestion process, especially when mixed with other organic waste (co-digestion). Because of all this, they are very suitable materials for the production of biogas, while the agronomic application of digestate manure improves the availability of nutrients and the stability of the soil's organic matter.

In relation to the organic fraction of municipal waste (bio-waste), around 450,000 tonnes are collected a year in Catalonia from more than 800 municipalities that have implemented selective collection. These tonnes are treated in 25 composting plants, the compost produced being a valuable resource for agriculture. Four of these facilities incorporate a prior process of anaerobic digestion. The rest of the rural and small municipalities promote self-composting, either on a household or community scale. This biowaste, when it is of good quality and free of inappropriate substances, facilitates its treatment and valorisation and generates a better quality compound with the absence of impurities and a low presence of microplastics.

Even now, there is a lot of organic matter from municipal waste within the remaining fraction (MOR). This biologically treated material is said to be "biostabilised" and is mainly destined for landfill, so citizens and municipalities need to improve in the separation and implementation of more efficient collection systems that capture this organic fraction to be valorised as resource

The agri-food industry is a very important sector in Catalonia and a major contributor to the bioeconomy, since practically all its waste is used as resources. It generates around 700,000 tonnes of organic waste per year, many of which are valorised within the same sector. The rest, around 400,000 tonnes, are processed in composting plants to obtain a very good quality compost or in anaerobic digestion plants, which produce biogas and digestates, which are also valorised for the benefit of agriculture. The diversity and types of waste produced by the agri-food sector is very large, as is the plurality of industrial areas and production processes where they are generated (slaughterhouses, horticultural, wine, olive, etc.).

As for the water purification sector, around 500,000 tonnes of sludge are generated annually, produced in almost 550 wastewater treatment plants (WWTP) spread throughout the Catalan territory. The main way of valorising WWTP sludge is agriculture, either through direct application (in the case of sludge treated at source, mostly through anaerobic digestion) or through a previous process in composting facilities. Sludges that do not meet the criteria established in the regulations for having too high a concentration of heavy metals are destined for disposal via landfill.

The graphs in Figure 1 show the quantities of the large groups of materials and organic waste generated in Catalonia according to their origin, and those of the processes that are currently applied. The organic matter of the remaining fraction has been included, as it is expected that in a few years this part will be collected separately and give rise to more FORM.

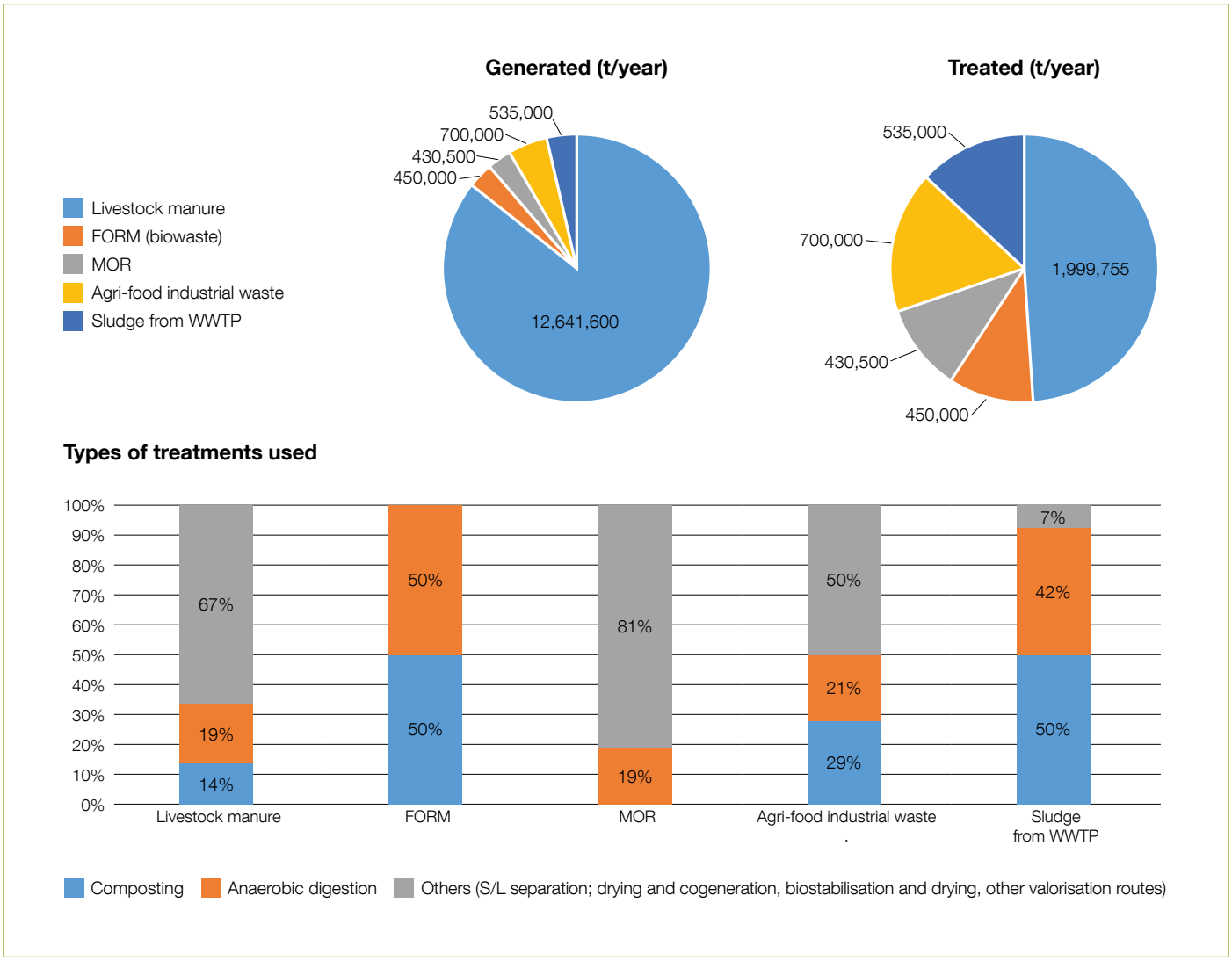


Figure 1. *Amount of potentially valuable organic waste generated in Catalonia according to its origin and type of processes. Source: DACC.*

In conclusion, most of the organic materials are valorised through the soil as a source of organic matter and nutrients, either directly or with a prior treatment, which is mainly composting and/or anaerobic digestion. This fact contributes to the closure of the nutrient cycle while reducing dependence on inorganic fertilisers, and to the sequestration of carbon in the soil, while generating renewable energy, in the case of anaerobic digestion. In order to achieve adequate valorisation, it is important that efforts continue to be made to improve the quality and quantity of these materials, either by optimising the separations at source or by working on the elimination of polluting loads that hinder their valorisation.

In Catalonia we generate a large amount and diversity of materials and organic waste that must be managed and valorised as material and energy resources.

02. Main future challenges and opportunities

The management of materials and organic waste in Catalonia must find a balance between technical feasibility, economic profitability, effects on the environment and social acceptance. In no case is there a single solution, but the type, quantity and quality of the waste must be assessed, as well as the specifics of the area where it is found, among other factors. With these premises, the different valuation routes can be considered and chosen.

Direct application to the soil, under reasonable criteria, can be the best practice in many cases. Despite this, the rules that regulate the application of organic materials for the benefit of agriculture are increasingly demanding, so certain sectors will have to pay attention to the origin of the waste. This is the main challenge facing the sanitation sector as a result of the entry into force of state regulations that reduce the limits of heavy metals in sewage sludge for agricultural use, as well as the content of persistent organic pollutants. The implications of these new thresholds will mean that efforts must be directed towards control and prevention upstream of the sewage treatment plants, so that the sludge has the best possible quality and can be valorised following the new requirements. The alternative to this approach would be to move the requirements to the end of the chain, with more surface area required and higher management costs.

However, if the high concentration of organic materials in certain areas makes their direct agricultural application impossible, it will be necessary to consider alternatives to implement treatment lines aimed at facilitating their export to other areas where, precisely, the lack of these products would generate a new market. The direct transport of unprocessed material is clearly limited by the conditions of the product (90% water in the case of slurry), as well as by the high economic (around €1.65/litre of diesel) and environmental (3.06 tCO_2 eq/litre of diesel) of the fuels.

The valorisation of organic matter through composting has the main challenge of improving the input material in quantity (the municipal waste recycling objective is 65% by 2035) and in quality (less than 10% inappropriate). The training of technical personnel to obtain a good product is still an outstanding subject, as well as the need to extend this practice to other sectors such as livestock. The compost obtained has a variable sales price depending on the main raw materials (suitable or not for organic farming), the sales format (bulk, bagged, pelletised) or if it is enriched with nutrients or mixed with other raw materials to make substrates or garden soil. These prices usually range between €5 and €80/t and can reach €200/t for some organo-mineral fertilisers.

If you consider taking advantage of the intrinsic energy of organic materials, the most interesting option is to subject them to an anaerobic digestion process, which produces and uses the biogas generated. The DACC has recently drawn up the Catalan Biogas Strategy 2023-2030 with the aim of defining a model for promoting the generation of biogas from the sustainable processing of livestock manure, organic waste and the resulting digestate, which identifies the key points to consolidate the sector in the 2030 horizon. This Strategy aims to multiply by 3.5 the current production of biogas in 2030 (up to 2 TWh/year), to cover 5.7% of the current equivalent consumption of natural gas and reduce emissions by 350,000 tonnes of CO_2 each year. Currently, there is the technological and regulatory framework for the enrichment of methane from biogas, often called upgrading, until obtaining a product equivalent to natural gas known as biomethane, and which can be injected into its distribution network or used as fuel for transport.

It must be taken into account, however, that the content of nutrients (including nitrogen) is not reduced after biodigestion. If, in addition, co-substrates are added to the process, the nitrogen content in the digestate may increase and require additional treatments for its recovery and export in areas that are surplus to this nutrient. However, the main challenge facing Catalonia to promote anaerobic digestion technology and achieve the goals set is to make it attractive to the livestock and industrial sectors. In this sense, the DACC plans to pro-

Biogas plant. Photo: DACC.

Composting plant. Photo: Alcarràs Bioproductors, SAT.

mote the installations of biogas plants and treatment of the organic material obtained with the investment of up to €80 million in aid in the period 2024-2026. Despite this financial injection, other obstacles must be overcome, such as the reduction of deadlines in the process of obtaining environmental and urban planning authorisations.

The production of local organic-based fertilisers to replace or at least reduce the use of mineral fertilisers dependent on fossil fuels is another opportunity in this area that is gaining a lot of prominence at present.

