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Università IUAV
di Venezia



Co-funded by the European Union
(LIFE18 CCA/CY/00086)

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Unit of Environmental Science and Technology



CIRCforBIO

A circular economy system for multi-source biomass conversion to added value products



LIFE18 CCM/GR/001180

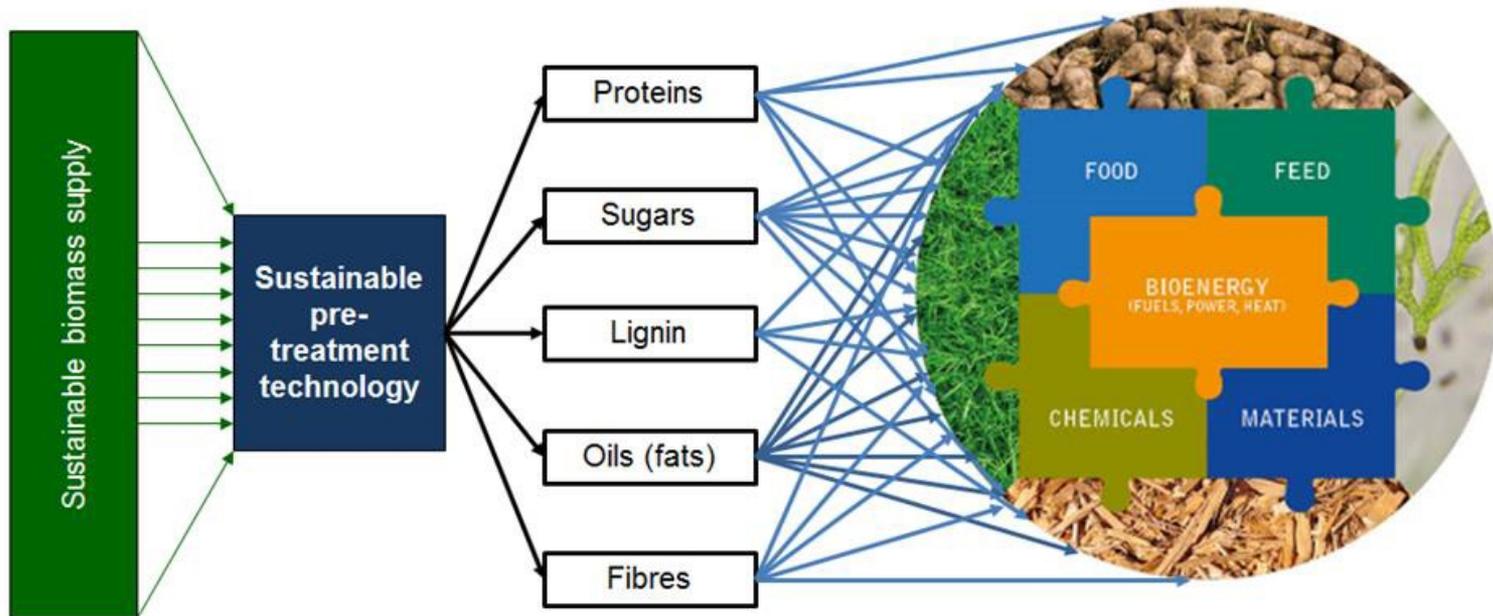
With the contribution
of the LIFE Programme
of the European Union

Project Duration: 01/10/2019 – 31/05/2023
Total project budget: 2,636,693 €
EU financial contribution (55%): 1,450,181 €

