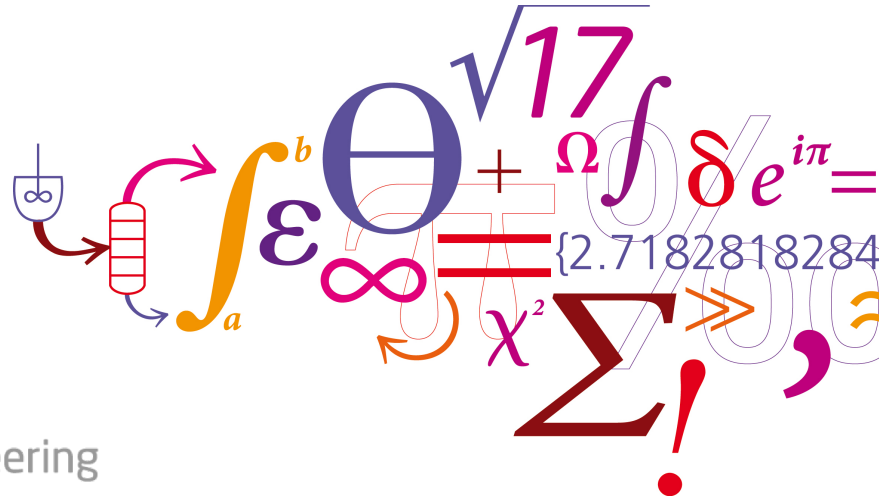
Sustainable Aviation Fuels - SAF
An introduction

Hariklia Gavala
Associate Professor
AT-CERE
Applied Thermodynamics - Center for Energy Resources Engineering



DTU Chemical Engineering
Department of Chemical and Biochemical Engineering

SAF – Definition and criteria

- Renewable Energy Directive
  - ✓ Land-use criteria
  - ✓ Direct GHG emissions – emission reduction criterion

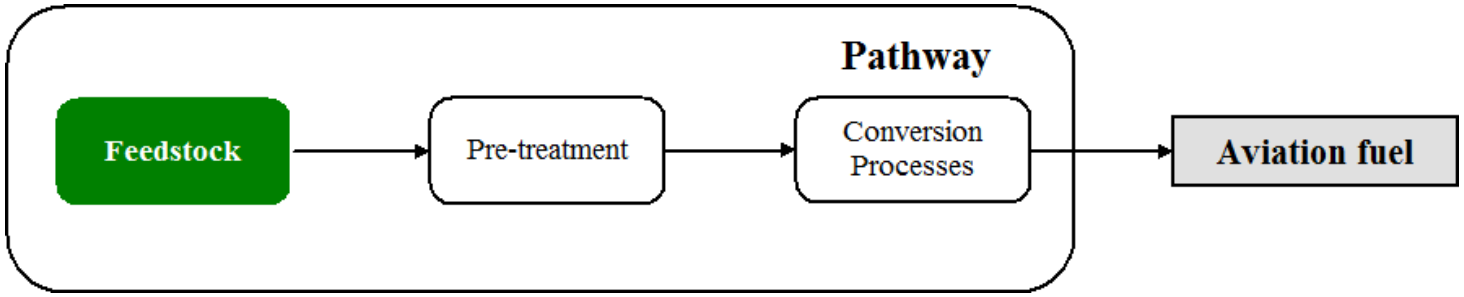
- Carbon from biomass and/or CO_2
  - ✓ Material of biological origin excluding material embedded in geological formations and transformed to fossil (Food and Agricultural Organisation of the United Nations)
  - ✓ Potentially other wastes (plastic, tyres etc.)

- Energy and reducing power for transformations (i.e. H_2) from renewable sources (i.e. solar, wind, geothermal, hydro, sea)

SAF – Definition and criteria

- Production pathways with biomass and/or CO_2 as main feedstock that:
  - ✓ Are technologically feasible
  - ✓ Are economically sound
  - ✓ Fulfill the sustainability criteria as defined by the Renewable Energy directive

- **AND** Approved by ASTM, American Society for Testing and Materials or other global standards bodies (DEF-STAN)



