CENER

CENTRO NACIONAL DE ENEGÍAS RENOVABLES
NATIONAL RENEWABLE ENERGY CENTER OF SPAIN

URBAN CIRCULAR BIOREFINERY FOR ADVANCED BIOFUELS

IEA EGRD workshop Green Fuels 21-22 October in Paris

Dr. Javier Gil
jgil@cener.com

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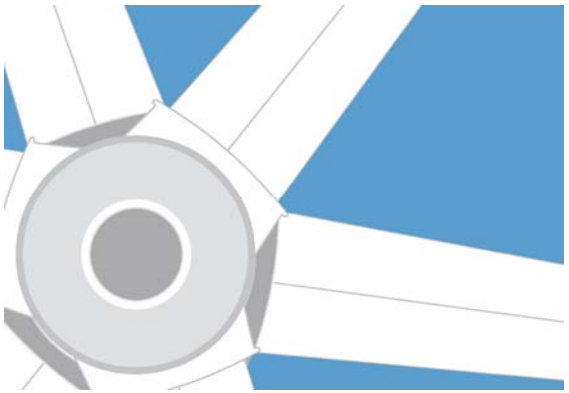
URBAN CIRCULAR BIOREFINERY APPROACH & PROJECTS

01

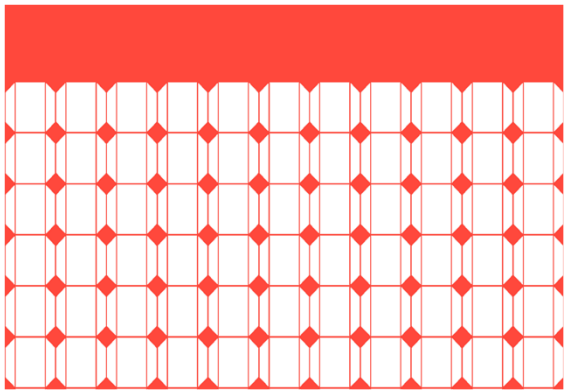
CENER OVERVIEW



RESEARCH AREAS



Wind Energy



Photovoltaic Solar Energy



Solar Thermal Energy



Biomass



Energy in Buildings



Grid Integration of Renewable Energy

02

BIOMASS DEPARTMENT



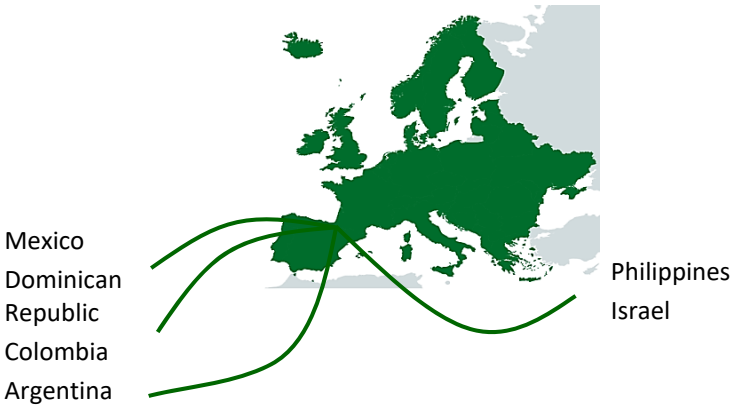
TEAM AND TRACK RECORD

HIGHLY SKILLED MULTIDISCIPLINARY TEAM OF PROFESSIONALS

LARGE EXPERIENCE IN BIOMASS VALORIZATION



Team



International presence. Europe and Beyond

The **team**:

- **25** researchers, engineers and technicians
- Biology, Chemical Eng., Agronomy, Chemistry, Biochemistry among others

Team's **expertise**:

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

Commercial **projects**:

- **300+** projects
- **100+** clients

R&D activity:

- **30+** public financed R&D projects

Participation in **international forums** and **groups of experts**

- EERA BIOENERGY JP
- ETIP BIOENERGY
- BIOENEGY EUROPE
- BBI
- BIOPLAT
- ASEBIO
- SUSCHEM
- ASOBIOCOM

BIO2C (https://www.bio2c.es/)

