CEN WORKSHOP AGREEMENT

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English version

Sustainable Aviation Fuel (SAF)

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Foreword

This CEN Workshop Agreement (CWA 18248:2025) has been developed in accordance with the CEN-CENELEC Guide 29 "CEN/CENELEC Workshop Agreements – A rapid way to standardization" and with the relevant provisions of CEN/CENELEC Internal Regulations - Part 2. It was approved by the CEN Workshop Agreement "Sustainable Aviation Fuel", the secretariat of which is held by "Danish Standards" consisting of representatives of interested parties on 2025-06-13, the constitution of which was supported by CEN following the public call for participation made on 2025-05-22. However, this CEN Workshop Agreement does not necessarily include all relevant stakeholders.

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Introduction

CEN Workshop Agreement has been initiated as part of the Horizon 2020 Alight project to raise awareness and alignment about the key role of Sustainable Aviation Fuel (SAF) in the transition to carbon neutrality in the aviation sector, as well as to explain the environmental benefits. One of the objectives of this CWA is to increase awareness in our industry on agreed terminology, which we should all use to avoid confusion and operational risks.

The ALIGHT project is a Horizon 2020 EU funded project that addresses the global need to reduce greenhouse gas (GHG) and other air emissions in order to adapt to climate change and promote a sustainable future. It is doing so through the development and demonstration of two sustainable solutions to be implemented in Copenhagen Airport (the Lighthouse airport), namely

1. the supply, implementation, integration and smart use of sustainable aviation fuel (SAF), and

2. the development, integration and implementation of smart energy systems (including renewable energy sources, energy storage and energy management).

On the SAF side, ALIGHT is tackling smart, sustainable and cost-effective handling of SAF in the operational context of a major airport. The project addresses the SAF chain from producer, supplier and procurement to integration and demonstration and ensures compliance with all relevant criteria, including sustainability.

Among the advantages of SAF approved today, is that it conforms to the same aviation fuel specifications as conventional aviation fuels and does not require separate infrastructures, as it is totally fungible and miscible with conventional aviation fuel.

In addition, the SAF value chain is fully covered by international standards, that ensure robust, relevant and sustainable implementation.

During the event organized on April 18th, 2024, in Brussels, by CEN CENELEC, about “Navigating the Transition (to carbon neutrality): Standards Powering the Journey of Alternative Fuel Infrastructure”, conclusions from the aviation session can be summarized as follows:

- SAF will be the key driver of the transition;
- SAF will be a reference for decades;
- SAF value chain is covered by robust sets of standards from production to usages;
- SAF definitely provide environmental benefits;
- SAF related challenges are related to:
    - Strong need from airliners to engage proactively in fueling with SAF;
    - SAF producers and users need the right policy and incentives to help overcome the premium price of the fuel.
- SAF can pave the way to scheming value chain management for other e-fuels, such as Hydrogen, electricity.

Recommendations from this event are the following:

- Raising awareness about SAF as a key driver of the transition;
- Branding the role of SAF in meeting our EU decarbonization targets by 2050;

- Boosting the production of SAF;
- Boosting the engagement of airliners in refueling with SAF (blending with progressive ratio as from the RefuelEU aviation);
- Adding incentives to producers and users to overcome the price premium, learning for exiting markets currently using them and effectively accelerating the use of SAF;
- Mapping SAF value chain with related standards in support of scheming value chain and standardization needs for other e-fuels;
- Supporting ALIGHT CWA proposal towards awareness raising in support of replication and deployment of SAF in all EU airports (and beyond);
- Supporting ALIGHT CWA proposal towards paving the way for other e-fuel scheme about value chain and standardization needs.

1 Scope

This CEN Workshop Agreement (CWA) aims to provide comprehensive documentation covering the following key areas:

- Terminology about SAF;
- Description of the value chain of SAF from production to fuelling the aircrafts, with the reference standards at each sequence of the value chain;
- A generic mapping of the value chain and the required standards to support other e-fuels value chain approach.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM D1655, *Standard Specification for Aviation Turbine Fuels*

ASTM D7566, *Standard Specification for Aviation Turbine Fuels Containing Synthesized Hydrocarbons*

DEF STAN 91-091, *Turbine Fuel, Kerosene Type, Jet A1; NATO Code: F-35; Joint Service Designation: AVTUR*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp/

— IEC Electropedia: available at http://www.electropedia.org/

SAF vs SBC

It is crucial to distinguish between SAF and Synthetic Blending Components (SBC).

Synthetic aviation fuel (SAF), SAF blend, or 'synthetic jet fuel blend' are other terms that are sometimes applied to synthetic jet fuel. In other industry communications and contrary to this publication SAF is sometimes used to refer to SBC. It is critical for quality assurance purposes that the definition of SAF being used in discussions and contract negotiations is confirmed/well understood. SAF is in widespread use as the acronym for Sustainable Aviation Fuel. It is an important distinction that not all synthetic aviation fuels can be considered as sustainable. SAF/ synthetic jet fuel is referred to as drop-in fuel, because it can be handled (stored, commingled, shipped and delivered to aircraft) in the same supply chains used for conventional jet fuel, which is critical for operational efficiency. As a drop-in fuel, it may be used for any civil aviation aircraft approved for conventional jet fuel and may be commingled in any ratio with conventional jet fuel. Currently, most approved drop-in SAF is a blend of SBC and conventional jet fuel. (Note: Military aircraft may have unique control requirements for use with semi-synthetic jet fuels requiring specific Military Authority approval.) .

3.1
SAF – Sustainable Aviation Fuel
aviation jet fuel containing components produced from non-petroleum sources either by blending (reference ASTM D7566) or co-processed (reference DEF STAN 91-091) conforming to international

specifications and requirements, (technical (e.g. DEF STAN 91-091) + environmental or sustainability criteria (e.g. Refuel EU Aviation))[1]

3.2
Synthetic aviation fuels
commonly used to refer to SBCs produced from non-biologic sources such as efuels produced from carbon dioxide and hydrogen

3.3
Synthetic Aviation Turbine Fuels (SATF)
terminology used in ASTM D7566 to describe jet fuel containing components not derived from conventional petroleum sources

3.4
SBC – synthetic blending component
synthetic kerosene blending components as defined in ASTM D7566 for blending with petroleum derived jet fuels to produce fuels compliant with ASTM D1655, DEF STAN 91-091

3.5
SSJF – semi-synthetic jet fuel
jet fuels containing a mixture of material derived from petroleum and non-petroleum sources

3.6
Carbon Neutrality
balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks

3.7
ReFuelEU Aviation
Regulation 2023/2405 on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation) promotes the supply of sustainable aviation fuels (SAF) and provides a subtarget for synthetic aviation fuels (efuels)

Note 1 to entry: The measure is part of the Fit for 55 package to meet the emissions reduction target of 55% by 2030. It sets requirements for aviation fuel suppliers to gradually increase the share of SAF blended into the conventional aviation fuel supplied at EU airports.

3.8
ICAO - International Civil Aviation Organization
United Nations agency which helps 193 countries to cooperate together and share their skies to their mutual benefit, established in 1944

Note 1 to entry: ICAO serves as the global forum of States for international civil aviation. ICAO develops policies and Standards, undertakes compliance audits, performs studies and analyses, provides assistance and builds aviation capacity through many other activities and the cooperation of its Member States and stakeholders.

3.9
IPCC - Intergovernmental Panel on Climate Change
United Nations body for assessing the science related to climate change

[1] Note that this "definition" is more of a description of what "SAF" usually implies. There is no uniform definition of "SAF" in the various legal frameworks.

3.10
Contrails - condensation trails
line-shaped clouds produced by aircraft engine exhaust or changes in air pressure, typically at aircraft cruising altitudes several kilometres/miles above the Earth's surface

Note 1 to entry: They are composed primarily of water, in the form of ice crystals.

3.11
EASA - European Union Aviation Safety Agency
Agency of the European Commission with responsibility for civil aviation safety in the European Union

Note 1 to entry: It carries out certification, regulation and standardisation and also performs investigation and monitoring. It collects and analyses safety data, drafts and advises on safety legislation and co-ordinates with similar organisations in other parts of the world.

3.12
ILUC - Indirect Land Use Change
displacement of agricultural production (food, feed) or forest production (fibre, timber) to previously uncultivated areas

Note to entry: According to CORSIA, ILUC means Induced Land Use Change. Feedstocks that have been classified as wastes, residues, or by-products by ICAO have a default ILUC value of zero, independently from region or conversion process. See clause 5.6.3.2.

Note 2 to entry: According to EU Commission Delegated Regulation (EU) 2019/807 of 13 March 2019 supplementing Directive (EU) 2018/2001, Indirect land use change ('ILUC') can occur when land previously devoted to food or feed production is converted to produce biofuels, bioliquids and biomass fuels.

3.13
RED - Renewable Energy Directive
Renewable Energy Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources establishes common rules and targets for the promotion of renewable energy across all sectors of the economy

Note 1 to entry: The directive is the legal framework for the development of renewables across all sectors of the EU economy. In 2023 RED was amended as part of Fit For 55 (FF55) whereby aviation became a part of the RED transport target.

3.14
EU ETS - EU Emissions Trading System
carbon emission trading scheme (or cap and trade scheme) intended to lower greenhouse gas emissions in the EU, which was established in 2003 and came into effect from 2005

Note 1 to entry: Cap and trade schemes limit emissions of specified pollutants over an area and allow companies to trade emissions rights within that area. The ETS covers around 45% of the EU's greenhouse gas emissions.

3.15
ETD - Energy Taxation Directive
European directive, which establishes the framework conditions of the European Union for the taxation of electricity, motor and aviation fuels and most heating fuels

Note 1 to entry: The directive is part of European Union energy law; its core component is the setting of minimum tax rates for all Member States.

3.16
AFQRJOS -Aviation Fuel Quality Requirements for Jointly Operated Systems
document (JIG PQ Bulletin) that defines the fuel quality requirements for supply into Jointly Operated Fueling Systems operated to JIG Standards

Note 1 to entry: The Aviation Fuel Quality Requirements for Jointly Operated Systems (AFQRJOS) for Jet A-1 embodies the requirements of the following two specifications, Defence Standard DEF STAN 91-091 latest Issue (for Turbine Fuel Kerosene Type, Jet A-1, NATO Code F-35, Joint Service Designation: AVTUR) and ASTM Standard Specification D1655 for Aviation Turbine Fuels "Jet A-1" (Latest issue).

Note 2 to entry: The Jet fuel that meets the AFQRJOS is usually referred to as "Jet A-1 to Checklist" or "Checklist Jet A-1" and, by definition, allows custodians of the fuel to supply against either of these specifications.

3.17
ASTM International
Standards organization that develops and publishes voluntary consensus technical international standards for a wide range of materials, products, systems and services including aviation fuels

3.18
DEF-STAN
Defence Standard, a series of standards developed by the UK’s Ministry of Defence

3.19
Conventional Jet Fuel
jet fuel, refined and produced from conventional hydrocarbons such as crude oil, condensates, shale oil and tar sands, to meet international jet fuel specifications such as ASTM D1655 and Def Stan 91-091

3.20
EI – Energy Inistitute
global professional organization for the energy industry, developing and sharing research, skills, and best practices toward safe, secure, and sustainable energy

3.21
JIG – Joint Inspection Group
international organization for the development of aviation fuel supply standards covering the entire supply chain for Aviation Fuels from refinery to wingtip

3.22
OEM – Original equipment manufacturer
aircraft engine and airframe manufacturers

3.23
Aviation fuel supplier
entity supplying fuel to the market that is responsible for passing fuel through an excise duty point or, where no excise is due or where duly justified, any other relevant entity designated by a Member State

3.24
Fuel handling
transportation, storage, delivery, fueling, and draining of fuel or fuel waste products and fueling of aircraft or vehicles

3.25
Batch (SAF)
distinct quantity of jet fuel that can be characterised by one set of test results and is homogeneous at point of origin

Note 1 to entry: This applies to all defined above, SAF, SBC and SSJF and conventional fuel.

3.26
Union airport
airports where passenger traffic was higher than 800,000 passengers or where the freight traffic was higher than 100,000 tonnes in the previous reporting period and which are not situated in an outermost region, as listed in Article 349 TFEU (Treaty on the Functioning of the European Union)

3.27
Aircraft operator
person that operates at least 500 commercial passenger air transport flights or 52 commercial all-cargo air transport flights departing Union airports in the previous reporting period

4 Background

4.1 General

In 1999, at the request of the ICAO, the Intergovernmental Panel on Climate Change (IPCC) released a special report on Aviation and the Global Atmosphere. This report concluded that "*Aircraft emit gases and particles directly into the upper troposphere and lower stratosphere where they have an impact on atmospheric composition. These gases and particles alter the concentration of atmospheric greenhouse gases, including carbon dioxide (CO2), ozone (O3), and methane (CH4); trigger formation of condensation trails (contrails); and may increase cirrus cloudiness—all of which contribute to climate change.*"

In 2020, the European Air Safety Agency (EASA) released a report, which reconfirmed that "*the net non-CO2 impact of aviation is a warming effect on the climate*" and "*the Effective Radiative Forcing (ERF) from the sum of non-CO2 impacts yields a net positive (warming) effect that accounts for more than half (66%) of the aviation net forcing in 2018*". In other words, while exact quantification is difficult, the climate impact of aviation non-CO2 is likely double that of CO2 emissions alone.

Sustainable aviation fuel (SAF) is a liquid hydrocarbon fuel which is widely regarded as critical to reducing the climate impact of aviation. There is no standard definition for SAF. However, what the various definitions of SAF typically have in common is that it

- shall offer a drop-in alternative to conventional fossil jet fuel[2],
- is produced from renewable sources, and
- requires a lower environmental footprint than conventional fossil jet fuel.

The European Union and the International Civil Aviation Organisation ("ICAO"), among others, have defined SAF in a similar, though not identical, manner and created regulatory frameworks for its use with the aim to address the environmental footprint of aviation and to reduce the dependency on fossil fuels. The following chapter will outline those legal frameworks.

Technical standards ensure safe use of the aviation fuel from non-petroleum sources in existing infrastructure and aircraft turbines (e.g. SAF may currently only be used as a blend or co-processed with

[2] An aviation jet fuel containing components produced from non-conventional sources either by blending or co-processed conforming to international specifications and requirements (including ASTM D7566 and DEF Stan 91-091).

conventional fossil jet fuel of up to a maximum of 50 %). The chapter “Technical Consideration” will describe those requirements in more detail.

A summery table of obligation and reporting can be found in Annex A.

