Biomass-To-Liquid technologies: status of recent developments & challenges

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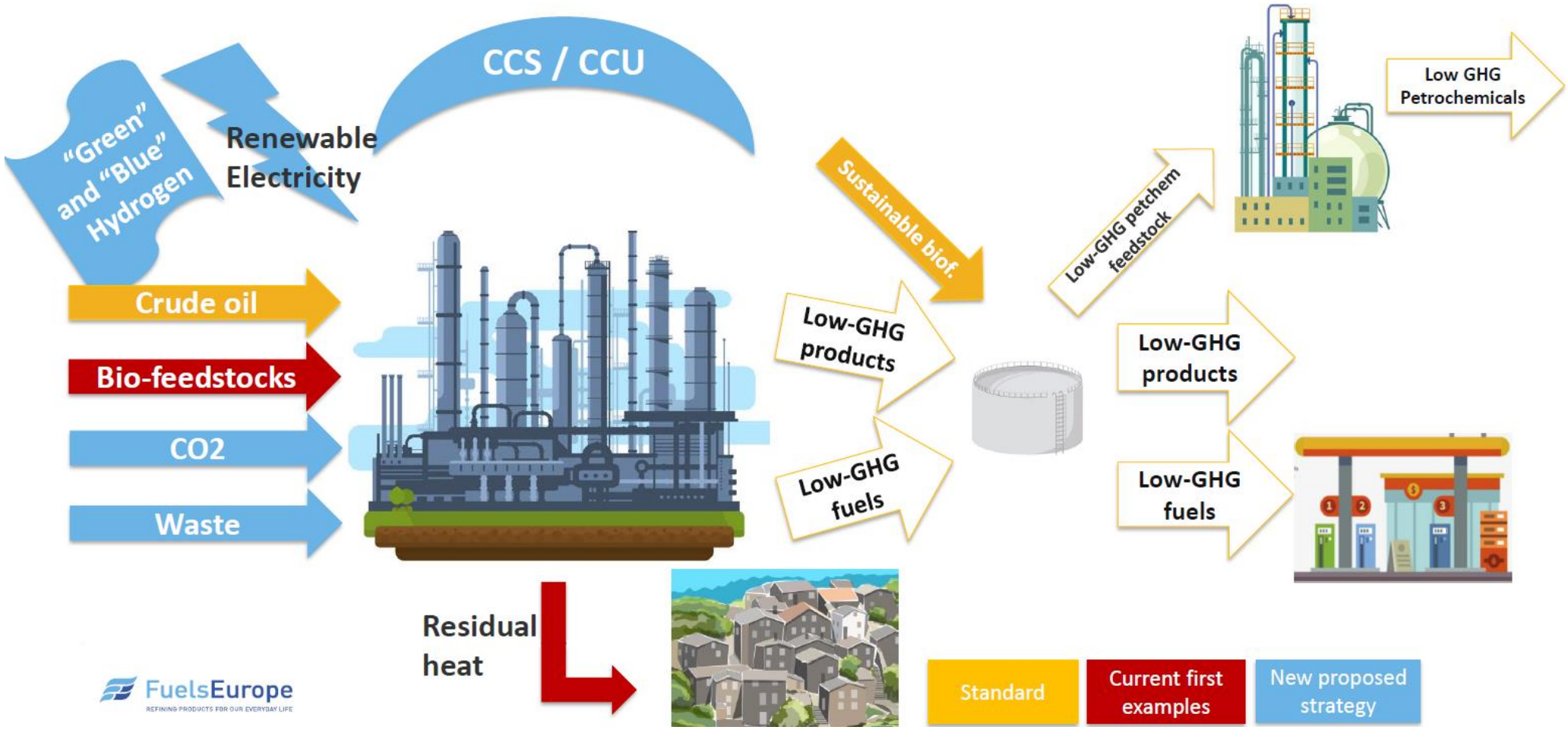
ORLEN Unipetrol

Fuels production vision 2050



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Biofuels production

Ambition:

- ✓ RED II (III) compliance;
- ✓ Reduction of carbon footprint related to automotive, marine and aviation fuels utilization;

