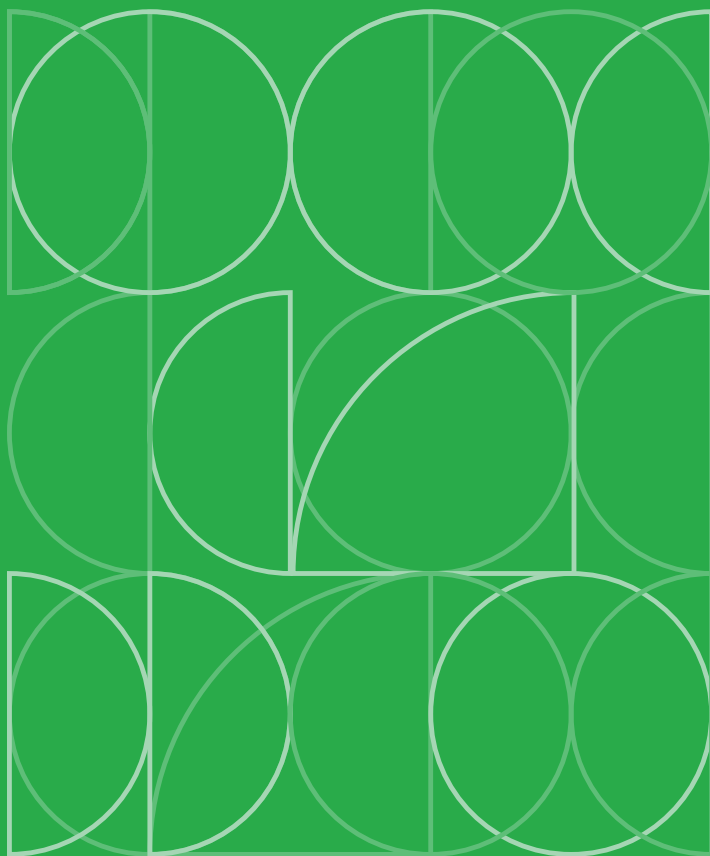




Circular  
Bio-based  
Europe  
Joint Undertaking



**A COMPETITIVE  
BIOECONOMY**  
FOR A SUSTAINABLE  
FUTURE



## UNLOCKING THE FUTURE OF THE CIRCULAR BIOECONOMY IN EUROPE

Climate change is an existential risk, and depending on fossil resources only worsens the situation. Simultaneously, the European economy has been affected by a pandemic and war. How can Europe transition to a low-carbon economy while continuing to ensure economic growth?

A sustainable and circular bioeconomy contributes to addressing these challenges. Crops, forests, animals and microorganisms all offer the potential for conversion into materials, food, bioenergy, and other bio-based products. In the bioeconomy, these renewable biological resources, along with waste from households and industrial processes, replace the existing, non-renewable sources of raw materials for fuel, energy and manufacturing.





View of the FARMYNG project biorefinery in Amiens, France.

## WHY ARE BIO-BASED INDUSTRIES ESSENTIAL?

Circular bio-based industries produce sustainable bio-based materials, products and ingredients from renewable resources, including agriculture, the food industry, wood sidestreams and waste. This is an essential development for a sustainable future and a key element in addressing the world's current environmental challenges.

There are multiple benefits to establishing a viable bioeconomy in Europe:

- Reduce dependence on non-renewable, unsustainable fossil fuels
- Decrease our reliance on imported protein and cut food waste
- Increase competitiveness and create new jobs in Europe
- Manage natural resources sustainably
- Bring a positive impact on the environment
- Support the modernisation and strengthening of the EU industrial base against global competition

The circular nature of the bioeconomy represents a wide range of environmental, social, and economic benefits. A bioeconomy-based system



allows for minimal waste and CO<sub>2</sub> production, thus contributing to the EU's economic and climate targets and policies such as the European Green Deal. Investments in the bioeconomy also create new jobs and opportunities in remote rural and coastal areas suffering from economic emigration.

## WHAT IS CBE JU?

The Circular Bio-based Europe Joint Undertaking (CBE JU) is a public-private partnership that funds projects deploying competitive, sustainable, and circular bio-based industries in Europe. By combining public

investment with the private perspective, CBE JU manages to simultaneously reduce the risk of investing in cutting-edge technologies while adding the skills and knowledge necessary to fulfil market demands.

