The potential and challenges of technologies for SAF and commercialisation status

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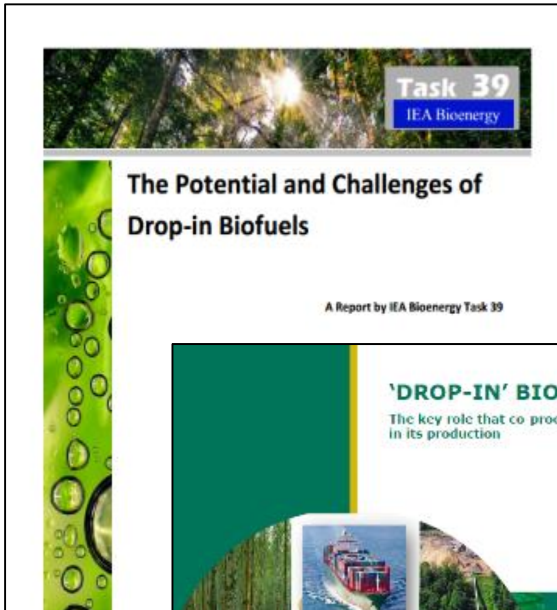
AMF TCP Task 63 online seminar on Feedstock & Conversion

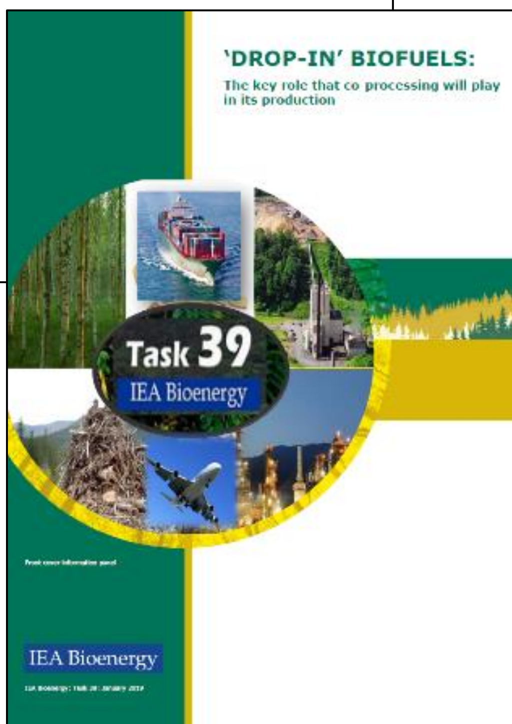
This presentation covers a report written for IEA Bioenergy Task 39 by Susan van Dyk and Jack Saddler

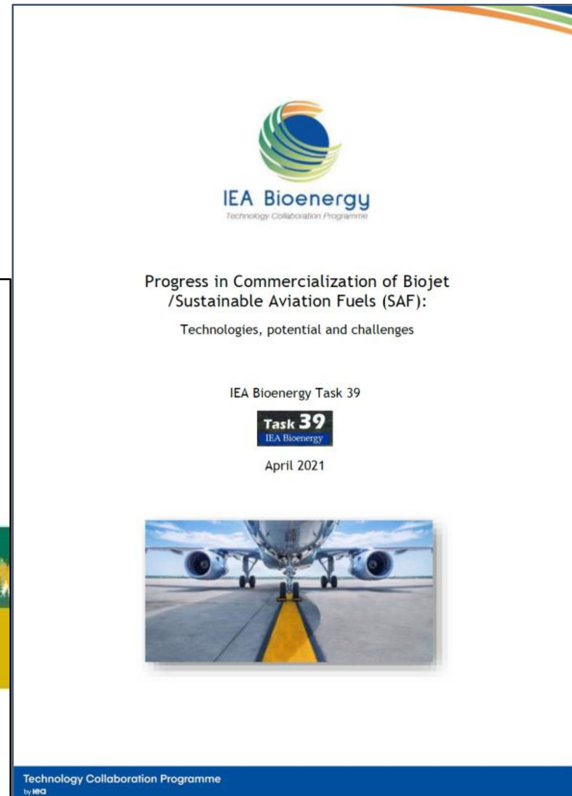
Work on SAF at UBC research group of Prof Jack Saddler over 9 years