Focus:

- ❑ Forest and agriculture residuum, municipal waste;

Key challenges:

- ➢ Waste biogenic feedstock provision → effective collection, storage, analysis, pretreatment;
- ➢ Technology maturity → TRL level, feedstock flexibility, feed quality sensitivity, yield of desired products, energy and hydrogen consumption, undesired product/waste utilization;
- ➢ Co-processing vs stand alone installation;
- ➢ Blending potential with existing fuels → RON, CI, stability, oxygen content;

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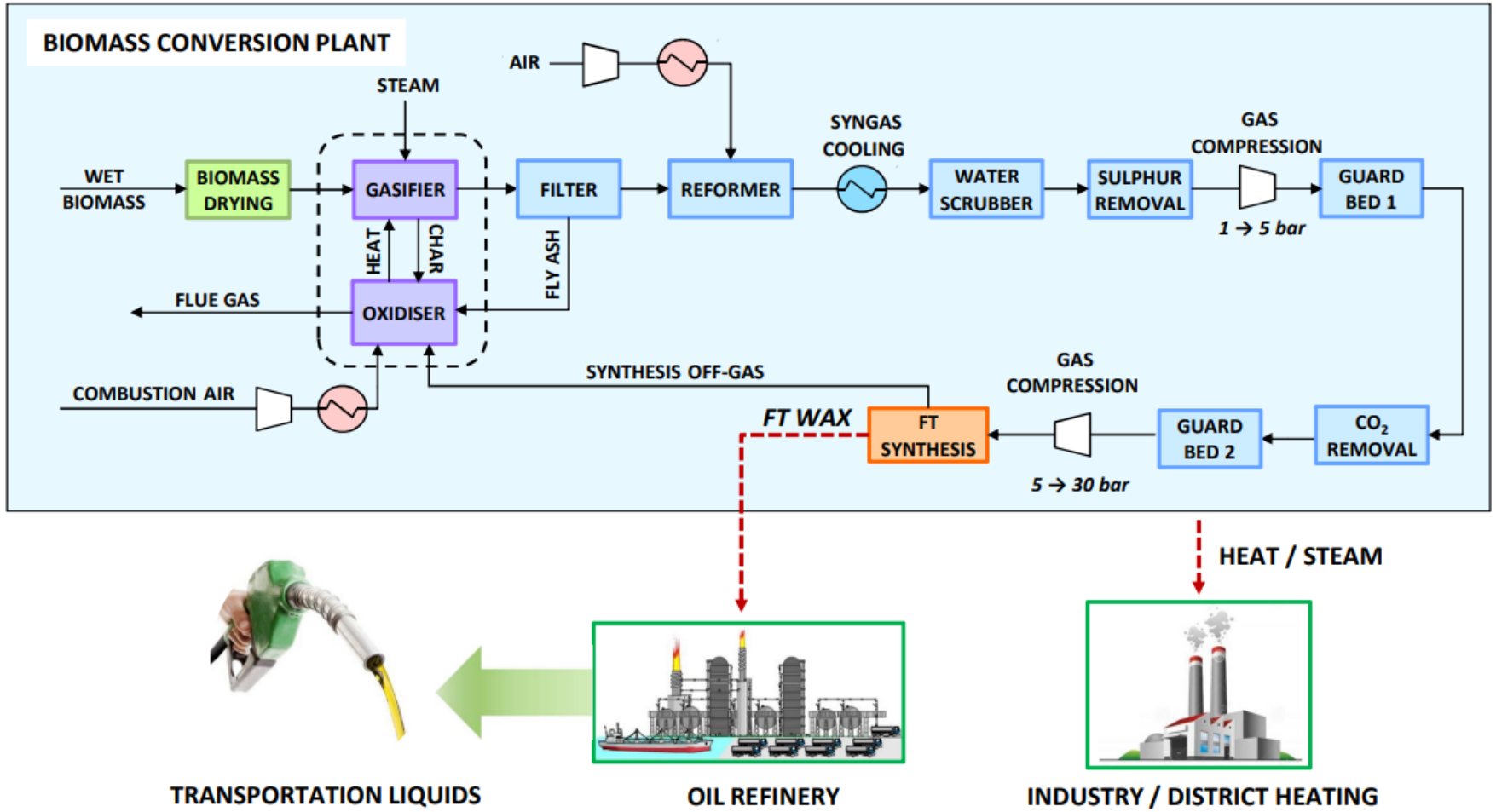
COMSYN process concept

