BBioNets

Boosting the adoption
of Bio-Based Technologies

BBTs Roadmap Implementation

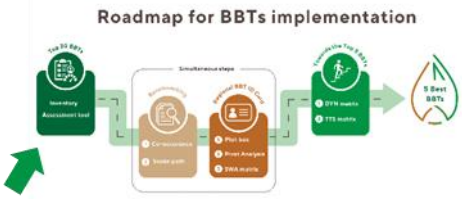
SPANISH

CREA - CONSIGLIO PER LA RICERCA IN AGRICOLTURA
E L'ANALISI DELL'ECONOMIA AGRARIA

CTA AND TEPRO

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1. Spain's top 20 BBts

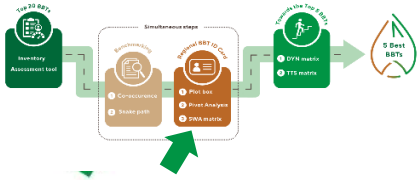
Thanks to the BBTs Assessment Tool, the **Spanish top 20 BBTs** are ranked. In particular, Table 1 provides the outlines of various projects and initiatives related to sustainable agricultural practices and the utilization of by-products and residues from farming and forestry stored in the Bio-Based Technologies (BBTs) inventory[1].

Table 1: Ranking of teh best Spanish BBTs.

BBT codes	Description BBT
EL80-OLIHERB/OLIVE	exploitation of olive leaves (rich in polyphenols and other bioactive ingredients) to produce herbal infusions and natural food additives
EL88-ΕΛΑΙΩΝΑΣ/OLFER	Utilisation of olive residues for the production of compost and biochar
EL5-BIO2CHP/B2CHP	BIO2CHP is a container-sized power generator that converts solid organic residues into energy on-site.
DE4-Lignocellulosic Biorefinery/LIGNO	Anaerobic digestion of farm residues (wood, grass, straw)
IT11-Clean-ER/CLINR	small wood chipping machine for collecting wood biomass from mountain forests and their pyrolysis to obtain energy and biochar
EL84-AGROSCHOOLBUS.BIO/RESOL	recovery of the nutrients contained in the residues (branches, leaves) of olive trees (and other productive trees) through composting
ES58-AgriCarbón/AC	Production of activated carbon using agricultural waste.
ES64-Biochar/BIOCH	Use of purnings for biochar production.
ES66-OleoValoriza/OLIVE	Recovery of sludge from olive-mill ponds through a composting process.
ES67-OleoValoriza/OLIV2	Use of olive trees residues to produce compost
IT6-Scarabeo/HMP2C	Hemp stems are collected, their fibers are separated through maceration, fibers are fed to BSFL and the woody marrow is pyrolized
FI3-ForestChip4Farm/FC4FH	farm-level heating plants (400-500kW) to use fresh forest-chips
ES65-BIORUMIOLI/FEED	Use of olive pulp as feed for small ruminants.
EL87-Innovative Rice Residue Management Practices/RICE	Rice residues returning to the soil as fertilisers
ES59-AGUACAVALUE/BYPRO	Use of avocado by-products in animal nutrition
ES63-BIOSUERO/WHEY	Use of whey as a biofertiliser.
IE1-Biorefinery Glas/GLAS	Perennial ryegrass can be pressed to produce Press Cake, which can be used as cattle feed. Grass Protein and Grass Whey are byproducts that can be used as feed for chicken and pig, and as fertiliser, respectively.
PL74-Polish Apples/PolishApples	developing fermented juice and compostable disposable packaging from apples
PL90-Agroleśnictwo w Dolinie Zielawy/Zielawa Herbs	Innovative model for production, processing and distribution of herbs
EL82-COMPOST-INNO/COMPO	improvement of compost production from the processing of by-product-waste mixtures from various sources

Source: Bio-Based Technologies (BBTs) inventory

[1] The Inventory and the Assessment Tool are freely and publicly accessible through the BBioNets project website (www.bbionets.eu).



2 Benchmarking: Regional characterization

In this step, the objective is to characterize the top 20 Spanish BBTS, both in relation to the top 20 selected for other regions (co-occurrence) and in terms of their overall positioning along the dimensions of efficiency and effectiveness (the snake).

The co-occurrence matrix (Table 2) is used to analyse the simultaneous presence of two or more BBTs in different regions, setting the Spanish region as a pivot, through the representation of a binary matrix.

