XV JORNADA DE JÓVENES INVESTIGADORES/AS DEL I3A

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"When life gives you olives stones…" Pyrolysis, Gasification & Adsorption.

Shacking the Present, Shaping the Future!

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Gasification for a Sustainable Future

The evolution of **global energy demand** shows an average annual growth of 1.7%. In the short term, fossil fuels will continue to be fundamental in the multidisciplinary field of energy.

Gasification has increasingly attracted attention as a thermochemical route for the replacement of conventional fossil fuels, enabling the conversion of carbonaceous feedstocks such as coal and biomass into a combustible ***syngas***.[1] Among the various reactor configurations, the ***Fluidized Bed Reactor*** (***FBR***) is one of the most extensively studied and industrially applied. The use of a ***FBR*** enhances phase contact, improves mass transfer, and maintains a uniform temperature throughout the reactor. The typical flue gas contains trace **contaminants** with disadvantageous synergistic effects, but they are often neglected in literature.[2]

Biomass represents a **renewable** material with high energy and environmental potential.[3] **Olives Stone** has been reported as a promising raw material in gasification processes. A densification method, with a natural **bio-resin** (***rosin***), is applied to optimize gasification products. This same olives stone is also available to produce, by **pyrolysis**, **biochar** for **gas capture**, based on a fixed-bed **adsorption** column system.[4]

Combining those three Chem.Eng. procedures, we are able to both gasify biomass, and purify the generated syngas through a biomass biochar adsorption filter. Zero-Waste & Waste-Upgrade.

Research Questions

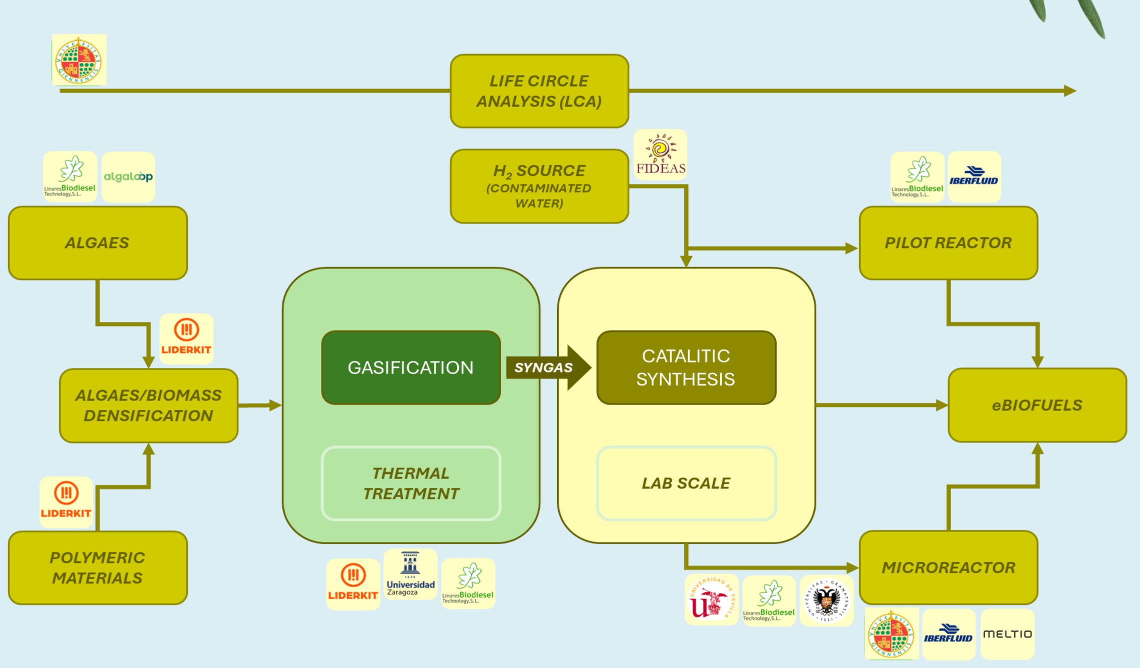
The main **objective** of this project is to design, develop, and implement a **circular technology** for the synthesis of advanced **biofuels** (*SAF* and *e-Diesel*) from and residual **biomass**, based on the combination of a **gasification**, with a **catalytic** system.

