Progress in Commercialisation of Low Carbon Intesive (CI) Biofuels

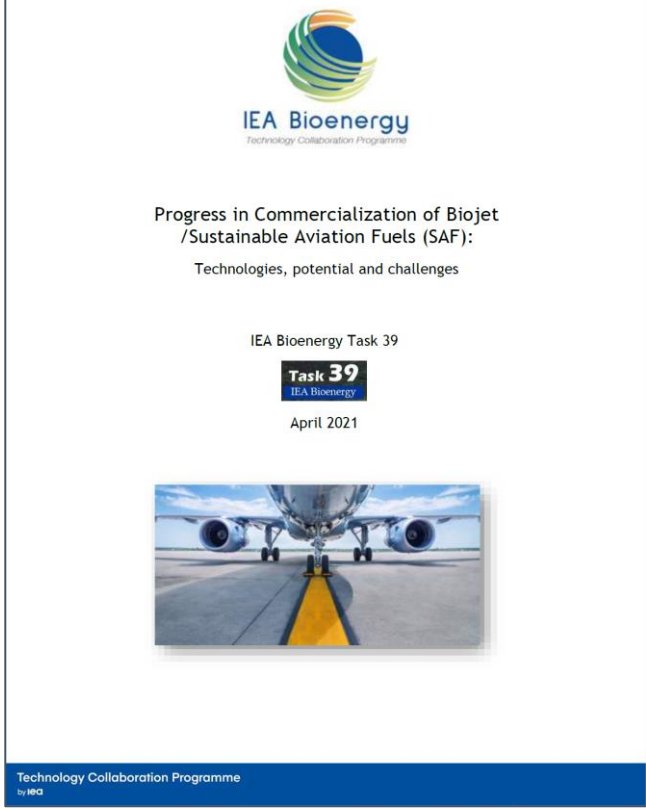
(Biojet fuels/Sustainable Aviation Fuels (SAF)

Technologies, potential and challenges

Scaling Up, Ottawa,

November 2022

Jack.Saddler@ubc.ca



BC-SMART: (https://www.bc-smart.ca)

The BC-Sustainable Marine, Aviation, Rail and Trucking (BC-SMART) Fuels Consortium

(Developing a decarbonisation strategy for long-distance transport)

BC SMART Low Carbon Fuels Consortium

Some of our BC-SMART Consortium Members

BOEING

Parkland

BRITISH COLUMBIA | Ministry of Energy, Mines and Petroleum Resources

BC Bioenergy Network
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HARBOUR AIR SEAPLANES

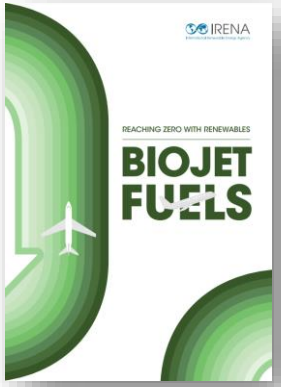
NORAM

UBC

NESTE

SAF/Biojet fuels

- 1.5C Scenario estimates that about 200 billion litres per year of biojet fuel will be required.
  - 2019 production – 140 ML (HEFA/HVO dominated): dramatic increase from 7 ML in 2018.
  - 315 000 flights have used a blend of biojet fuels.
  - Eight pathways have been ASTM approved (7 +coprocessing)
  - Likely to involve around USD 5 billion of investment per year
  - New technologies need to be scaled up
- Currently biojet fuel is 3-6 times more expensive than conventional jet fuel and is likely to be so for some time~$272/bbl (Rotterdam HEFA sustainable aviation fuel, 2020)



July 2021

Available at: www.irena.orgpublications /

Take-home messages

- Biojet fuels/SAF are essential if we are to reduce emissions from aviation
- Hydrogen and electric planes cannot deliver high reductions and technology still being commercialized
- Current volumes of SAF still very low (~150 MLPY), although many new facilities under construction
- Only one technology is fully commercial for SAF – hydrotreatment of fats and oils (HEFA)
- Gasification plus Fischer-Tropsch; AND Alcohol-to-jet advocated to be the next commercial SAF technologies
- Co-processing in existing refineries; pyrolysis/HTL and Power-to-Liquids will become more significant
- The biggest challenge for commercialization is the high price of SAF!! Policy will be the key driver (E.g., CFR)