Main Targets :

- Concept: decentralized primary conversion of biomass in 30 – 150 MW units.
- Target: reduction of biofuel production cost up to 35% compared to alternative routes → production cost for diesel lower than 0.80 €/l.
- GHG savings: 80 %
- Overall efficiency to FT biocrude + heat: 80%



FT products characteristaion

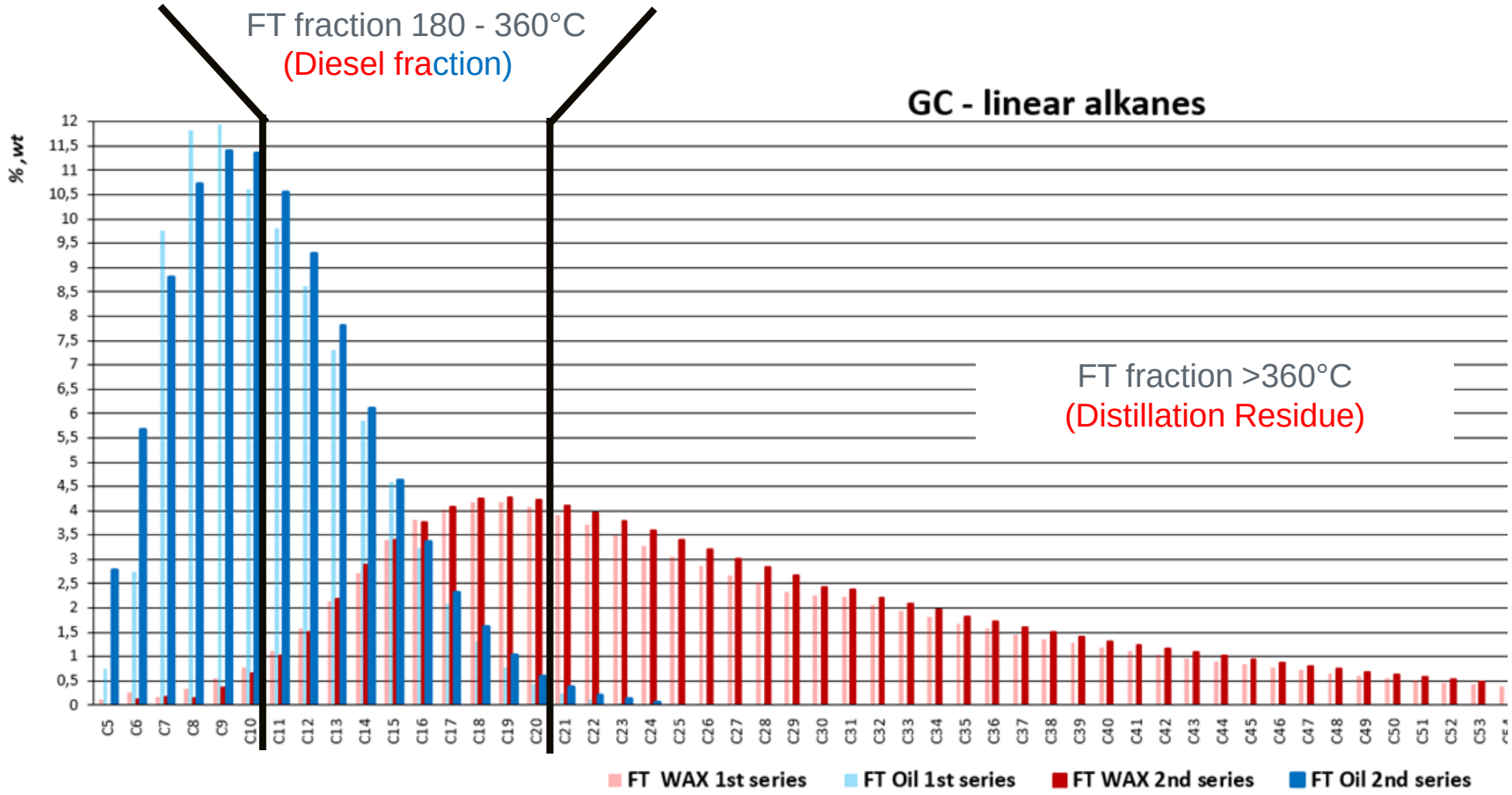
GAS CHROMATRORAPHY

- FT Liquid product - Oil

FT fraction 36-180°C
(Gasoline fraction)

- FT Wax

FT fraction 180 - 360°C
(Diesel fraction)



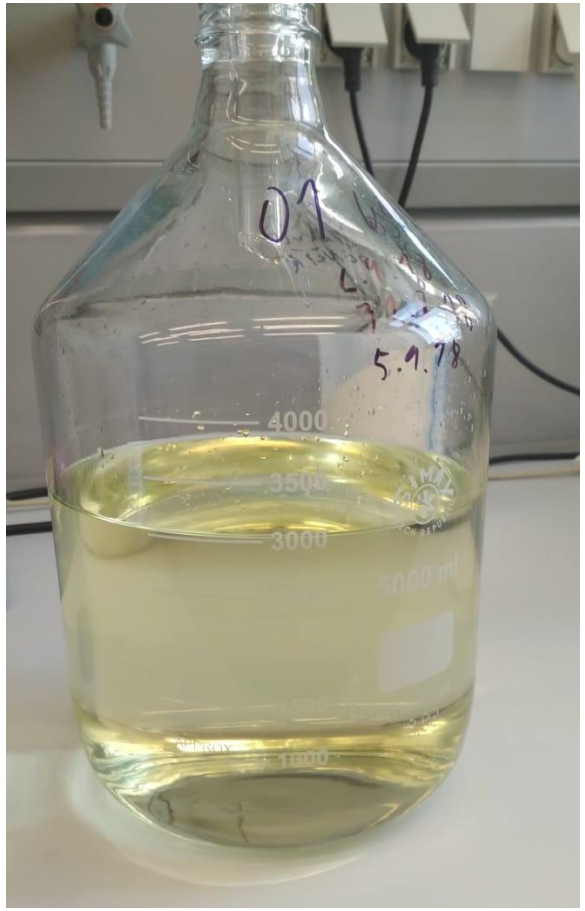
FT fraction >360°C
(Distillation Residue)

COMPARISON OF FT DIESEL FRACTION TO EN 590 AND EN 15940

		Diesel EN 590		Paraff. diesel EN 15940		FT diesel	
Parameter	unit	min.	max.	min.	max.	1st S.	2nd S.
Density at 15 °C	$kg.m^{-3}$	820	845	765	800	774.6	769.2
Kinematic viscosity at 40°C	$mm^2.s^{-1}$	2	4.5	2	4.5	2.3	2.1
Flash point	°C	>55	-	>55	-	93	84
CFPP, mild climate (grade A-F)*	°C	5	-20	5	-20	-6	-8
Cloud point	°C					-1.5	-1.7
Cetane index	-	46	-	65	-	86.7	82.8
Water content	$mg.kg^{-1}$	-	200	-	200	93.6	87.4
Sulphur content	$mg.kg^{-1}$	-	10	-	5	0.72	0.68

* 15.04. – 30.9. grade B (CFPP max. 0 °C)
01.10. – 15.11. grade D (CFPP max. -10°C)
16.11. – 28.02. grade F (CFPP max. -20 °C)
01.03. – 14.04. grade D (CFPP max. -10°C)