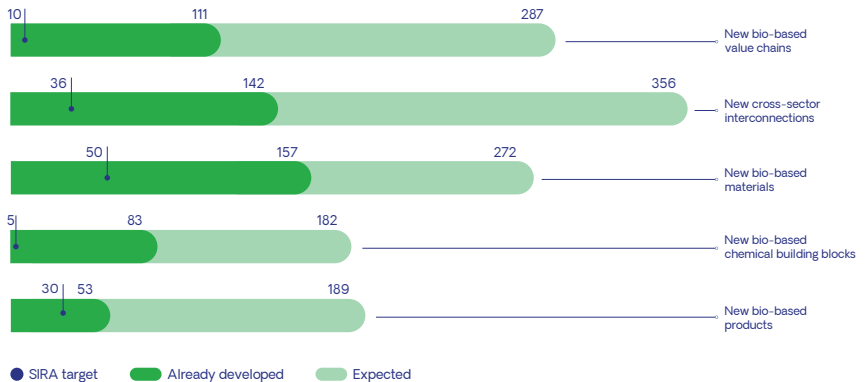
CBE JU builds on the success of its predecessor, the Bio-based Industries Joint Undertaking (BBI JU), which helped position Europe as the world's bioeconomy leader. Continuing that legacy, CBE JU's goal is to help Europe become the world's first climate-neutral continent while increasing the sustainability and circularity of production and consumption systems.



Projects funded by CBE JU are expected to contribute to a more competitive and sustainable Europe. They help reduce pollution and Europe's

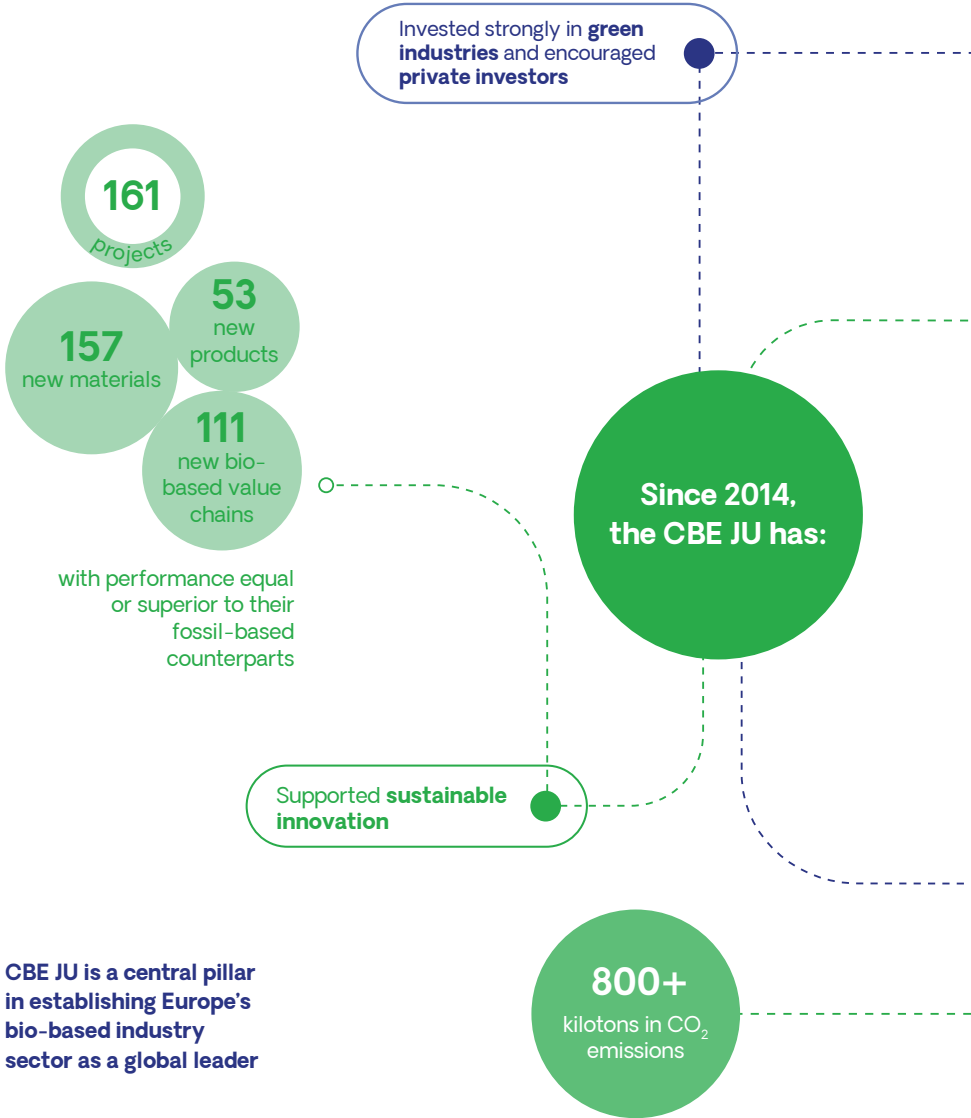
dependence on fossil resources and spur green investments and sustainable economic growth.

