BioTheRoS

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

Advanced biofuels from fast pyrolysis bio-oil

Evert Leijenhorst, BTG

Vienna, March 12, 2025

The BioTheRoS Project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101122212.

Advanced biofuels from FPBO

FPBO = Fast Pyrolysis Bio-Oil

At BTG, multiple pathways are considered to produce advanced biofuels from biomass, via fast pyrolysis

Main topic: the BioTheRos ‘pyrolysis route’

Side note: the combined pyrolysis / gasification pathway

Synergies with the BioTheRos route

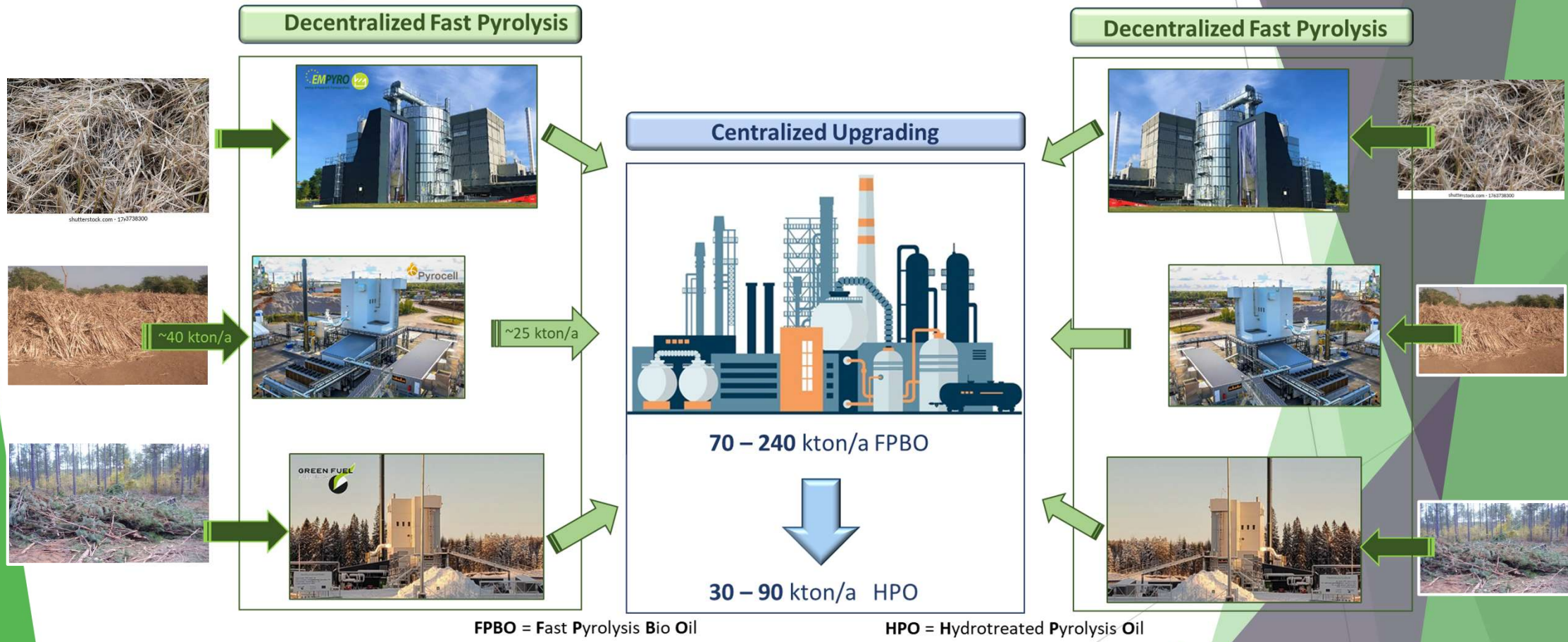
Matches with the ‘Focus Gasification’ of this workshop

Pyrocell

EMPYRO
energy & materials from pyrolysis

BioTheRoS

Fast Pyrolysis Value Chain



Fast Pyrolysis - Biomass to FPBO

FPBO = Fast Pyrolysis Bio-Oil

- Thermal cracking of organic material in absence of oxygen
- Main product: liquid bio-oil (FPBO)
- Other products: gas and char
- Minerals recovered at low temperature
- Autothermal operation, no external energy required
  - Excess energy (or drying biomass up to 50% moisture possible!)

