

Biomass pyrolysis @PyMicoLab

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National Research Council



Institute of Science and Technologies
for Sustainable Energy and Mobility

Workshop - IEA Bioenergy Task 34: Direct Thermochemical Liquefaction

01 July 2026

BEST – Bioenergy and Sustainable Technologies GmbH - Wieselburg - Austria



STEMS *Institute of Sciences and Technologies for Sustainable Energy and Mobility* belongs to the **DIITET** (Department of Engineering, ICT and Technologies for Energy and Transport) of National Research Council, **CNR**.

- 3 locations in Italy (Napoli, Torino, Ferrara)
- Specialized laboratories with advanced equipment
- Different size plants from the laboratory scale to the pilot scale
- Its staff includes more than 100 researchers, 50 technicians and administratives and over 50 trainees
- It is involved in national and international research networks



Pyrolysis Mild Combustion LABoratory: PyMiCoLAB



Pino Sabia



Giancarlo Sorrentino



Mara de Joannon



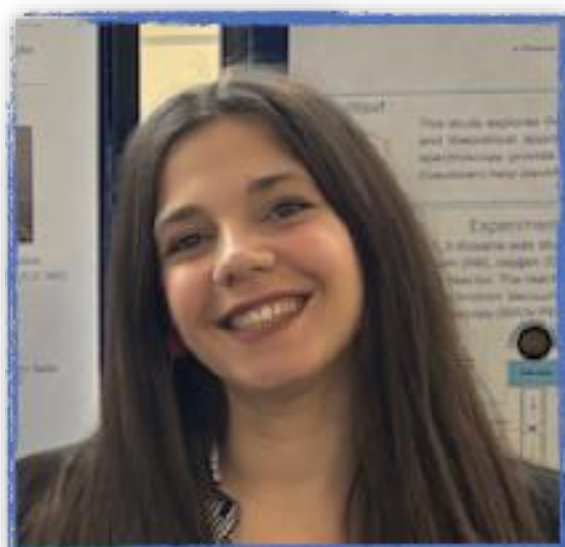
Raffaele Ragucci



Corinna Maria Grottola



Paola Giudicianni



Maria Virginia Manna



Giovanni Ariemma

PyMi Cola



Davide Amato



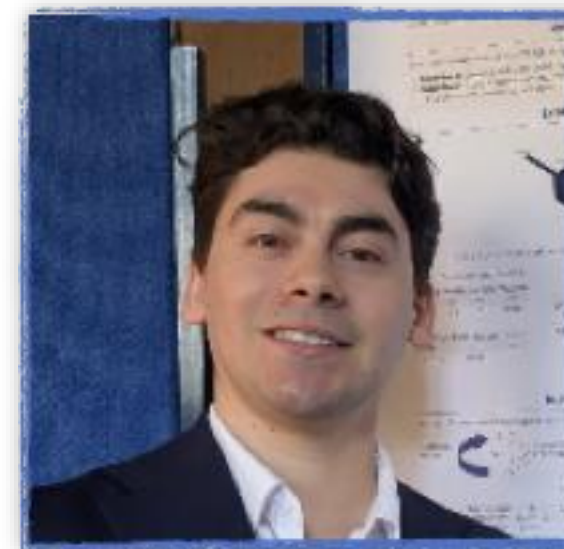
Lelio Pesapane



Vicente Castro



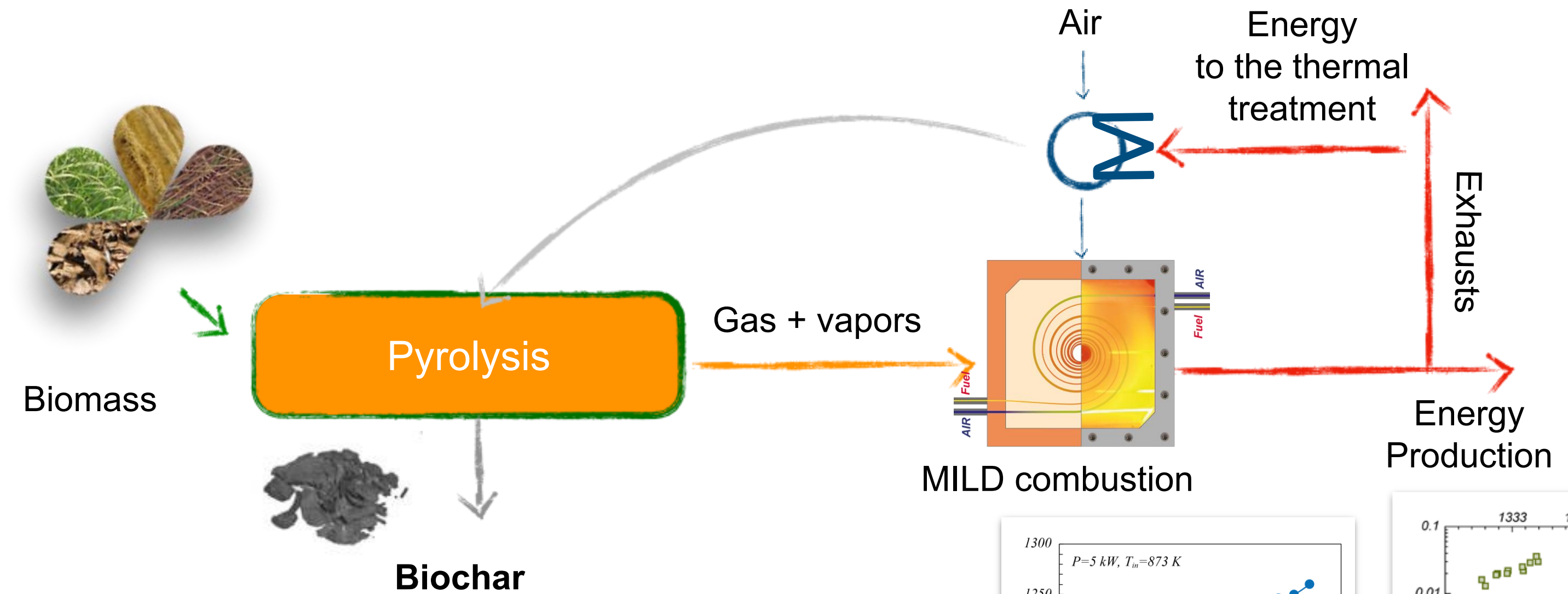
Biagio Cassese



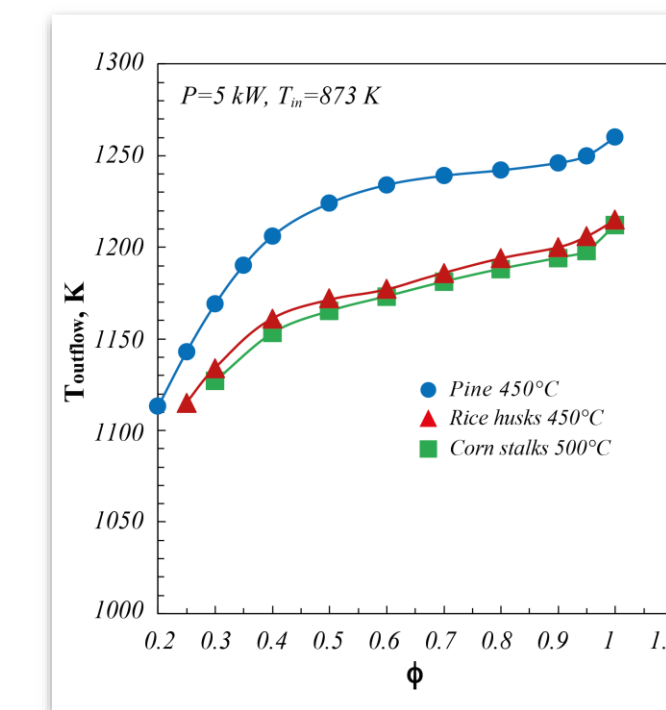
Vincenzo Rosati



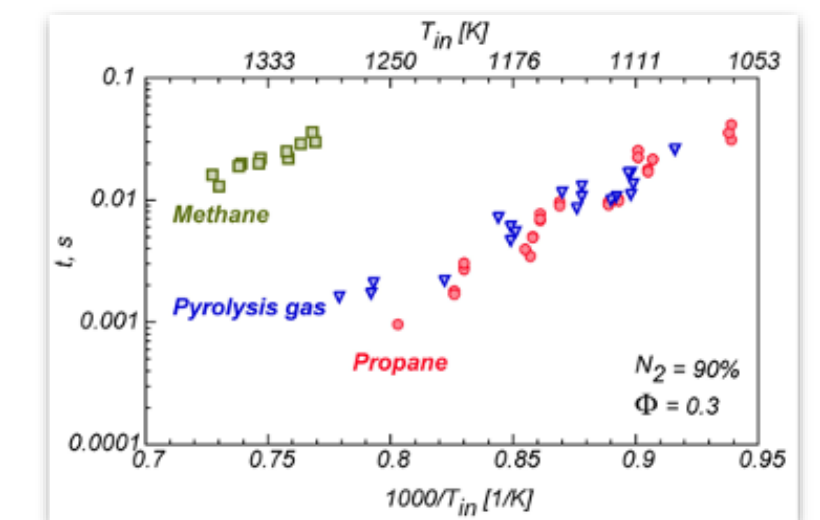
Giovanni Fabozzi



- ✓ Adsorption of Crystal violet (Grottola et al., 2026)
- ✓ Filler in polymers (PLA, Botta et al., 2024)
- ✓ Bio-remediation in contaminated mining soil (Pinna et al., 2023)
- ✓ antimicrobial activity (Kiani et al., 2023)
- ✓ Anaerobi digestion (Florio et al., 2019)