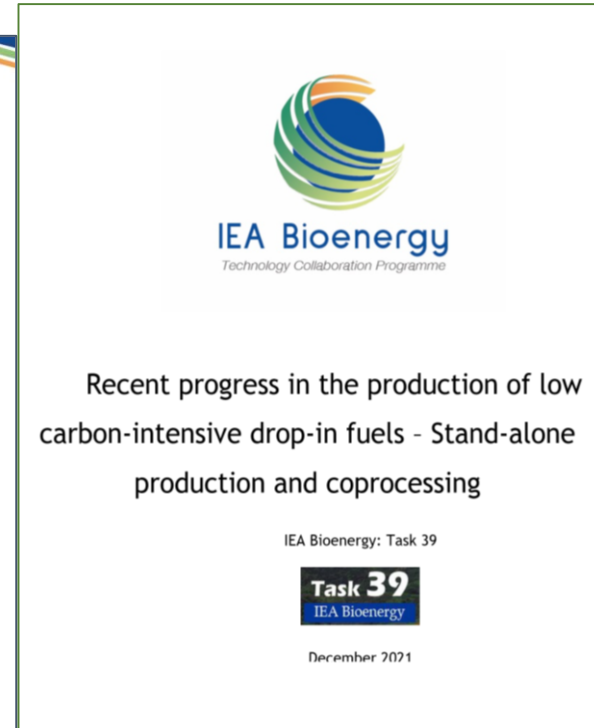
- Report on SAF technologies and feedstock in Canada (Transport Canada) (2014)
- Boeing-funded study on SAF from forest residues in British Columbia (2015)
- 3-year study funded by Boeing and the Green Aviation Research and Development Network – production of SAF through fast pyrolysis, catalytic pyrolysis and hydrothermal liquefaction (2016-2018)
- Various reports for IEA Bioenergy Task 39 on drop-in fuels and SAF (2014-2022)
- 2 reports for IRENA on SAF (2017 & 2021)
- SAF roadmap for Canada (current)

- Drop-in biofuels reports for IEA Bioenergy Task 39 (2014, 2019 & 2021, 2022)



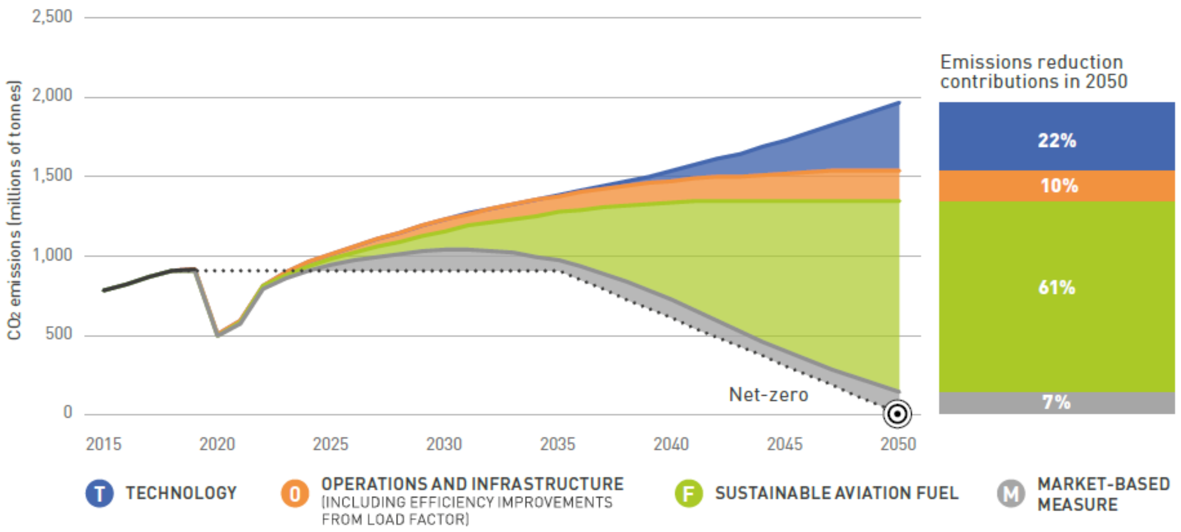






Background

- SAF is essential to reduce emissions from aviation
- Current volumes of SAF still very low (~150 MLPY) but many new facilities under construction
- Target for 2050 (IATA) - net-zero
- Estimated volume of SAF needed by 2050 >400 billion litres
- 5000-7000 new facilities by 2050 (ICF)



