

Development and commissioning of an innovative biorefinery for the conversion of contaminated biomass into high-quality energy carriers



Fraunhofer Institute for
Environmental, Safety and Energy
Technology UMSICHT

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EUBCE

31st European Biomass
Conference & Exhibition

IN PERSON,
ONLINE

Bologna
2023



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101006912.

5 – 8 June | Conference & Exhibition
9 June | Technical Tours



Agenda

1



Project overview and description of the biorefinery

2



Challenges commissioning a biorefinery

3

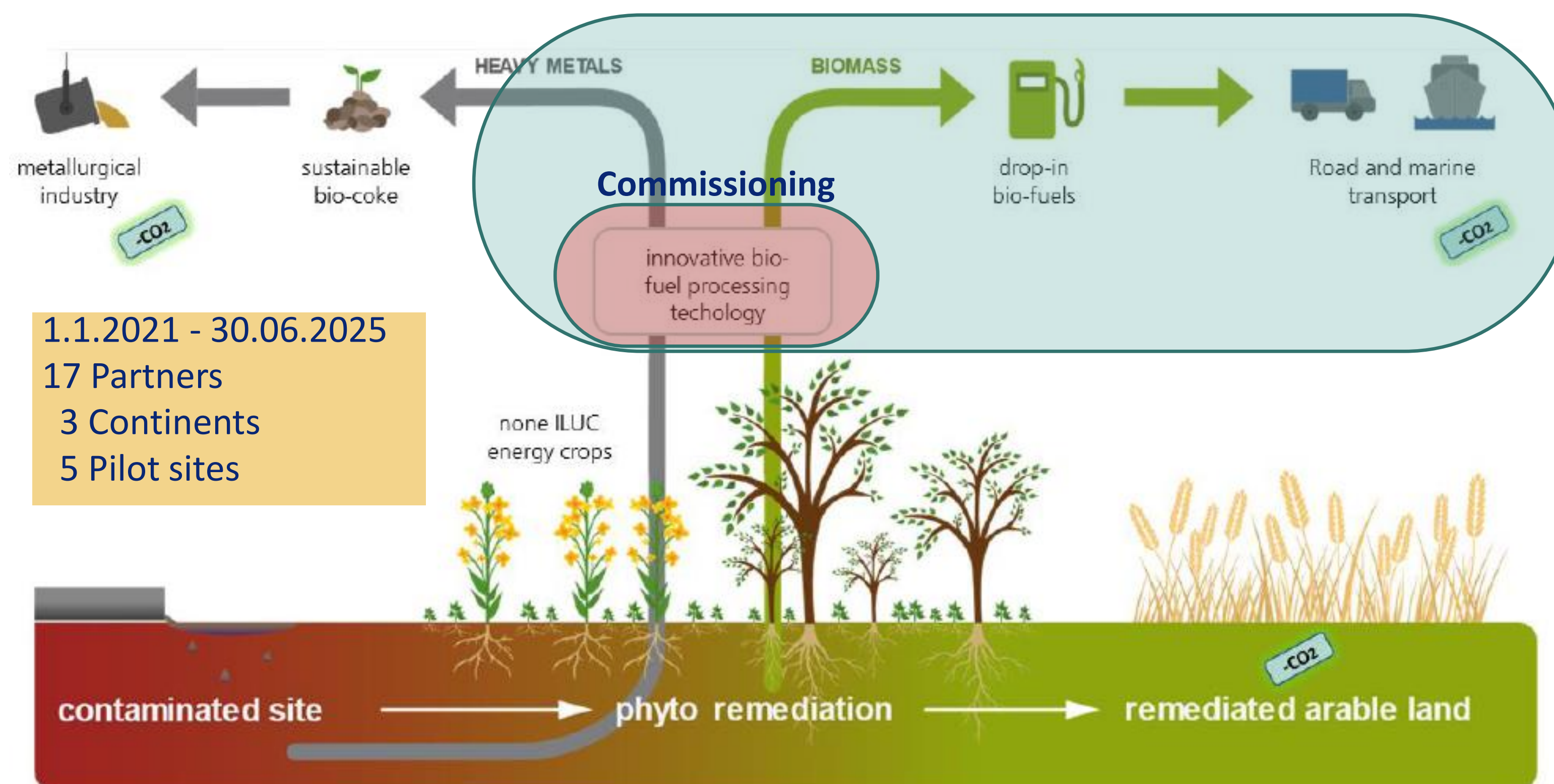


