BIOMASS AREA

CENER'S CIRCULAR ECONOMY STRATEGY

CENER | NATIONAL RENEWABLE ENERGY CENTRE

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VICEPRESIDENCIA TERCERA DEL GOBIERNO
MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO
MINISTERIO DE CIENCIA E INNOVACIÓN
Ciemat
Gobierno de Navarra
Nafarroako Gobernua

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04 **REFERENCES & COOPERATION FRAMEWORKS**

05 **HORIZON-JU-CBE-2025-IA-03 Scaling-up nutritional proteins from alternative sources**

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01

ABOUT US

OUR FOCUS

CENER

- Renewable Energies Generation
- Energy Conversion & Storage
- Industry Decarbonization & Circular Economy
- Smart and Low Carbon Cities
- Digital Transformation

MAIN FIGURES

100 M€

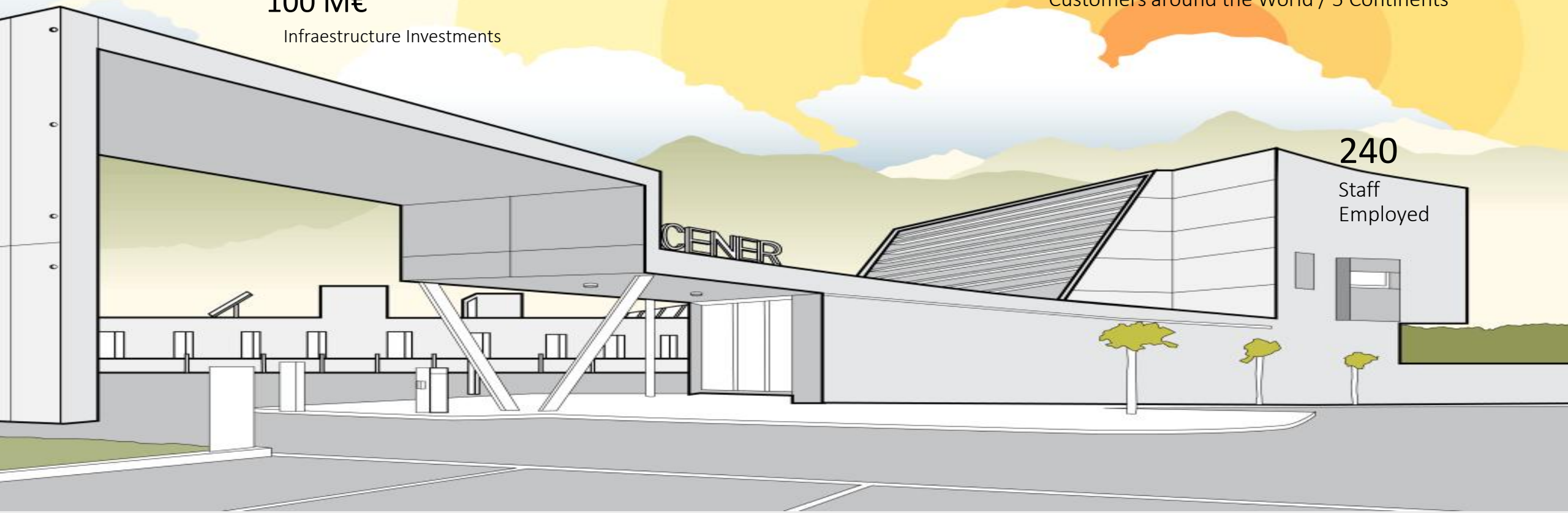
Infraestructure Investments

> 500

Customers around the World / 5 Continents

240

Staff Employed



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02

BIOMASS AREA

