Refinery co-processing alternatives towards Biofuels

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Approved by the Consortium

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 818120.

EU funded Projects research in Co-Processing

Gasification and Pyrolysis routes for Biofuels production

FAST CARD

REPSOL, eni, GRACE (Talent | Technology | Trust), btg (biomass technology group), JM Johnson Matthey (Inspiring science, enhancing life), SAINT-GOBAIN, PDC, SINTEF, ECN (Your energy. Our passion.), cnrs, NTNU, GHENT UNIVERSITY, BIC SB RAS, University of Stuttgart Germany

Pyrolysis and HTL of Lignocellulose feedstock toward co-processing in Refinery

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REPSOL, MOL, btg (biomass technology group), E4tech, SINTEF, cr, VTT, AALBORG UNIVERSITY DENMARK

Pyrolysis and HTL of Municipal Waste as feedstock toward co-processing in Refinery

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OMV, EGE Energigjenvinningsetaten, btg-btl (biomass-to-liquid), btg (biomass technology group), CRF, PDC, SINTEF, cea, cnrs, VTT, TU WIEN

Integration to existing Refineries

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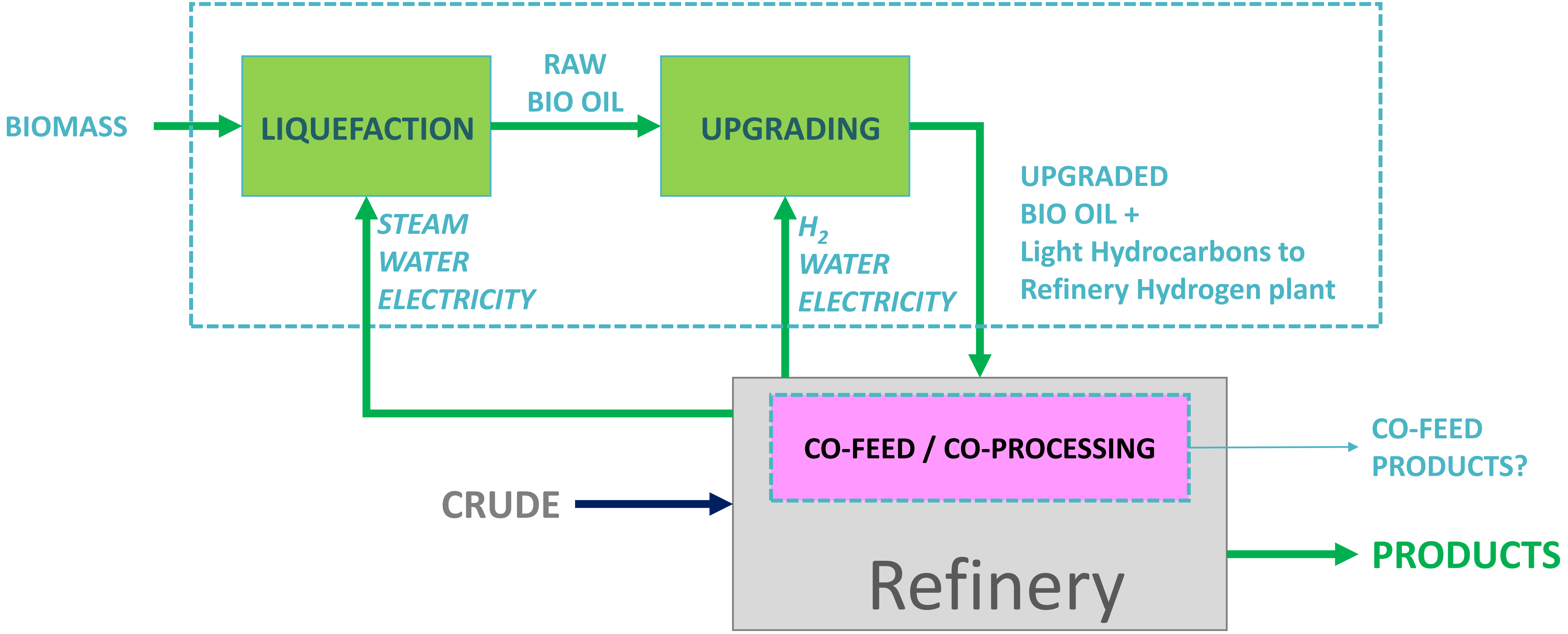
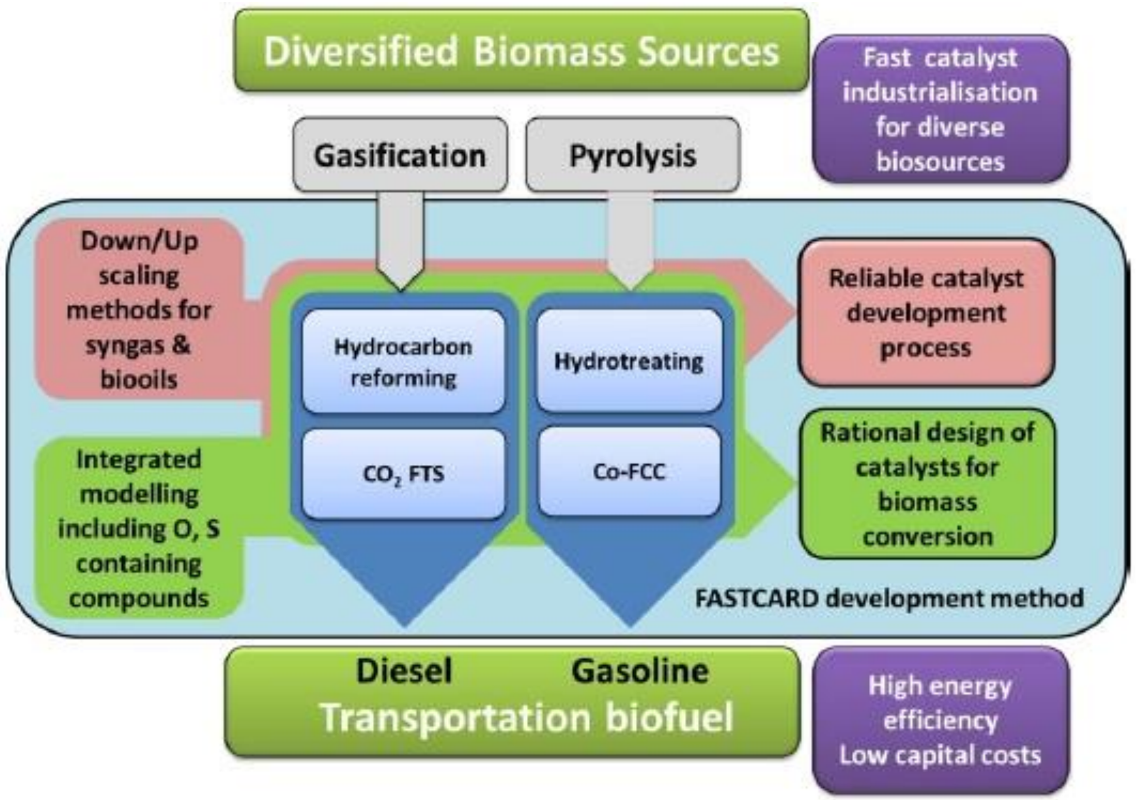
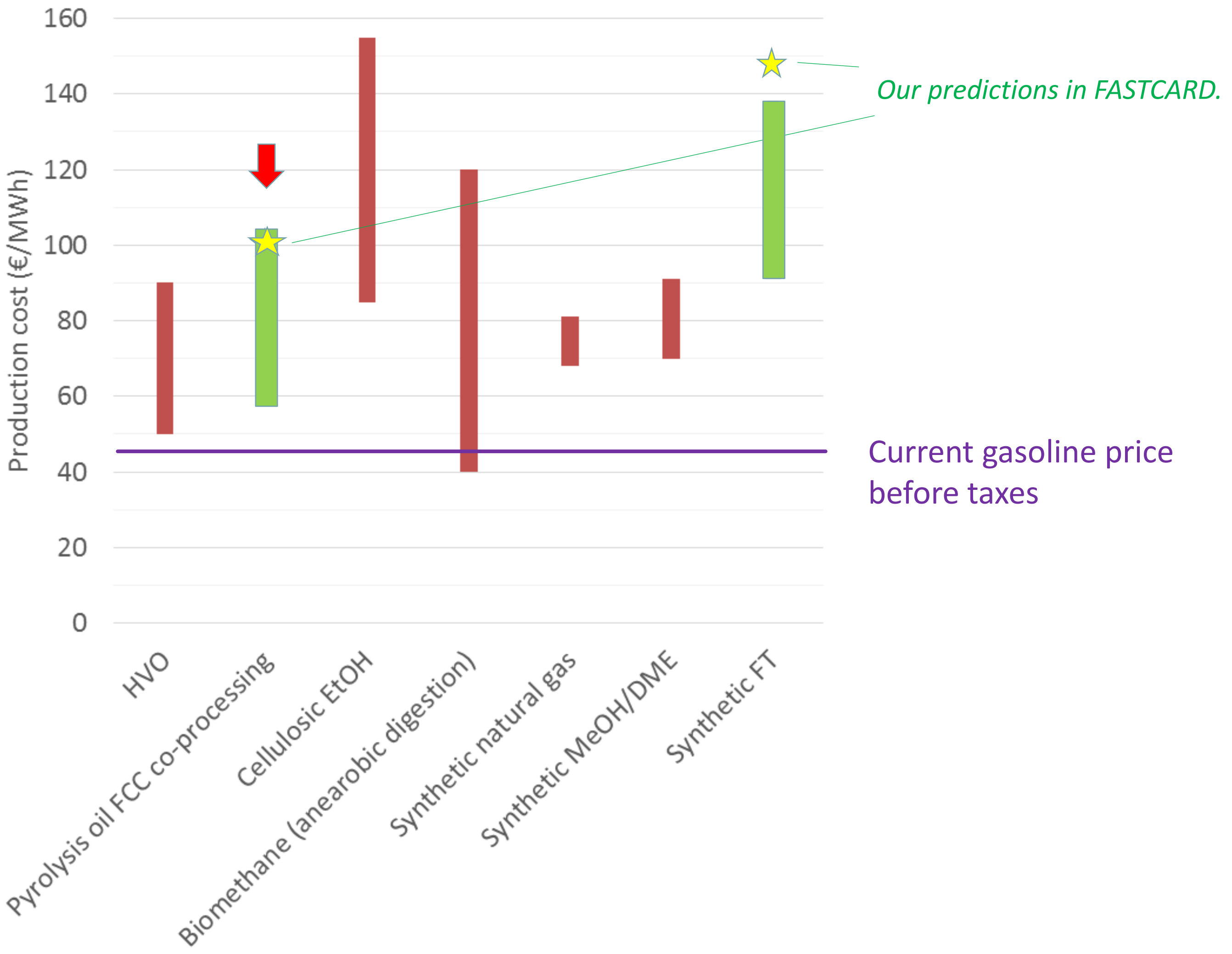


