

# Advanced Bio Fuels from Pyrolysis Oil

TC Biomass, Denver  
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# Advanced Bio Fuels from Pyrolysis Oil

1. BTG Bioliquids short introduction
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# Company introduction

- As a technology provider and product leader we are committed to the commercial deployment of our fast pyrolysis technology.
- Explicitly made from biomass residues which is known as second generation (2G) or advanced biofuel which means that it does not compete with the food chain.



# Our company history & milestones



1987

BTG starts as a spin-off from the University of Twente



2008

BTG Bioliquids is established by BTG



2015

Start up of Empyro in the Netherlands



2016

Cooperation agreement with TechnipEnergies

Starting BTG Bioliquids webshop



2020

Start up of GFN plant in Finland



2021

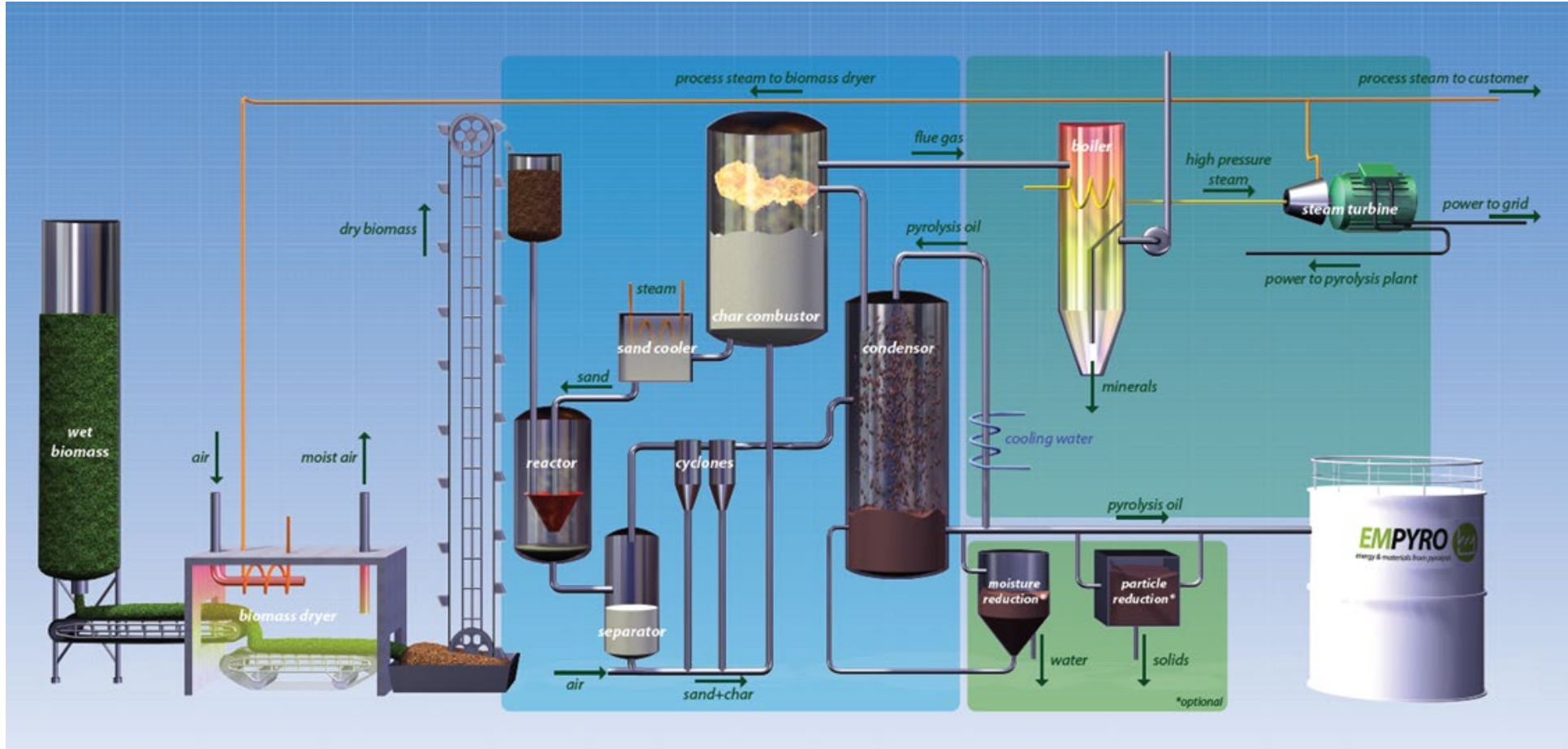
Start up of Pyrocell plant in Sweden



# Fast pyrolysis technology

- Thermochemical decomposition of biomass residues through rapid heating (450-600 °C) in absence of oxygen.
- Different types of biomass residues can be converted into homogeneous energy carrier: Fast Pyrolysis Bio Oil (FPBO).
- By products are heat (steam) and power (electricity)

