Global policy market scenario relevant for HTL in the energy transition

Sylvain Verdier, Haldor Topsoe A/S

Workshop “Hydrothermal Liquefaction (HTL) in the green energy transition”, January 28 2021

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Take-home message

Global policy market scenario relevant for HTL in the energy transition

Legislation

In place in EU and UK

And potentially specific legislation expected in North America

PetChem industry

Will implement thermochemical technologies for plastic-to-plastic strategy

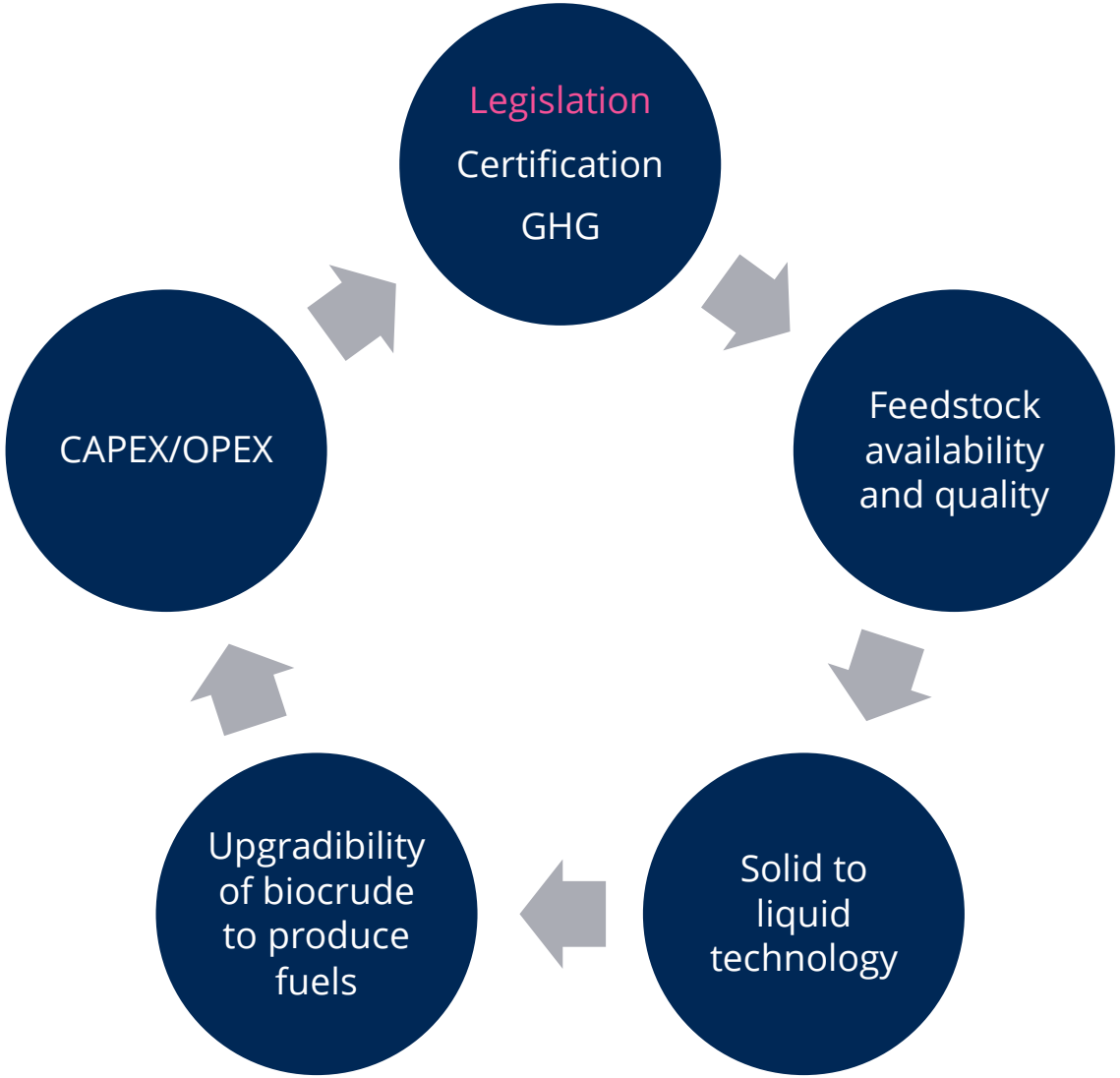
Aviation and marine fuels

Role of HTL for advanced SAF and marine fuels to clarify but high potential

Public Funding

Public funding available for green transition

What to consider for production of advanced biofuels from solid waste?



