SAF production technologies:

Key Challenges and opportunities

Susan van Dyk

(SVD Consulting and UBC)

IEA-AMF and BBEST webinar

Seminar #2 – Process parameters and properties

20 May 2025

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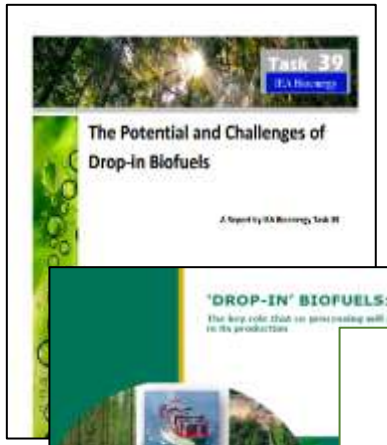
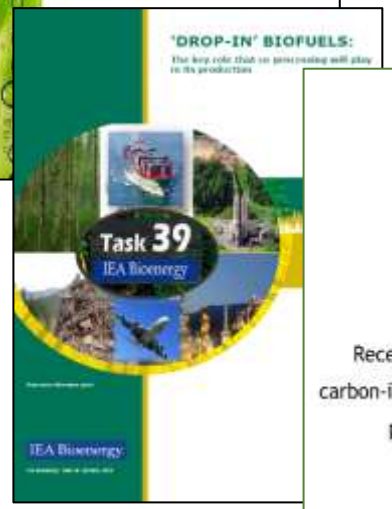
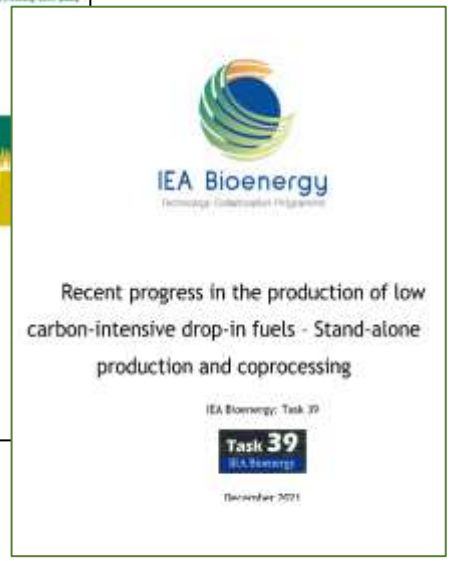
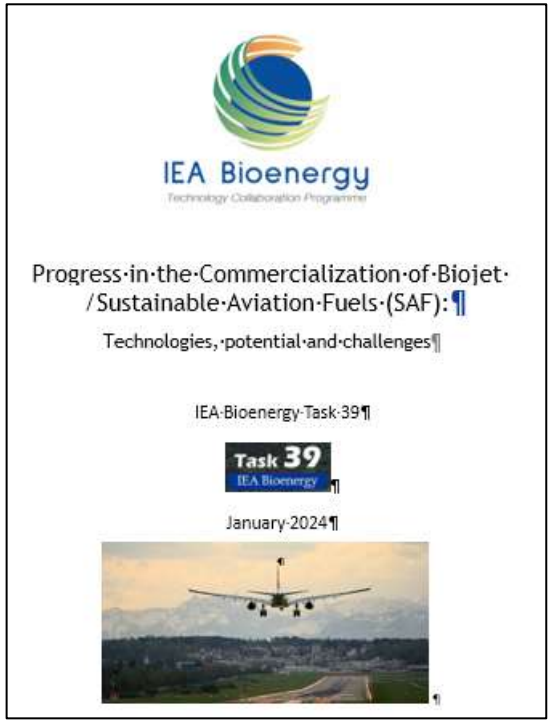
IEA Bioenergy Task 39 - Drop-in biofuels and SAF reports (2014, 2019 & 2021, 2022, 2024)







SAF reports



BC SMART Low Carbon Fuels Consortium

BC Bioenergy Network
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Key take-aways

- We need to produce > 400 BLPY of SAF by 2050 to reach net zero
- Current production <1%
- ALL technology pathways must be pursued – no silver bullet
- Only SAF from the HEFA pathway is fully commercial today and will be the main source of SAF in 2030
- It is critical for other technology pathways to reach commercial scale, but this will take time
- Policy is critical to make the economics work