Recently, the regulations that regulate the marketing of fertilisers at state and community level have been updated, with the aim of giving greater legal coverage to fertilisers of organic origin. The processing of livestock manure or other organic materials must be a business motivation in order to obtain finished products with a higher market value than the fresh materials from which they come. An even more advanced level would be to adapt these fertilisers to demand. This means adapting them to the needs of certain crops, but taking into account the types of soils, their level of fertility or any other specific conditions that are required. To date, the main difficulties in moving forward in this line are: complying with regulations that are continuously evolving; bet on technological innovation that requires high levels of funding to move forward; bring to commercial scale the technological advances achieved; obtain organic fertilisers suitable for the user, such as products that are homogeneous over time and that are easy to apply with the machinery that the agricultural sector has available.

To design strategies for the valorisation of organic materials, it is necessary to take into account the consumption of resources and energy necessary for the proper functioning of the process and to obtain products of added value, such as compost or biogas. In many cases, the combination of technologies will be the most appropriate strategy to achieve these milestones, as this way the limitations of each one separately can be minimised and the overall system can become more flexible.

The organic materials management model for the coming years must be based, undoubtedly, on the bioeconomy to guarantee the use of materials (nutrients, organic matter, water, etc.) and/or energy (biogas) under technically and economically sustainable criteria. The collateral effects of this country strategy based on the use of our own resources will inevitably lead us towards enhancing organic fertilisation, with the consequent improvement of soil quality, and towards making us less dependent on external resources, such as mineral fertilisers or energy consumption based on fossil fuels. If we are able to set these milestones and work along these lines, we will make Catalonia a country more focused on decarbonisation and, ultimately, more resilient.

> The management model of organic materials for the coming years must be based on the bioeconomy and guarantee the use of materials and energy under technically and economically sustainable criteria.

03. Initiatives to valorise livestock manure and organic waste

03.01 R&D&I projects

Parallel to the growth and importance of the livestock sector, the sustainable management of the animal manure it generates has become a topic of great relevance in research and transfer activity in Catalonia. Since the 1980s, the number of indexed scientific articles published by the different Catalan research institutions has been growing, until accumulating a corpus bibliography consisting of nearly 500 publications. The main institutions to which the authors of these scientific publications belong are the three large public universities (UPC, UAB and UB), but research centres such as IRTA, ICRA, CREAF, LEITAT and the BETA Centre, or other universities such as Girona and Lleida.

A detailed analysis of the main keywords that appear in these works indicates that the research revolves around aspects related to the management of livestock manure on the farm, its valorisation through composting and anaerobic digestion, as well as application to land and water pollution and the emissions that may result.

Currently, research on the sustainable management of livestock manure in Catalonia is faced with several fundamental challenges that require a multi- and interdisciplinary approach, in line with what is marked by the strategies of the bioeconomy and the circular economy. Accordingly, the main challenges in R&D&I activities are:

1. Carry out accurate and complete quantification and characterisation. This includes the precise identification of pollutant components, their variety and their concentration, as well as the determination of their potential effects on the environment and health, but also in terms of their recovery. There is a particular interest in developing technologies that can perform this characterisation in situ and in real time.
2. Develop innovative treatment and management technologies, inside and outside the agricultural field (on the farm and in centralised plants), which transform them into useful resources with added value at an acceptable cost and at the same time minimise the negative impacts on the environment. Examples include the integration into existing technologies of advanced nutrient separation and recovery techniques.
3. Develop and validate innovative products, such as fertilisers inoculated with beneficial microorganisms for the soil and crops (biofertilisers), or products enriched in nutrients of organic origin that are analogous to inorganic fertilisers.
4. Optimising the use of organic materials as fertilisers efficiently and safely. This involves research into the best agricultural practices, such as the optimal time of application, the amounts required and the combination with other sources of nutrients. In this area, among others, the adaptation of intelligent agriculture techniques to organic fertilisation is contemplated.
5. Control the emission of pollutants inherent in organic fertilisation to reduce the presence of undesirable components, such as heavy metals, microplastics and pathogenic microorganisms, and minimise the emission of greenhouse gases.
6. Improve sector participation and public awareness of the importance of sustainable livestock manure management. This can help improve social acceptance of new practices and technologies.
7. Promote adaptation to climate change by studying how climate variability can affect the management of livestock manure and organic waste, both in terms of production and demand.
8. Include the economic and regulatory aspects of good bioresource management practices to ensure feasibility and large-scale adoption. In addition, there is a need to improve collaboration with regulatory authorities to develop regulations that encourage the sustainable management of livestock manure and organic waste.

These challenges have marked the objectives of the research projects that have been coordinated from Catalonia in recent years. Table 1 presents a list of some of the most relevant projects carried out in the field of sustainable treatment and management of livestock manure and/or organic waste.

03.02. Valorisation of livestock manure

Today, there are a series of facilities for the valorisation of cattle manure that are pioneering in terms of their scale, management model, the technologies implemented or their degree of integration. Of these, the composting plant promoted by 150 livestock families of Alcarràs Bioproductors SAT, which was inaugurated in 2022, stands out.

This facility occupies two hectares, where compost is made from solid livestock manure from their own farms. Most of the compost produced is made from cow manure and is suitable for organic agriculture. It is a highly technical plant, equipped with forced ventilation driven by photovoltaic solar panels, sensors for monitoring the composting process and with recirculation of leachate and rainwater. It is designed for a production capacity of 27,000 tonnes of finished compost per year.

Once this first phase of the project has been successfully completed, the promoters' aim is to expand the facilities to build an industrial bio-estate that will occupy 14 hectares and will func-

Acronym	General objective	Duration:	website
LIFE AGRICLOSE	Promote new local fertilisation strategies to improve the management of by-products from slurry treatment	2018-2022	https://agriclose.eu/
ORGANIC +	Validate and demonstrate the progressive elimination of controversial inputs from organic and conventional agriculture	2018-2022	https://organic-plus.net/
LIFE SPOT	Develop a new treatment process that removes nitrates and micropollutants from groundwater and produces good quality drinking water according to legal requirements	2019-2023	https://lifespotproject.eu/
NUTRI2CYCLE	Using an integrated approach to support the transition of European agriculture towards the next generation of agronomic practices based on optimised nutrient and organic carbon cycling	2018-2023	https://www.nutri2cycle.eu/
CIRCULAR AGRONOMICS	Validate and demonstrate practical solutions to improve the closure of C, N and P cycles in agricultural ecosystems and in processes along the food production value chain	2018-2023	https://www.circularagronomics.eu/
FERTIMANURE	Recover nutrients in an innovative way for the production of fertilisers with high added value from livestock manure	2020-2024.	https://www.fertimanure.eu/es/
LIFE INFUSION	Demonstrate the intensive treatment of residual FORM effluents and conversion into useful and sustainable resulting products: biogas, nutrients and water	2020-2025.	https://lifeinfusion.eu/ca/

Table 1. *Examples of relevant research projects in the field of sustainable management and valorisation of livestock manure and other organic waste, carried out over the last five years in Catalonia. Only cases of international collaboration financed by the European Union are shown. Source: own work.*

tion as a true biorefinery. This space envisages the implementation of a biogas plant that will produce electricity and biogas/biomethane for the entire industrial complex from slurry and manure. The complex plans to create an ecosystem where different industries collaborate and create synergies with each other, so that they can innovate on an industrial scale with the valorisation of a wide range of bioresources. An example would be the production of insects from vegetable by-products, as an alternative protein source, or the pyrolysis of lignocellulosic waste for the production of biochar.

03.03. Valorisation of industrial organic waste

Nufri is one of the main producers of juices, concentrates, creams, oils and essences in the country. With a 50-year history, the agro-industrial group has its origins in Mollerussa and is currently made up of four divisions: fresh fruit, processed products, markets and energy.

The process of improvement and utilisation has allowed the agro-industrial group to valorise its production in the form of by-products for human food (flavours, polyphenol essences and oils) and for animal food (dehydrated pulp), biomass to generate energy (solid plant remains) and for the production of biogas (water with a high content of organic matter and other plant remains).

One of the decarbonisation lines of its production consists of the biomass collection service from the uprooting of fruit tree plantations, with which it generates energy for its facilities. In the last 10 years, it has used the equivalent of 100,000 tonnes of biomass from more than 2,000 hectares of fruit trees.

With the energy produced during the combustion of biomass and biodigestion, it obtains electricity and water vapour, which it uses in its production processes and also in the drying of the sludge produced to obtain fertilisers of high fertilising value. The surplus part of energy is sold to third parties.

03.04. Valorisation of municipal organic waste

Throughout the Catalan territory, there are a total of 77 composting plants that treat organic waste from different origins and that work to achieve a quality product aimed at the needs of the agricultural sector. Of these, 25 facilities deal with FORM, and standing out among them is the Manresa composting plant, managed by the Bages Consortium for waste management. This plant treats 20,000 tonnes of FORM per year from selective collection mainly from the municipalities of Bages. The quality of the organic fraction they collect makes it possible to produce a quality compost that is sold retail and bagged, a differentiating feature compared to other public composting plants.

03.05. Valorisation of WWTP sludge

There are several WWTPs that have digesters to treat the sludge generated in the purification process and that use the biogas for the production of electrical and thermal energy used in their own process. It should be noted, however, that some facilities have started other initiatives to achieve a higher performance of the biogas generated. This is the case of the Prat de Llobregat WWTP and the Lleida WWTP, designed with treatment capacities of 2,000,000 and 140,000 equivalent inhabitants, respectively, which generate an amount of 60,000 and 8,000 tonnes of sludge per year that are managed for agriculture. These sludges are treated through anaerobic digestion in sewage treatment plants, which use biogas to produce electrical and thermal energy. In the case of the El Prat WWTP, the transformation of part of the biogas into biomethane has been projected. This biomethane will be injected into the natural gas transport network and will contribute around 25 GWh of primary energy per year to the gas system. Lleida's WWTP is also working to generate biomethane from surplus biogas and use it as biofuel.