First results and outlook

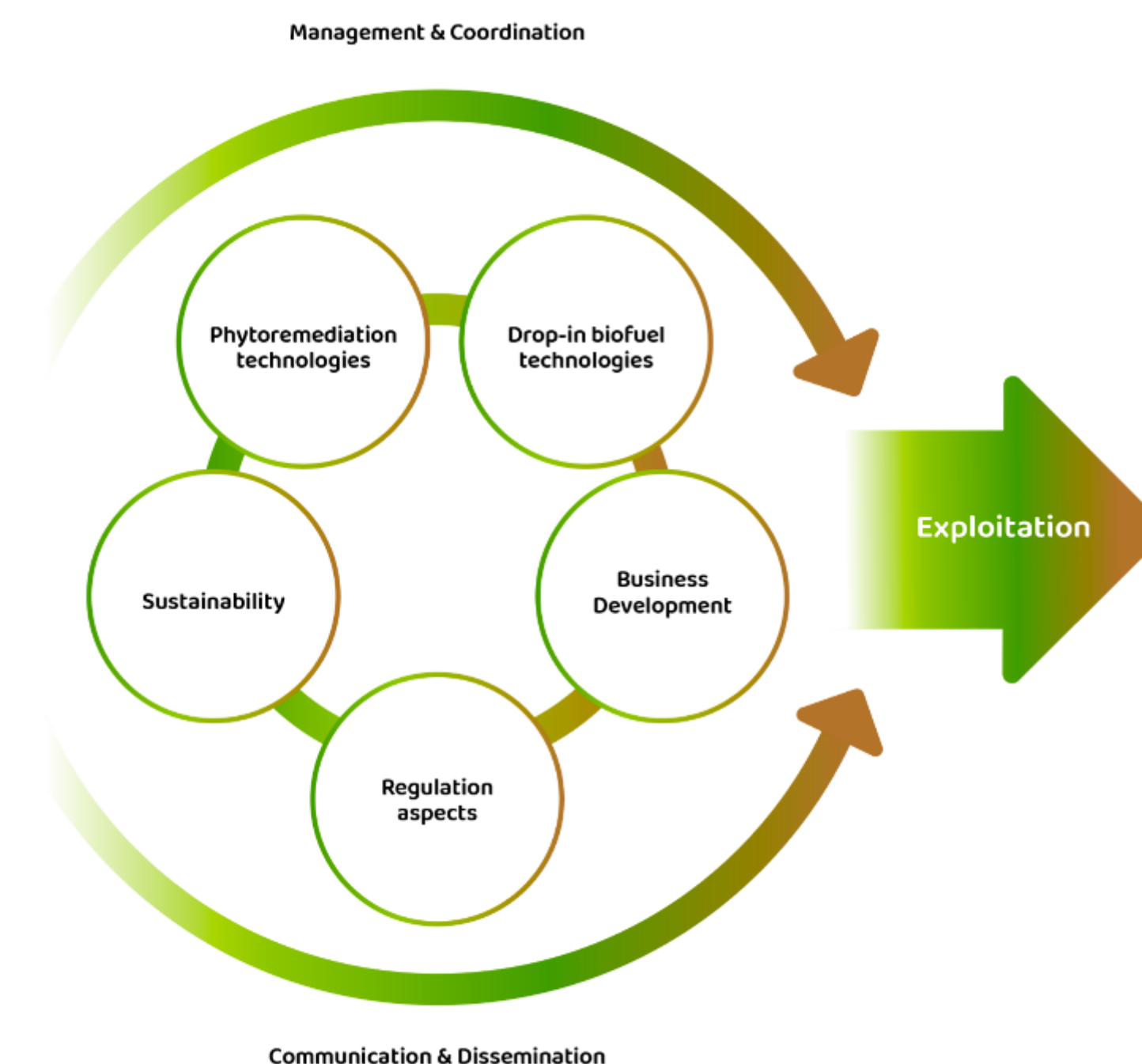


Phy2Climate - Combining phytoremediation with biofuel generation

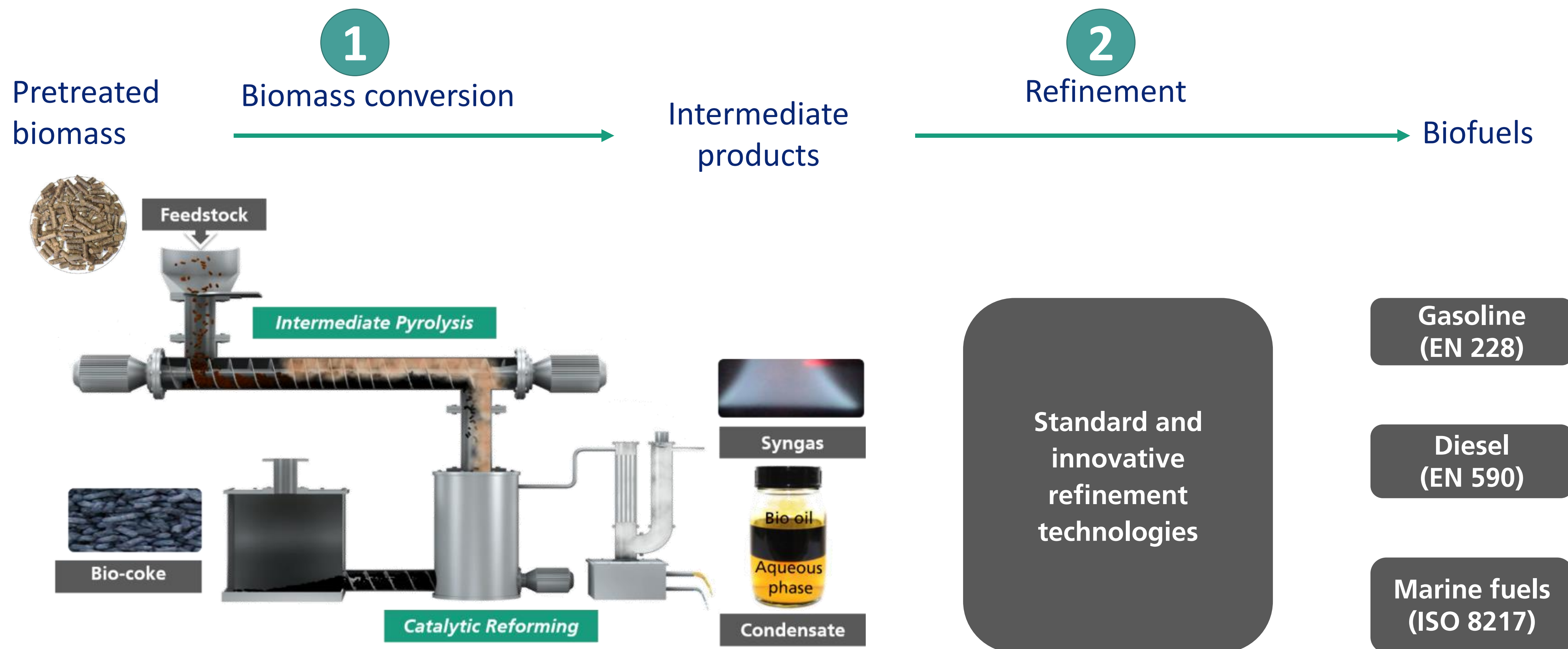
Focus of Fraunhofer UMSICHT



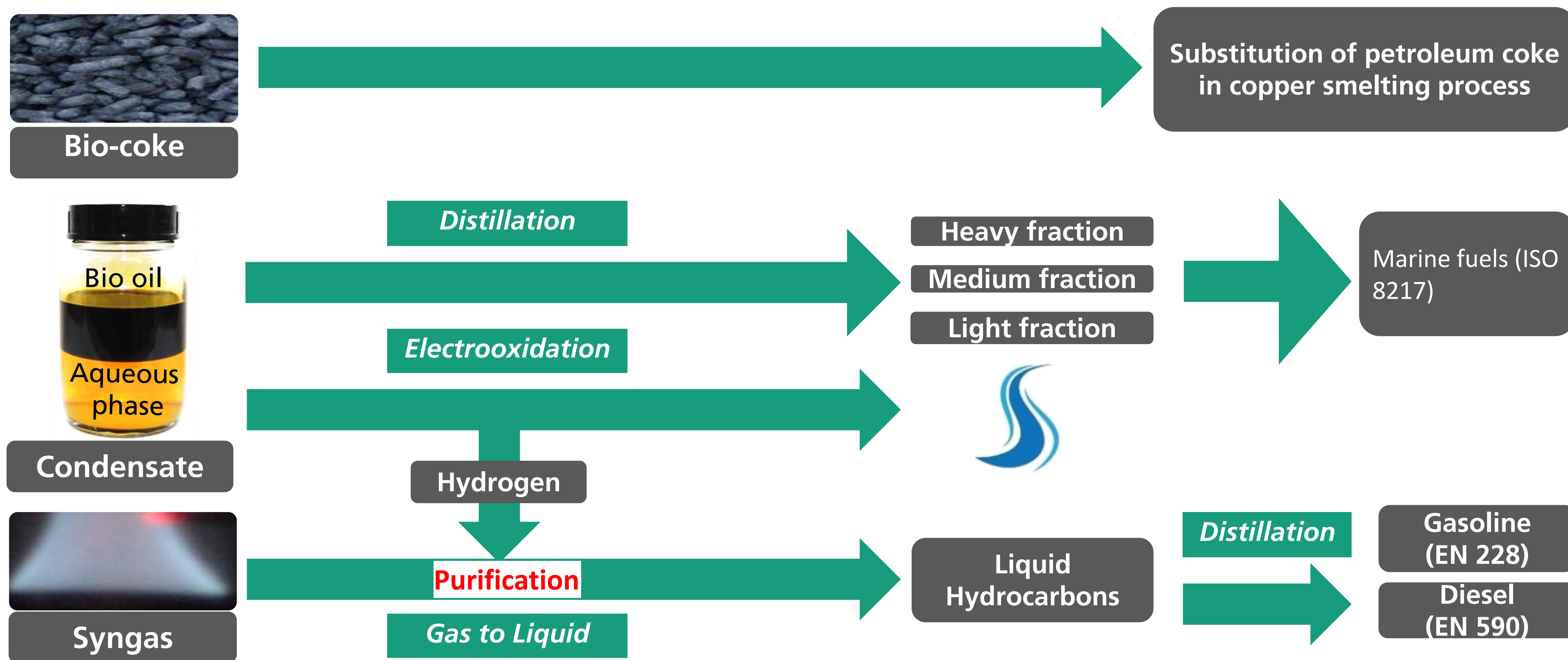
1.1.2021 - 30.06.2025
17 Partners
3 Continents
5 Pilot sites