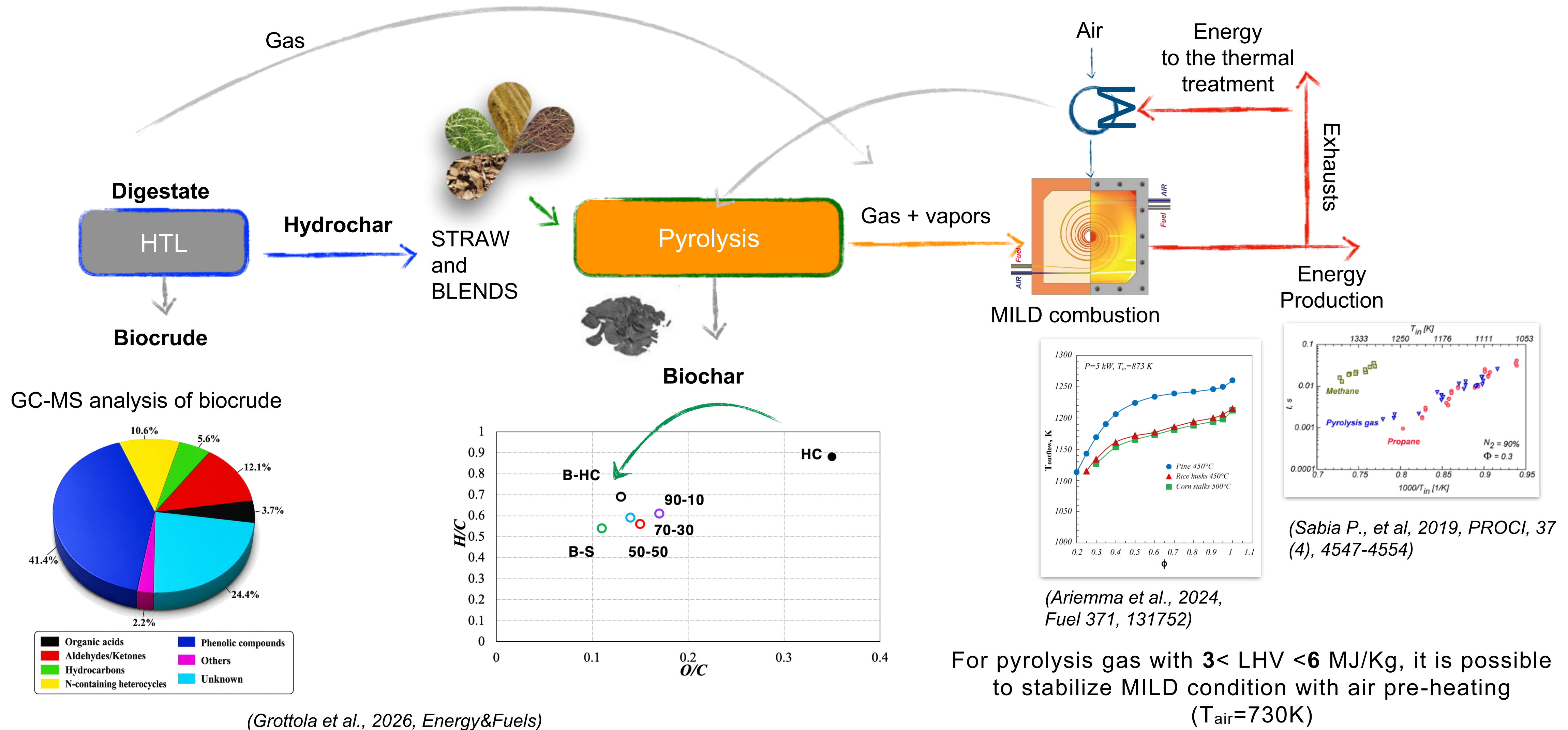
(Ariemma et al., 2024,
Fuel 371, 131752)



(Sabia P., et al, 2019, PROCI, 37
(4), 4547-4554)

For pyrolysis gas with $3 < \text{LHV} < 6 \text{ MJ/Kg}$, it is possible to stabilize MILD condition with air pre-heating ($T_{\text{air}}=730\text{K}$)