To find out more

Practical guide for the development and operation of biogas energy utilisation plants from slurry and other organic products (ICAEN, 2008) https://icaen.gencat.cat/web/.content/10_ICAEN/17_publicacions_informes/04_coleccio_QuadernPractic/quadern_practic /archives/01_produccio_biogas.pdf

Practical guide for the design and operation of composting plants (Waste Agency of Catalonia, 2016) https://residus.gencat.cat/web/.content/home/lagencia/publicacions/instalacions/GuiaPC_web_CA.pdf

Guide to livestock manure treatment technologies in Catalonia (DACC and IRTA, 2020). https://agricultura.gencat.cat/ca/detalls/Publicacio/a02-04-2020-Guia-de-les-tecnologies-de-tractament-de-les-dejeccions-ramaderes-a-Catalunya

Bioeconomy Strategy of Catalonia 2030 (DACC, CTFC, IRTA, 2021). https://ruralcat.gencat.cat/documents/20181/9479472/EBC2030_EN.pdf/51d819d9-b139-4fb9-b297-278344bf72ea

Guide for on-farm composting of livestock manure. Department of Climate Action, Food and Rural Agenda (DACC, 2022) https://ruralcat.gencat.cat/documents/20181/7816840/Guia_compostatge_AGRICLOSE.pdf/1cb4a726-4c66-4783-8194-7153731828fc

Guide and video for the sustainable development of biogas and biomethane in Catalonia (Bioenergy Cluster of Catalonia, 2023) https://www.clusterbioenergia.cat/wp-content/uploads/2023/11/BiogasImpulsat.pdf

Authors

Laia Sarquella Planella
Energy Management Division.
Catalan Energy Institute.
DACC.
laia.sarquella@gencat.cat

Meri Pous Alo
Head of the Soil Protection Department. Circular Economy Area. Catalan Waste Agency.
DACC.
mpous@gencat.cat

Noemí León Quiñones
Department of Soil Protection.
Circular Economy Area.
Catalan Waste Agency.
DACC.
nleonq@gencat.cat

Carlos Ortiz Gama
Head of Fertilisation and Management of Organic Matter. Soil and Environmental Management Service for Agricultural Production.
DACC.
carlos.ortiz@gencat.cat

Joan Parera Pous
Office of Fertilisation and Livestock Manure Treatments. Soil and Environmental Management Service for Agricultural Production.
DACC.
jparera@gencat.cat

Francesc Prenafeta Boldú
Researcher of the Biosystems Sustainability Programme. Coordinator of the Bioeconomy Strategic Initiative.
IRTA.
francesc.prenafeta@irta.cat

THE UTILISATION AND VALORISATION OF CO-PRODUCTS AND BY-PRODUCTS of the food chain

01. Current situation

According to data from the World Food Organization (FAO), a third of the food produced is lost or wasted along the food chain. This leads to the generation of more than 1,300 million tonnes of food per year that end up being thrown away and becoming waste. In Europe, this figure is around 58 million tonnes, according to data from the latest Eurostat report, which is equivalent to 131 kg per person per year[1].

Food loss and wastage is a complex problem, with multiple and systemic causes, such as the global supply system, certain food marketing requirements and standards, market dynamics and consumption habits, among others. The result is a great social, environmental and economic impact, and at the same time the wastage of a huge volume of resources that could be used as raw materials for the production of new products in the food chain itself or in other economic sectors.

Faced with this situation, international public agendas agree on the importance and urgency of promoting prevention measures and reducing the generation of food waste, to help minimise the environmental impact of agri-food systems and make them more sustainable, resilient, fair and secure. As pointed out at the last United Nations climate summit (COP28)[2], minimising the adverse effects that food systems have on the environment is one of the main challenges to be addressed globally to mitigate the effects of climate change.

In 2015, the United Nations General Assembly adopted the 2030 Agenda[3], and with it the Sustainable Development Goals (SDGs), which include quantitative goals in the area of improving the sustainability of food systems and, specifically, in the prevention of food waste by the year 2030[3]. These milestones have subsequently been subscribed to by European strategies, such as the European Green Deal[4] and the Farm to Fork[5] strategy.

International agendas and strategies have also been transferred to those of regional governments, as is the case

Figure 1. *Example of use opportunity sheet. Source: DACC.*

of Catalonia, which in 2020 approved Law 3/2020, of 11 March, on the prevention of food loss and wastage in Catalonia, to have a specific regulatory framework for the development of measures in this area.

Regarding the legislation linked to the prevention of bio-waste, the valorisation of by-products of the agri-food sector and the management of food waste, it is also necessary to take into account Law 7/2022, of 8 April, on waste and soil contaminated by to a circular economy, which incorporates the European Directive approved in 2018 on waste into the Spanish legal system[6].

Food losses and wastage generate a large social, environmental and economic impact and at the same time represent the wastage of a huge volume of resources that could be used as raw materials for the production of new products.

On the other hand, in Catalonia the challenge of preventing losses, wastage and food waste is also tackled through sectoral strategic plans, as is the case with the Strategic Food Plan of Catalonia (PEAC), the Let's Fight Against Food Waste strategy and the Circular Economy Roadmap of Catalonia (FRECC) 2030.

The PEAC[7], in its dimension 1, foresees measures and instruments, some of which are already in development, to promote the valorisation of co-products and by-products of the food chain. The Let's Fight Against Food Waste strategy[8], through which the DACC works to prevent food loss and wastage, promotes research along the entire chain, quantifying the volume and the economic and environmental impact of food loss and wastage, and also the main trends in innovation and detection of opportunities for the use of co-products and by-products for various agri-food subsectors (Fig. 1)[9].

For its part, the FRECC 2030[10], recently approved and which aims to accelerate the transformation of Catalonia towards a circular economy that acts as a lever for economic recovery, places the agri-food sector as one of the sectors with the greatest potential to apply circularity.

02. Co-products and by-products of the agri-food sector

While "co-product" is a term used to refer to products that are generated simultaneously or jointly during a main production process, a "by-product" is defined as a substance or object, resulting from a process of production, whose primary purpose was not the production of that substance or object. In this regard, the main difference between both concepts lies in the intentionality: while the first has been produced intentionally with a certain economic value, the second is a secondary result, often without specific planning and whose economic value can be inferior or non-existent.

Law 3/2020 establishes a hierarchy of uses that must be complied with by all companies in the food chain that must be taken into account when managing food waste and, therefore, also when take advantage of the co-products and by-products of the food chain (Fig. 2).

This hierarchy prioritises the prevention of food loss, wastage and the resulting food waste. However, it is clear that the agri-food sector, in all the processes of production, transformation, distribution, and also in the chain of consumption, generates co-products, by-prod-

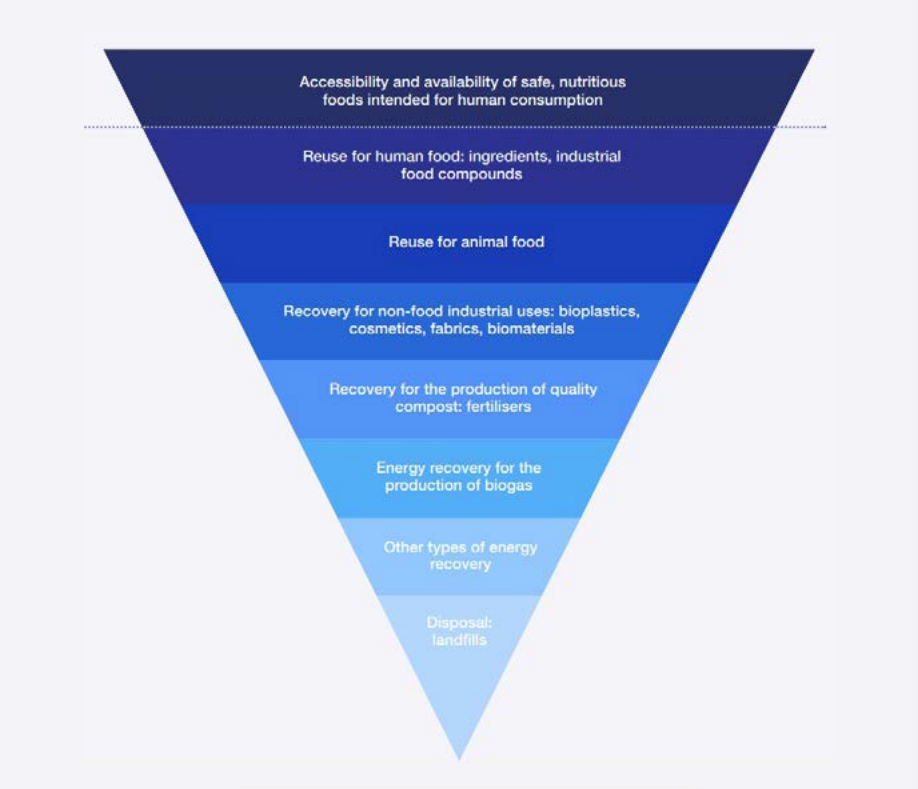


Figure 2. *Hierarchy of food uses. Source: DACC.*

ucts and waste, as well as losses and surpluses, which, despite the fact that the sector can dedicate efforts to prevent them, are inherent in the same activity. This is what happens in cases as diverse as the amurca or lees obtained in the production of olive oil, the whey from a cheese factory, or the spines and skins of the fish that remain after it has been gutted. in an industry within the sector.

Following the hierarchy, whenever possible, the first step must be the use of these discarded foods for human consumption, for example for the preparation of new products, substances or additives that allow their reintroduction in the value chain. If this is not possible, the next option is to use them for animal feed.

Subsequently, the hierarchy contemplates utilisation for industrial uses, through the recovery of elements and substances, such as the use of fat or animal collagen for the production of pharmaceutical or cosmetic products or the use of plant fibres for the production of new materials (fabrics, bioplastics, etc.). In the final part of the hierarchy, biological treatment is contemplated, which includes composting or anaerobic digestion of these wastes, and final treatment, where energy recovery is planned and, as a last option, the controlled deposit in landfill.

03. Main future challenges and opportunities

The agri-food sector has the responsibility to ensure the reduction, management and valorisation of the by-products and waste it generates. Not only because it is one of the main sectors of economic activity in Catalonia, but because discarded food involves the loss of a valuable resource and generates a significant environmental impact and a high economic cost derived from its treatment.

Law 3/2020 establishes a hierarchy of uses that must be taken into account when making use of food and managing food waste.

To make better use of food, challenges related to technology and research, regulation, logistics and cross-sector collaboration need to be addressed.

The co-products and by-products of the agri-food sector have great potential in the area of circularity and are a source of raw materials of high added value due to their nutritional, functional or technical properties (food fibres, organic acids, proteins, vitamins, antioxidants, etc.), of great use for the development of new products that can make the sector more competitive, bring greater economic benefit and at the same time improve its environmental sustainability.

To be able to unfold all this potential, however, some challenges related to technology and research, regulation, logistics and collaboration between sectors need to be addressed. In this regard, it is necessary to develop new technologies and innovative processes that allow opening new horizons for the use of by-products, with the collaboration of research centres, institutions and the sector itself, and that guarantee the technical, economic and environmental of the valuations. On the other hand, it is important that the current regulations adapt to the new times and that they allow innovation and the maximum use of resources, always ensuring adequate, safe management with the least possible environmental impact. Thirdly, it is necessary to make the sector aware and coordinate the supply and demand of these co-products and by-products to guarantee an efficient valorisation. And finally, collaboration between the different agents of the food chain is key to promoting correct management and valorisation.