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TARGETED SECTORS

Industry Decarbonisation

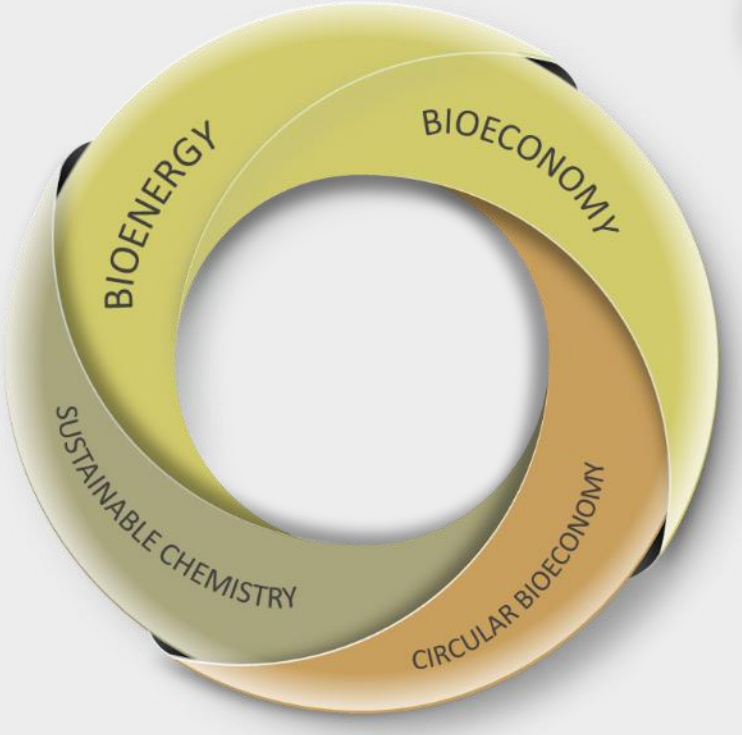
Torrefied solid biofuels

Biobased Products

Biodegradable Biopolymers
Bioaromatics from lignin
Biostimulants & Biofertilizers

P2X - Chemical energy storage

CO2/Syngas biological methanation



Transport decarbonisation

Advanced liquid biofuels
- Hydrothermal licuefaction
- Pyrolisis
- Gasification + syngas fermentation

Bioresidues valorisation

Into advanced biofuels & bioproducts

Chemical recycling of plastic residues

- Hydrothermal licuefaction
- Pyrolisis
- Gasification + syngas fermentation

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TEAM AND TRACK RECORD

THE TEAM

40 researchers, engineers & technicians
Biology, Chemical Eng., Agronomy, Chemistry, Biochemistry ...

EXPERTISE

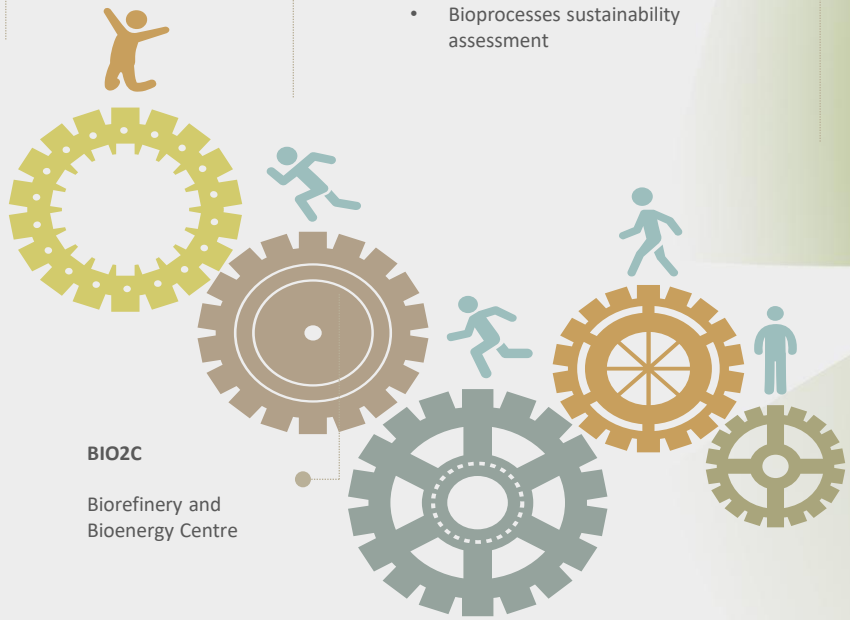
- Biomass resources assessment and characterization
- Biochemical and thermochemical processes
- Ash chemistry
- Bioprocesses sustainability assessment