Results are not dependent on mixture composition but only on **LHV values**

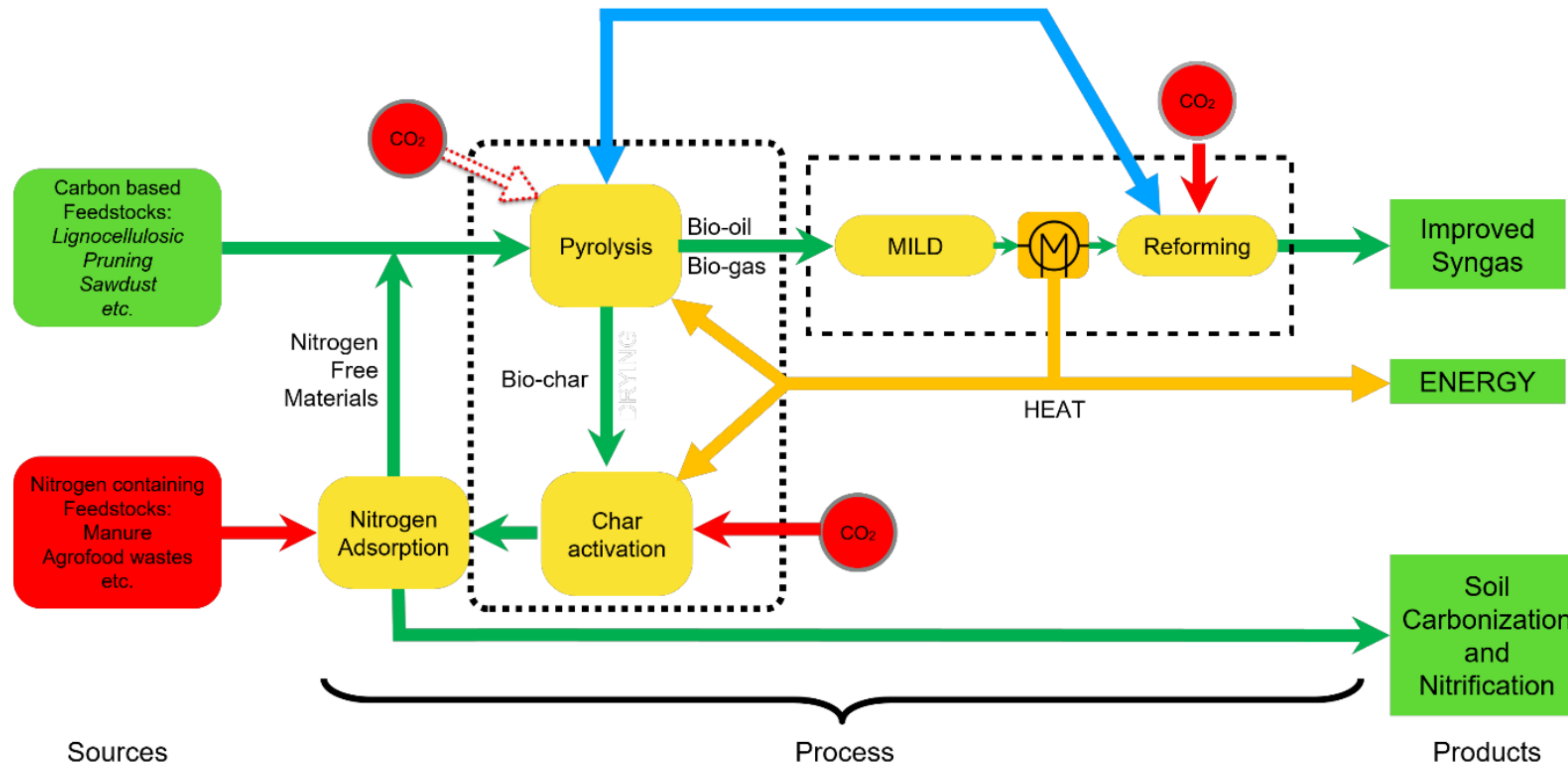


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Contributing to an environmentally sustainable **management of CO₂ and N₂** through the combined production of **energy/biofuel** and materials for **N-compounds adsorption**