4.2 SAF Benefits

SAF has the potential for a significantly lower greenhouse gas emission footprint[3] compared to fossil jet fuel over its entire life cycle, considering amongst others the raw materials, production route and combustion. The total emissions savings as well as other environmental benefits that SAF can achieve vary accordingly. To ensure a certain level of emissions savings and environmental benefits, policymakers have set minimum thresholds for emissions savings and established sustainability criteria for feedstock use. Factors like feedstock availability, direct and indirect land use change risks, and fraud risk are part of the balancing act of policy makers defining under which conditions aviation fuels can be considered ‘sustainable’.

Certain types of SAF further have the potential to lower the so-called non-CO2 impact of aviation. Compared to conventional fossil jet fuel, they have the potential to reduce non-volatile PM and sulphate aerosols (SOx), and consequently contrails, and might also reduce nitrogen oxides (NOx).

Notwithstanding existing uncertainties in research, the vast amount of fundamental research over the past decades has led to deeper understanding, including the fact that contrails are one of two largest quantifiable aviation non-CO2 effects. Contrails have a net positive RF (warming effect). European policymakers are currently taking the lead in further evaluating and addressing the non-CO2 impact of aviation.[4] Under the EU Emissions Trading System (EU ETS), aviation operators have a legal obligation to monitor, report and verify (MRV) their CO2 emissions and surrender allowances equivalent to their emissions.

SAF offers significant potential for reducing aviation’s climate impact, but its deployment is limited, accounting for 0,53 % of global jet fuel consumption in 2024.[5] Scaling up production substantially in the coming years is crucial. Current limitations include low demand and insufficient legal certainty for new investments. Future demand will face challenges related to feedstock availability for the already mature SAF production pathways and high cost for newer, less mature SAF production pathways. Simultaneous development of both mature and immature SAF production technologies is necessary for cost-effective decarbonization of the aviation sector.

The coming decades will show increased demand for SAF ensured by regulatory frameworks requiring or incentivizing its use. The following chapters will provide insight into the regulatory setup for SAF deployment on EU level.

[3] Depending on the methodology, it can reduce GHG Emmissions up to 90%.
[4] See ECLIF 3 Study: https://acp.copernicus.org/articles/24/3813/2024/
[5] https://www.easa.europa.eu/sites/default/files/eaer-downloads/EASA_EAER_2025_Book_v4.pdf

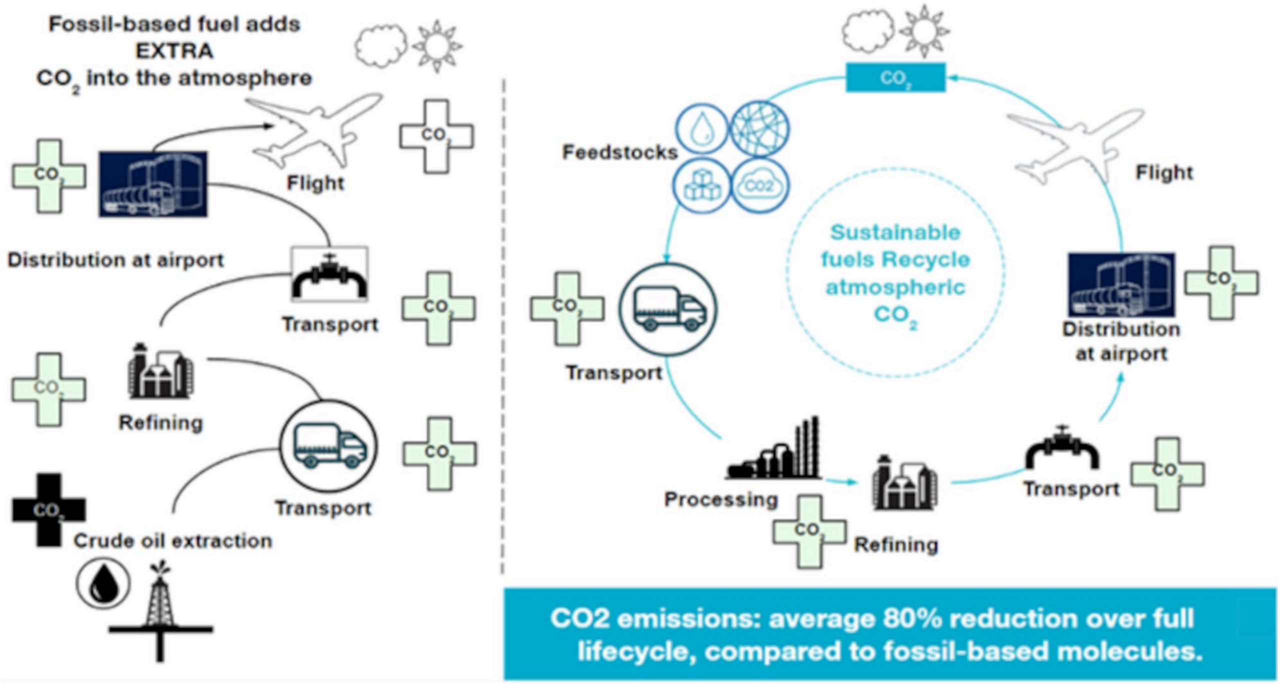


Figure 1 — CO2 lifecycle of fossil and non-fossil aviation

5 Regulatory context

5.1 Introduction

At the UN Climate Change Conference (COP21) in Paris on 12 December 2015, 196 States adopted the Paris Agreement which is a legally binding international treaty on climate change. It entered into force on 4 November 2016. The goal of the Paris Agreement "is to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1,5°C above pre-industrial levels."[6]

Under the European Green Deal, the European Commission proposed a comprehensive package of measures under the name "Fit for 55", aiming at reducing the greenhouse gas emissions ("GHG") in the EU by 55 % by 2030, compared with 1990 levels. The EU contributes to the Paris Agreement with the -55 % GHG emissions target. As part of the so-called 'Fit for 55 Package', amongst others the

— **Renewable Energy Directive**[7] ("RED") was amended. RED is an EU Directive on the promotion of the use of energy from renewable sources which serves as lex generalis to ReFuelEU Aviation. The RED sets the sustainability criteria and GHG saving thresholds for renewable fuels in the EU;

— **ReFuelEU Aviation Regulation**[8] ("ReFuelEU Aviation") was introduced as 'lex specialis' to the RED to ensure the uptake of SAF at Union airports;

[6] https://unfccc.int/process-and-meetings/the-paris-agreement

[7] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources

[8] Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation)

— **EU Emissions Trading System**[9] ("EU ETS") was revised to incentivize the usage of SAF;

— **Energy Taxation Directive**[10] ("ETD") revision was proposed to introduce a kerosene tax on intra-European flights but has not been finalised yet. Therefore, this report will not cover the ETD in any more detail.

On a global level, the ICAO has introduced the **Carbon Offsetting and Reduction Scheme for International Aviation**[11] ("CORSIA") which on an EU level is implemented under the EU ETS.

Please see the table below listing adopted legislation.

Table 1 — Overview adopted legislation

Table header	**Scope**	**Compliance**	**Eligible Fuels**	**Sustainability criteria and GHG methodology**
RED	Renewable energy Within the RED, there is a renewable energy target for all transport sectors in the territory of the EEA	Member State specific implementation of fuel supplier obligations to supply a minimum share of renewable energy or reduce the GHG intensity in the transport sector	Renewable fuels, incl. biofuels and renewable fuels of non-biological origin ("RFNBO") (and recycled carbon fuel ("RCF") upon Member State decision)	Land-use related sustainability criteria and RED GHG saving thresholds The RED GHG methodology covers the whole lifecycle
ReFuelEU Aviation	Aviation fuel supplied at *Union airports* (EEA)	Aviation fuel suppliers to supply minimum share of eligible fuel at Union airports	SAF, i.e. aviation biofuels, synthetic aviation fuels and recycled carbon aviation fuels with reference to RED definitions; renewable hydrogen for aviation with reference to RED definition, and low-carbon aviation fuels, i.e. synthetic low-carbon aviation fuels and low-carbon hydrogen for	Reference to RED for SAF; Relevant parts from the Gas Directive criteria and methodologies (still drafts) will apply to low-carbon aviation fuels

[9] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
[10] COUNCIL DIRECTIVE 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity COUNCIL DIRECTIVE 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity
[11] https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx

<table>
<tr><td></td><td></td><td></td><td>aviation defined in ReFuelEU Aviation</td><td></td></tr>
<tr><td rowspan="2">EU ETS</td><td rowspan="2">GHG emissions released from aviation activities: intra-EEA flights (incl domestic flights), EEA->UK & EEA->CH</td><td>SAF is one compliance option to reduce GHG, but its usage is not obligatory; alternatively, EU allowances can be acquired and surrendered</td><td>‘zero-rated fuels’ means biofuels, bioliquids, biomass fuels, RFNBO or RCF with reference to RED</td><td>Reference to RED for eligibility;
ETS reports the GHG emissions released from the aircraft</td></tr>
<tr><td colspan="2">Support mechanism for eligible aviation fuels covers: Usage of SAF, and other aviation fuels that are not derived from fossil fuels[c], for subsonic flights - which in conclusion covers the following fuels: aviation biofuel, synthetic aviation fuels, synthetic low carbon aviation fuels</td><td>Reference to ReFuelEU Aviation which refers to RED for SAF and “relevant Union law” for synthetic low carbon fuels (i.e. Gas Directive criteria and methodologies which are currently still drafts)</td></tr>
<tr><td>CORSIA</td><td>Aviation fuel used on international flights; note: For international flights within the EEA, to the UK and to CH, the EU ETS implements CORSIA</td><td>Usage of CORSIA Eligible Fuels or purchase of CORSIA Eligible Emissions Units</td><td>SAF and lower carbon aviation fuels; note: CORSIA SAF has a different definition and criteria than the SAF defined in the ReFuelEU Aviation.</td><td>CORSIA methodology</td></tr>
<tr><td colspan="5">a This paper will however only elaborate on aspects of RED which are relevant for aviation.
b European Economic Area: EU Member States, Iceland, Liechtenstein, Norway.
c The criterion “not derived from fossil fuels” shall exclude RCF.</td></tr>
</table>

In the following, we will elaborate on the different legal frameworks.

5.2 Renewable Energy Directive

5.2.1 General

In 2003, the EU adopted the first Directive which aimed at “promoting the use of biofuels or other renewable fuels to replace diesel or petrol for transport purposes”.

In 2009, the first Renewable Energy Directive was adopted with the aim to "promote energy from renewable sources" in the EU. It also introduced the sustainability criteria for biofuels. Since then, the RED has been amended by the so-called ILUC[12] Directive in 2015 which introduced caps on food and feed crop-based biofuels, and the so-called RED II was introduced in 2018 providing a sub-target for advanced biofuels. The latest amendment (RED III) was adopted in 2023.

Being an EU Directive with EEA relevance, the RED needs to be implemented in national law in the EU Member States as well as Liechtenstein, Norway and Iceland.

Related to transport, the RED III allows the Member States to choose between a transport target expressed as a greenhouse gas intensity reduction target or as a share of the consumption of renewable energy. It provides the EU Member States with flexibility to design their policies to decarbonise transport and how to reach either the 29 % renewable energy incorporation or the 14,5 % GHG intensity reduction target in the transport sector in their territory.

5.2.2 Aviation sector & SAF consideration

Thus, the contribution of RED compliant aviation fuels, together with other transport sectors' fuels, is taken into account in the Member State's reporting to reach the transport target. However, the RED requires dedicated obligations on aviation fuel suppliers to be regulated pursuant to ReFuelEU Aviation which was introduced as a *lex specialis* to RED. EU Member States may not introduce any national obligations under RED which require SAF supply or use beyond the share of SAF mandated by ReFuelEU Aviation.

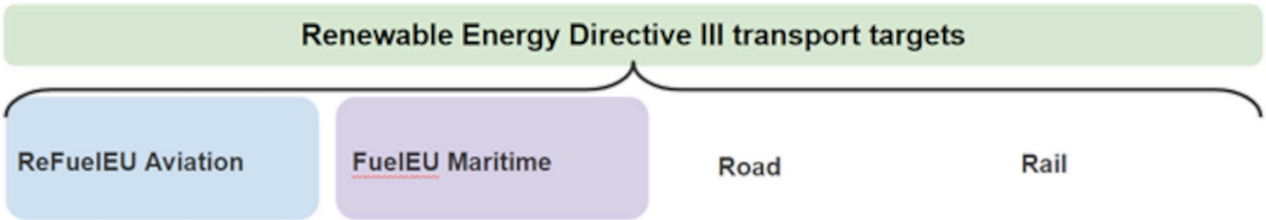


Figure 2 — The EU has an overall renewable energy target for all transport sectors (RED), and dedicated obligations for aviation (ReFuelEU Aviation) and for maritime (FuelEU Maritime)

5.2.3 Sustainability context

To ensure that the fuels eligible under RED are a truly sustainable alternative to fossil fuels, RED imposes specific requirements for the overall environmental impact of those fuels. Amongst others, RED requires minimum GHG emissions savings thresholds, imposes sustainability criteria related to land-use and certain limitations to feedstocks and introduces certification requirements. For further detail, please see Section 5.6.1 RED Sustainability and GHG emissions saving criteria.

5.3 ReFuelEU Aviation

5.3.1 General

ReFuelEU Aviation was adopted at the end of 2023 and came into force at the beginning of 2024, with its main provisions starting to apply in 2025. Being an EU Regulation with EEA relevance, it applies directly in all EU Member States and needs to be implemented in national law in Liechtenstein, Norway and

[12] Indirect land-use change

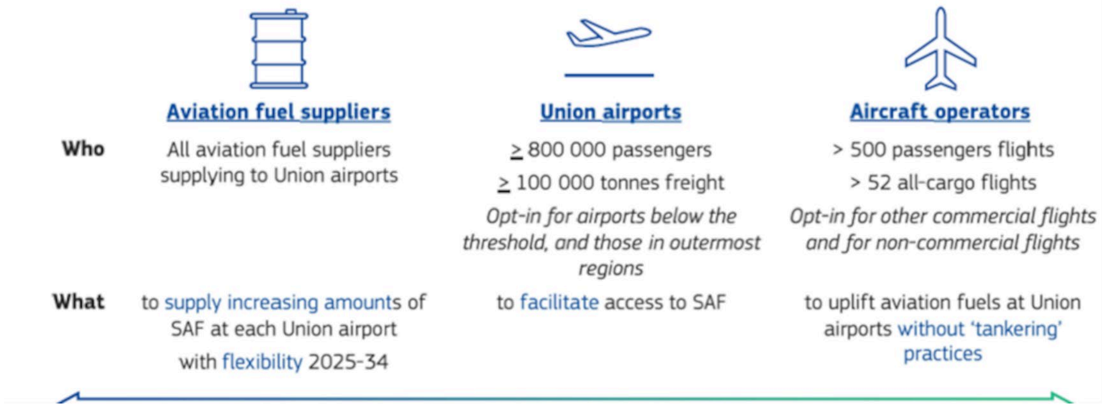
Iceland.[13] Only a few provisions in ReFuelEU Aviation also require national transposition in the EU Member States.