# Our process from biomass to FPBO



# Empyro The Netherlands

In 24/7 operation since 2015

First commercial FPBO plant in the world at Twence/Empyro in the Netherlands, in 24/7 operation since 2015. Empyro is sold to Twence at the beginning of 2019.

- Biomass feedstock – wood residue
- Biomass input – 36.000 ton/year
- FPBO output – 24.000 ton/year
- Steam output – 80.000 ton/year
- Electricity output – 2.200 MWh/year



Front view of Empyro plant including bulk silo

# Empyro and more



GFN, Lieksa  
Finland - 2020

**December 2020**  
Start commercial  
production !



Empyro Twence, Hengelo  
The Netherlands - 2015

**March 2015**  
Start commercial  
production !



Pyrocell Setra, Gävle  
Sweden - 2021

**September 2021**  
Start commercial  
production !



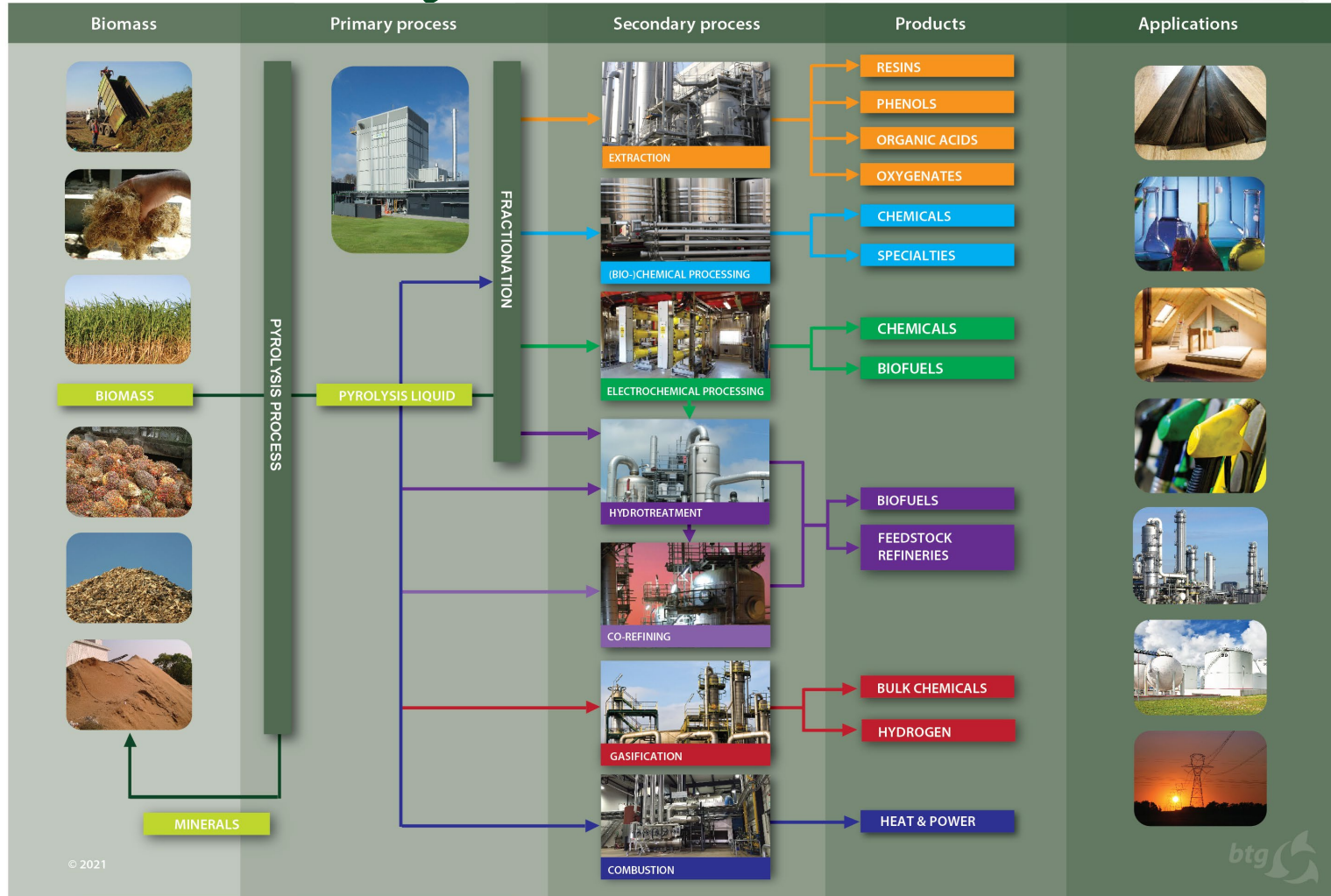
# Pyrocell (Sweden) from sawdust to tank