Table 2: Co-occurence matrix for Spain

BBT codes	Code	ES	IT	IE	PL	EL	CZ	TOT
EL80-OLIHERB/OLIVE	EL80	1	1		1	1		4
EL88-ΕΛΑΙΩΝΑΣ/OLFER	EL88	1	1			1		3
EL5-BIO2CHP/B2CHP	EL5	1	1	1	1			4
DE4-Lignocellulosic Biorefinery/LIGNO	DE4	1		1	1	1	1	5
IT11-Clean-ER/CLINR	IT11	1		1			1	3
EL84-AGROSCHOOLBUS.BIO/RESOL	EL84	1	1	1	1	1		5
ES58-AgriCarbón/AC	ES58	1	1			1		3
ES64-Biochar/BIOCH	ES64	1				1		2
ES66-OleoValoriza/OLIVE	ES66	1	1			1		3
ES67-OleoValoriza/OLIV2	ES67	1	1			1		3
IT6-Scarabeo/HMP2C	IT6	1		1	1	1		4
FI3-ForestChip4Farm/FC4FH	FI3	1					1	2
ES65-BIORUMIOLI/FEED	ES65	1	1			1		3
EL87-Innovative Rice Residue Management Practices/RICE	EL87	1	1			1		3
ES59-AGUACAVALUE/BYPRO	ES59	1	1		1			3
ES63-BIOSUERO/WHEY	ES63	1	1			1		3
IE1-Biorefinery Glas/GLAS	IE1	1		1	1			3
PL74-Polish Apples/PolishApples	PL74	1		1	1			3
PL90-Agroleśnictwo w Dolinie Zielawy/Zielawa Herbs	PL90	1						1
EL82-COMPOST-INNO/COMPO	EL82	1		1	1	1		4

Spain shows strong relationship with Greece and Italy in implementing multiple BBTs—particularly olive-related ones—while seven originate from Spain, most others come from the Mediterranean area and a small amount form northern Europe.

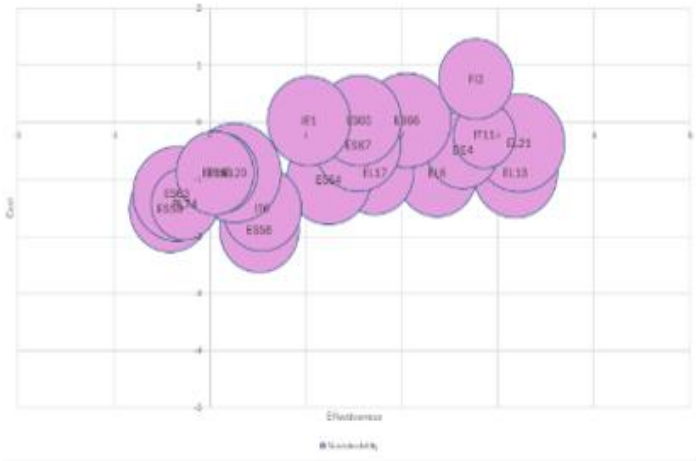


Figure 1: Snake path for Spain

The Figure 1 illustrates the so-called “snake” representing the Top 20 BBTs in Spain compared with the other six regions. Compared to other regions, **Spanish** BBTs are closely clustered and distributed across three quadrants (first, third, and fourth). The effectiveness dimension stands out as particularly significant, forming a snake-like pattern along the x-axis that reflects both positive and negative relative values. Regarding costs, two opposite conditions can be observed: some BBTs operate under cost-saving circumstances, while others face critical situations with negative values.

3 Regional BBT ID card

The **plot box graph** presents the distribution of the three variables brought back to a common range of variability (adjusted), i.e. efficiency, cost, sustainability, of the total 113 BBTs presented in the Bio-Based Technologies (BBTs) inventory, according to the Spanish ranking (BBTs Assessment Tool).

In the Spanish case, **COST_adj** displays the widest dispersion, indicating strong discrimination between observations, from very high to extremely low values. **SUST_adj** drops below zero but with less variability, while **EFF_adj** remains comparatively stable. Overall, **COST_adj** appears the most selective yet potentially distorting, whereas **SUST_adj** stands out for its concentration in higher values, highlighting top-performing cases.

