Goizeder Barberena Ibañez · Biomass Business Development



FUTURE OF BIOCHEMICALS 2026 (12/11/2026)

FROM WASTE TO WORTH

Scaling biobased polymers, ingredients, biotics, bioaromatics & antioxidants at CENER's BIO2C

From the lab bench to 6 m³ fermenters, backed by TEA and LCA, with a proven track record

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BIO2C
Biorefinery and Bioenergy Centre

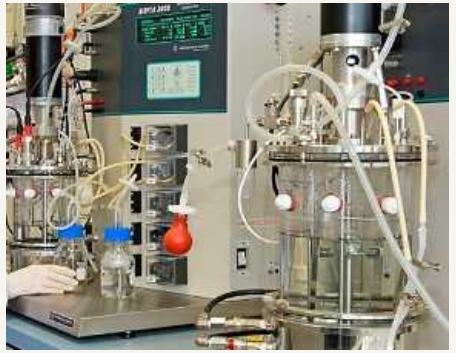
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Most biobased technologies never reach the market.

The gap between a promising lab result and a working industrial process is where good chemistry quietly dies. It is called the valley of death, and crossing it is the real innovation.

Scaling up in BIO2C means increasing commercialization success, step by step.



01

LAB

Product validation



02

PILOT

Process design



03

DEMO

Operation and production

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BIO2C in numbers

Biorefinery and Bioenergy Centre of CENER, in Aoiz (Navarra)

300+

commercial projects

100+

clients

40+

publicly funded R&D projects

40

researchers, engineers and technicians

Expertise: biomass resource assessment and characterization, biochemical and thermochemical processes, ash chemistry, bioprocess sustainability assessment. Team backgrounds: biology, chemical engineering, agronomy, chemistry, biochemistry.



International presence, Europe and beyond: Mexico, Dominican Republic, Colombia, Argentina, Philippines.

Active in ETIP Bioenergy, Bioenergy Europe, CBE, EUREC, BIOPLAT, ASEBIO, SUSCHEM, ASOBIOCOM, GASNAM, AST, CRECEMOS.

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One roof. Three scales. Zero guesswork.

The same team and the same methodology from lab to industrially relevant volumes, so results at one scale can be trusted at the next.

TRL 2 to 3

LAB

Microplates and flasks up to 1 L

TRL 4 to 5

BENCH

Bioreactors 2 to 5 L, gas fermenter 10 L

TRL 6

PILOT

Fermentation 40 to 100 L, hydrolysis 200 L

TRL 7

DEMO

Fermentation 1 to 6 m3, hydrolysis 2 x 3 m3

MARKET



Sarriguren: CENER headquarters



Sarriguren: laboratories



Aoiz: Biorefinery and Bioenergy Centre (BIO2C)

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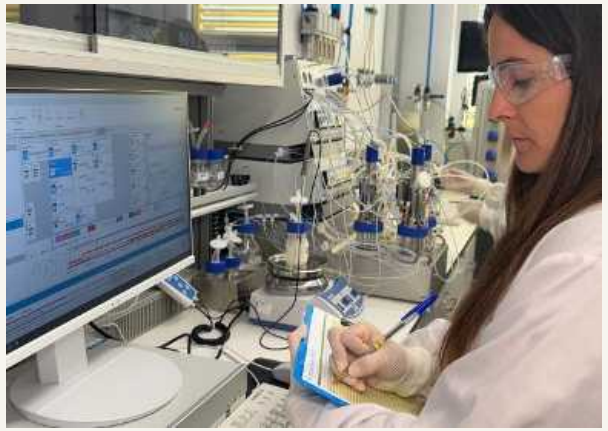
The lab: where the process is born

Define

- Selection of product and cultivation media
- Screening of enzymes and microorganisms
- Parameter selection and media optimization
- Process control

Engineer

- Genetic tools for aerobes and anaerobes
- Pathway assembly, gene expression, enzyme characterization
- Multibioreactor for adaptive evolution
- In house Oxford Nanopore DNA sequencer



Ferment

- Microplates under 1 ml, flasks up to 1 L, bioreactors 2 to 5 L
- Batch, fed batch and continuous
- ATEX gas fermenter, 10 L, proprietary design
- Online analysis of sugars, nutrients, O2 and CO2

Characterize

- HPLC: sugars, organic acids, inhibitors, molecular weight
- GC FID and MS: methanol, ethanol, butanol, lipids
- Elemental analysis: proteins



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Pilot scale: validate before you invest

Define the process configuration from equipment requirements and auxiliaries, and validate lab results in an industrial environment.