Definition of the Phy2Climate biorefinery



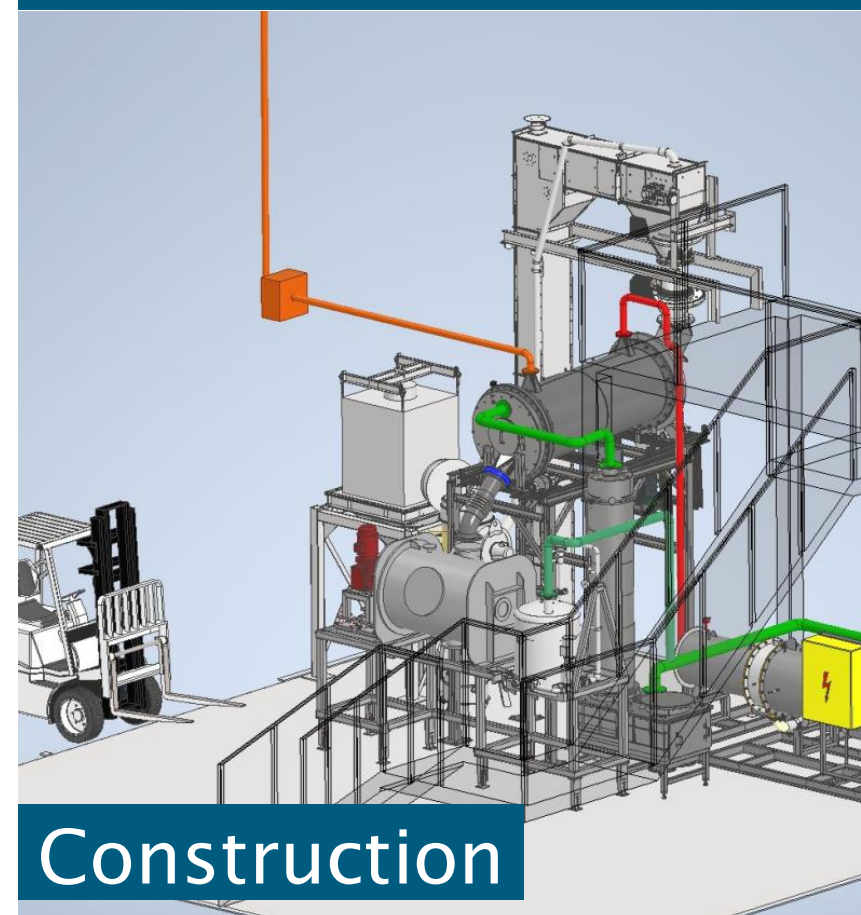
TCR-product refinement within Phy2Climate



Challenges in commissioning the biorefinery

- Managing the interfaces of the single biorefinery parts
- Design and commissioning of new biorefinery parts (e.g. gas purification unit)
- Assembly of the biorefinery because of bottlenecks in the supply chain

From innovation to application



Purification of TCR gas - critical gas components

Initial situation

- TCR® process at 1000 l/h gas flow rate
- Ammonia (NH₃) up to 5vol.-%
- Hydrogen sulfide (H₂S) between 0.5% and 2%
- HCN, COS, HCL, Br, F, alkalis

Requirements for GtL catalyst: < 50ppm NH₃ and H₂S



TCR gas composition with sewage sludge as feed, PR: 600°C

Gas component	Fraction in vol%
H ₂	34.2
CO	11.6
CO ₂	24.2
CH ₄	0.04
C _x H _y	1.06
NH ₃	< 5
H ₂ S	0,5 - 2



TCR gas cleaning - strategy & technical design

Gas scrubbers

- Acidic (initial cleaning of NH_3)
 - Basic (initial cleaning of H_2S)
- operated in series, filled with packing