04. RDI projects and relevant business initiatives

In Catalonia, more and more projects are being developed in the field of research, development and innovation (RDI) focused on the utilisation and valorisation of products with little commercial value, co-products and by-products of the food chain, led by universities, research centres and companies in the sector. This section shows some relevant projects that are part of calls for operational groups[11] from the Department of Climate Action, Food and Rural Agenda, a funding instrument that promotes innovation projects to turn innovative ideas into real solutions for the sector.

On the other hand, some examples of business initiatives are also shown that take use and give value to these resources offered by the agri-food sector with the extraction of substances and raw materials for human animal food or for the preparation of high added value products aimed at reintroducing these resources back into the food chain.

1. Source: Eurostat, 2023 (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Food_waste_and_food_waste_prevention_-_estimates#Amounts_of_food_waste_ at_ EU_ level). 2. https://www.cop28.com/en/food-and-agriculture. 3. https://www.un.org/sustainabledevelopment/es/sustainable-consumption-production/. 4. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/agriculture-and-green-deal_en. 5. https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en. 6. https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32018L0851. 7. https://agricultura.gencat.cat/ca/ambits/alimentacio/estrategia-alimentaria/pla-estrategic/. 8. https://agricultura.gencat.cat/ca/ambits/alimentacio/malbaratament-alimentari/. 9. https://agricultura.gencat.cat/ca/ambits/alimentacio/malbaratament-alimentari/eines-reduccio/. 10. https://dogc.gencat.cat/ca/document-del-dogc/?documentId=975456. 11. https://grupsoperatius.cat/

Hortivalor

Non-marketable tomato. Photo: DACC, 2023.

Valorisation of products from organic gardens through the use of emerging technologies for the treatment of vegetable juices and creams

Participating entities

Drissa Private Foundation, IRTA, Ecoregió, Anna Ecològica, Èxit Girona Cluster Association, Oriol Molist and Formatgeries Montbrú.

Description

The main objective of the project is the development of organic juices and creams from surplus fruit and vegetables from the primary organic agricultural production of the Drissa Foundation. To develop the new products, the technology of high hydrostatic pressure is applied, for the sanitisation and preservation of juices and creams, while maintaining the sensory properties and bioactive compounds of the product.

Main results

Organic juices and creams with a high added value.

Link

https://grupsoperatius.cat/fitxes/2019_2_22.pdf

Ekoferm

EKOFERM project. Photo: Eurecat.

Valorisation of products from the organic garden through fermented vegetables

Participating entities

Drissa Private Foundation, EURECAT Foundation, Èxit Girona Cluster Association, Oriol Molist (researcher).

Description

EKOFERM is a project for the valorisation of products from the organic garden through fermented vegetables, which uses by-products from the process of making fruit and vegetable juices. Within the framework of the project, it is planned to select the most suitable raw materials and ingredients to be used in the production of fermented products, as well as the realisation of tests and product designs from the residual bagasse from the production of juices for the production of kombucha, nutritional and functional analysis of the resulting product and dissemination actions to publicise the progress of the project.

Main results

Improvement of the performance of the processes for the preparation of processed vegetable products through the use of the resulting by-product for the preparation of fermented foods.

Link

https://grupsoperatius.cat/fitxes/2021_2_66.pdf

Valacticat

VALACTICAT project. Photo: IRTA.

Pilot project for repurposing whey in Catalan food industries

Participating entities

Betara, Ametller Origen, FoodService Cluster and Eurecat.

Description

The objective of the project was to characterise the nutritional composition of the whey that is generated in the participating food industries, to study the technical and economic feasibility of implementing optimised valorisation processes to develop new innovative food products with high added value.

The project has made it possible to verify that the valorisation of the whey is environmentally and economically viable and that it contributes to sustainability, while also opening the door to the development of new product ranges and cooperation between companies.

Main results

Optimisation of the whey valorisation process.

Link

https://grupsoperatius.cat/fitxes/2018_2_9.pdf

Valorisation of proteins of low commercial value from by-products of pig slaughterhouses

Meat products obtained. Photo: DACC.

Participating entities

Patel, INNOVACC, Frigoríficos del Nordeste, S.A., Olot Meats, S.A., Friselva, S.A., Frigoríficos Costa Brava, S.A.

Description

The aim of the project was to obtain proteins from pig organs of low commercial value which, due to their functional properties and high nutritional value, would be useful as ingredients for the food industry. The project has made it possible to advance the protein extraction processes for the preparation of meat preparations, such as sausages, and the formation of zinc-protoporphyrin (ZnPP), which is a natural pigment that gives a reddish colour to the meat product and which is of great value in the world of the meat industry for the preparation of derived products.

Main results

Extraction of substances and raw materials for the meat industry through the valorisation of by-products from pig slaughterhouses.

Link

https://grupsoperatius.cat/fitxes/2016_2_31.pdf

ART Cervesers

"9 hores" beer. Photo: ART Cervesers.

Sector
Drinks

Description
In February 2016, Art Cervesers started a project to make beer with leftover bread from bakeries, as was already being done in other countries such as Great Britain and Belgium. This is how "9 hores" beer was born, a seasonal beer made with the aim of reusing bread and creating a valorisation process that is commercially profitable and with high added value.

Product
Beer made with leftover bread.

Link
https://artcervesers.com/

Es Imperfect Food

Jams made from pickled fruits and vegetables. Photo: Es Imperfect.

Sector
Transformation of fruits and vegetables

Description
Espigoladors was born with the triple objective of contributing to the reduction of food waste, of providing healthy food for the most vulnerable groups and of generating opportunities for these groups, through a productive circular economy model.
To achieve these objectives, it recovers an old activity now disused in our territory, which is that of going collecting in the field: entering the field once the farmer has finished the harvest, always with their consent and following their instructions, and recover all those fruits and vegetables that, despite not being marketable, are perfectly suitable for consumption.
Under the Es Imperfect Food brand, they make preserves such as pâtés, creams, jams, compotes and sauces with these fruits and vegetables at their workshop in El Prat de Llobregat, where people in vulnerable situations are provided with work.

Product
Jams, pâtés, creams and imperfect fruit and vegetable preserves.

Link
https://esimperfect.com/

Escata

Escata products Photo: Escata Food.

Sector
Preparation of sauces and condiments

Description
In February 2016, Art Cervesers started a manufacturing project. Escatafood is a company that takes advantage of the by-products produced during the anchovy salting process for the preparation of sauces and condiments. Specifically, they take advantage of the salt and liquid resulting from the salting process and the spine of the anchovy. With these three products, and a long research process to make use of the whole of this resource, they have brought four products to the market: Escata Salsa Mediterrània, a reinterpretation of garum, a sauce known to the Greeks and Romans; Escata Oli, a mixture of garum and olive oil to dress any dish; Escata Sal, a flavoured salt; and Escata Espina, roasted anchovy spine powder.

Product
Condiments with anchovy base.

Link
https://www.toufood.com/producto/salsa-mediterranea-escata/

Copiral

Source: Copiral.

Sector
Valorisation of by-products of the food industry

Description
Copiral is a company located in Agramunt (Lleida), dedicated to the valorisation of food by-products not suitable for human consumption to transform them into raw materials for animal feed (biscuit flour, milk flour, yogurt flour and casein).
They handle more than 150,000 tonnes of by-products per year from large companies in the food industry that generate surpluses during the transformation process.

Product
Raw materials for animal feed.

Link
http://www.copiral.com

Celler Credo

"Vespers de Verema" herbal infusion. Photo: Celler Credo.

Sector

Production of wines and cava

Description

Celler Credo is located in Penedès. It has developed an innovative product by valorising the products derived from the harvest and the first treatments of the grapes to make wine.

This company has created the "Vespres de Verema" infusion, inspired by the local landscape, using the skin, seeds and pomace of the grape, to which it adds vine leaves and aromatic plants specific to the territory such as rosemary, lavender and fennel.

It is an initiative that, far from wanting to make use of the large amount of by-products generated by the wine sector, becomes an example of how they can be used to give rise to new innovative and unique products.

Product

Infusion using by-products of the harvest.

Link

https://shop.recaredo.com/ca/producte/infusions-vespres-de-verema/

To find out more

RIBAS-AGUSTÍ, Albert; JOFRE, Anna; BOVER-CID, Sara. (2021) "Valorisation of organic horticultural surpluses". *TECA: Food Technology and Science,* Vol. 20, no. 20 p. 39-44, https://raco.cat/index.php/TECA/article/view/395463.

Food and Agriculture Organization of the United Nations (FAO) (2011). Global food losses and food waste – Extent, causes and prevention [online]. Rome: FAO. http://www.fao.org/3/a-i2697e.pdf

VILAS-FRANQUESA, Arnau; CASERTANO, Melania; TRESSERRA-RIMBAU, Anna; VALLVERDÍ-QUERALT, Anna; TORRES-LEÓN, Cristian (2023). Recent advances in bio-based extraction processes for the recovery of bound phenolics from agro-industrial by-products and their biological activity. *Critical Reviews in Food Science and Nutrition*, 1-25. https://www.tandfonline.com/doi/abs/10.1080/10408398.2023.2227261

MANZANO, Paulo (2016). Characterisation and valorisation of fruit by-products in the food industry. Final degree thesis. Higher School of Agriculture. Polytechnic University of Catalonia (UPC).

https://upcommons.upc.edu/bitstream/handle/2117/99285/memoria.pdf?sequence=1&isAllowed=y

DACC Website
https://agricultura.gencat.cat/ca/ambits/alimentacio/malbaratament-alimentari/

Authors

Alba Graells Roca
Food loss and wastage prevention technician.
Sub-directorate of Transfer and Agri-Food Innovation.
DACC.
albagraells@gencat.cat

Carlos Guirado Gonzalez
Food loss and wastage prevention technician.
Sub-directorate of Transfer and Agri-Food Innovation.
DACC.
carlesguirado@gencat.cat

BIOECONOMY
and socio-environmental resilience

Forest ecosystem. Photo: Francisco Lloret.

01. Context

In 2021, the Government approved the objectives and content of the Bioeconomy Strategy of Catalonia 2030 (EBC2030), which defines the bioeconomy as "a circular and sustainable economic model based on the use of renewable and local biological resources for produce goods and services in all economic sectors". The specific objectives of the EBC2030 are to (i) improve the use of biomass in Catalonia; (ii) develop a business network based on the circular bioeconomy throughout the territory, with special attention to the primary sector; (iii) promote the use and consumption of bioproducts, bioenergy and biomaterials in the market; and (iv) promote resilient agroforestry landscapes and the sustainable provision of ecosystem services.

