



Collaborative actions to bring novel **BIO**fuels **THE**rmochemical  
**RO**utes into industrial **Scale**

*“Collaborative Actions to Bring Novel Biofuels Thermochemical Routes into Industrial Scale within the BioTheRoS project”*



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*Online*



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# BioTheRoS Overview

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## Project Details

BioTheRoS is an EU Horizon Programme under Grant Agreement No 101122212 running from 2023

## Consortium Members

The project is made up of 6 consortium members from several European countries



## Demonstration Cases

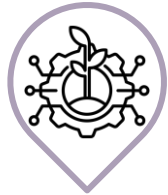
Application in pyrolysis and upgrading units in Netherlands & gasification unit in Austria

# BioTheRoS Objectives



## BioTheRoS Goal: Transfer biomass into an opportunity

BioTheRoS aims to develop a **comprehensive approach** that will accelerate the production of sustainable biofuels. **Synergies** are foreseen to maximize the circular economy-based scale up of thermochemical advanced biofuels.



Development of cost-effective & sustainable technologies for thermo-chemical conversion of biomass to produce biofuels to TRL5



Selection & assessment of biomass feedstocks for scaled-up biofuel value chains employing predictive biomass demand AI models



Development of scale-up rules of biofuels production based on advanced modelling techniques, lab/pilot-scale trials & LCSA principles



Identification of concrete measures to improve the sustainability of pyrolysis & gasification processes



Provide valuable insights into the market dynamics of scaled-up pyrolysis and gasification biofuel value chains

# BioTheRoS Breakthrough

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BioTheRoS develops **innovative** & cost-competitive **Fast Pyrolysis-to-biofuels** and **Gasification-FT-Synthesis value chains**, combining **Carbon Capture Utilization (CCU)** and **fuel upgrading** for accelerating the scale-up of sustainable biofuels.

***Breakthroughs are elaborated as follows:***

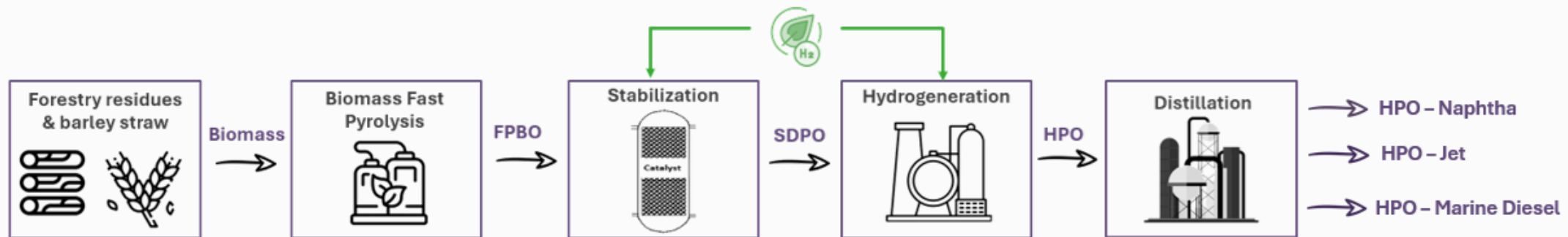
- 1 Full value chains**  
Demonstration of the full pyrolysis & gasification value chains from biomass to high quality jet/marine fuel
- 2 Carbon capture unit**  
Deployment of innovative carbon capture unit of gases from fast pyrolysis & gasification
- 3 RES hydrogen utilization**  
Utilization of renewable hydrogen as an add-in option to advanced biofuel pathways
- 4 Joint application of LCSA & MCDA**  
Development & application of novel models, combining LCSA & multi-criteria methods for environmental, economic & social performance optimization of full pyrolysis & gasification value chains.
- 5 Holistic guidelines**  
Development of a holistic guidelines for scale-up & increased market uptake of advanced biofuels in aviation & shipping from a CE perspective

# The Netherlands: Pyrolysis Unit

- ❖ BTG operates in its lab a pyrolysis **bench scale** unit (2-5 kg/h) & a **larger-scale pilot plant** (80-200 kg/h).
- ❖ **Forestry residues & barley straw** are used as feedstock for pyrolysis.
- ❖ For the **upgrading** of pyrolysis oil to transport fuel, a 0.8-1.5 kg/day continuous upgrading unit will be utilized.
- ❖ **Fast Pyrolysis Bio-Oil (FPBO)** can be upgraded to Hydrotreated Pyrolysis Oil (HPO).
- ❖ **HPO** is fractionated into Naphtha, SAF and Renewable Marine Diesel.