The FASTCARD concept:

- Two independent catalyst-based pathways for conversion of biomass to advanced
  - LIQUID route (short term): Hydrotreating of pyrolysis oil → co-processing in FCC
  - GAS route (long term): Hydrocarbon reforming → Fischer Tropsch synthesis



Biobased motor fuel: a helicopter view



EC Sustainable Transport Forum: Sub Group on Advanced Biofuels. Final Report, 2017.

Alternative routes of bio-liquids in refinery

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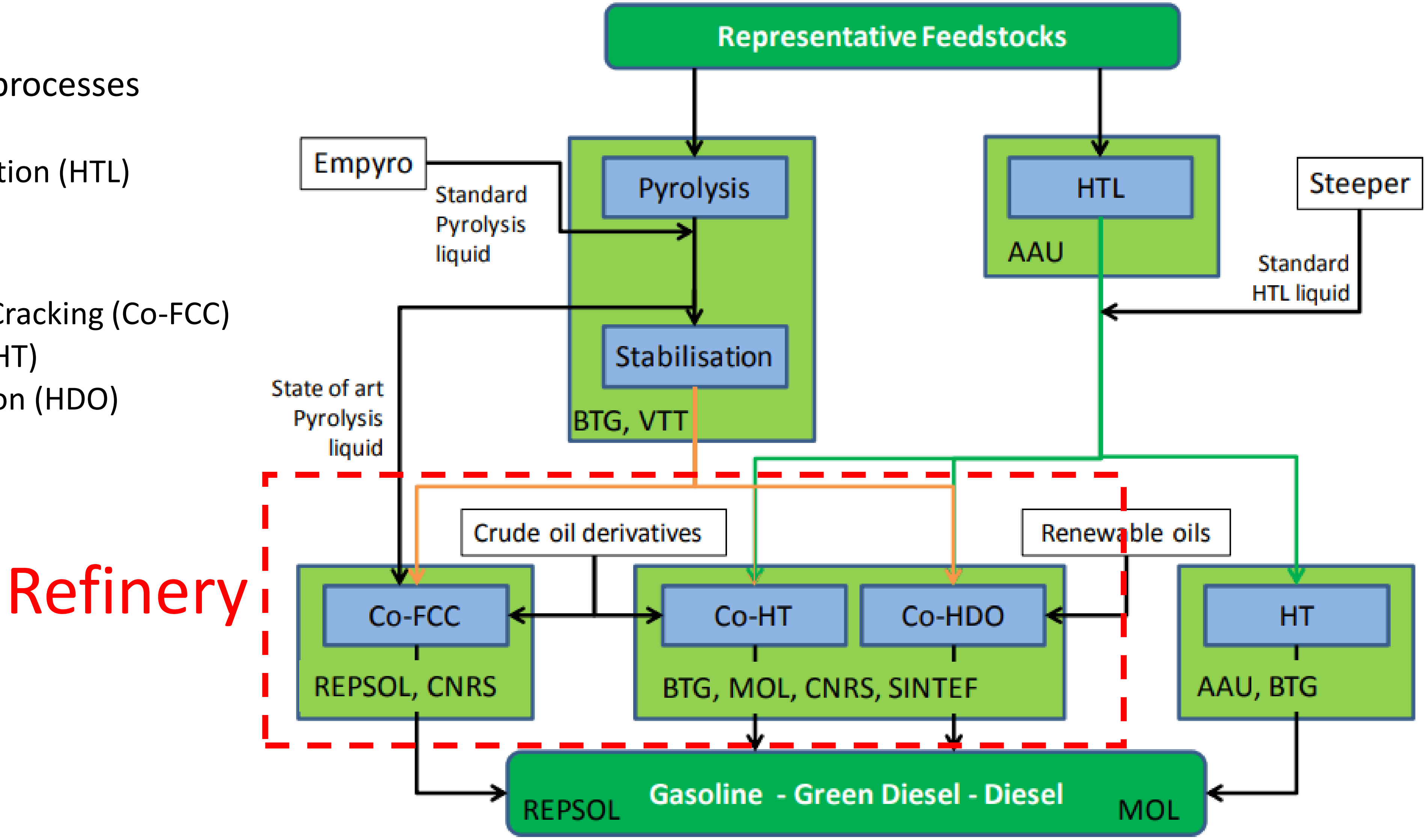
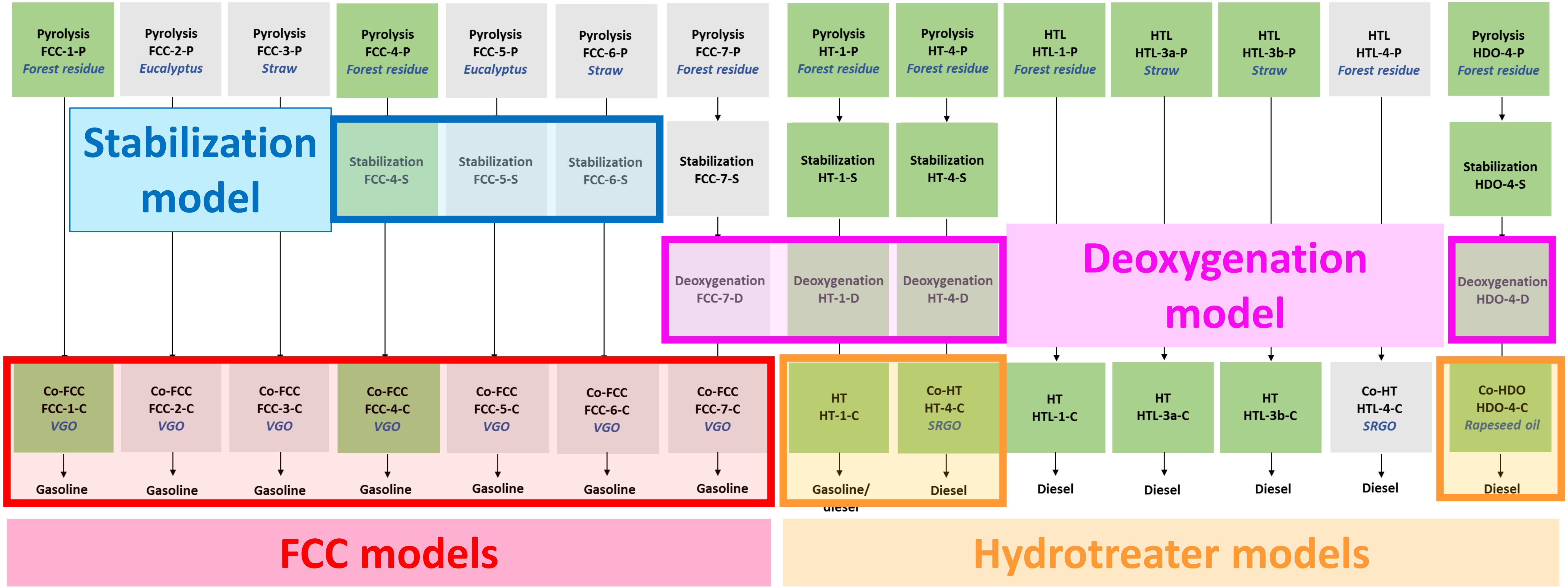
- Two primary conversion processes
  - Pyrolysis
  - HydroThermal Liquifaction (HTL)
- Four refining processes
  - Co-Fluidized Catalytic Cracking (Co-FCC)
  - Co-HydroTreating (Co-HT)
  - Co-HydroDeOxygenation (HDO)
  - HydroTreating (HT)
- Final products
  - Gasoline
  - Diesel
  - LPG