3rd Virtual ADAPTtoCLIMATE Conference

19-20 April 2021

Biorefinery



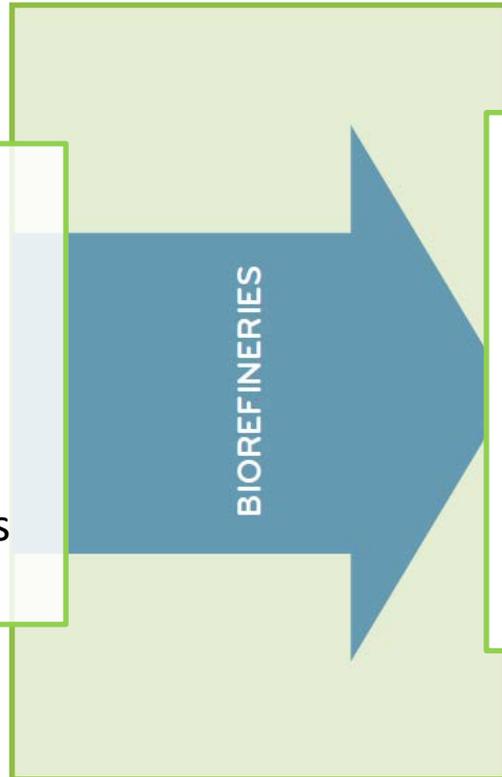
Sustainable processing of biomass into a portfolio of marketable biobased products (food and feed ingredients, chemicals, materials, fuels, energy, minerals, CO₂) and bioenergy (fuels, power, heat).

Valorization - Biorefinery



Biomass

- Agricultural residues
- Forestry residues
- Animal manure
- Food waste
- Dedicated ligno-cellulosic crops
- New promising biomass sources
- Industrial side-streams



Bio-based products & markets

- Bio-based chemicals
- Bioplastics / biomaterials / packaging
- Advanced biofuels
- Specialties (eg. Biosurfactants, lubricants, pharmaceuticals)
- Food ingredients and feed
- Bioenergy

A circular economy system for multi-source biomass conversion to added value products



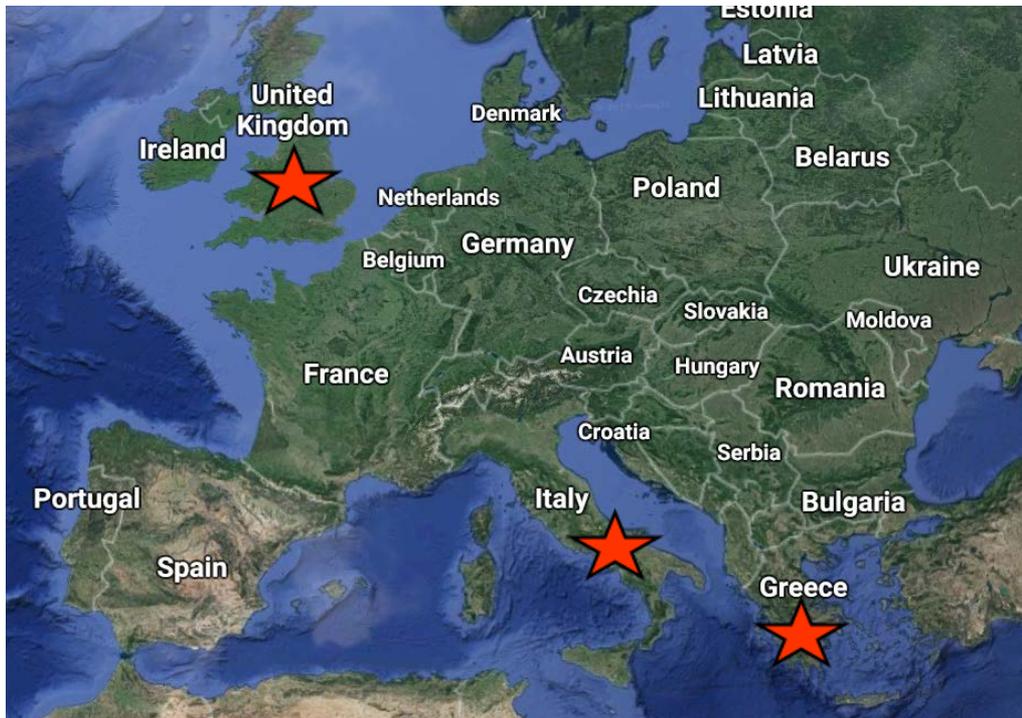
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Coordinating Beneficiary:



NATIONAL TECHNICAL UNIVERSITY OF ATHENS (NTUA)

Beneficiaries:



MUNICIPALITY OF LAVREOTIKI



FEDERATION OF HELLENIC FOOD INDUSTRIES



HELLENIC PETROLEUM S.A.



ENVIRECO CONSULTING S.A.



SATISTICA LTD.