MINICOR CONCEPT: PYROLYSIS

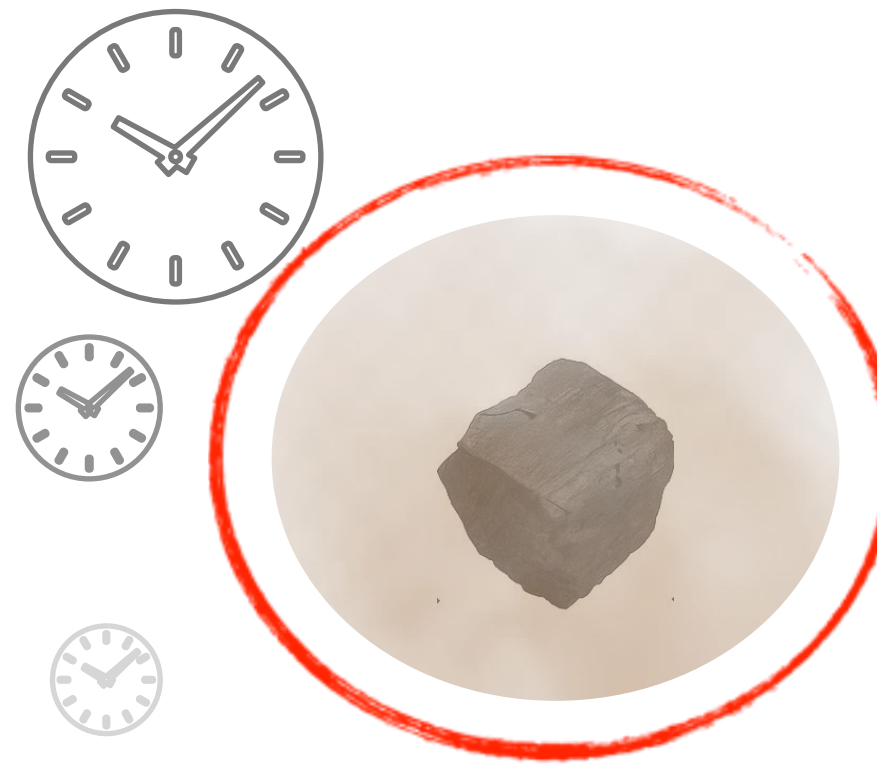


Biomass



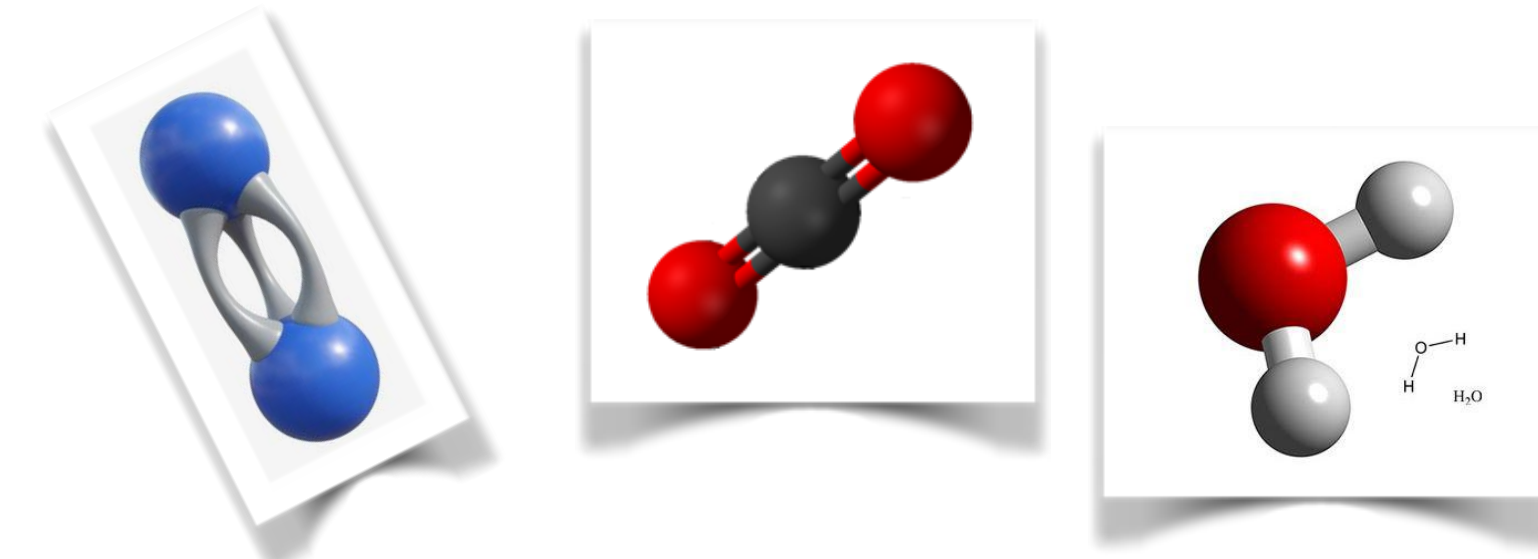
600 °C
450 °C
360 °C

Temperature



Solid residence time

t= 0 t=1 h



N₂

CO₂

H₂O

And Mixture of them

Pyrolysis environment

Softwood
Poplar
Straw



Effects of biomass type, temperature, holding time and carrier gas type on pyrolysis products yields:

- ▣ biochar properties for ammonia adsorption
- ▣ bio-oil aging
- ▣ bio-oil and gas composition for MILD combustion and dry reforming

Motivation

Instability and storage of bio-oil:

- *High oxygen and water content
- *Complex composition
- *Time-dependent chemical reactivity