01 Pretreatment

- Continuous horizontal reactor
- Feed flow up to 5 kg/h
- Pressure up to 14.5 bar
- Temperature up to 200 °C
- High flexibility in feedstocks



02 Enzymatic hydrolysis

- High solids stirred tank reactor
- 200 L capacity, up to 125 °C
- Self sterilizable
- Pressurizable (min 1.5 bar)



03 Fermentation

- Fully monitored bioreactors
- 40 L and 100 L capacity
- Temperature 23 to 80 °C
- Adjustable agitation, air and gas ratios, pH, nutrients

Demo scale: first preindustrial batches

- Process operation optimization
- First precommercial batches for product validation in application trials
- Empirical data to design an industrial plant and run technoeconomic and environmental analyses at precommercial scale

2 x 3 m³

high solid enzymatic reactors

900 to 3000 L, 20 to 130 °C, sterile, high viscosity products

1, 3, 6 m³

fermentation train

Monitored bioreactors, 23 to 80 °C, sterile, adjustable agitation, air and gas ratios, pH, nutrients



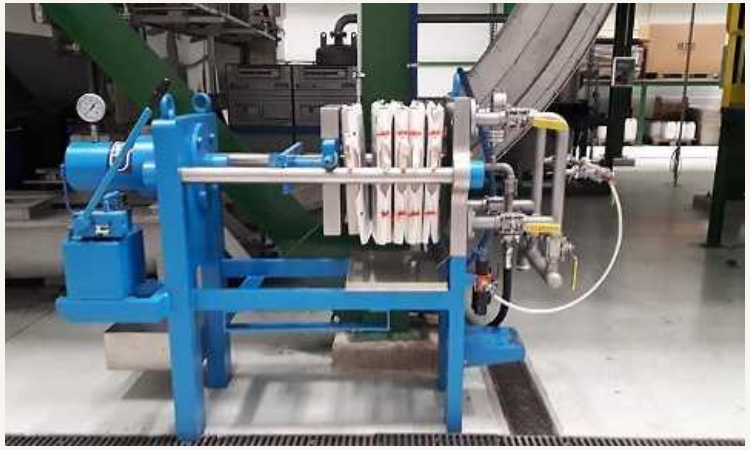
Downstream: from broth to product

Ad hoc downstream processing for different final products, with flexible equipment that adapts processes from early lab trials to near industrial demonstration: efficient separation, purification and concentration.



01 Lab and bench

- Centrifuges
- Membrane filtration: micro and ultrafiltration
- Vertical press
- Lyophilization



02 Pilot

- Centrifuges, vertical press, press filter
- Membrane filtration: micro, ultra and nanofiltration
- Liquid liquid extraction column system
- Rotary evaporator



03 Demo

- Membrane filtration technologies
- Liquid liquid extraction column system
- Rotary evaporator
- Continuous thin film evaporator

The full package to market

We don't just develop it. We prove it pays: every scale comes with its economic and environmental case.

Feedstock assessment → Lab development → Pilot validation → Demo and precommercial batches → Downstream → TEA and LCA → Certification support → Market

TECHNOECONOMIC, FROM TRL 3 TO 4

Is it worth building?

- SuperPro process simulation
- Process flow diagram, mass and energy balances
- CAPEX and OPEX
- Operating account, IRR and payback

ENVIRONMENTAL AND SOCIAL SUSTAINABILITY

Is it worth defending?

- LCA and GHG assessments (SimaPro, Ecoinvent database)
- Carbon footprint and water footprint
- Certification systems development and support
- EU and US standards and ISO guidelines

Ad hoc feedstock assessment

Biomass potential of agricultural and forestry sectors, industrial waste and byproducts, crops for biofuels and bioproducts, cultivation on marginal lands, intermediate crops and intercropping.

Eight pathways from waste to product

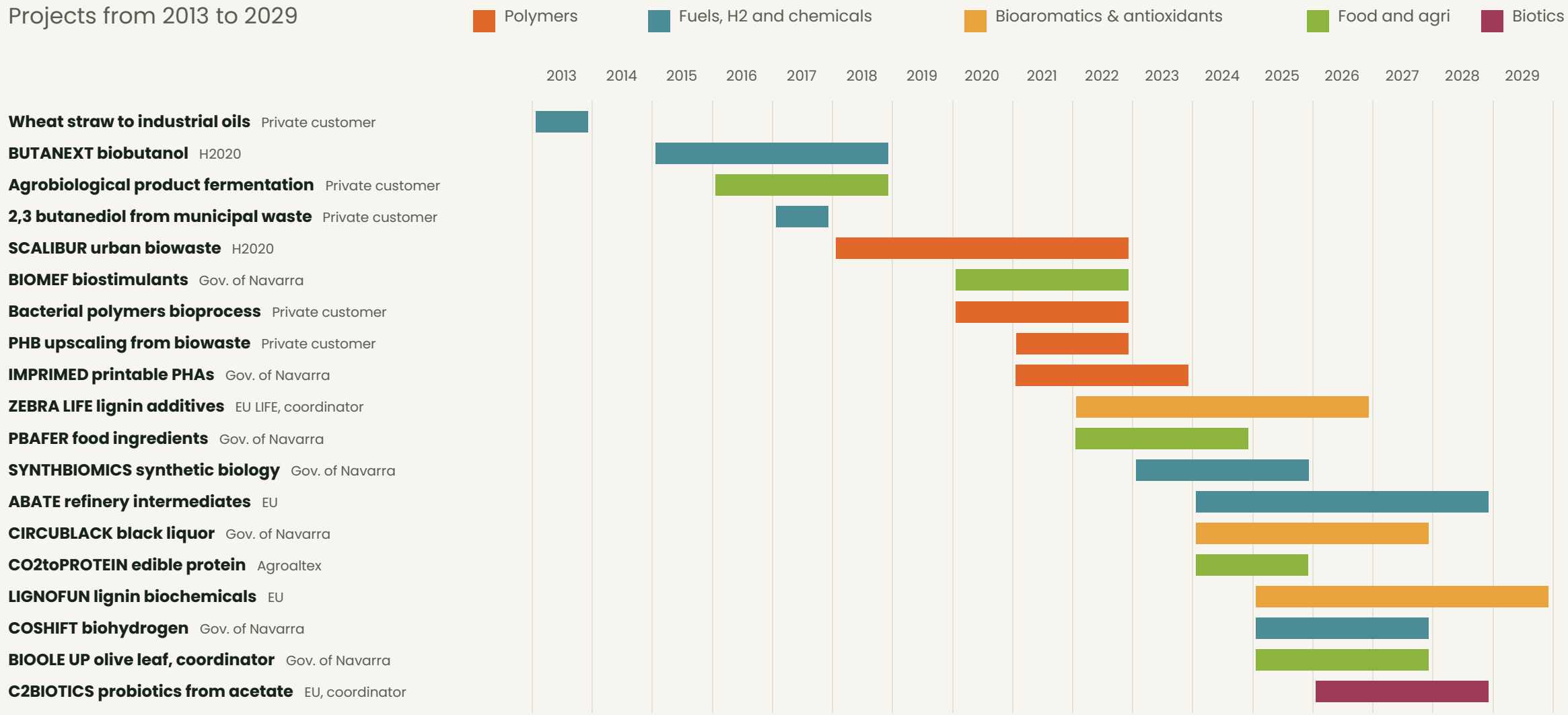
Residual biomass, bioresidues, side streams and gases valorized into biobased products.