NEVIS - NOVEL ENVIRONMENTAL SOLUTIONS S.A.



UNIVERSITA DEGLI STUDI DI VERONA



The project is co-funded by the EU through LIFE programme for the Environment and climate action



Background information on LIFE CIRCforBIO

Aim of LIFE CIRCforBIO project

The overall aim of the CIRCforBIO project proposal is to:

- achieve **high GHG emission savings** from the substitution of fossil fuels with advanced biofuels
- promote the realization of the **circular economy concept for biomass**.

This will be achieved through:

- the implementation and **demonstration of an innovative biorefinery** system for the production of **bioethanol, used oil** (raw material for biodiesel) and **other bioproducts** using municipal and industrial biomass.
- the **creation of an interactive platform** for facilitating the realisation of the circular economy concept for 2nd generation biomass in Greece.

Main expected impact of LIFE CIRCforBIO

- **Biorefinery capacity:** 1tn/d feedstock-biomass
- **Production capacity:**
 - 30-60 L/d EtOH
 - & 15-20 kg/d used oil
- **Energy production:** 69,500kWh/y from biofuels and biogas
- Reduction of **raw materials consumption:** ~4,5tn mineral fertilisers substitution

LIFE CIRCforBIO relevance to EU Policy

- **2020 Climate & Energy package (2007):** 20% GHG emissions reduction , 20% energy from RES and 20% improvement in energy efficiency, by 2020
- **2030 Climate & Energy framework (2014):** 40% cuts in GHG , 32% share from RES, 32.5% improvement in energy efficiency by 2030
- **Energy and fuel focused policies are targeted:**
 - RED 2009/28/EC (10% RE target in the transport sector by 2017)
RED II 2018/2001/EC (14% RE target in the transport sector by 2030)
 - Fuel Quality Directive 2009/28/EC (6% reduction by 2020 in GHG intensity of fuels),
 - Directive 2015/1513 (ILUC) (target of 0.5% for advanced biofuels)
- **Waste management related policy** (Waste Framework Directive 2008/98/EC, Directive (EU) 2018/851, Landfill Directive 1999/31/EC, Directive (EU)2018/850
- **Circular Economy Action Plan**

LIFE CIRCforBIO relevance to Greek Policy

- National and Regional plans on climate change (12.2018) expected to be updated in 2020
- National and Regional plans on waste management (2015 and 2016) expected to be updated in 2020 and 2021
- National strategy on circular economy (12.2018)