PARTICIPATION IN INTERNATIONAL FORUMS AND GROUPS OF EXPERTS

- ETIP BIOENERGY
- BIOENEGY EUROPE
- CBE
- EUREC
- BIOPLAT
- ASEBIO
- SUSCHEM
- ASOBIOCOM
- GASNAM
- BIOVEGEN

LARGE EXPERIENCE IN BIOMASS VALORIZATION

- Commercial projects:
  300+ projects
  100+ clients
- R&D activity:
  40+ public financed R&D projects



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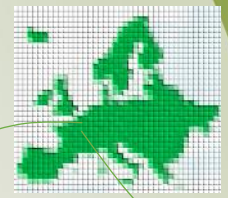
INTERNATIONAL PRESENCE. EUROPE AND BEYOND



Mexico
Dominican Republic
Colombia
Argentina
Philippines

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TARGETED SECTORS

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STRUCTURED IN 3 AREAS

SUPPORTING THE WHOLE INDUSTRY CHAIN AND INSTITUTIONS

1. THERMOCHEMICAL PROCESSES

2. BIOPROCESSES

3. DOWNSTREAM

4. SUSTAINABILITY & TECHNOECONOMIC ASSESSMENTS

TARGETED SECTORS

BIO2C
Biorefinery and Bioenergy Centre

STRUCTURED IN 3 AREAS

SUPPORTING THE WHOLE INDUSTRY CHAIN AND INSTITUTIONS

1 – THERMOCHEMICAL PROCESSES

- Process development:
  - **Torrefaction**
  - **Pelletizing**
  - **Gasification**
  - **Pyrolysis**
  - **Lignin depolymerization** processes
  - **Hydrothermal Liquefaction**
- Solid Biofuels **Characterization**
- Simulation of **Ash behavior**

2 – BIOPROCESSES

- Process development:
  - **Enzymatic** and **fermentative** processes
  - **Fractionation** of lignocellulosic biomass
  - **Gas fermentation**
  - **Separation** and **purification** technologies
- Feedstock **Characterization**

3 – SUSTAINABILITY & TECHNOECNOMIC ASSESSMENTS

- Ad-hoc **Sustainability** services for:
  - Certification systems development
  - LCA and GHG assessments
- **Techno-economic evaluation:**
  - Process **flow diagram**
  - **Mass and energy balances**
  - **CAPEX and OPEX**
  - **Operating account**: LPC, TIR, PAY-BACK

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03
RESOURCES

CENER's Industrial research infrastructure for bioprocesses

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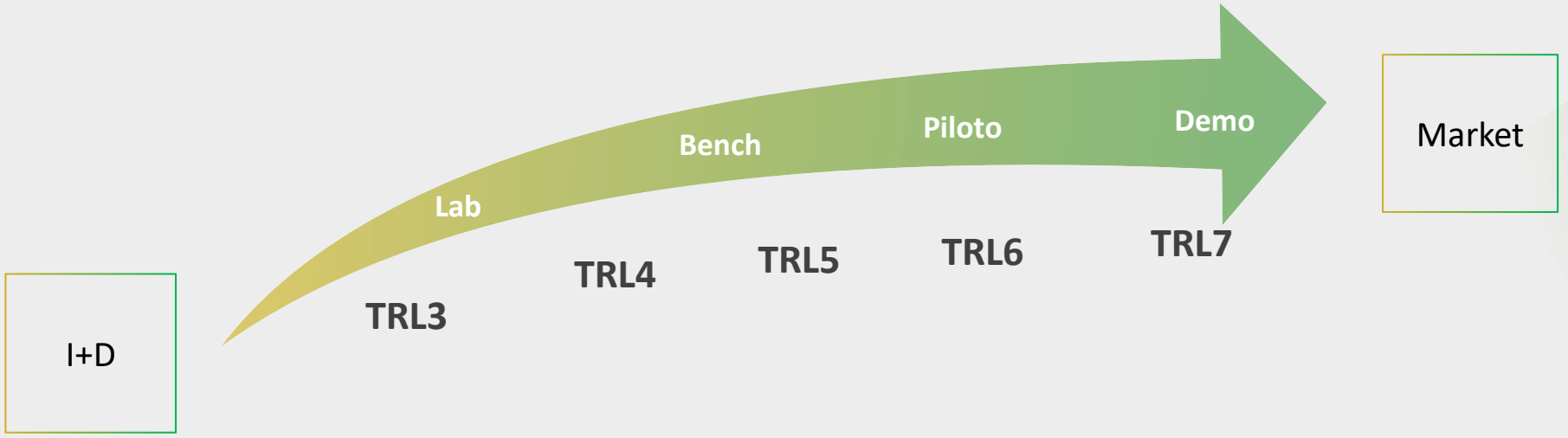
HEADQUARTER
Sarriguren