Challenges to SAF

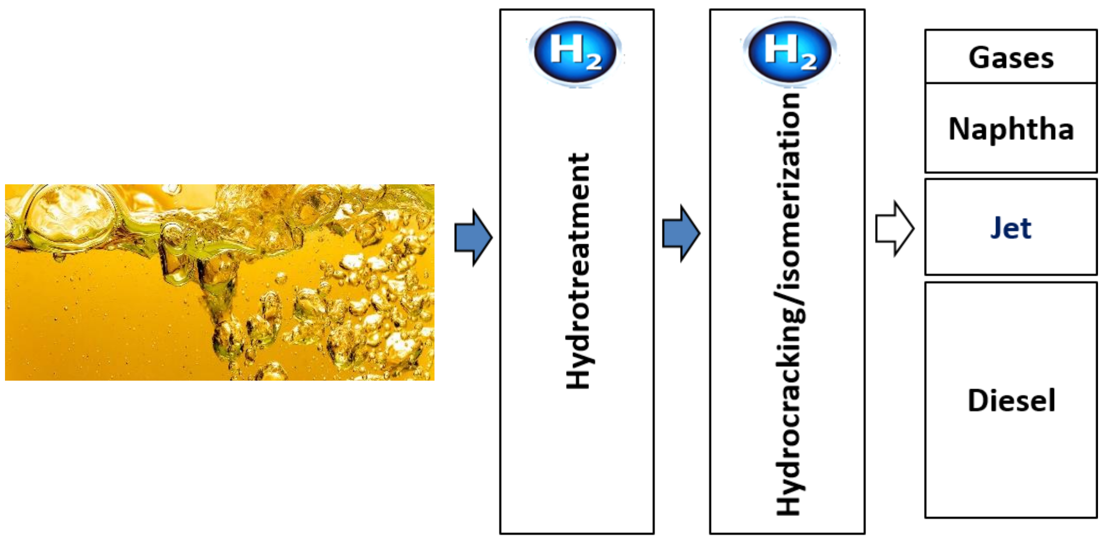
- Slow technology scale-up and commercialisation
- High cost of SAF
- Low availability of SAF
- Adequate policy support
- Feedstock availability and sustainability

SAF Technologies - Main take-aways

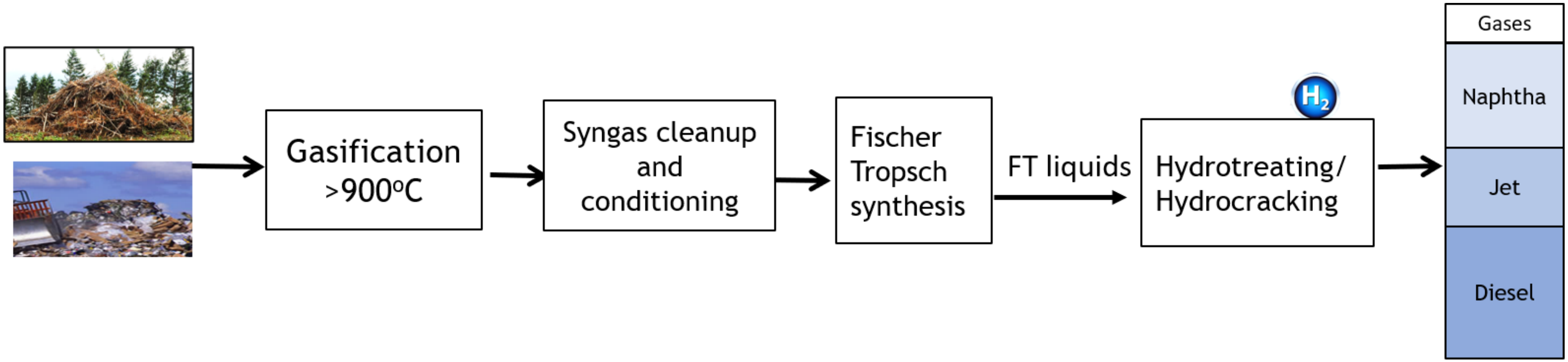
- There is no "silver bullet" technology - ALL SAF technology pathways can contribute to the ambitious targets set by the sector
- It is not a case of "Will a technology work?" but:
  - How long will it take to scale up to deliver significant volumes (billions of litres)? (one facility is not enough, we need 20, 30, 50, etc.)
  - What it will cost? and
  - Will there be enough feedstock?
- HEFA (hydrotreated esters and fatty acids) technology is currently the only fully commercial pathway and will be the main supplier of SAF over the next 10 years – including co-processing
- Gasification-FT and ATJ (alcohol to jet) will start delivering large volumes towards 2030 as multiple facilities start operating
- Other technologies, such as PtL (power to liquids) and thermochemical liquefaction (pyrolysis; hydrothermal liquefaction) pathways, will take longer to reach commercial scale