Hydroisomerisation step needed



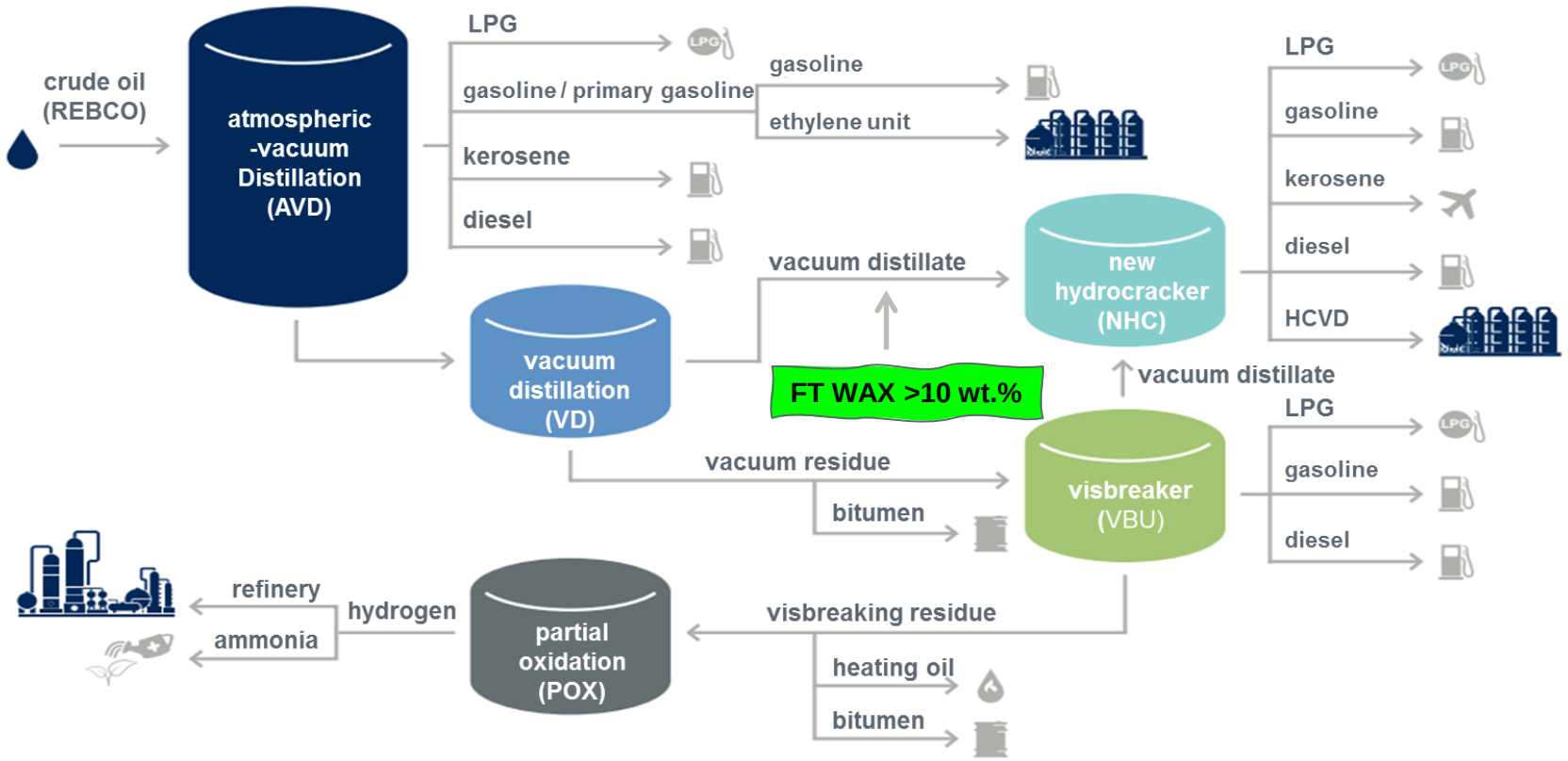
Sample of FT diesel

Simulation processing in existing refinery (CR)