Biowaste	**Enzymatic hydrolysis**	**Sustainable sugars**	*Demonstrated up to the demo plant*
Sustainable sugars	**Fermentation**	**Biobased polymers (PHB, PHAs) and biopesticides**	*Demonstrated up to the demo plant*
Wheat straw, municipal organic waste	**Hydrolysis and fermentation**	**Butanol, 2,3 butanediol, industrial oils**	*Pilot to demo campaigns*
Agrofood byproducts	**Fermentation**	**Food ingredients: aromatics, exopolysaccharides, vitamin B12, omega 3**	*PBAFER: 100 L fermentation*
Acetate rich side streams, such as vinegar	**Acetate fed fermentation**	**Biotics: pre, pro, post and synbiotics**	*C2BIOTICS: pilot to demo planned*
Lignin from black liquor and paper mills	**Depolymerization (OHRIGINS, METNIN), HTL**	**Bioaromatics & antioxidants for cosmetics, food, rubber, resins, foams, nylon 66, biocrude**	*ZEBRA LIFE: 20 kg/h pilot. LIGNOFUN: TRL 6 to 7 target*
Olive leaf	**Cascade fractionation**	**XOS, polyphenols and oleuropein, lipids, antioxidants for nutraceuticals**	*BIOOLE UP: ongoing*
CO2, syngas and pyrolysis gas	**Gas fermentation and bioconversion**	**Biohydrogen, biomethane, edible protein, acetic acid**	*COSHIFT, ABATE (100 L TBR), CO2toPROTEIN: lab to 100 L*

Maturity differs by pathway: ask us for the current TRL of each.

More than a decade of scaling, project by project

Projects from 2013 to 2029

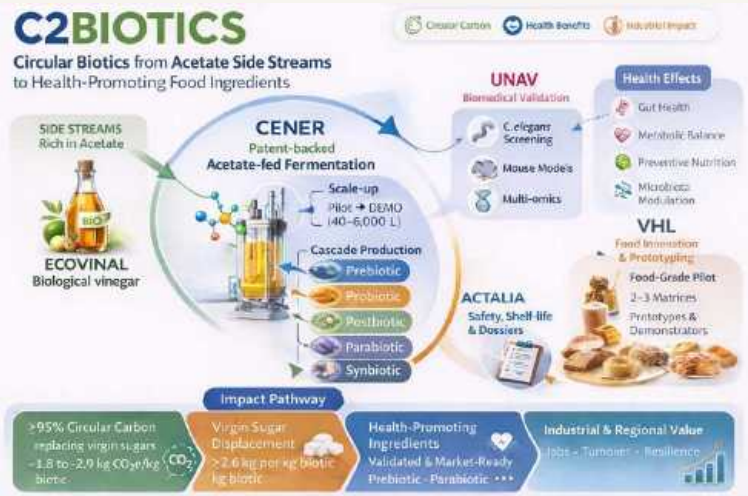


2026 TO 2028

Biotics from acetate side streams

C2BIOTICS

Circular Biotics from Acetate Side Streams to Health Promoting Food Ingredients. Ongoing project: TRL targets are objectives. Project no. 101161155