Techno-Economic Evaluation building MODELS for range of alternatives for Refinery integration



Feedstock/Location: Final selection of value chains

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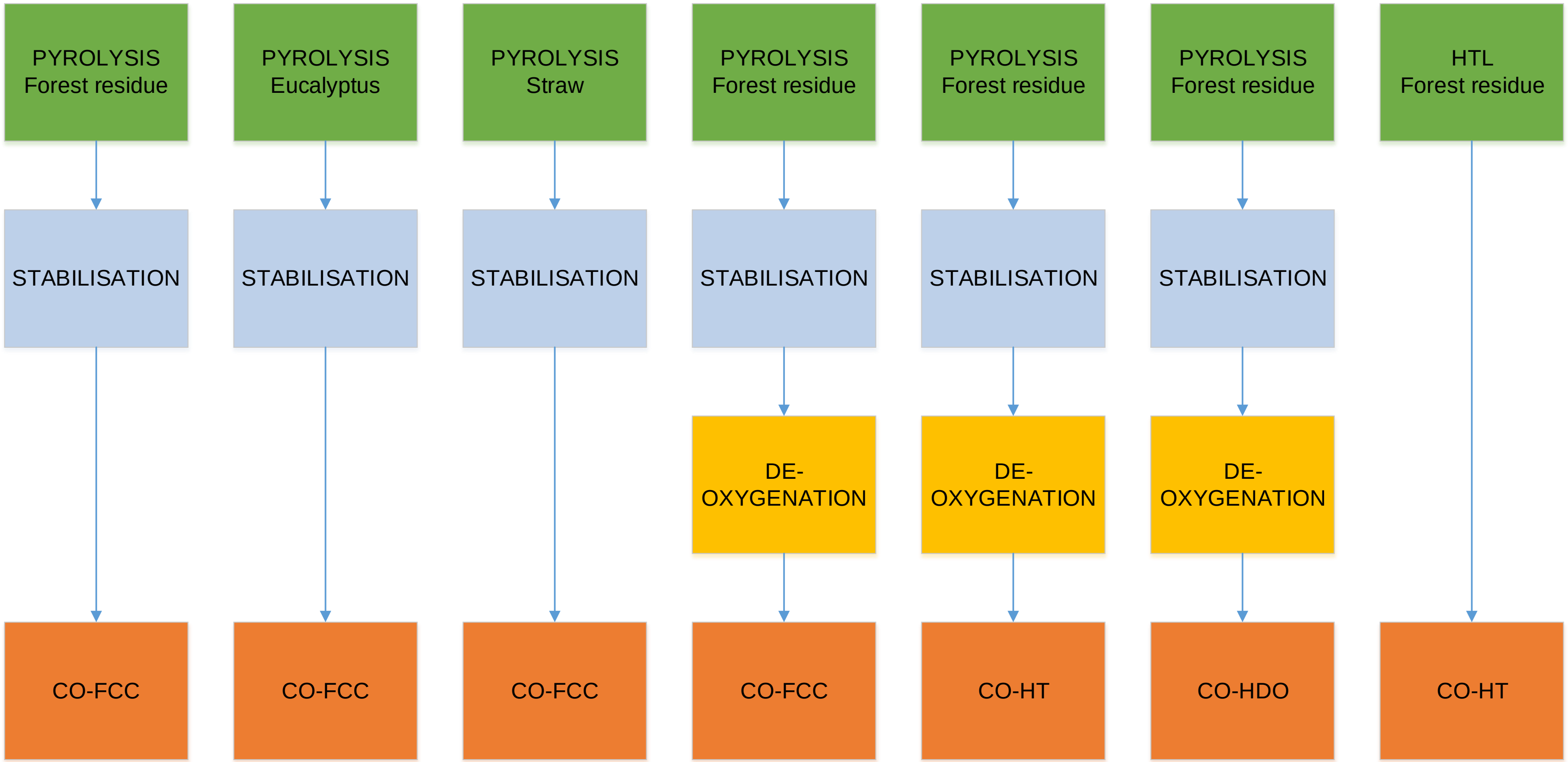
- **Forest residue:**
  - Northern Europe
  - Baltics
- **Eucalyptus:**
  - Southwestern Europe (Spain)
- **Straw:**
  - Central Europe
  - Denmark



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Scenario analysis:
Ranking of Technical and Economic feasibility

Treatment	Post-treatment	Final refining	Raw material	Location	Technical feasibility	Economic feasibility
Pyrolysis	Stabilisation	co-FCC	Forest residue	Baltics	++	+++
			Forest residue	Northern Europe	++	++
			Eucalyptus	Spain	+	++
			Straw	Central Europe	---	+++
			Straw	Denmark	---	+
	Stabilsation Deoxigenation	co-FCC	Forest residue	Baltics	+++	--
		co-FCC	Forest residue	Northern Europe	+++	---
		co-HT	Forest residue	Baltics	-	-
		co-HT	Forest residue	Northern Europe	-	--
		co-HDO	Forest residue	Baltics	+++	--
		co-HDO	Forest residue	Northern Europe	+++	---
HTL	-	HT	Forest residue	-	---	not defined

Focus of Business Case scenarios

Business Case	Raw Material	De-centralised Pre-processing	Refinery Processing		Product
FCC-1	Forest Residue	**Fast Pyrolysis** N plant(s)		**FCC**	Gasoline
HTL-1	Forest Residue		**HTL** 1 plant	**HT**	Diesel
HT-1	Forest Residue	**Fast Pyrolysis** N plant(s)	**UPGR** 1 plant	**HT**	Diesel