SAF – ASTM approved production pathways

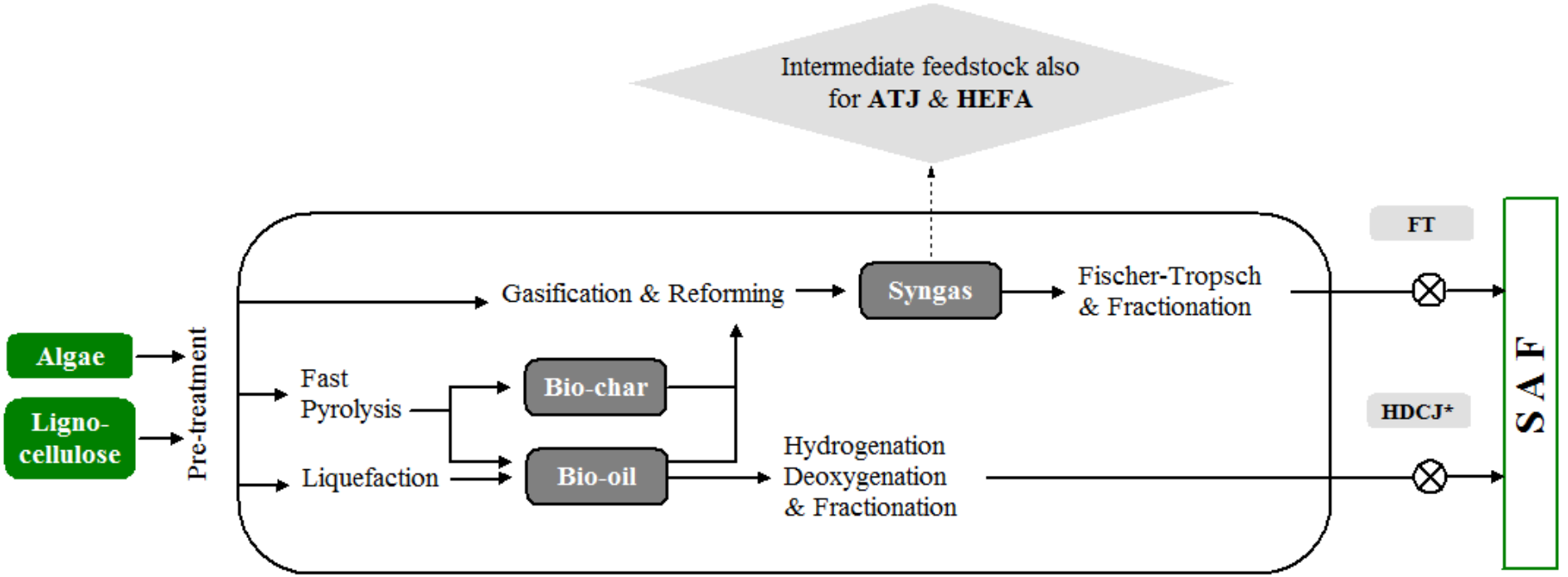
International Civil Aviation Organisation (ICAO 2017)

Conversion Process	Abbreviation	Possible Feedstock	Blending ratio by Volume
Fischer-Tropsch hydroprocessed Synthesized Paraffinic Kerosene	FT-SPK	Biomass	50%
Hydroprocessed Esters and Fatty Acids for Synthesized Paraffinic Kerosene	HEFA-SPK	Renewable oils (e.g. vegetable oils and fats, animal fat, recycled oils etc.) and Biomass	50%
Hydroprocessed Fermented Sugars to Synthesized Iso-Paraffins	HFS-SIP (or DSHC)	Biomass rich in sugars	10%
Alcohol-to-jet Synthesized Paraffinic Kerosene	ATJ-SPK	Biomass	30%
Synthesized kerosene with aromatics derived by alkylation of light aromatics from non-petroleum sources	FT-SPK/A	Biomass	50%

SAF – ASTM approved production pathways

International Civil Aviation Organisation (ICAO 2017)

Fischer-Tropsch hydroprocessed Synthesized Paraffinic Kerosene	FT-SPK (also FT-SPK/A)	Biomass	50%