Project scope

- Innovative biotechnology platform to convert acetate rich industrial side streams into valuable ingredients through fermentation and cascading valorization
- Bioactive ingredients: prebiotics, probiotics, synbiotics and postbiotics
- Partners (Ecovinal, UNAV, Actalia, VHL) characterize functionality and safety, validate food and health applications and assess feasibility

CENER role

- CENER coordinates the project
- Generate an acetate rich stream from vinegar
- Industrial upscaling of the fermentation and of the downstream for cascade production of pre, pro, post and synbiotics (6 SKUs)
- At least 3 batches at TRL 5 and 1 batch at TRL 7
- Fermentation and downstream protocol for food grade biotics
- Technical, economic and life cycle assessment, plus dissemination and commercialization plan

40 to 6,000 L planned scale up of the acetate fed fermentation, from pilot to demo

European Circular Innovation Valley

Co-funded by the European Union

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RÉGION NORMANDIE

SNN

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2025 TO 2029

From lignin to high value biochemicals and biomaterials

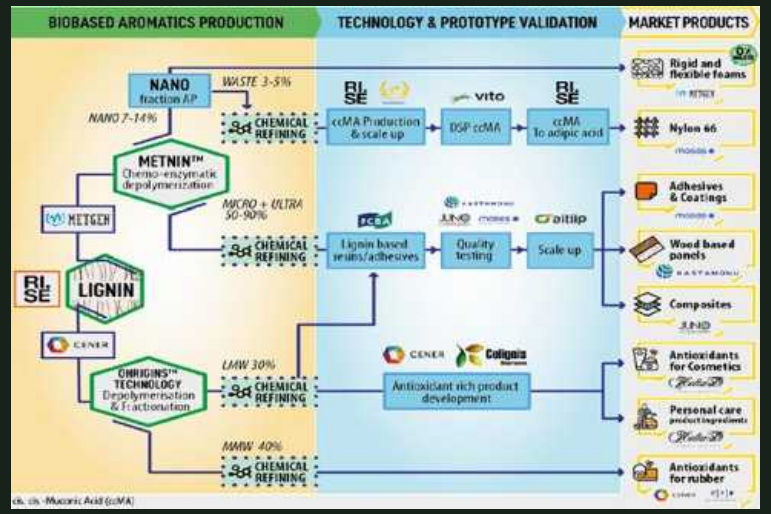
LIGNin based arOmatic FUNnelling to high value biochemicals and biomaterials production

Project scope

- Replace fossil derived aromatic chemicals with sustainable, lignin based alternatives
- Advance two depolymerization technologies (METNIN and OHRIGINS) to industrially relevant scale (TRL 6 to 7) and valorize underutilized lignin from paper mills
- Demonstration prototypes: foams, nylon 66, adhesives, coatings, composites, wood panels, personal care and rubber products

CENER role

- Work package leader
- Production and scale up of lignin derived polyphenolic fractions by catalytic depolymerization (OHRIGINS)
- Process adjustment through end user feedback in personal care, cosmetics and rubber, and as precursor of phenolic resins and adhesives
- Stream characterization, system definition and mass balance
- Environmental, circularity and social impact assessment (TEA, social LCA, SSbD, LCC)



TRL 6 to 7 target scale for lignin depolymerization (OHRIGINS), at industrially relevant scale

Co-funded by the European Union

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2025 TO 2027

Biohydrogen from biomass syngas

COSHIFT

Development of a novel fermentation process transforming biomass syngas to produce biohydrogen

Project scope

- 99% of the H2 used today comes from fossil fuels and 1% from water electrolysis
- Renewable H2 through the biological conversion of the CO in syngas from biomass gasification
- Selection of suitable microorganisms, then H2 production at laboratory and pilot scale
- Advanced technology to separate and capture the CO2 from the fermentation gas, for green H2

CENER role

- Identify industrial and natural environments in Navarra with potential microorganisms
- Isolate the microorganisms and adapt them to culture media and syngas
- Optimize operating conditions at laboratory scale
- Production tests in a 10 L trickle bed bioreactor (TBR)
- Process balance and technoeconomic analysis



10 L TBR trickle bed bioreactor tests for the bioconversion of CO into H2

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2025 TO 2027

Olive leaf biorefinery for health and nutraceuticals

BIOOLE UP

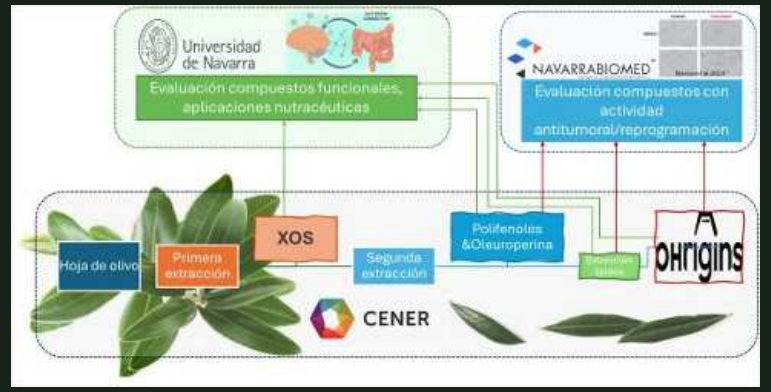
New biorefinery concept from olive leaf for advanced medical and nutraceutical treatments. Collaborative projects of the Government of Navarra