Fixed bed reactors

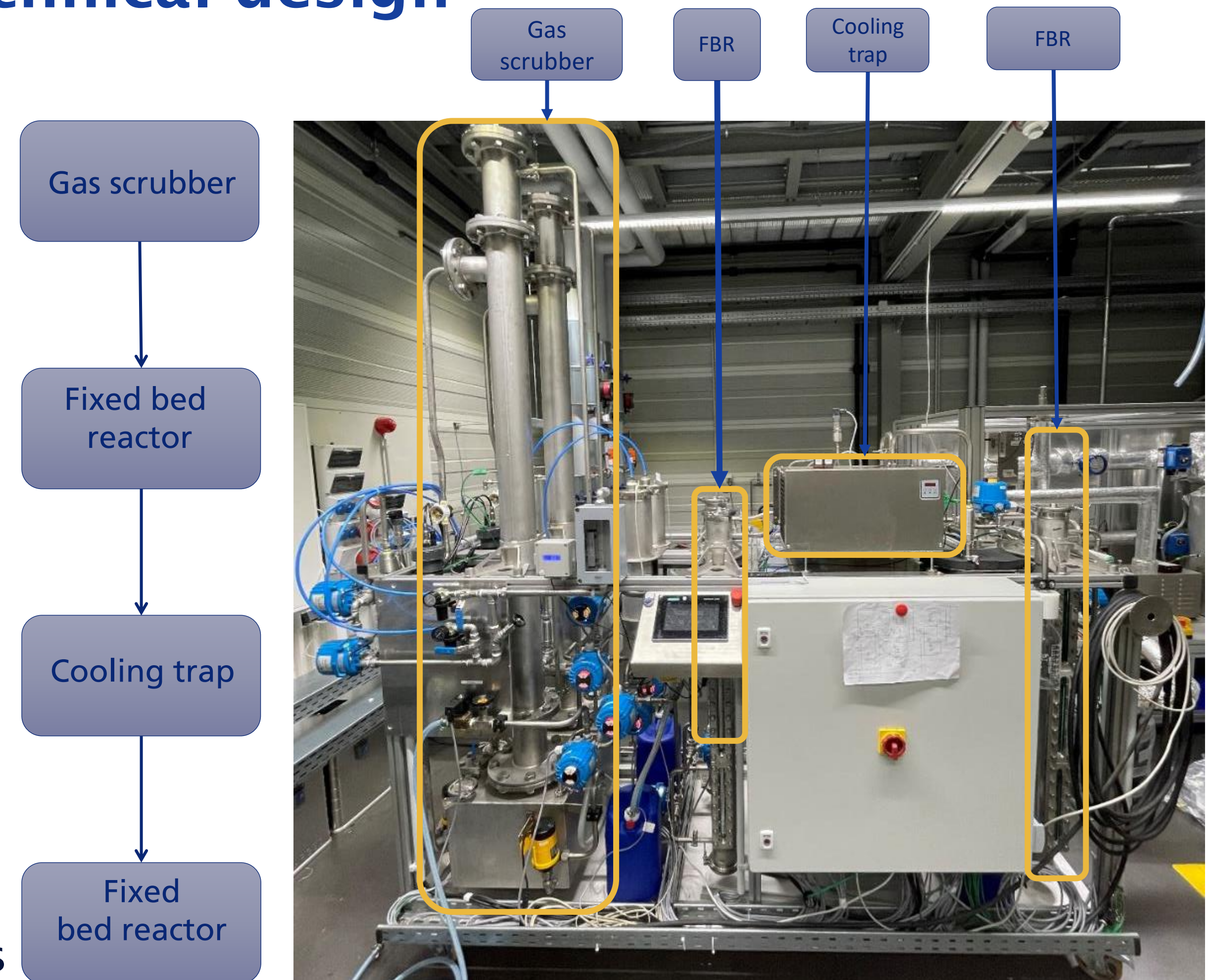
- Final cleaning of H_2S
- iron oxide pellets as reaction agent
operated alternately

Cooling trap

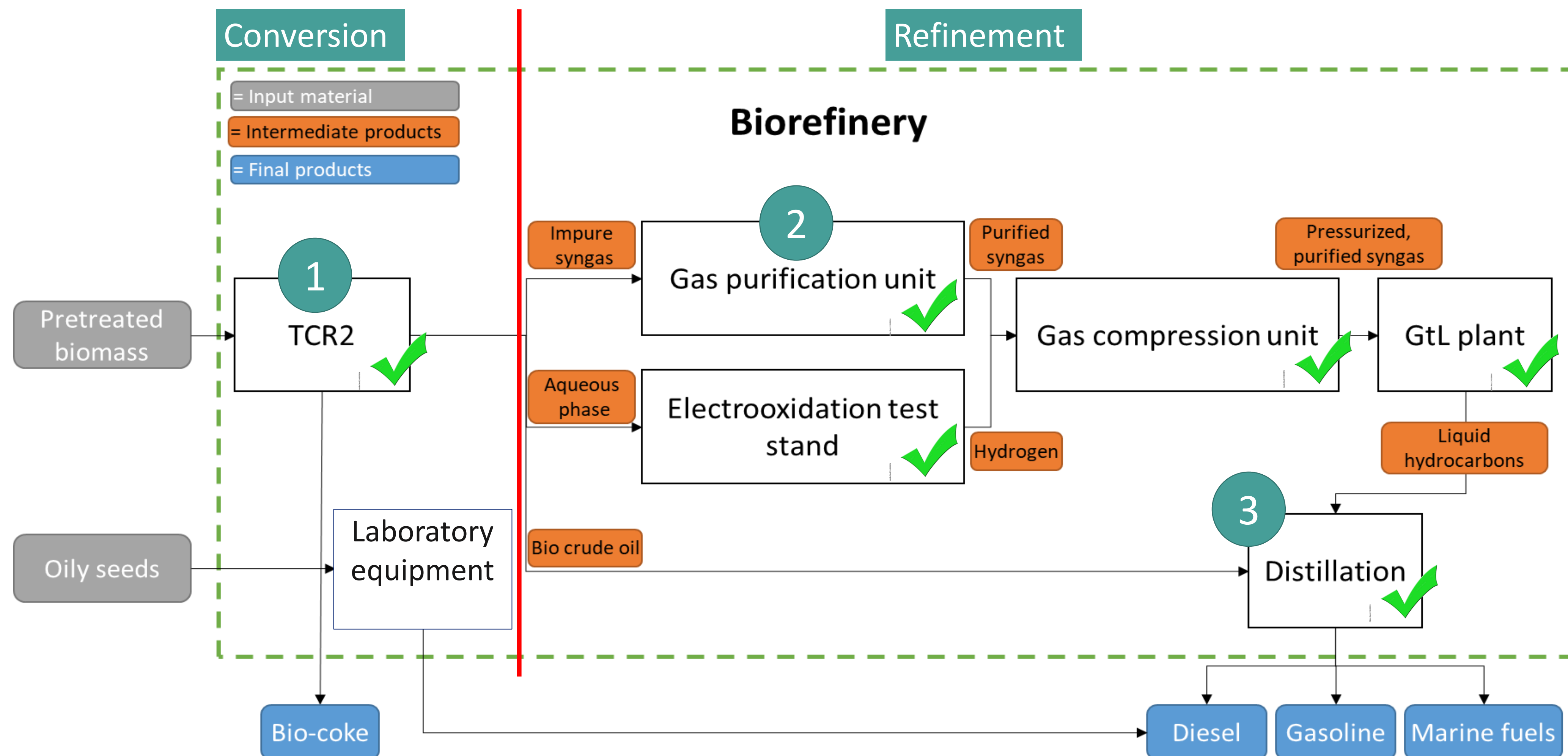
- 2-step process for removal of H_2O and NH_3