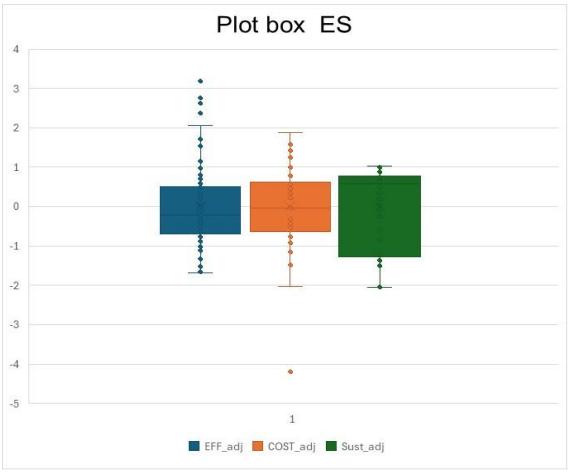
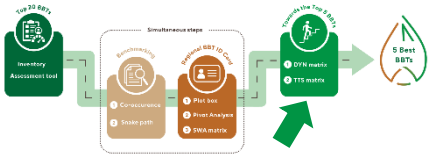


Figure 2: Spanish Cost–Sustainability–Effectiveness box plot.

Table 3: Spanish SWA matrix

	Strong Factor	Weak Factor	Ambiguous Factor
Reference sector	A1.6Support activities to agriculture and post-harvest crop activities (14)	A2.1Silviculture and other forestry activities (1); A2.4Support services to forestry (1) A1.2Growing of perennial crops (4)	
Funding	Rural development 2014-2020 for Operational Groups (15)	Other EU research funds (1) Other rural... (3) Other public research funds (1)	
Partner (n°)			n.r.
Type partner	Advisor (13) ; Researcher (32); Processor or retailer (14); Farmer (25)	Forester (0) ; trainning bodies (0), ngo (1); public authority (3)	
Focus area	Pirority 5: FA 5E: Fostering carbon conservation + FA 5D: Reducing greenhouse gas ; FA 1B: Strengthening the links (6)	FA 1A: Fostering innovation (1); FA 2A: Improving the economic performance of all farms (1); FA 4B: Improving water management (1); FA 4A: Restoring, preserving biodiversity (1)	
Status			n.r.: Completed (10); Ongoing (10)
Geographical scale	Local & regional (18)	National (2)	
Key words	Circular economy, incl. waste, by-products and residues (10)	Forestry, soil, climate change, agro-ecology, energy.	
BBT categories	Crop residues and perennial plants F1 (16); Biorefineries C2 (12)	Designer crops for optimised biomass content F2 (2); Algae biomass F3 (2)	
Feedstock	Biomass residues (13) (Olive, avocado, forest resideues)	Biomass (mixed biomass, ryegrass) (3), waste (apple by-products, breeding by-products) (4)	
Outcome	Agronomic input (10) (Biochar, fertilizer)	Natural additives (3), breeding input (4)	
TRL			n.r.
Mobility	Mobile (12)		
Availability	3 - High potential - (15)	2 – Medium potential (5)	
C sink	3 - High potential	2 – medium (6) ; 1 – Low (6)	n.r.
Conditions			
Complexity	2 -easy to use /replicate (9)	1 - very easy to use/replicate (3)	
Sust eco	3 - High potential		n.r.
Sust socio	2 - Medium potential (10)	3 - High potential (3)	
Sust envi	3 - High potential (17)	2 – médium (3)	
Value added	Food/Feed = High (8)		

The Spanish **SWA** (Strong, Weam Ambiguous Factors) **Matrix (Table 3)** is based on the first 20 Spanish BBTs, processed using a pivot scheme. The matrix highlights the factors most frequently represented across these BBTs and is also used to outline a hypothetical "ideal Spanish BBT." This ideal BBT would focus on agriculture and post-harvest activities, utilizing locally available biomass residues from permanent crops. It would primarily be funded through Rural Development funds at a regional scale and involve researchers and farmers as the main partners, alongside processors and advisors. Its outputs would include agronomic inputs such as biochar and fertilizers, relying on mobile, user-friendly, and replicable technologies connected to crop residues, waste, or biorefining processes. Finally, it would ensure high environmental sustainability, a strong carbon sequestration potential, and consider economic and social dimensions.



4. Towards the top 5 BBTs

The table is the **matrix of regional dynamics (DYN)** (Table 4). It represents a snapshot of the Spanish region situation in terms of biomass and technologies availability, regulation framework, support and financial policies, as well as the research and development system.
The Spanish regional dynamics are strongly influenced by the large presence of the agricultural and agro-industrial sector, which provides abundant feedstock and opportunities for bio-based applications. The bio-based industry is rapidly developing, supported by a significant financial investment in the research and development private and public sector.