### Expected outputs of CBE JU projects by 2024





# CBE JU-FUNDED PROJECTS IN NUMBERS



**CBE JU is a central pillar in establishing Europe's bio-based industry sector as a global leader**



**€904 million**  
invested in projects

and every euro has attracted almost **three times as much** in private investment

Stimulated **local economies**

The first **13 flagship biorefinery projects**

**1,200**  
beneficiaries  
42% SMEs  
25% universities  
and research centres

**39**  
countries

Supported Europe's **research** and **business sectors**

**4,700+**  
direct jobs

**15,000+**  
indirect jobs

**€1.3 billion**  
investment

Contribute to saving

Are expected to **generate**

# WHAT ARE THE CBE JU'S FLAGSHIP PROJECTS?



The flagship projects – first-of-their-kind large-scale production facilities in Europe – provide support for designing and constructing novel, commercial-scale biorefineries. The goal is to deliver technically mature facilities that are

ready for commercial operations by the completion of the project. Flagship projects seek to demonstrate the viability of processes with improved environmental and economic performance compared to existing, fossil-based competitors.

## Project's feedstock & final product

- |   |  |
|---|--|
| <p><b>1</b><br/> <b>AgriChemWhey</b><br/>Dairy sidestreams<br/>↳ <b>Lactic acid, minerals for food and fertilisers</b></p>                                 | <p><b>2</b><br/> <b>EXILVA</b><br/>Cellulose<br/>↳ <b>MFC - MicroFibrillated Cellulose</b></p>  |
| <p><b>3</b><br/> <b>SWEETWOODS</b><br/>Lignin &amp; hardwood residues<br/>↳ <b>High-quality C5/C6 sugars &amp; dried lignin</b></p>                        | <p><b>4</b><br/> <b>VI OBOND</b><br/>Forest-based<br/>↳ <b>Bio-based resins</b></p>   |
| <p><b>5</b><br/> <b>PLENITUDE</b><br/>Residues of cereal crops<br/>↳ <b>Mycoproteins</b></p>   | <p><b>6</b><br/> <b>PEference</b><br/>Crop residues<br/>↳ <b>FDCA for bioplastics</b></p>   |
| <p><b>7</b><br/> <b>FARMYNG</b><br/>Mealworms &amp; agri-food sidestreams<br/>↳ <b>Proteins for animal feed &amp; organic fertiliser</b></p>               | <p><b>8</b><br/> <b>AFTERBIOCHEM</b><br/>Sidestreams from sugar beet<br/>↳ <b>Flavourings, fragrances, hygiene products, pharmaceuticals, antimicrobials &amp; polymers</b></p> |
| <p><b>9</b><br/> <b>ReSolute</b><br/>Sidestreams from pulp &amp; paper industry<br/>↳ <b>Biodegradable, safer &amp; bio-based solvent: Cyrene</b></p>     | <p><b>10</b><br/> <b>SCALE</b><br/>Microalgae<br/>↳ <b>Nutritional ingredients for food, feed and cosmetics</b></p>  |
| <p><b>11</b><br/> <b>CIRCULAR BIOCARBON</b><br/>Municipal solid waste<br/>↳ <b>High-value products from fertilisers to 5G technology</b></p>             | <p><b>12</b><br/> <b>FIRST2RUN</b><br/>Underutilised oil crops<br/>↳ <b>Building blocks for polyester production &amp; vegetable oils</b></p>                                 |
| <p><b>13</b><br/> <b>LIGNOFLAG</b><br/>Crop residues<br/>↳ <b>2G bioethanol biofuel - building block</b></p>   | <p><b>14</b><br/> <b>SYLPLANT</b><br/>Agri-based &amp; wood based<br/>↳ <b>Alternative protein sources for food &amp; feed ingredients</b></p>                                |
| <p><b>15</b><br/> <b>SUSTAINEXT</b><br/>Crops &amp; agro-industrial sidestreams<br/>↳ <b>Ingredients for food, feed, cosmetics &amp; fertilisers</b></p> |  |