Bio-oil separation and analysis (GC-MS)

Aqueous



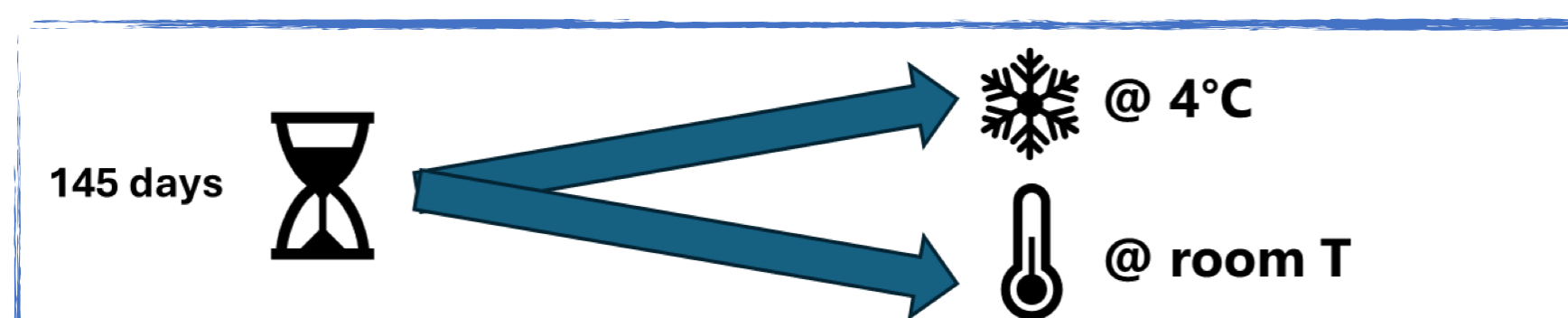
Whole bio-oil



Organic/oily



Parametres to study the Aging



Effect of Biomass and Inorganic Content – Multi-technique Characterisation

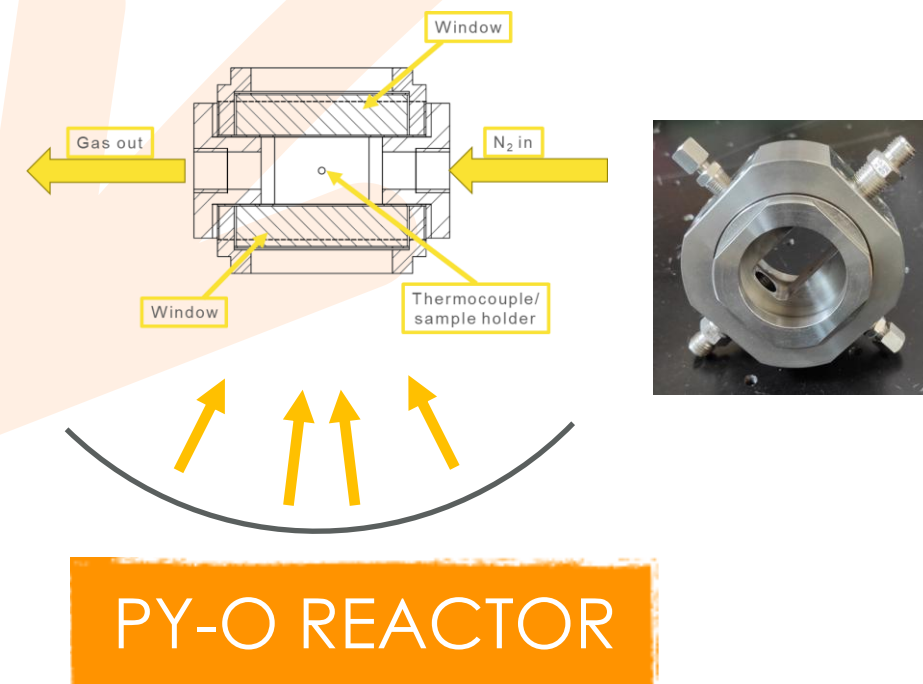
*CNR-STEMS (Napoli) - CNRS /LRGP (Nancy) •
Université de Lorraine - (Metz)*

Sample code	Pre-treatment / Rationale
P	Untreated poplar: baseline, contains original structure and inorganic ash (K, Ca, Mg, etc.)
P-WASHED	Water-washed poplar: removes water-soluble inorganics (mainly K); isolates the effect of the organic matrix alone.
P-DOPED	Washed poplar + controlled re-addition of selected salts (e.g. KCl, CaCl ₂ at defined loadings): reconstructs specific catalytic effects.