80% reduction in the GHG emissions was reached for studied case

Obtained Production cost for biofuel is 1.10 EUR/l

The Break-even price of FT Biofuels after refining upgrade is at 1.7 EUR/kg



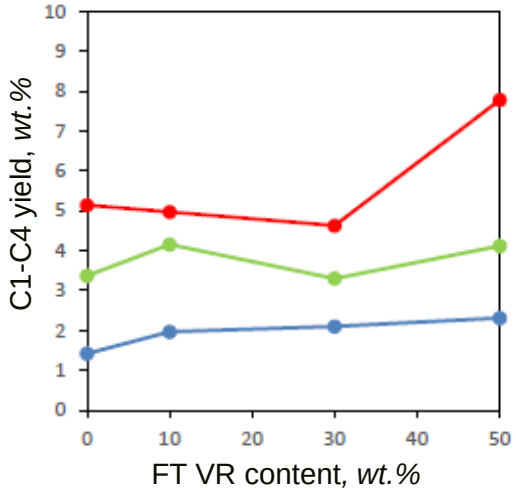
BENEFIT	84 wt. % of FT Oil+Wax is converted to motor fuels.
No benefit CURRENTLY	14 wt. % of FT Oil+Wax is converted to Steam cracker feedstock. 2.6 wt. % of FT Oil+Wax converted to fuel gas

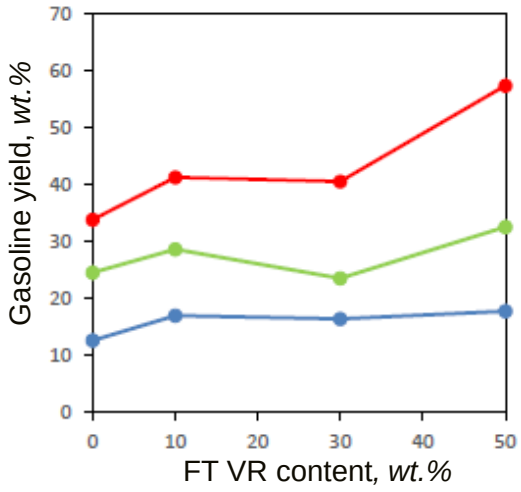
RESULTS OF HYDROCRACKING EXPERIMENTS

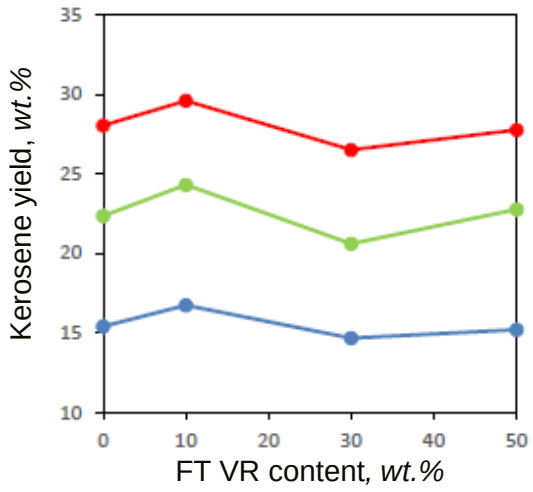
Hydrocracking of FT VR in co-processing with VD

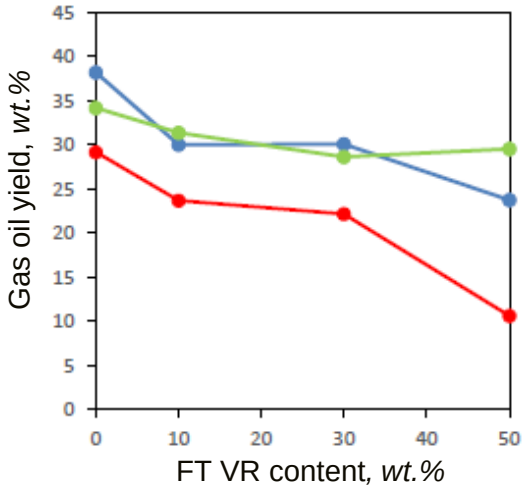
Addition of FT Vacuum Residue (FT VR) 0, 10, 20, 30, 50 and 100 wt.% in the Vacuum Distillate (VD) feedstock