## Simplified Flowchart of advanced biofuels value chain



~10-20 wt% Naphtha, ~45-55% wt% Jet, ~30-40 %wt Marine Diesel

# Austria: Gasification Unit

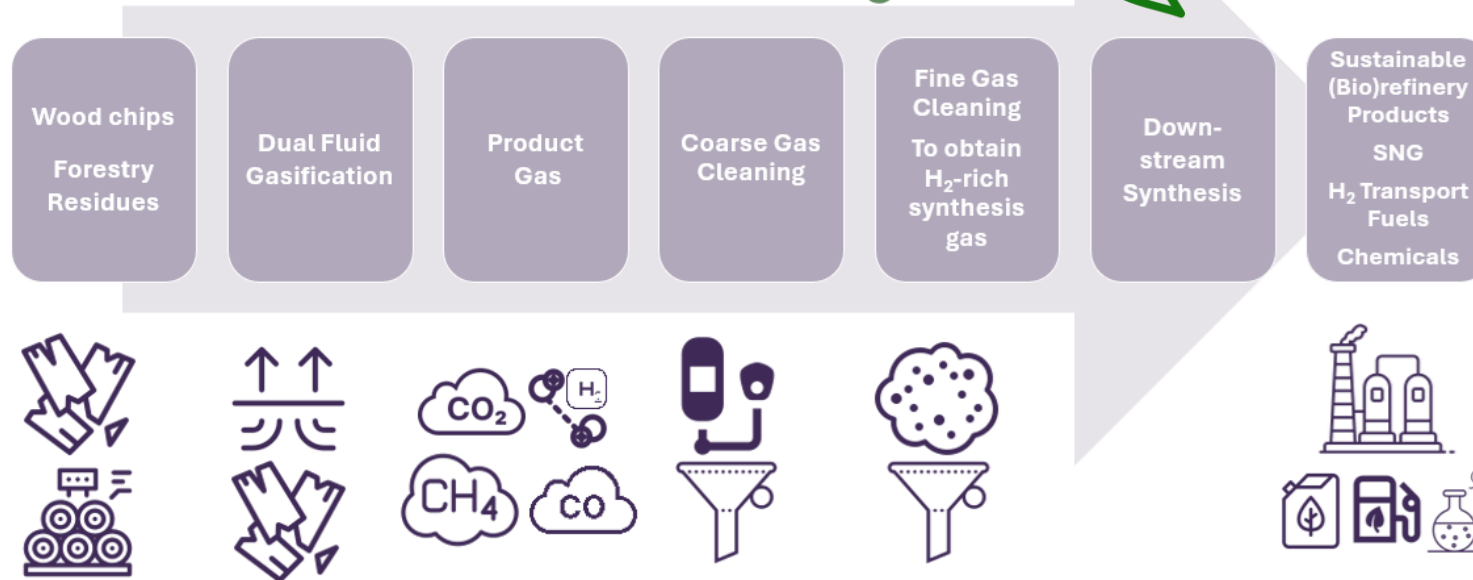
- ❖ BEST operates in its plant, a **1 MW scale DFB reactor** (200 kg/h), and a **250-kW pilot Fischer Tropsch synthesis unit** (produced FT-raw product amount aimed at 15-20 L).
- ❖ For the upgrading of the FT waxes, a **hydrocracking pilot plant** unit in Greece, will be utilized.
- ❖ **Feedstock** for gasification value chain: (i) high quality **wood chips (steam wood)** as reference feedstock & (ii) **forestry residue (treetops)** as biogenic residue



FT pilot plant based on slurry technology (250 kW)