The purpose of ReFuelEU Aviation is to ensure a level playing field for sustainable air transport by obliging

- aviation fuel suppliers to supply a minimum share of physical SAF at Union airports;
- aircraft operators to uplift at least 90 % of the yearly aviation fuel annually at any Union airport[14];
- Union airport managing bodies to facilitate the access of aircraft operators to SAF.

The two obligations for aviation fuel suppliers and aircraft operators are complemented with corresponding reporting obligations.

In preparation for future commercial aircraft propulsion technologies, such as hydrogen and electricity, ReFuelEU Aviation also requires stakeholders to cooperate with their respective Member State for the preparation of the national policy frameworks for the deployment of alternative fuels infrastructure in airports. There are furthermore a few provisions, such as enforcement provisions and the designation of competent authorities, which require national transposition.



[Source: European Commission/DG MOVE, 2023]

Figure 3 — Main ReFuelEU Aviation obligations

Excursus: Differing national aviation fuel supplier definitions

ReFuelEU Aviation lacks a clear definition for 'aviation fuel supplier'. Instead of defining the aviation fuel supplier in a uniform manner in the Regulation itself, it refers to the fuel supplier definition in RED which does not only provide several options[15] *but is also up to Member State interpretation. This leads not only to scattered interpretations of aviation fuel suppliers across the Member States. In some cases, obligated parties own the fuel before it is sold to aircraft operators using it, other obligated parties only handle the fuel at the airport but never own the fuel. In some cases, aviation fuel suppliers could qualify for cross-border fuel deliveries, in others not. There is also no clarity if the obligation is triggered through supply at the*

[13] Note that at this point ReFuelEU Aviation has not yet been implemented in the EEA States. It will therefore only be applied in the EU for the time being and EEA airports are not yet in scope of the Regulation. The EU is, however, engaging with EEA states to facilitate the swiftest adoption of ReFuelEU Aviation.

[14] Note that there is no obligation for aircraft operators in ReFuelEU to uplift SAF.

[15] Under RED, a 'fuel supplier' means an entity supplying fuel to the market that is responsible for passing fuel through an excise duty point or, in the case of electricity or where no excise is due or where duly justified, any other relevant entity designated by a Member State.

airport ("into-plane") or to the airport ("into-tank"), or possible even further upstream, and different interpretations are possible there. All in all, the definition in ReFuelEU Aviation does not provide certainty about who shall qualify as an aviation fuel supplier and meet corresponding obligations.

Excursus: Reference period in Union airport definition

'Union airport' is referred to as an 'airport' as defined in Article 2, point (1), of Directive 2009/12/EC of the European Parliament and of the Council (12) where passenger traffic was higher than 800 000 passengers or where the freight traffic was higher than 100 000 tonnes in the previous reporting period, and which is not situated in an outermost region, as listed in Article 349 TFEU.

All main provisions in ReFuelEU Aviation, such as the SAF supply mandate, the refuelling obligation for aircraft operators as well as the reporting obligations are tied to the Union airport definition. The fact that the Union airport definition refers to the respective previous reporting period, which means the previous calendar year, can lead the the unexpected situation that there is only clarity towards the end of that very reporting year that the airport will qualify as Union airport in the following period. To give a first-hand example, Rovaniemi airport, an airport in Finnish Lapland, happened to exceed the threshold of 800 000 passengers in December 2024 and thus qualifies as Union airport since the beginning of 2025. The exact implications for compliance of the difference stakeholders will be seen over the reporting year 2025.

5.3.2 SAF supply obligation

ReFuelEU Aviation requires aviation fuel suppliers to supply a "minimum share" of SAF at Union airports. This minimum share replaces any national obligations for SAF. National obligations for SAF supply or uptake alongside ReFuelEU Aviation which would lead to a higher level of obligation for SAF are not allowed.[16]

The SAF definition covers (a) synthetic aviation fuels; (b) aviation biofuels; or (c) recycled carbon aviation fuels. 'Aviation fuel' is defined as drop-in fuel manufactured for direct use by aircraft.

The minimum share starts at 2 % in 2025 and increases every five years up to 70 % in 2050. From 2030 onwards, ReFuelEU Aviation introduces a sub-target for synthetic aviation fuel, often referred to as "eSAF", starting at 1,2 % in 2030 and increasing up to 35 % in 2050 (see graph below). Note that there are certain flexibilities provided for the provision of the minimum shares of synthetic aviation fuel increasing gradually from 2030 through 2034, starting with a minimum share of 0,7 % in 2030 reaching 2 % in 2034.

[16] See question 29 in C/2025/1368, COMMUNICATION FROM THE COMMISSION on the interpretation and implementation of certain legal provisions of Regulation (EU) 2023/2405 of the European Parliament and the Council on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation).

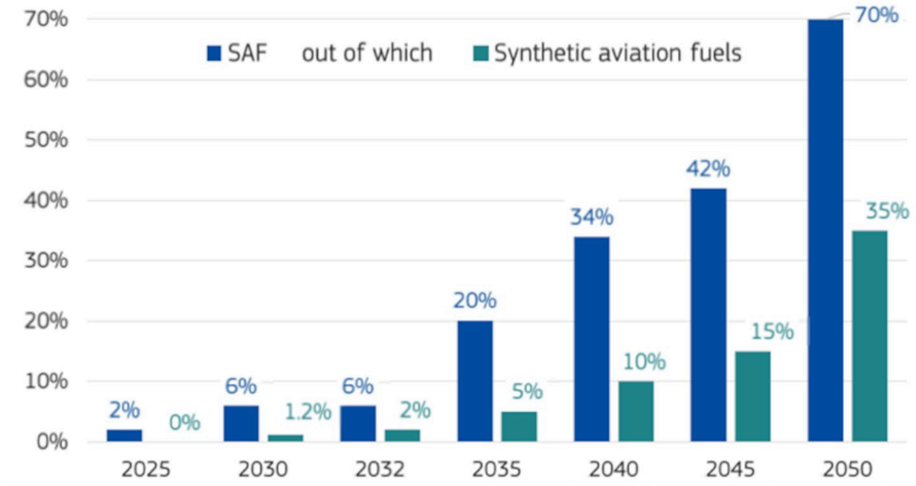


Figure 4 — Minimum shares

[Source: European Commission/DG MOVE, 2023]

The above obligations can also be met where the minimum shares are reached using other eligible fuel, namely renewable hydrogen for aviation[17] or low-carbon aviation fuels. For further information, see right below.

Excursus: Controversial trajectory of minimum shares of SAF and synthetic aviation fuel

As mentioned above, there are certain flexibilities provided for the provision of the minimum shares of synthetic aviation fuel in the first five years from 2030 to 2034.

While the minimum share of SAF in 2030 stays at 6 % for five years, the minimum share of synthetic aviation fuel[18] *starts at an average share of 1,2 % for the years 2030 and 2031, of which each year a minimum share of 0,7 % of synthetic aviation fuels needs to be supplied, and reaches a minimum share of 2,0 % of synthetic aviation fuels, of which in the years 2032 and 2033 a minimum share of 1,2 % of synthetic aviation fuels needs to be supplied. In more simple terms, while the minimum share of SAF stays flat for 5 years before it increases significantly in 2035, the minimum share for synthetic aviation fuel increases in a more linear manner. This leads to a relative decline in demand for fuels eligible to contribute to the minimum shares of SAF, other than synthetic aviation fuels from 4,8-5,3 % in 2030 to 4 % in 2034, just before the overall SAF target rises sharply to 20 % in 2035.*

According to the recently published Communication from the Commission on the interpretation and implementation of RefuelEU Aviation, it is not possible to carry over amounts of SAF supplied above the respective minimum shares for one reporting period to the following reporting period.[19]

5.3.3 Flexibility mechanism for aviation fuel suppliers

From 1 January 2025 until 31 December 2034, aviation fuel suppliers are provided with certain flexibilities: They may supply the minimum shares of SAF as a weighted average over all the aviation fuel

[17] 'renewable hydrogen for aviation' means hydrogen for use in aircraft that qualifies as an RFBNO under RED complies with the required lifecycle emissions savings threshold and is certified in compliance with RED. For more information, please see clause 5.2.

[18] Which can be considered a sub-target to the overall SAF target.

[19] C/2025/1368, COMMUNICATION FROM THE COMMISSION on the interpretation and implementation of certain legal provisions of Regulation (EU) 2023/2405 of the European Parliament and the Council on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation).

they supply across Union airports for the respective reporting period[20]. The level of flexibility for each aviation fuel supplier depends on how "fuel supplier" is defined in national laws implementing RED, which can vary between Member States.

The flexibility mechanism may lead to SAF not being made available at all Union airports within the first 10 years of the SAF supply obligation. However, the European Commission sees limited risk of a significant geographic concentration of blended SAF in few Union airports.

In order for an aircraft operator to claim the use of SAF, the EU ETS requires the physical supply of SAF at an airport situated in the EEA from which the aircraft operator operates. Therefore, the flexibility mechanism has raised concerns amongst the aircraft operators fearing that they will not have any physical access to SAF. As part of the flexibility mechanism, the European Commission is evaluating a system of tradability of SAF to enable fuel supply in the Union without it being physically connected to a supply site. Such a possible system, incorporating elements of a book and claim scheme, might enable aircraft operators or fuel suppliers, or both, to purchase SAF through contractual arrangements with aviation fuel suppliers and to claim the use of SAF at Union airports. In the recently published report on the ReFuelEU Aviation SAF flexibility mechanism, the European Commission confirmed that it could so far not identify any unified industry-wide position neither on the design nor the necessity of implementing such a system of tradability.[21]

Excursus: Flexibility mechanism tied to the aviation fuel supplier definition

The flexibility mechanism is tied to the aviation fuel supplier definition. Depending on the respective aviation fuel supplier definition, there might be no, little or great flexibility for aviation fuel suppliers to comply with the minimum shares of SAF. This situation may thus create an unlevel playing field between aviation fuel suppliers across Europe.

5.3.4 Refuelling obligation for aircraft operators

ReFuelEU Aviation contains a refuelling obligation for aircraft operators which requires them to uplift at least 90 % of the yearly aviation fuel required at any given Union airport. The purpose of the refuelling obligation for aircraft operators is to avoid 'tankering'. Tankering is the practice of aircraft operators of uplifting more fuel than necessary for a trip to cover its return trip. Through this practice aircraft operators take advantage of lower fuel prices at the airport of origin and avoid loading fuel at an airport where it is more expensive.

An aircraft operator may fall below the 90 % threshold if this is necessary to comply with the applicable fuel safety rules. In such cases, the aircraft operator concerned shall duly justify to the competent authorities and EASA the reason for falling below this threshold and indicate the routes concerned. Exceptionally, the aircraft operator may, when duly justified, request from the competent authorities a temporary exemption from the outlined refuelling obligation for the flights on a specific existing or new route of a certain maximum distance.[22] Any exemption granted shall have a limited period of validity of maximum one year, after which it shall be reviewed upon request of the aircraft operator. The European Commission has adopted guidelines on the application of the exemptions.[23]

[20] Reporting period is the period on which the reporting is being done. The respective reporting period starts on 1 January and runs 31 December of the year preceding the reporting year; the reporting year refers to the year in which the reports referred are to be submitted.

[21] COM(2025) 59 final, REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL, The ReFuelEU Aviation SAF flexibility mechanism.

[22] To qualify for exemption, flights must be less than 850 kilometres, or 1 200 kilometres for routes connecting with airports situated on islands without rail or road connections, departing from a Union airport. Those distances are measured by the great circle route method.

[23] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52024XC05997

5.3.5 Sustainability context

5.3.5.1 General

ReFuelEU Aviation determines range of fuels eligible to contribute to the minimum shares. This section will provide information on the eligible fuel categories. For more detailed information on the sustainability criteria of the fuel, please refer to Section 5.6.1 RED Sustainability and GHG emissions saving criteria.

5.3.5.2 Eligible fuels

In the ReFuelEU Aviation, '*sustainable aviation fuels'* (SAF) means:

- *aviation biofuels,*
- *synthetic aviation fuels*, or
- *recycled carbon aviation fuels*.

In addition to SAF, the ReFuelEU Aviation targets can be fulfilled with *renewable hydrogen for aviation* and with *synthetic low-carbon aviation fuels* and *low-carbon hydrogen for aviation*.

- ReFuelEU aviation biofuels

The ReFuelEU '*aviation biofuels*' means:

- advanced biofuels that are produced from the feedstock listed in RED Annex IX Part A,
- biofuels that are produced from the feedstock listed in RED Annex IX Part B, or
- other RED compliant biofuels with the exception of biofuels produced from food and feed crops.

SAF produced from the following feedstocks is excluded from the calculation of the minimum shares of SAF set out in the ReFuelEU Aviation:

- food and feed crops as defined in the RED, and
- intermediate crops, palm fatty acid distillate and palm and soy-derived materials, and soap stock and its derivatives unless they are included in the RED Annex IX.

- **ReFuelEU synthetic aviation fuels & renewable hydrogen for aviation**

ReFuelEU Aviation provides its own definition for '*synthetic aviation fuels*' and '*renewable hydrogen for aviation*'. These refer to renewable fuels of non-biological origin (RFNBO) as defined in the RED.

The definition of "synthetic aviation fuels" in the ReFuelEU Aviation is thereby limited to those e-fuels that are produced from renewable energy other than biomass (RFNBO).

- **ReFuelEU recycled carbon aviation fuels**

The '*recycled carbon aviation fuels*' means aviation fuels that are recycled carbon fuels (RCF) as defined in the RED. In practice, those are aviation fuels produced from fossil waste streams.

- **ReFuelEU low-carbon aviation fuels**

ReFuelEU Aviation also acknowledges '*synthetic low-carbon aviation fuels*' and '*low-carbon hydrogen for aviation*' which are from non-biological origin and their energy content is derived from non-fossil low-carbon hydrogen.

In practice, the synthetic low-carbon aviation fuels in the ReFuelEU Aviation are e-fuels that are produced from non-renewable, non-fossil energy, for example nuclear energy. Through this acknowledgement, the targets of ReFuelEU Aviation can also be met without a contribution towards the renewable energy targets of RED.