ASTM-approved pathways

ASTM D7566	Blend level
Fischer-Tropsch Hydroprocessed Synthesized Paraffinic Kerosene (FT SPK)	50%
Synthesized Paraffinic Kerosene from Hydroprocessed Esters and Fatty Acids (HEFA SPK)	50%
Synthesized iso-paraffins (SIP)	10%
Fischer-Tropsch Synthesized Kerosene with Aromatics (FT SPK/A)	50%
Alcohol-to-jet synthetic paraffinic kerosene (ATJ-SPK)	50%
Catalytic Hydrothermolysis jet (CHJ)	50%
HC-HEFA	10%
Alcohol to Jet Synthetic Kerosene with Aromatics (ATJ-SKA)	50%
ASTM D1655	
Co-processing (lipids, Fischer-Tropsch liquids)	5%
Co-processing hydrotreated lipids of FT liquids	Max 24% insertion, max 10% in final fuel

Progress in SAF commercialisation

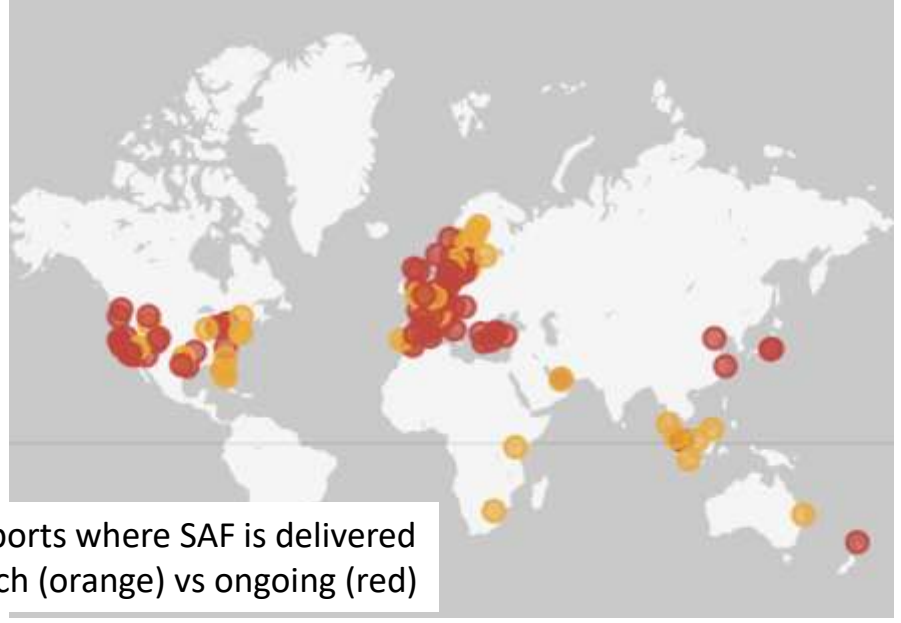
ASTM approved pathways

- 11 technology pathways have been approved under ASTM D7566 and D1655
- Many new pathways under evaluation

- **ASTM approval does not mean a technology is commercial or that the fuel produced will be sustainable**
- ASTM uses the term “synthetic blending component”

ICAO SAF tracker

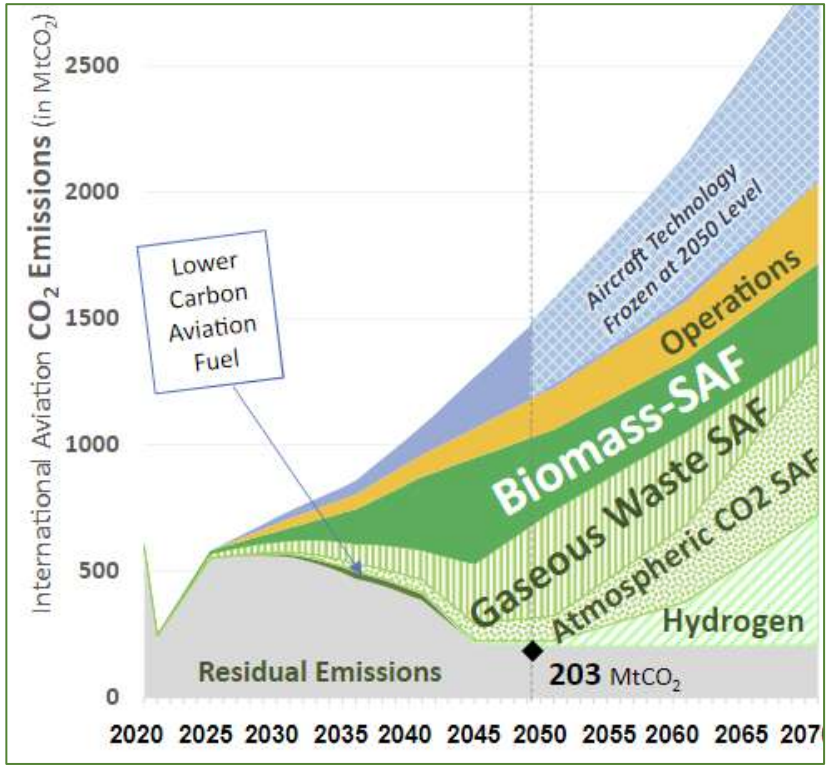
- 337 SAF facilities announced/construction/in operation
- 127 airports have distributed SAF (some ongoing)
- 53 billion litres under offtake agreements