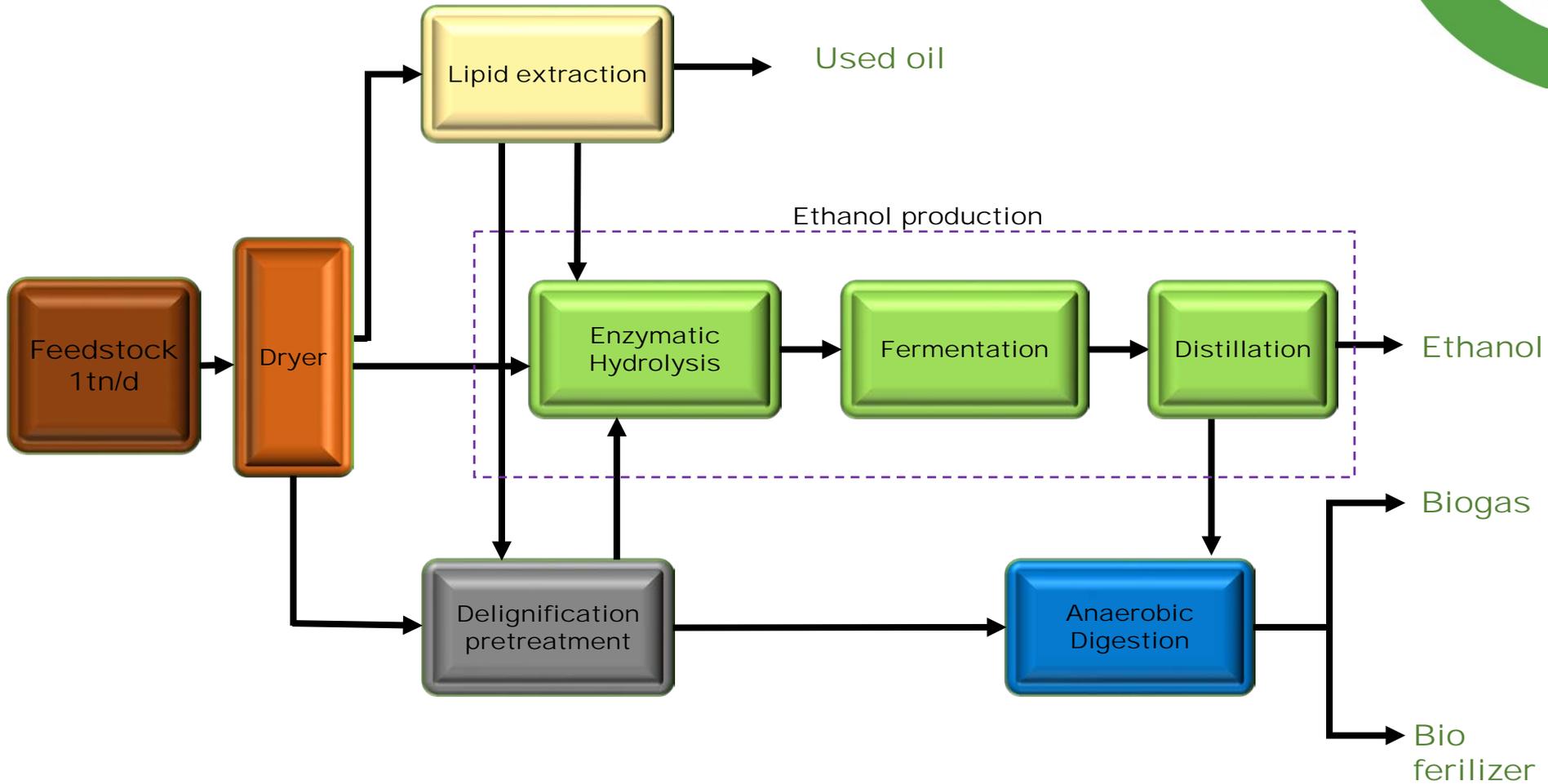
LIFE CIRCforBIO Feedstock collection system

Identification and engagement of biomass producers in order to establish the network of waste producers that shall provide the necessary feedstock to the biorefinery plant. The biomass streams to be collected and their respective suppliers are:

- **Municipal biomass (Municipality of Lavreotiki-Lavrio)**
 - food waste (households and restaurants)
 - spent coffee grounds (cafeterias)
 - bread waste (bakeries)
 - agricultural residues (agricultural cooperatives)
- **Industrial biomass (SEVT)**
 - Potato peel waste (potato chips industry - TSAKIRIS AVEE)
 - Brewer's spent grains (breweries - Hellenic Brewery Atalantis SA)
 - Fruits peels and pomace (juice industry - ASPIS SA)

