BioMeGaFuel

Bio Methanol Production via Chemical Looping Gasification Coupled with Membrane Reactors

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Webinar on intensified (bio)methanol production

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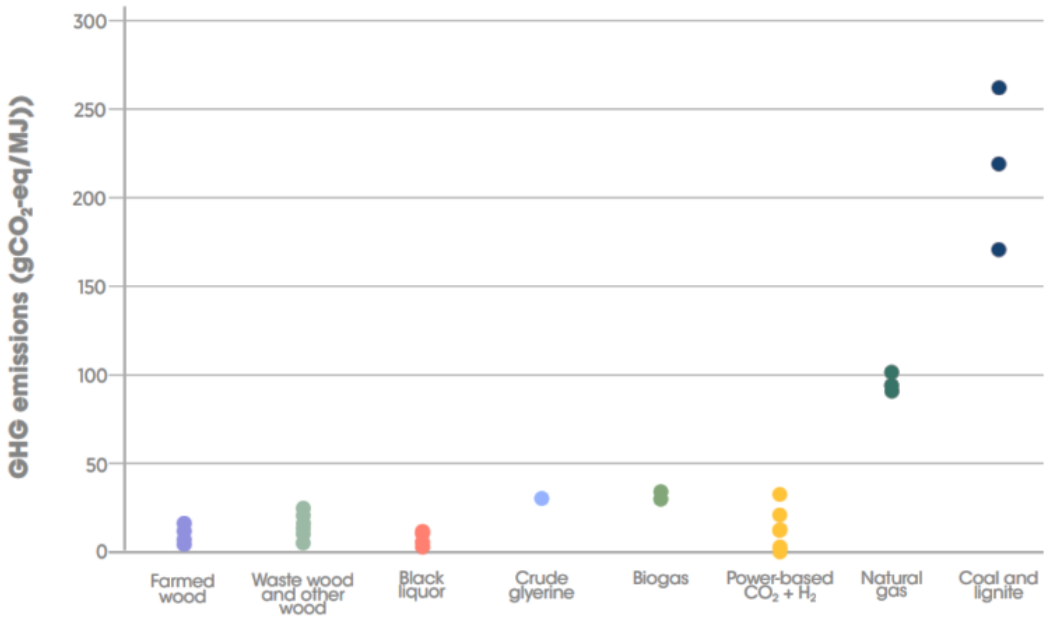
Methanol

- Beyond its role as an important chemical commodity, methanol can serve as a hydrogen carrier and a versatile fuel.

- Around 102 Mt of methanol were produced in 2020 with expectations of increasing to 500 Mt/year by 2050.
  - Correspond to releasing 1.5 Gt CO_2 per annum if solely sourced from fossil fuels.

- In 2020, around 65% of methanol is produced by natural gas reforming, and 35% is produced by coal gasification. Only less than 1% of global methanol production is renewable methanol.
  - Renewable methanol is produced from sustainable biomass (biomethanol) or biogenic carbon dioxide and hydrogen using renewable electricity (e-methanol).



GHG emission for methanol production from various feedstocks

Innovation Outlook: Renewable Methanol (2021), International Renewable Energy Agency (IRENA)

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BioMethanol

- While the production of biomethanol from biomass can significantly reduce the CO_2 emission, the amounts of biomass that can be generated in a sustainable way are limited.
- Currently there are several on-going/operational projects for biomethanol production from MSW, and waste wood using gasification technologies
  - the yield of biogenic carbon in the biomethanol product is relatively low since the main part of the biogenic carbon will be converted to CO_2 in the gasifier and in the syngas conditioning.
  - the overall conversion efficiency is relatively low
  - these technologies are often unable to utilize low-value biogenic residues without pretreatment as feedstock, owing to their heterogenous nature and naturally high amount of contaminants
- According to IRENA, the cost of biomethanol can increase significantly from $43/ton to $660/ton by increasing the cost of biomass (from 1.5 $/GJ to 15 $/GJ) and decreasing conversion efficiency (from 70% to 50%) and while the cost of fossil-based methanol is $100-250/ton.