HEFA-SPK from fats, oils and greases

- Most facilities only produce renewable diesel, not SAF – POLICY drivers can change this (e.g. a multiplier)
- Significant expansion of production capacity is taking place – new builds, refinery conversions, and co-processing (but mostly renewable diesel)
- Key challenges – feedstock cost, availability and sustainability

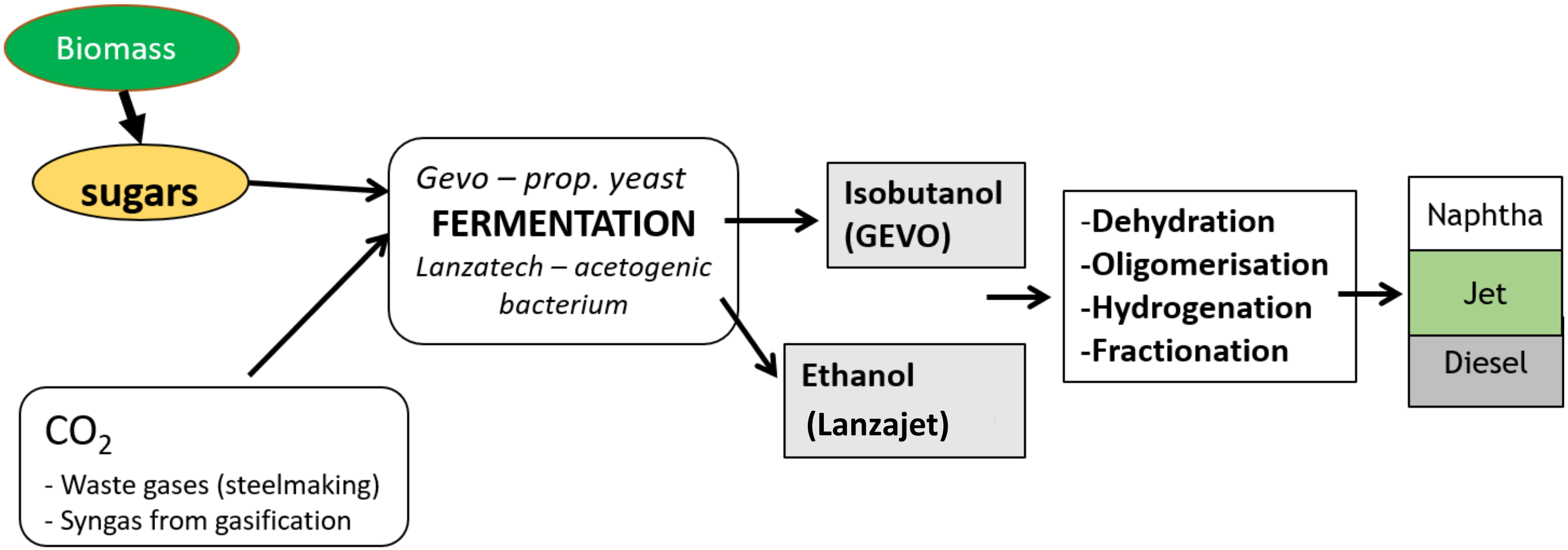


Gasification and Fischer-Tropsch (FT-SPK)