Project scope

- Biorefinery from olive oil sector residues, valorizing olive leaf by selective cascade extraction and purification of extracts and active principles
- Fractions: XOS (xylo oligosaccharides), polyphenols and oleuropein, lipids, and lignin based antioxidants
- Tested for chronic diseases such as diabetes and fatty liver, and in cancer models, with Universidad de Navarra and Navarrabiomed

CENER role

- CENER coordinates the project
- Cascade fractionation of the olive leaf into the 4 fractions
- XOS, polyphenols and oleuropein: fractionation optimized from characterization and functional value
- Lipids characterized and evaluated for antiadipogenic and antiinflammatory effects
- Lignin depolymerized into antioxidants, tested for antiadipogenic, antiinflammatory, cell reprogramming and anticancer effects



4 fractions from olive leaf: XOS, polyphenols and oleuropein, lipids, lignin antioxidants

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2024 TO 2028

Advanced biobased intermediates for refineries

Valorization of lignocellulosic biomass to advanced biobased intermediates to substitute fossil hydrocarbons in refineries

Project scope

- Residual biomass is first converted into fast pyrolysis bio oil (FPBO) and biochar
- The CO2 produced is captured and converted into methanol, then stabilized into a high quality intermediate for conventional refineries
- Stabilization by a novel catalytic hydroprocessing step, integrated with green hydrogen and biological carbon capture and utilization (CCU) through biomethanation

CENER role

- Valorize the CO2 from the fast pyrolysis off gas into methane, by bioconversion with a mixed culture
- Evolve the microorganisms by adaptation to gas substrate and contaminants: shorter start up, higher yield, less inhibition
- Optimize a trickle bed reactor (TBR): pressure, H2/CO2 ratio, gas retention time, pH, temperature
- Scale up biomethanation to a 100 L TBR

abate
Advanced Bio-based Refinery Intermediates



Co-funded by the European Union

100 L TBR biomethanation scale up, with three tests of 30 days each

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2024 TO 2027

A biorefinery inside the paper mill

CIRCUBLACK

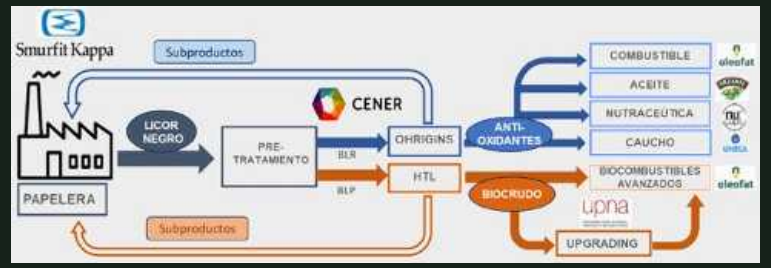
Back to Black Liquor: new concept of biorefinery integrated in the paper sector through the direct valorization of black liquor

Project scope

- Valorize black liquor, the main byproduct of the paper industry, as a source of bioaromatic antioxidants (food, nutraceuticals, rubber, fuels) and as precursor of advanced fuels
- A pretreatment splits it into a heavy fraction (rich in lignin) and a light fraction (rich in polysaccharides)
- Heavy fraction: OHRIGINS technology, developed by CENER, for antioxidants. Light fraction: hydrothermal liquefaction (HTL) to biocrude, then upgrading to advanced fuel

CENER role

- Leader of Activities 2 and 3
- Development of the black liquor pretreatment process
- Research, tuning and scale up of OHRIGINS and HTL
- Batches of antioxidants and biocrudes for formulation and validation
- TEA and LCA studies, and stream characterization for integration in the paper industry business model



2 routes

OHRIGINS antioxidants and HTL biocrude from one black liquor stream

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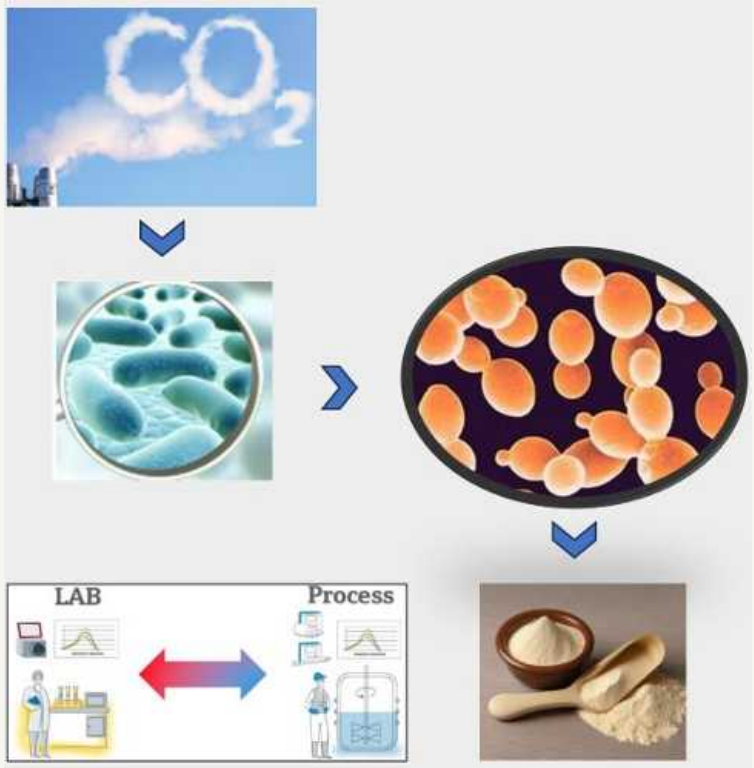
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2024 TO 2025