## Possible Sector Coupling

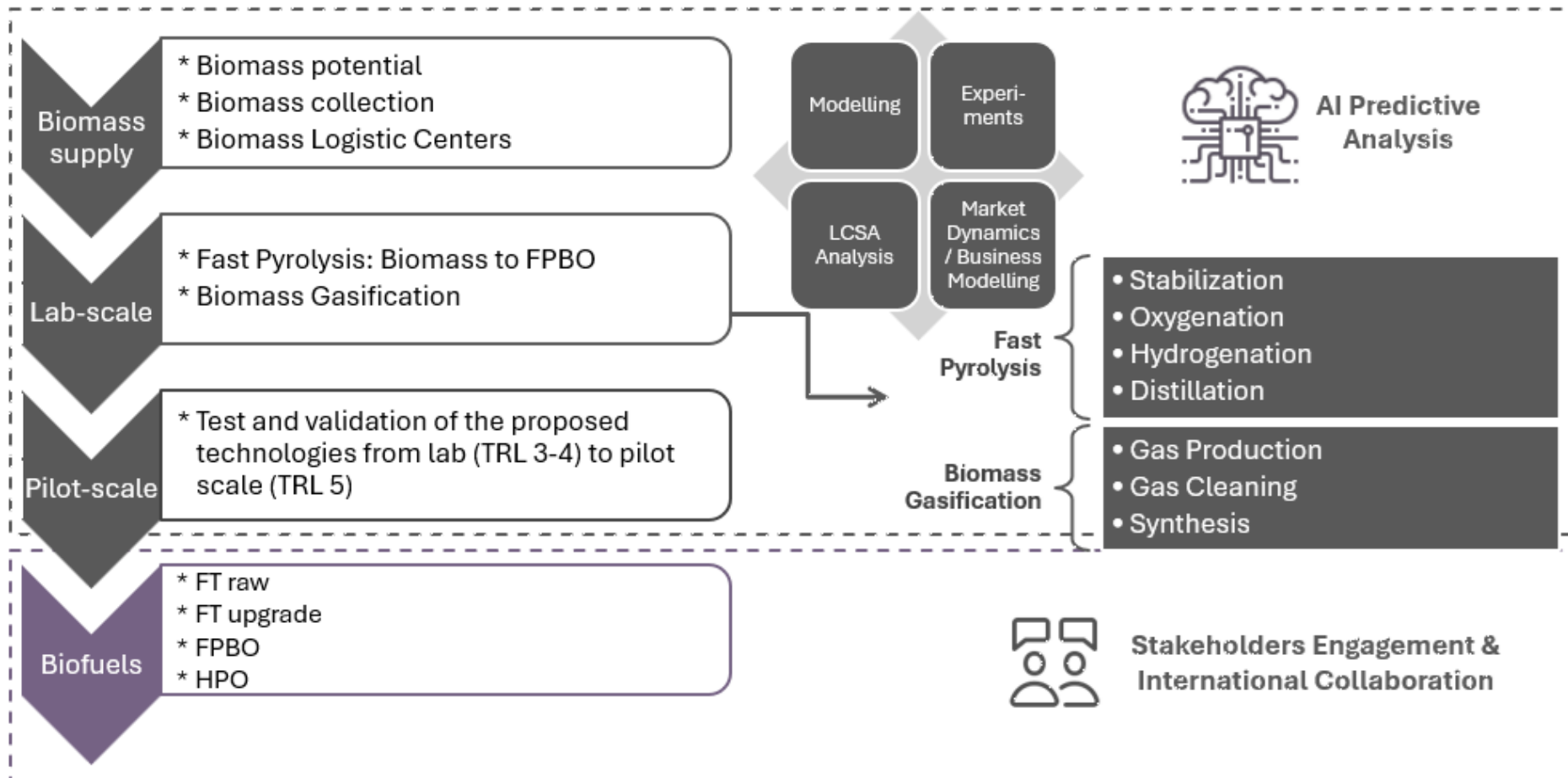
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**Lab-, pilot- and demonstration-scale infrastructure for experimental de-risking to enable industrial implementation**