Airports where SAF is delivered
Batch (orange) vs ongoing (red)

Which technology pathway will be next?

- HEFA is still the only fully commercial technology and by 2030, the majority of SAF will come from HEFA
- However, limited volumes of waste fats and oils is expected to impact further growth of HEFA, and other technologies must deliver the SAF volumes required
- We need other technologies to reach commercial scale, but this has been challenging
- Hundreds of projects announced – how many will succeed?
- How fast will other technologies become commercial?



Commercialising a new technology takes time

- Progression across TRL stages (2-3 years per TRL stage)
- Timeline from announcement to operation (funding, permitting, construction, commissioning)
- Some technologies (e.g. gasification/FT facilities) have very long construction periods (after FID) – 5 years
- Announcements versus Final Investment Decision (FID)
- SAF projects based on unproven technologies represent a high risk for investors
- Danger of scaling up too fast

- Meeting SAF targets will be extremely challenging

Overlooked challenges – feedstocks and supply chains

- While we tend to focus on the technology itself, many of the critical issues are feedstock related
- Critical to establish cost-effective feedstock supply chains that deliver acceptable quality feedstocks

- Low energy density feedstocks, e.g. forest and agricultural residues, cannot be economically transported over long distances
- Location of biorefineries must be close to feedstock – but may not be close to downstream fuel supply chains

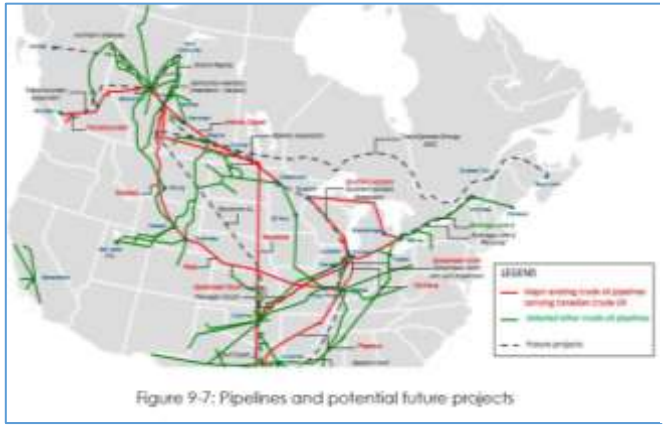
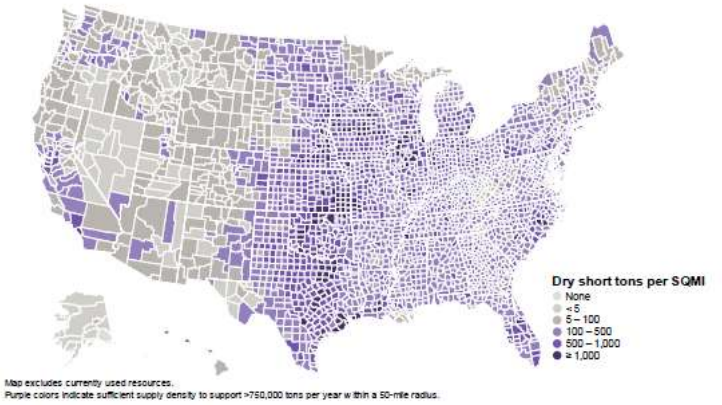