The detailed criteria to produce synthetic low-carbon aviation fuels and renewable hydrogen for aviation are still pending clarifications through expected DAs to the Gas Directive.

Table 2 — Eligible aviation fuels under ReFuelEU Aviation

aviation fuel	drop-in fuel manufactured for direct use by aircraft
sustainable aviation fuels ('SAF')	aviation biofuels, synthetic aviation fuels, or recycled carbon aviation fuels
aviation biofuels	advanced biofuels (RED Annex IX A), biofuels (RED Annex IX B), or other biofuels (RED biofuels except produced from food and feed crops)
synthetic aviation fuels **renewable hydrogen for aviation**	RED RFNBO
recycled carbon aviation fuels	RED RCF
low-carbon aviation fuels	synthetic low-carbon aviation fuels, or low-carbon hydrogen for aviation (non-fossil, non-renewable)

Excursus: Inconsistency of terminology between ReFuelEU Aviation and technical standards

SAF in ReFuelEU Aviation is defined as aviation fuel, and aviation fuel as drop-in fuel. This definition fails to reflect current fuel production and blending limitations, eg. that (sustainable) "synthetic blending components" need to be blended with fossil kerosene to be considered drop-in (also called "semisynthetic jet fuel"), as regulated in ASTM D7566 and DEF STAN 91-091. For further information, please refer to Chapter Technical Consideration (safety, quality).

As only the renewable share in the blended or co-processed (aviation) fuel can meet the sustainability criteria of RED and consequently contribute to its targets, as well as is zero-rated under the EU ETS, it can be assumed that only that renewable share in the aviation fuel can contribute to the minimum shares of ReFuelEU Aviation as "SAF". It can therefore further be assumed that "SAF" as referred to in ReFuelEU Aviation intends to refer to either (1) the synthetic blending component in the aviation fuel blend or (2) the renewable share in co-processed aviation fuel, if it meets the sustainability criteria of RED.

5.3.6 Reporting

5.3.6.1 Reporting obligation for aviation fuel suppliers

To show compliance with the SAF supply obligation, aviation fuel suppliers shall submit certain information to the Union Database[24] by 14 February of each reporting year. The information to be provided concerns aviation fuel supply in the respective preceding calendar year (the 'reporting period') and shall include, inter alia, the amount of aviation fuel supplied at each Union airport, the amount of SAF[25] supplied at each Union airport as well as more detailed information on that SAF, and certain the content of aromatics, naphthalenes and sulphur of the fuel. The first reporting will take place in 2025 and concern aviation fuel supply in 2024.

As in 2024, there was no SAF supply obligation, the reporting obligation in 2025 can be considered a dry run. Also, the Union Database is not yet fully implemented. Therefore, aviation fuel suppliers will have to fulfil their first reporting obligation in 2025 by reporting the required information via Excel, for which the European Commission has provided a template at the webpage of the Union Database.[26]. The reporting obligation in 2025 concerns fuel deliveries to Union airports in 2024.

Excursus: Inconsistency of terminology between ReFuelEU Aviation and technical standards

As mentioned above, the terminology in ReFuelEU Aviation is not aligned with technical standards. Not only the partly contradictory definition raises questions under the reporting obligation, but also other terms create difficulties. There are different definitions of the term "batch" in different frameworks. Whereas ReFuelEU Aviation defines 'batch' as a quantity of SAF that can be identified with a number and can be "traced" (within the flexibilities of mass balance according to Art 29 RED), which is different to the definition in DEF STAN 91-091, which states as follows: Aviation fuel quality assurance is based on two key concepts: batches and traceability. A batch of fuel is defined as a distinct quantity of jet fuel that can be characterised by one set of test results.

5.3.6.2 Reporting obligation for aircraft operators

Aircraft operators shall, by the end of March of each reporting year, report all relevant data to prove compliance with their refuelling obligation in the respective reporting period, to the competent authorities as well as EASA via the Digital Reporting Tool[27]. The information to be reported includes, amongst others, tper Union airport the total amount of aviation fuel uplifted, the yearly aviation fuel required and the yearly non-tanked quantity[28, 29] purchased for flights departing from Union airports and further information per purchase of SAF. The report shall be verified by an independent verifier in accordance with the provisions on monitoring, reporting and verification of the EU ETS.

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[24] The Union Database is referred to in Article 31a of Directive (EU) 2018/2001. It is a Union-wide database which is being established under the RED with the aim to ensure the traceability of transport fuels that are eligible for being counted towards renewable energy share for transport in any Member State.

[25] References to SAF shall be construed as referring also to low-carbon aviation fuels and to renewable hydrogen for aviation.

[26] See https://transport.ec.europa.eu/transport-modes/air/environment/refueleu-aviation_en under "Main documents"

[27] https://www.easa.europa.eu/en/domains/environment/refueleu-aviation-digital-reporting-tool.

[28] Yearly non-tanked quantity means the difference between the yearly aviation fuel required and the actual fuel uplifted by an aircraft operator prior to flights departing from a given Union airport.

[29] References to SAF shall be construed as referring also to low-carbon aviation fuels and to renewable hydrogen for aviation.

<u>a) Template to report fuel tankering, ReFuelEU Aviation</u>

Union Airport Name	ICAO Code of Union Airport	Total flights operated departing from the Union Airport (№ flights)	Yearly aviation fuel required (tonnes)	Yearly actual aviation fuel uplifted (tonnes)	Yearly non-tanked quantity (tonnes)	Yearly tanked quantity for fuel safety rules (tonnes)

<u>b) Template to report SAF purchases, ReFuelEU Aviation</u>

Fuel Supplier	Batch Number	Amount Purchased (tonnes)	Category of eligible fuel for use in aircraft	Feedstock	Lifecycle emissions of the Eligible Fuel (cCO2eq/MJ)	Eligible Fuel (tonnes) claimed under EU ETS	Eligible Fuel (tonnes) claimed under CH ETS	Eligible Fuel (tonnes) claimed under CORSIA	Eligible Fuel (tonnes) claimed under other MBMs	Eligible Fuel (tonnes) not claimed

Figure 5 — Templates

5.3.7 Aircraft operators claiming use of SAF

Aircraft operators can claim the usage of SAF that is supplied under the ReFuelEU Aviation under a GHG scheme, such as the EU ETS. To ensure that aircraft operators do not claim benefits for the use of an identical batch of SAF under more than one GHG scheme, they shall share with EASA which GHG schemes they participate in and in which it is possible for them to report SAF as well as a declaration that they have not reported identical batches of SAF under more than one GHG gas scheme.

The two biggest GHG schemes relevant for European aircraft operators are the EU ETS and CORSIA (for further detail see sections 5.4 and 5.5 below). They are separate systems but have a partially overlapping geographical scope. While the SAF eligible under ReFuelEU and the EU ETS must be RED certified, the SAF eligible under CORSIA must be CORSIA certified. No cross-recognition of the respective other certification between the two GHG schemes exists, and so far, no dual conformance certification has been implemented. So, there is currently no risk of “double-claiming” of the SAF under CORSIA and the EU ETS.

To give an example of a situation which the outlined provision aims to address: While the EU ETS and UK ETS are designed to complement each other geographically, there are minor overlaps bearing the risk of “double-claiming” of the SAF used. The EU ETS requires SAF to be uplifted at an EU airport in order to be claimed, whereas the UK ETS has no such geographical restriction. This could therefore lead to SAFs being claimed twice under both schemes. More specifically, a batch of SAF purchased by an aircraft operator at an EU airport and claimed under the EU ETS could theoretically also be claimed under the UK ETS in the absence of a robust registry to record these claims.

5.3.8 Enforcement

Member States shall designate competent authorities responsible for enforcing the application of ReFuelEU Aviation and for imposing the fines for the obligated parties. The list of designated competent authorities has been published.[30]

By December 2024, Member States shall lay down the rules on penalties applicable to non-compliance with ReFuelEU Aviation and shall take all measures necessary to ensure their implementation. The penalties provided for must be effective, proportionate and dissuasive taking into account, in particular, aggravating factors, such as the nature, duration, recurrence and gravity of the infringement.

Aviation fuel suppliers failing to comply with the supply of the minimum shares of SAF and synthetic aviation fuel shall be liable to a fine which is at least twice as high as the amount resulting from the multiplication of the difference between the yearly average price of SAF or synthetic aviation fuel, respectively, and conventional aviation fuel per tonne by the quantity of the aviation fuel not complying with the relevant minimum shares. Aviation fuel suppliers which have accumulated shortfalls from the

[30] https://transport.ec.europa.eu/document/download/5fe92a9b-eaf3-491d-9432-cbb2c24453c4_en?filename=ReFuelEU_list_authorities.pdf

obligation to supply a minimum share of SAF / synthetic aviation fuel in a given reporting period, shall supply the market in the subsequent reporting period with a quantity of that respective fuel equal to that shortfall, in addition to their reporting period obligation.

Aircraft operators failing to comply with their refuelling obligations shall be liable to a fine of at least twice as high as the amount resulting from the multiplication of the yearly average price of aviation fuel per tonne by the total yearly non-tanked quantity.

Union airport managing bodies shall be subject to a fine if they fail to take the necessary measures to address a lack of adequate access by aircraft operators to aviation fuels containing minimum shares of SAF.

5.4 EU Emissions Trading System

5.4.1 General

The EU Emissions Trading System (EU ETS) is one of the main greenhouse gas emission schemes particularly relevant for European aircraft operators, alongside CORSIA.

The EU ETS and CORSIA are two separate but partially overlapping systems for reducing aviation emissions. While the EU ETS covers both domestic and international flights, CORSIA “only” covers international flights. While operating as separate systems, the EU ETS and CORSIA are increasingly linked through exemption mechanisms, reporting harmonization, and efforts to avoid the double-counting of emissions from aircraft operators based in the EU. Non-EU based aircraft operators operating intra-European routes may be covered by both regulations, effectively leading to double-counting of their emissions.

5.4.2 General

The EU ETS, launched in 2005, is a so-called cap-and-trade system designed to reduce greenhouse gas emissions. It covers a significant portion of the EU's emissions, including those from power plants, large factories, aviation and maritime transport. Its overall objective is an absolute reduction of GHG emissions across the sectors concerned of 63 % by 2030, as compared to 1990.[31] The EU ETS works by setting a limit, or "cap," on the total amount of greenhouse gases that obligated entities can emit each year. This cap decreases over time, forcing a reduction in overall emissions. It is expressed as a number of emission allowances in circulation, also sometimes referred to as ”total allowances in circulation". Each allowance permits the emission of one tonne of CO2 equivalent (CO2eq). Obligated entities must acquire enough allowances—through auctions, free allocation, or trading with other entities—to cover their verified emissions and must surrender these allowances each year. Failure to surrender sufficient allowances results in penalties. This system essentially creates a market for emissions allowances, encouraging businesses to invest in cleaner technologies and reduce their environmental impact.

5.4.3 Aviation sector consideration

While the EU ETS initially only covered the emissions of stationary installations, it added aviation activities to its scope in 2012 and has since then been covering commercial aviation activities departing from airports located in the EEA to the largest extent.

[31] On the 11 December 2020 the European Council endorsed a new and more ambitious EU climate target for 2030 applicable to the EU and its 27 Member States of “a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990” and submitted it to the UNFCCC Secretariat as an updated and enhanced nationally determined contribution (NDC) on 18 December 2020. The emissions reduction targets under the EU legislation are covered by the EU Emissions Trading System (EU ETS), the Effort Sharing Regulation (ESR), and the regulation on land-use related emissions and removals (LULUCF). (https://unfccc.int/sites/default/files/NDC/2023-10/ES-2023-10-17%20EU%20submission%20NDC%20update.pdf)

To qualify as aviation activity falling under the scope of the EU ETS, certain thresholds and exceptions apply. The threshold excludes aircraft operators that have operated less than 243 flights per period for three consecutive four-month periods, or with flights with total annual emissions of less than 10.000 tonnes per year. Furthermore, for example, state flights, military flights and search and rescue flights are excluded from the scope.

Aircraft operators are required to

(1) **report** their emissions on all domestic and international flights departing from and arriving at airports located in the EEA and

(2) **reduce** their emissions on all flights within the EEA, from the EEA to the United Kingdom and from the EEA to Switzerland[32] (with temporary exceptions in place for flights from or to outermost regions of the EEA[33])

This means that for aerodromes located outside the EEA, there is no reporting or emission reduction obligation under the EU ETS. For those flights, CORSIA is applicable.

By 1 July 2026, the European Commission shall submit to the European Parliament and to the Council a report where it carries out an assessment of CORSIA to see if it is sufficiently delivering on the goals of the Paris Agreement. The European Commission may accompany the report, if deemed necessary, with a legislative proposal that extends the scope of the EU ETS to include departing flights from aerodromes located in the EEA to aerodromes located outside the EEA, other than the United Kingdom and Switzerland, from January 2027 onwards. The accompanying proposal shall also, as appropriate, allow the possibility for aircraft operators to deduct any costs incurred from CORSIA offsetting on those routes, to avoid double charging.

For aviation activities, the EU ETS has been covering CO2 so far. Non-CO2 aviation effects are defined as '*effects on climate of the release during fuel combustion of oxides of nitrogen (NOx), soot particles, oxidised sulphur species, and effects from water vapour including contrails*'. They are soon added to the scope of the EU ETS: Aircraft operators shall report on the non-CO2 aviation effects of their activities from 2025 onwards. By 2028, the European Commission will submit a report and, where appropriate, a legislative proposal after having first carried out an impact assessment to mitigate such effects by expanding the scope of the EU ETS to include non-CO2 aviation effects. The chemical composition of the fuel used, characterized via properties like as sulphur content, H/C ratio, aromatics type and content, can impact non-CO2 effects. Depending on chemical composition of the SAF used and the methodology for the reporting, SAF usage can lead to lower non-CO2 effects for the reported flights.

5.4.4 Reporting

5.4.4.1 General

The monitoring, reporting and verification (MRV) of emissions is crucial to ensure credibility of the EU ETS. Each aircraft operator must monitor its annual emissions from activities falling under the EU ETS. Each aircraft operator is expected to determine the fuel consumption for each flight and for each fuel, including fuel consumed by the auxiliary power unit.

[32] Based on the Trade and Cooperation Agreement between the European Union and the United Kingdom and the Swiss Linking Agreement between Switzerland and the United Kingdom.