Background - Aviation's emission challenges

- Aviation produces 2-3% of global CO_2 emissions

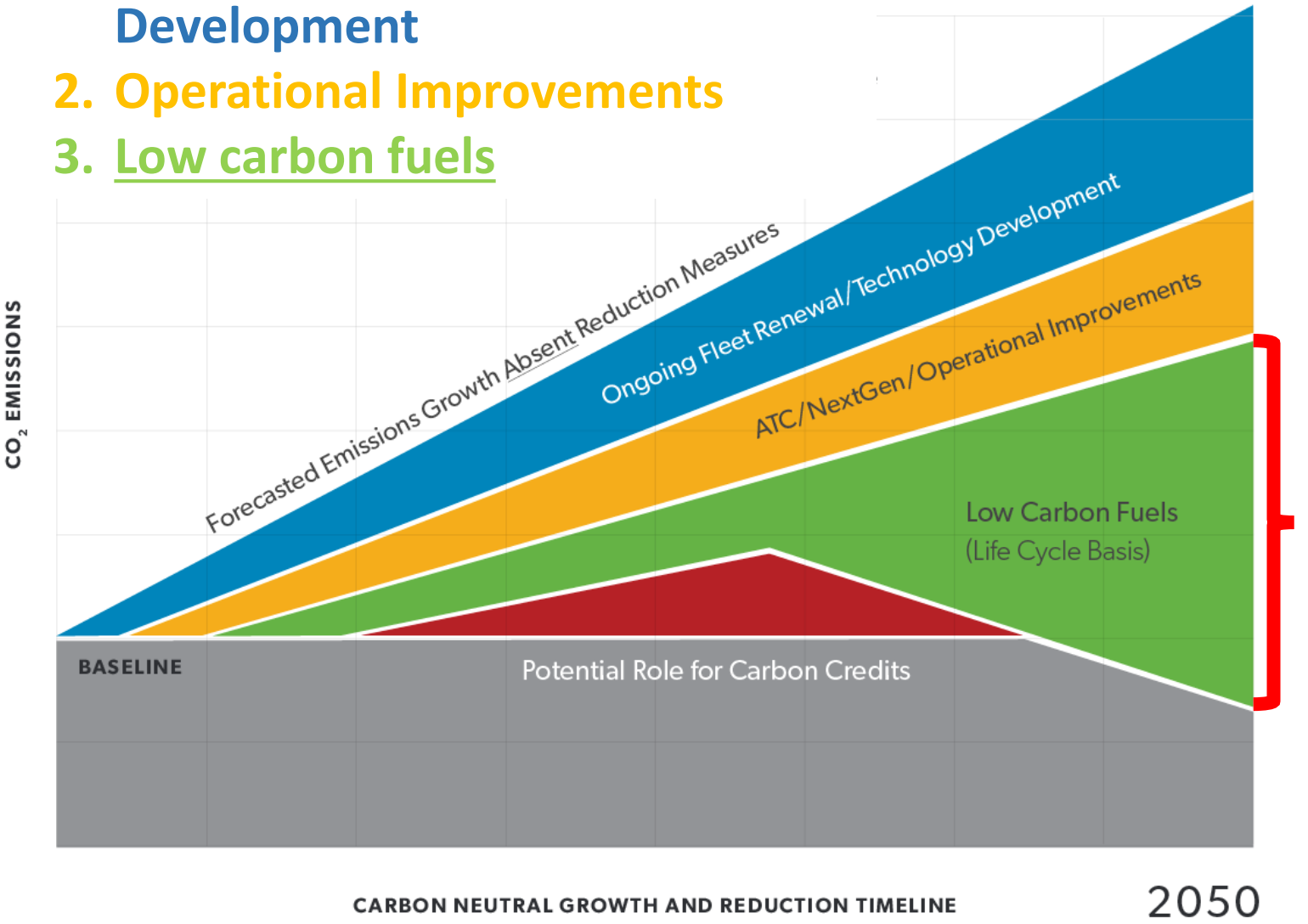
  ~1 billion tons CO_2 per year

- Reasons for urgent action
  - Fastest growing transportation sector – CO2 emissions will double by 2050
  - **VERY** Hard-to-decarbonise sector