- Joint Venture of Setra and Preem
- FPBO from sawdust – **started up in September 2021**
- Turn-key EPC delivery by TechnipEnergies
- FPBO production: 24,000 tonnes/year
- GHG reduction of 80 -90%
- Preem Lysekil refinery will co -process FPBO to produce advanced biofuels and have co-fed more than 2000 tons until now, blending rate 1 -3 %.
- In compliance with EU REDII-Annex 9

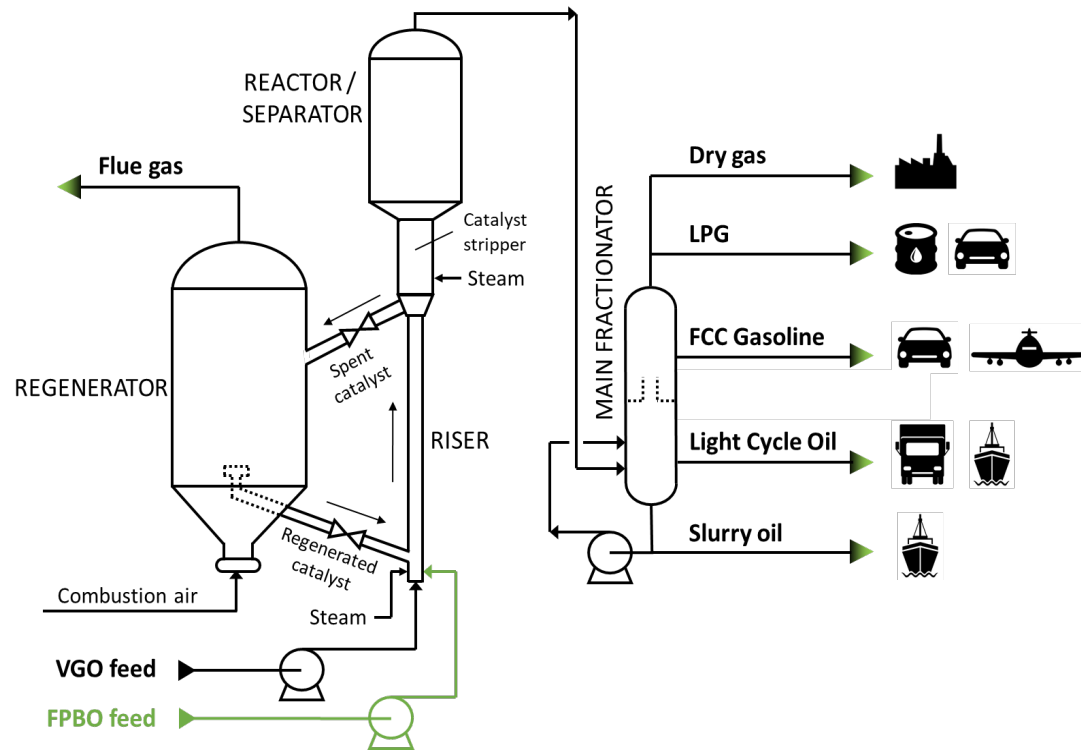


Picture rights by Pyrocell, Sweden