LABORATORIES
Sarriguren

BIOREFINERY AND BIOENERGY CENTRE (BIO2C) Aoiz



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CENER's Industrial research infrastructure for bioprocesses

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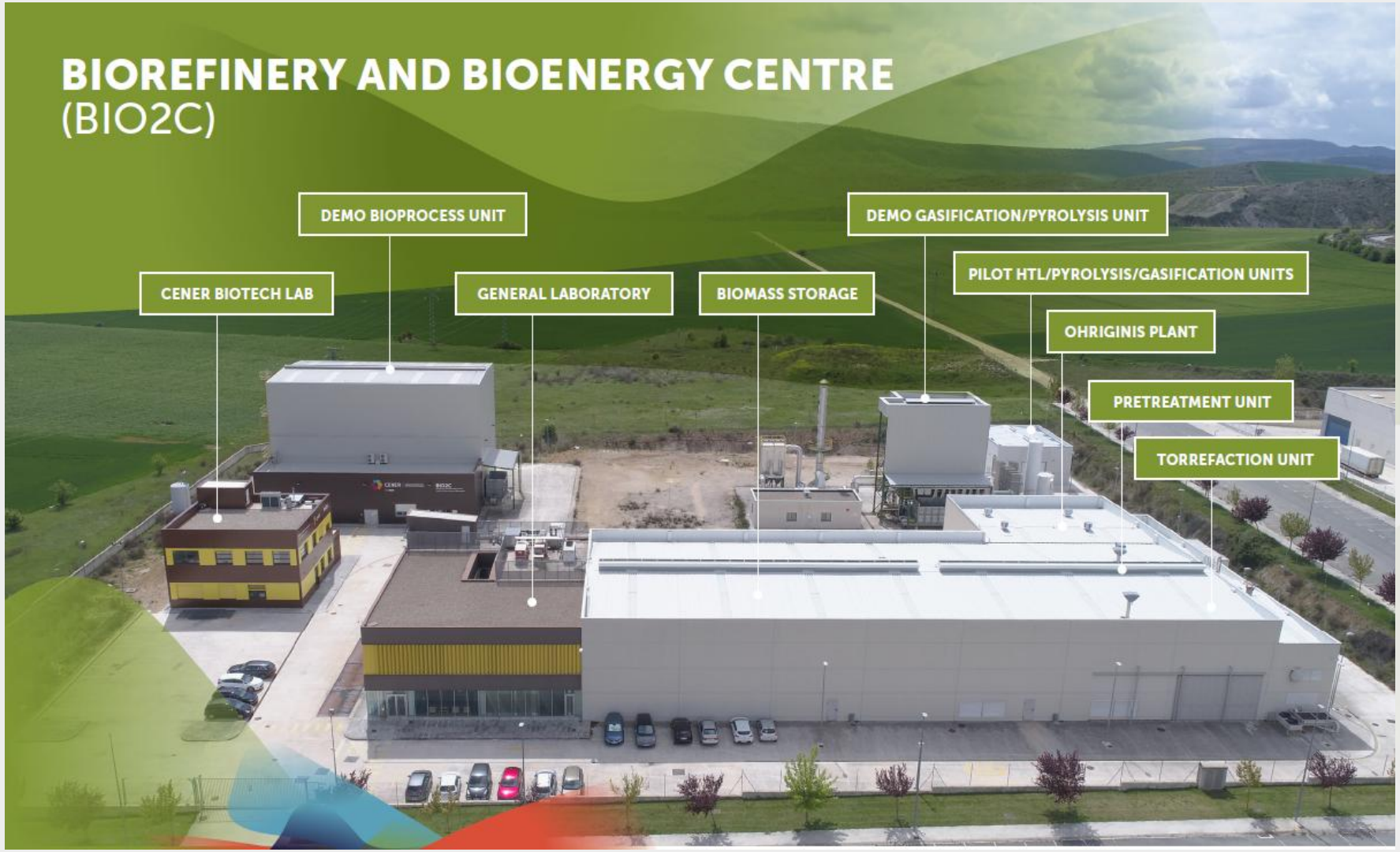