Project: **AFTERBIOCHEM**  
 Biorefinery location: **Saint-Avoid, France**  
 CBE JU funding: **€20 million**  
 Coordinator: **AFYREN NEOXY, France**

The EU is the world's largest producer of sugar beet. The sector currently supports 140,000 sugar beet growers and around 27,000 direct jobs in sugar beet processing. The AFTERBIOCHEM project is building the first all-in-one biorefinery for transforming the sugar industry's sidestreams – mainly pulp and non-food waste – into bio-based molecules of industrial interest. This will increase the economic and environmental sustainability of the sugar beet industry. In addition, the process will be flexible enough to adapt to alternative feedstocks in the future.



Project: **CIRCULAR BIOCARBON**  
 Biorefineries location: **Zaragoza, Spain & Sesto San Giovanni, Italy**  
 CBE JU funding: **€15 million**  
 Coordinator: **Urbaser, Spain**

Despite gigantic advances in waste recycling in recent decades, some waste is not recovered as efficiently as it could: the organic fraction of municipal solid waste and sewage sludge. The CIRCULAR BIOCARBON flagship project is building two first-of-their-kind biorefineries converting waste into four value-added products and a range of other intermediate products. The project's goal is to open new business frameworks based on an innovative circular approach to urban waste treatment. By doing so, the organic waste that currently goes to landfill and incineration will be reduced, it will also cut greenhouse gas emissions, notably methane and carbon dioxide.



Project: **EXILVA**

Biorefinery location: **Sarpsborg, Norway**

CBE JU funding: **€27.4 million**

Coordinator: **Borregaard AS, Norway**

Why do we need to use fossil-based materials to absorb water when trees give us the most advanced water absorption technology? Now, we know how to use nature's wisdom! The EXILVA project was conceived to substitute fossil-based chemicals in personal care, coatings, and adhesives with advanced bio-based innovations. This enabled a significantly lower carbon footprint compared to existing technologies.



Project: **FARMYNG**

Biorefinery location: **Poulainville, France**

CBE JU funding: **€19.6 million**

Coordinator: **YNSECT, France**

Alternative plant-based and sustainable proteins are needed for a meat-free future. At the same time, two-thirds of Europe's protein needs are imported. FARMYNG produces sustainable proteins with low environmental impact for animal feed by growing worms in the largest vertical farm in the world. On top of the outstanding environmental performance, producing alternative proteins in the EU will help reduce our dependence on protein imports. The project's appeal has propelled the French start-up leading the project, YNSECT, to raise more than €400 million. YNSECT is planning to replicate the biorefinery in other locations.



Project: **FIRST2RUN**  
 Biorefinery location: **Porto Torres, Italy**  
 CBE JU funding: **€17 million**  
 Coordinator: **Novamont SPA, Italy**

In Europe, many lands are not suited for agriculture. Due to their topography or uses of the past, marginal lands are forgotten and not taken care of to produce renewable resources. This project involved local farmers to grow cardoons, an underutilised oil crop, in the Mediterranean landscape of Sardinia to make biodegradable and compostable bio-based products that are now well established in the market.



Project: **LIGNOFLAG**  
 Biorefinery location: **Podari, Romania**  
 CBE JU funding: **€24.7 million**  
 Coordinator: **Clariant Produkte GmbH, Germany**

Straw is a common waste generated by agriculture. Until now, farmers have relied on traditional and inefficient uses of straw. The LIGNOFLAG project found the solution and built the first biorefinery in the world producing bio-based ethanol from non-food resources. The carbon footprint is much lower than fossil fuels, representing greenhouse gas savings that could reach up to 95%. In addition, the liquid by-product can be applied as a fertiliser for the crops used in the process. The completion of the biorefinery added alternative income sources for the 300 farmers in the region who will supply the straw. This project also has a high replicability potential, as new plants are already being planned.



