## Sustainable Aviation Fuels (SAF) Options and Challenges

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Wissen für Morgen

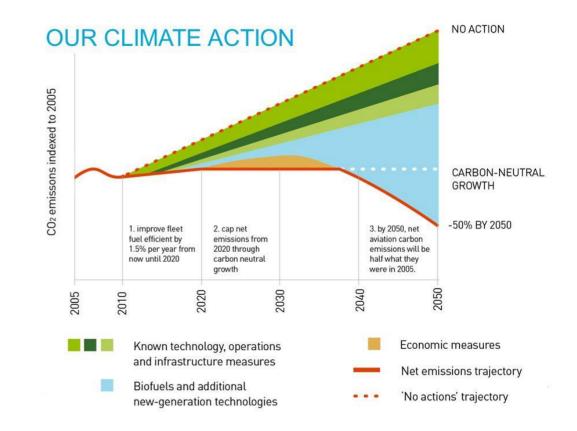
ISCC Global Sustainability Conference February 24, 2021



## Challenge

Maintaining Social & Economic Benefits while Reaching Climate Targets

- 915 million tons of CO₂ produced by flights worldwide in 2019
  → 2.4% of anthropogenic CO₂ emissions
  - $\rightarrow$  2.4% of anthropogenic CO<sub>2</sub> emissions
  - $\rightarrow$  12% from all transport sources
  - → 80% of aviation CO<sub>2</sub> from flights of over 1500 km,
- 4.5 billion passengers with 82% average occupancy per aircraft,
- 87.7 million jobs supported worldwide in aviation & tourism.



#### Very ambitious target for 2050

Sources: Air Transport Action Group (ATAG) www.atag.org 2019 Beginner's Guide to Aviation Efficiency, IATA Economics.



#### **Planned SAF-Quotas in Europe**

Norway	binding quota: 2020: 0.5%, 2030: 30%
Sweden	Quota planned: 2021: 1%, 2025: 5%, 2030: 30%
Finland	Quota planned:
and Denmark	2030: 30%
Netherlands	Quota planned from 2023:
	2030: 14%
Germany	National Hydrogen Strategy:
-	2026: 0.5%, 2030: 2%-PtL-Quota
France	Quota planned (formulated in a Roadmap)
	2025: 2%, 2030: 5%
Spain	Quota planned (together with France): 2025: 2%



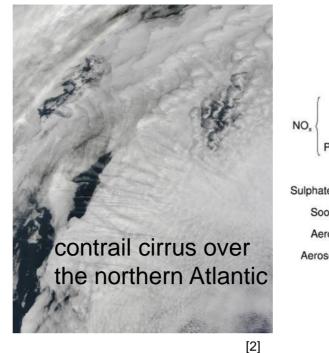
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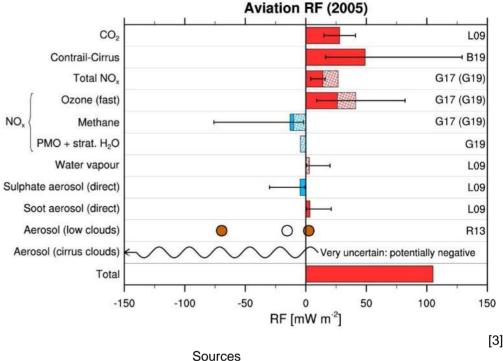


**Aviation** More than CO<sub>2</sub> Effects

The contribution of global aviation in 2011 was calculated to be 3.5 % of the net anthropogenic effective radiative forcing  $ERF^{[1]}$ . Two-thirds are non-CO<sub>2</sub> terms

- CO<sub>2</sub>
- $NO_x \rightarrow CH_4 \& O_3$
- H<sub>2</sub>O
- Soot particle emission
- SO<sub>x</sub>
- Unburnt Hydrocarbons (UHC)
- Formation of persistent linear contrails
- Aviation induced cloudiness (AIC)





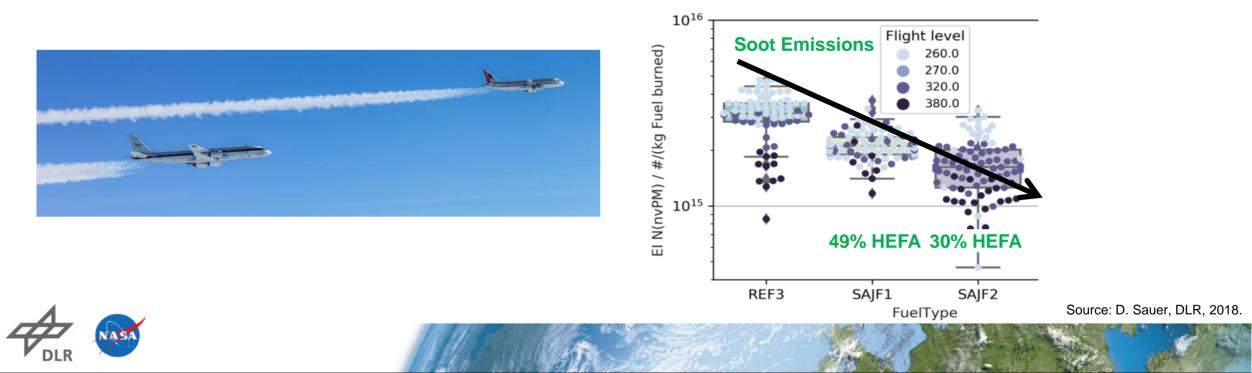
[1] Lee et al. Atm. Env. 2021.