Biorefinery and Bioenergy Centre

STRUCTURED IN 3 AREAS

SUPPORTING THE WHOLE INDUSTRY CHAIN AND INSTITUTIONS

1 – SOLID BIOFUELS



- Process development:
  - Torrefaction
  - Pelletizing
  - Gasification
- Solid Biofuels Characterization
- Simulation of Ash behaviour

2 – BIOPROCESSES



- Process development:
  - Enzymatic and fermentative processes
  - Fractionation of lignocellulosic biomass
  - Lignin depolymerization processes
  - Separation and purification technologies
- Feedstock Characterization

3 – SUSTAINABILITY



- Ad-hoc Sustainability services for:
  - Bio-based products and processes
  - Biofuels
  - Bio-Power
  - Thermal uses

MAIN R&D PROJECTS IN 2019

SOLID BIOFUELS

- Chemical Looping gAsification foR sustainAble production of biofuels
- Advanced MEMBranes & membrane assisted procEsses for pre- and post- combustion CO2 captuRe
- Simulation and monitoring of biomass ash behavior
- Development Improved control system for biomass boilers
- Biofuels Research Infrastructure for Sharing Knowledge II

BIOPROCESSES

- Scalable Technologies for Bio-Urban Waste Recovery
- Circular Urban Biorefinery in Navarra
- Sustainable Drop-In Transport Fuels from Hydrothermal Liquefaction of Low Value Urban Feedstocks
- Chemical building blocks from versatile MSW biorefinery
- Kraft Lignin biovalorisation into Vanillin
- Network of Technological Centres for the Development of a Microalgae Based Biorefinery
- Enhanced bioconversion of agricultural residues through cascading use
- Advanced biofuel production with energy system integration
- Advanced sustainable BIOfuels for Aviation

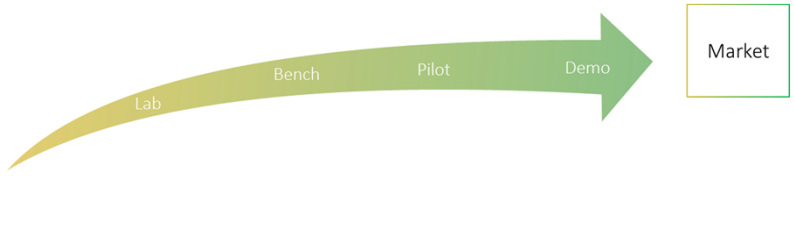
Clara · MEMBER · Bioboiler · ALIGAS · BRISK · SCALIBUR · Biourbana · NEXTGEN roadfuels · PERCAL · KI Vainillina · CYCLALG · BIO RESCUE · AMBITION · Bio4A

03

BIOREFINERY & BIOENERGY CENTRE (BIO2C)



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BIO2C – Biorefinery and Bioenergy Centre (https://www.bio2c.es/)

The **Biorefinery and Bioenergy Centre (BIO2C)** is a **semi-industrial pilot scale test facility** able to develop production processes for bioproducts, solid biofuels, advanced liquid or gaseous biofuels, as well as biorefinery concepts integrating different valorization routes, as an intermediate step between laboratory and the industrial scale-up of these technologies.

The centre constitutes an **integrated trial and demonstration platform** designed **to develop** processes, equipment and specific, components, new **bio-products** or biofuels and bio-refinery concepts.





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BIO2C Unidades de procesos

Hasta TRL 6-7

Pretratamiento

Desde 2008



2MWt-500kg biomasa/h

- Astillado y picado
- Secado
- Torrefacción
- Molienda
- Peletizado

Gasificación

Desde 2012



2MWt-500kg biomasa/h

- Gasificador
- Oxidador térmico
- Tratamiento de gases

Procesos Bioquímicos

Desde 2013



1,5t biomasa/semana

- Pretratamiento
- Fraccionamiento líquido/sólido
- Procesos biológicos (Hidrólisis Enzimática y Fermentación)