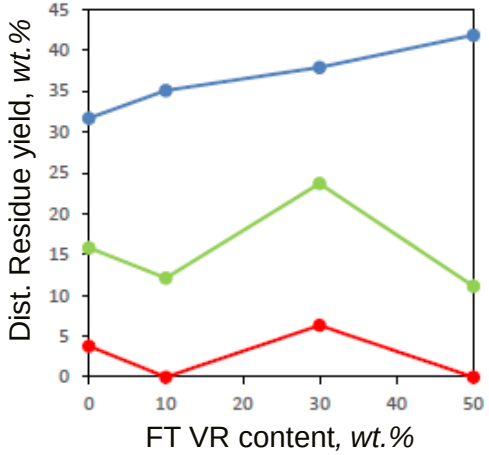
Hydrocracking experiments were performed at conditions: pressure of 16 MPa and reaction temp.: 390, 400 and 410 °C



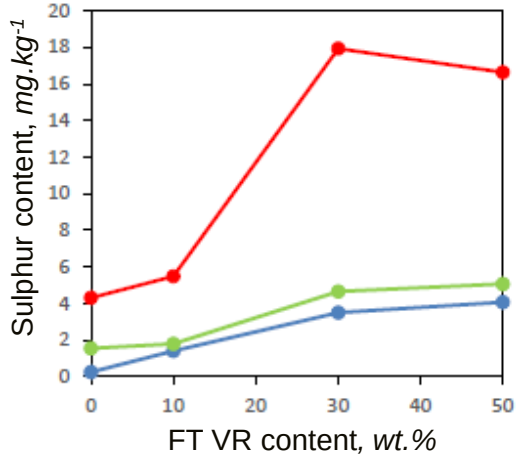








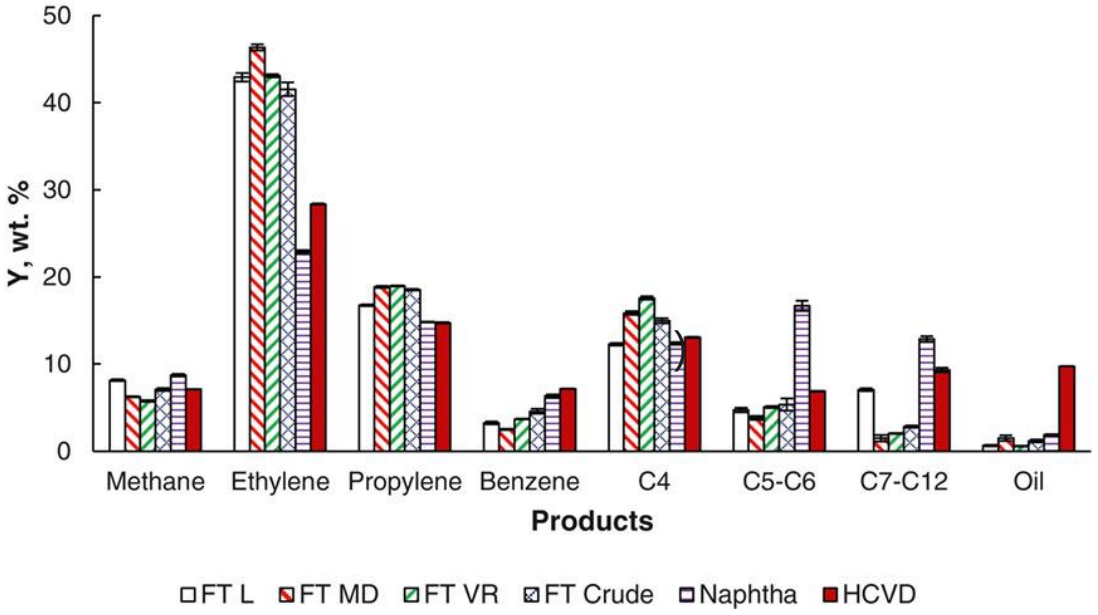
Gasoline yield C5 –150 °C
Kerosene yield 150–230 °C
Gas oil yield 230–360 °C
Dist. residue > 360 °C