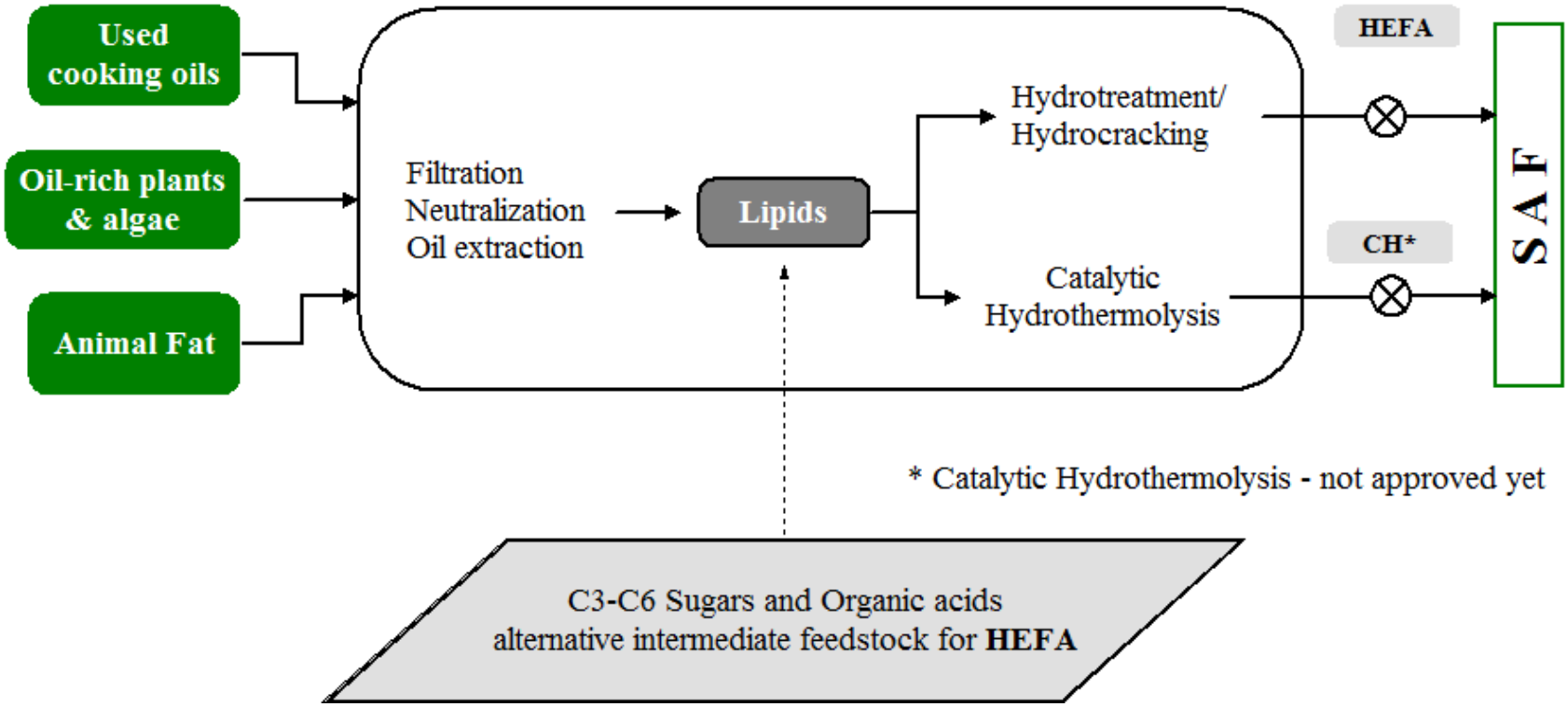


* Hydrotreated Depolymerized Cellulosic to Jet - not approved yet

SAF – ASTM approved production pathways

International Civil Aviation Organisation (ICAO 2017)

Hydroprocessed Esters and Fatty Acids for Synthesized Paraffinic Kerosene	HEFA-SPK	Renewable oils (e.g. vegetable oils and fats, animal fat, recycled oils etc.) and Biomass	50%