- Which **biomass** will display the most promising results, for both **Gasification** and **Pyrolysis**?
- Are **bio-resins** able to suitability improve **H_2/CO** ratio in outlet ***syngas*** composition?
- Is the obtained **biochar** able to **selectively adsorb** CO_2, CH_4 and C_2H_4 from the gasification gas production?
- Is it possible to obtain an **enriched**, free of disadvantageous **traces**, ***syngas*** stream?
- Will **re-valorization** processes revolutionize current **industry**?

Collaborative Science for Challenging Objectives: *BioCAs-CCU*

Consortium Organization

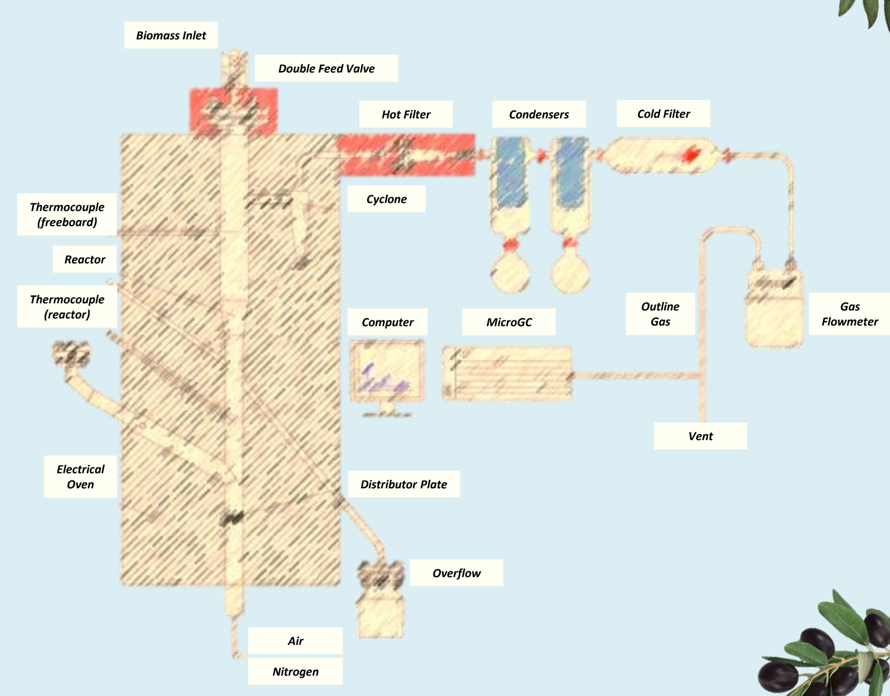
This project is a collaboration between several companies and institutions, funded by *MICIU* in its *Strategic Lines Projects Program*. **BioCAs-CCU** consortium is made up of 4 technological companies, and 5 Spanish public institutions, constituting the perfect example of **public-private** scientific **collaboration**.



Pilot-Plant design & construction

GTP installations at ***I3A*** hold a recently renovated gasification pilot-plant (reactor diameter: 40 cm). A ***microGC*** analyzes the gas composition of the reactor outlet stream (***syngas***).