RESULTS OF STEAM CRACKING EXPERIMENTS

Main pyrolysis products of pure feedstocks

Pyrolysis conditions: 815 °C, 65 NmL min^{-1}, 400 kPa



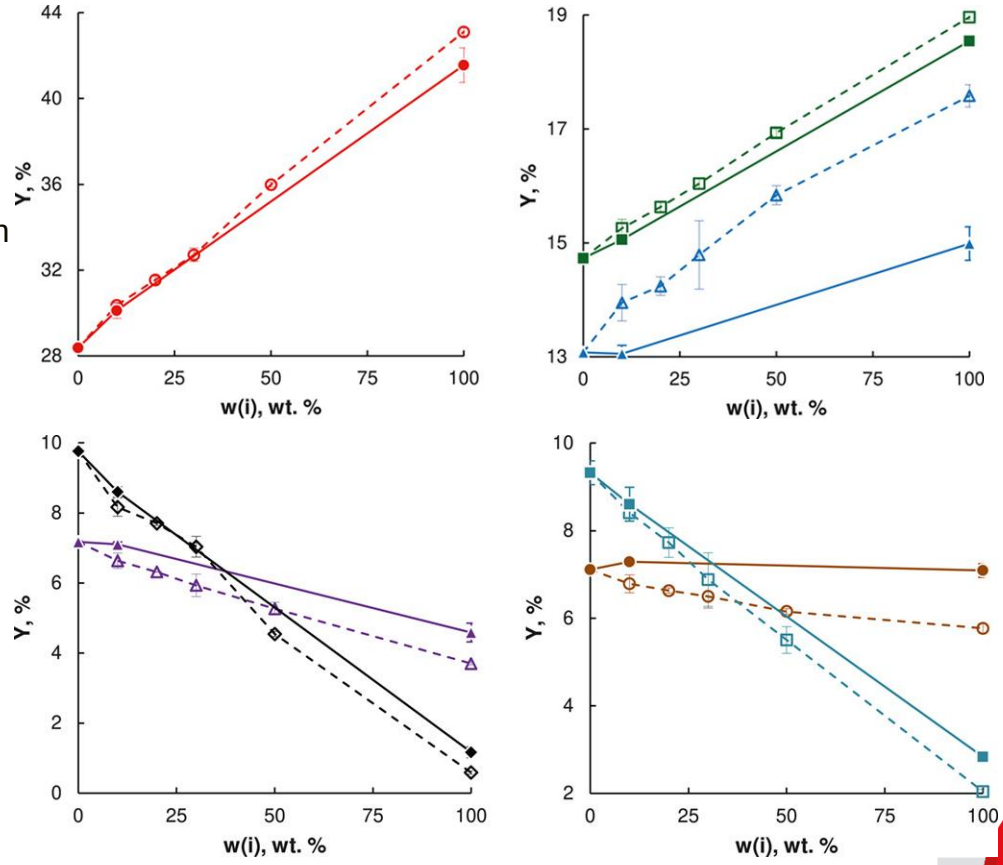
FT L – FT lights
FT MD – middle distillate
FT VR – vacuum residue
FT Cr – crude (Wax)
HCVD – hydrocracked vacuum distillate

Pyrolysis products of co-processing

Addition of FT Cr (▲ ♦ ● ■) and FT VR (Δ◊○□) of 0, 10, 20, 30, 50 and 100 wt.% in the HCVD feedstock

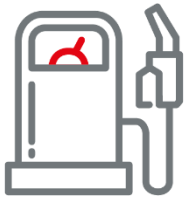
○• ethylene
□▪ propylene
Δ▲ C4 fraction

Δ▲ benzene
◊♦ oil
○• methane
□▪ C7–C12



CONCLUSIONS

- Reduction of crude oil consumption.
- Double counting of CO_2 emissions via processing of Waste Renewable Materials.



- COMSYN technology and its products are valuable source of potential feed for already existing refinery.
- The addition of FT products to fossil feeds will not impair the quality of the offered fuels.

- Addition of FT products showed a positive influence on the conversion of the fraction boiling above 400 °C to lighter fractions consequently causing higher production of basic plastics (already with recycled biomaterial).

- Processing and co-processing of waste materials in the existing refineries will help to preserve an employment in regions currently dependent on crude oil refining.

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Thank You for Your attention