Fixed bed reactors

- For removal of HCN , COS , HCL , Br , F and alkalis



Current status



First results - Overview of conversion trials

Feedstock origins and TCR trials carried-out

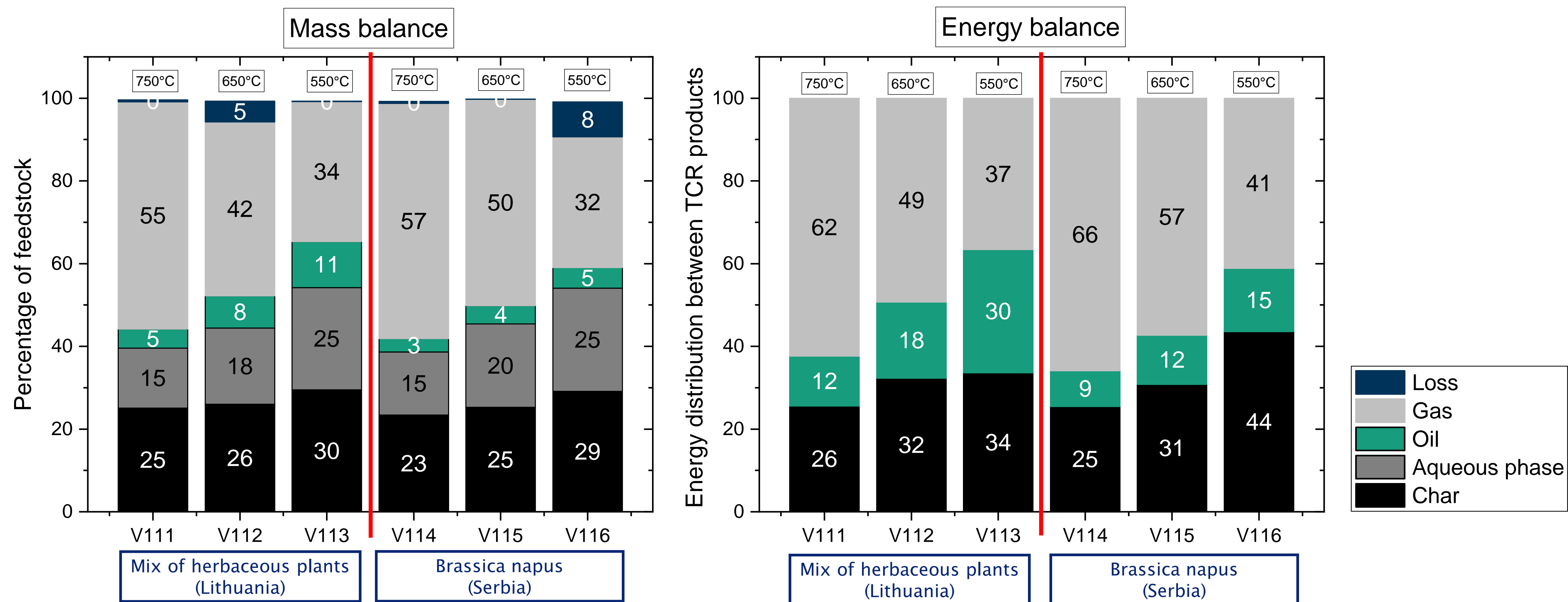
Feedstock origin	Soil contamination	Used plant species for phytoremediation	Reactor temp. (°C)	Postreformer temp. (°C)
Lithuania	Petroleum hydrocarbons	Tall fescue, Perennial ryegrass, Alfalfa, Festuca perennis, Bird's-foot trefoil	450	750
			450	650
			450	550
Serbia	(Cr; Cu; Zn; Cd; Pb; Ni / Petroleum hydrocarbons, organochlorine pesticides)	Brassica napus	450	750
			450	650
			450	550