Edible protein from CO2, through acetic acid

CO2toPROTEIN

New approach to decarbonization by converting CO2 into edible protein. Agroaltex funding, contract signed with Eatex



Project scope

- Convert the acetic acid produced by acetogenic bacteria from CO2 fixation into edible protein ingredients
- Microorganisms with approved status for human food use, optimized to produce high quality protein from acetic acid
- Adaptive laboratory evolution (ALE) and classical mutagenesis to increase acetic acid tolerance
- Lab scale fermentations give the data to simulate an industrial process and run a TEA

CENER role

- Find microorganisms able to use the acetic acid from acetogenic CO2 fixation as main carbon source, to generate protein rich biomass
- Improve the selected microorganisms by classical mutagenesis and ALE
- Ferment to produce protein extracts, sent to CNTA for characterization
- Simulate the industrial process with SuperPro Designer and calculate the levelized production cost (LPC)

Lab scale fermentations with food approved microorganisms, with a simulated industrial process

2023 TO 2025

Synthetic biology for health, food and energy

Disruptive innovations in Synthetic Biology to promote Health, Food, Sustainable Energy and Industrial Decarbonization

Project scope

- Make visible the potential of synthetic biology in key areas for the economic development of Navarra
- A biotechnology strategy with three pillars: a synthetic library of nanobodies, biosensors for contaminant detection in food, and fixation of C1 compounds
- C1 fixation gives chemical intermediates that can become advanced fuels and other bioproducts

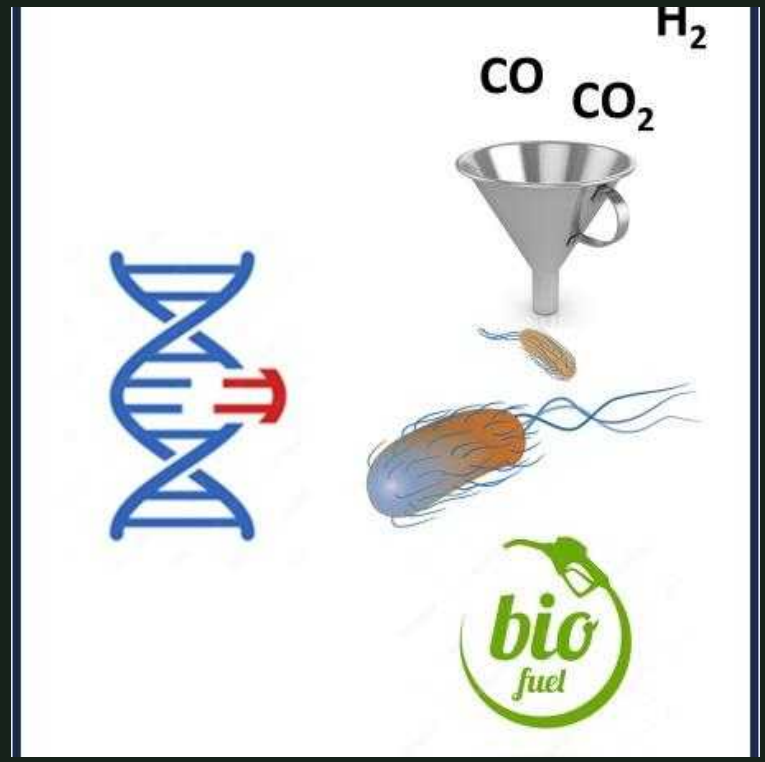
CENER role

- Develop genetically modified microorganisms that are more efficient chemical platforms for the synthesis of building blocks
- Sustainable and efficient processes to produce advanced (bio)fuels
- Other (bio)based products from gaseous streams

C1 gases

CO, CO2 and H2 converted into building blocks by engineered microorganisms

SYNTHBIOMICS
Innovative Biotechnology Solutions



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2022 TO 2026

Lignin from black liquor to renewable additives

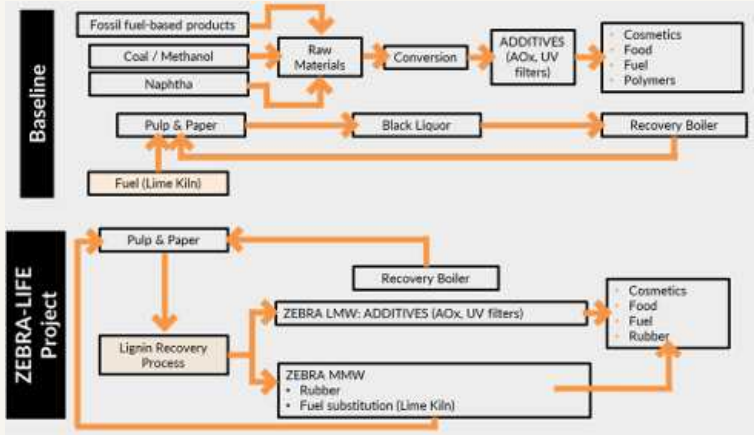
Zero Emission Biochemical and Renewable Additives

