URBAN BIOREFINERY: SECOND GENERATION BIOETHANOL, BIOPRODUCTS AND BIOENERGY FROM ORGANIC MUNICIPAL SOLID WASTE

WATER CYCLE MANAGEMENT AND MUNICIPAL BIOWASTE EXPLOITATION IN THE CONTEXT OF CIRCULAR ECONOMY: FROM CONCEPT TO STANDARD PRACTICE

8th of October, 2018

Caterina Coll Lozano
Chief Operating Officer IMECAL S.A.
Metal mechanical company founded in 1979.
Located in L’Alcúdia (Valencia – Spain)
High technological capacity. Experience in petrochemical and refinery sectors.
25,000 m² of facilities. 180 employees.
About 100 Mt of municipal biowaste is generated every year in Europe.

Only about a third (30 Mt) of this was separately collected and composted and/or digested (European Compost Network (ECN))

New Waste legislation (22 may 2018)

- Mandatory separate collection of bio-Waste: 31/12/2023
- Maximum 10% landfill of MSW 2035.

Biorefinery from organic urban waste

**Biotechnological process:**
Transform the organic fraction of municipal waste into advanced bioethanol, bioproducts and bioenergy.

- The Process is Real, Feasible, Replicable and Profitable.
- Proven Pre-industrial process.
  Pilot plant 25 t/d from 2007.
Patented biotechnology to transform the Organic fraction of Municipal Solid Waste into second-generation Bioethanol bioproducts and bioenergy.

Partners:

Collaboration with different Universities, Private companies, European Associations, Municipalities and Public Authorities
PERSEO Bioethanol®: Sustainable process to turn bio-waste fraction from MSW into bioethanol, bioproducts and bioenergy.
PERSEO Bioethanol®: Urban Biorefinery

Integrable module

**PERSEO + AD**
- Municipal Solid Waste
- Sorting
- Bioethanol
- AD
- Composting
- Biogas
- Biofertiliser
- Reject

**PERSEO + WTE**
- Municipal Solid Waste
- Sorting
- Bioethanol
- Waste to Energy
- Bioenergy
- Reject (ashes)
- + 50%

**PERSEO + composting**
- Municipal Solid Waste
- Sorting
- Bioethanol
- Composting
- Biofertiliser
- Reject

*From sorted OFMSW*
Bioethanol market:

- **Biofuel**: 90% of total biofuels. In **Europe** 13 billion € in 2030
- **Chemical Building block**: Bioethanol is considered as one of the “top 10” potential biobased raw materials for the chemical industry. (US Energy Department)

*Ethanol as building block for the production of valuable chemicals (Bienfait and Erdl, 2013).*
## IMECAL biorefinery Projects

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
<th>Project Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017-2021</td>
<td>Demonstration of an integrated innovative biorefinery for the transformation of Municipal Solid Waste (MSW) into new BioBased products. (GA No. 745785)</td>
<td></td>
</tr>
<tr>
<td>2017-2020</td>
<td>Chemical building blocks from versatile MSW biorefinery. (GA No. 745828)</td>
<td></td>
</tr>
<tr>
<td>2017-2020</td>
<td>Valorization of urban wastes to new generation of bioethanol (EXP-00098459 / SERA-20171009)</td>
<td></td>
</tr>
</tbody>
</table>

Este proyecto ha recibido financiación del programa ERA-NET CO-FUND BESTF3 con cofinanciación de CDTI y MINECO en España y DECC en Reino Unido así como del Programa Marco de Investigación e Innovación, H2020, de la Unión Europea.
The URBIOFIN consortium

Demonstration of an integrated innovative biorefinery for the transformation of Municipal Solid Waste (MSW) into new BioBased products. (GA No. 745785)

Demo Project Budget: 15 M€
Duration: 4 years project (6/2017 – 5/2021)
The objective

NEW MODEL OF OFMSW TREATMENT

Biorefinery
Multiple bioproducts
Higher value

Landfill
Composting
Anaerobic Digestion

URBIOFIN - BIOREFINERY

BIO-BLOCKS
- Bioethanol
- Volatile fatty acids
- Biogas

BIO-POLYMERS
- Polyhydroxyalkanoates
- Combined PHA’s

ADDITIVES
- Bioethylen
- Biochemical products

VALUE
Biorefinery concept

Non-organic (Recycling)

MSW

Sorting

OMSW

Pre-treatment + Hydrolysis + Fermentation

BIOTECHNOLOGY

Biogas

AD1

VFAs

Elongation

PHA production (pure culture)

Extraction

BIODEGRADABLE

PHA production (mixed culture)

Extraction

PHASE

Upgrading

Microalgae

Biomass/enrichment

PHA production • Extraction

Hydrolysis / concentration

SPBD

OBSERVATION

DRY GRANULES

AA

SCL-PHA

BIOMETHANE

SCL-PHA

Agriculture Bioplastics

Agriculture Bioplastics

Solid Fertilizer

Liquid Fertilizer

BioPlastics

FRUIT RIPENING

Cosmetics Bioplastics

Biorefinery Products

BIOETHYLENE

BIOETHANOL

Catalysis

APPLICATIONS

MODULE 1

MODULE 2

MODULE 3

URBIOFIN - Urban Biorefinery

Bio-Based Industries Consortium

Horizon 2020 European Union Funding for Research & Innovation
URBIOFIN: Demonstration sites
Market of bioproducts

- **Bioethanol:**
  - **Biofuel:** 90% of total biofuels. **Market Forecast in Europe:** 13 billion € in 2030
  - **Chemical Building block:** Bioethanol is considered as one of the “top 10” potential biobased raw materials for the chemical industry. (US Energy Department)

- **Bioethylene:**
  - Global bioethylene market size was over USD 160 billion in 2015 and is foreseen to exceed USD 235 billion valuation by 2024
Bioplastics:

- Biodegradable bioplastics market is expected to double between 2014 and 2019.
- In the case of PHA market it is expected a growth from 32 to 104 Mton, mainly related to flexible or rigid packaging and agriculture purposes.