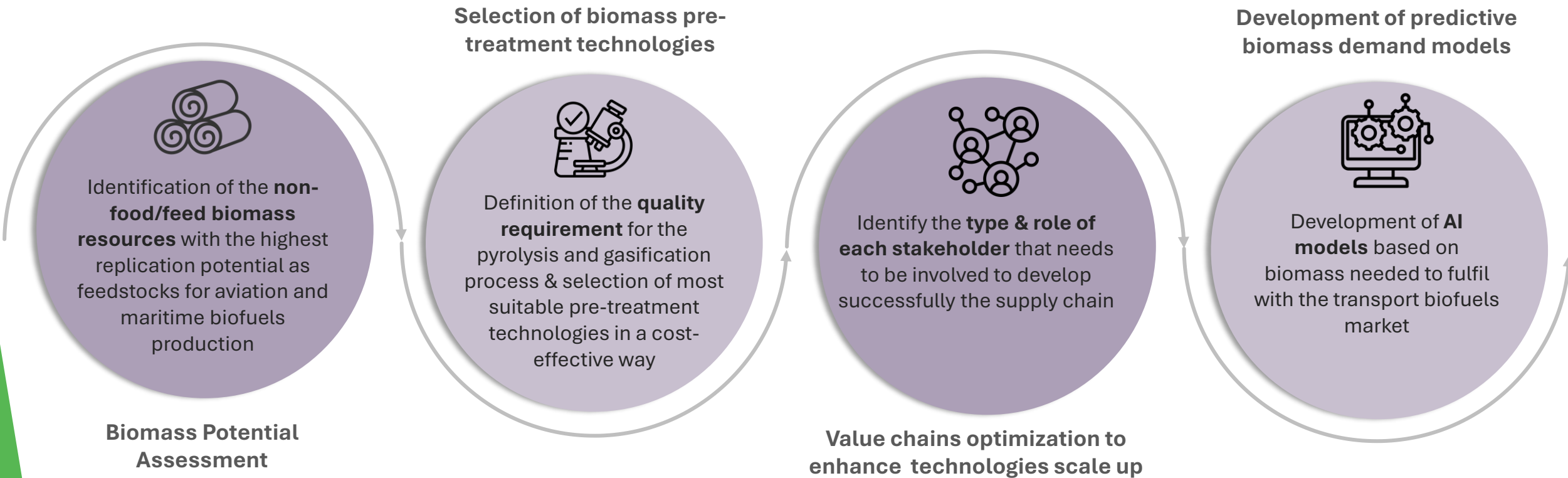
# BioTheRoS Methodology

Application of a **multidisciplinary stepwise approach** including feedstock selection, pilot experimental validation, scale up simulation and modelling, environmental, techno-economic and social assessments for the sustainable scaling of pyrolysis & gasification advanced biofuels value chains.



# New value chains design within BioTheRoS

Mapping biomass feedstock and circular bioeconomy options based on technical parameters, market needs, and compliance with environmental policies.





# Technologies validation & products evaluation

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## Pyrolysis Technology:

- \* Operation of a multistep hydrotreatment process to produce HPO;
- \* Identification of constraints and opportunities for scale up of pyrolysis pathway;
- \* Operation of the full value chain, including the distillation units to produce lights, jet fuel, and road/marine fuel;
- \* Simulation and modelling for scale-up of pyrolysis value chain;
- \* Experimental assessment of fuel synergies between pyrolysis fractions and FT fuels.



## Gasification Technology:

- \* Characterization of gas impurities and possible catalyst poison and adaption of gas cleaning section;
- \* Identification of constraints and opportunities for scale up of gasification pathway;
- \* Operation of the full process to obtained FT raw product
- \* Upgrading of the FT raw product to high quality sustainable biofuel
- \* Modelling and simulation for assessment of the possible scale up of the technology

# Integrated LCSA/MCDA & TEA Application

*Evaluation of BioTheRoS biofuels **value chains sustainability** considering environmental, economic & social aspects from a life cycle perspective*



Application of **Life Cycle Analysis (LCA)** to identify, quantify, interpret and evaluate the environmental impacts based on ISO 14040 -14044 Standards.



Application of **Life Cycle Costing (LCC)** to quantify the total costs over the entire lifetime, i.e., from acquisition, installation, operation & maintenance to the ultimate disposal of raw materials.



Application of **social Life Cycle Analysis (sLCA)** to assess the effects of an activity or service related to the value chain on the social dimension, considering all stake-holders (e.g., workers, local community, etc.)



**Joint application of Life Cycle Sustainability Assessment (LCA + LCC+ sLCA) & Hybrid Multi-Criteria Decision Analysis (MCDA)** for performance assessment of BioTheRoS value chains and selection of the optimal one based on stakeholders preferences.



Thorough **Techno-economic Assessment (TEA)** of CCUS and renewable hydrogen as add-in options to advanced biofuel pathways

Development of a holistic guidelines for sustainable scale-up & increased market uptake of advanced biofuels in aviation & shipping sector !!!

# BioTheRoS Expected Impacts

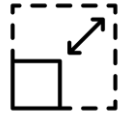
## How will BioTheRoS contribute to biofuels promotion??



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### Biomass-to-Biofuel Optimization Process

Mapping of biomass potential promotes the optimization of biomass-to-biofuel value chain



2

### Building knowledge for upscaling

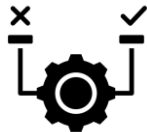
Experimental validation of BioTheRoS thermochemical technologies promotes identification of key bottlenecks and risks for building global knowledge for upscaling.



3

### Biofuels efficiency enhancement

Overcoming of technical bottlenecks & integration of CCU and renewable hydrogen enhance the efficiency of advanced biofuel production.



4

### Best available alternative identification

Multi-criteria analysis promotes the definition of the best available scenario and enables coordinated actions between stakeholders & end-users.



5

### Economic Viability

Techno-economic analysis evaluates the economic performance of the biofuel production and promotes the creation of new market opportunities.