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Overall Conclusions

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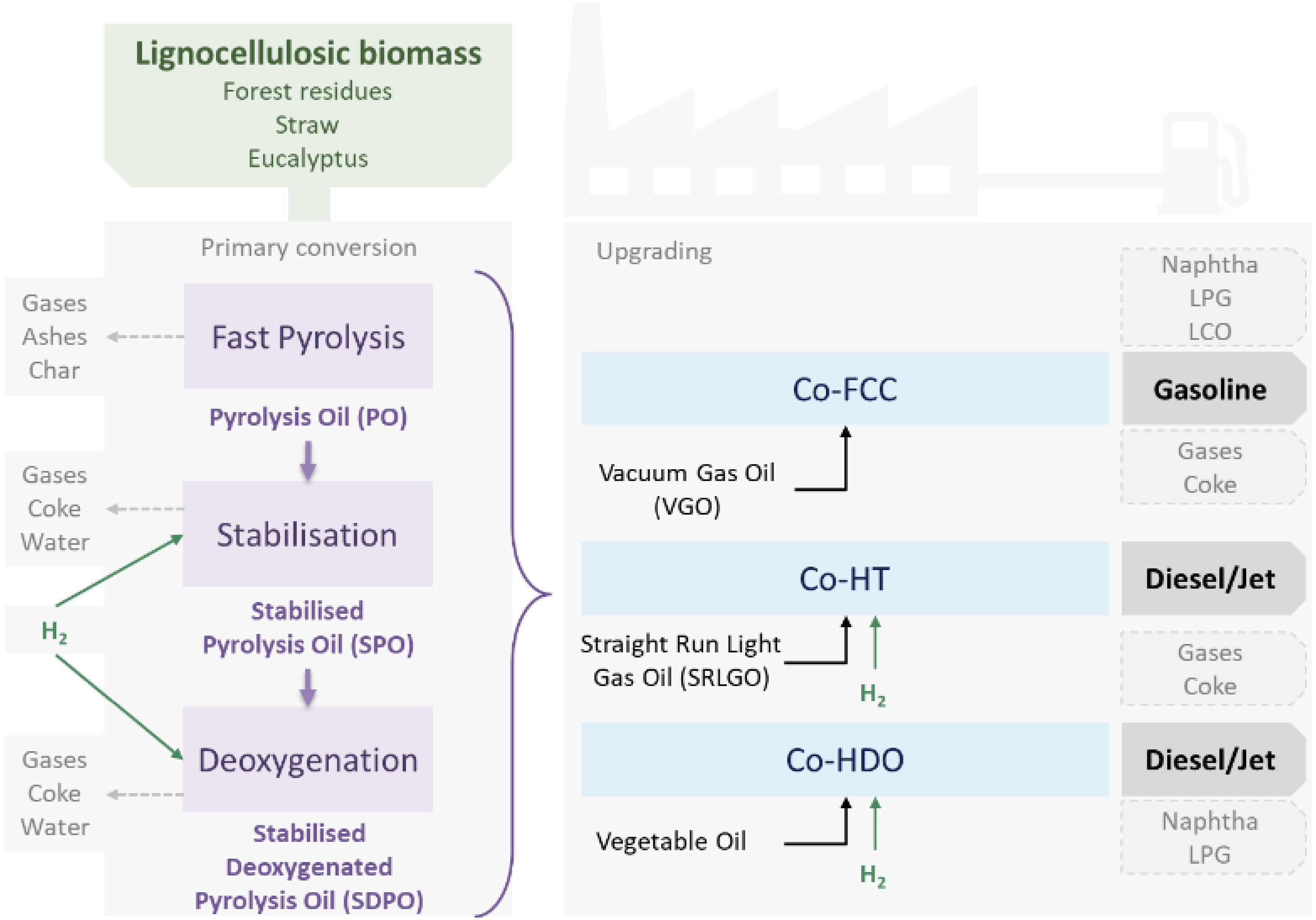
- There is significant potential to make use of existing EU refineries
- HTL less mature than FP – Still technical challenges to be tackled in the near-future
- Co-HT less mature than co-FCC - but there are significant mid-to-long-term opportunities for co-HT
    - The aviation and shipping industries present a longer-term market for co-processed fuels



Supply chain & market assessment – **Feedstock**

CONTENT

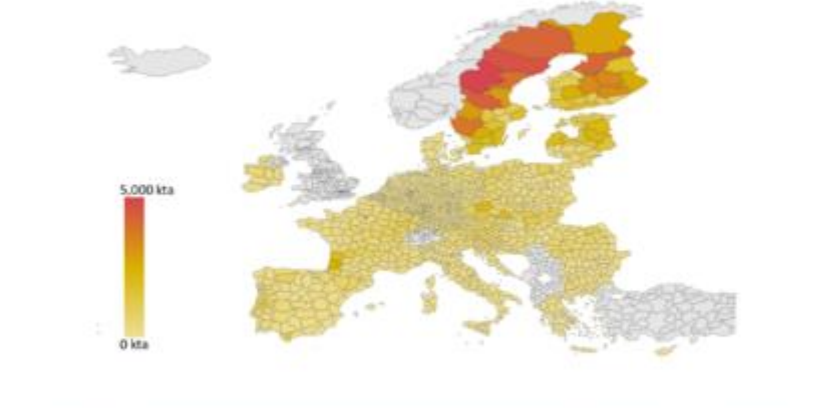
- Supply chain structure
- Supply chain security
- Supply chain costs

OBJECTIVES

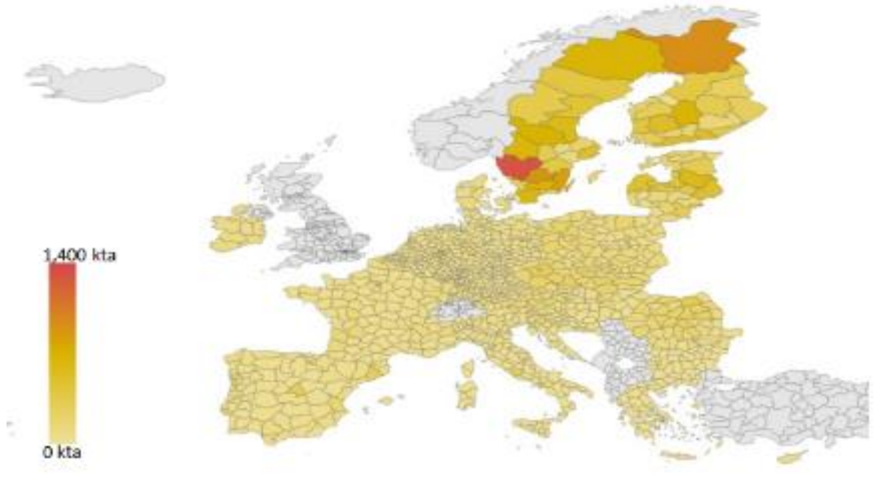
- Estimate feedstock costs and sensitivities
- Define supply chain logistics (to identify potential suppliers/partners, and infrastructure requirements)

