European Union Aviation Safety Agency

What are Sustainable Aviation Fuels (SAF) exactly?

Sustainable Pilot Training Webinar

14-15 June 2022

Working for quieter and cleaner aviation.

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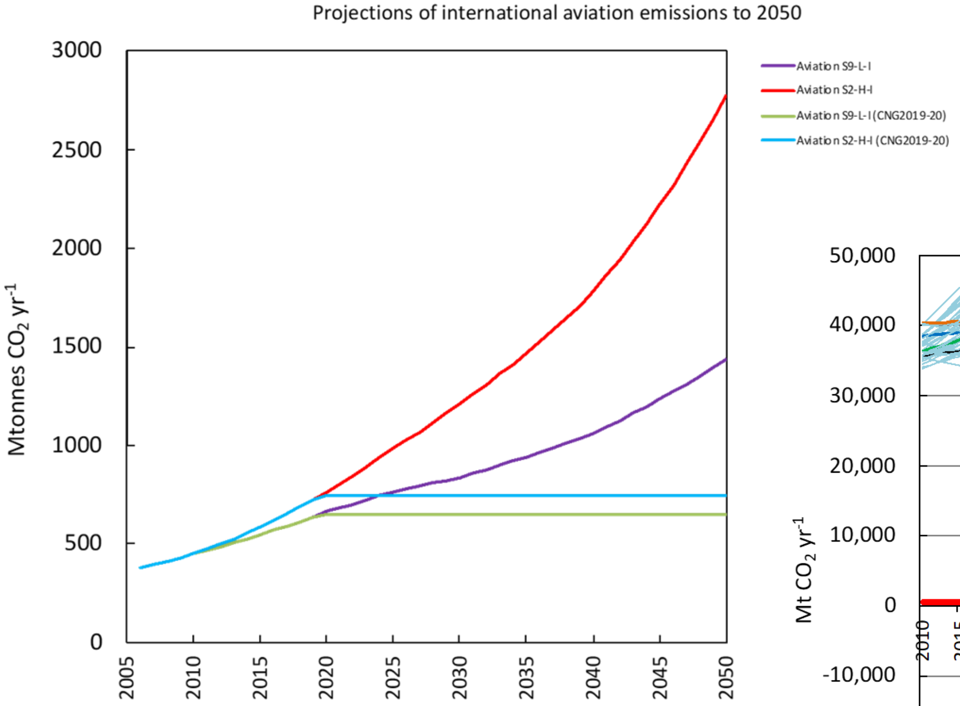
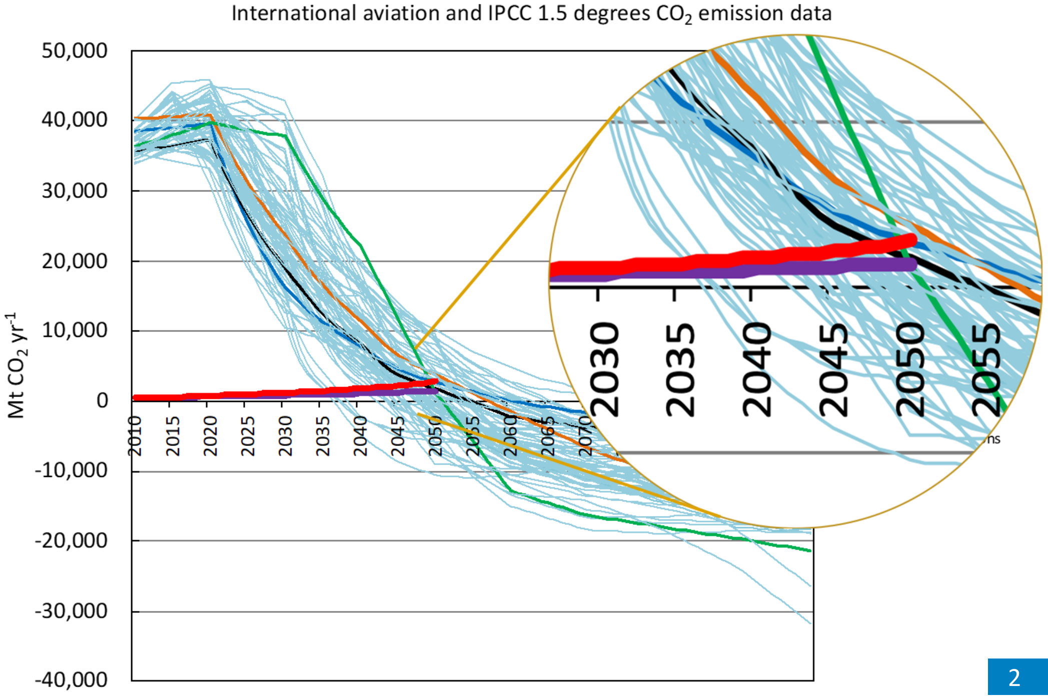
The Challenge