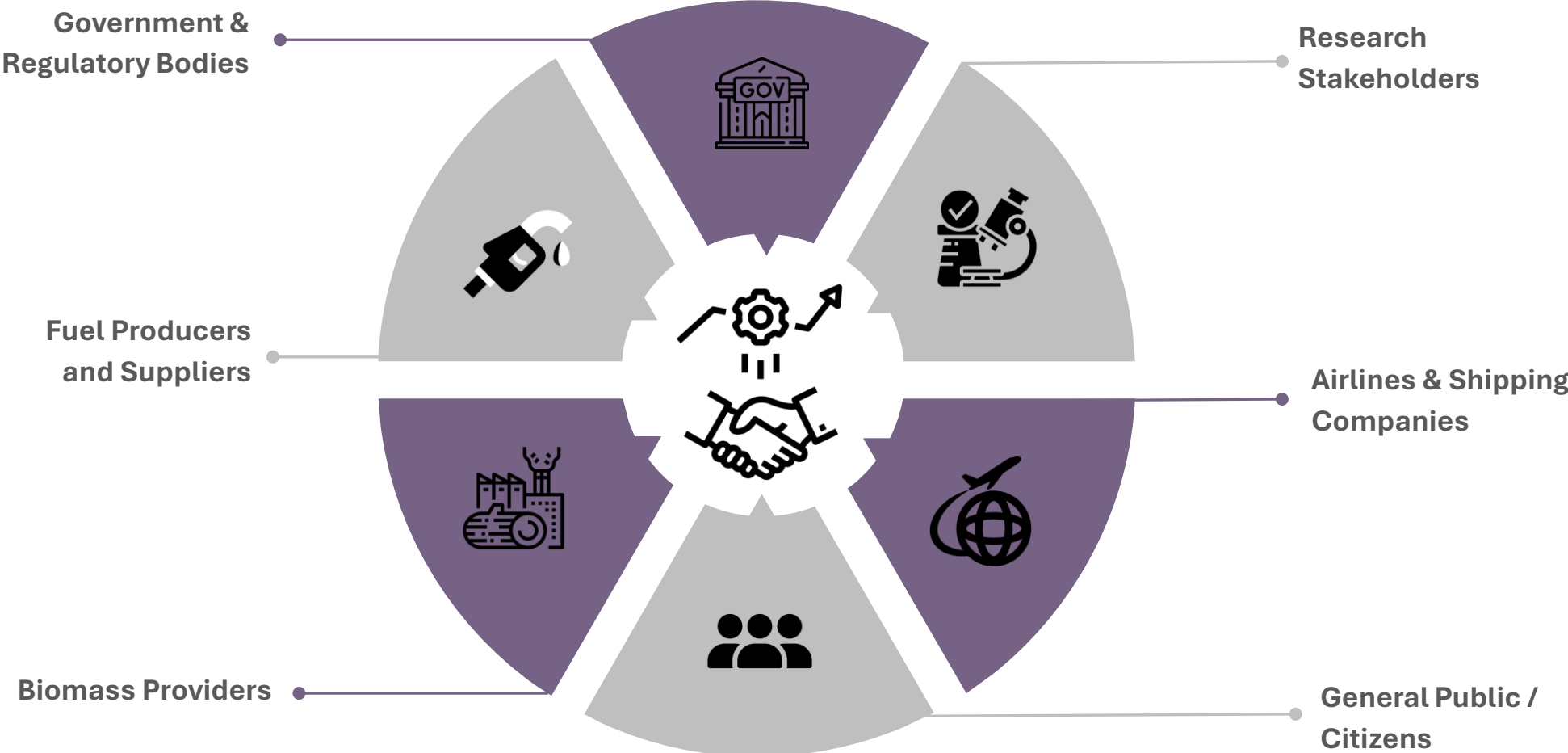


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### Building knowledge for upscaling

Knowledge exchange between BioTheRoS and international networks promotes collaboration opportunities and identification of innovation needs.

# Potential Synergies



# Take-Home Messages

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- The **sustainable supply of quality, cost-effective feedstocks** to future biorefineries is fundamental to growing the bioenergy industry.
- **Managing biomass supply chain risk** is a critical part to favor long term sustainability of advanced biofuels in terms of adequate fuel supply.
- The deployment of a **holistic circular economy-driven guidelines** for the full supply chain of advanced biofuels is needed to stimulate the growth of aviation and maritime biofuel markets. The **constraints & opportunities** for scale up of pyrolysis & gasification pathways should be also highlighted.
- The increasing focus on the GHG impact of maritime & aviation biofuels requires the utilization of **Life Cycle Analysis (LCA) Models**. In the context of **Circular Economy**, economic, environmental and social aspects should be considered in an integrated manner.

# Thank you!

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