- Industry targets for emission reduction:
  - A cap on net aviation CO_2 emissions from 2020 (**carbon-neutral growth**) – CORSIA (Carbon Offset and Reduction Scheme for International Aviation)
  - A **reduction in net aviation CO_2 emissions of 50%** by 2050, relative to 2005 levels, is the goal!

Measures to reduce emissions

1. Fleet renewal & Technology Development
2. Operational Improvements
3. Low carbon fuels



Role of Biojet /SAF

Task 39
IEA Bioenergy

Sustainable Aviation Fuels (SAF) / Biojet fuels (www.Task39.com)

- Drop-in fuel – *functionally equivalent* to existing petroleum fuels and *compatible* with existing infrastructure
- Fueling infrastructure and planes do not have to be modified
- Biojet/SAF will have the greatest impact on emission reduction!
- Will also impact non-CO2 climate effects (e.g. contrail production)

SAF production: volumes, future capacity, long-term demand

CURRENT PRODUCTION

- Average of 0.29 MLPY (2013-2015) to 6.45 MLPY (2016-2018)
- In 2019 Neste produced 125 million litres

Source: ICAO Stocktaking 2019

- Announced SAF capacity for Neste by 2023 – 2 BLPY

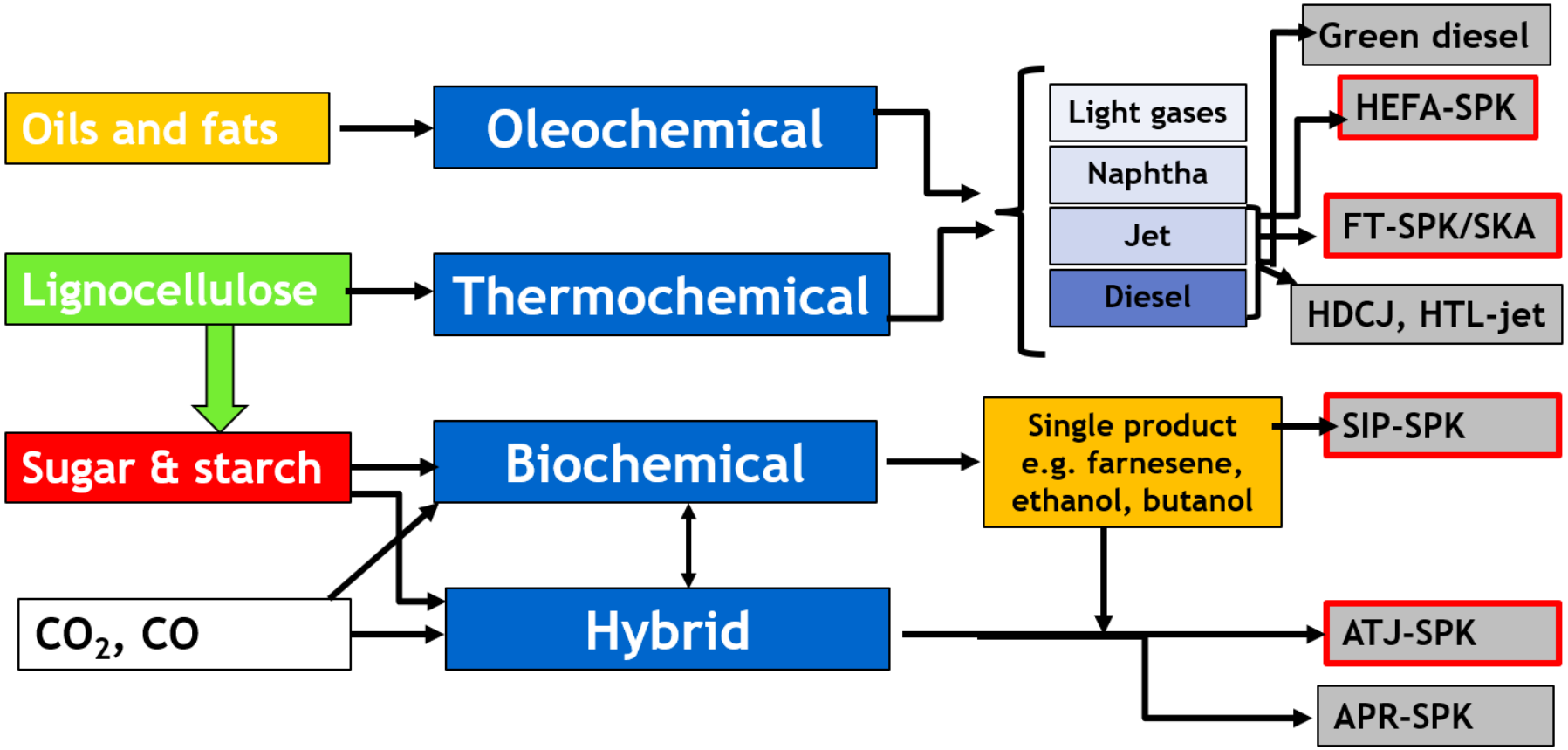
- **Current jet fuel demand ~360 BLPY**
- **Volume of Biojet fuel required by 2050? At least 200 BLPY!!!**