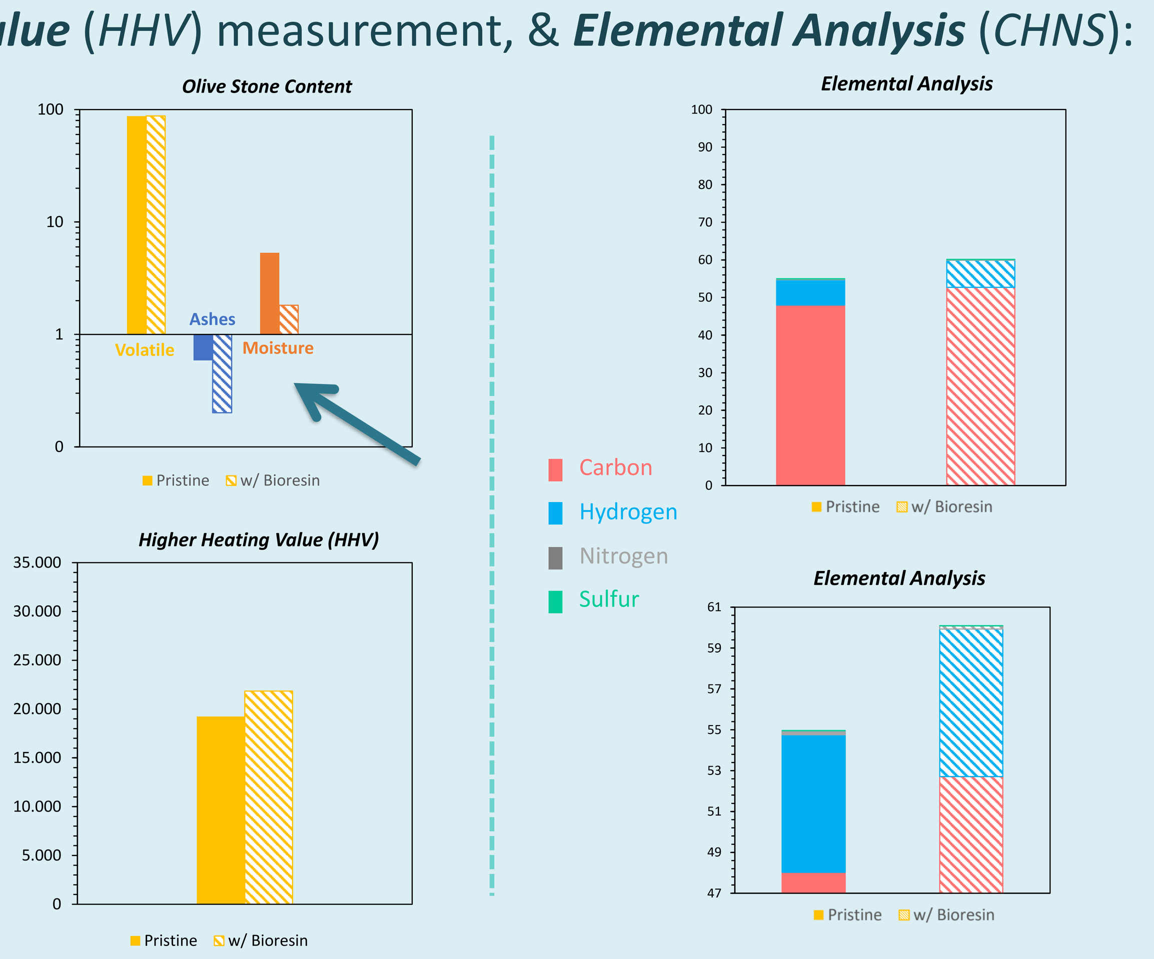
A **typical gasification experiment** was performed at 900 °C, under 0,2 stoichiometric ratio, air flow rate ranging 1,5 - 2 L/min, and a biomass feed rate between 1 - 2 g/min (in order to operate at the required 2-5 u/u_{mf} ratio for a ***FBR***).