By mid-century aviation could account for major part of global CO_2 emissions budget

Projections prior Covid-19



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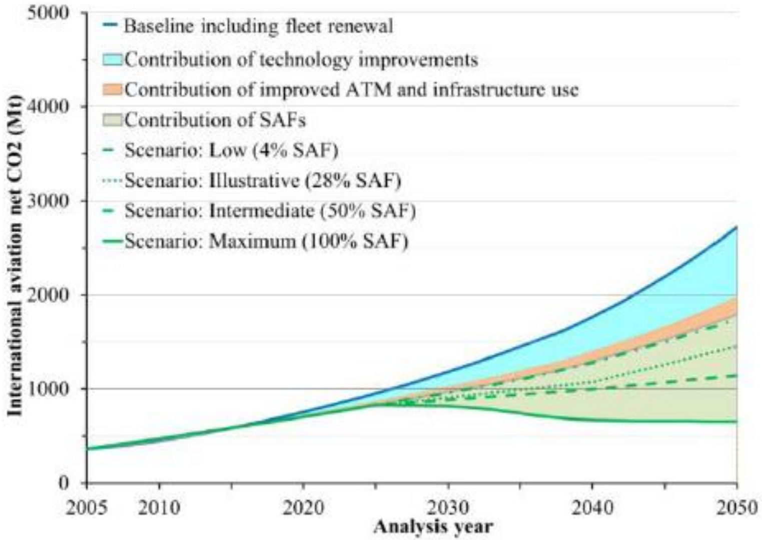
Basket of Measures

- → Technology-Design, Operations, **Sustainable Aviation Fuels (SAF)** and Market Based Measures.
- → Expectation that drop-in SAF will play a significant role in the mitigation of aviation CO_2 emissions using the existing global fleet.

- → **But what are Sustainable Aviation Fuels?**



What are Sustainable Aviation Fuels?

- Sustainable aviation fuel (SAF) is the main term used by the aviation industry to describe a sustainable, non-conventional, alternative to fossil-based jet fuel.

- SAF is the preferred ICAO term, but other terms often used to describe types of SAF (e.g. renewable jet fuel, biojet fuel, e-fuels)