increase in particle size / reactor capacity

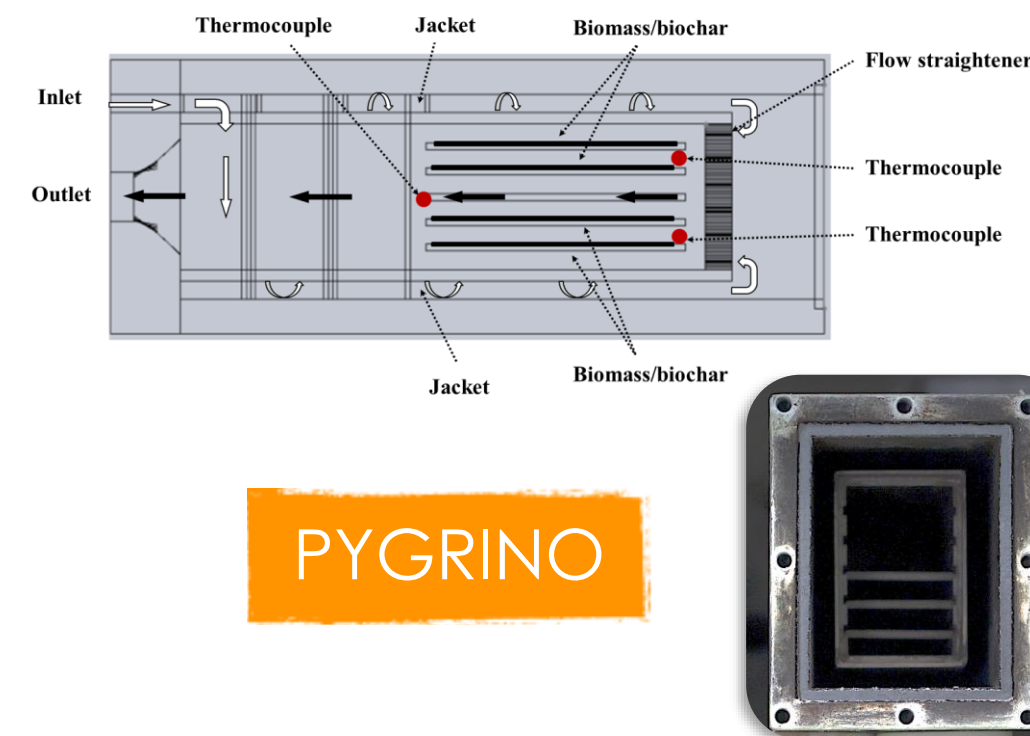
Single-particle reactor

- Effect of solar radiation on fast/flash pyrolysis



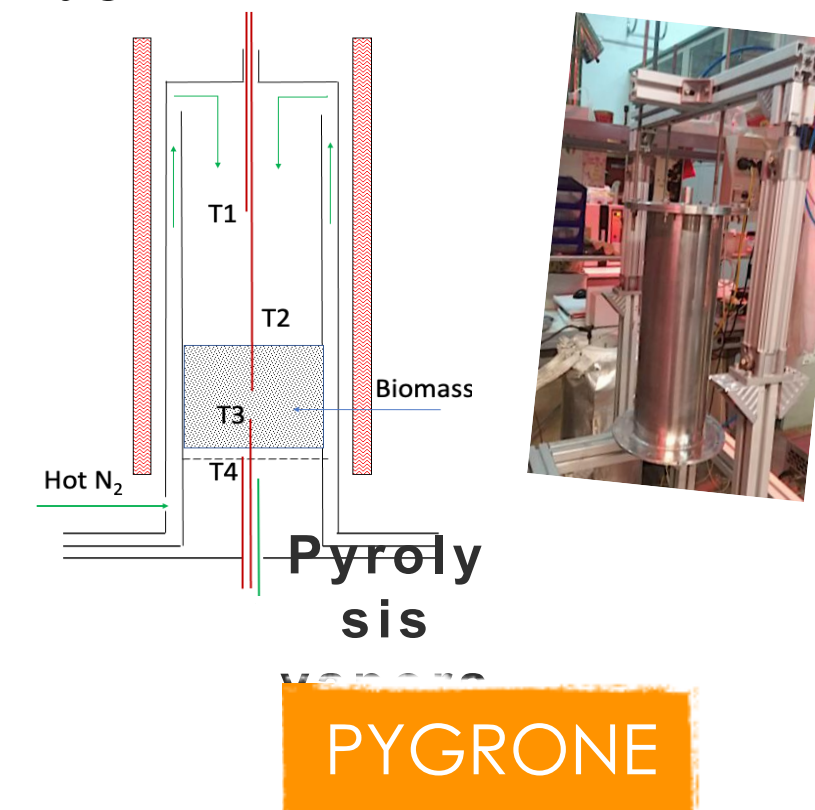
Fundamental studies on pyrolysis mechanisms:

- conditions similar to TG
- advantage of producing bio-oil and biochar for offline characterization