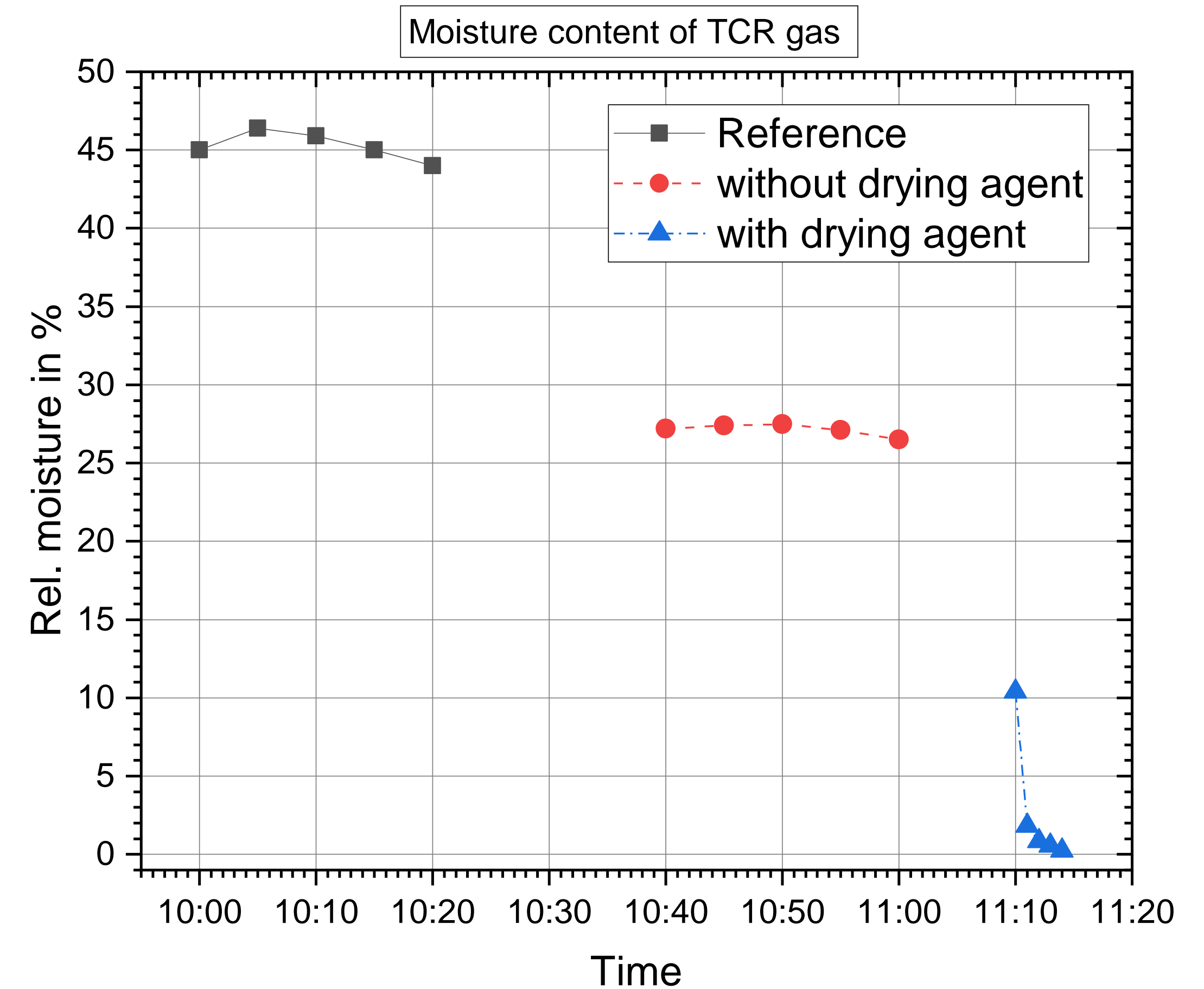
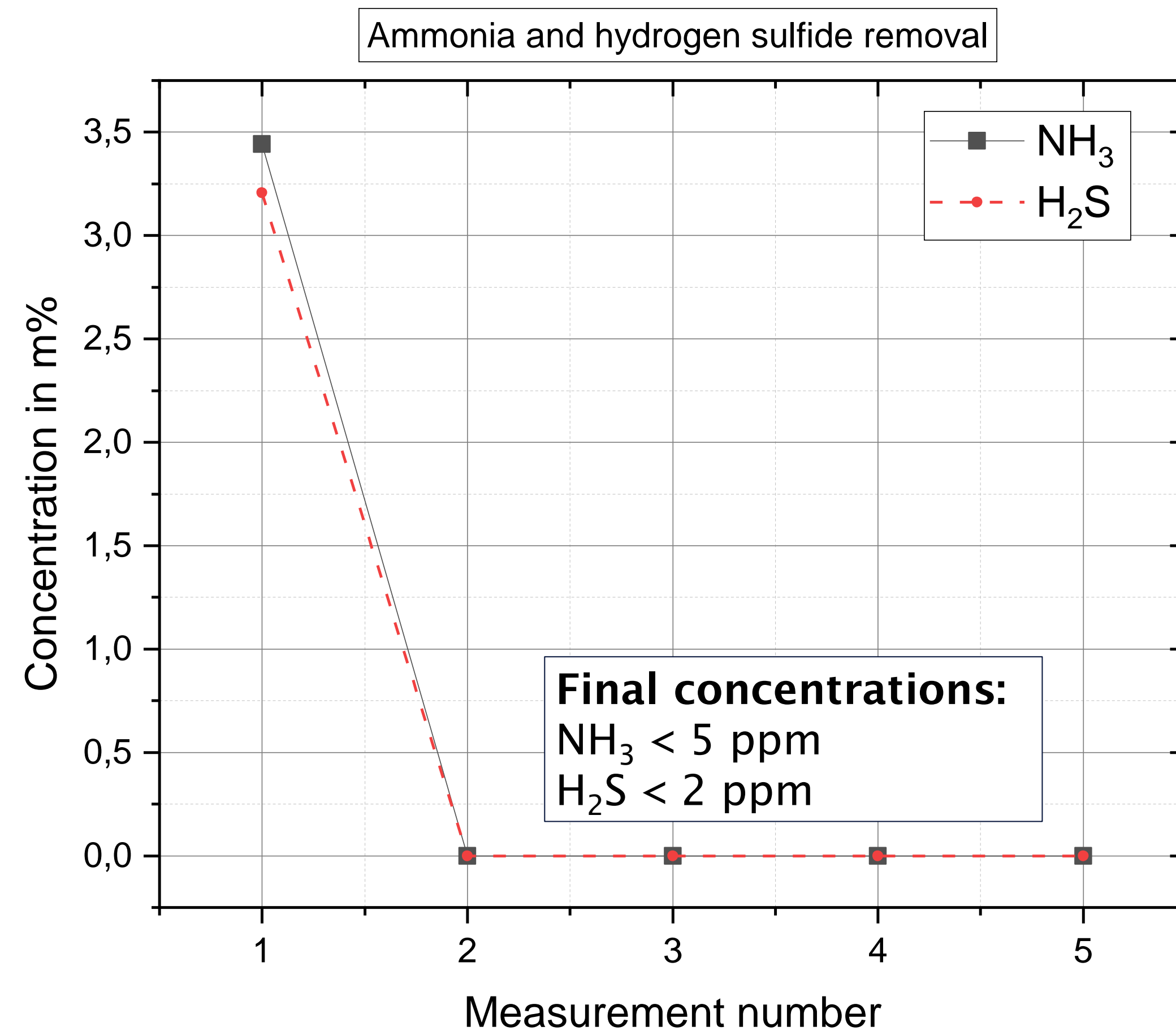
Analysis done