Drop-in fuels

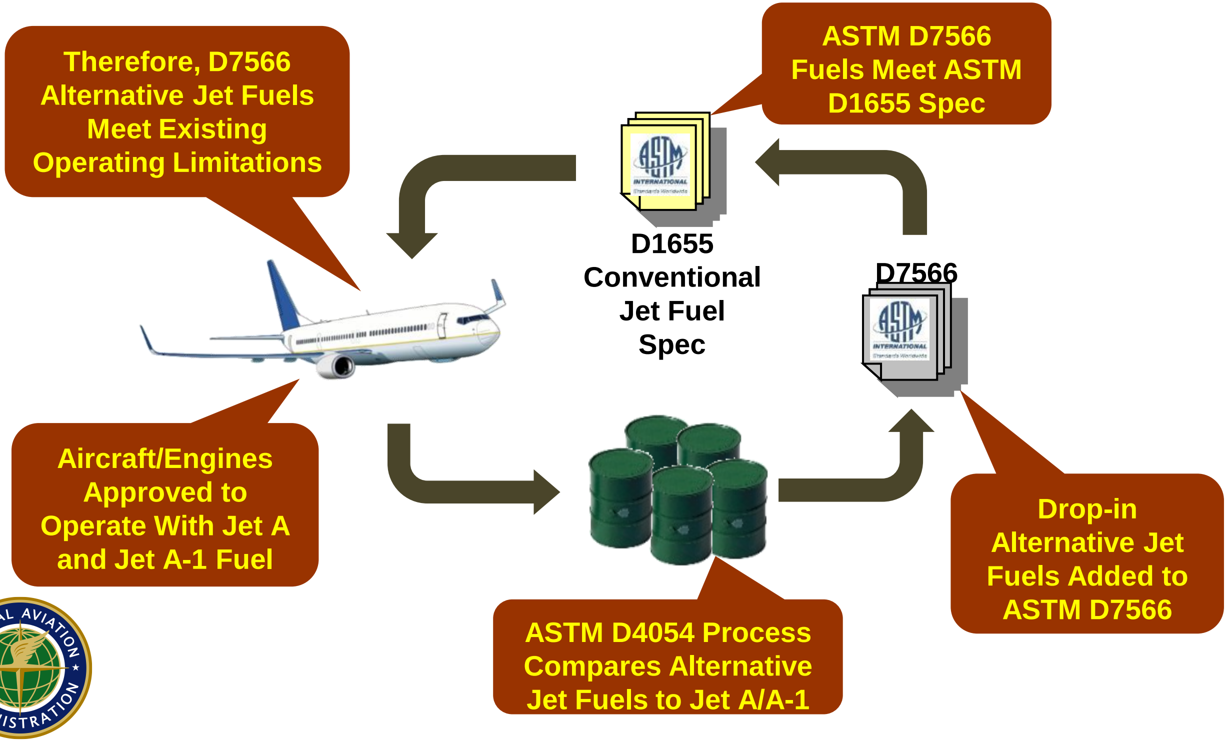
- Current SAF focused on so-called ‘**drop-in fuels**’
  - Physical and chemical characteristics are almost identical to conventional fossil based jet fuel and can therefore be safely mixed (at various blend ratios).
  - Uses the same fuel supply infrastructure and doesn’t require adaptation of current global fleet.

- Drop-in fuels need to comply with international jet fuel specifications (e.g. ASTM D1655 and Def Stan 91-91)
  - Contain requirements for composition, volatility, fluidity, combustion, corrosion, thermal stability, contaminants, additives etc.

Approved SAF pathways

Production pathway	Feedstocks	Certification name	Blending limit
Biomass Gasification + Fischer-Tropsch (Gas+FT)	Energy crops, lignocellulosic biomass, solid waste	FT-SPK	Up to 50%
Hydroprocessed Esters and Fatty Acids (HEFA)	Vegetable and animal fat	HEFA-SPK (up to 50%)	Up to 50%
Direct Sugars to Hydrocarbons (DSHC)	Conventional sugars, lignocellulosic sugars	HFS-SIP	Up to 10%
Biomass Gasification + FT with Aromatics	Energy crops, lignocellulosic biomass, solid waste	FT-SPK/A	Up to 50%
Alcohols to Jet (AtJ)	Sugar, starch crops, lignocellulosic biomass	ATJ-SPK	Up to 50%
Catalytic Hydrothermolysis Jet (CHJ)	Vegetable and animal fat	CHJ or CH-SK	Up to 50%
HEFA from algae	Microalgae oils	HC-HEFA-SPK	Up to 10%
FOG Co-processing	Fats, oils, and greases	FOG	Up to 5%
FT Co-processing	Fischer-Tropsch (FT) biocrude	FT	Up to 5%