FUTURE PRODUCTION?

Recent commitments and targets from 60 corporations for 10% SAF by 2030

- Amounts to about 30 BLPY

Technologies for drop-in fuel and SAF production (www.Task39.org)



SAF Technologies - status of commercialisation

- HEFA technology (hydrotreatment upgrading of fats, oils and greases) is currently the only fully commercial pathway and will be the main supplier of SAF over the next 10 years
- Commercial scale facilities for Gasification-FischerTropsch and Alcohol-to-Jet are being built and are proceeding towards commercialization
- Lower CI jet fuel via co-processing – e.g. BP, Parkland, Preem, ENI, etc., can be produced now
- Other technologies, such as Power-to-Liquids, will take **much-longer** to reach commercial scale

ASTM certification

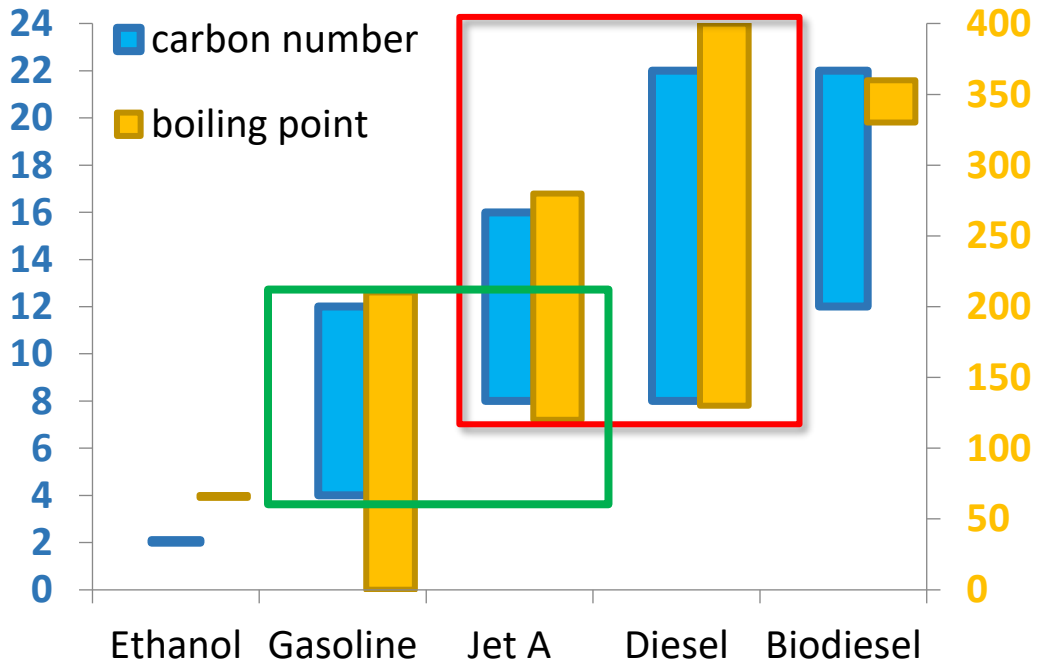
8 Approved pathways

- Fischer-Tropsch SPK & SKA (2009) (50%)
- HEFA SPK (2011) (50%)
- Synthesized Iso-paraffins (SIP) (2014) (10%)
- Alcohol to jet SPK (isobutanol (2016), ethanol (2018)) (50%)
- Catalytic hydro-thermolysis of lipids to jet fuel (50%)
- HC-HEFA-SPK – lipids from *Botryococcus braunii* algae (10%)
- Co-processing of lipids & FT liquids (5%)

- Maximum blends currently limited to 50% **(but why go to 50% as it is expensive?)**
- Several other pathways in progress towards ASTM certification as technology commercialisation is ongoing
- Maximum blends for coprocessing (5%)

Competition between renewable diesel and SAF production

- Production of SAF is more expensive than renewable diesel only
- Jet can be sold as diesel, and this creates competition
- Resolved through POLICY – current policies make renewable diesel more valuable



Distillation cuts based on boiling point, determines product slate

Price of SAF – challenges and future prospects for price parity

- HEFA SAF currently about 3-6 x the price of conventional jet (~USD$2,000 - $2,300) (Argus media, Greenea)
- Other technologies are not commercial and, consequently, weak techno-economic analyses (TEA) available
- Price based on volume, not VALUE of low carbon intensity
- PRICE considered one of the biggest obstacles to airlines
- SAF will potentially always be more expensive, although significant cost reductions will take place over time