The EBC2030 meets the main objectives of the European Bioeconomy Strategy approved by the European Commission (EC) in 2012, which are the sustainable management of natural resources and the mitigation and adaptation to climate change. These objectives are maintained in the 2018 update of this Strategy, which explicitly incorporates the concept of the circular economy, the protection of ecosystems and the understanding of the ecological limits of the bioeconomy, with a special emphasis in the fact that its development is done by alleviating the pressures on the environment and its values, protecting its biodiversity and promoting the set of ecosystem services.

EBC2030 also connects with the European Green Deal approved by the EC in 2019, which aims for Europe to become climate neutral by 2050 through five pillars: climate (with a specific regulatory provision), energy (decarbonising the different sectors), buildings (promoting refurbishment to make them more energy efficient), industry (supporting its reconversion) and mobility (promoting less polluting, healthy and cheap forms of public and private transport). The European Green Deal has become the central framework of reference in relation to the European Economic Recovery Plan to deal with the effects of the crisis caused by Covid-19. It also links with three major European strategies approved in 2020: the Biodiversity Strategy (reinforced in 2023 with the approval of the European Nature Restoration Act), the European Forestry Strategy and the Farm to Fork strategy. It is therefore a clear alignment of European policies, in which the implementation of the European Bioeconomy Strategy plays a prominent role, and where it is emphasised that the bioeconomy must be circular and an agent of conservation of biodiversity and natural capital.

02. Bioeconomy and functioning of ecosystems

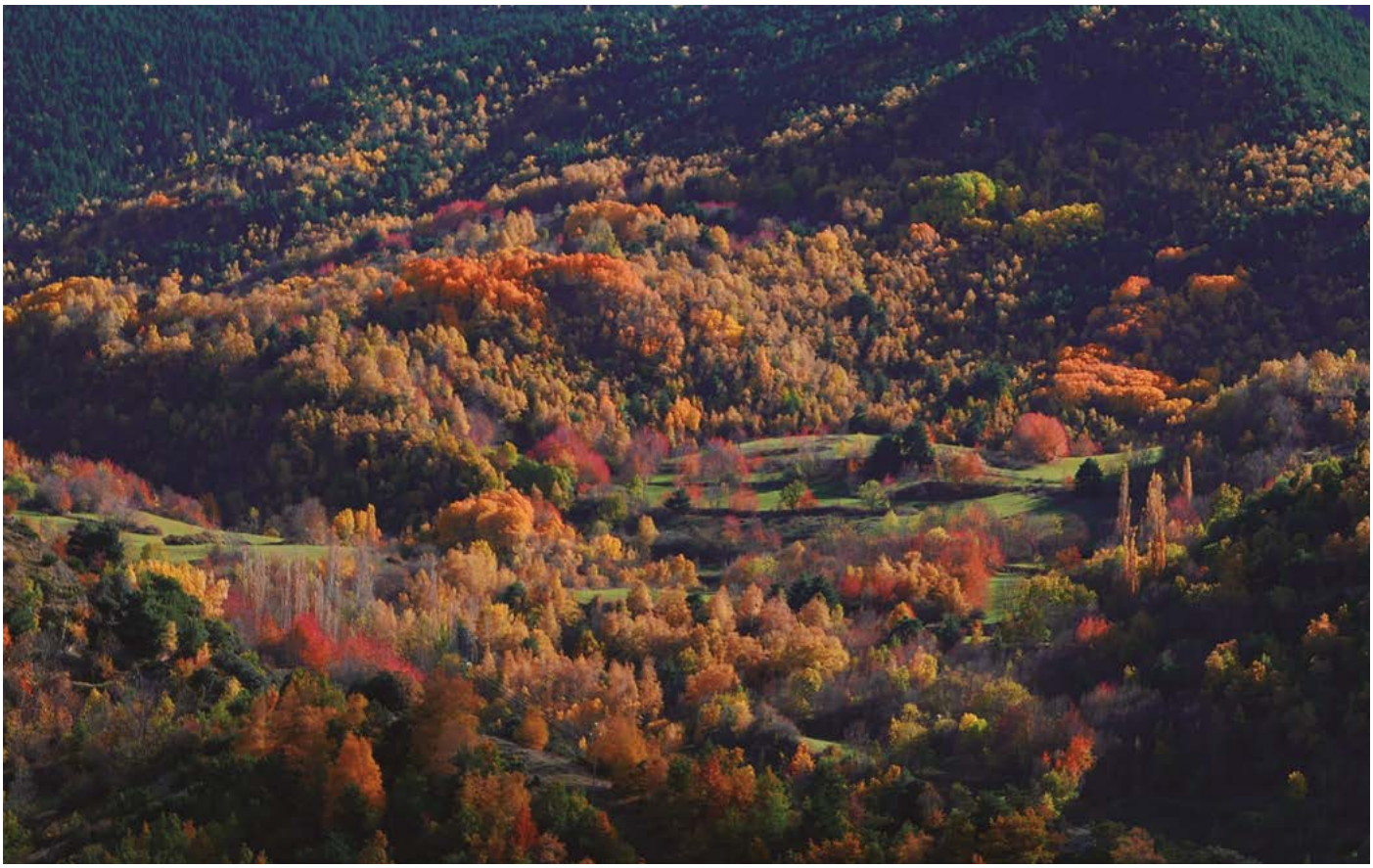
The commitment to the bioeconomy arises from the realisation that we cannot continue to deplete resources and degrade the ecosystems that are the basis of our societies. It is part of a new inclusive paradigm where the distinction between society and the natural environment fades away and the concept of a socio-ecological system emerges that integrates both natural and socio-economic processes, and in which the cross-influence of the two components in terms of the respective health of both ecosystems and people (in accordance with the One Health conceptual framework). This new look puts the focus on the ecological processes that take place in ecosystems and on their intimate relationship with human societies, to determine that the use of ecosystems must be sustainable. Therefore, the development of the bioeconomy is only understood as possible if the maintenance of functional and healthy ecosystems is guaranteed at all times.

EBC2030 meets the main objectives of the European Bioeconomy Strategy approved by the European Commission.

The bioeconomy emphasises the goods and services we obtain from ecosystems (as captured, for example, by the Intergovernmental Panel on Biodiversity and Ecosystem Services, IPBES; www.ipbes.net). These include provisioning services (such as the production of food, energy sources, materials and chemicals), regulation services (climate, water cycle, erosion control) and cultural services (aesthetic and recreational, spiritual or educational). The most current views of ecosystem services place them in the more inclusive framework of nature's contributions to people (NCP), which focuses on the cultural aspects and social values that contextualise these contributions. All this new conceptual framework also allows us to define positive future scenarios regarding the relationship between societies and nature (such as *Nature Futures Framework* (NFF) of the IPBES; www.ipbes.net/scenarios-models), and that can help design and evaluate policies at multiple scales. The awareness that people's well-being depends on the maintenance of healthy and diverse ecosystems has also given rise to the concept of nature-based solutions (NBS), which uses the processes that take place 'naturally' in ecosystems as a key element in addressing today's environmental challenges, including mitigation and adaptation to the climate emergency.

But what makes an ecosystem functional and able to stay healthy? Research in ecology in recent decades has shown that one of the key aspects that determine the functioning of ecosystems, perhaps the most integrative, is biodiversity in a broad sense. More diverse ecosystems tend to be more productive and more stable (and therefore more resilient to disturbance), and this has been shown in a multitude of experiments, modelling work and observational studies in a wide variety of terrestrial and aquatic ecosystems. There are many processes that explain this central role of biodiversity, but most can be summarised in one: the complementarity between species. The more species we have in a community and, above all, the more different those species are in their functioning, the more efficient the use of resources (e.g. energy, matter) in the ecosystem, and the wider the range of conditions that these species (as a whole) can tolerate. In the same way, a greater functional diversity of species promotes the multifunctionality of ecosystems, that is to say, a wider range of their services (or contributions), from which we can benefit. Functional diversity and multi-functionality are one of the safest bets in a context of accelerated changes, both in environmental conditions and in social dynamics.

The implications of biodiversity for the current and future dynamics of ecosystems, and their contributions to society, are enormous. For example, we know that in the current context of climate warming, Catalan forests are changing towards a greater dominance of drought-tolerant species, which have low growth rates. This should imply a reduction in the productivity of forests, but this reduction



Forest ecosystem. Photo: Francisco Lloret.

is much less than expected because we have increasingly diverse forests, especially in terms of drought tolerance mechanisms, which makes them able to work in a wider range of conditions. In this case, biodiversity is acting, at least for the time being, as insurance against a negative consequence of climate change. This central role of biodiversity in the current and future functioning and dynamics of ecosystems is explicitly recognised in all strategies to promote the bioeconomy.

The development of the bioeconomy is only understood as possible if the maintenance of functional and healthy ecosystems is guaranteed at all times.

03. Promoting the bioeconomy in the face of global change: resilience as a key value

The commitment to the bioeconomy is, in short, inseparable from the need to face a global change that has exacerbated the environmental crisis in which we find ourselves. This change is forcing to incorporate the principles of the bioeconomy not only in the productive activities directly related to the extraction of natural resources (such as agriculture, livestock, fishing, the forestry sector or mining), but also in all sectors that are directly or indirectly related to the environment (such as health, culture, leisure or the provision of water and energy).

Thus, the exhaustion of natural resources and the deterioration of environmental quality lead us irremediably to the urgency of applying new models of sustainability and circularity, which are making up the new bioeconomy. In addition, the destruction of biodiversity leads to the loss of essential functionalities of ecosystems and threatens the basic principles of human societies, which the bioeconomy also faces. As we mentioned before, greater biodiversity provides alternative ways to maintain the processes of ecosystems, such as the fixing of atmospheric carbon or the recycling of chemical compounds, as well as a wider range of responses and the ability to adapt to an environment in constant change. Therefore, the bioeconomy must be proactive in the maintenance of biodiversity, given that the success of its operation is based on the natural processes that depend on it.

Climate change, included in global change, entails a series of profound alterations of the socio-ecological system. Among these alterations we find an exacerbated climate variability which in the case of Catalonia is expressed in an increase in heat

waves and prolonged periods of drought which, in addition to catastrophic events such as forest fires, affects the agricultural, health and all the production chain dependent on regular water supply. The integration of the bioeconomy into an ecosystem's functioning channelled by its biodiversity will allow it to better deal with disturbances and alterations that jointly affect the ecosystems and the social environment itself. This ability of socio-ecological systems to maintain their essential functioning, adapting as much as possible to new situations, is what we know as resilience. Obviously, this socio-ecological resilience is intimately associated with that of ecological ecosystems and also incorporates the socio-economic component.