[2] NASA, MODIS, Terra Satellite February 9, 2015.

[3] DLR Institute of Atmospheric Physics

# ECLIF – II / ND-MAX Measurement Campaign Results

- Using sustainable aviation fuel (SAF) to reduce CO<sub>2</sub> emissions from a LCA perspective: Roundtable on Sustainable Biomaterials (RSB) report shows HEFA biofuel used in ECLIF-II yields > 60% reduction in CO<sub>2</sub> emissions w/r fossil Jet A-1.
- Designing the composition to reduce non-CO<sub>2</sub> effects: Designer fuel based on 30% HEFA (SAF2), which is currently more realistic from a production capacity and economic perspective leads to greater reductions in soot emissions and ice crystal concentrations than the 49%-51% blend (SAF1).





# Sustainable Aviation Fuels Drop-In vs. Near Drop-In vs. Non Drop-In Fuels

# Drop-In

Fully compatible to transport-, storage- and technology systems

- Max. 50% SAF blend
- Max. 40% CO<sub>2</sub> reduction

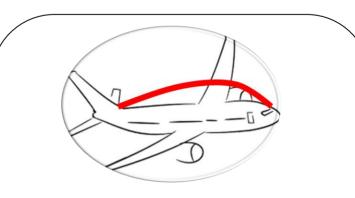


Near Drop-In

Up to 100% SAF

(e.g. FT-SAF according to

- D7566 fully compatible)
- 80-100% CO<sub>2</sub> reduction
- No sulfur
- No aromatics
- Increased local air quality



#### Non Drop-In

#### $LH_2$

- Zero emissions of carbon and soot
- Significant water emissions
- Open question: tank volume



# **Don't forget the certification process for Jet Fuels!**

#### Fuel prescreening process (JETSCREEN & NJFCOP joint development) Phase1: 6 Months ~ \$50k (Testing Cost) ~ 200 liter Neat Fuel **Property Predictions** Tier 2 & Blend Estimations Tier 1 Tier alpha 5 mL · GCxGC Phase 1 IR absorption, and/or ASTM NMR Research Report Educates about ASTM D4054 & provides indicative target values and direction Fit-For-Purpose Specification Properties Properties Tier 4 Tier 3 **Critical Properties** Tier & Blend Limits Phase 2 'beta 500 ml ASTM DCN Viscosity Research Tier beta Surface Tension Density (0.5) Report Distillation Curve Thermal stabil. Systematic de-risking for preparing ASTM D4054 Engine/APU Testing Component/Rig Testing based on low cost measurements and accurate Phase 2: 2 - 3 Years predications ASTM ~ \$4M (Testing Cost) Review ~100k - 450k liter Neat Fuel Accept & Ballot ASIM

#### **ASTM D4054 Fuel Evaluation Process**

INTERNATIONAL

Standarits Workheit

**ASTM Specification** 

6 Months to 1 Year

~ \$350k (OEM Cost)

Ioneywel

Rolls-Rovce

**OEM Review &** Tier 3 & 4 Requirements

> SAFRAN BOEING

**OEM Review & Approval** 

lonevwo

Rolls-Royce

AIRBUS

6 Months - 1 Year

~ \$1M (OEM Cost)

**FAA Review** 

(Mark Rumizen, FAA)

Re-Eval

As Require

Rejec

ASTM Specification

**ASTM Balloting Process** 

AIRBUS

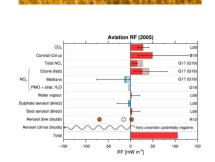
SAFRAN BOFING

## **Final Remarks** Sustainable Aviation Fuels: Options and Challenges

Sustainable Aviation Fuels (Bio- and e-Fuels!) essential for climate targets while increasing local air quality



# - AT TY



#### **Advanced Bio-Fuels**

- Development and demonstration of process technologies for waste material and advanced biomass
- Support investment by supporting regulations and business cases
- Decentralized concepts feasible

#### PtL technologies

- Processes steps are known, lack of experience for commercially sized plants and entire process chain
- Development and demonstration large-scale plants
- Initiative of BMVI for a development platform for PtL fuels
- Research for specific technical components (as CO<sub>2</sub>-source, MtJ, ...)

#### **Challenges and Chances**

- Reduction of costs!
- Important non-CO<sub>2</sub> component of the aviation climate impact (>50%) e.g. aircraft induced cloudiness (AIC)

SAF will reduce climate impact: Mitigation of  $CO_2$  emissions and reduction of AIC

 $\rightarrow$  A premium jet fuel worth the premium price

# Thank you for your attention!





Credits: DLR/NASA/Friz