BIOCHEMICAL PROCESS UNIT

R&D → Lab → Bench → Pilot → Demo → Market

PILOT PLANT

Pretreatment



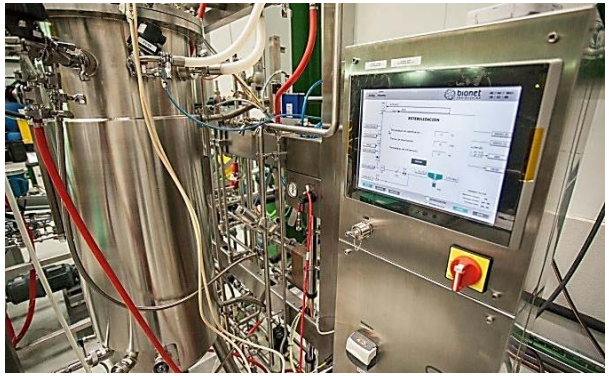
- **Continuous horizontal** reactor
- Feed flow: up to **5 kg/h**
- Pressure up to **14.5 bar**
- Temperature up to **200ºC**
- High **flexibility** in **feedstocks**

Enzymatic Hydrolysis



- **High solids** enzymatic hydrolysis **stirred tank reactor**
- **200l** capacity
- Temperature**: 20-80 ºC**
- **Atmospheric pressure**

Fermentation



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

CENER's BIOCHEMICAL PLATFORM

Lab → Bench → Pilot → Demo → Market

R&D

Modular and **flexible** facility. Main equipments:

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

BIO2C BIOPROCESS UNIT







04

URBAN CIRCULAR BIOREFINERY APPROACH & PROJECTS



Urban Biowaste Potential In Europe

- Availability in Europe: **100 million t/y** (Eurostat 2017),
- **Steady generation, distributed every where**
- **Existing/devloped logistics. Separate biowaste collestion** compulsory in 2023 for all member states.
- No more than 10% of MSW should be sent to landfill by 2030
- Composition with a **high valorization potential** into bioproducts



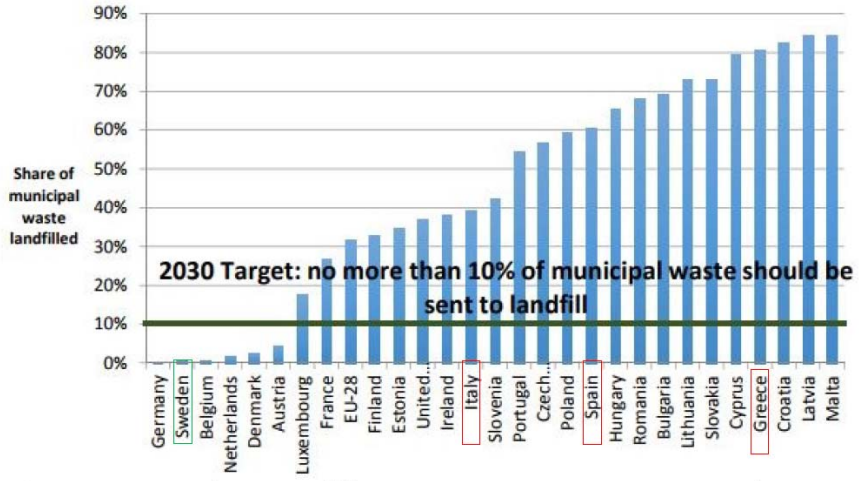


Figure 6. EU Municipal Waste Landfilling rates per country. Source: European Parliamentary Research Service: "Towards a circular economy – Waste Management in the EU"