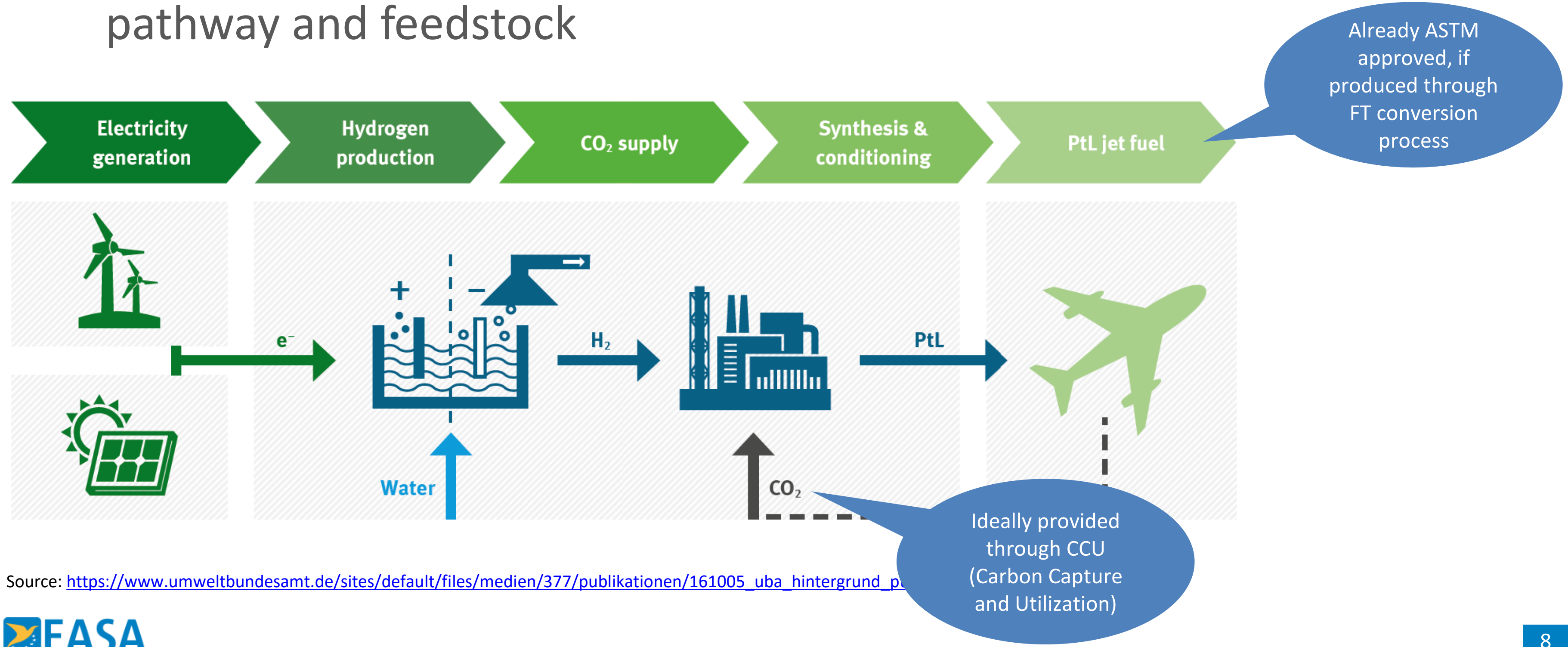
Aviation Fuel Approval Tied to Aircraft/Engine Type Certificate



Source: FAA

Power-to-Liquid SAF

→ Power-to-Liquid (PtL) 'e-fuels' offer another alternative production pathway and feedstock



Source: https://www.umweltbundesamt.de/sites/default/files/medien/377/publikationen/161005_uba_hintergrund_p

100 % SAF – Options, Open Questions

- Drop-in vs. Non Drop-in fuel
- Drop-in:
  - Has to have same composition and properties as conventional Jet A-1
  - Can be used on all aircraft without restrictions, no change to ground infrastructure
  - ASTM D4054 process applicable
  - Limits the pathways – e.g. 100% Synth. Paraffinic Kerosin (SPK) cannot be used (density too low, material compatibility issues due to lack of aromatics)
- Non Drop-in:
  - New fuel grade, new fuel specification, approval process not addressed in detail in current D4054
  - Only for new aircraft, separate infrastructure required
  - Not bound to the limitation of Jet A-1 → more flexibility regarding fuel production pathways

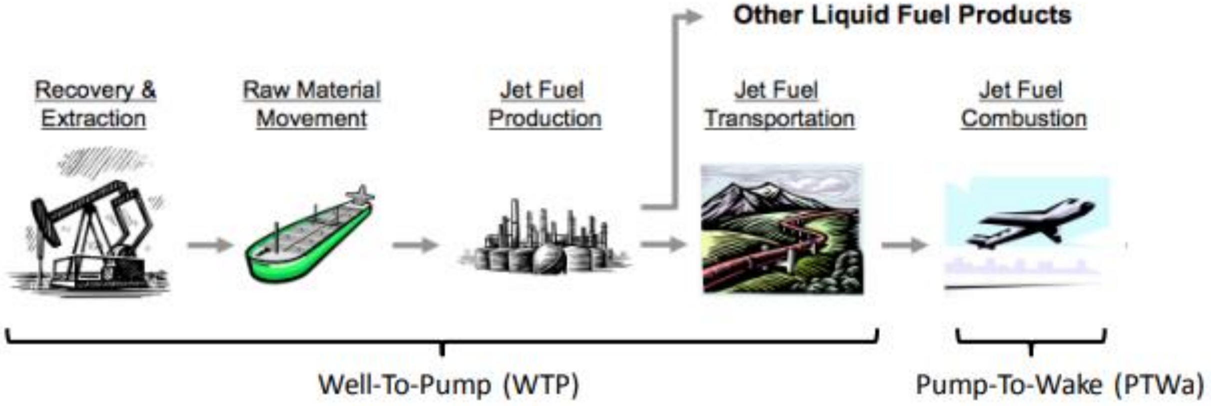
ASTM Task Force on 100% SAF standardization established in February 2021