GASIFICATION UNIT AND SYNGAS CLEANING SYSTEM

BIO2C
Biorefinery and Bioenergy Centre

BUBBLING FLUIDIZED BED

Nominal power: **2 MWt** (500 kg/h)

- Operation pressure: **0,3 barg**
- Temperature : **650-1000ºC**
- Two operation modes:
  - Air gasification
  - Steam + O_2 gasification
- Inertization: CO_2
- Wide range of **biomasses and wastes**

Biomass or organic waste is thermochemically converted into synthesis gas (**syngas**), primarily composed of carbon monoxide (CO), hydrogen (H_2), and carbon dioxide (CO_2).

SYNGAS CLEANING PILOT FACILITY

(**100 Nm^3/h of syngas**) to **removal of impurities and contaminants** generated during gasification:

- Tars
- Particles
- Nitrogenous compounds (NH_3 and HCN)
- Sulfur compounds (H_2S and COS)
- Halides (HCl and HF)
- Alkaline compounds (Na and K)
- Metals (Hg and Cd).

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CENER Biotech LAB

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FEEDSTOCK/PRODUCT CHARACTERIZATION

- **Liquid Chromatograph HPLC**
  - Carbohydrates/sugars
  - Organic acids
  - Inhibitors
  - HP-SEC average molecular weight
- **Gas Chromatograph GC-FID & MS**
  - Methanol, ethanol, butanol
  - Lipids
- **Elemental Analysis**
  - Proteins

BIOPROCESSES: ENZYMATIC HYDROLYSIS & FERMENTATION

- **Process parameters optimization** in:
  - From microplates: < 1ml
  - Erlenmeyers or flasks: up to 1L
  - Bioreactors: 2-5L
  - Batch, Feed-batch, continuous
  - Adjustable agitation speed, air/gas ratios, pH, nutrients
- **Gas-fermenter** (ATEX): 10L (propietary design)
- **Laminar air flow cabinet & Anaerobic cabinet**
- **Incubators** with adjustable agitation, temperature, gas inlet
- Online analysis for **sugars and nutrients**
- Online analysis of **exhaustive O2 and CO2 gases**

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BIOCHEMICAL PROCESS UNIT

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PILOT PLANT

PRETREATMENT

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

ENZYMATIC HYDROLYSIS

- **High solids** enzymatic hydrolysis **stirred tank reactor**
- **200l** capacity
- Temperature**: 125 ºC**
- **Self-sterilizable**
- **Presurizable (**min 1.5 bar/21,75 psi)

FERMENTATION

- **Fully monitored bioreactors**
- **40l** and **100l** capacity
- Temperature: **23-80ºC**
- **Adjustable** agitation speed, air/gas ratios, pH, nutrients

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BIOCHEMICAL PROCESS UNIT

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INDUSTRIAL PLANT

Modular and flexible facility. Main equipment:

- High solid enzymatic reactors (2 x 3 m^3)
- Press Filter/Centrifuge for solid- liquid separation,
- Detoxification of inhibitors
- Liquid fraction concentration
- Fermentation train consisting of several monitorized bioreactors (1, 3 and 6 m^3)