[33] Exempted are all emissions from flights between an aerodrome located in an outermost region within the meaning of Article 349 of the Treaty on the Functioning of the European Union and an aerodrome located in another region of the EEA but outside the outermost region of arrival or departure. The EU currently includes nine outermost regions: Canary Island, French Guiana, Guadeloupe, Martinique, Mayotte, Réunion, Saint-Martin, Azores and Madeira. Emissions from flights between aerodromes in the same outermost region remain fully covered by the EU ETS. (Source: MRR guidance).

The EU ETS compliance cycle follows the calendar year. Within three months after the end of each calendar year, the aircraft operator must prepare the annual emissions report, seek verification, and submit the verified report to the competent authority. There are simplified monitoring, reporting and verification requirements for small emitters. So far, the EU ETS for aviation has only covered CO2 emissions.

From 2025 onwards, aircraft operators shall also report on the **non-CO2 aviation effects** resulting from each aircraft they operate on routes for which emissions are reported. 'Non-CO2 aviation effects' are defined as the effects on the climate of the release, during fuel combustion, of oxides of nitrogen (NOx), soot particles, oxidised sulphur species, and effects from water vapour, including contrails. The European Commission should have adopted by 31 August 2024 an implementing act to include non-CO2 aviation effects in a monitoring, reporting and verification framework. That framework shall contain, at a minimum, the three-dimensional aircraft trajectory data available, and ambient humidity and temperature to enable estimation of a CO2 equivalent from non-CO2 effects per flight.

By 31 December 2027, the European Commission shall submit a report and, where appropriate and after having first carried out an impact assessment, a legislative proposal to mitigate non-CO2 aviation effects by expanding the scope of the EU ETS to include non-CO2 aviation effects.

5.4.4.2 SAF consideration & sustainability context - Emission allowances and consideration of SAF

Until end of 2023, aircraft operators received a large part of their allowances free of charge.[34] This free allowance allocation to aircraft operators started being phased out gradually in 2024 and will entirely stop in 2026. This means that aircraft operators will have to acquire sufficient allowances to cover the part of their aviation activities for which they need to reduce emissions. The verified emissions must correlate with the surrender of allowances in the Union Registry. The Union Registry is an online database that ensures the precise accounting of all allowances issued under the EU ETS. It keeps track of the ownership of the allowances in circulation and helps assess compliance under the EU ETS.[35]

As an alternative to surrendering allowances, obligated parties can also directly reduce their GHG emissions to comply with the EU ETS. The EU ETS does not prescribe any specific technology for GHG emission reduction but specifies the GHG emissions calculation methodology for certain technologies. Aviation emissions correspond to the jet fuel usage whereby 1 ton of Jet A1 corresponds to 3.16 tons of CO2. Aircraft operators can reduce their emissions through improved operations, more efficient aircraft and SAF. All types of SAF, including RED certified aviation biofuels, synthetic aviation fuel and recycled carbon fuels, are zero-rated or, in other words, deemed to have zero emissions under the EU ETS.

In the RED GHG methodology, the tailpipe emissions of vehicles, including aircraft, using sustainable biofuels are zero. Aligned with that, the EU ETS has established a new definition of 'zero-rated fuels' which covers biofuels, bioliquids, biomass fuels, synthetic low-carbon fuels, RFNBO or RCF or fractions of mixed fuels or materials which comply with the criteria as specified in the EU ETS Implementing Regulation (EU) 2024/2493. Biofuels are zero-rated when complying with the RED sustainability and GHG emissions saving criteria; RFNBOs and RCFs are zero-rated when complying with the RED RFNBO and RCF GHG emissions saving criteria; and synthetic low-carbon fuels are zero-rated if they comply with the GHG criteria provided by the Gas Directive and further criteria set by the Monitoring and Reporting Regulation[36].

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[34] However, there are significant differences between aircraft operators, depending on when they started operations and how fast they have grown since then. The baseline year for determining the share of free allowance allocation was 2010. For further information, please see https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/allocation-aviation-sector_en.

[35] https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/union-registry_en

[36] Article 39a (4) of Commission Implementing Regulation (EU) 2018/2066.

5.4.4.3 Support mechanism for eligible aviation fuels

Under the last revision of the EU ETS, a support mechanism was established to promote the usage of "eligible aviation fuels". By "eligible aviation fuels", all non-fossil eligible fuel categories under ReFuelEU Aviation are covered, which means that recycled carbon aviation fuels are excluded from the support mechanism.

As part of the support mechanism, 20 million allowances were set aside to incentivise the uptake of eligible aviation fuels from 2024 until 2030. Those allowances shall be allocated free of charge to aircraft operators using eligible aviation fuels for subsonic flights to compensate for all or part of the price differential between fossil kerosene and the relevant eligible aviation fuels. Depending on the fuel category and uplift location, different levels of incentive apply:

- 100% for eligible aviation fuel uptake on small islands, at small airports or in outermost regions
- 95% for RFNBOs[37];
- 70% for advanced aviation biofuels[38] and renewable hydrogen for aviation;
- 50% for 'other' aviation biofuels[39], non-fossil synthetic low carbon aviation fuel and synthetic low carbon hydrogen for aviation (excluding recycled carbon aviation fuels).

In order to operationalise this support mechanism, the European Commission established detailed rules for the yearly calculation of the price difference between eligible aviation fuels and fossil kerosene taking into account incentives from the price of carbon and from harmonised minimum levels of taxation on aviation fuels as well as rules for the allocation of allowances for the use of the eligible aviation fuels.[40] The European Commission will annually publish detailed information on the average cost difference between fossil kerosene and eligible aviation fuels, considering carbon price incentives and harmonized tax levels, in the Official Journal of the European Union.

On an annual basis, aircraft operators may apply for an allocation of SAF allowances based on the amount of eligible aviation fuel used on flights between 1 January, 2024, and 31 December, 2030, whose emissions must be reduced under the EU ETS. Note that the uplift of eligible aviation fuel at small islands, at small airports or in outermost regions would receive a 100% support while for the uplift of such fuels at Union airports the support level will depend on the category of eligible aviation fuel[41]. In order to minimise the administrative efforts required from aircraft operators and competent authorities, aircraft operators apply for the allocation of allowances by simply reporting the use of eligible aviation fuels in their annual emissions report., the support level will be determined. Last but not least, due to the zero-

[37] Due to the reference to eligible fuels under ReFuelEU Aviation, the support is limited to synthetic aviation fuels which are drop-in RFNBOs.

[38] Aviation biofuels produced from feedstocks listed in Annex IX part A of RED

[39] Including (1) aviation biofuels produced from feedstocks listed in Annex IX part B of RED and any other (2) aviation biofuels, except for biofuels produced from 'food and feed crops', which comply with the sustainability and lifecycle emissions savings criteria laid down in and are certified in compliance with RED.

[40] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14020-Aviation-fuels-emissions-trading-calculating-the-price-difference-between-eligible-fuels-and-kerosene-detailed-rules-_en

[41] To ensure tailor-made support, the European Commission distinguishes between ten different categories of eligible aviation fuels (including the respective support level): Renewable fuels of non-biological origin (95%), Co-processed renewable fuels of non-biological origin (95%), Advanced aviation biofuels (70%), Advanced co-processed fuels (70%), Renewable hydrogen for aviation (70%), Aviation biofuels (50%), Other aviation biofuels (50%), Non-fossil low-carbon hydrogen for aviation (50%), Non-fossil synthetic low-carbon aviation fuels (50%) and Co-processed fuels (50%).

rating of the fuel, the ETS price[42] and potential difference in taxation which might be in place on country level will be deducted.

If the demand for the SAF allowances exceeds availability in a given year, the allowances will be proportionally reduced for all aircraft operators.

The European Commission shall carry out an assessment of the application of the support mechanism and present results in a report to the European Parliament and the Council by 1 January 2028. The report may be accompanied by a legislative proposal to allocate a maximum and time-limited quantity of allowances until 31 December 2034 to further incentivise the use of eligible aviation fuels, in particular the use of renewable fuels of non-biological origin.

Excursus: Inconsistency of terminology between ReFuelEU Aviation and the EU ETS

With the last revision of EU ETS, a financing mechanism for "eligible aviation fuels" was introduced. While it intends to promote all fuels eligible to meet the targets of ReFuelEU Aviation[43], except for recycled carbon fuels, it does not use the same terminology as in ReFuelEU Aviation. Non-consistent use of language creates uncertainty. Amongst others, the wording in Article 3c para 6 of Directive 2003/87/EC

- *excludes aviation fuels that are not derived from fossil fuels from "eligible aviation fuels" under the support mechanism. Only the listed fuel categories of the established rules for the yearly calculation of the price difference between eligible aviation fuels and fossil kerosene suggest that recycled carbon fuels are not eligible for support.*

- *uses the term "renewable fuels of non-biological origin", even though renewable fuels of non-biological origin for aviation are called "synthetic aviation fuels" in ReFuelEU Aviation.*

- *provides a support level of 100 % of the remaining price differential for usage of eligible aviation fuels at, amongst others, "airports which are insufficiently large to be defined as Union airports in accordance with a regulation on ensuring a level playing field for sustainable air transport and at airports located in an outermost region". This is partly overlapping with the while Union airport definition in ReFuelEU Aviation which refers to airports meeting certain thresholds and that are not situated in an outermost region.*

5.4.4.4 Reporting requirements for SAF

As mentioned above, aircraft operators shall determine the fuel consumption for each flight and for each fuel. The aircraft operator shall determine the fraction of the zero-rated fuel in mixed aviation fuels containing zero-rated fuel. In order to claim zero-rated fuel and to benefit from the support mechanism to use eligible aviation fuels, certain requirements must be met.

Where SAF is physically mixed with fossil fuels and delivered to the aircraft in physically identifiable batches, the aircraft operator may carry out an analysis to determine the biomass fraction, on the basis of a relevant standard and the analytical methods, provided that these are approved by the competent authority. Where the aircraft operator provides evidence that such analyses would incur unreasonable costs or are technically not feasible, the aircraft operator may base the estimation of the biofuel content on a material balance of blending fossil fuels and biofuels purchased. If the biomass fraction was determined using the mass balance, no evidence for unreasonable costs or technical feasibility shall be required.

[42] ETS price = fossil kerosene emissions factor x price of ETS emission allowance. For prices of ETS emission allowances, an average annual price will be used. For daily auction values, you may consult: https://www.eex.com/en/market-data/market-data-hub/environmentals/eu-ets-auctions.

[43] Referred to as " a regulation on ensuring a level playing field for sustainable air transport".

Where purchased (blended) biofuel batches are not physically delivered to a specific aircraft but to a co-mingled storage at the airport, the aircraft operator shall not use analyses to determine the biomass fraction of the fuels used but may determine the biomass fraction using documentation that provides sufficient evidence for the SAF usage, such as purchase records of biofuel of equivalent energy content.[44] The eligible documentation requirements differ largely between the Member States. The European Commission published a guidance accepting the use of a so-called "Proof of Compliance" in November 2024[45], followed by the ISCC EU.[46]

Where eligible aviation fuels cannot be physically attributed at an aerodrome to a specific flight, the aircraft operator shall attribute the fuel to its flights for which allowances have to be surrendered proportionally to the emissions from those flights departing from that aerodrome calculated using the preliminary emission factor.[47] Note that for claiming eligible aviation fuel in order to benefit from the mentioned support mechanism, specific rules apply.[48]

Excursus: Physical SAF requirement under EU ETS vs flexibility mechanism under ReFuelEU Aviation

The flexibility mechanism under ReFuelEU Aviation temporarily exempts aviation fuel suppliers from the obligation to make the minimum shares of SAF available at each Union airport. This means that the is no guarantee that there will be SAF at each Union airport and consequently this potentially limits the access of aircraft operators to physical SAF. Without access to physical SAF, aircraft operators can currently not claim the usage of SAF under the EU ETS and benefit from the support mechanism for eligible aviation fuels.

Excursus: National documentation requirements as evidence for SAF usage for aircraft operators

Even if there might be physical supply of SAF and aircraft operators purchase that SAF, they might not be able to claim the SAF as national transposition of the reporting requirements might require documentation that aircraft operators are unable to obtain. There are currently no harmonized implementation requirements across the different Member States.

5.4.5 Enforcement

Aircraft operators who do not surrender sufficient allowances by 30 September of each year to cover their emissions during the preceding year shall be held liable for the payment of an excess emissions penalty of EUR 100[49] for each tonne of CO2eq emitted for which no allowance has been surrendered. Payment of the excess emissions penalty shall not release the aircraft operator from the obligation to surrender a number of allowances equal to those excess emissions.

Furthermore, Member States shall ensure the publication of the names of aircraft operators that are in breach of requirements to surrender sufficient allowances.

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[44] Article 54 of Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012

[45]https://www.kem.gov.lv/sites/kem/files/media_file/20241219_alternativfuelsETS_Guide_forAESAWG_clean.pdf/

[46] https://www.iscc-system.org/wp-content/uploads/2024/12/ISCC-Guidance-Document-Proof-of-Compliance-V1.0.pdf

[47]See Article 53a of Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012

[48] See Article 54a of Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012

[49] The excess emissions penalty relating to allowances issued from 1 January 2013 onwards shall increase in accordance with the European index of consumer prices.

If an aircraft operator fails to comply with the requirements under the EU ETS and where other enforcement measures have failed to ensure compliance, its administering Member State may request the European Commission to decide on the imposition of an operating ban on the aircraft operator concerned.