Knowing the mechanisms that provide resilience becomes, therefore, the fundamental preliminary step for implementing strategies and actions, and getting ahead of situations of deterioration. Therefore, the bioeconomy must incorporate and guarantee the maintenance of these mechanisms in order to also become resilient in the current context of climate and socioeconomic change. Some of these mechanisms are the diversification of agents (and therefore biodiversity, as explained above) and the extensification of processes (as opposed to the intensification, for example, of land use or agro-livestock and forestry activities), connectivity (although modulating it with certain filters to avoid the spread of disturbances), the utilisation and recycling of surpluses and waste, or the incorporation and adaptation in new contexts of information previously generated. These general principles must be applied to local situations, taking into account their potentialities, but without exceeding the limits that mark the sustainability of the multiple functionalities of the ecosystem (for example, in terms of ecosystem services), as establishes the European Biodiversity Strategy. Despite recognising that these local systems are immersed in wider systems until reaching a global scale, this sustainability is not compatible with a circulation of goods between distant regions directed exclusively by commercial criteria.

The depletion of natural resources and the deterioration of environmental quality lead us irremediably to the urgency of applying new models of sustainability and circularity, which are making up the new bioeconomy.

04. Conclusion

Ultimately, the bioeconomy must be conceived as a transformative framework for our productive relationship with nature, governed by ecological principles and focused on ensuring the sustainability of the socio-ecological system and its resilience in the face of environmental change. This entails the need to identify the main mechanisms involved and the operational ways to implement them, and it will only be possible through the promotion of scientific knowledge, the development of effective tools (models, maps, etc.) and the dialogue between scientific knowledge, management practice and public policy planning and action.

To find out more

BIGGS R, SCHLÜTER M, SCHOON M.L. (2015). *Principles for building resilience. Sustaining ecosystem services in social-ecological systems.* Cambridge Univ. Press, Cambridge

DÍAZ, S. et al. (2018) Assessing nature's contributions to people. *Science* 359: 270-272.

DÍAZ, S. et al. (2020) Set ambitious goals for biodiversity and sustainability. *Science* 370: 411-413.

European Commission. Directorate-General for Research and Innovation. Unit F – Bioeconomy (2018) A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. European Commission.

GARCÍA-VALDÉS, R; VAYREDA, J; RETANA, J; MARTÍNEZ-VILALTA, J (2021) Low forest productivity associated with increasing drought-tolerant species is compensated by an increase in drought-tolerance richness. *Global Change Biology* 27: 2113-2127.

TILMAN, D; ISBELL, F; COWLES, JM. (2014). Biodiversity and Ecosystem Functioning. *Annual Review of Ecology, Evolution, and Systematics* 45:471-493.

Authors

Francisco Lloret Maya
Professor of Ecology at the Autonomous University of Barcelona (UAB).
CREAF researcher
francisco.lloret@uab.cat

Jordi Martínez-Vilalta
Professor of Ecology at the Autonomous University of Barcelona (UAB).
CREAF researcher
jordi.martinez.vilalta@uab.cat

Josep Maria Espelta Morral
CREAF researcher
josep.espelta@uab.cat

Joan Pino Vilalta
Professor of Ecology at the Autonomous University of Barcelona (UAB).
Director of CREAF
joan.pino@uab.cat

THE BIOHUB CAT: the hub of Catalonia's bioeconomy

Photo: Shutterstock image bank.

01. The transformation towards the bioeconomy

The Bioeconomy Strategy of Catalonia 2030 promotes the transformation of the Catalan economy towards a model based on the sustainable use of renewable biological resources. This transformation involves the replacement of a large part of the raw materials and means used in the current production processes, but also the creation of new value chains and new product categories. In a global scenario with increasingly frequent disruptions to security and the cost of supplies, strengthening productive systems based on local natural capital is not only a tool to fight against the climate emergency and for the preservation of ecosystem services, but an opportunity to create a more resilient industrialisation that contributes to the territorial rebalancing of the country.

The transformation towards a bioeconomy involves the replacement of a large part of the raw materials and means used in the current production processes, but also the creation of new value chains and new product categories.

Although it is society as a whole that urgently needs to redefine the relationship between the economy and the

environment, it is companies that carry out this transformation. And they are also the ones who assume the risk of paving the way for the implementation of new resources, new technologies, more expensive processes (due to lack of maturity or economies of scale) and alternative goods that must compete on the market with conventional ones. The bioeconomy starts from renewable resources, but it is necessary to find a way to create and capture the maximum added value from these resources and for companies to gain competitiveness. The role of the other actors in this field must therefore be to smooth the way forward for companies.

02. The barriers to achieving the transformation

Economic transformations are systemic changes, complex processes that require the simultaneous activation of levers in different but complementary areas that, taken together, contribute to overcoming obstacles. A company that wants to replace a raw material or an energy source needs to know the availability and composition of potential alternatives, the logistical complexity of their collection, the technologies available to transform them and their degree of maturity. And you will also have to calculate the impact of changes in production costs, the amortisation of investments, the impact on the characteristics of the product and the reaction of the market, among others. In addition, it is often not easy to know the regulatory restrictions that affect the movement, storage, location or utilisation of certain organic matter for particular uses (even if it is after a long and strict production process that technically eliminate health risks, for example). Also, after having overcome all the obstacles on paper, in order to implement the transformation it is necessary to have specialist personnel, supportive ecosystems and symbioses that make industrial management easier and adequate lines of financing that understand the specific characteristics of the transition to the bioeconomy. The case of companies that have by-products that are not being valorised or that of companies that want to launch new categories of products on the market are quite similar, with an even greater degree of uncertainty in the latter.

Overcoming barriers of such a diverse nature requires solutions that are also very heterogeneous, and which must be driven by different types of actors who have skills in each of the areas of work. Thus, for example, universities need to experiment with new valorisation routes and technology centres need to develop and optimise processes and equipment (in both cases with maximum cooperation with companies), administrations must adapt regulation and promote measures that reduce the market gap and encourage the discovery of opportunities, and training centres at all levels must train people in engineering, technology and operations to meet the demand for professionals. At the same time, it must be borne in mind that the development of the bioeconomy (either through changes in the current value chains or the creation of new chains) makes possible the emergence of companies that provide all kinds of services aimed at overcoming these barriers, especially technological developments.

Economic transformations are systemic changes, complex processes that require the simultaneous activation of levers in different areas.

Photo: Shutterstock image bank.

03. The one-stop shop for development of the circular bioeconomy

Some of the difficulties presented need a specific solution for each business, as they are particular to each process, matter or destination. Others, however, require background, cross-cutting work that drives forward the context, entrepreneurs and professionals, researchers, administrations and public opinion. In all areas, Catalonia has suppliers who can help companies at any point in the innovation process and who also have the ability to positively influence the transformation of the

Photo: Shutterstock image bank.

The hub of Catalonia's bioeconomy has been set up as the point of reference to which companies can turn to details their needs and find the best alternatives for tackling them.

economic system as a whole. However, these services, provided by a large number of public and private entities, are not organised, structured or coordinated, and it is not easy for companies, entrepreneurs and natural persons who are potential users to know them or to have access to it

In this context, the hub of Catalonia's bioeconomy is constituted as the point of reference to which companies can turn to expose their needs and find the best alternatives to face them. To fulfil this function, the BioHub CAT must collect, organise and promote the capacities of public and private entities that develop and offer solutions and knowledge. In no case may the hub directly provide services already offered by the associated entities, and it needs to ensure that resources are not duplicated and efficient. In addition, as an integrating centre for the country's activity in the field of the bioeconomy, and given the collaborative nature of its governance, the BioHub CAT also needs to promote synergies between the actors and become a space for strategic debate, which influences and promotes coordination between future country strategies and reinforces the positioning of the Catalan ecosystem in Europe. The BioHub CAT is a transformative action included in the 2022-2024 Action Plan of the EBC2030 and has materialised as a result of an agreement between the Department of Climate Action, Food and Rural Agenda, the Lleida Regional Council (Diputació de Lleida), the Lleida City Council (Paeria de Lleida) and the Parc AgroBioTech Lleida.

04. Objectives and lines of action of the BioHub CAT

The analysis of the barriers described above that was carried out prior to the start-up of the BioHub CAT has made it possible to define the strategic objectives (SO) of the office in a practical and complementary way to those specific to the EBC2030, in a way that is focused on overcoming challenges and systemic change. These objectives are as follows:

- SO1. Offer and promote specific services to support the reduction of risks associated with the development of business models in the circular bioeconomy.
- SO2. Contribute to creating the ideal environmental conditions for attracting bio-industries and improving the competitiveness of existing ones.
- SO3. Bring together the actors of the RDi system and facilitate their orientation towards solving the challenges of companies.
- SO4. Encourage public and private demand for products and services linked to the circular bioeconomy model.
- SO5. Contribute to the definition, implementation and validation of policies and public support instruments.
- SO6. Foster alliances with the main European referents.

Specific objectives	Lines of action	Brief description
SO1 Services for the reduction of risks	BIOHUB CAT Tech	Open access pre-industrial escalation facilities
	BIOHUB CAT Feedstock push	Observatory of renewable resources that can be valorised
	BIOHUB CAT Business services	Business support services
	BIOHUB CAT Accelerator lab	Support for entrepreneurship in the bioeconomy
SO2 Environmental conditions	BIOHUB CAT Arena	Territorial planning model
	BIOHUB CAT Industrial parks	Specialised industrial areas, with synergies
	BIOHUB CAT Skills	Professional profiles and training activities on offer
	BIOHUB CAT Sustainability constraints	Coexistence between value chains
SO3 RDi system	BIOHUB CAT RDi nodes	Exploitation of the capabilities of the RDi system
SO4 Incentivise demand	BIOHUB CAT Awareness	Citizen awareness-raising
	BIOHUB CAT Market pull	Promotion of the consumption of bioproducts and bioenergy
SO5 Policies and public instruments	BIOHUB CAT Policy instruments	Regulatory adaptation for the reduction of barriers and promotion of the bioeconomy
SO6 European positioning	BIOHUB CAT EU links	Missions, exchange of experiences, promotion of participation in European projects

Table 1. *Specific objectives and lines of action of the BioHub CAT. Source: own work.*

These objectives have given rise to a total of 13 lines of action (Table 1), which define the areas of work that need to allow us to overcome the current and future challenges associated with the deployment of the circular bioeconomy in Catalonia.