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GAS/SYNGAS FERMENTATION UNITS

BIO2C
Biorefinery and Bioenergy Centre

Cutting-Edge Equipment Designed In-House by CENER

10L Reactor

100L Reactor

TRICKLE BED BIOREACTOR FOR GAS FERMENTATION

- **2 scales**
  - 10L
  - 100L
- Operation pressure: **0-10 bar**
- Temperature : **20-65ºC**
- **Sterile conditions**
- Operation modes:
  - Continuous
  - Feed-batch
  - Batch
- **ATEX**
- **2 operation modes**
  - Trickle Bed
  - Airlift
- Wide range of **substrate gases**
  - **CO_2**
  - **CO**
  - **H_2**
- **Wide range of microorganisms**
  - **Aerobes**
  - **Anaerobes**

The syngas/pure CO_2 stream is fermented using patented consortia bacteria that metabolize CO_2/CO and H_2 to produce chemical platforms. This fermentation occurs at low temperatures and pressures, enhancing energy efficiency

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Innovative Biotechnological Pathways for CO_2 Valorization

Bioproducts from CO_2 Conversion

- Biomethane and biofuels production from renewable carbon sources
- Protein production using CO_2 as the carbon feedstock
- CO_2 conversion into valuable chemicals (e.g., acetate, lipids)

Technological Development and Scale-Up

- Gas fermentation at larger scale: high-capacity pilot plants
- Optimization of metabolic pathways for CO_2 valorization
- Advanced genetic engineering (e.g., CRISPR/Cas9) for optimized microbial strains
- Microbial adaptation to new process conditions

Key Process Challenges

- Optimization of gas–liquid transfer: a limiting factor in gas-based fermentations
- High industrial scale-up costs: a barrier to commercialization

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04

REFERENCES & COOPERATION FRAMEWORKS

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OUR REFERENCES

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R&D PROJECTS, KNOWLEDGE & TECHNOLOGY TRANSFER

LEAF4VALUE | ZEBRA LIFE | abate Advanced Bio-based Refinery Intermediates | COSEC | LIGNOFUN (starting 06/2025)

BUTANEXT Next Generation Biobutanol | MEMBER | AMBITION | BIO RESCUE | BRISK BIOFUELS RESEARCH INFRASTRUCTURE

Clara | NEXTGEN roadfuels | PERCAL | BioTrade2020+ www.BioTrade2020plus.eu | CYCLALG

LOGISTEC | ENERMASS | ecodiesel | Bio4A | SCALIBUR

energreen | Value | www.bioclus.eu | Bio South | SECTOR

Participation in European Programmes (Biomass area):

- Horizon Europe
- H2020
- CBE/BBI
- LIFE
- INTERREG
- FP 7
- Areas: Energy, Materials, Bioeconomy, Infrastructures

Coordinated Projects:

- ZEBRA-LIFE
- BioRescue
- BioTrade2020+

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CENER'S APPROACH

Objective:

To demonstrate the use of acetate as a carbon source for producing protein from *arrowia lipolytica*.

- **Why?**
- *Y. lipolytica* is recognized as safe for human and animal consumption.
- High protein content: >50% in *Y. lipolytica*.

How?

By combining fermentation strategies with mutagenesis and ALE (Adaptive Laboratory Evolution).

CENER'S WORK PLAN

Activity 1. Selection, acquisition and activation of *Yarrowia lipolytica* strains

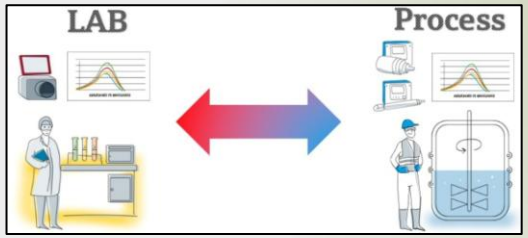
Activity 2. Fermentation trials at flask and mini-fermenter scale

•Using alternative carbon sources (acetate)

•Mutagenesis and ALE (Adaptive Laboratory Evolution) to increase productivity from acetate into SCP

Activity 3.