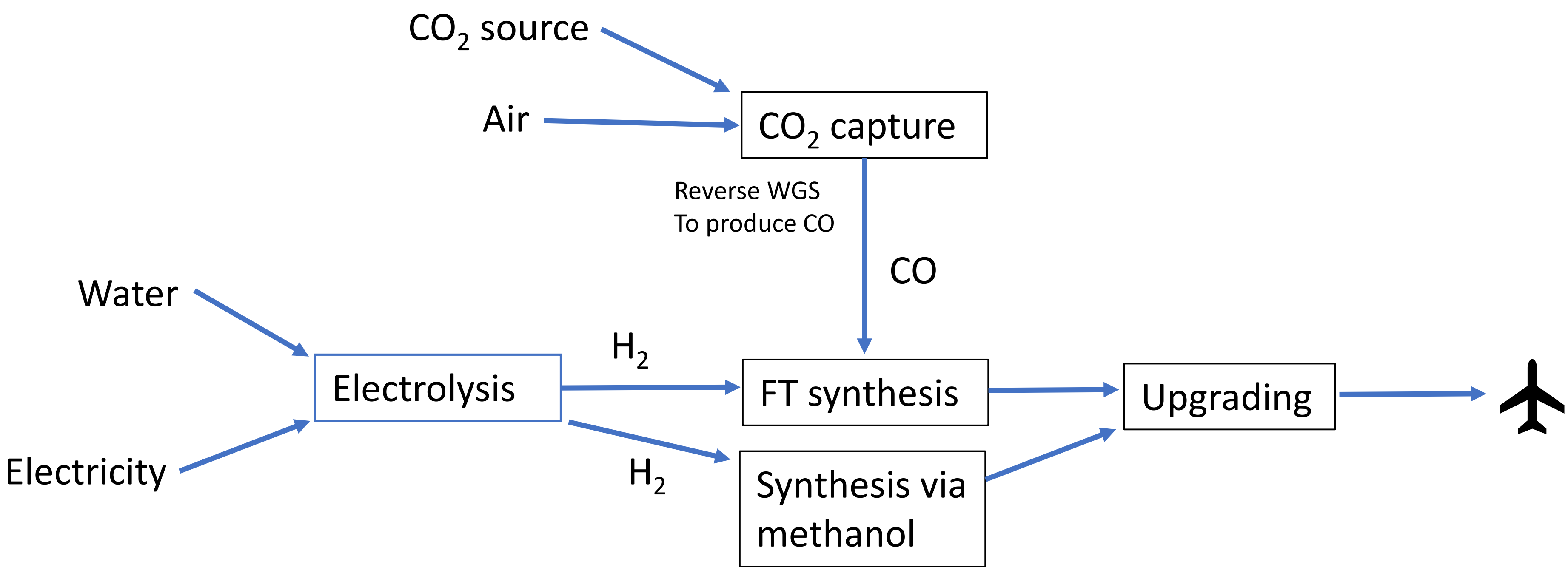
- First full-scale commercial facilities – Fulcrum Bioenergy, Sierra Nevada facility completed - (municipal solid waste)
- Very high capital cost
- Syngas cleanup from biomass gasification is challenging and expensive
- Other companies – Red Rock Biofuels, Velocys, Enerkem