# Bio-liquids refinery



# Co-FCC of FPBO how does it work?

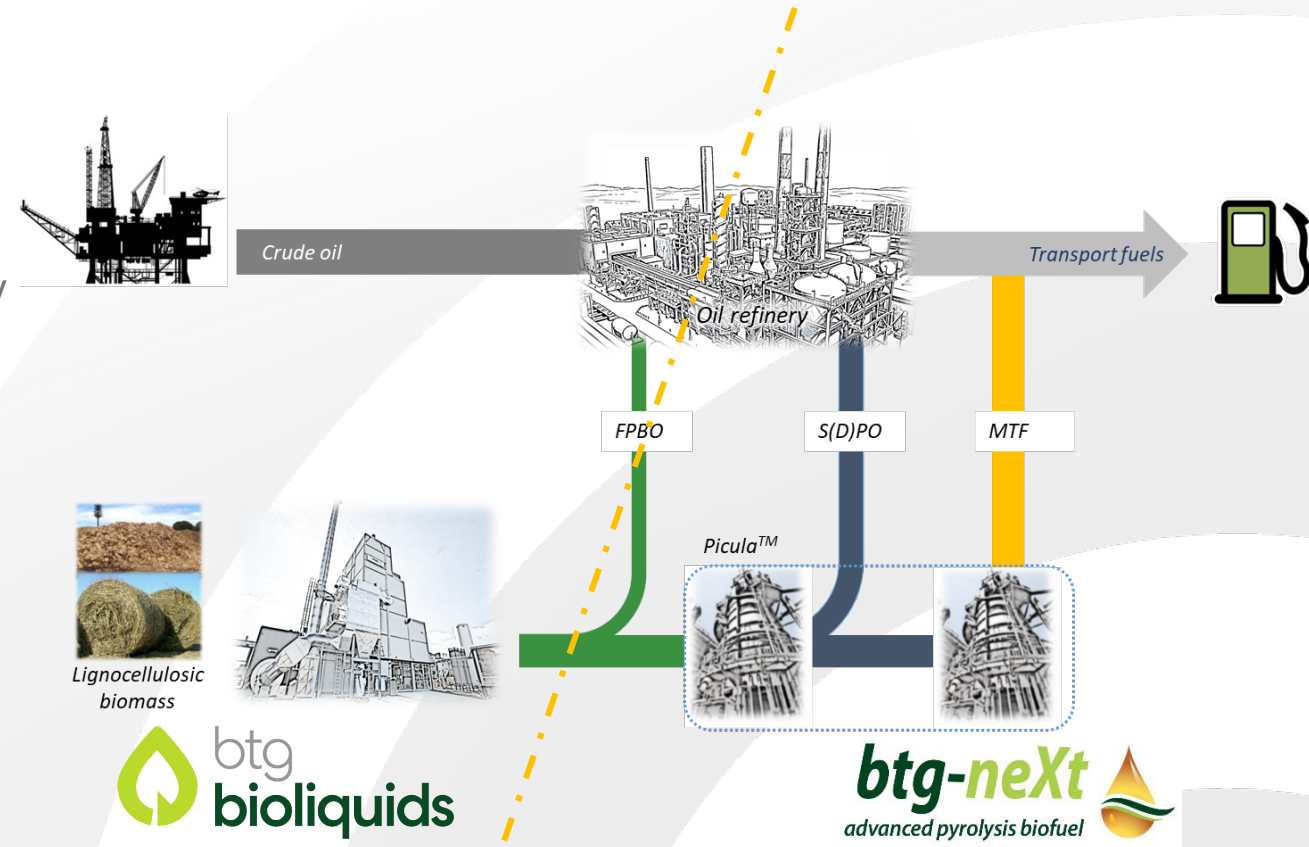


Indicative co-FCC scheme

- FPBO fed by separate injection line & nozzles
- Biomolecules cracked together with regular feed
- Acidity disappears upon contact with hot catalyst
- Green content distributed across the products
- Commercial FCC operability proven for 5 % FPBO
- Pilot scale operability proven for 10 % FPBO

