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XV JORNADA DE JÓVENES INVESTIGADORES/AS DEL I3A

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Design and optimization of a gasification lab-scale plant for biomass/bioresin residual materials.

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. In a *FBR*, the introduction of excess gas generates bubbles that rise through the bed, enhancing phase contact, improving mass transfer, and maintaining a nearly uniform temperature throughout the reactor. The typical flue gas contains many trace **contaminants** that present disadvantageous synergistic effects, but they are often neglected in literature.[2]

Biomass represents a **renewable** material, with high degree of **CO_2 capture**, and well-known in **thermo-chemical** processes *state of the art*.[3-4] **Olives Stone**, **Olives Pulp** and **Olives Pruning**, together with **Algae**, will be involved in a densification method with a natural **bio-resin** (***rosin***) to optimize gasification process, and to obtained an upgraded ***syngas*** outlet stream (*biomass:bioresin; 80:20-50:50*).

Research Questions

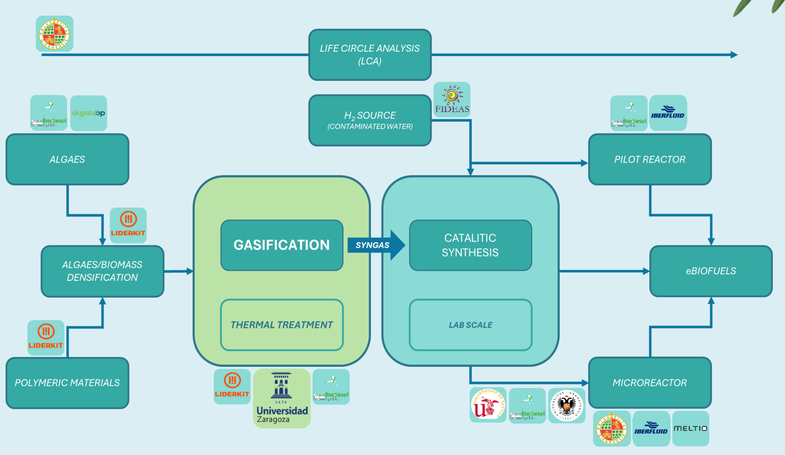
The main **objective** of this project is to design, develop, and implement a **circular technology** for the synthesis of advanced **biofuels** (*SAF* and *e-Diesel*) from and residual **biomass**, based on the combination of a **gasification**, with a **catalytic** system.

- Which **biomass** will display the most promising results, in a typical **industrial Gasification** process?
- Are **bio-resins** able to suitability improve **H_2/CO** ratio in outlet ***syngas*** composition?
- Are we able to tune ***syngas*** composition through biomass **selection**, and **operation condition** optimization?
- Will **re-valorization** processes revolutionize current **industry**?

Collaborative Science for Challenging Objectives: *BioCAs-CCU*

Consortium Organization

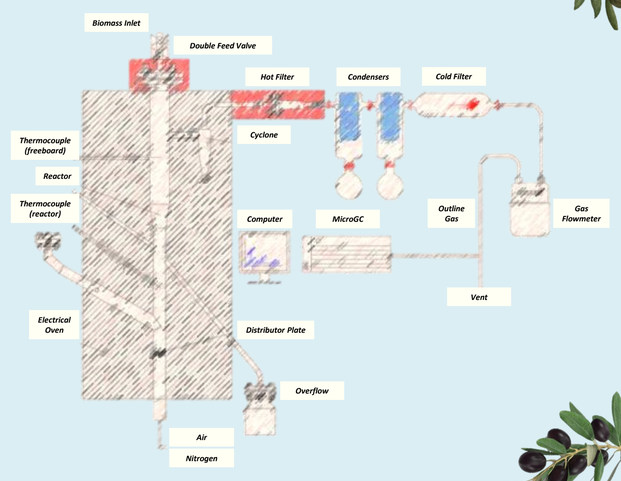
This project is a collaboration between several companies and institutions, funded by *MICIU* in its *Strategic Lines Projects Program*. **BioCAs-CCU** consortium is made up of 4 technological companies, and 5 Spanish public institutions, constituting the perfect example of **public-private** scientific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



Pilot-Plant design & construction

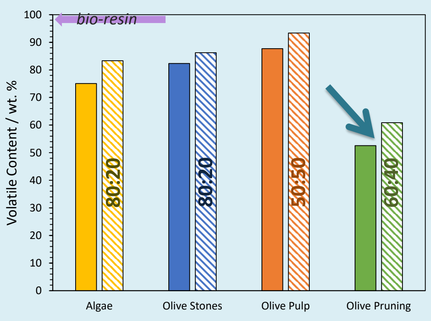
GTP installations at ***I3A*** hold a recently renovated gasification pilot-plant (reactor diameter: 40 cm). A ***microGC*** analyzes the gas composition of the reactor outlet stream (***syngas***).

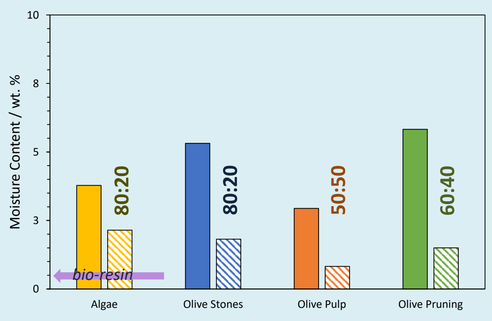
A **typical gasification experiment** was performed at 800 °C, under 0,2 stoichiometric ratio, air flow rate ranging 1,5 - 2 L/min, and a biomass feed rate between 1 – 2,5 g/min (to operate at the required 2-5 u/u_{mf} ratio for a ***FBR***).