OUTCOME

- Biomass supply chains are relatively immature at present - vary by feedstock and region.
- Common challenges:
  - The large amounts of biomass needed lead to expensive transportation costs.
  - Introducing variability (source location) into the process complicates supply chain logistics and affects the quality and yield of the conversion process
  - Local assessment of feedstock availability needs to be performed on case by case basis to determine true level of feedstock availability



Sustainable technical potential of harvesting residues in the EU in 2030 (dry mass)



Sustainable technical potential of wood processing residues in the EU in 2030 (dry mass)

WASTE2ROAD value chain

Feedstock supply	Primary conversion	Upgrading	Validation
Oslo, L&T, Twence, suez	btg, VTT, btg-btl biomass-to-liquid, cea	OMV, cnrs, TU WIEN, SINTEF	CRF CENTRO RICERCHE FIAT
			
Municipal waste	Fast Pyrolysis/HTL	co-HT & co-FCC	Engine & vehicle tests

Process modelling, value chain integration, risk asessment, TEA & LCC PDC Process Design Center

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Waste sorting in the City of Oslo

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Waste materials – screening bio-conversion tests to pick the best candidates for biofuel value chains

Contaminated wood (Twence/L&T)

Pre-treatment reject from food waste (REG)

Black liquor (IPN Grenoble)

Sunflower seed husk (ALK trading)

Roadside grass[1] (Twence)

Digestate from biogas reactors (REG)

Food waste from canteens

Organic fraction of MSW (SUEZ)

1. Brown, A.E., et al., *An assessment of road-verge grass as a feedstock for farm-fed anaerobic digestion plants.* Biomass and Bioenergy, 2020. **138**: p. 105570.

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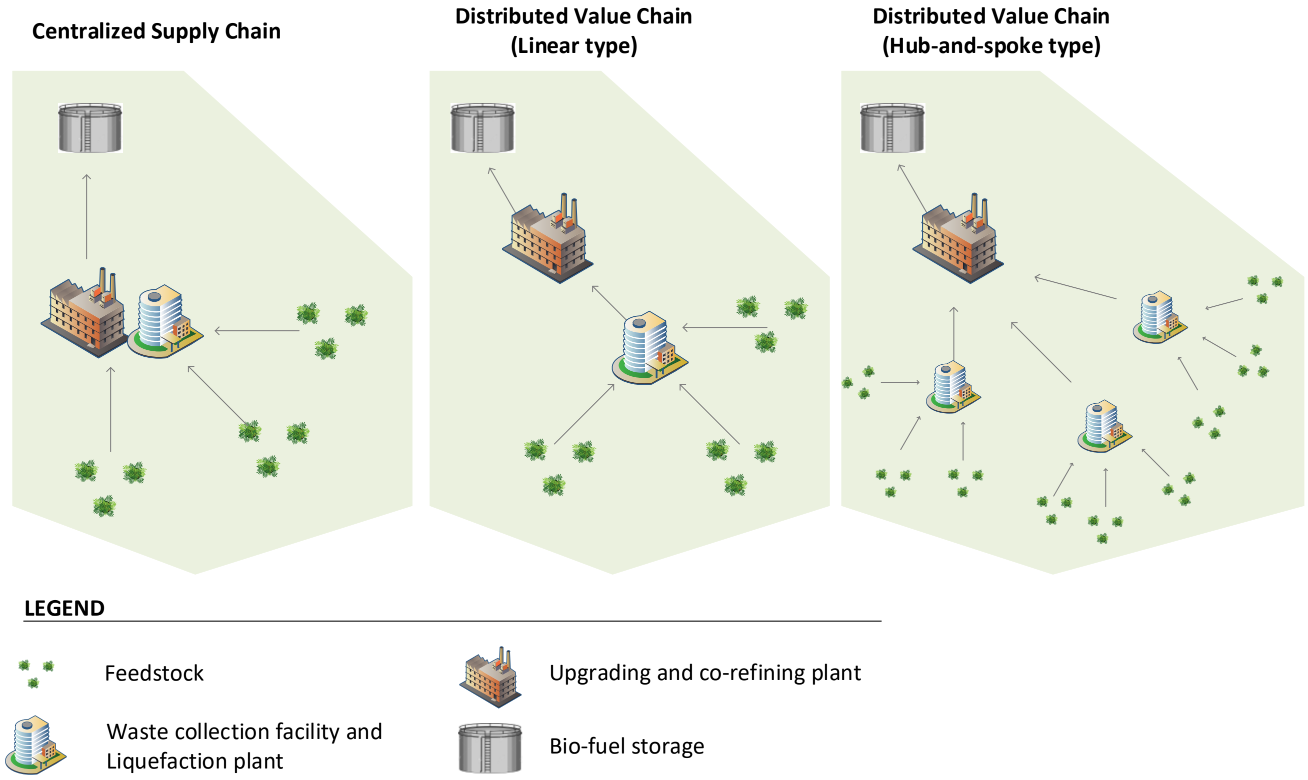
Aspects of value chain integration and optimization