Table 4: Spanish DYN matrix

BIOMASS AND TECHNOLOGY	REGIONAL DYNAMICS
Geographical Scope	coast, mountain and forest
Primary sector	**Agriculture-->** in the agricultural sector, is mainly made up of small companies (96%); permanent crops 39,8%; annual crops 35,1%; **Forestry-->** the main forest formations are holm oak forest (23.5%), pine forest (14.8%) and cork oak groves (4.33%). In Andalusia, 74.4% of the forest land is private property, while the remaining 25.6% is public. wood (92%), scrub (8%)
Agro-industrial sector	The most important agroindustry in Andalusia are the oil and fat industries, with largest production of olive oil; the meat industry, the second most important in the Andalusian agri-food industry in terms of turnover; and the horticultural industry.
Biomass availability	wineries and breweries, pruning oil, rice mills, agricultural waste, slaughterhouses, manure, wood, scrub, Alfalfa, barley, cotton, maize, rapeseed, sugarbeet, wheat
Management and logistics	processing plants to produce biodiesel or bioethanol; seasonality and storing must be considered when designing logistics circuits
Bio-based industry	Biomass electricity generation; Biogas generation; Thermal use, Pellets manufacturing; Olive bone and chip production for thermal use; Biofuels
Bio-products market	Main target markets for bio-products: bioenergy and biofuels, chemical industry, pharmaceutical industry, agriculture and aquaculture, food and beverage industry, cosmetic industry, construction, and plastic industry
REGULATORY FRAMEWORK	
Programmes	Spanish Bioeconomy Strategy; Andalusian Circular Bioeconomy Strategy; Circular Economy Law
SUPPORT AND FINANCIAL POLICIES	
Public support	Ministry for Ecological Transition; Centre for Industrial Technological Development (CDTI); regional Ogs
Private support	Investment fund; Business Angels & Venture Capital
R&D system	
R&D system associated with biomass valorisation	In turnover terms, Andalusia is the third Spanish region that invest more in research and development in absolute terms and position itself as the 5th with respect to the regional GDP

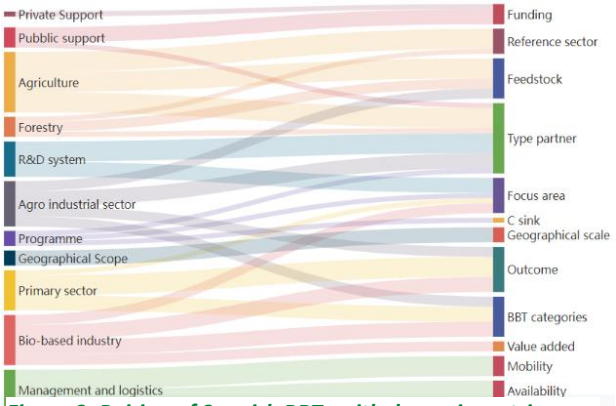


Figure 3: Pairing of Spanish BBTs with dynamic matrix components in a Sankey diagram

The cross-referencing of the DYN Matrix and SWA Matrix enables the assessment of relationship consistency among different items under a coefficient's matrix (**Techno-territorial synergy matrix TTS**). Applying those coefficients to the 20 selected BBTs could allow to estimate and identify the very best 5 BTTs in the given region.

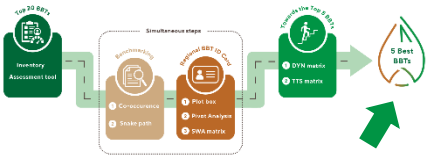
The figure uses a Sankey chart to represent the links between regional dynamics and BBTs characteristics, used to estimate the techno-territorial synergy.

The suitable best BBTs for Spain focus on the agricultural sector rather than forestry, be mainly supported by public programmes, involve farmers and R&D actors as key partners, and use agricultural biomass to supply outputs to primary and agro-industrial sectors. Key factors include biomass availability, environmental sustainability, and bio-based industry and market considerations, while economic and social aspects are less critical.

These criteria are applied to the top 20 BBTs to identify the five most suitable for the FAN area.