SAF – ASTM approved production pathways

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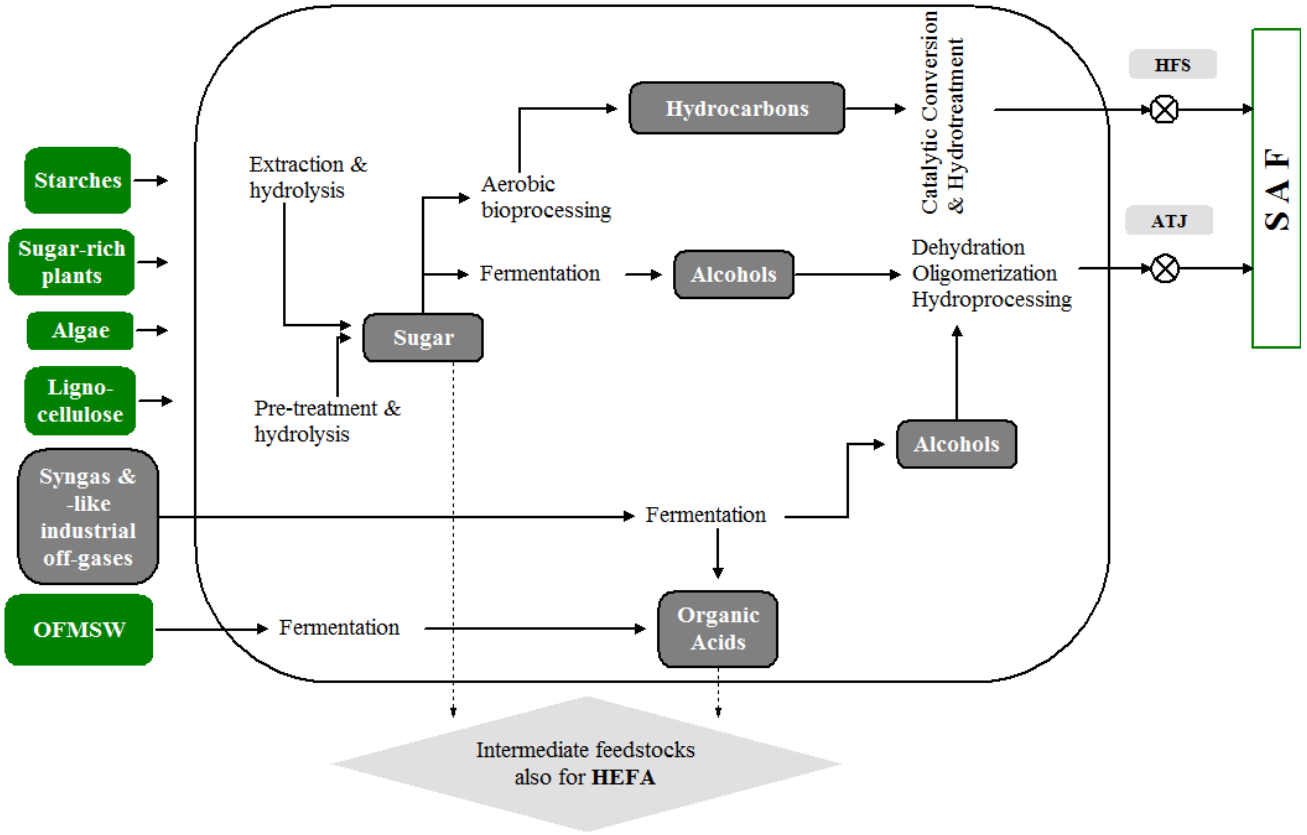
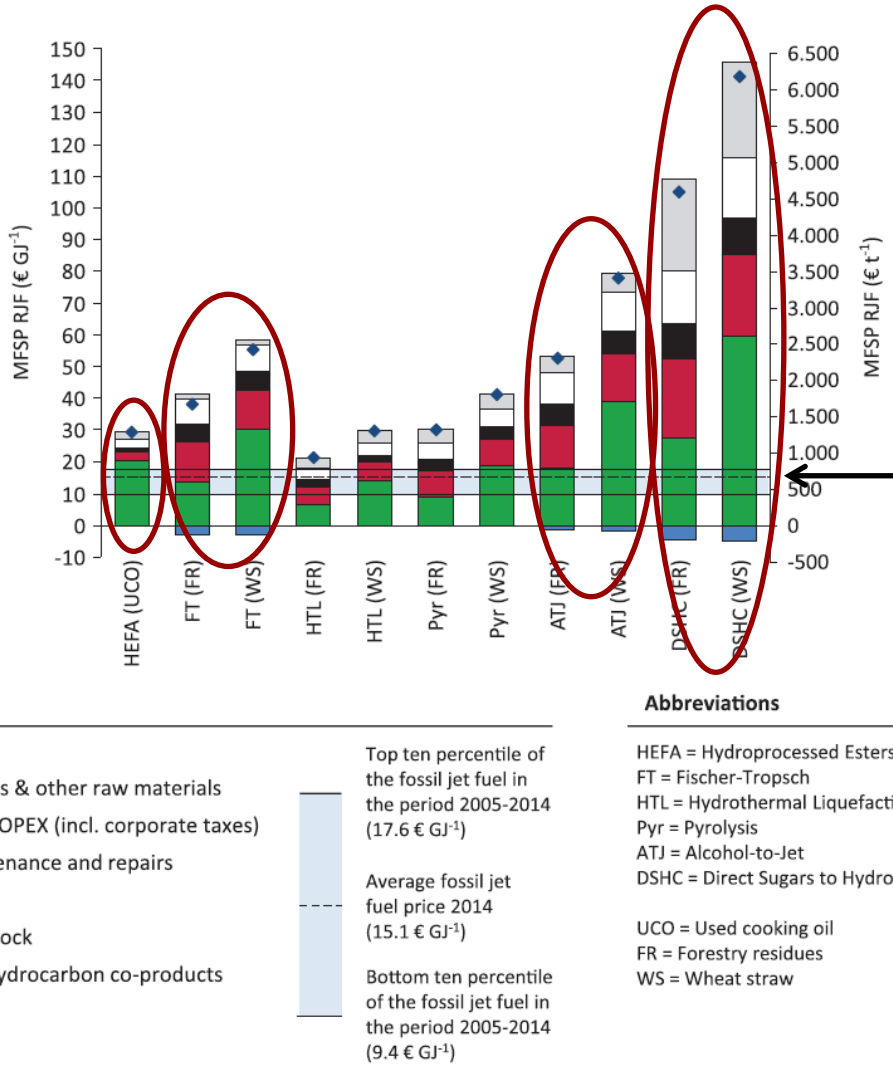