Figure 9-7: Pipelines and potential future projects



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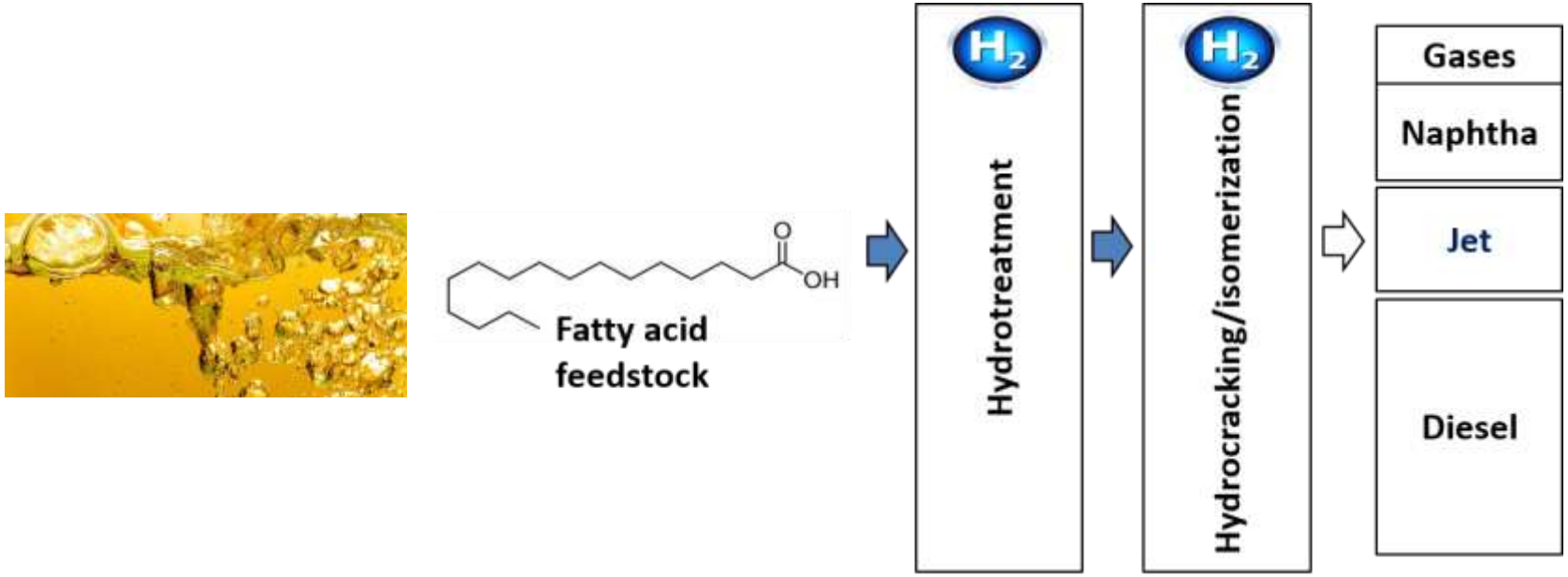
HEFA-SPK from fats, oils and greases

- Hydrotreatment of oils and fats is a fully commercial technology for renewable diesel production - But production of **SAF** using this technology is still limited
- Diverting a jet fraction in existing renewable diesel facilities can provide substantial SAF volumes in a very short period of time
- 15% SAF can be readily produced in every HEFA refinery and 50% or more is possible under the right conditions