SAF-specific policies will have the greatest impact on SAF expansion (Key role of LCA assessment!)

- **California/BC LCFS does/hopes to include aviation/marine** - linked to **carbon intensity reduction**
- **US RFS includes SAF**
- Mandates and proposed mandates in Norway, Sweden, Finland
- **ReFuelEU** proposed mandate (volumetric) – 2% in 2025, moving to 5% in 2030, 20% in 2035, 32% in 2040, and 63% in 2050
- **Sustainable Skies Act** (USA) – proposed blenders tax credit; linked to **carbon intensity reduction**
  - $1.50 per gallon up to $2 per gallon for 100% emission reduction
- Voluntary corporate actions & BUYERS ALLIANCES (Sustainable Aviation Buyers Alliance) could create a strong demand signal (irrespective of national policies) (based on SAF certificates)

US Inflation Reduction Act (IRA) provides strong support for SAF (CEM/MI meeting, 22-23 Sept, Pittsburgh)

- **Creates a new tax credit to support the sale and use of SAF**
  - New SAF tax credit starts at $1.25 per gallon for SAF that achieves a 50% GHG reduction when compared to a baseline fossil fuel
  - An additional 1 cent per gallon is available for each percentage point by which the lifecycle GHG emission reduction of the fuel exceeds 50%.
  - The tax credit is capped at $1.75 per gallon

- **Establishes a competitive grant program in support of alternative aviation and fuels and low-emission aviation technology**
  - The program will provide grants to eligible entities to carry out projects located in the U.S. that produce, transport, blend or store SAF.
  - Nearly **$250 million** in funding will be available to support SAF projects under the program.

Conclusions

- Biojet/SAF/Biofuels will be essential if aviation/marine are to decarbonize and **very large volumes** are needed

- Technical challenges remain, but high price difference with conventional jet fuel remains the biggest obstacle

- Policies are essential and there is significant developments on this front in the EU and USA that will have a major impact on SAF development

- However, there is no 'silver bullet' – Thus, commercialization of ALL technologies should be pursued as they can utilize different feedstocks, take advantage of regional differences, "enabling" policies, etc.

Thanks!

www.BC-SMART.com

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