Project: **PEference**

Biorefinery location: **Delfzijl, the Netherlands**

CBE JU funding: **€25 million**

Coordinator: **Avantium Chemicals BV, the Netherlands**

Modern human societies need plastic for a wide range of uses. At the same time, plastics are polluting the environment at an alarming level. The PEference flagship project is establishing the first industrial-scale, cost-effective biorefinery producing FDCA, a bio-based chemical, to make high-value products. The goal is to replace a significant share of fossil-based plastics with 100% bio-based polyesters. These can compete with traditional packaging products in price and performance when produced at scale. The resulting bio-based material is sustainable and completely recyclable.



Project: **PLENITUDE**

Biorefinery location: **Sas van Gent, the Netherlands**

CBE JU funding: **€17 million**

Coordinator: **3F BIO Ltd, United Kingdom**

The European Union is by far the biggest importer of food worldwide. At the same time, there is an increased need for plant-based and sustainable alternative proteins. The PLENITUDE project aims to produce affordable plant-based proteins for human consumption. Their process reduces substantial amounts of CO<sub>2</sub> per year and consumes significantly less water compared to beef farming while using waste from agriculture as the main resource.

ReSolute



Project: **ReSolute**

Biorefinery location: **Saint-Avoid, France**

CBE JU funding: **€11.6 million**

Coordinator: **Circa Group AS, Norway**

The goal of this project is to provide a biodegradable, safer, and bio-based solvent alternative to the fossil-based chemicals currently in use, all while using waste from pulp and paper industries as renewable raw material. The resulting bio-based solvent will have many applications, like pharmaceuticals, coatings, adhesives and electronics. This way, the European industry can employ solvents which are safer for human health and the environment in many cutting-edge industries (like microchip production) whilst reindustrialising an old petrochemical site in France.

Scale  
 scale



Project: **SCALE**

Biorefinery location: **Baillargues, France**

CBE JU funding: **€14.3 million**

Coordinator: **Microphyt, France**

What if we could grow renewable resources in very reduced space to free soil for forestry and agriculture? What if we could even capture CO<sub>2</sub> from the atmosphere to feed this resource? The SCALE project strives to build and operate the world's first fully integrated microalgae biorefinery to produce natural active ingredients of high nutritional value for the food, food supplements, feed, and cosmetics sectors. Led by a French small business, this project aims to reduce the dependency on fossil-based resources, replacing them with bio-based alternatives.





Project: **SWEETWOODS**  
 Biorefinery location: **Imavere, Estonia**  
 CBE JU funding: **€21 million**  
 Coordinator: **Fibenol OU, Estonia**

Lubricants, adhesives, and plastics are extremely useful materials, but they are made of fossil-based raw materials, contributing to global warming and pollution. SWEETWOODS is building a first-of-its-kind, highly efficient, reduced environmental impact industrial biorefinery to obtain high-value compounds using hardwood waste as a raw material. The biorefinery is spurring the creation of a new industry and innovation hub in Estonia focused on forestry-based chemicals and materials.



Project: **VI OBOND**  
 Biorefinery location: **Riga, Latvia**  
 CBE JU funding: **€15.9 million**  
 Coordinator: **Latvijas Finieris A/S, Latvia**

Wood panels use glues whose components - phenol and formaldehyde - may pose risks to human health. By transforming hardwood residues, this project demonstrates the feasibility of an effective and efficient business model for lignin transformation into harmless and sustainable bio-based resins for wood panels and construction materials. This project can be replicated elsewhere in Europe and has high market potential, as the current sales of phenolic resins in Europe are around €1 billion.



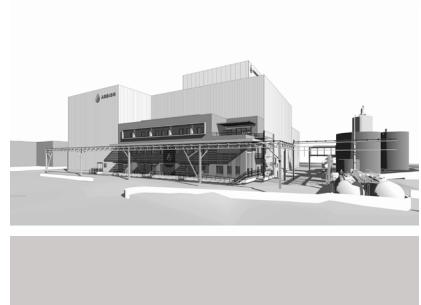
Project: **SUSTAINEXT**

Biorefinery location: **Hervás, Spain**

CBE JU funding: **€14 million**

Coordinator: **Natac Biotech, Spain**

How to put in practice a zero-waste and circular-by-design industrial process in a rural region in Europe? SUSTAINEXT is up to the challenge in Extremadura, Spain. The project is turning an existing production plant into a digitalised circular biorefinery to produce healthy plant-based ingredients from local medicinal and aromatic plants, and agricultural sidestreams. This will generate value and new jobs for the region, showing the positive impact of pursuing the European Green Deal objectives. The project's model is easily adaptable and replicable and can run on renewable energy.