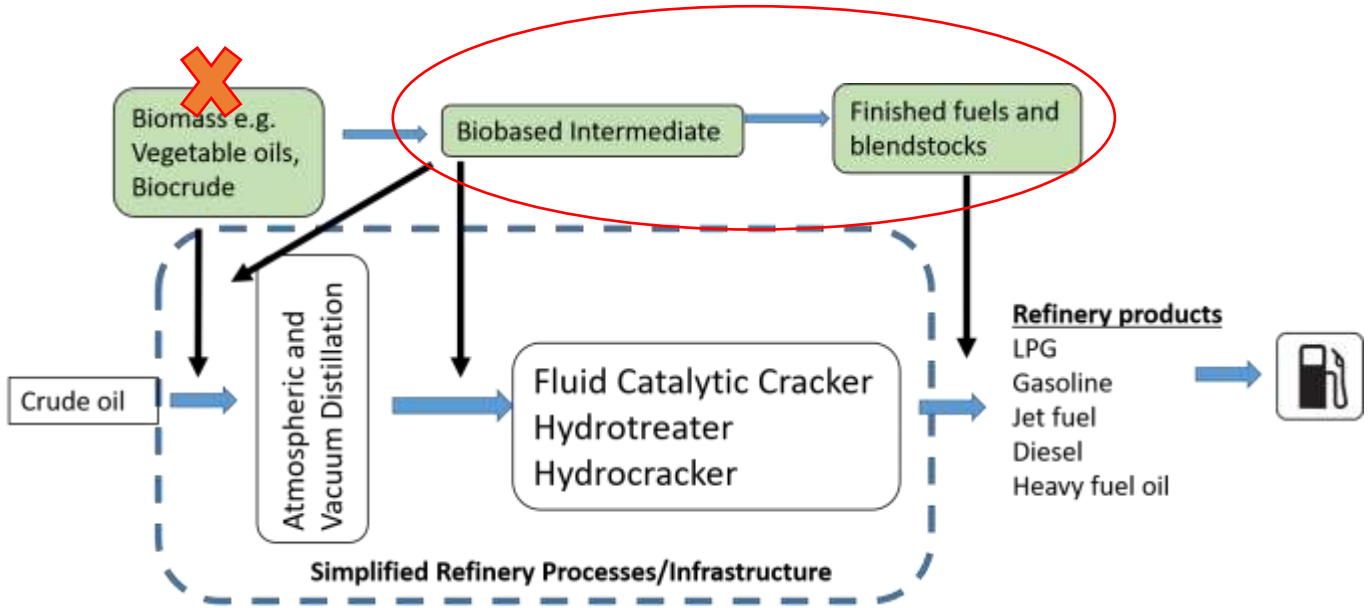
HEFA - Opportunities and challenges

- Shifting renewable diesel facilities to produce SAF is an immediate and significant opportunity to expand SAF volumes
- To make more than 15% SAF in a HEFA refinery, extra processing is needed to produce a bigger fraction of jet-range carbon chains and total yield of liquid product is reduced
- Creating favourable economics for increased SAF is a policy challenge

- Increasing the supply of sustainable and low CI feedstock is a challenge

Potential for co-processing in existing refineries for SAF production

- *Co-processing is the "insertion of biobased intermediates (biogenic feedstocks) into existing refinery processing units; and the simultaneous transformation of these intermediates with petroleum distillates to produce lower carbon intensity drop-in fuels"*
- Approved under ASTM D1655 for hydrotreated oils & fats (24%), oils & fats (5%), FT liquids (5%)
- Fully commercial for co-processing of fats & oils (HEFA) – critical for expanding SAF volumes