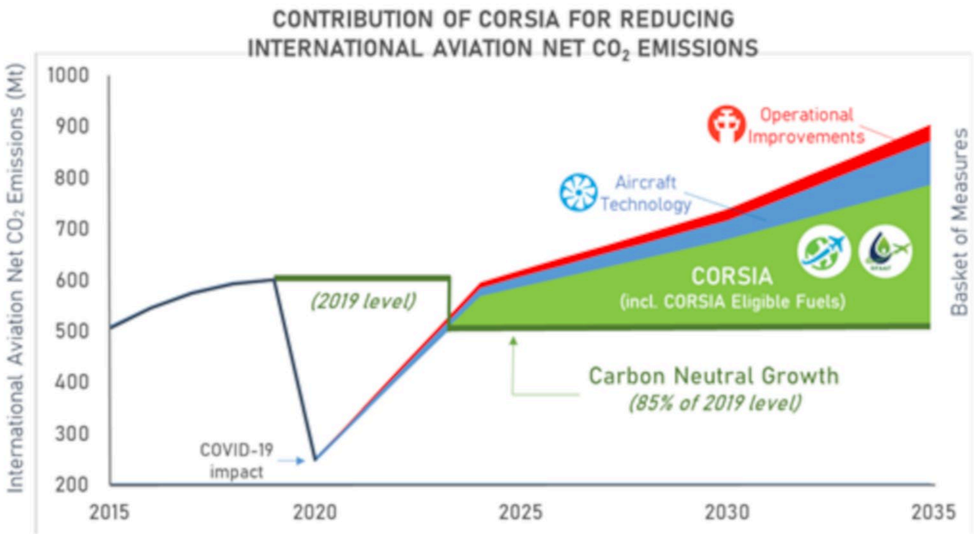
5.5 Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

5.5.1 General

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is an offsetting scheme to address CO2 emissions from international (commercial) aviation.[50] Its objective is carbon neutral growth of international aviation from 2020 onwards (compared to the 2019 baseline[51]). CORSIA is part of the basket of measures ICAO foresees to achieve the long-term aspirational goal of net-zero CO2 by 2050. It contributes to the Paris Agreement by covering those aviation GHG emissions that are beyond the scope of the EU ETS. [52]

CORSIA is applicable to air carriers that produce annual CO2 emissions greater than 10,000 tons from the use of aeroplanes with a maximum certified take-off mass greater than 5,700 kg conducting commercial international flights. The two main obligations resulting from CORSIA are:

- Reporting of CO2 emissions from international flights between ICAO Member States
- Offsetting of CO2 emissions above the 2019 baseline level (85 % of 2019 emissions as the CORSIA baseline for flights from 2024 onwards) from international flights between pairs of States participating in CORSIA



[Source: ICAO.int/environmental-protection/CORSIA/ FAQ 2022[53]]

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[50] Outside of the scope of CORSIA are emissions from domestic flights, small operators (less than 10,000 t CO2 p.a.), medical, humanitarian, and firefighting operations and military and governmental operations.

[51] From 2021-2023, the 2019 emissions are used as a baseline value. From 2024-2035, the baseline will be 85 % of 2019 emissions.

[52] Note that this way, CORSIA and the EU ETS complement each other with respect to contributing to the Paris Agreement GHG inventory.

[53] www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_FAQs_Dec2022.pdf p. 13

Figure 6 — Contribution of CORSIA for reducing international aviation net CO2 emissions

The CORSIA requirement to monitor, report and verify CO2 emissions from aviation covers all international flights[54], while the CORSIA offsetting requirement applies to flights between States participating in CORSIA. Air carriers need to meet offsetting requirements for a given compliance period. The offsetting requirement can be met through the use of CORSIA Eligible Fuels or the purchase and cancellation of CORSIA Eligible Emissions Units.

5.5.2 Reporting & SAF consideration

5.5.2.1 Monitoring, reporting and verification of CO2 emissions

The monitoring of CO2 emissions is either based on a Fuel Use Monitoring Method, or the on use of the ICAO CORSIA CO2 Estimation and Reporting Tool (CERT). The air carrier's level of activity will determine whether it is eligible to use the ICAO CORSIA CERT. An activity threshold applies. Air carriers are required to describe its approach to CO2 emissions monitoring in an Emissions Monitoring Plan, which they will submit for approval by the State. After monitoring and calculating* CO2 emissions, the necessary information will be reported from air carriers (in form of a verified Emissions Report) to their State Authority, and from States (in aggregated form) to CORSIA Central Registry which is the main database for States to submit CORSIA-specific data.[55] Verification of CO2 emissions information is done in the following to ensure that the data is accurate and free of errors. CORSIA foresees a three-step pathway for the verification exercise, including (1) voluntary internal pre-verification by the air carrier, (2) third party verification by an independent third-party verification body and (3) a magnitude review by the State Authority.

All States whose air carriers undertake international flights had to develop a monitoring, reporting and verification (MRV) system for CO2 emissions from international flights starting from January 2019. The MRV requirement is independent from the offsetting requirements. While international flights between States which are not participating in CORSIA for offsetting purposes are exempted from the offsetting requirements, they retain simplified reporting requirements. The data reported by the States will be used for the calculation of the CORSIA baseline, as well as for the calculation of the air carrier's offsetting requirements.

The EU ETS implements CORSIA for aircraft operators holding an air operator certificate issued by an EEA Member State or are registered in an EEA Member State. These aircraft operators must thus not only report their emissions from (domestic and) international flights within the EEA[56] under the EU ETS, but also their emissions from international flights within and outside the EEA under CORSIA. For reasons of administrative efficiency and to minimise compliance costs for aircraft operators, EU policymakers have tried to align provisions and formats for the reporting obligation and have, amongst others, adopted the CORSIA conversation factor for one ton of fossil jet fuel to equal 3,16 tons of CO2.

5.5.2.2 Offsetting requirement

While the above-described MRV requirement applies to all international flights and needs to be done on an annual basis, the offsetting is only required for international flights between pairs of States participating in CORSIA[57] and per compliance cycle. The approach of addressing State pairs is also referred to as the "route-based approach" and means that when calculating the emissions covered by the CORSIA offsetting, only emissions from covered routes are accounted for, see illustration below,

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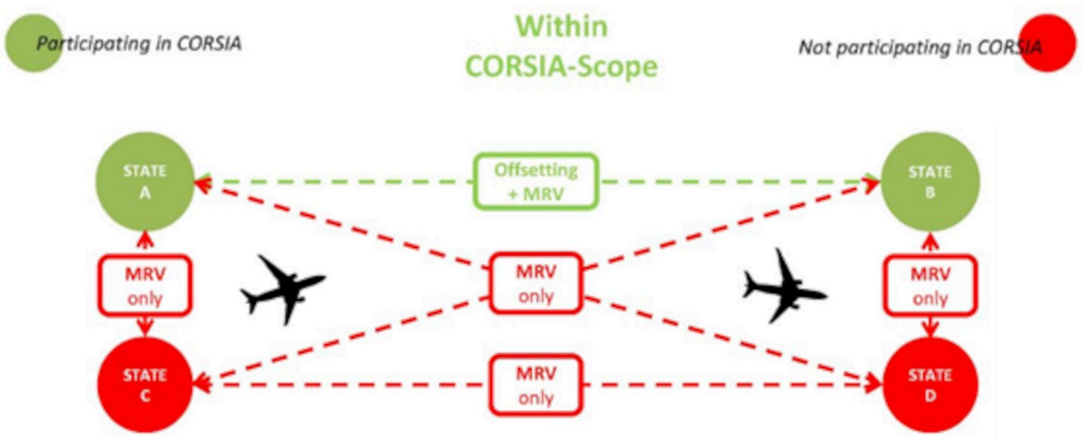
[54] Note that, similar to the EU ETS, also CORSIA stipulates certain minimum thresholds and execptions for aviation activities and aircraft operators to qualify.

[55] https://www.icao.int/environmental-protection/CORSIA/Pages/CCR.aspx

[56] As well as flights from the EEA to the UK and to Switzerland.

[57] https://www.icao.int/environmental-protection/CORSIA/Pages/state-pairs.aspx



[Source: Carbon Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) FAQ[58]]

Figure 7 — CORSIA route-based approach

Before 2027, the participation of States in CORSIA offsetting is voluntary. In 2025, there will be 129 Volunteer States[59]. From 2027 onwards, participation is mandatory for all ICAO Member States[60], excluding exemptions. The exemptions apply to Small Islands, Least Developed Countries, Land-locked Developing Countries

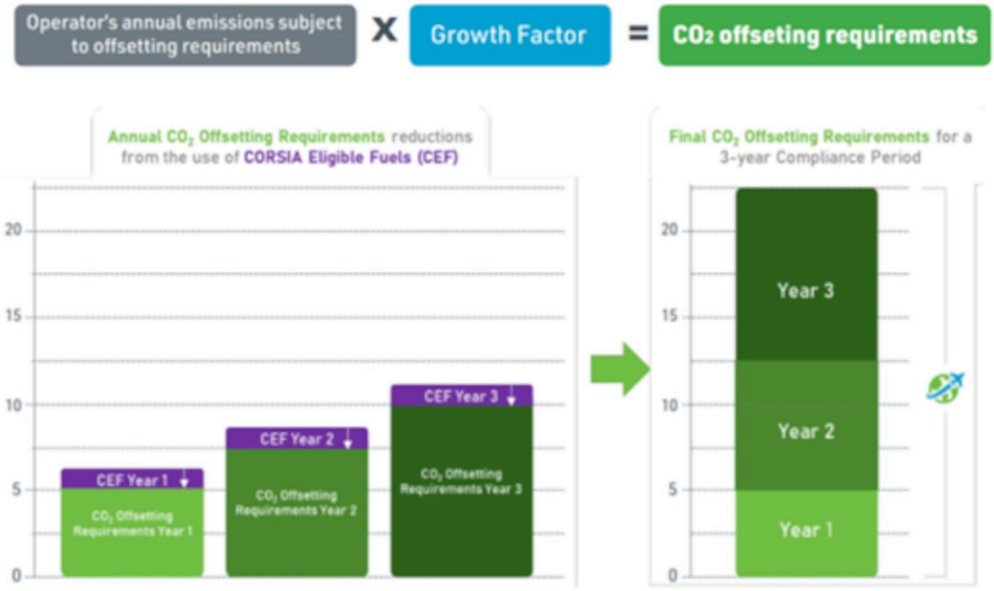
CORSIA offsetting obligation is subject to three-year compliance cycles. The first (voluntary) compliance period was called 'Pilot Phase' and covered the years 2021 to 2023. The second (voluntary) compliance period is called 'First Phase' and covers the years 2024 – 2026. The first mandatory compliance cycle starts in 2027 and kicks of the 'Second Phase' which covers the years 2027 to 2035, thus three compliance cycles.

For flights within the EEA as well as flights from the EEA to the UK or to Switzerland, the offsetting requirement is deemed to be met through the emission reduction obligation aircraft operators have under the EU ETS.

5.5.2.3 Calculating the offsetting requirement

The air carriers' annual CO2 offsetting requirement is a multiplication of its annual emissions and the annually determined and published Growth Factor. The Growth Factor represents the %-increase in the amount of emissions between the baseline and the reporting year. The State accounts for the benefits from the use of CORSIA Eligible Fuels and informs the air carriers under its authority of their final CO2 offsetting requirements. As mentioned above, the obligation to offset is subject to three-year compliance periods.

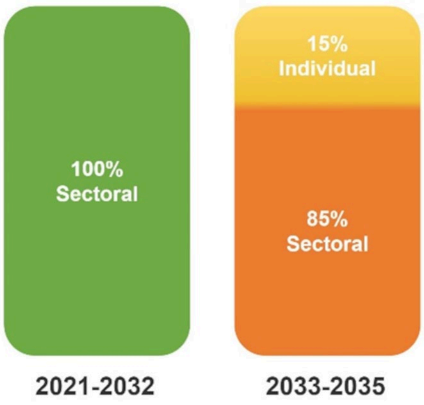
[58] https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_FAQs_Dec2022.pdf
[59] https://www.icao.int/environmental-protection/CORSIA/Pages/state-pairs.aspx
[60] https://www.icao.int/about-icao/pages/member-states.aspx



[Source: Carbon Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) FAQ[61]]

Figure 8 — Air Carriers' Offsetting Requirements

The Growth Factor changes every year taking into account the annual Sector's Growth Factor (calculated by ICAO) and from 2033 the air carrier's Individual Growth Factor. This means that air carriers are subject to an offsetting requirement regardless of their individual increase of decrease in emissions compared to the baseline emissions until 2032. From 2033, air carriers' incentive for individual emission reduction will be strengthened by calculating 15% of offsetting requirements according to their individual performance.



[Source: Carbon Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) FAQ[62]]

Figure 9 — Growth Factor

[61] https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_FAQs_Dec2022.pdf
[62] https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_FAQs_Dec2022.pdf

5.5.2.4 CORSIA Eligible Fuels

Air carriers can reduce their CORSIA offsetting requirements by claiming emissions reductions from CORSIA Eligible Fuel (CEF)[63], covering the following two categories:

- CORSIA Sustainable Aviation Fuel
- CORSIA Lower Carbon Aviation Fuel

The use of CEF shall be reported as part of the air carrier's annual Emissions Report. Certain supplementary information on CEF is needed, including certain details on the CEF and associated emissions reductions.

5.5.3 Enforcement - CORSIA Eligible Emissions Units

The State accounts for the benefits from the use of CEF and informs the air carrier of its final CO2 offsetting requirements which can be reduced through purchase and cancellation of CORSIA Eligible Emissions Units. Those emissions units are generated when emissions from a specific project or programme are reduced, compared to a baseline (or business-as-usual), through the implementation of emission reductions techniques/technologies. These projects or programmes can be implemented in various sectors, e.g. electricity generation, industrial processes, agriculture, forestry and waste management

One emissions unit represents one tonne of CO2 emissions reduced. The trade of emissions units happens through the carbon market. Air carriers are required to meet their offsetting requirements by cancelling CORSIA Eligible Emissions Units in a quantity equal to their total final offsetting requirements for a given compliance period

The air carrier will then submit a copy of the verified Emissions Unit Cancellation Report and the associated Verification Report to the State.

The State is responsible for ensuring CORSIA compliance and determining the enforcement provisions.

5.6 Sustainability Criteria and GHG thresholds

5.6.1 RED Sustainability and GHG emissions saving criteria

5.6.1.1 General

The RED provides two types of criteria for biofuels: 1) Sustainability criteria and 2) Greenhouse gas emissions saving criteria. Fulfilling these criteria is a prerequisite to enter the EU market qualifying as a biofuel. For example, the EU ETS and the ReFuelEU Aviation refer to the RED sustainability and greenhouse gas emissions saving criteria when they define 'zero-rated fuels' and 'sustainable aviation fuels', respectively.

5.6.1.2 RED Sustainability criteria, i.e. land-use criteria

The RED sustainability criteria relate to land-use and they provide special restrictions for agricultural biomass, forest biomass, and agricultural, aquaculture, fisheries and forestry residues as raw materials for biofuel production.

For the RED, biofuels cannot be made from raw material obtained

- from land with a high biodiversity value in or after January 2008,

[63] To be eligible, CEF must achieve net greenhouse gas emissions reductions of at least 10 % compared to the baseline life cycle emissions values for aviation fuel on a life cycle basis. For further information see: https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx

- from land with high-carbon stock, or
- from peatland.

In addition to these land-use criteria, forest biomass has certain additional requirements.

The definition in the RED for food and feed crops refers to agricultural land that is used for cultivation of the raw material, and the RED introduces a cap for using food and feed crop-based biofuels for the RED transport target. In addition to the food and feed crop cap, in 2019, the European Commission published a Delegated Regulation supplementing the RED in regards to the determination of high indirect land-use change-risk feedstock for which a significant expansion of the production area into land with high carbon stock is observed and the certification of low indirect land-use change-risk biofuels, bioliquids and biomass fuels. According to that, biofuels produced from palm oil are so-called high ILUC-risk biofuels and they are phased out from contributing to the RED targets.