Project: **SYLPLANT**

Biorefinery location: **Le Péage-de-Roussillon, France**

CBE JU funding: **€14 million**

Coordinator: **Arbiom, France**

The world faces the challenge of feeding a growing population sustainably. Additionally, the EU ought to reduce the large protein imports. The SYLPLANT project will produce protein-rich ingredients from underutilised resources, like agricultural and forestry residues. Building on the success of the CBE JU-funded SYLFEED demonstration project, SYLPLANT is building a commercial biorefinery to produce 10,000 tons of protein-rich ingredients for food and feed per year. It sets a roadmap for larger plants in other locations, showing how to use underused local resources to produce food and feed ingredients.

## WHAT IS THE REAL ECONOMIC AND SOCIAL IMPACT OF THESE PROJECTS IN EUROPE?

The elements for a sustainable European bioeconomy are increasingly in place; these already represent an important contribution to the EU economy, responsible for nearly 5% of the EU's GDP and almost 9% of the workforce.

The bio-based economy has also encouraged investments and created new employment opportunities. Many of these are new, highly skilled jobs in remote, rural, and coastal areas, where many resources and biomass are located. Therefore, there is the potential to revitalise areas of Europe affected by young people's economic migration to search for jobs and opportunities.

Moving forward, CBE JU-funded flagship projects are helping to create and increase the tangible impact of these green sectors, as the reach of funded biorefineries covers all the European territory. They also have a high socio-economic impact, as the first thirteen flagship projects have:

- **Created over 20,000** direct and indirect jobs
- **Attracted €5.2** of private investment per each **€1 of CBE JU funding**, reaching a total of **€1.3 billion in private investment**
- Demonstrated a **high replicability potential** in other regions and countries





## DEMONSTRATION ACTIONS

Demonstration actions, as the name suggests, are designed to demonstrate the technical and financial feasibility of new or improved bio-based processes.

By the end of their activities, these projects are expected to reach TRLs (Technology Readiness Levels) of 6 or 7 and be of sufficient scale to produce enough products to allow market testing and entire business models.

**46**  
projects

**€302m**  
in funding

## PULP2VALUE Capturing more than sugar from sugar beet

**The PULP2VALUE consortium has realised the potential of sugar beet.**

Sugar beet is one of Europe's major crops and its pulp is primarily used as low-value animal feed. However, treated correctly, this pulp has great potential as a source of other, higher value products, such as microcellulose fibres, arabinose, and galacturonic acid. These substances can be used for a wide variety of applications such as chemical building blocks, in food and flavour applications, and in detergents and personal care products.

**PULP2VALUE has constructed demonstration plants and developed positive business cases** for microcellulose fibres and galacturonic acid, and confirmed the health benefits of arabinose.

Currently, these microcellulose fibres are being used as new structurants for particles in solution in **detergents, adhesives, paints and coatings, and drilling muds**. Arabinose is being used to develop **foods** with a low glycaemic index, and galacturonic acid is finding applications in **personal care** and as an environmentally friendly corrosion inhibitor.

## RESEARCH AND INNOVATION ACTIONS

Research and innovation actions fund the examination and development of potential innovative technologies that offer the capacity to fill the gaps in existing bio-based value chains by developing, improving, or optimising key technologies.

### BARBARA Advanced automotive components from biowaste

The **BARBARA project** was established to **address the need for plastic in automotive applications**.

**The project is developing a range of bio-based plastics from food waste.**

These can replace those plastics derived from the unsustainable fossil-based resources, and have all the required properties - mechanical, thermal, aesthetical, optical, and antimicrobial - for this demanding environment.

The project has **produced organic materials suitable for manufacturing bio-based plastics** for a range of

applications such as filaments for 3D printing. With FIAT (carmaker), these were used to print car door trims and a dashboard fascia, and with ACCIONA (building infrastructure company) they were used to fabricate truss joints.