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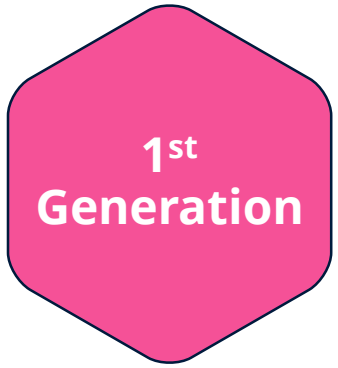
Production of biofuels is expected to increase significantly

In Million Barrels Per Day

	2018	2025	2030	2035	2040
IEA – Stated Policies (2019)	1.9	2.8	3.5	4.1	4.7
IEA – Sustainable development (2019)	-	-	6.3	-	7.7
OPEC (2019)	2.5	2.9	3.3	3.5	3.8
BP - Evolving Transition (2019)	-	-	-	-	4.0
BP – Alternative Scenario (2019)	-	-	-	-	6.0
IRENA – Remap Case (2019)	2.2	-	6.4	-	9.1

Types of feedstocks to produce FAME, HVO, SAF



Virgin Oils

Rapeseed oil
Palm oil
Sunflower oil
Soybean oil

Waste oils and fats

Used Cooking Oils (UCO)
Animal Fats
Distillers Corn Oil (DCO)
Crude tall oil (CTO)

Palm Oil Mill Effluent (POME)
Palm Fatty Acid Distillate (PFAD)
Spent Bleaching Earth Oil (SBEO)

Solid Waste

Agricultural residue
Sewage sludge
Forestry residue
Organic fraction of MSW
Mixed plastic waste

Low ILUC/rotational/winter crops

Carinata
Castor
Micro or macro algae
Miscanthus

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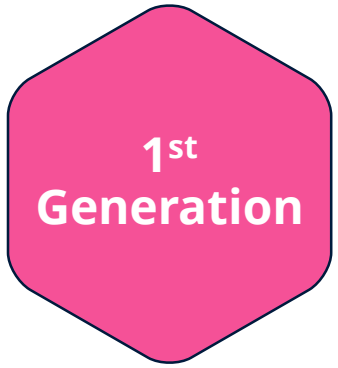

Virgin Oils

160 MT/y (UFOP, 2019)

(About 3 M BPD HVO if all of it was used for fuels)

Waste oils and fats

40 MT/y (WEF, 2020)

(About 0.8 MPD HVO)

Solid Waste and Low ILUC/rotational/winter crops

Feedstock needed to fill the gap!

Legislation supporting advanced biofuels from solid waste

	Agricultural residues	Algae	Wastes and processing residues	Non-food cellulosic and ligno-cellulosic material	Recycled carbon
Examples	Forestry residues, bagasse, cobs, husks, nut shells, straw	Algae if cultivated on land in ponds or photobioreactors	Grape marc and wine lees, manure, organic MSW, POME, sewage sludge	Miscanthus, short rotation crops	Plastic waste, tires
RED II (EU-27)	Min 3.5% in 2030 (Annex IX part A)				Counts for 14% renewable fuel targets
RTFO (UK)	Min 2.8% in 2032 (development fuels)				Might be considered
LCFS (California)	Forestry residue included in approved feeds (pyrolysis)	-	-	-	-
RFS (USA)	Category M	-	Category M	Category M	-

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RFS Category M

	Fuel type	Feedstock	Production process requirements	D-Code
M	Renewable Gasoline and Renewable Gasoline Blendstock; Co-Processed Cellulosic Diesel, Jet Fuel and Heating Oil	Crop residue, slash, pre-commercial thinnings, tree residue, and separated yard waste; biogenic components of separated MSW; cellulosic components of separated food waste; and cellulosic components of annual cover crops.	Catalytic Pyrolysis and Upgrading, Gasification and Upgrading, Thermo-Catalytic Hydrodeoxygenation and Upgrading, Direct Biological Conversion, Biological Conversion and Upgrading utilizing natural gas, biogas, and/or biomass as the only process energy sources providing that process used converts cellulosic biomass to fuel; any process utilizing biogas and/or biomass as the only process energy sources which converts cellulosic biomass to fuel.	3 (cellulosic biofuel)

https://www.epa.gov/renewable-fuel-standard-program/approved-pathways-renewable-fuel

Additional drivers for thermochemical technologies
Chemical recycling

- In EU, legislation supporting plastic recycling:
  - 50% of plastic packaging waste to be recycled in 2025
  - 800 eur/t tax on non-recycled plastic packaging waste from 2021
- Investment and commitment from PetChem industry in chemical recycling:
  - Many players have high targets to use plastic waste
  - Examples: Neste (1 MT/y from 2030), SABIC (200,000 t/y), BP (100,000 t/y), Total (30% of plastic produced from recycled plastic by 2030), etc.