Co-processing can rapidly increase SAF volumes

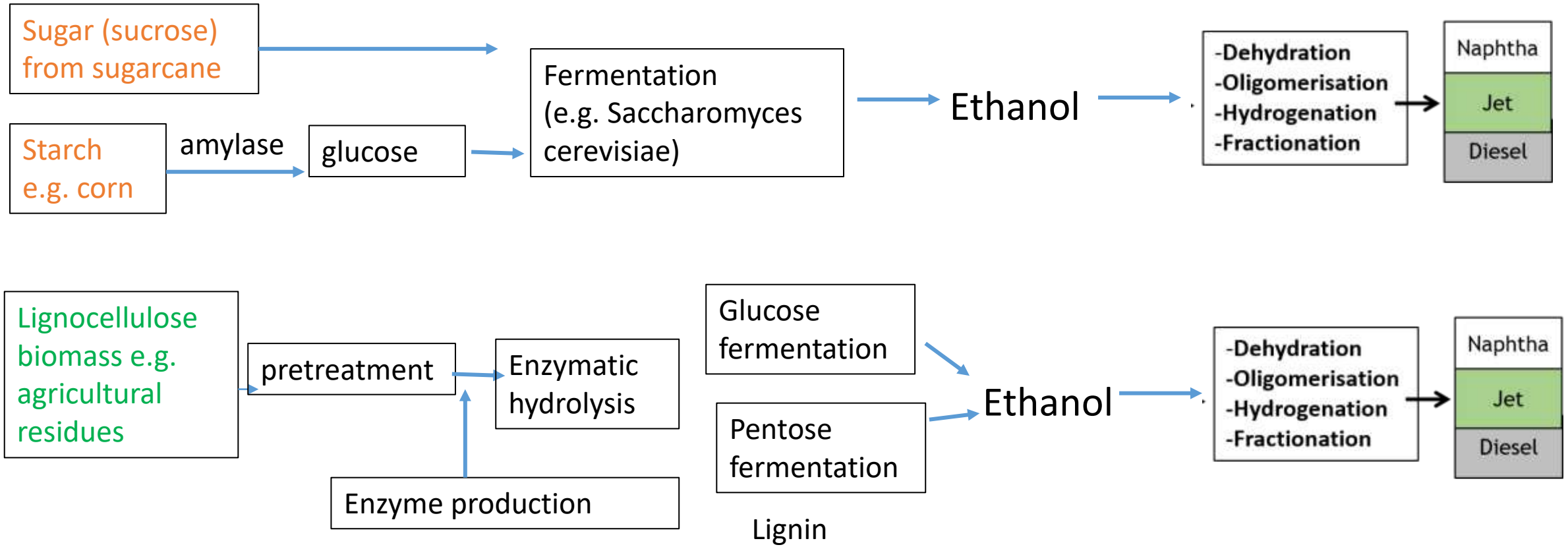
- Petroleum refineries can produce SAF (low carbon-intensity jet fuel) in a relatively short period of time compared to building a new biorefinery
  - Existing infrastructure
  - Requires a relatively low investment e.g. feedstock storage tanks
  - Established downstream supply chain for delivering jet fuel

- Challenge – feedstock supply

Alcohol-to-jet technology

ASTM approved for ethanol, isobutanol, and mixed alcohols

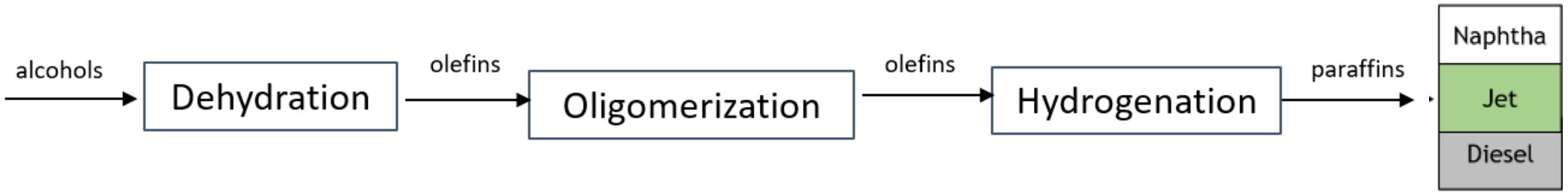
Feedstocks for alcohol production can vary – starches/sugars, cellulosic alcohols, syngas fermentation



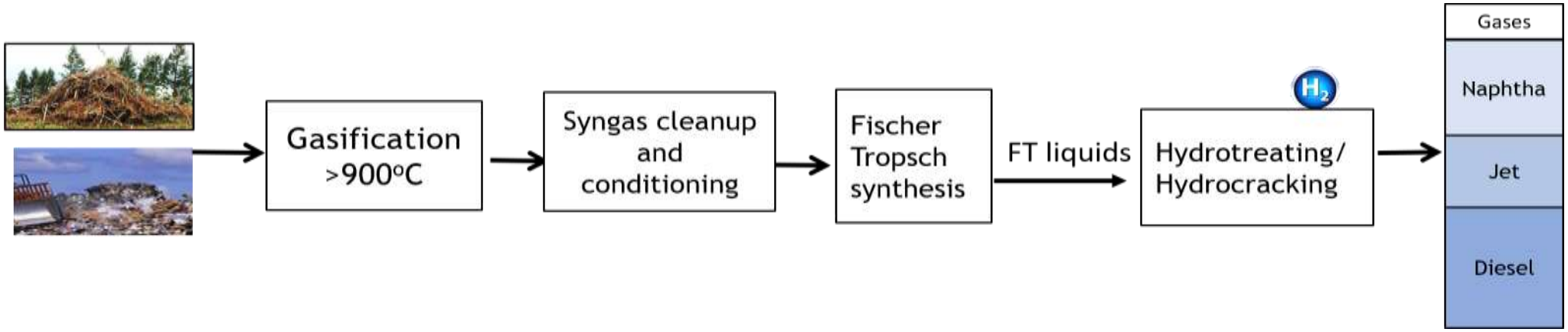
Opportunities and challenges

- Near-term commercial status
- Opportunity to use 1G ethanol – sugarcane ethanol has very low CI