First conversion results - Mass- and energy balances



First refinement results - TCR-gas purification



First refinement results - TCR-oil distillation

Boiling cuts: 150°C and 250°C



Oil phase < 150°C Oil phase < 250°C Oil phase > 250°C

Next steps: Analysis of distillation products according to ISO 8217:2017 Petroleum products — Fuels (class F) — Specifications of marine fuels



Summary and Outlook

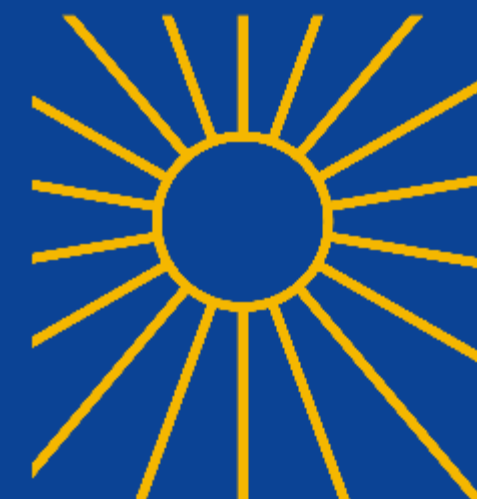
Things successfully achieved so far:

- Designing, assembling and commissioning of a biorefinery
- First conversion trials
- First product refinement

Next steps:

- Further conversion trials
- Ongoing refinement of intermediates & evaluation according to the project goals
- Development of a mass and energy concept of the overall biorefinery





Thank you



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