Innovation Outlook: Renewable Methanol (2021), International Renewable Energy Agency (IRENA)

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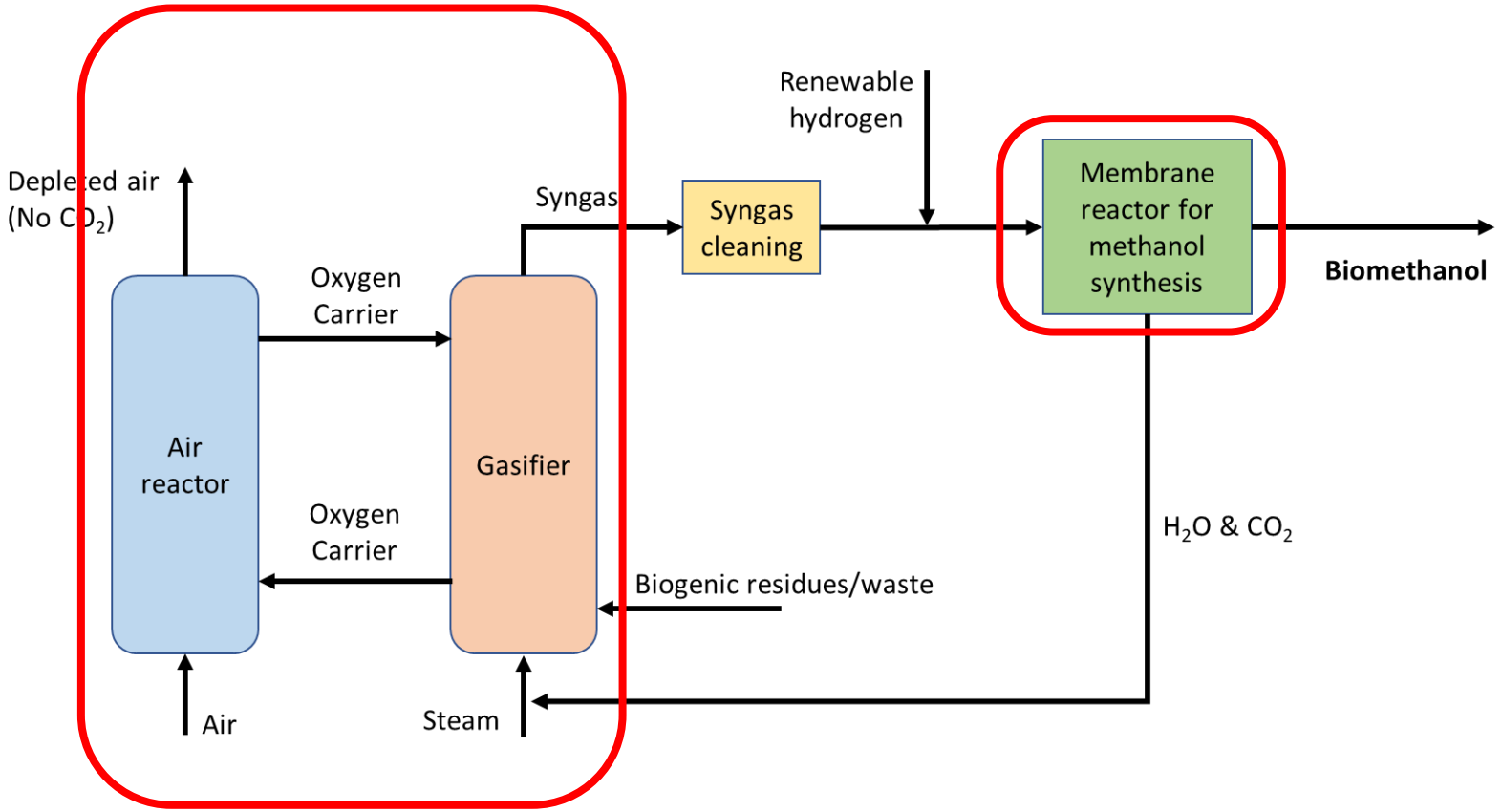
Develop a novel, **efficient, and scalable process** to convert **low-value biogenic residues** and organic waste to **biomethanol** through **chemical looping gasification** coupled with **membrane reactors**



CLG

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- Flexible toward feedstocks and can utilize various biogenic residues and wastes
- Higher conversion efficiency compared to conventional gasification and methanol synthesis methods, leading to lower production costs and maximum biogenic conversion to biomethanol.
- Reducing the number of downstream units, with the possibility of heat and power integration, provides significant potential for cost reduction.
- Produce biomethanol with near zero emissions (significant emission reduction).
- The process is less energy intensive and is self-sufficient in terms of heat.