SAF Sustainability

- Achieving a **net CO_2 emissions reduction** is the main objective for using SAF in order to meet the aviation sector's ambitious climate goals.
- Various sustainability criteria (e.g. **CORSIA, EU RED**).
- SAF must demonstrate a net carbon reduction through a **lifecycle analysis (LCA)**
- Emissions from the combustion of drop-in SAF are comparable to fossil-based jet fuels, except for marginal efficiency gains, hence **the majority of the reductions in GHG emissions originate from the production process**

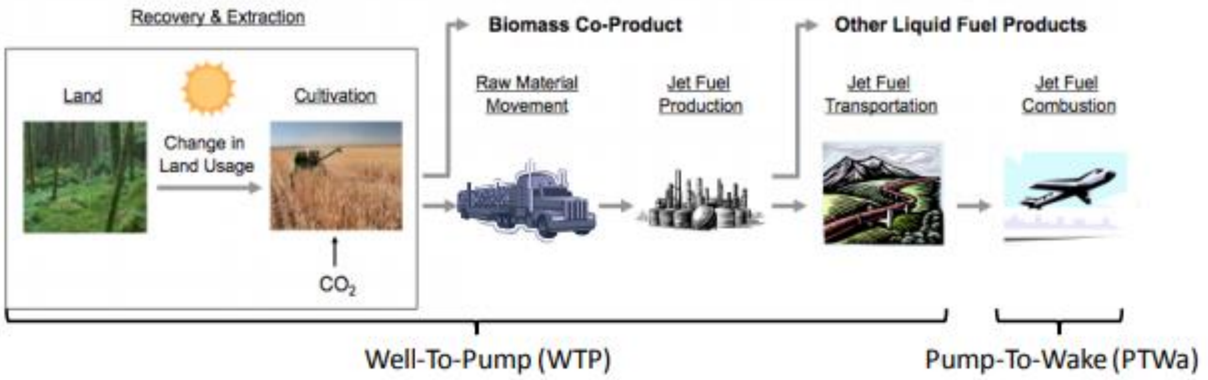
SAF Lifecycle Assessment

Well-to-Wake Pathway for Conventional Jet Fuel



Life Cycle Analysis (LCA)

Well-to-Wake Pathway for <u>Bio-Based</u> Alternative Jet Fuel



Source: https://greet.es.anl.gov/files/aviation-lca

SAF Environmental Benefits

- → SAF can achieve **CO_2 emission reductions of up to 80%** on a lifecycle basis.
- → Fewer compounds (e.g. sulphur, aromatics) → improving air quality by reducing sulphur dioxide (SO_2) and particulate matter (PM) emissions.
- → Use of municipal waste biomass for SAF feedstock avoids it going to landfill.

SAF challenges

- Challenges turning aspirational goal into reality, including:
  - Price competitiveness
  - Ensuring sustainability
  - Meeting technical requirements, i.e. fuel specification standards
  - Fragmented policy landscape

ReFuelEU Aviation

→ Legislative proposal to ensure a **well-functioning aviation market** while accelerating decarbonisation with a gradual ramp-up of SAF

→ **Ambitious binding SAF targets** focusing on innovative, sustainable and scalable fuel technologies:

Total shares in the fuel mix (in %)	2025	2030	2035	2040	2045	2050
SAF ramp up:	2	5	20	32	38	63
Of which: sub-mandate on e-fuels	-	0.7	5	8	11	28

→ Adoption expected in late 2022

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Questions?

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