Table 5: TTS Spanish matrix

Spain	Geographical scope	Agriculture	Forestry	Primary sector	Agroindustrial sector	Management and logistics	Bio-based industry	Bio-products market	Programmes	Public support	Private Support	R&D system
Reference sector												
Funding												
Type partner												
Focus area												
Geographical scale												
BBT categories												
Feedstock												
Outcome												
TRL												
Mobility												
Availability												
C sink												
Sust eco												
Sust socio												
Sust envi												
Value added												
		Very high		High		Medium		Low		Nr		



5. The 5 best BBTs for Spanish region

Table 6: Spanish 5 best BBTs

Region	TTS Rank	BBT Code	Description BBT	Needs/ Problem Statement	Score
Spain	1	DE4-Lignocellulosic Biorefinery/LIGNO	Anaerobic digestion of farm residues (wood, grass, straw)	To valorize the lignocellulosic residues (meadow grass) from farms in a sustainable way.	5,69
Spain	2	EL80-OLIHERB/OLIVE	exploitation of olive leaves (rich in polyphenols and other bioactive ingredients) to produce herbal infusions and natural food additives	management of the significant quantities of olive leaves produced as by-products during cultivation (pruning), harvesting of olives and olive oil production (milling stage)	5,25
Spain	3	EL82-COMPOST-INNO/COMPO	improvement of compost production from the processing of by-product-waste mixtures from	-lack of sufficient amounts of organic waste in the cultivation sites	5,13
Spain	4	ES67-OleoValoriza/OLIV2	Use of olive trees residues to produce compost	The reuse and recovery of olive by-products are essential to reduce environmental pollution and contribute to increasing the efficiency of the agricultural and industrial sectors involved and reduce their production costs.	5,00
Spain	5	EL84-AGROSCHOOLBUS.BIO/RESOL	Recovery of the nutrients contained in the residues (branches, leaves) of olive trees (and other productive trees) through composting	Sustainable management of the residues (branches and leaves), pruning of the olive tree (and other productive trees).	4,88

The selection of the five most suitable Biomass-Based Technologies (BBTs) (Table 6) for Spain highlights the country's potential to advance a circular and sustainable model in agriculture and forestry, particularly in the olive sector, organic waste management, and nutrient recovery from residues.

The top-ranked DE4-Lignocellulosic Biorefinery/LIGNO focuses on anaerobic digestion of lignocellulosic residues (straw, wood), enabling renewable energy generation and nutrient recovery. **EL80-OLIHERB/OLIVE** transforms olive pruning by-products into herbal infusions and natural additives, promoting innovation and waste reduction. **EL82-COMPOST-INNO/COMPO** improves compost production from agricultural by-products, enhancing soil fertility and organic farming. **ES67-OleoValoriza/OLIV2** reuses olive residues for compost, reducing pollution and improving economic efficiency. **EL84-AGROSCHOOLBUS.BIO/RESOL** recovers nutrients from olive and other tree residues, supporting sustainable soil management and circular resource use.

Overall, these BBTs provide practical solutions for renewable energy, organic waste management, and value creation, fostering more sustainable and resilient agri-food systems. The Spanish BBioNets Advisory Board validated this region-specific prioritization, particularly emphasizing waste valorization in Andalusia, where technologies targeting olive residues, woody biomass, and agricultural by-products offer both environmental and economic benefits. With current trends, implementation within five years appears feasible and beneficial.

FURTHER SOURCES OF INFORMATION: Roberto Cagliero, Laura Mirra, Francesco Basset, Francesca Moino, Patrizia Borsotto (CREA), Macarena Ureña Mayenco Sofía Sánchez Seda Nathalie Chavrier Paula Rosa Álvarez María Alonso González (CTA), Maria Munoz Villalon (Tepro)

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Document information

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Project type	Coordination and Support Action
Programme	Horizon Europe – Cluster 6
Funding	1,998,636.20 €
Coordinator	Munster Technological University Ms. Carmen Girón Domínguez (carmen.dominguez@mtu.ie)
Project overview	BBioNets constitutes a thematic network that relies on, promotes, and further advances the work carried out by EIP-AGRI Operational Groups (OGs) with respect to **management and/or processing of agricultural and forest biomass with Bio-Based Technologies (BBTs)**. The project has set up 6 regional Forest and Agriculture Networks – FANs (IE, ES, IT, EL, PL, CZ) that identify local needs, prioritise specific BBTs and share BBT knowledge ready for practice to farmers and foresters, boosting the (re)definition of value chains, stimulating cross-fertilisation beyond borders, and bringing Europe to the forefront of farming, forestry and bioeconomy with economically viable and sustainable practices.
Consortium	MTU, Cegasc, IUNG Institute of Soil Science and Plant Cultivation State Research Institute, crea, CTA, American Farm School Thessaloniki, TEPRO, FOCUS, Bio East Hub

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