Design and installation of the biorefinery system

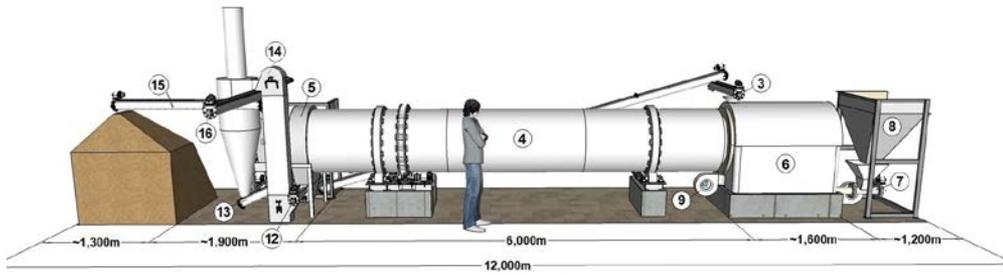
Basic Process Design



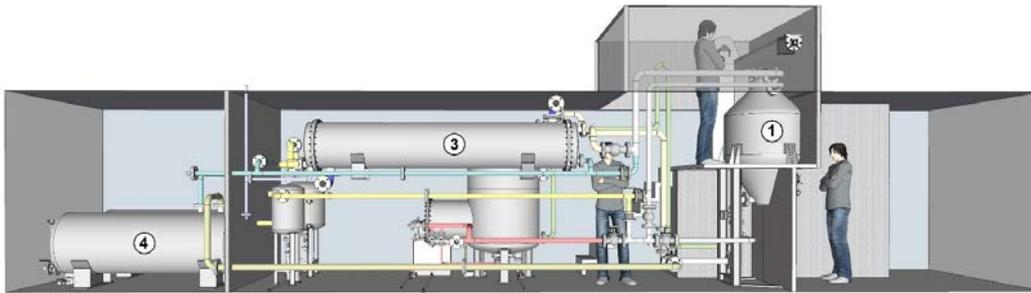
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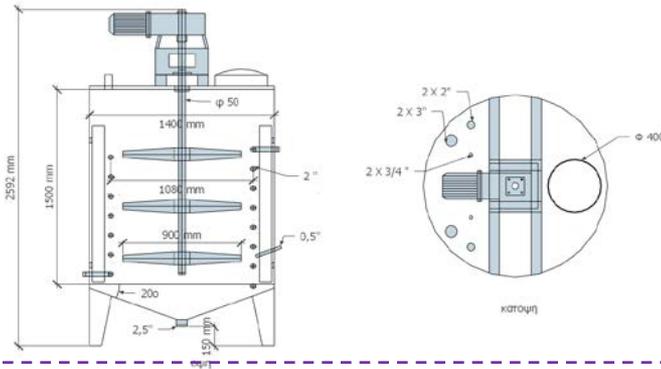
Designs of the biorefinery system



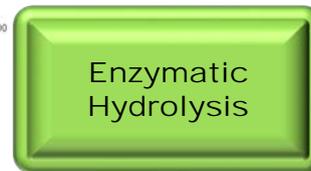
Dryer



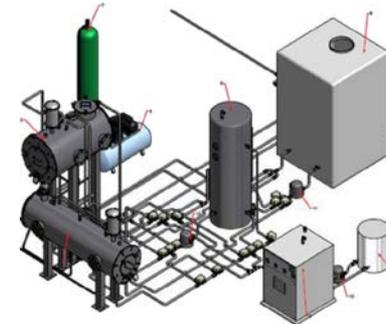
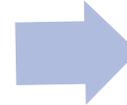
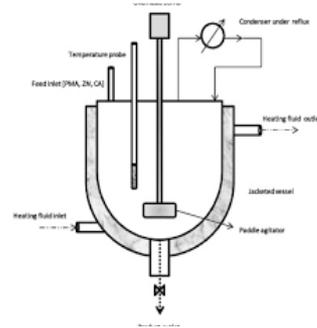
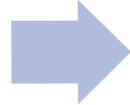
Lipids & Oil extraction unit