Based on the results obtained in Activity 2, process optimization at TRL 7 from 100 to 3,000-liter liquid fermenters



Activity 4. Techno-economic assessment:

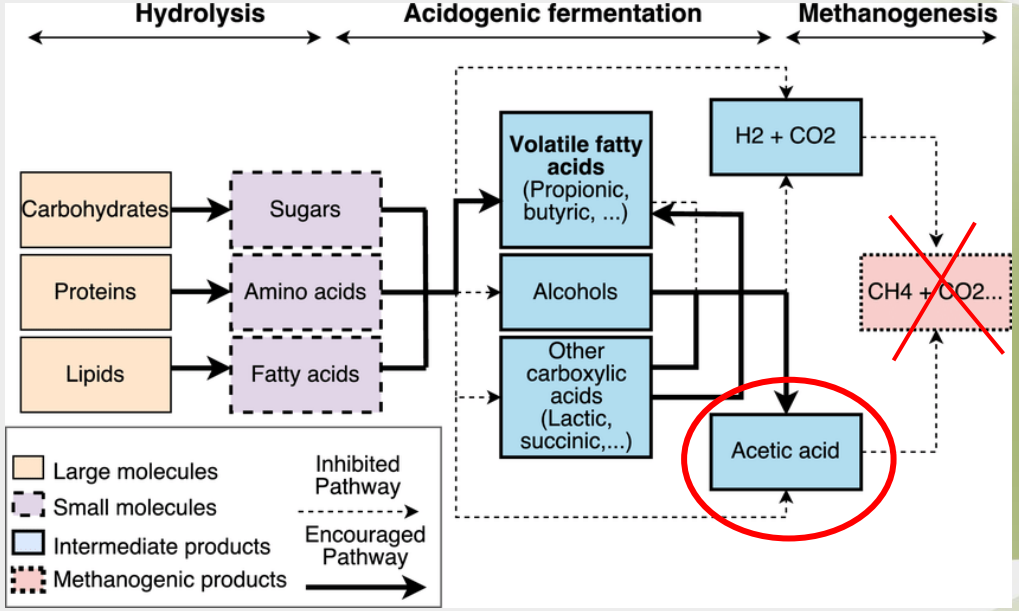
•Mass balance

•Energy balance

•Simulation at industrial scale

1. ALTERNATIVE CARBON SOURCES: ACETATE

SEWAGE SLUDGE



High-temperature anaerobic fermentation of sewage sludge is a biotechnological process aimed at valorizing sludge from wastewater treatment plants (WWTPs) by converting it into short-chain organic acids (also known as volatile fatty acids, VFAs).

Instead of continuing anaerobic digestion to methane production, this process is intentionally stopped at the acidogenic phase to accumulate higher-value acids such as acetate, propionate, or butyrate.