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BioMeGaFuel

- Developing biogenic resides and wastes gasification with oxygen carriers to maximize the conversion of biogenic residues and wastes to syngas
  - ✓ Testing five different biogenic fuels including microalgae, buck wheat, waste wood, olive pits and spruce
  - ✓ Operate the 1 MW CLG pilot plant at TUDA in auto-thermal modes to gasify 50-70 tons of biogenic residues (TRL 5)
  - ✓ 80% gasifier cold gas efficiency
  - ✓ 98% carbon conversion in gasifier
  - ✓ <10% of reactive ash species released in air reactor

- Developing membrane reactors for methanol synthesis:
  - ✓ Demonstrate membranes at TRL5 in a standalone setup to produce biomethanol
  - ✓ Significantly increase the yield of biomethanol production from syngas by two-fold.
  - ✓ Separating unconverted products and biogenic CO_2 to recycle back to the gasifier

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➢ Process evaluation and sustainability analysis

- ✓ Design of a full chain process for the production of biomethanol from residual biomass via CLG
- ✓ Compare different process configurations to identify the optimal operation of the production plant.
- ✓ Estimate CAPEX and OPEX of the production plant and identify how the production cost is affected by the plant capacity and other process parameters (i.e., sensitivity analysis)
- ✓ Estimate the carbon footprint from the production of bio-methanol via the Bio-MeGaFuel concept.
- ✓ Assess the social and socio-economic impacts of the Bio-MeGaFuel concept throughout the entire life cycle

➢ Exploitation and whole Value Chain analysis

- ✓ Market, production, and end-user uptake analysis of biomethanol (production potential, cost analysis, etc.)
- ✓ Current and conceptual value chains and business models

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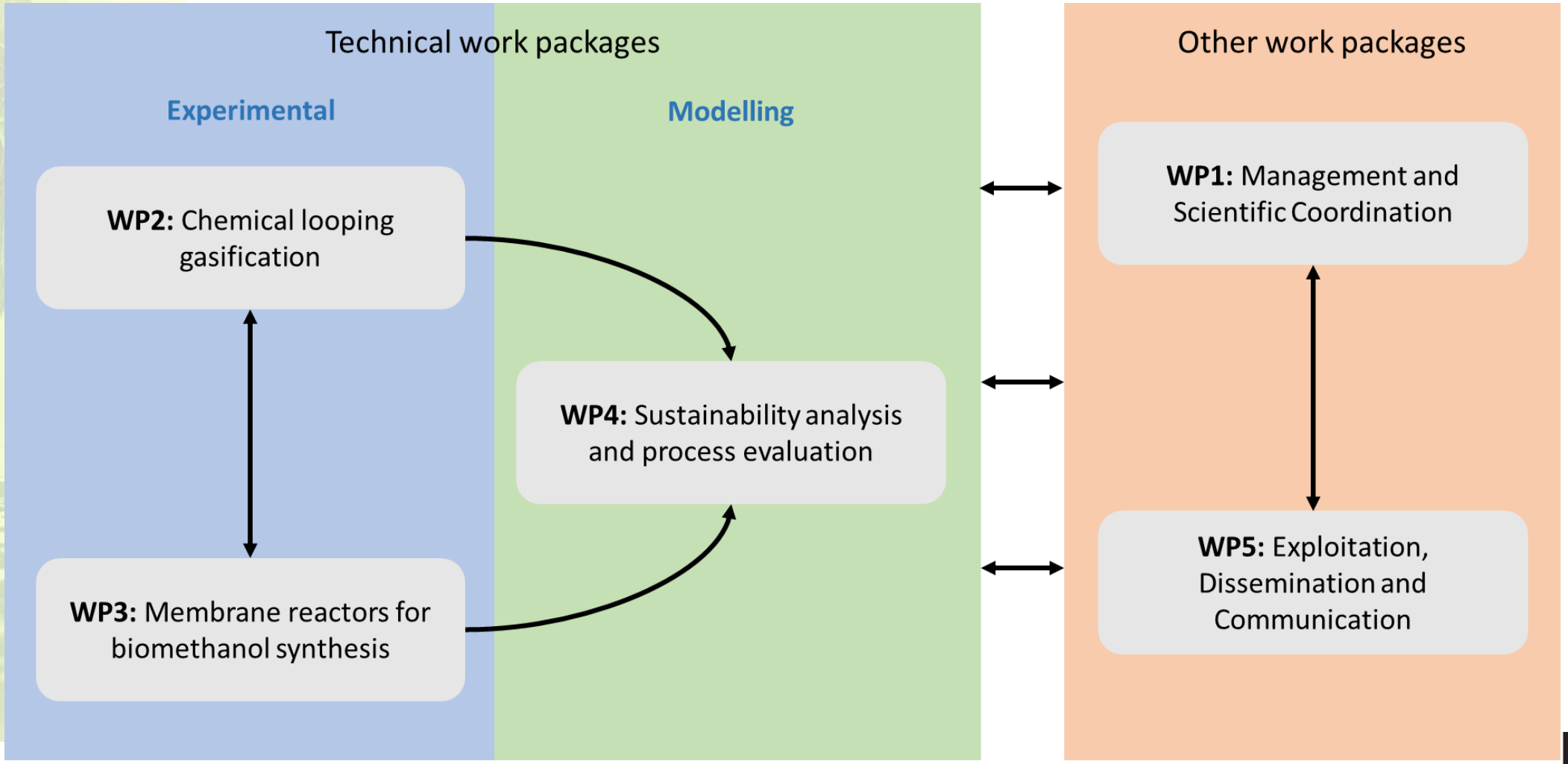
The overall structure of the work plan in Bio-MeGaFuel:



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Bio-MeGaFuel

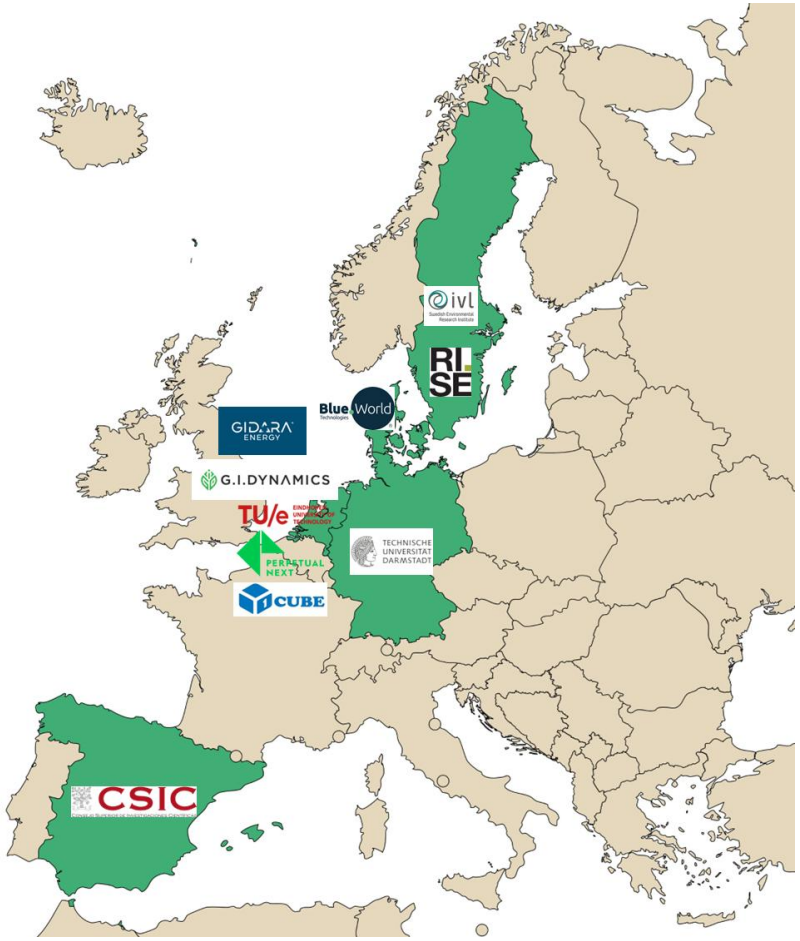
Duration: 48 months

Start date: September 2024

Budget: Approximately 3.8 Million Euros (Funded by EU)

The Bio-MeGaFuel consortium consists of 9 partners from 5 countries and includes:

- Three Research Institutes: RISE Research Institutes of Sweden, The Spanish National Research Council (CSIC), and IVL Swedish Environmental Research Institute.
- Two Universities: The Technical University of Darmstadt and Eindhoven University of Technology.
- Four Companies: GIDARA Energy, Perpetual Next, 1Cube and Blue World Technologies.



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Thank you for your attention

www.biomegafuelproject.eu

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