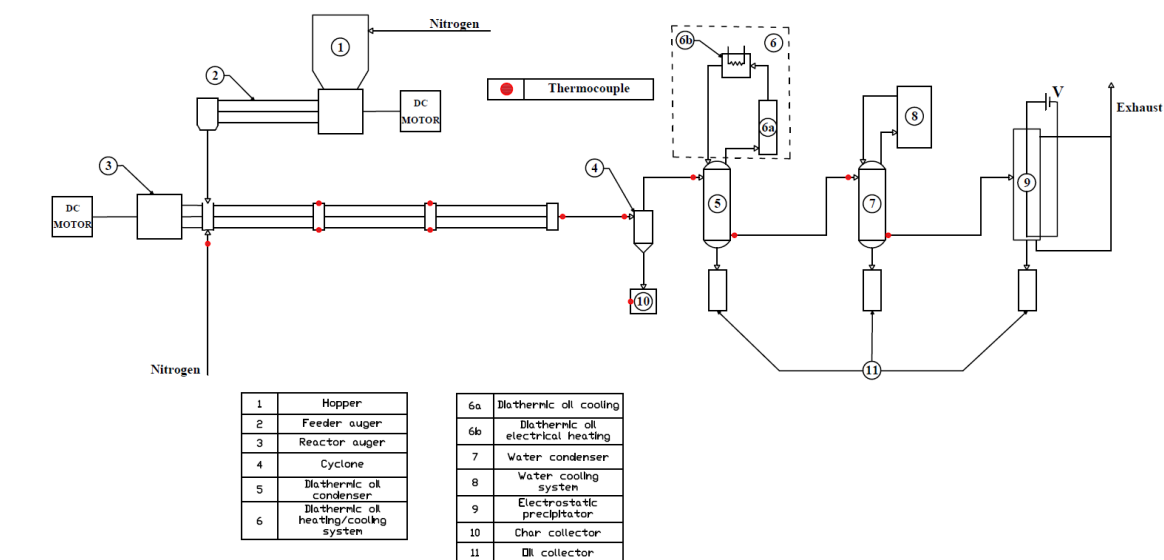
Fixed bed reactor:

- produce high amounts of torrefied biomass/biochar and torrefaction liquid under the optimal conditions defined with Pygrino

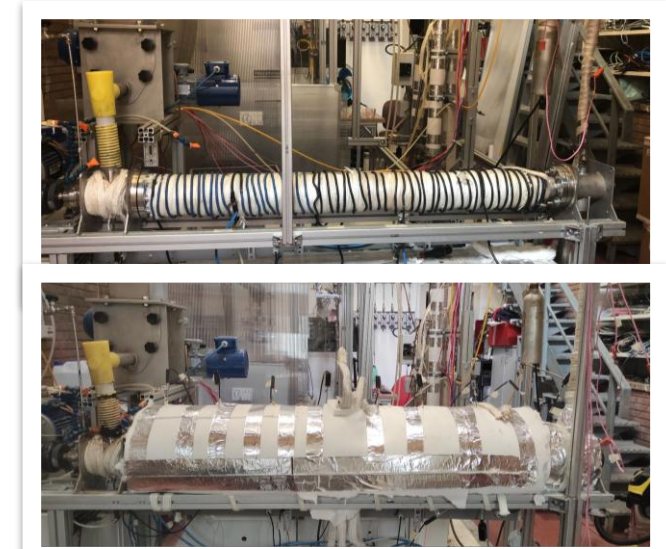


Continuous reactor:

- Process optimization for combined biochar and bio-oil production in continuous mode

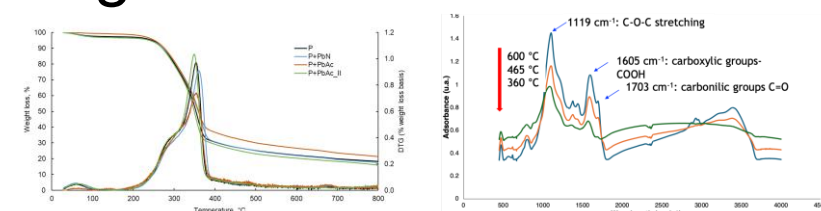


PYC-AUGER



investigation of intrinsic reaction kinetics

- Limitation: small sample quantities not representative for heterogeneous materials
- internal heat and mass transfer phenomena within the particle are neglected



SCALE-UP



The logo for the Institute of Science and Technology for Sustainable Energy and Mobility (STEMS). It features a stylized 'S' icon followed by the word 'STEMS' in a bold, sans-serif font. Below the name, the full name of the institute is written in a smaller font: 'Istituto di Scienze e Tecnologie per l'Energia e la Mobilità Sostenibili'. The entire logo is enclosed in a blue oval.

Thank you

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