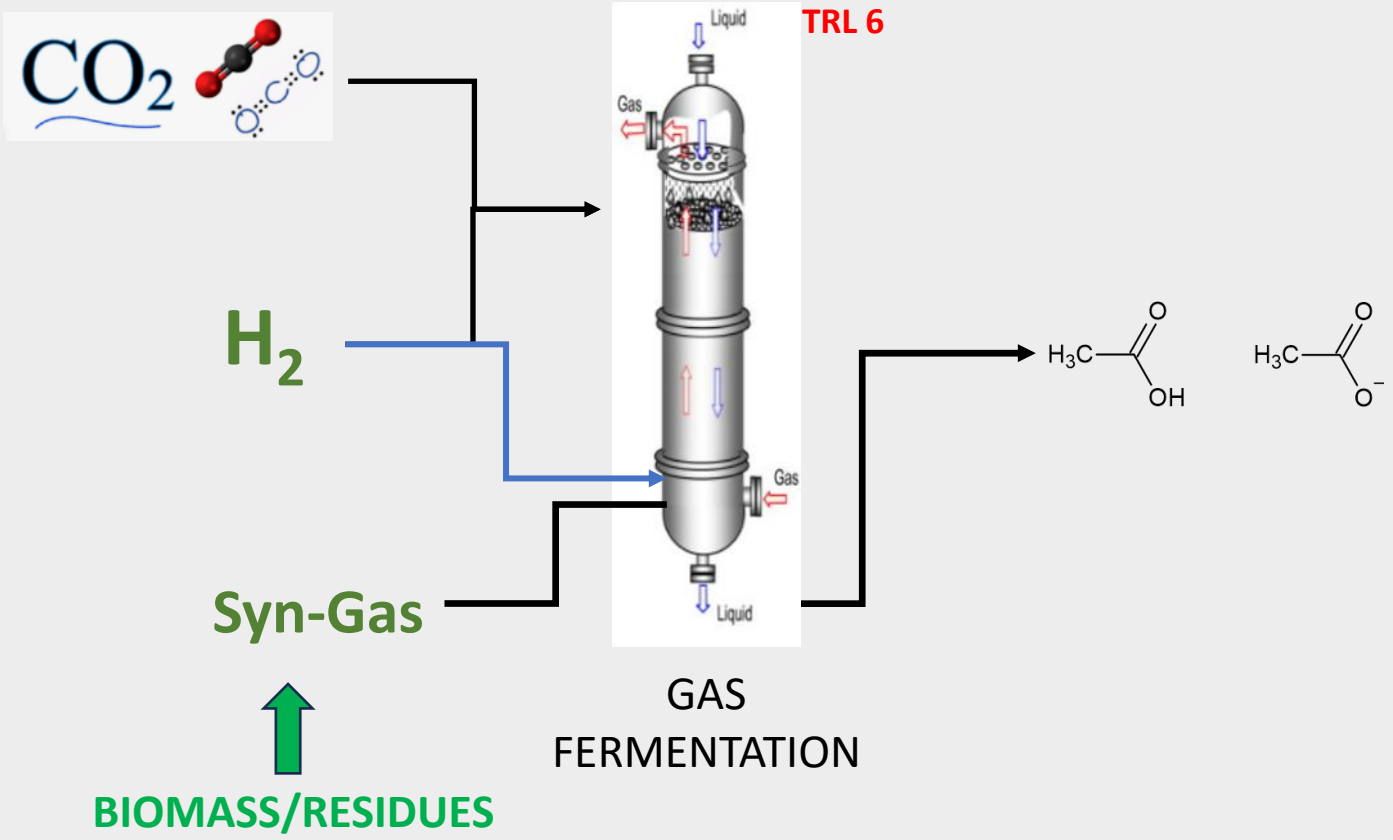
This approach is part of a circular economy strategy to recover valuable chemicals from organic waste (sludge), while simultaneously reducing the amount of final sludge and its environmental impact.

In Europe, the production of short-chain organic acids from sludge is still emerging, with several pilot and demonstration initiatives underway, and some companies driving its commercialization. The technology readiness level (TRL) is currently estimated at around TRL 5–7 (pilot/demonstration phase).

Potential Partners to be contacted:

- CETAQUA (Pilot plant ECOVAL Sudoe Project)
- BBPP
- Project WOW
- PERSEO AND URBASER Projects: URBIOFIN and CIRCULAR BIOCARBON
- NILSA (Spain-WWTPs)

2. ALTERNATIVE CARBON SOURCES: ACETATE



Biotechnological Gas Fermentation: Turning CO_2 into Acetate

•What?

A cutting-edge biotechnological process that uses specialized microorganisms to convert CO_2-rich gas streams into acetate.

•Why?

This approach offers a sustainable alternative to fossil-based carbon sources, enabling the valorization of industrial CO_2 emissions.

•How?

Through anaerobic gas fermentation using acetogenic bacteria capable of fixing CO_2 and H_2 via the Wood–Ljungdahl pathway.

•Applications

The acetate produced serves as a versatile platform molecule for bio-based chemicals as Single Cell Protein (SCP) production.

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THANKS A LOT.

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