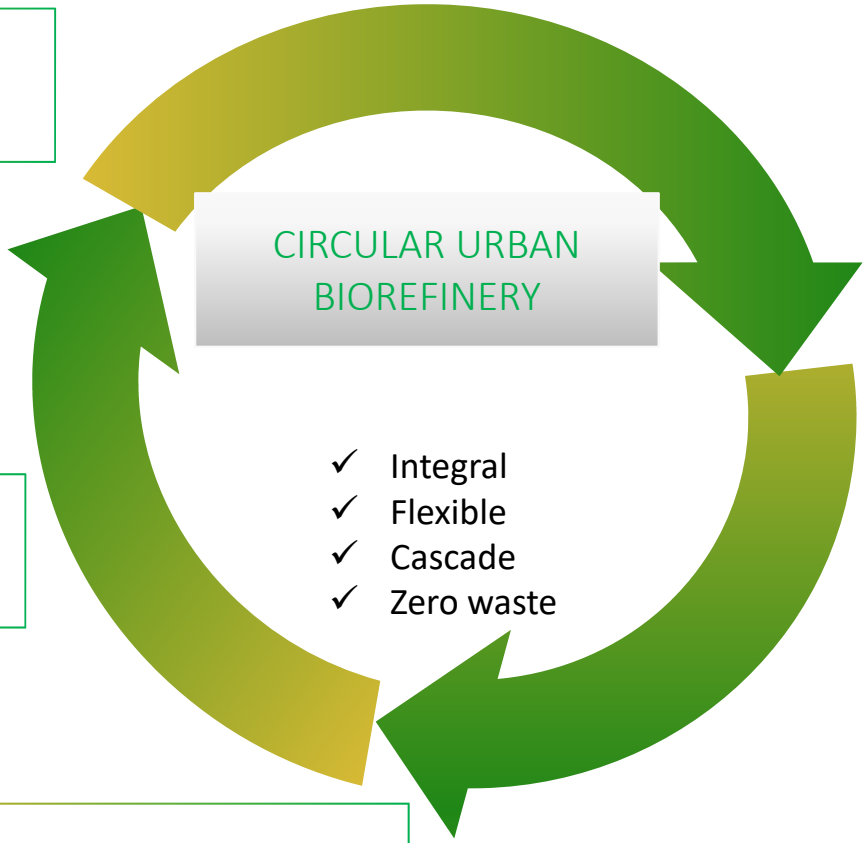
CENER Towards Circular Urban Biorefinery