Ethanol production unit



Lab & Pilot scale simulation of the process



$V_{\text{reactor}} = 250\text{mL}$ -
Process Verified

$V_{\text{reactor}} = 4\text{L}$ -
Process Verified

$V_{\text{reactor}} = 2\text{m}^3$ -
Under study
LIFE Waste2bio
unit

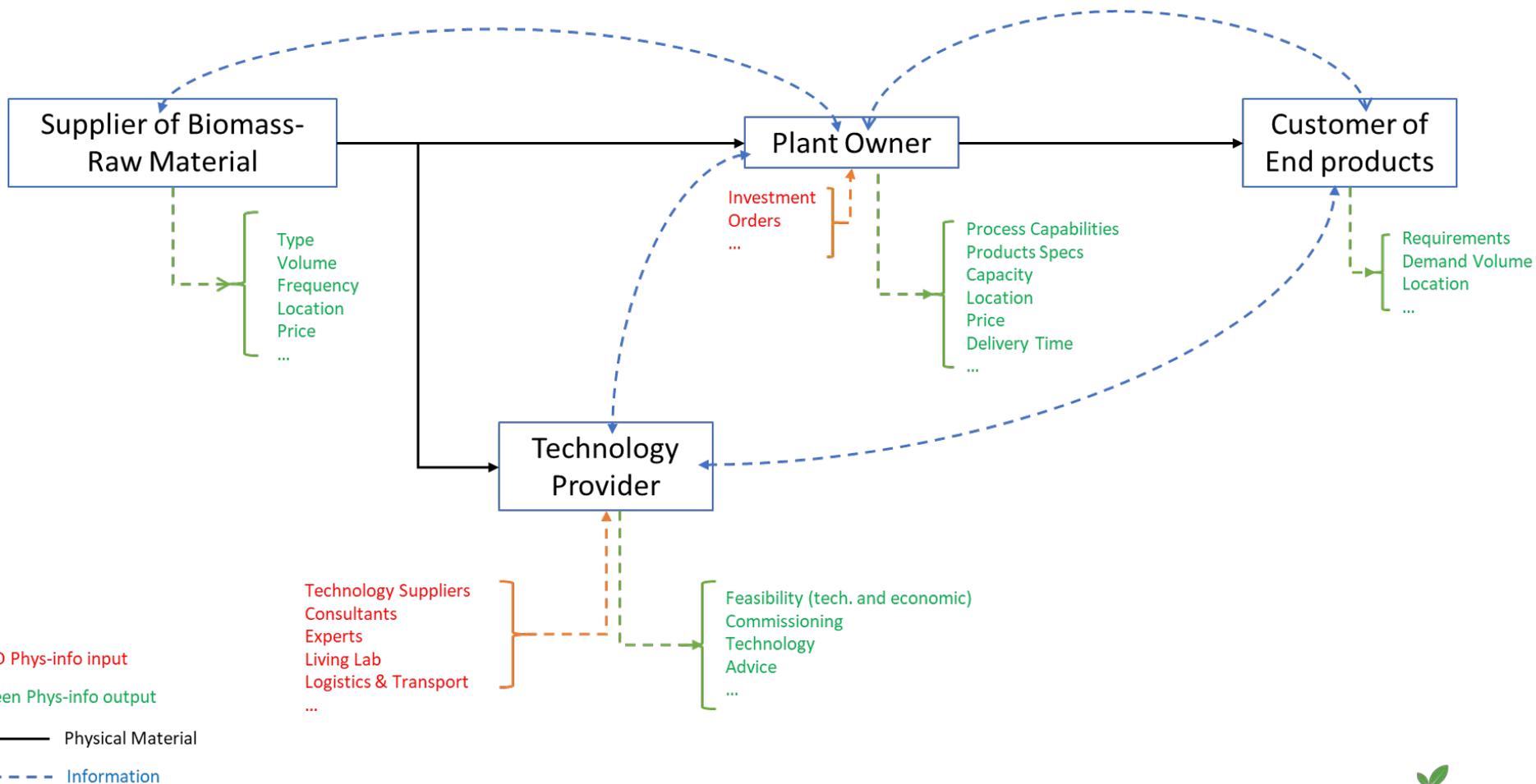
Thermal Pretreatment was performed with GAIA-100 and the dried feedstock was used for process simulation

Biorefinery evaluation

- Performance evaluation of fuel mixes with the produced biofuels in motor engines
 - Investigation and optimization of biofuels addition in commercial grade fossil fuels via blending refinery fractions
 - Testing of designated fuel blends in a laboratory engine and/or a selected vehicle engine in terms of the performance characteristics of the engine and the gaseous emissions (CO₂, CO, HC, NO, NO_x)
- Conduction of an economic feasibility study of the proposed system and evaluation by Hellenic Petroleum SA (HELPE) for investing in the installation of a full scale CIRCforBIO biorefinery plant at their industrial premises.
- Evaluation of the overall environmental performance of the biorefinery system through the conduction of Life Cycle Analysis.
- Constant monitoring and evaluation of the project' s progress against the set targets.