- '*Liquid Composition*': carboxylic acids, ketones, aldehydes, alcohols, carbohydrates, depolymerized lignin, extractives, water,…

- TRL 8-9, three full scale installations in Europe with BTG technology.

The challenge

Fast Pyrolysis Bio-Oil

Water content	25	wt%
Density	1,170	kg/m^3
LHV	16	MJ/kg
Acid Number	70	mg$_{KOH}$/g
Sulfur	< 500	ppm
FlashPoint	?	°C
Cetane Number	< 20	-
MCRT	> 15	wt%

Components: Acids, carbohydrates, ketones, aldehydes, water, phenolic,..

Fast Pyrolysis Oil - **FPBO**

Drop-in Fuels

Water content	< 0.008	wt%
Density	< 840	kg/m^3
LHV	> 42.8	MJ/kg
Acid Number	< 0.015	mg$_{KOH}$/g
Sulfur	< 15	ppm
FlashPoint	> 38	°C
Cetane Number	> 35	-
MCRT	<< 1	wt%

Components: hydrocarbons

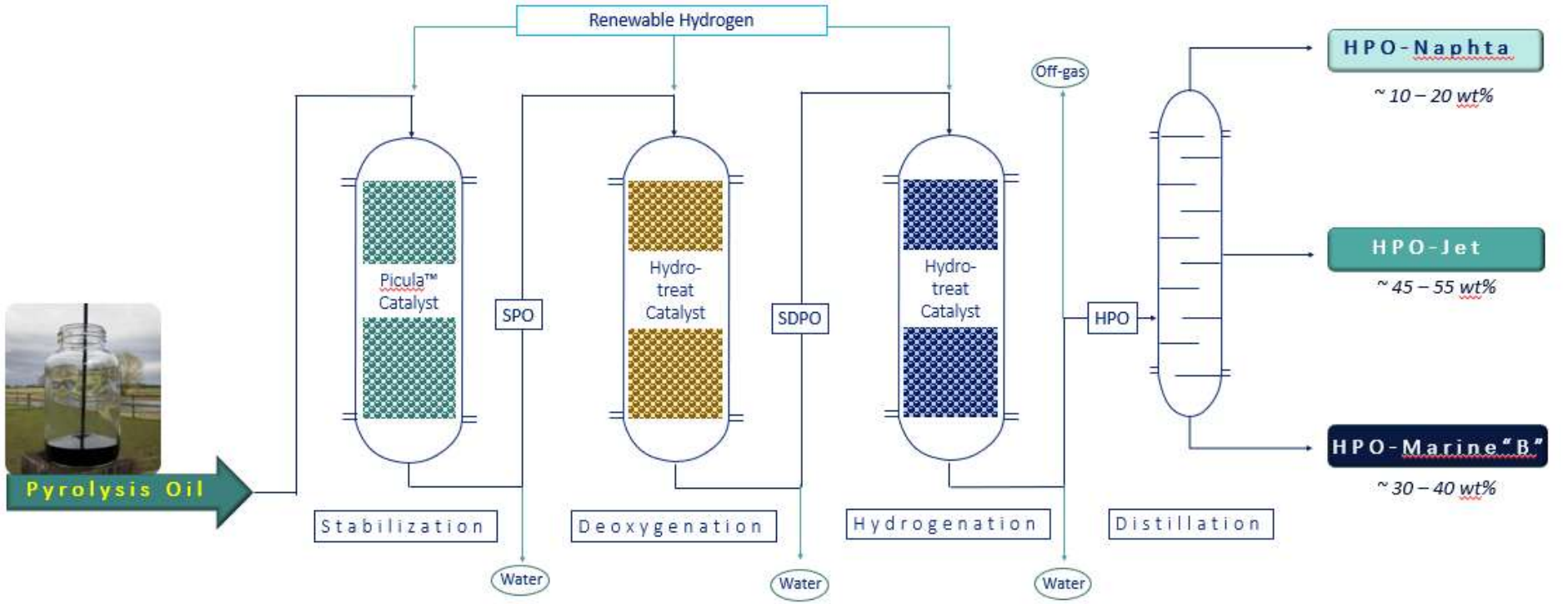
Aviation Fuel – JET A/A1

Water content		wt%
Density	< 890	kg/m^3
LHV	~42	MJ/kg
Acid Number	< 0.5	mg$_{KOH}$/g
Sulfur	< 1,000	ppm
FlashPoint	> 60	°C
Cetane Number	> 40	-
MCRT	< 0.3	wt%