- Challenges - Lack of commercial production of 2G/advanced ethanol
- High cost of cellulosic ethanol and supply chain challenges
- Sustainability and CI of crop-based ethanol

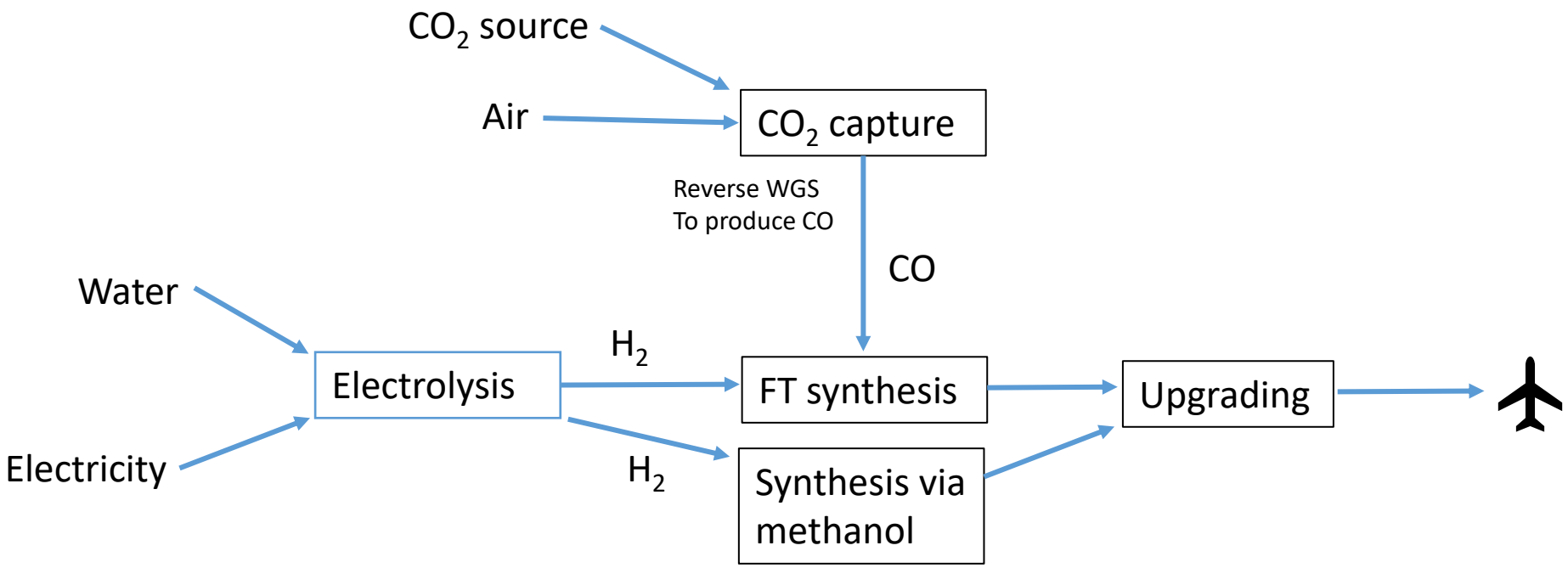


Gasification and Fischer-Tropsch (FT-SPK)



- Technical challenges are hampering the commercialization of gasification
- Very high CAPEX
- Supply chain challenges
- Large volumes of feedstocks available
- Very low carbon intensity SAF through this pathway

Power-to-Liquids



- Very high production cost of SAF
- Still some technical challenges and successful scale-up still to be demonstrated
- Does not require biomass feedstocks
- Can achieve very low carbon intensity

Overall opportunities and challenges

- Expanding HEFA feedstocks is a big opportunity
- Other technologies getting close to commercial scale
- High investment cost and high production cost is very challenging

- Need more policies in more countries

Thanks!

Susan van Dyk

svandyk100@gmail.com

Download link for report:
https://task39.ieabioenergy.com/wp-content/uploads/sites/37/2024/05/IEA-Bioenergy-Task-39-SAF-report.pdf

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