Project scope

- Transform the paper industry waste with the highest recovery potential: the lignin in black liquor becomes bio aromatic compounds
- They replace fossil origin compounds used in food, cosmetics, rubber, fuels and lubricants
- Scale up a novel Kraft lignin depolymerization and functionalization technology to obtain renewable additives with high antioxidant capacity

CENER role

- Project coordinator and technology licensee
- Design, construction and operation of a pilot plant (20 kg/h) to demonstrate the technoeconomic feasibility
- Batches of antioxidant product for end users to formulate and validate
- With the paper mill, integrate the ZEBRA technology into the current pulp and paper business model



20 kg/h pilot plant for Kraft lignin depolymerization and functionalization

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2022 TO 2024

Food ingredients from agrifood byproducts

Development of food ingredients through circular biotechnological strategies to improve the nutritional and sensory properties of alternative plant based food products

Project scope

- Ingredients that improve the nutritional and sensory properties of plant based products, to make them different from current market options
- Sensory improvement (flavor, aroma, texture): aromatic compounds and exopolysaccharides
- Nutritional improvement: cobalamins (vitamin B12) and healthy omega 3 fats

CENER role

- Matrix of agrifood byproducts as raw material for food ingredients
- Fermentable bases at pilot scale from the selected byproducts
- Fermentation trials in a 100 L bioreactor
- Product recovery tests
- Technoeconomic and environmental assessment of the process

100 L bioreactor fermentation trials for food ingredients

PBAFER



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2021 TO 2023

Printable biomedical polymers from agrofood byproducts

Biotechnology applied to obtain printable polymers with biomedical applications using agrofood byproducts from Navarra

Project scope

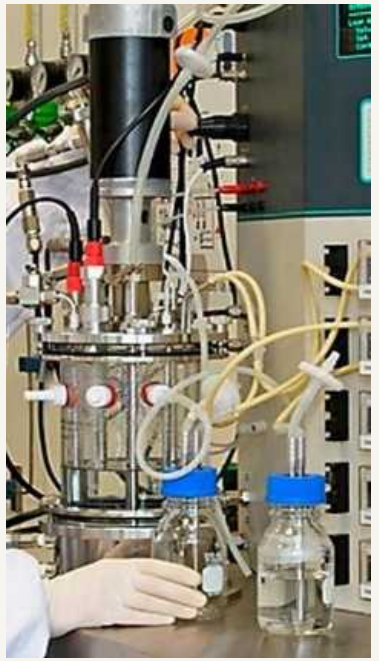
- New solutions for the valorization of agrofood wastes of the Navarran industry through white biotechnology
- Biodegradable, biocompatible and printable materials based on polyhydroxyalkanoates (PHAs) for biomedicine and tissue engineering, with 3D printing
- Bacterial fermentation combined with genetic engineering

CENER role

- Characterization and fractionation of agrofood wastes
- Scale up of fermentation and downstream (recovery and purification) of PHAs: P3HB and the P3HB copolymer with 4HB
- Final phase: tools developed at AIN scaled up in the CENER pilot plant to produce the copolymer
- Technoeconomic and environmental feasibility assessment

PHAs printable biomaterials, from agrofood waste to pilot plant production

IMPRIMED









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2020 TO 2022

Microbial biostimulants for phosphorus use efficiency

BIOtechnological tools for the improvement of the Efficiency in Phosphorus use

BIOMEF

Project scope

- Model species (Arabidopsis thaliana) and a Mediterranean horticultural species of agronomic interest (tomato)
- Improve phosphorus acquisition efficiency of plants using biostimulants of microbial origin
- Understand how these biostimulants perform and why they work

CENER role

- Optimization and scale up of an agrobiological production by fermentation
- Optimize the main parameters (pH, agitation, duration) that affect yield and production costs (nutrients, culture medium)
- Scale up the process to 100 L bioreactors
- Technoeconomic and environmental feasibility assessment





100 L scale up of a microbial biostimulant fermentation

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2018 TO 2022

Scalable technologies for urban biowaste recovery

Closing the gap between technological feasibility and industrial application of urban biowaste valorization

SCALIBUR
LEADING A REVOLUTION IN BIOWASTE RECYCLING

Horizon 2020
European Union Funding for Research & Innovation





Project scope

- Close the gap between technological feasibility and industrial applications of urban biowaste valorization
- Value chain from urban biowaste to biobased polyesters and biopesticides

CENER role

- Biowaste valorization by enzymatic hydrolysis and fermentation in the BIO2C demonstration plant (TRL 7)
- Feeds the later production of biobased polyesters (NOVAMONT) and biopesticides (CENER)
- Technoeconomic and environmental sustainability assessment by CENER