Food and feed crops and high iluc-risk biofuels are in practice not relevant in the context of the ReFuelEU Aviation, because aviation biofuels produced from food and feed crops are excluded from the ReFuelEU Aviation's definition of SAF and are not eligible for the ReFuelEU obligations.

5.6.1.3 RED greenhouse gas emissions saving criteria

The RED requires that the GHG emissions saving from the use of biofuels is at least 50 %, 60 % or 65 % compared to the fossil fuel comparator 94 gCO2e/MJ. The threshold depends on when the biofuel production installation has started its operation. These thresholds apply to the 'aviation biofuels' in ReFuelEU Aviation.

The GHG emissions from the production and use of aviation biofuels are calculated over the whole lifecycle according to the RED Annex V GHG calculation methodology.

The total GHG emissions of a biofuel is the sum of

- emissions from the extraction or cultivation of raw materials, carbon stock changes caused by land-use change, processing, transport and distribution and the fuel in use,
- and emission savings from soil carbon accumulation via improved agricultural management, from CO2 capture and geological storage and from CO2 capture and replacement.

Each step, such as the which feedstock and processing technology is used and how long transport distance is, have an impact on the GHG emissions savings of a biofuel. It is relevant to note that wastes and residues are considered to have zero lifecycle GHG emissions up to the process of collection, and that the emissions from the biofuel use are zero-rated.

Similarly, the RED requires that the energy from the use of RFNBO and RCF is only taken into account if the GHG emissions saving from the use of them is at least 70 % compared to the fossil fuel comparator. This threshold applies to 'synthetic aviation fuels' and 'recycled carbon aviation fuels' in the ReFuelEU Aviation.

The GHG methodology for RFNBO and RCF is provided in a delegated regulation of the RED. In addition, another delegated regulation of the RED provides the rules for determining when electricity used for the production of RFNBO can be considered fully renewable. These rules describe requirements related to additionality, temporal correlation and geographical correlation.

Table 3

Fuel as defined in the ReFuelEU Aviation	**RED GHG emissions saving threshold**	**GHG Methodology**
aviation biofuels (Annex IX A, IX B, other)	50 %, 60 % or 65 % (depending on when the installation in operation)	RED Annex V
synthetic aviation fuels (RFNBO)	70%	RED Delegated Act
recycled carbon aviation fuels (RCF)	70%	RED Delegated Act

5.6.1.4 Sustainability certification under RED

In order to be acknowledged as renewable energy and to be able to contribute to the corresponding targets under the RED and the ReFuelEU Aviation, but also to be zero-rated under the EU ETS, renewable fuels must comply with the RED sustainability and greenhouse gas emission reduction criteria. For that purpose, the whole life-cycle value chain of the biofuel must be documented, certified and verified through independent certification bodies and third-party audits.

The European Commission describes that: "Voluntary schemes and national certification schemes of EU countries help to ensure that biofuels, (...) RFNBOs, and RCF are sustainably produced by verifying that they comply with the EU sustainability criteria, as the relevant methodologies for RFNBOs and RCF." and "Several schemes also take into account additional sustainability aspects such as soil, water, air protection and social criteria. For the certification process, an external auditor verifies the whole production chain from the origin of the raw material and energy to the fuel producer or trader. While the schemes are run privately, the European Commission can recognise them as compliant with the rules included in the Renewable Energy Directive."

The EC provides the approved voluntary schemes and national certification schemes on its web page. Each certification scheme collaborates with certification bodies which conduct audits of the relevant stakeholders and processes.

(https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/voluntary-schemes_en#voluntary-schemes-under-the-revised-renewable-energy-directive)

Excursus: Inconsistencies between the RED and the ReFuelEU Aviation

- *Not all RED eligible biofuels are eligible for the ReFuelEU Aviation targets:*
    - o *The RED defines EU sustainability criteria for renewable energy eligible to be counted towards EU climate and energy targets for all transport sectors, including aviation. The ReFuelEU Aviation definition of aviation biofuel refers to biofuels which comply with the sustainability and lifecycle emissions savings criteria laid down in the RED Article 29 and are certified in compliance with Article 30 of the RED. However, SAF produced from the following feedstocks is excluded from the calculation of the minimum shares of SAF set out in the ReFuelEU Aviation: food and feed crops as defined in the RED, and intermediate crops, palm fatty acid distillate and palm and soy-derived materials, and soap stock and its derivatives unless they are included in the RED Annex IX. The exclusion from ReFuelEU Aviation of feedstocks compliant with the RED sustainability criteria leads therefore to inconsistency between the two pieces of legislation.*
- *The RED and the ReFuelEU Aviation provide a variety of caps:*

- *The RED sets caps for the use of food and feed crop-based biofuels in the transport sector, but the ReFuelEU Aviation excludes food and feed crop-based aviation biofuels altogether.*
- *The RED sets a cap for biofuels produced from feedstocks listed in RED Annex IX Part B, but that cap is not applied for the ReFuelEU Aviation obligations.*
- *The ReFuelEU Aviation sets a cap that is applied only for the ReFuelEU Aviation obligations: aviation biofuels produced from other feedstocks than listed in Annex IX account for a maximum of 3 % for the ReFuelEU Aviation minimum shares.*

5.6.2 Biomass Standard EN 16214

The Biomass Standard EN 16214 plays a role for the production of eligible biofuels. It was developed “with the aim to assist EU Member States and economic operators with the implementation of RED II and it is limited to certain aspects” and sets the “Sustainability criteria for the production of biofuels and bioliquids for energy applications - Principles, criteria, indicators and verifiers”, covering:

- Part 1: Terminology
- Part 2: Conformity assessment including chain of custody and mass balance
- Part 3: Biodiversity and environmental aspects related to nature protection purposes, and
- Part 4: Sustainability criteria for the production of biofuels and bioliquids for energy applications, and Calculation methods of the greenhouse gas emission balance using a life cycle analysis.

Part 1 provides a selection of terminology and a decision tree to differentiate between waste and residue and co-product. Although the decision tree is meant to be used only as additional guidance, secondary to the REDII and national legislation or guidance documents, in practice, it provides a good illustration of the, sometimes complicated, issue of estimating the status of biofuel feedstock for the RED and ReFuelEU Aviation targets.

Parts 2 and 3 provide examples of Examples of Sustainability conformity assessments procedures, an example of mass balance and guidance on recognizing the RED feedstock categories and their sustainability requirements. Part 4 contributes with GHG calculations.

The standard has not yet been updated to the latest amendments by RED III An update of the standard would increase clarity and assist economic operators evaluating different sustainable feedstock options for the various obligations and targets referring to the RED biofuel sustainability criteria.

5.6.3 Sustainability and certification criteria for SAF under CORSIA

5.6.3.1 General

The two main categories of the eligible fuel under CORSIA (CEF) which aircraft operators may use to reduce their offsetting requirements are CORSIA sustainable aviation fuel (CORSIA SAF) and CORSIA lower carbon aviation fuel (CORSIA LCAF).

CORSIA LCAF is defined as a fossil-based aviation fuel that meets the CORSIA Sustainability Criteria.

5.6.3.2 CORSIA SAF

CORSIA SAF[64] is defined as a renewable or waste-derived aviation fuel that meets the CORSIA Sustainability Criteria[65].

CORSIA defines a range of Sustainability Criteria for CORSIA SAF production:

Table 4

Theme	Principle
1. Minimum GHG emissions reduction	CORSIA SAF should generate lower carbon emissions on a life cycle basis. It needs to achieve net GHG emissions reductions of at least 10 % compared to the aviation fuel baseline of 89 g CO2e/MJ.
2. Carbon stock	CORSIA SAF should not be made from biomass obtained from land/aquatic ecosystems with high biogenic carbon stock that were converted after January 2008, such as primary forest, wetlands, peat lands, coral reefs and kelp forests. In case of land use conversion after January 2008, direct land use change emissions (DLUC) will be calculated. If DLUC GHG emissions exceed the default ILUC value, the DLUC value replaces the default ILUC value.
3. GHG emissions reduction permanence	Emissions reductions attributed to CORSIA SAF should be permanent. Operational practices should monitor, mitigate and compensate any material incidence of non-permanence resulting from carbon capture and sequestration activities.
4. Water quality and availability	The production of CORSIA SAF should maintain or enhance water quality and availability. Water should be used efficiently and depletion of surface or groundwater resources beyond replenishment capacities should be avoided.
5. Soil health	The production of CORSIA SAF should maintain or enhance soil health, such as physical, chemical and biological conditions. Agricultural and forestry best management practices for feedstock production or residue collection should be implemented for that purpose.
6. Air quality	The production of CORSIA SAF should minimize negative effects on air quality.
7. Conservation	The production of CORSIA SAF should maintain biodiversity, conservation value, and ecosystem services. CORSIA SAF may not be made from biomass obtained from such areas protected by the State due to their biodiversity, conservation value or ecosystem services, unless the protection purposes can be upheld, and adverse effects can be avoided. Low invasive-risk feedstock should be selected for cultivation and appropriate controls should be adopted.
8. Waste and chemicals	The production of CORSIA SAF should promote responsible management of waste and use of chemicals. Water arising from production processes as well as chemicals used should be stored, handled and disposed of responsibly. Pesticide use should be limited or reduced. Any damage from unintentional release of fossil resources, fuel productions and other chemicals should be prevented, minimized and mitigated through appropriate operational practices.

[64] https://www.icao.int/environmental-protection/pages/SAF.aspx
[65] https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_Eligible_Fuels/ICAO%20document%2005%20-%20Sustainability%20Criteria%20-%20November%202022.pdf

9. Human rights and labour rights	The production of CORSIA SAF should respect human and labour rights.
10. Land use rights and land use	The production of CORSIA SAF should respect existing land rights and land use rights including indigenous and/or customary rights.
11. Water use rights	The production of CORSIA SAF should respect prior formal or customary water use rights of local and indigenous communities.
12. Local and social development	The production of CORSIA SAF should strive to, in regions of poverty, improve the socioeconomic conditions of the communities affected by the operation.
13. Food security	The production of CORSIA SAF should promote food security of directly affected stakeholders in food insecure regions.

There are five feedstock categories eligible for CORSIA SAF production:

- **Primary and co-products** are the main products of a production process. They have significant economic value and elastic supply, which means that there is a causal link between feedstock prices and the quantity of feedstock being produced.

- **By-products** are secondary products with inelastic supply and economic value.

- **Wastes** are materials with inelastic supply and which the holder discards or intends or is required to discard. Feedstocks or substances that have been intentionally modified or contaminated to meet this definition are excluded from this definition.[66]

- **Residues** are secondary materials with inelastic supply and little economic value.

By-products, wastes and residues are entitled to an ILUC value of zero on the calculation of the Life cycle emission value of the SAF. Primary and co-products can also be entitled to zero ILUC value with the use of low LUC risk methodologies defined in Chapter 5 of the ICAO document " CORSIA Methodology for Calculating Actual Life Cycle Emissions Values".

ICAO is constantly assessing new feedstocks for SAF production. The feedstocks that are recognized for the production of CORSIA SAF to date are published in the "SAF feedstocks" website[67].

CORSIA also provides for Default Lifecycle Emissions Values for CEF. While neither RED nor ReFuelEU Aviation explicitly refer to specific production pathways, CORSIA lists all production pathways for which default lifecycle emission values can be used and determines these values per production pathway and feedstock.

In line with the Sustainability Criteria, CEFs must be certified by an ICAO-approved Sustainability Certification Scheme, i.e. ISCC CORSIA, RSB ICAO CORSIA and ClassNK SCS.[68]

Excursus: CORSIA Eligible SAF and SAF eligible under ReFuelEU Aviation & RED

[66] While CORSIA framework attributes no economic value to waste feedstock, they have however a certain value once they are eligible for SAF production.
[67] https://www.icao.int/environmental-protection/Pages/SAF_Feedstocks.aspx
[68] See: https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_Eligible_Fuels/ICAO%20document%2004%20-%20Approved%20SCSs%20-%20October%202024.pdf

As mentioned under the section on SAF reporting under the EU ETS, there is no harmonization between the sustainability and certification criteria between CORSIA and RED. In order to be eligible under either system, the respective sustainability and certification criteria must be met. There is no double-certification possible or cross-recognition of the respective other scheme.

Excursus: CORSIA and RED terminology for feedstocks that are not primary products

CORSIA provides a co-product and a by-product feedstock category which are non-existent in the RED.

On the other hand, the residue definition is not the same under CORSIA and the RED.

In addition, CORSIA uses economic value as a criterion for defining the feedstock category which is not a criterion under the RED which uses the aim of the aim of the process as the criterion.

5.6.3.3 CORSIA LCAF

CORSIA LCAF[69] is defined fossil-based aviation fuel that meets the CORSIA Sustainability Criteria which contain a dedicated chapter to the requirements for LCAF. LCAF shall serve as a complementary measure alongside SAF in helping to reduce aviation GHG lifecycle emissions. Examples for LCAF technologies are carbon capture and storage, process gas management, use of renewable electricity and energy conservation measures.

To be eligible, CORSIA LCAF must achieve net GHG emissions reductions of at least 10% compared to the aviation fuel baseline of 89 gCO2e/MJ and be in line with environmental and socio-economical aspects. They further need to be certified by one of the ICAO-approved Sustainability Certification Schemes.

On top of the CORSIA sustainability Criteria outlined for CORSIA SAF, the production of CORSIA LCAF requires operational practices in place to ensure the reduction of seismic, acoustic and vibrational impacts of the production of the fuel.

In line with the Sustainability Criteria, CEFs must be certified by one of the ICAO-approved Sustainability Certification Schemes. Note, however, that so far none of these schemes offer the certification of CORSIA LCAF. Certification methodology is still under development.

5.6.4 Aviation fuel requirement

The following chapter “Technical Considerations” will provide an insight into the framework of existing technical standards that define the characteristics, production, handling and use of aviation fuel, including synthetic blending components.

6 Technical Consideration (safety, quality)

6.1 General

The following chapter “Technical Considerations” will provide an insight into the framework of existing technical standards that define the characteristics, production, handling and use of aviation fuel, including synthetic blending components.

6.2 Fuel Production

6.2.1 Background

Aviation Turbine fuel or Jet fuel specifications are identified as an aircraft operating limitations listed in the Airworthiness Authority (e.g. EASA) Type Certificate Data Sheet (TCDS) and in the aircraft operational documentation (e.g. Aircraft Flight Manual AFM)). It is the aircraft / engine manufacturers responsibilities to define the fuel specifications approved for their respective equipment and identify the

[69] https://www.icao.int/environmental-protection/pages/LCAF.aspx

operational limitations. It is the aircraft operator's responsibility to ensure they only uplift fuel compliant with the specifications defined in the aircraft TCDS, AFM etc.