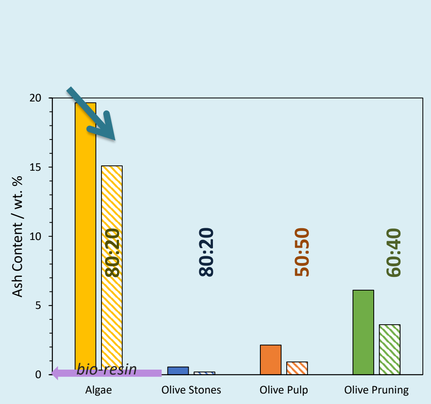


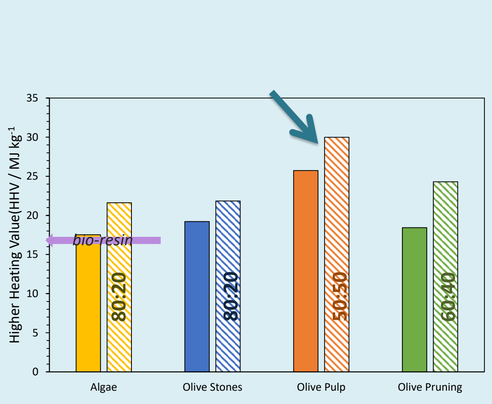
Biomass Characterization & Gasification Experiments

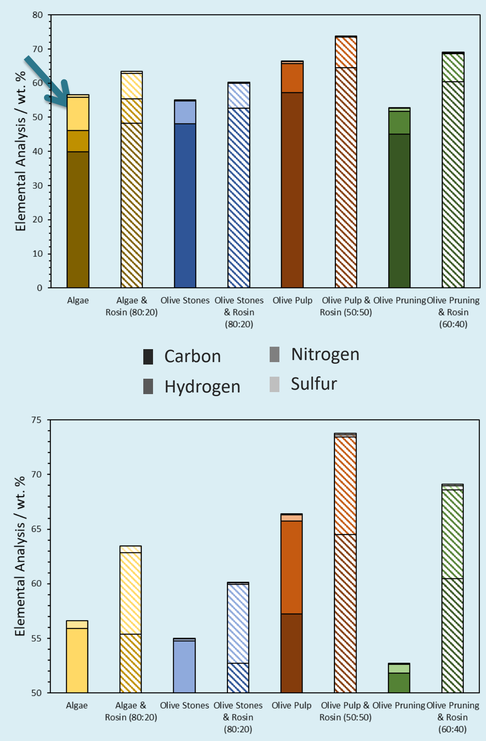
Biomass samples were thoroughly characterized by ***Volatile***, ***Ashes*** and ***Moisture*** contents analysis, ***Higher Heating Value*** (*HHV*) measurement, & ***Elemental Analysis*** (*CHNS*):





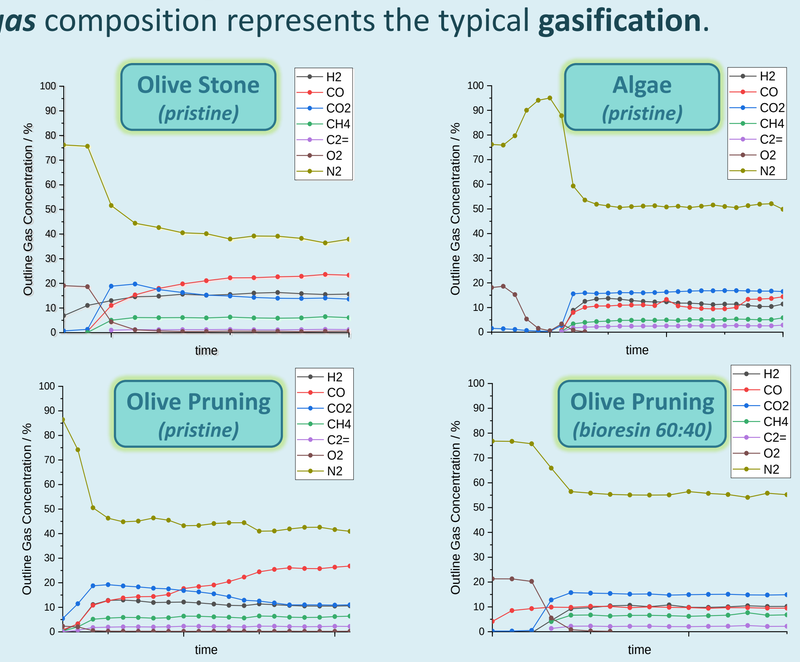






Gas Concentration Evolution in a typical Gasification:

The absence of O_2 evidences gasification success. The observed ***syngas*** composition represents the typical **gasification**.



Olives Pruning stands out as the most **productive *syngas*** biomass. The addition of ***rosin*** generally leads to a decrease in H_2 and CO concentration, but displaying a slightly **increase** in **H_2/CO ratio**.

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.
- **Bioresin** addition improves **H_2/CO ratio**, but reduces industrial **operability**.
- **Gasification** pilot-plant smart-**design** promotes functionality and operativity.

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.
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