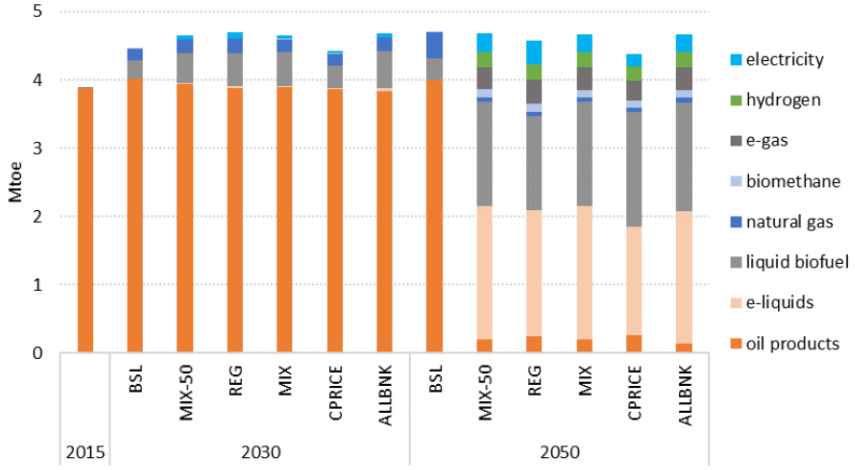
Additional drivers for thermochemical technologies
Sustainable Aviation Fuels

- In EU, ReFuels EU aviation initiative presented in 2021
  - Specific targets for advanced biofuel SAF (35% in 2050?)
  - Will it be feedstock and technology specific?
- Approval of HTL pathway (ASTM D7566)
  - *"Significant number of additional prospective pathways (…) currently being pursued (…) using biological (…) or thermochemical (pyrolysis, hydrothermal liquefaction, catalytic conversion, etc.) processes"* (CAAFI website)
- What about product properties?
  - Paraffinic product with low aromatic content

Additional drivers for thermochemical technologies
Renewable marine fuels

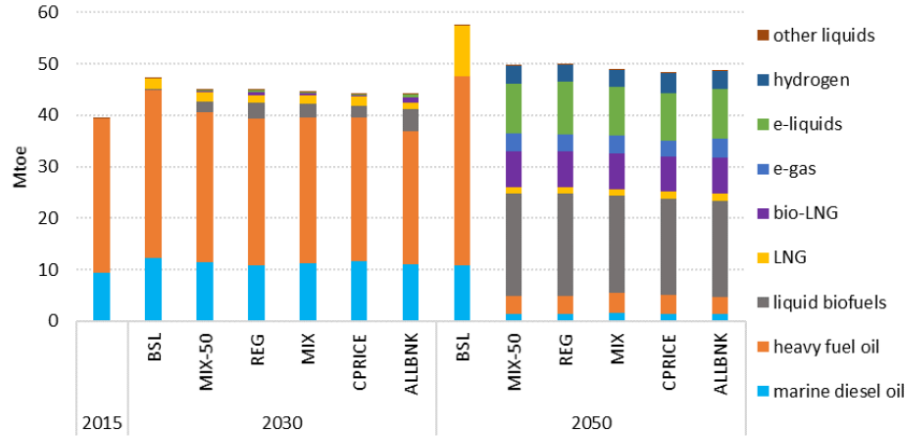
- In EU, FuelEU Maritime initiative launched in 2021
- EU Smart and Sustainable mobility plans predicts high share of biofuels for marine fuels
  - Biocrudes and bio-oils are suited for this application

Figure 52: Inland waterways and national maritime fuels mix in the Baseline and policy scenarios in 2030 and 2050



Source: PRIMES-TREMOVE transport model (E3Modelling)

Figure 53: International maritime fuels mix in the Baseline and policy scenarios in 2030 and 2050



Source: PRIMES-TREMOVE transport model (E3Modelling)

Source: Sustainable and Smart Mobility Strategy, December 2020

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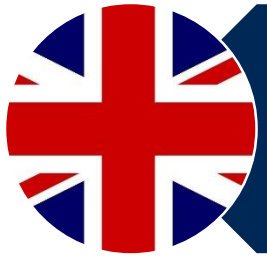
Additional drivers for thermochemical technologies

Examples of public funding supporting green transition

Connecting Europe Facility, Horizon Europe, Innovation Fund, Just Transition Fund, Invest EU, European Recovery Plan, etc. (> billions euros)

Federal level: $ 1.5 billion fund (2/3 for low carbon fuels)

British Columbia: credits under “Part 3” agreement for low carbon fuels



SAF competition scheme being implemented

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Thank you

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