In short, the Biohub CAT is a tool to achieve the milestone set by the EBC2030 to develop a business fabric based on the bioeconomy throughout the territory. And to achieve this, as the Strategy also explains, it is necessary to promote the joint work of companies throughout the value chain to attract supply and demand, a definition that corresponds to that of a hub. Therefore, the success of the BioHub CAT action will lie in the active participation of the actors who make up (and those who will make up) the Catalan ecosystem of the bioeconomy, who work in the collective construction of a more sustainable and innovative future on the basis of our renewable biological resources and our knowledge.

To find out more

Bioeconomy Hub of Catalonia
https://biohub.cat/

Authors

Victor Falguera Pascual
General Coordinator of the Bioeconomy Hub of Catalonia
vfalguera@biohub.cat

A FAVOURABLE POLITICAL CONTEXT in a difficult social environment for the Catalan bioeconomy

Photo: Pixabay image bank.

01. A favourable political context

Attempts to move towards a more circular economy which is based more on endogenous resources are nothing new and indeed have been numerous (in Catalonia, for example, it has been more than three decades since the By-products Exchange was created, which set out from the same philosophy), but they have rarely succeeded in changing the course of things. In a way, they are attempts which run against the grain of a linear economic system that is based on the extraction of resources and the generation of waste without paying attention to the ecological and social consequences that all of this entails.

Now we may find ourselves at a watershed, with a global context characterised by a three-pronged energy, ecological and climate crisis, which could shake the foundations regarding the supply of basic factors for the operation of the model and, therefore, open the door to facilitate the transition towards sustainability. In fact, we are already in the middle of the restructuring of the energy matrices and the redefinition of globalisation, which will involve the relocation of many economic activities. This is what has been understood by the European institutions, which have launched an enormous financial plan (*European Green Deal*) aimed at modifying the productive and energy structures of the continent (*RePower-EU*) (EC 2019, 2022).

> We may be at a turning point that can open the door to facilitate the transition towards sustainability.

This is the context in which the Bioeconomy Strategy of Catalonia 2030 must be deployed, which aims to "reduce dependence on fossil and mineral fuels, promote a better integration of ecosystem services and biodiversity in the economy and promote economic development and the creation of new jobs in accordance with the principles established by the SDGs" (EBC2030, Department of Climate Action, Food and Rural Agenda, 2021:17). It is a context that provides favourable elements, such as the urgencies and needs derived from the multiple crises mentioned above and the commitments that have been expressed (and financed) by the European institutions and governments at the different levels, but also serious obstacles, such as resistance to a change in model on the part of the economic and social sectors that could be perceived as losers, who will most likely raise conflicts and express negative views regarding that necessary change.

For this reason, the design and implementation of the EBC2030 would require the accompaniment of a strategy to manage the perceptions and expectations of those sectors that may be harmed by it, and this entails considering relations with a citizenry that does not always perceive the benefits, while feeling exposed to the risks of this transition.

02. A difficult social context

A glance at the proposals expressed in the ECB2030 document allows us to deduce different situations in which certain populations or sectors of activity can be perceived as exposed to suffering damage or losses of different types.

Firstly, circular bioeconomy activities can compete for land uses with other activities in the territory. Currently, for example, the tensions between agricultural and energy uses have resulted in a conflict that has considerably slowed down the transition towards a renewable matrix. It seems clear that bioeconomy activities will require the conversion of agricultural and forestry uses, as well as the construction of a series of facilities on the territory. We find ourselves in a context in which rural populations, scarred by a series of historical losses, are on the defensive against a new modernising wave that will restructure the distribution of damages and benefits, usually relegating them to the status of victims watching as the benefits travel far from their territories. How can we prevent the circular bioeconomy from contributing to maintaining or increasing this perception of plunder?

A look at the ECB2030 proposals allows us to make out different situations in which certain populations or sectors of activity can be perceived as exposed to suffering damage or losses of different types.

Secondly, the circular bioeconomy activities will need a series of facilities for the management of organic waste that may cause discomfort to nearby populations (odours, pollution, etc.), which people may perceive as threats to their health and well-being, or their economic activities (depending on how they are managed, they may not be compatible with rural tourism, the image of quality food production, etc.). If prior work has not been done to jointly build expectations with these sectors, misgivings may be inevitable and difficult to manage.

Thirdly, a modification of the territorial economic fabric such as that proposed by the EBC2030, if it does not contain compensation, involvement and listening mechanisms, could contribute to making the territory available to large external companies and feed the extraction-centric dynamics to which the agricultural and rural environment has often been subjected. In an economic context like the current one, and with a future sector of the bioeconomy that will predictably need economies of scale to be profitable, the change may end up leaving small local companies and local actors on the sidelines. It is a dynamic that has predominated in the agricultural world during the last few decades and that EBC2030 can contribute to support or intensify.

Fourthly, the proposals derived from the EBC2030 will require a reuse of flows of biological materials which will probably involve changes in our ways of producing, processing and consuming. It must be taken into account that, in the case of citizens, there are many people whose living and working conditions prevent them from organising themselves in different ways. It is not easy to change the consumption patterns of people who have overlong or irregular working days or unpredictable schedules, who have few resources, who suffer from highly accentuated gender roles, or who, in short, have little autonomy to modify their ways of life Changing the forms of consumption is not something that is socially neutral, but rather entails demanding transformations from the population that, for some social sectors, can be perceived as an additional sacrifice that they are not always in a position to achieve.

03. The social dimensions of the risk

In short, the productive and socio-economic restructuring that is proposed in the ECB2030 will inevitably lead to benefits and losses that could be distributed unequally between the sectors of activity and the population. The fact that there could be winners and losers conditions the perceptions and expectations of the different sectors that are challenged by this process. For this reason, the European institutions continue to insist on the concept

of a 'just transition' (EC 2021), since it is predicted that if the appropriate measures are not taken to compensate for the possible losses, the most affected sectors will raise conflicts and resistances that could hinder or make impossible the achievement of the intended objectives.

What losses are we talking about? Theories on risk perceptions can help us understand the different positions of people and groups that oppose certain transformations (Espluga et al. 2018). Often, when a person or a group perceives themselves to be exposed to a risk, it is very likely that they will put into practice behaviours and actions of protest or rejection. This perception can be made up of different dimensions that, taken as a whole, correspond to different types of perceived damage or loss. Up to five types of risk dimensions are distinguished depending on their consequences:

a. Perception of damage or loss of (human) health: in the form of illnesses, accidents, etc., caused by possible pollution and working and living conditions associated with the new activities.
b. Perception of environmental damage or loss: in the form of loss of biodiversity and ecosystem imbalances due to pollution and alteration of the soil, water, atmosphere, etc.
c. Perception of damage or economic losses: in the form of job losses, disappearance of certain activities, ecosystem restoration costs, compensation, etc.
d. Perception of socio-cultural damage or loss: with the perception of loss of local beliefs, values and traditions, changes in ways of life, erosion of local identities, loss of networks of social relationships, etc.
e. Perception of damages or losses of a politico-institutional type: reflected in the increase of mistrust in political and business institutions, perceptions of situations of injustice, inequality, iniquity, etc.

Individuals or groups can perceive up to five types of risks linked to the transition to the circular bioeconomy.

Any situation of social conflict in the face of measures such as those proposed by the ECB2030 would need to be analysed based on this five-dimension scheme, in order to find out what the weight of each one is in shaping each specific conflict.

Regarding the first three dimensions (health, environment and economic issues), there is a long experience in the creation of indicators and in the ways of measuring them, as well as in the management of the conflicts related to them. In these cases, informative, awareness-raising, communicative measures and so forth are essential, while benefit/risk compensation measures (compensation, fiscal measures, etc.) can play a key role in resolving potential conflicts.

On the other hand, the management of conflicts based on socio-cultural and political-institutional dimensions is much more complex. In the former, we refer to those cases where people protest because they perceive threats to their social networks, for example, because the installation of new infrastructure in the territory may force them to change their place of residence, may prevent their use of certain spaces or prohibit certain of their traditional activities, among other things. This is what can happen, for example, when a new industry settles in a rural region and requires a large number of foreign workers, when new environmental protection is introduced in an area, when a community area or a resource of the territory (water, forests, soil, etc.) is privatised or when certain local traditions are regulated (hunting, collection of forest products, etc.). These are situations that affect local ways of life and that part of the population can perceive as potential threats.

The politico-institutional dimension has more to do with the relationships that people maintain with institutions (public and private). Sometimes, the entities, companies or public administrations that promote a project or infrastructure have generated a public image, based

Photo: Pixabay image bank.

on past behaviour, that can mean they are viewed as untrustworthy by some sectors of the population in that territory. These are situations in which people feel slighted or victims of injustice, for example due to the perception of an inequitable distribution of risks and/or benefits between different territories or social groups. From the perspective of the population, it is not possible to express judgments about bioeconomy projects without also doing so about the companies and administrations that promote them. If the behaviour of these entities is perceived as unfair or inconsistent, certain social groups may experience it as a loss of quality of the political or economic system in which they live and, therefore, may express their rejection of those projects, not so much for the projects themselves, but as a protest against the entities promoting them.

In these situations in which the socio-cultural and/or political-institutional dimensions are predominant, however much the promoters of those changes can demonstrate with reliable data that the project will not have implications for health or the environment, or that it will bring economic benefits, it will still be difficult to avoid social conflicts. If the population perceives threats to their social networks or ways of life, or distrusts the political system, even if it is guaranteed that there will be no health, environmental or economic damage, it will be difficult to prevent the conflict from being ongoing. In fact, in these cases merely informative, communication or compensation measures, although essential, are not usually very effective for their resolution, and may even be counterproductive, since the public can interpret them as attempts at manipulation or bribery.

The only management options in these cases are participatory measures, co-design and co-decision, which should be launched well in advance of the implementation of the projects. This entails having a governance strategy that guarantees that all actors potentially affected by the territory will have a say in decision-making, from the design phases to implementation and operation, so that projects are perceived not only as to efficient or sustainable from an environmental point of view, but also as fair and equitable from a social, political and cultural point of view.

04. Conclusion

The EBC2030 has provided for a series of objectives and measures to address the social issue. Specifically, there is a cross-cutting objective which consists of "preparing Catalan society for the change towards the circular bioeconomy". Among the actions planned to achieve this goal, two main lines stand out. On the one hand, communication and awareness actions at different scales (aimed at the general public, at schoolchildren, at consumers, etc.). On the other hand, citizen involvement actions in the design and implementation of circular bioeconomy projects, as well as developing inclusive governance systems for key actors.