Development of the CIRCforBIO online platform

Dynamics of CIRCforBIO platform



Development of the CIRCforBIO online platform



CIRCforBIO

Supplier - ben - LC Energy Logout

Inventory

Inventory Sold Biomass

Add Biomass Inventory

Select Biomass

- Forestry Waste
- Agricultural waste
- Wood
- Forestry Waste
- Animal Waste
- Industrial Residue
- Sewage

Shipment Price

Add Biomass

| # | Biomass Type | Biomass Volume | Price per Tonne | Shipment Price | Update | Delete |
|----|--------------|----------------|-----------------|----------------|--------|--------|
| 1 | Sewage | 5000kg | £200 | £1000 | | |
| 2 | Wood | 9000kg | £89.99 | £809.91 | | |
| 11 | Sewage | 4000kg | £100 | £400 | | |

CIRCforBIO

Plant - michael - Verdo Biomass Logout

Available Biomass

Suppliers Available Biomass Purchase History Customers Inventory Sold Products

| # | Supplier | Location | Biomass Type | Biomass Volume | Price per Tonne | Shipment Price | Purchase | Filters |
|----|-------------------------|-----------------|----------------|----------------|-----------------|----------------|----------|---------------------|
| 1 | 2 - LC Energy | Berkshire - UK | Sewage | 5000kg | £200 | £1000 | + | Filter Biomass Type |
| 2 | 2 - LC Energy | Berkshire - UK | Wood | 9000kg | £89.99 | £809.91 | + | |
| 4 | 4 - Beeches Biomass Ltd | Teddington - UK | Animal Waste | 6000kg | £115 | £690 | + | |
| 6 | 4 - Beeches Biomass Ltd | Teddington - UK | Forestry Waste | 8000kg | £134 | £1072 | + | |
| 7 | 8 - JWC International | Ascot - UK | Forestry Waste | 4000kg | £238 | £952 | + | |
| 9 | 8 - JWC International | Ascot - UK | Animal Waste | 500kg | £956.47 | £478.235 | + | |
| 10 | 4 - Beeches Biomass Ltd | Teddington - UK | Wood | 5000kg | £68.45 | £342.25 | + | |
| 11 | 2 - LC Energy | Berkshire - UK | Sewage | 4000kg | £100 | £400 | + | |
| 12 | 8 - JWC International | Ascot - UK | Sewage | 2000kg | £0 | £0 | + | |
| 13 | 2 - LC Energy | Berkshire - UK | Sewage | 5000kg | £86 | £430 | + | |



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Demonstration of the innovative biorefinery system through Circular Economy Living Labs

Circular Economy Living Labs involve real-time demonstration of the biorefinery system through at least 15 events aiming at:

- ✓ Accelerating the innovation process from biorefinery concept to market launch
- ✓ Explore and highlight new business potentials
- ✓ Increasing acceptance of biobased products from waste and residues
- ✓ Fostering the replication of the proposed methodology to other entities and geographical areas.
- ✓ Promote public awareness on climate change mitigation, circular economy concepts
- ✓ Fostering co-creation activities

Upcoming 6months Implementation Milestones

- Installation & Startup of the DEMO biorefinery at Lavrio Technological and Cultural Park



Upcoming 6months Implementation Milestones

- Initiation of the feedstock collection scheme for municipal & industrial biomass