URBAN BIORESIDUE valorization

BIOREFINERY concepts

BIOBASED PRODUCTS

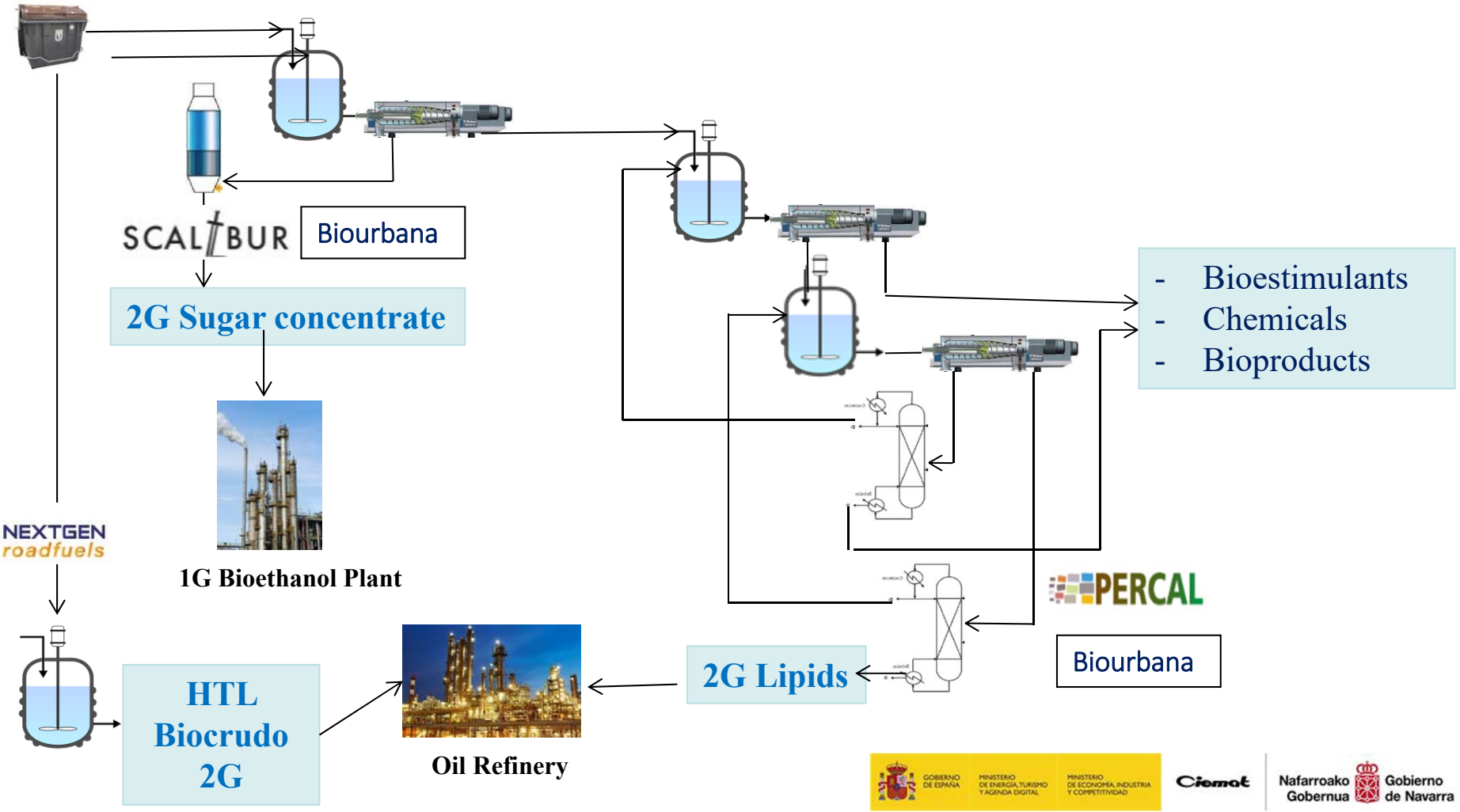
ADVANCED BIOFUELS



	% dry basis	range
Carbohydrates	**41**	**(24-57)**
Protein	15	(11-18)
Fames	**6**	**(2-15)**
Lignin	9	(4-10)
Inorganics	16	(11-24)

CIRCULAR BIOREFINERY FOR ADVANCED BIOFUELS

Production of concentrated energy carriers to be further transformed into advanced biofuels in existing infrastructures



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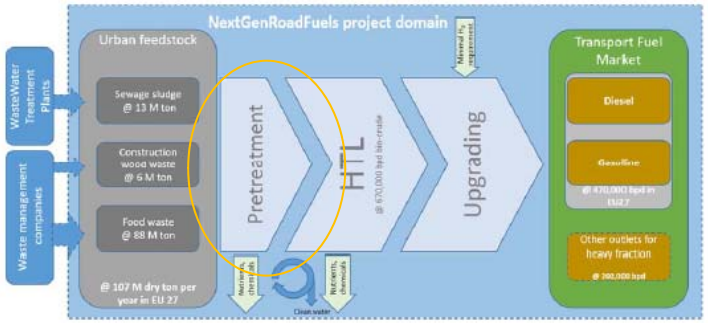
NEXTGEN roadfuels

2018-2022

Sustainable Drop-In Transport Fuels from Hydrothermal Liquefaction of Low Value Urban Feedstocks

https://www.nextgenroadfuels.eu/









PROJECT SCOPE

To prove the **HTL technology pathway** as a viable, sustainable and efficient route for production of liquid drop in fuels for road transport.

Use of advanced HTL technology , and low H2 upgrading techniques for the **valorization of low value aggregated urban sewage wastes and biowastes** into drop-in quality **synthetic gasoline and diesel.**

CENER ROLE

To lead the research line related to the **improvement sewage sludge as feedstock** for reducing the organic nitrogen content in sewage sludge before its treatment by HTL to **meet the specifications on biofuel emissions** during combustion:

- **pretreatment** of feedstock using a mild & low temperature enzymatic hydrolysis.
- **extraction & purification** for protein-derived amino acid and peptides valorization

Sustainability Assessment

Horizon 2020
European Union Funding
for Research & Innovation

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SCALIBUR

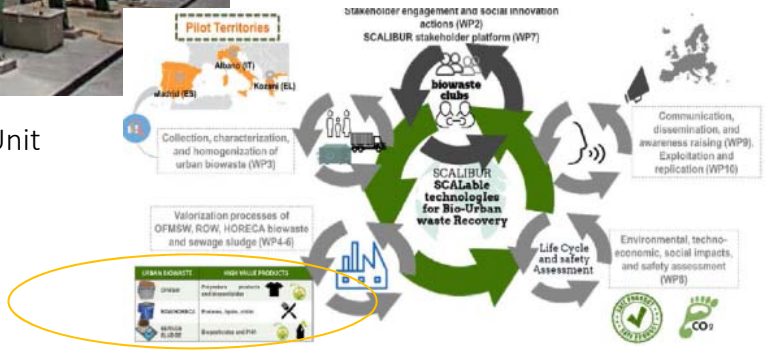
2018-2022

Scalable Technologies for Urban Biowaste Recovery

www.scalibur.eu/



General overview Biochemical Process Unit



PROJECT SCOPE

SCALIBUR aims at closing the gap between technological feasibility and **industrial applications** of **urban biowaste valorisation** by enhancing **strategic cooperation between sectors.**