Technological solutions are here but…?

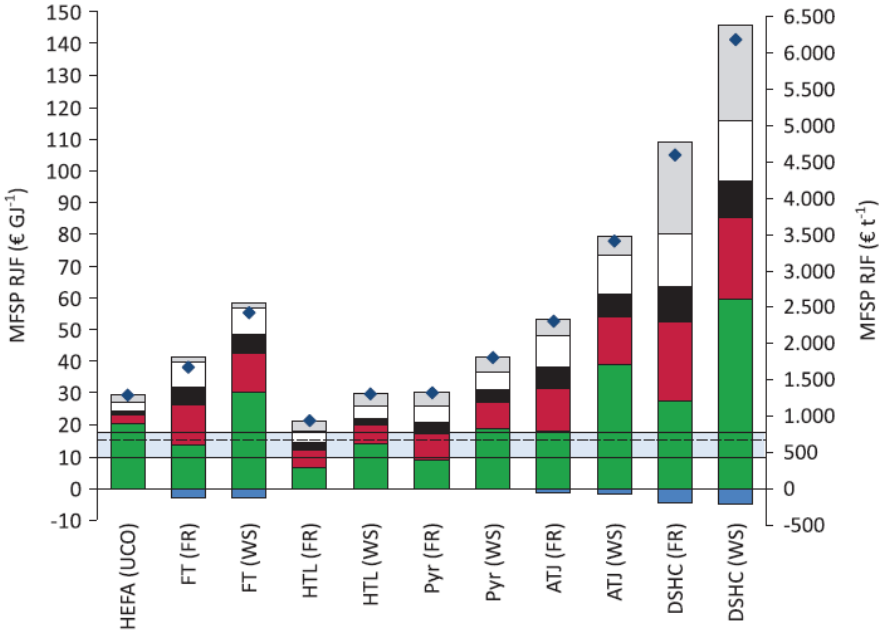


Jong et al., 2015 Biofpr, 9:778-800

RENJET under EIT Climate-KIC

Average fossil jet fuel price

Technological solutions are here but…?



Jong et al., 2015 Biofpr, 9:778-800

RENJET under EIT Climate-KIC

MFSP, € L-1	Jong et al., 2015	Wormslev et al., 2016
HEFA	1,4	0,8 – 1,5
FT	1,6 – 2,5	2,2
ATJ	2,3 – 3,4	1,7 – 2,0
DSHC ()	4,5 – 6,1	-

Wormslev et al., 2016

Sustainable jet fuel for aviation

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Targets from a technological point of view

- Share experiences from high TRL applications – how we can expand and increase production and what the challenges are

- Suggest technological solutions for cost-reduction
  - ✓ Short term: ASTM approved & higher TRL
  - ✓ Long term: not ASTM approved & lower TRL

Welcome and looking forward to presentations & discussions