In this regard, it can be concluded that the EBC2030 has provided for some of the lines of work necessary to spread its benefits and involve the key actors. Another thing entirely is how they will play out in practice, since these are actions that require time and resources (more than is usually thought) and that need to be planned well in advance. One of the added difficulties is the segmentation of a Public Administration accustomed to working in watertight compartments, with a sectoral logic that interdepartmental commissions rarely succeed in rectifying. The challenge posed by the EBC2030 is of such magnitude that it can only be achieved with a global change in priorities and ways of understanding socio-economic, political and cultural dynamics, something that is difficult to manage in a coordinated manner. Rather, there is a high probability that the paradigm shift will come out of obligation (imposed by the EU, for example) or necessity (in the face of the collapse of the current energy system, for example), usually too late to be able to do so in the appropriate manner. If we were able to plan it with sufficient advance and means, we would surely have a fairer type of change with more potential to benefit the people of the territory.

To find out more

EC (2019). *The European Green Deal. COM(2019) 640 final*. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee Of The Regions. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019DC0640

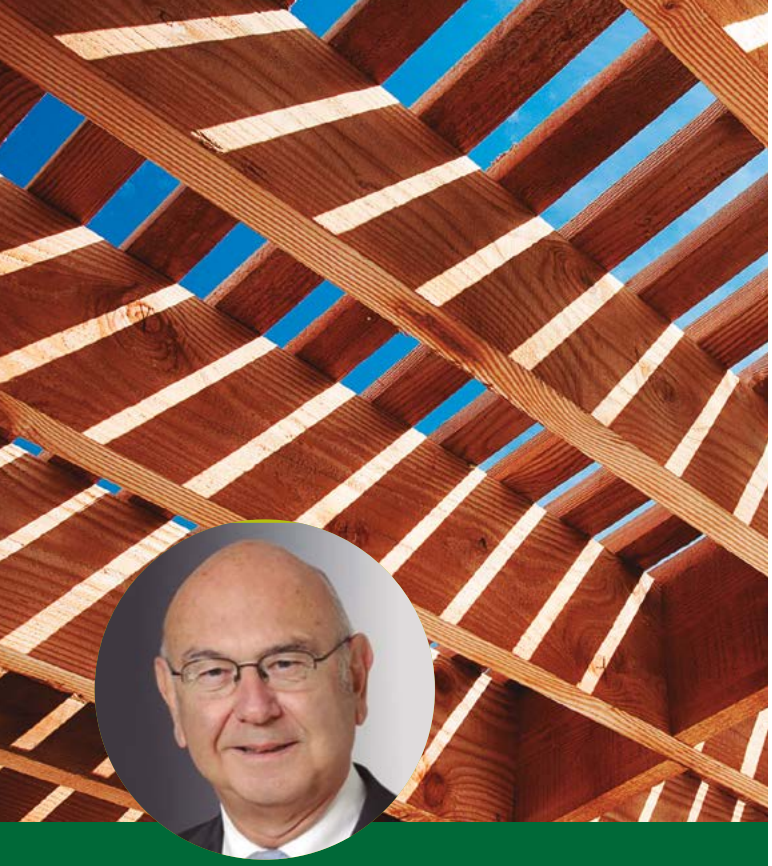
EC (2021) A fair transition towards climate neutrality. https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_6823

EC (2022) Communication REPowerEU Plan COM(2022)230 (europa.eu). https://commission.europa.eu/publications/key-documents-repowereu_en

SPLUGA TRENC, J.; RUSCHEINSKY, A.; PRADES, A. (2018) "The concept of risk and its application to the analysis of socio-environmental conflicts." A: A. Vallejos-Romero; J. Valencia Hernández & A. Boso (eds.) *Riesgos, Gobernanza y Conflictos Socioambientales (Risks, Governance and Socio-Environmental Conflicts.).* Temuco (Chile): Ediciones Universidad de La Frontera. P. 69-90,

Authors

Josep Espluga Trenc
Autonomous University of Barcelona Department of Sociology & IGOP
JosepLluis.Espluga@uab.cat



We talk to:
CHRISTIAN PATERMANN

Christian Patermann is a former director of the European Commission. Between 1996 and 2003 he was director of Environment, Sustainability and Climate and, subsequently, until 2007, director of Agriculture, Food, Forestry, Fisheries and Biotechnology of the Directorate General for Research and Technology of the EU. He introduced the concept of bioeconomy in the 7th Framework Programme, known at the time as "Knowledge-Based Bioeconomy" in Europe.

He was previously Deputy Director General of the German Ministry of Research and Science. Among other functions, he was cabinet director and spokesman.

He is a lawyer and has also studied Economics in Germany, Switzerland and Spain. He retired at the end of 2007 and has since advised governments and companies on the development of the bioeconomy.

Around 2005, the European Union started talking about the bioeconomy. Why and from what approach?

The start of the bioeconomy in Europe occurred as a result of a mixture of reasons. The European Union (EU) had just approved the first biotechnology strategy in 2002, the OECD mentioned and defined the bioeconomy for the first time in a footnote in the report "Biotechnology for Sustainable Growth and Development" in January 2004, and at that time we were thinking about the future 7th Framework Programme.

Within my Directorate, we thought that perhaps we should consider biological resources more and see their advantages. They are renewable, they give us the opportunity to be more climate-neutral and to achieve new characteristics, properties and materials while using less energy and water in production.

The commissioner authorised us to test these ideas by visiting major partners in Canada, the United States, Brazil, Argentina, South Africa, India, China, Japan, Russia and even New Zealand. And after that, we proposed a strategy and held the first sustainable bioeconomy conference in September 2005, which was officially announced as the Knowledge-Based Bioeconomy (KBBE).

The budget for the bioeconomy was €2 billion in the 7th Framework Programme started on 1 January 2007. In general, it was a research strategy that considered that the bioeconomy could contribute to sustainability if life cycle analysis corroborated this. It would not be a miraculous solution, but it could modestly contribute to solving planetary problems and would boost value chains based on producing added value to the economy.

Almost 20 years have passed since then, how has the approach to the bioeconomy in EU policies evolved?

From this 7th Framework Programme research initiative, we moved to a political model reflected in the European Bioeconomy Strategy in 2012. And our first big surprise was that all over the world these ideas were being adopted and sometimes more strongly outside than inside Europe. More and more countries considered the bioeconomy as an economic model and based their national or regional strategies on it. Today we have more than 60 countries and even more regions using a bioeconomy strategy.

However, some dangers also exist. Sometimes it seems like the bioeconomy is everywhere. And if so, this is a po-

sition of weakness. The bioeconomy must focus heavily on the use of biological resources and also on knowledge from other technologies. It has a close relationship with nanotechnology, information technologies, cognitive sciences and the digital transition.

The legal and institutional framework and standards are more important for the bioeconomy than for other economic models, due to their complexity and also because of their novelty.

We must be humble and patient. But also when there is a bio-based product or service, we must call it bio-based.

The European Commission approved the European Bioeconomy Strategy in 2012 and updated it in 2018 with an action plan. Why is it important to design and implement planning instruments to boost the bioeconomy?

The bioeconomy is one of the most complicated business models because it is based on the natural sciences. It is about life and there is nothing more complicated in our world than life. It brings change, innovation. Industry and society are often reluctant to accept change. Therefore, you need to plan to provide them with stability and security. The legal and institutional framework and standards are more important for the bioeconomy than for other economic models, due to their complexity and also because of their novelty.

In 2021, the Bioeconomy Strategy of Catalonia 2030 was approved. What aspects would you highlight about it?

The first thing I want to emphasise is that it is not only strategically oriented, but also action-oriented. Secondly, I would point out that it has a very clear structure: with facilitating objectives and very concrete, understandable and measurable actions. This is very important. And the third point is that it focuses on the achievement of the Sustainable Development Goals (SDGs): it includes the One Health approach, governance, cross-cutting skills, including education, outreach and communication. And, what I think is extremely important is that stakeholders have been involved from the beginning.

Where I see a certain deficit is in the existence of production facilities. In the end, biological production facilities such as biorefineries or biofoundries, whether smaller, larger or decentralised, are needed. My wish is that in the next four or five years you start up one or two plants.

How do you rate the Forestry Strategy in Catalonia compared to other European strategies?

I have always said that no region can do everything. All regions should focus on their strengths, their priorities and also what they think they can do better. And here in Catalonia I see that forestry is very important. You see forestry and the bioeconomy as complementary and working together. And it's wonderful that you consider resilience in agroforestry landscapes to be an important issue. This aspect is still ignored by many strategies.

In fact, in Catalonia there are enormous amounts of urban biomass, agricultural and livestock biomass and even marine biomass. We must bring production closer to consumption and strengthen this regional or local approach to the bioeconomy using local biomass.

The European Commission also needs to understand resilience a little better. We need resilience for our daily lives, in health, in access to water, soil or air.

The use of agricultural and livestock biomass at all levels is an area which still has a long way to go. What would you highlight about this side of the bioeconomy?

In fact, in Catalonia there are enormous amounts of urban biomass, agricultural and livestock biomass and even marine biomass. And that's why I think your country should not hesitate in relation to the availability of biomass because you have enough of it.

Over the last few decades, Europe has outsourced its biomass consumption. With the bioeconomy, we must go in the opposite direction, bring production closer to con-

Photo: Pixabay image bank.

sumption and strengthen this regional or local approach to the bioeconomy using local biomass. This will help us to be resilient and more efficient.

In these years of deployment of the Bioeconomy Strategy in Catalonia, what are the main changes you observe?

I see you are on the right track, but I have three wishes. The first is what I have already mentioned. Please work seriously on setting up production facilities, prototypes, demonstration biorefineries and new fermenters with the different types of biomass.

The second wish relates to forests. I would love for you to focus more on this area and think about a regional lignin research centre, either on your own or in collaboration with neighbouring regions.

And the third is that you continue to focus on funding. New mechanisms to finance these changes are extremely important because all innovation is costly. I see excellent initiatives being developed here, such as the cooperation proposal promoted by the Bioeconomy Alliance during COP 28 in Dubai, in which the CTFC is actively involved.

What do you think will be the impact on society and on the economic model in the medium term?

I am very happy that the so-called cross-cutting skills are taken into account in your Strategy, because this includes contact with society, information, communication with interest groups, etc. This is very important.

But we have to be more specific. It is not about spreading knowledge everywhere and all the time. We should focus on pressure and influence groups such as teachers, journalists, investors and public authorities, who can then amplify the message and action on the bioeconomy and, consequently, its impact.

Generalitat de Catalunya

xarxa·i.cat
Xarxa d'Innovació agroalimentària i rural de Catalunya