CENER ROLE

OFMSW valorization by enzimatic hydrolisis to produce **2G sugar concentrate** and fermentation in **BIO2C demostration plant (TRL7)**, for a later production of bio-based **polyesters** and **biopesticides**

Sustainability assessement

Horizon 2020
European Union Funding
for Research & Innovation

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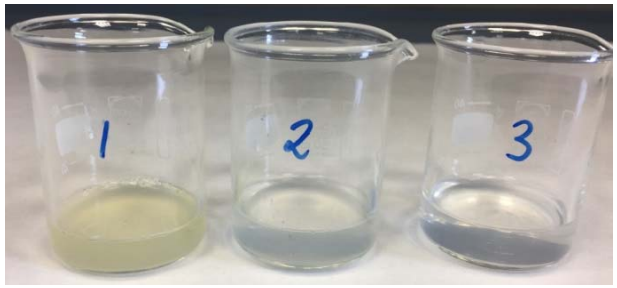
PERCAL

Chemical Building Blocks from versatile MSW biorefinery

2017-2020

https://www.percal-project.eu/





PROJECT SCOPE

To exploit Municipal Solid Waste (MSW) as feedstock to develop **intermediate chemical products and derived final products** at high yield and low impurity level with huge industrial interest:

- **Ethanol** to produce:
  - Biofuels
- **Lactic Acid** to produce:
  - Eco-friendly ethyl lactate solvents
  - Hot-melt adhesives
- **Succinic Acid** to produce:
  - Polyols for the polyurethane industry.
- **Biosurfactants**

CENER ROLE

To lead WP and research line of **biosurfactants production by valorising the bioethanol, lactic acid or succinic acid fermentation by-products** in order to increase the recovery from the organic content of MSW:

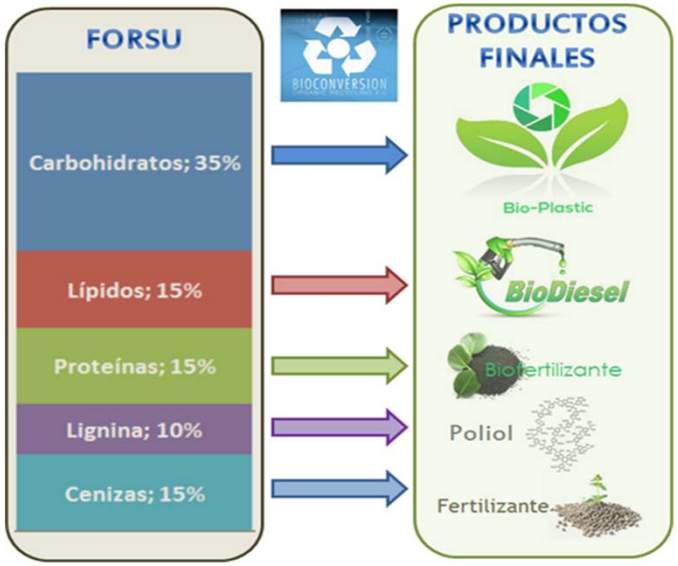
- Hydrolization and extraction of protein and lipid fraction of the fermentation by-product
- Synthesis of biosurfactant
- Validation with industry

BIO-BASED INDUSTRIES Public-Private Partnership
Bio-based Industries Consortium
Horizon 2020 European Union Funding for Research & Innovation

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BioUrbaNA 2018-2022

Circular Urban Biorefinery in Navarre





PROJECT SCOPE

Design a **new concept of integral and cascade valorisation of the different fractions** that make up the **organic fraction of urban solid waste** (OFMSW) to obtain **bioproducts** with greater added value.

Development of the **bio-waste refinery** through the application of the **circular economy** concept

CENER ROLE

Process development for :

- Conditioning/**fractionation** methods
- **Polysaccharides** valorization
- Valorization of **protein** fraction
- Valorization of **lipid** fraction
- Valorization of **lignin** fraction

Enzimatic Hydrolisis & Fermentation process **optimization and upscaling**

Upstream / downstream **processes for the separation and / or purification** of the different fractions

Process flows / Material balances / Feasibility studies


THANK
YOU VERY
MUCH!