Components: hydrocarbons

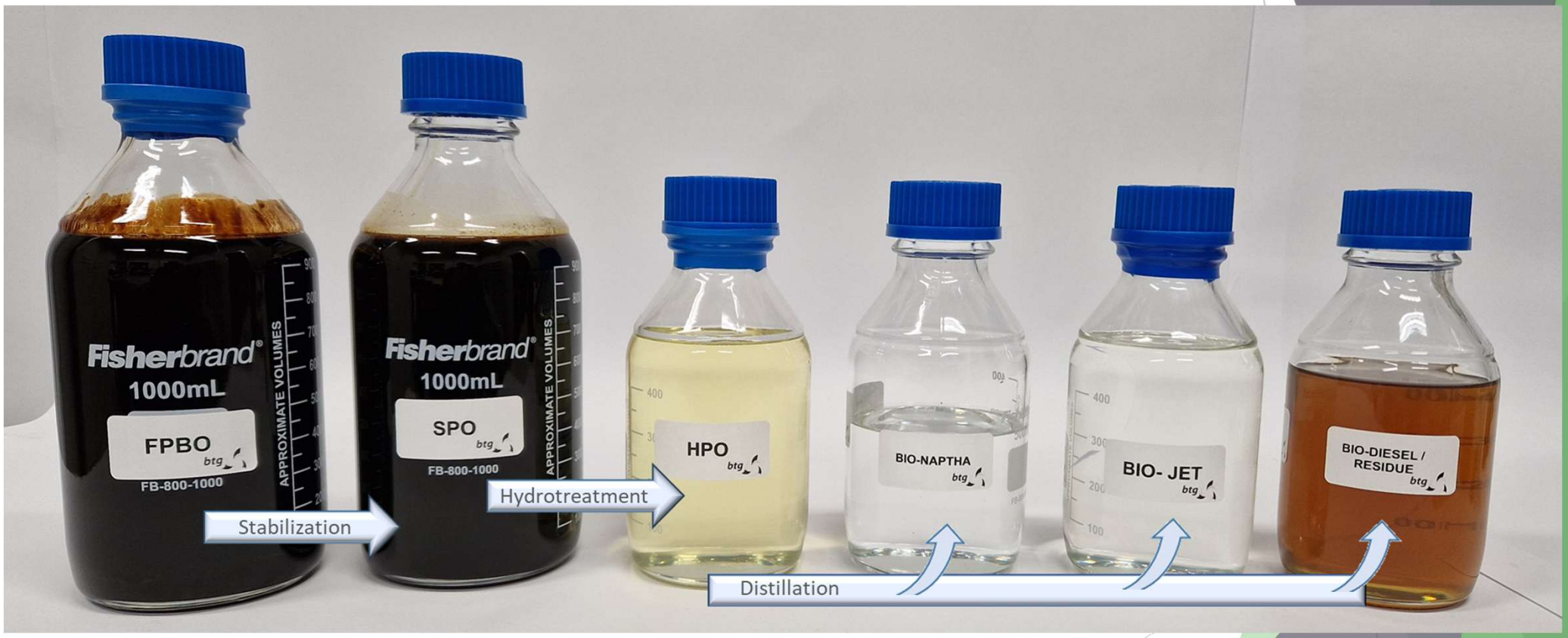
Distillate Marine Fuel – DMA

Process



FPBO = Fast Pyrolysis Bio-Oil **SPO** = Stabilized Fast Pyrolysis Oil **SDPO** = Stabilized Deoxygenated Pyrolysis Oil **HPO** = Hydrotreated Pyrolysis Oil

FPBO to advanced biofuels



Fuel properties

Parameter	Unit	HPO-Naptha	HPO-Jet	HPO-Marine
Density (T=20 °C)	kg/l	0.74 – 0.78	0.82 – 0.84	0.87 – 0.92
Viscosity (40°C)	cSt	0.6 – 1	1.3 – 1.6	11 – 14
Acid number	mg KOH/g	< 0.02	< 0.02	< 0.05
Carbonyl content	mmol/g	<0.1	<0.1	<0.1
MCRT	wt.%	0	0	0
Flash point	°C	-15 – 0	39 – 47	> 120
ICN	-	-	36 – 42	40 – 58
Net heat of combustion	MJ/kg	42.8 - 44	42.7 – 43.0	42 – 43
	MJ/L	32 - 35	35 - 36	37 – 39

⚠ *Indicative values*

Fuel properties

HPO-Jet: Recent samples comply with the physical-chemical properties defined in ASTM-D4054!