Olive Stone: One material, Multiple opportunities

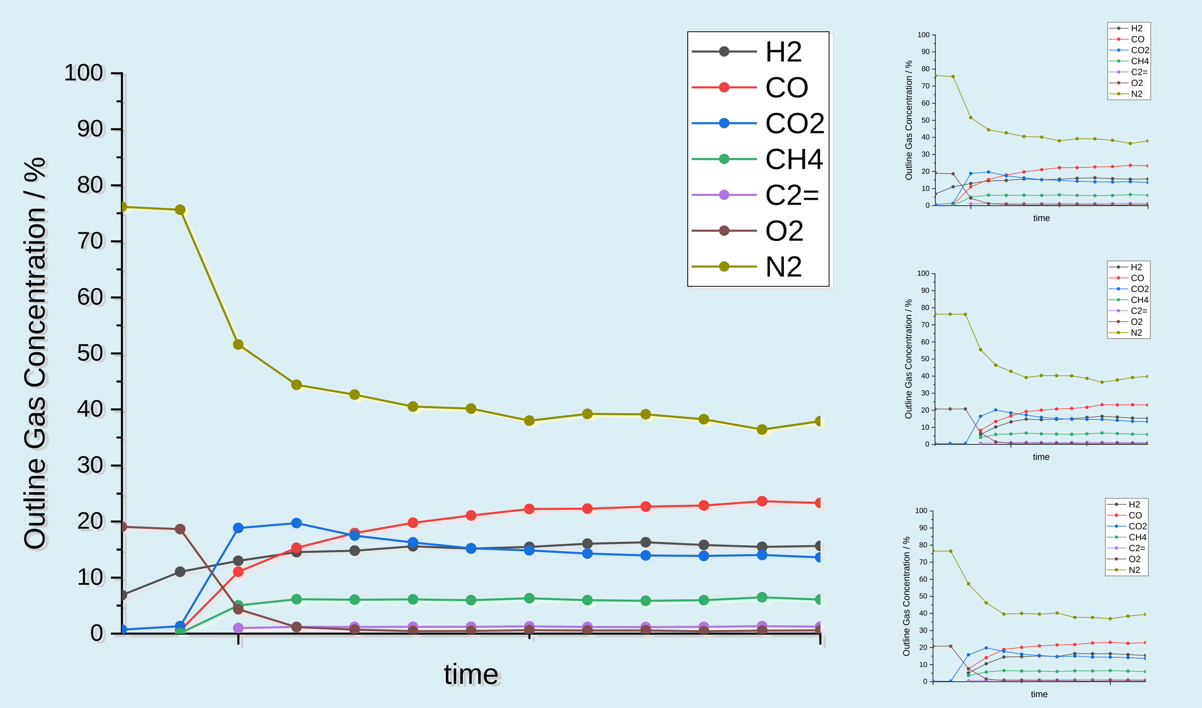
Biomass Characterization

Olives Stone was thoroughly characterized by ***Volatile***, ***Ashes*** and ***Moisture*** contents analysis, ***Higher Heating Value*** (*HHV*) measurement, & ***Elemental Analysis*** (*CHNS*):



Gasification Experiments

Gas Concentration Evolution in a typical Gasification:

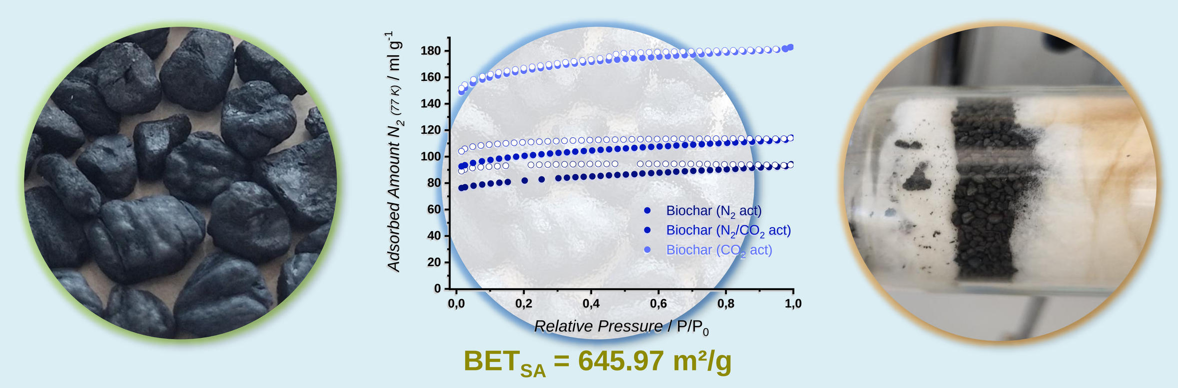


The absence of O_2 evidences gasification success. The observed ***syngas*** composition represents the typical **gasification**. To assure process **reproducibility**, each experiment has been successfully replicated three times.

Biomass Biochar

Olives Stone was **pyrolyzed** at 900 °C, and activated under CO_2 stream. The obtained biochar was **texturally characterized**, and placed in a **fixed-bed column**.

N_2 adsorption/desorption volumetric **isotherms** (77 K) evidence the potential of this inexpensive biomaterial:



The preliminary results after the incorporation of the extra homemade **biochar-filter** in the outlet gasification stream, exhibit a **reduction** in the **carbon dioxide** and **ethylene** concentrations, in the ***syngas***.

Conclusions

- A promising **strategy** for mitigating anthropogenic environmental impact involves integrating **waste** and **by-products** from one process, as inputs for another.
- **Biomass** (raw material) properties tune ***syngas*** composition and suitability.
- **Gasification** pilot-plant smart-**design** promotes functionality and operativity.
- Additional home-made **biochar** (pyrolysis) **adsorption** filter enriches ***syngas***.

References & Acknowledgements

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[2] Gil-Lalaguna, N., et al, Chemical Engineering Journal (2014) 248, 373 – 382.
[3] Afailal, Z., et al, Fuel (2023) 332, 125970.
[4] Navarro, A., et al, Biomass and Bioenergy (2025) 197, 107778.

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