# BTG neXt options to produce a drop-in fuel

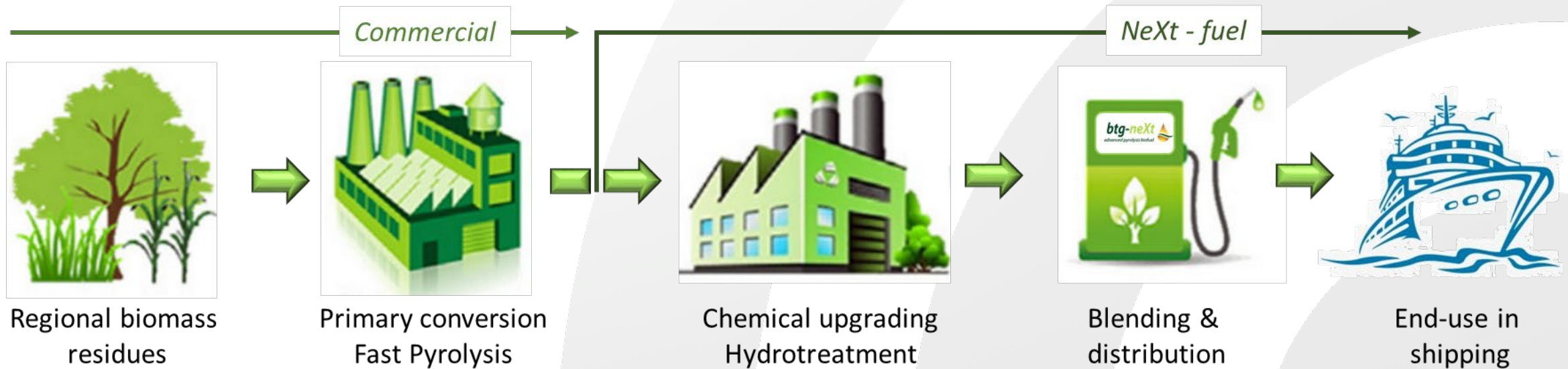
1. Co-feed of FPBO with VGO in existing FCC unit
  - 🔥 Extensive testing by Petrobras
  - 🔥 Several successful tests in the US and Europe on commercial units with several hundreds of tons of pyrolysis oil.
  - 🔥 Successful test runs by UOP-Preem on refinery (2021)
  - 🔥 Demonstrated with more than 2000 tons full -scale by Preem with co -feeding rate between 1 and 3 % (2022)
  - 🔥 Max co -feed around 5 -10 wt %
2. Co-feed of SPO with VGO in existing FCC unit
  - 🔥 Lab- and pilot testing
  - 🔥 Higher co -feed ratio's possible (20 -30 wt %)
  - 🔥 Less impact on product slate compared to crude FPBO
3. Stand-alone upgrading of FPBO to drop -in (HPO)
  - 🔥 Lab- and pilot testing
  - 🔥 Multi -step hydrotreating process
  - 🔥 Product (HPO) is fully miscible with fossil fuels



FPBO= Fast Pyrolysis Bio-Oil  
 S(D)PO= Stabilized (Deoxygenated) Pyrolysis Oil  
 HPO = Hydroprocessed Pyrolysis Oil

# BTG neXt summary

- 🔥 Fast pyrolysis bio-oil commercial production plants are realized in Europe (the Netherlands, Sweden and Finland);
- 🔥 Fast pyrolysis bio-oil can be upgraded to an advanced drop-in, liquid biofuel;
- 🔥 The upgrading process is based on 2-step hydrotreating process; the 1st step needs a dedicated catalyst;
- 🔥 Initial target market is the shipping sector; in particular blending the biofuel with marine distillate fuels;
- 🔥 BTG-neXt ambition is to demonstrate the FPBO upgrading on a pre-commercial scale of a few barrels/day by 2023.