TRL 7 urban biowaste valorized in the BIO2C demonstration plant

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2015 TO 2018

Next generation biobutanol

BUTANEXT Next Generation Biobutanol

Horizon 2020 European Union Funding for Research & Innovation

Whole process integrated at pilot scale in the BIO2C plant. More at butanext.eu







Project scope

- Overcome the technical and economic constraints to the use of biobutanol as an advanced biofuel
- Develop highly efficient production processes and convert sustainable feedstocks

CENER role

- Project technical coordinator
- Optimization of biomass pretreatment and enzymatic hydrolysis at lab scale
- Whole process integrated in the BIO2C plant at pilot scale: 2 step pretreatment (milling and thermochemical), hydrolysis with improved enzyme cocktails
- Continuous fermentation with an improved butanol tolerant strain and a pervaporation unit for continuous removal of ABE solvents

Pilot scale whole process integrated, from pretreatment to continuous solvent removal

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Bacterial polymers, from biowaste to prototype

2021 TO 2022 Upscaling a fermentation process for PHB production

Feedstock conditioning	Enzymatic hydrolysis	Hydrolysate recovering	Detoxification	**Fermentation**	Biomass separation	Purification	Compounding	Two prototypes

CENER role

- Project coordination
- Plant operation up to the fermentation stage
- 1st stage: upscaling to the PILOT plant, 100 to 200 L
- 2nd stage: upscaling to the DEMO plant, 1,000 to 3,000 L
- Monitoring and data recording of relevant parameters

2020 TO 2022 Technological bioprocess design and upscaling of bacterial polymers production

- Bioprocess design from research on the biological raw materials to production in a preindustrial volume pilot plant
- A more efficient and more sustainable value chain, based on low carbon footprint feedstocks






PRIVATE CUSTOMERS (CONFIDENTIAL)

More scale up campaigns, more feedstocks, more products



2017

2,3 butanediol from municipal solid waste (organic fraction)

- Process: feedstock conditioning, enzymatic hydrolysis, hydrolysate recovering, fermentation, biomass separation, supernatant delivered to the customer
- Coordination, including equipment selection (decanter, centrifuge)
- Pilot 100 to 200 L, then demo 1,000 to 3,000 L



2013

Wheat straw converted into industrial oils

- Process: pretreatment, enzymatic hydrolysis, filtration, fermentation, centrifugation, drying
- Coordination, including vendor equipment (plate filter, centrifuge, drier)
- 3 test campaigns: 2 batches of 3,000 L hydrolysis and 3,000 L fermentation



2016 TO 2018

Optimization and upscaling of an agrobiological product

- Flask to 100 L, with advice on scale up adaptation
- Lower operational and consumable costs, low cost media adaptation
- Optimized: inoculum, pH, dO2, agitation, residence time, media. Chromatographic protocol to monitor the process

A track record you can rely on

R&D projects, knowledge and technology transfer, biomass area

3
Horizon Europe

12
H2020

4
CBE and BBI

Areas: energy, materials, bioeconomy, infrastructures.
Also LIFE and Interreg programmes.

Coordinated by CENER

ZEBRA LIFE, BioRescue, BioTrade2020+, C2BIOTICS, BIOOLE UP

Latest

A CBE JU Innovation Action, running from 06/2025



CENER | NATIONAL RENEWABLE ENERGY CENTRE

BIO2C
Biorefinery and Bioenergy Centre

Ciemat

Gobierno de Navarra
Nafarroako Gobernua

Why BIO2C? Your path to results

Run your campaign

- Ad hoc service for each customer
- Fast planning and execution of campaigns
- Logistics of feedstock and final product
- Effective resolution of challenges during campaigns
- Face to face supervision by the customer

Get your product

- Precommercial batches provider
- Support in bioprocess configuration
- Specialists in biochemical and thermochemical processes
- Proven track record
- Products so far: polymers, food ingredients, biotics, bioaromatics & antioxidants, biohydrogen, protein

Prove your case

- Technoeconomic analysis of the process
- Environmental assessment: LCA, carbon footprint, water footprint
- Support in certification
- Ad hoc advisory
- Cost savings versus investment

Let's build the future together

Our cooperation frameworks

01

Direct service to customer

- Direct contracting by the customer
- Agility in project preparation and execution
- Ad hoc services for each customer

02

National cooperation

- CENER subcontracted for specific tasks
- Support and collaboration in proposal preparation and execution
- For example: CIEN projects, CDTI missions, CDTI individual R&D projects, public private collaboration, NEOTEC, AEI

03

EU level cooperation

- CENER as partner, WP leader or coordinator
- Long term projects executed in consortium
- Depends on the work programme
- Examples: Horizon Europe, CBE, LIFE

“Most biobased technologies don't fail because the science is wrong. They fail in the gap between lab promise and industrial reality. Closing that gap means replacing leaps of faith with evidence, validated at every scale, one step at a time.”

Goizeder Barberena Ibañez

Biomass Business Development, CENER

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THANK YOU

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Plan de Recuperación, Transformación y Resiliencia

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