Biofertilizers

- Global bio-based fertilizers market is expected to reach USD 1.9 Billion by 2020 at a CAGR of 14.0% from 2015 to 2020
The achievements

Process definition and improvements

Pilot plants start the DEMO activity.

- Final products requirements

2017-2018

2019-2020

2020-2021
This project has received funding from the Bio-Based Industries Joint Undertaking under the European Union’s Horizon 2020 research and innovation programme under grant agreement Nº 745785.
**PERCAL**

*Chemical building blocks from versatile MSW biorefinery*

- 12 partners covering the value chain of MSW treatment to bioproducts

**Project coordinator:** IME CAL perseo

**Project budget:** 3.4 M€

3 years project (7/2017 – 6/2020)

**Partners:**

- AIMPLAS: PLASTICS TECHNOLOGY CENTRE
- Leibniz-Institut für Agrartechnik und Bioböden (ATB)
- visum: #SeeingNewData
- covestro
- CENER: AB1tech
- tbw RESEARCH
- YPAREX
- HAYAT
- exergy

**Bio-based Industries Consortium**

**European Union Funding for Research & Innovation**
PERCAL will exploit OFMSW as feedstock to develop intermediate chemical products at high yield and low impurity level with huge industrial interest.

- **Bioethanol** (current PERSEO Bioethanol® technology) as chemical building block.
- **Lactic acid (LA)** to produce:
  - Eco-friendly ethyl lactate solvents by reactive distillation from lactic acid & bioethanol.
  - Hot-melt adhesives in combination with maleic anhydride by reactive extrusion.
- **Succinic acid (SA)** as an intermediate building block to produce polyols for the polyurethane industry.
- **Biosurfactants** by chemical modification of proteins and lipids from the remaining fraction of MSW fermentations.
Chemical building blocks from versatile MSW biorefinery

Overall concept

Representative selected MSW streams

Succinic acid
Lactic acid
Ethanol

Chemicals Intermediates

Fermentation by-products

Final products

Solvents for cleaning products, inks...
Hot melts Adhesives for cardboard
Polyols for polyurethane Industry

Final products

Biosurfactant

Hydrophilic Moiety
(Surfactant head)

Hydrophobic Moiety
(Surfactant tail)

Biobased surfactants for cleaning's chemicals
Main results so far

✓ A list of specific requirements for PERCAL’s intermediate and final products was defined.

✓ Pre-treatment and enzymatic hydrolysis processes were optimized.

✓ LA and SA selected strains have been used to perform small scale fermentations and identify the best strains. LA fermentations have shown promising results with high conversion yields.

✓ Fermentation residues were analyzed showing similar composition, rich in lipids and proteins, which will be used for the synthesis of biosurfactants.

✓ First tests to optimize the synthesis of final products ethyl lactate, LA based hot melts adhesives and polyester polyols have been performed.

✓ The study of the adaptability and monitoring of a versatile biorefinery to obtain three chemical intermediates (ethanol, lactic acid and succinic acid) has been started.
Chemical building blocks from versatile MSW biorefinery
VALORIZATION OF URBAN WASTES TO NEW GENERATION OF BIOETHANOL (WASTE2BIO)

ERA-NET Cofund Bioenergy Sustaining the Future 3
BIOENERGY DEMONSTRATIONS OF THE EUROPEAN INDUSTRIAL BIOENERGY INICIATIVE

Project budget: 1,7 M€
March 2017 / March 2020
The main objective of the WASTE2BIO project is to validate and demonstrate a global process for the production of bioethanol as liquid biofuel and biogas from the remaining recoverable organic fraction from MSW in order to enhance the valorization of residues, reducing energy costs and impacts from waste management and contribute to an improved balance of GHG emissions from biofuels and to the achievement of the EU’s objectives.
WASTE2BIO PROJECT  Main results so far

- OFMSW pretreatment improved.
- PERSEO Biothanol® process optimized
- AD tests show similar/better biogas yields than fresh OFMSW.
Validation and Demonstration of the Integrated Process

PERSEO Bioethanol® plant
Benefits of an urban biorefinery:

**Profitability**
- **Higher annual benefits**, when compared to current MSW technologies

**Circular Economy**
- **Improvement of the performance through the use of by-products generated** in their own processes – landfill diversion

**Bioresources**
- **Versatility** to treat different fractions of waste to obtain maximum added value and profitability
- **Reduction of fossil resources** dependence in energy and products.

**Sustainability**
- Evolution towards the path of the bioeconomy defined by the EU.
- **Boost competitiveness**, foster sustainable economic growth and generate new jobs
THANKS!

Caterina Coll Lozano
Chief Operating Officer
Caterina@imecal.com
http://www.imecal.com/perseo