# Bio4 Products



**BIO4  
PRODUCTS**  
Creating sustainable resources  
for process industry

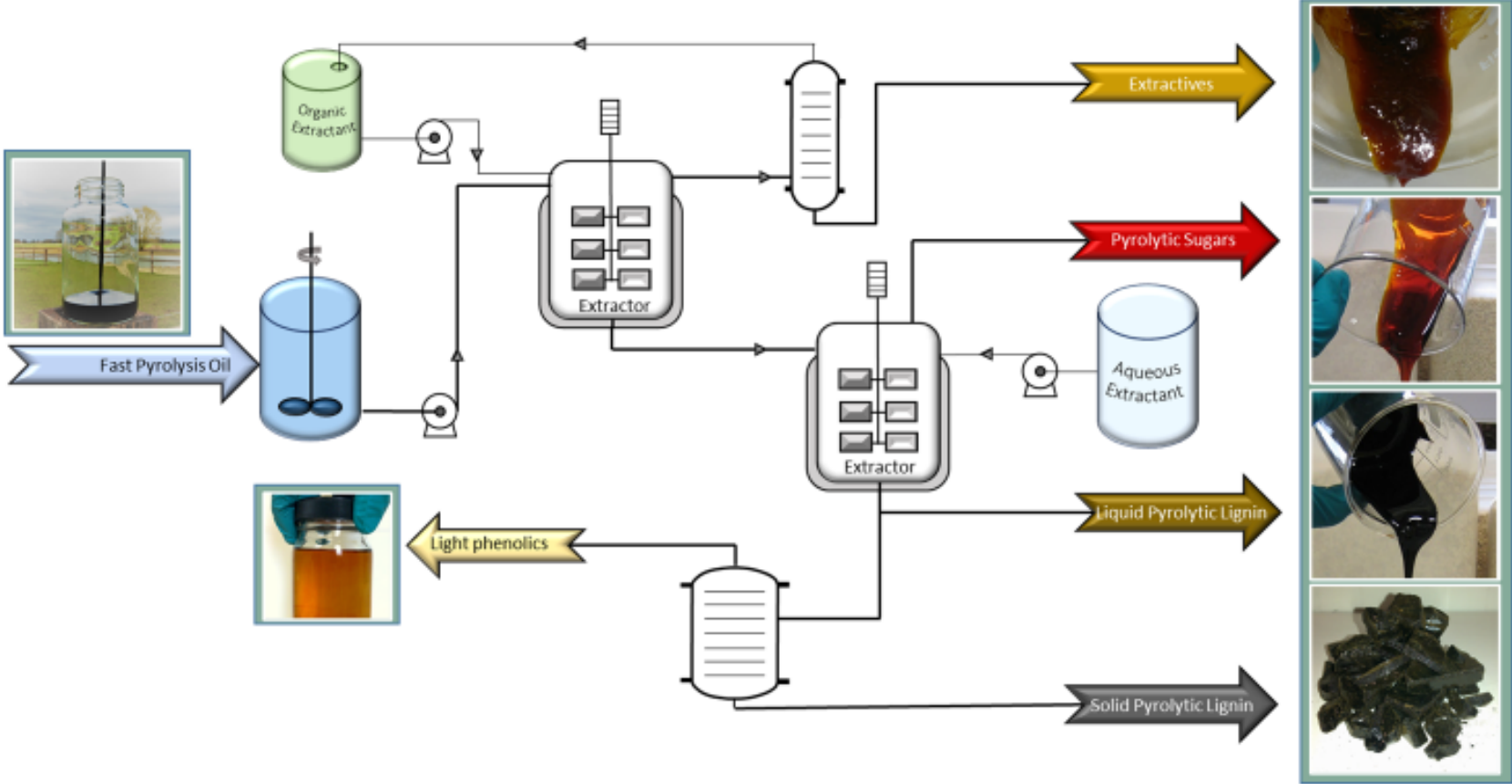
- Demo-plant for FPBO fractionation is operational
- Based on liquid-liquid extraction of the whole oil
- Products are: pyrolytic lignin, pyrolytic sugars (& pyrolytic extractives)
- Proven capacity ~120 kg/h FPBO feed
  
- REACH registration filed for P.lignin and p.sugars (1-10 t/h)

#### CAS numbers

Pyrolytic sugars:	2414605-13-1
Pyrolytic lignin:	2411004-28-7
Solid Pyrolytic Lignin:	2411004-20-9



# Bio4 Products - Fractionation





# Summary & Conclusions

- Fast Pyrolysis Bio-Oil production reached commercial maturity
- Advanced biofuels from FPBO co-processing has high potential
  - Low CAPEX, Short time-to-market, Fast GHG emissions reduction
- Feasibility of FPBO co-processing in FCC is proven up to 5 wt-%
  - Demonstrated at commercial scale, favourable gasoline yield
  - Exact yields depend on unit, feedstock and process conditions
- Other refinery pathways of FPBO at various stages of maturity
  - Hydrotreating, Hydrocracking, Gasification (Fischer-Tropsch)
- FPBO bio-based chemical applications at various stages of maturity
  - Wood preservation, paint, resins, foam, ...





BTG Bioliquids

we replace fossil  
fuels