- Siting of the value chain (feedstock availability and existing infrastructure)
- Logistics (centralized or distributed value chain, transport distances and storage)



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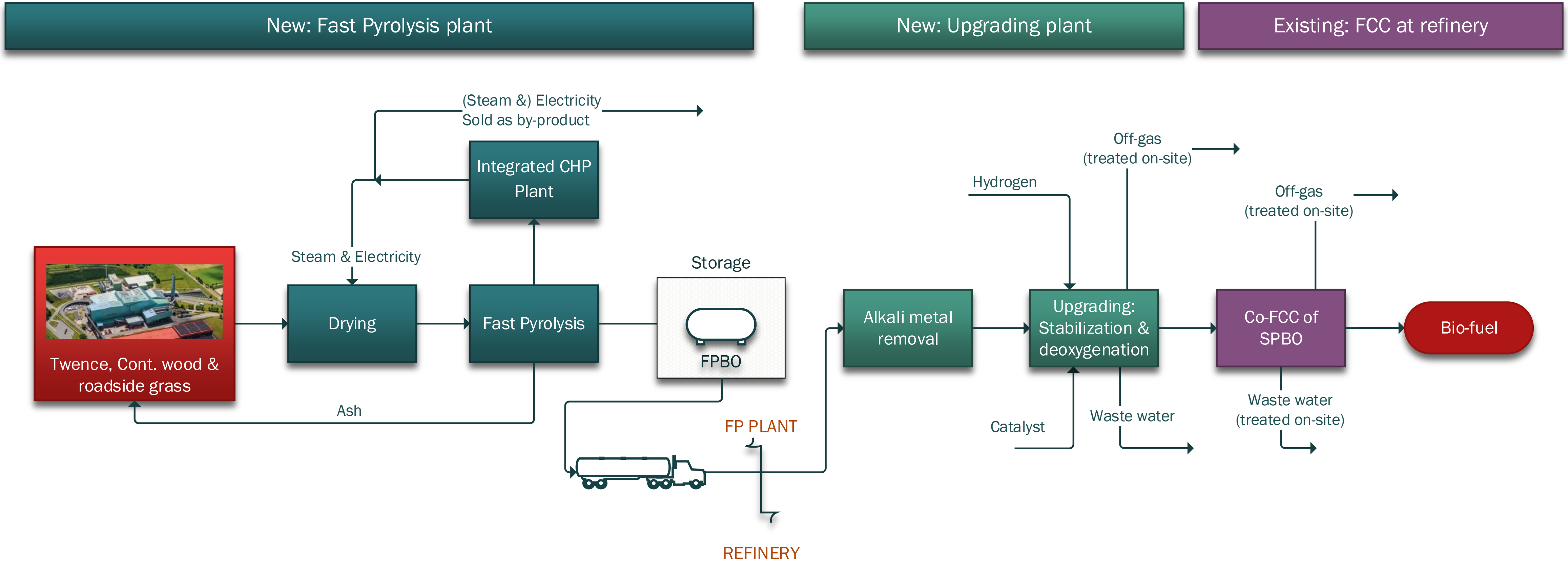
Example of a block flow diagram for one complete value chain showing the process streams and processing steps



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Main Results…so far

- Conversion of a number of different types of residues and waste
- Production of sufficient amounts of bio-liquids for development of viable value chains via FP and HTL
- Suitable gasoline blending components can be produced by FCC co-processing of 5% and 10% SPO/SDPO from clean wood (reference)

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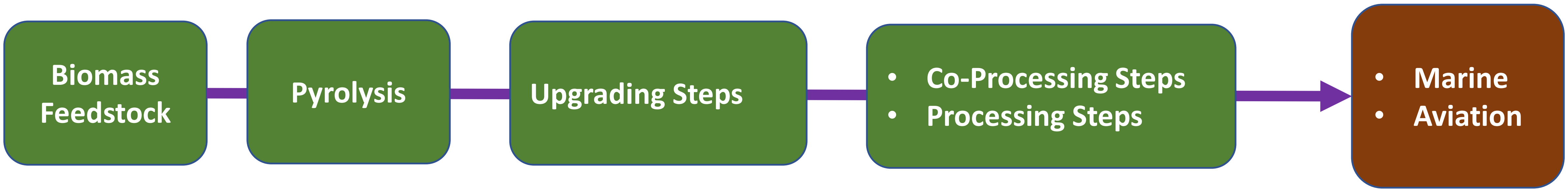
Extension of the Value chain being developed



Thank you for your attention!

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