(I) Municipal biomass

Businesses



Households



(II) Industrial biomass

- ✓ Hellenic Brewery Atalantis (EZA) SA - brewer's spent grains,



- ✓ ASPIS SA - fruit peel waste,

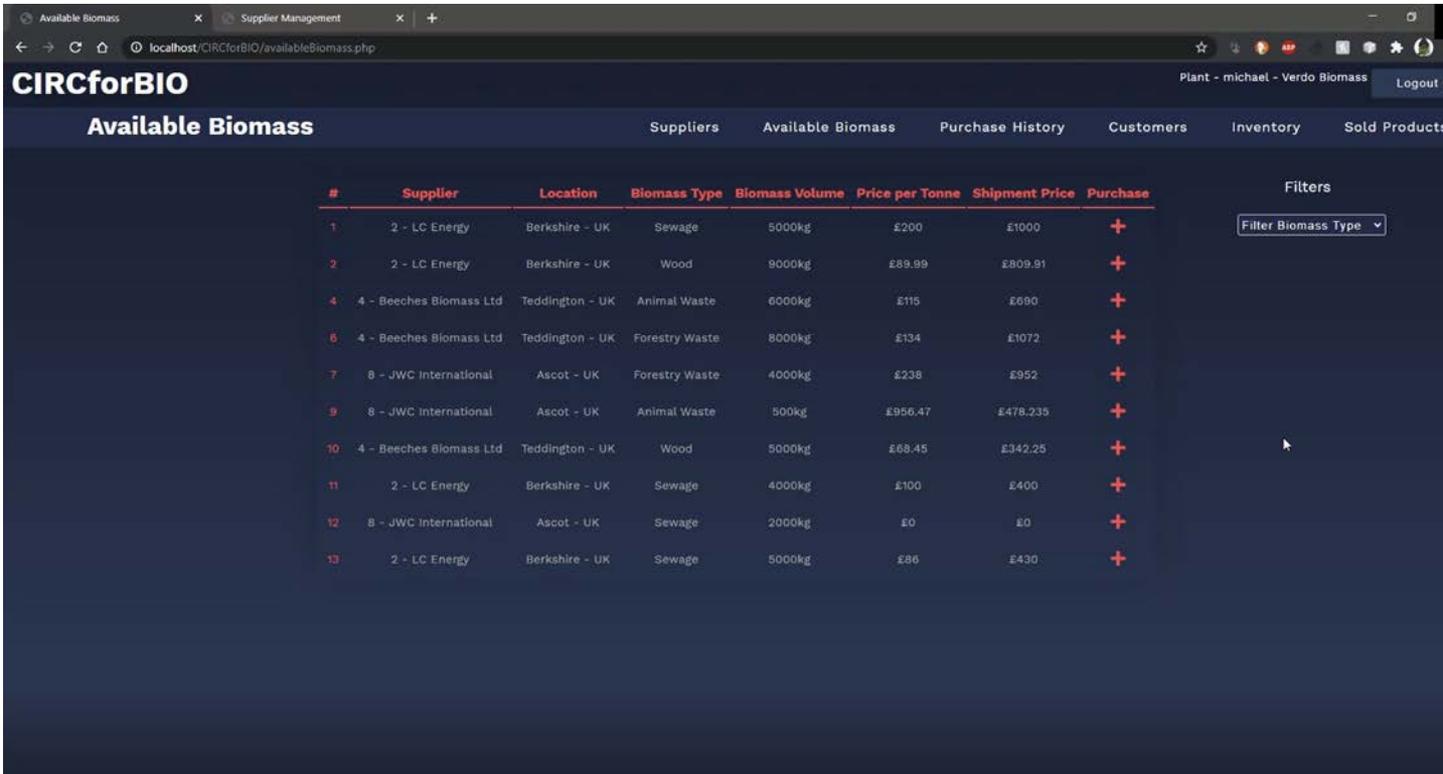


- ✓ TSAKIRIS AVEE - potato peel waste.



Upcoming 6months Implementation Milestones

➤ Launching of LIFE CIRCforBIO platform



The screenshot shows the CIRCforBIO web application interface. The main heading is 'Available Biomass'. Below the heading is a navigation bar with links for Suppliers, Available Biomass, Purchase History, Customers, Inventory, and Sold Products. The main content area displays a table of available biomass with the following columns: #, Supplier, Location, Biomass Type, Biomass Volume, Price per Tonne, Shipment Price, and Purchase. A 'Filters' dropdown menu is located on the right side of the table.

| # | Supplier | Location | Biomass Type | Biomass Volume | Price per Tonne | Shipment Price | Purchase |
|----|-------------------------|-----------------|----------------|----------------|-----------------|----------------|----------|
| 1 | 2 - LC Energy | Berkshire - UK | Sewage | 5000kg | £200 | £1000 | + |
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Connect with LIFE CIRCforBIO/Website & Social Media

Visit LIFE CIRCforBIO website:
www.circforbio.eu



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Connect with LIFE CIRCforBIO/Newsletter

- The **first set of Newsletters** has been distributed by each project partner to their associated target groups.

1st Newsletter
SEPTEMBER 2020

A circular economy system for multi-source biomass conversion to added value products

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Kick-off Meeting

The Kick-off meeting took place on November 1st, 2019, in NTUA premises, with the participation of all beneficiaries involved in the project implementation.

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Subscribe to our Newsletter!!!

<https://circforbio.eu/newsletter/>





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**Thank you for your
attention!**



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