HPO-Jet from BioTheRos feedstocks in progress, expected Q3-2025

HPO-Diesel: possible to comply with road (EN-590) or marine (ISO-8217) standards in high blends (>50%)

HPO-Diesel from BioTheRos feedstocks in progress, expected Q3-2025

Side note: gasification of FPBO

Use of FPBO as gasification feedstock gives similar advantages for the value chain as for the hydrotreatment route:

Decoupling location, scales & times.

Providing a feedstock flexible intermediate.

Allows the use of high-ash residues, which may not work in direct gasification

…However, the overall energy efficiency will be lower compared to direct gasification of biomass.

Side note: gasification of FPBO

Synthesis gas composition virtually independent of the original biomass feedstock:

FPBO derived from Arundo, Eucalyptus, Sorghum, Wood residue & clean pine wood are all gasified in BTG's autothermal catalytic reformer1

Dry syngas on volume basis: 50% H2, 20-25% CO, 25-30% CO2, 1% CH4 [1]

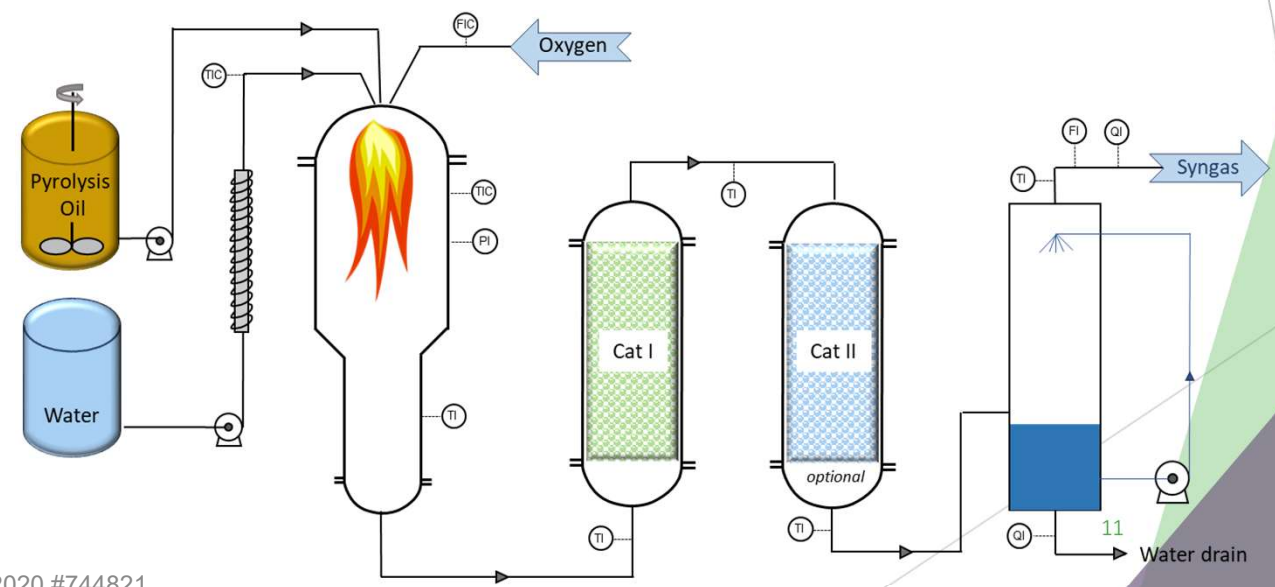
BTG's Autothermal Catalytic Reformer:

5-10 KW capacity

Oxygen blown

Steam 0 - 2 kg/kg FPBO

Tar < 10 mg/Nm3



[1] Results of the BECOOL project, H2020 #744821

Summary

Fast Pyrolysis Bio-Oil (FPBO) can be upgraded to Hydrotreated Pyrolysis Oil (HPO).

HPO is fractionated into Naptha, Sustainable Aviation Fuel (SAF) and Renewable Marine Diesel.

In the BioTheRos project the value chain will be demonstrated using forestry residues and Barley straw as feedstock for the ‘pyrolysis value chain’.

Project Partners

CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

circe

btg
biomass technology group

BEST
Bioenergy and Sustainable Technologies

MOTOR OIL

WIP RENEWABLE ENERGIES

Thank you!

Contact:

Evert Leijenhorst
BTG
leijenhorst@btgworld.com