Alcohol-to-jet



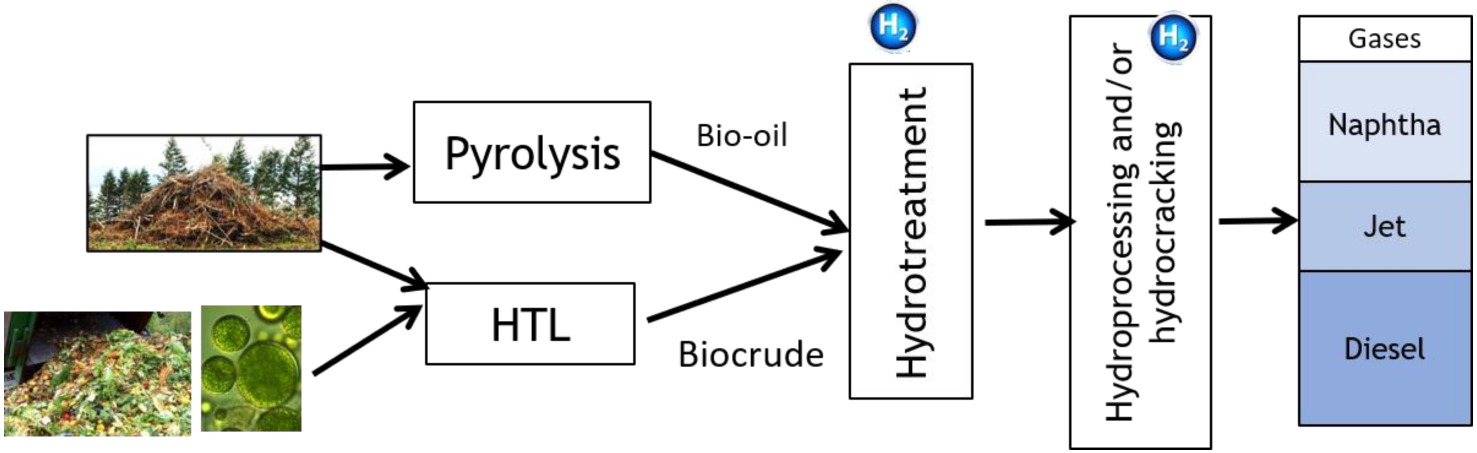
- Two main companies – Lanzajet and Gevo
- Several commercial facilities under construction
- Ethanol from corn, sugarcane, or sugarbeet will be "easy" feedstocks, but have sustainability concerns
- Cellulosic ethanol from biomass (e.g. agricultural residues) – technology not fully commercial

Power-to-Liquids



- Currently one of the most expensive SAF pathways
- Sufficient and additional renewable energy for hydrogen production is essential to achieve real climate benefits – BUT competition for renewable energy – heat, electricity, EVs
- Point source capture cheaper than direct air capture, but lower GHG reductions

Direct thermochemical liquefaction (HTL, Fast Pyrolysis, Catalytic pyrolysis)



- Not ASTM approved
- Technologies for production and upgrading of bio-oil/biocrude still at various TRL levels – Alder Fuels (catalytic pyrolysis) targets SAF
- Upgrading of bio-oils/biocrudes into finished fuels a key challenge
- Bio-oils/biocrudes suitable as a biobased intermediate for co-processing in refineries

Potential for co-processing in existing refineries for SAF production

"Insertion of biobased intermediates (biogenic feedstocks) into existing refinery processing units; simultaneous transformation of these intermediates with petroleum distillates to produce lower carbon intensity drop-in fuels"

- Feedstocks: Lipids, Fischer-Tropsch liquids (ASTM approved for SAF)
- 5% limit to coprocessing but to be increased to 30%
- Coprocessing fully commercial for fats & oils feedstock
- Several companies are producing SAF through co-processing:
    - BP Castellon refinery in Spain (5% FOGs in hydrotreater for SAF);
    - ENI Taranto Refinery in Italy (5% FOGs in hydrotreater for SAF);
    - Phillips66 (Humber refinery, UK);
    - OMV (Austria);
    - Chevron, Exxon, Petrobras, Repsol, Shell, Equinor, Honeywell/UOP

Policy is driving the development of SAF

- The large price gap with conventional jet fuel is a significant challenge for expansion of SAF
- Policies will be critical to bridge this gap

Current major policies influencing SAF development

- **European Union - ReFuelEU** volumetric mandates
  - Creates structural demand
  - Dedicated mandate for Power-to-Liquids (e-kerosene)
- **Inflation Reduction Act (USA)**
  - Blenders tax credit ($1.25-1.75 per gallon) (2023-2024)
  - A multiplier is integrated with SAF earning higher tax credits than renewable diesel
  - Production tax credit (2024-2027)

Thank you