**There is a high potential for BARBARA technologies in other areas**, including in biotechnology, nanotechnology, advanced materials and advanced manufacturing technologies.

81  
projects

€301m  
in funding

## COORDINATION AND SUPPORT ACTIONS

While developing these technologies advances Europe's bio-based industry sector, their long-term future success relies on ensuring they reach the market, and once there, boost their uptake and build share of use. This is the role of the CBE JU coordination and support actions, which address the cross-sectoral challenges of the bioeconomy in order to facilitate this process.

### PILOTS4U Multipurpose pilot and demo infrastructures database

**PILOTS4U provides an easily accessible database of relevant facilities for the bioeconomy** available to all companies and research institutes. Any user can search for multipurpose demo infrastructures in the open-access database, which would be difficult to find otherwise. This addresses the challenge of locating and

19  
projects

€22m  
in funding

accessing the facilities needed to scale up to pilot and demonstration size before commercial production.

The database can be searched according to specific requirements of each project. This way, **PILOTS4U helps new bio-based products and techniques stepping from the laboratory bench to the market.**



## ENCOURAGING BUSINESSES AND RESEARCHERS

CBE JU-funded projects offer opportunities for small and medium-sized enterprises (SMEs), industry, primary producers, trade associations, and end users, to develop technologies and business models that can drive Europe's green economy while helping companies scale up their own technologies and improve their market access.

CBE JU has  
**1,190** beneficiaries

**42%** of these beneficiaries are SMEs

SMEs coordinate  
**33%** of all CBE JU-funded projects

SMEs receive  
**40%** of CBE JU funding



With a funding share of 40%, industrial biotechnology SMEs are important technology providers in CBE JU-funded projects.

Other small businesses are involved in a variety of sectors, such as chemicals, food, feed, materials, engineering, construction, waste processing, recycling, plastics packaging, agriculture and aquaculture.

Accelerating the innovation process for bio-based solutions is one of CBE JU's core objectives. Research organisations, representing one-quarter of all CBE JU beneficiaries and one-third of all funding, are key providers of innovative bio-based solutions for the projects.



## Academia and research centres represent:

CBE JU funding 33%

Participations in projects 25%

## SMEs represent:

CBE JU funding 40%

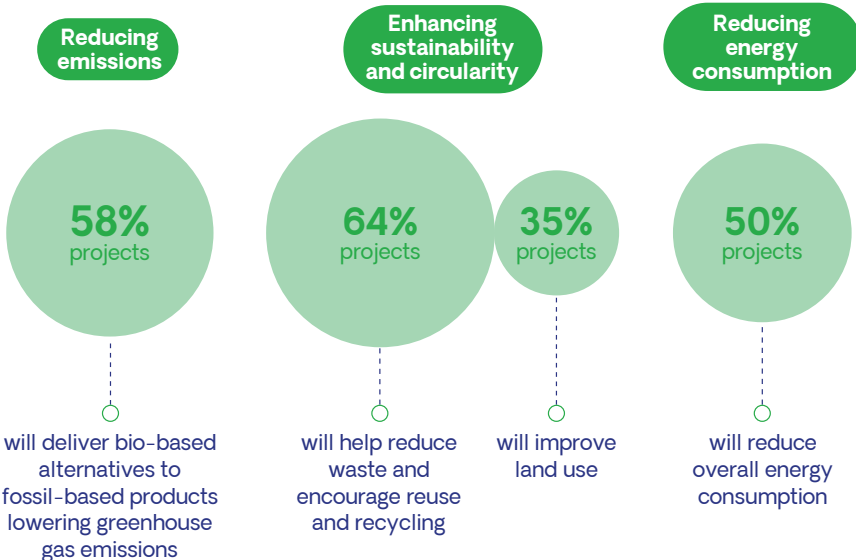
Beneficiaries 42%

Private organisations involved in projects 64%

## A SIGNIFICANTLY IMPROVED ENVIRONMENTAL IMPACT

As the CBE JU is dedicated to developing bio-based products in pursuit of a circular economy, it makes a significant contribution to reducing many environmental impacts.

All demonstration and flagship projects must undertake a Life Cycle Assessment analysis to guarantee the sustainability of their whole value chain. This ensures they avoid environmental damage and do not compete with land or other resources needed for food production.



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