Aviation fuel for gas turbine engines, known as jet fuel or kerosene, consists of a range of paraffins[1] and aromatic hydrocarbon compounds in the range of C8 to C16. The requirements for jet fuels are captured in specifications such as DEF STAN 91-091 (Jet A1) or/and ASTM D1655 (JET A & JET A1).

The safe operation of airframe and engine fuel systems is based not only on the general specified properties that are required to be tested by the jet fuel specifications, (e.g., Table 1 Test Requirements in DEF STAN 91-091), but also on what are considered inherent or "fit-for-purpose" properties that have historically been observed in petroleum derived fuels. These fit-for-purpose properties are identified as critical by the airframe and engine manufacturers (commonly called Original Equipment Manufacturers or OEMs), in their fuel system designs. Examples of fit-for-purpose properties are electrical permittivity, bulk modulus and auto-ignition temperature.

Traditionally jet fuels were produced from distilled petroleum, however in the last 25 years jet fuels also included components that have been synthesised from an increasing variety of different hydrocarbon sources such as coal, natural gas, used cooking oils, sugar cane or forestry waste. The semisynthetic jet fuels (SSJF) manufactured from petroleum and synthesised hydrocarbons must not only meet the specified properties for conventional jet fuels but must also exhibit the fit-for-purpose properties required by the OEMs before they are certified for use by each OEM.

The development of semi-synthetic jet fuels and other transport fuels from non-petroleum sources was initially driven by the limited availability of petroleum to some countries. These constraints stimulated early research into alternative feedstocks and methods to produce jet fuels.

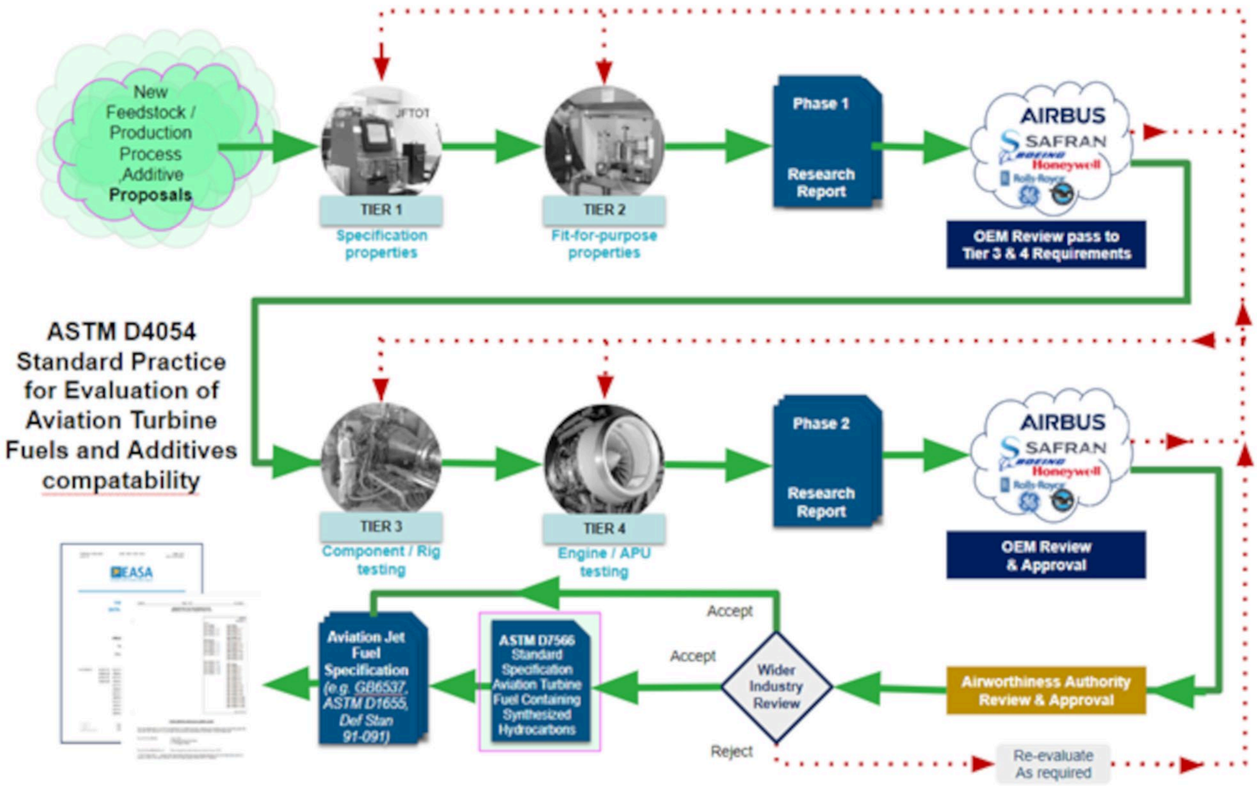
Semi-synthetic jet fuel (SSJF) can be any jet fuel that contains material derived from non-petroleum sources which may not necessarily be sustainable. Semi-synthetic jet fuels produced from sustainable feedstocks are frequently called Sustainable Aviation Fuels or SAF. Note, however, that the sustainability does not make a difference for its safe use in an aircraft; For this reason, the term semi-synthetic jet fuel is used instead within fuel specification bodies and the aviation fuel supply and distribution community. Correspondingly, this chapter 6 is focused on the study and discussion of the physical properties (specification and fit-for-purpose) of the fuel and applicable quality assurance processes to ensure safe flight. Sustainability criteria are studied and discussed in Chapter 5 and will therefore not be considered in this Chapter.

NOTE The first non-petroleum pathways were published into ASTM D7566 in 2009 driven by aviation industry initiatives. (Sustainability is discussed in Chapter 5.6 5.2.3 above'). Today eleven non-petroleum feedstock based pathways have been approved within DEF STAN 91-091, with eight of those pathwaysspecified in ASTM D7566 and an additional three co-processing pathways specified in ASTM D1655.

6.2.2 Process to follow for New Fuels Approval (ASTM D4054) and Clearing House concept

The engine and airframe OEMs are required, by their respective airworthiness authorities, (e.g. EASA, FAA), to identify all fuel specifications, with their associated operational limitations (e.g. operational temperatures, altitude), as part of the aircraft certification requirements. Engine and airframe OEMS, through ASTM International, have developed, over many decades, an industry protocol *"Standard Practice for Evaluation of New Aviation Turbine Fuels and Fuel Additives"* (ASTM D4054) to ensure that both specification and fit-for-purpose properties of Jet fuel (e.g. JET A-1) are properly controlled so that any changes to the Jet fuel specifications, (e.g. new semi-synthetic jet fuel pathways) and new additives, provide the required levels of performance and safety to comply with the Airworthiness Authorities certification regulations.

Below *Figure 10* outlines the process for proposed changes to fuel specification and fit-for-purpose properties that new non-petroleum feedstocks and production processes must pass before they are approved by the OEMs, their respective airworthiness authorities and the wider industry:



[Source: Airbus]

Figure 10 — ASTM D4054 Assessment and Approval Process for Fuels and Additives

The properties, procedures, tests, and selection of materials identified in the protocol are based on industry expertise to provide the necessary data to determine if the new or changed fuel or additive is suitable for use on existing aircraft and engines and for use in the current aviation operational and supply infrastructure. The quantity of fuel required to perform the initial testing is in the order of litres whereas the later testing requires thousands of litres of fuel. The testing is designed such that the expensive engine testing requiring large volumes of fuel is only performed if the fuel property data obtained during Tier 1 and 2 testing is insufficient to substantiate the fit for purpose of the fuel or additive.

NOTE Refer to ASTM D4054 for a full description of the process.

There are presently three clearing houses, (one in the EU, one in the UK and one in the USA), that have been established, with common test methods and standards, to guide and assist new semi-synthetic Jet fuel production process ‘candidates’ or new additives through the ASTM D4054 process. For candidate fuels that exhibit composition and properties that are very similar to conventional Jet fuel there is a “Fast Track” method available that can lead to a 10% approval by the OEMs without having to pass through tiers 3 and 4.

Because of the diversity of aviation hardware and potential variation in fuel/additive formulations, not every aspect may be fully covered by the protocol and further work may be required by the OEMs. Therefore, additional data, beyond that described in the protocol, may be requested by the OEMs, the ASTM task force, ASTM Aviation Fuels Subcommittee J, or Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, upon review of the specific composition, performance, or other characteristics of the candidate fuel or additive. The DEF STAN and ASTM International specification processes are very reactive and enable rapid evolution of the specifications to enable new pathways, test methods etc, (for example in 2024 ASTM D7566 was revised four times).

6.3 Reference to relevant Jet fuel Specifications in the world

The principal specifications for Jet fuel include the DEF STAN-91-091 for JET A-1, the ASTM International D1655 for JET A[70] and JET A-1, and the Chinese National Specification GB 6537 for No 3 Jet fuel.

The properties and characteristics of Def-Stan-91-091, ASTM D1655 and GB 6537 specifications are very closely aligned and are used by the OEMs to define the operational envelope and limitations for their equipment. Without the approval of the OEMs and their respective airworthiness authorities no new fuels can be certified for use on civil aircraft.

The engine and airframe OEMs (e.g., Airbus, Boeing, GE, Honeywell, Pratt and Whitney, Rolls Royce, Safran), actively participate in both the UK DEF STAN 91-091 and ASTM International D1655 Jet fuel specification bodies to ensure that all changes to these specifications are compatible with the continued safe operation of their equipment in accordance with their airworthiness authorities regulations. In addition, the DEF STAN 91-091 ASTM D7566 and ASTM D1655 specification bodies are able to rapidly update the specifications that facilitates the approval of new pathways, test methods, (for example ASTM D 7566 has been updated four times in 2024).

When other jet fuel specifications evolve where the OEMs are not part of the specification governing committee, (Chinese GB 6537), some or all the OEMs may not approve/certify the revised specification for use on their respective engines and airframes, and therefore it is prohibited to be used. This has previously required that a revised specification be withdrawn, and the previous version reinstated.

6.4 State of the Art of approved Semi-Synthetic Jet fuel

6.4.1 General

Semi-synthetic jet fuel has been used for around 25 years and has evolved in respect of raw materials and production processes during that time. The following section provides a view of the status of semi-synthetic jet fuel as of September 2024.

6.4.2 Semi-Synthetic Jet fuel

Semi-synthetic jet fuel (JET A-1) can be divided into two categories, co-processed and blended. Co-processed semi-synthetic jet fuels are fuels where non-petroleum feedstocks, for example used cooking oils, are commingled with petroleum derived production streams in the refinery to produce JET A-1. Blended semi-synthetic jet fuels are products of non-petroleum manufacturing streams (Synthetic Blending Components (SBCs)) that are then combined with petroleum jet fuels (JET A-1) and the blended product is then recertified as JET A-1.

Figure 11 below is a simplified example of jet fuel production pathways, 100% petroleum, and HEFA co-processing and blending:

[70] Jet A is similar to Jet A1 but with a higher freeze point limitation of -40°C compared to -47°C for Jet A1.

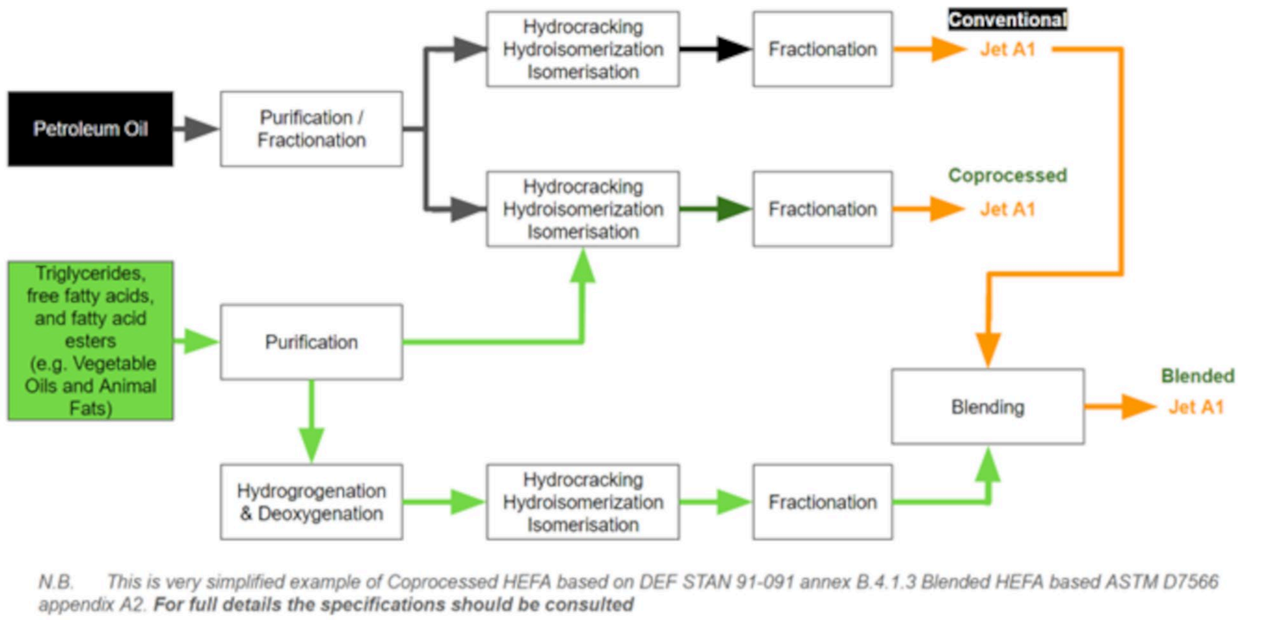


Figure 11 — Simplified schematic to show the principles of the different treatment of HEFA oils to produce Co-processed and Blended JET A-1

6.4.3 Co-processing to produce Semi-Synthetic Jet fuel

As of December 2024, there are three approved co-processing pathways that are incorporated directly into the DEF STAN 91-091 (JET A-1) and ASTM D1655 (JET A/A-1) specifications. The three co-processing pathways are defined by the feedstocks that are permitted to be used with associated limits as shown below:

- Co-hydroprocessing of mono-, di-, and triglycerides, free fatty acids and fatty acid esters

- Co-hydroprocessing of Fischer-Tropsch hydrocarbons

- Co-processing of hydrocarbons from hydroprocessed mono-, di-, and triglycerides, free fatty acids and fatty acid esters

The esters and fatty acids co-processing pathway via hydrocracking has been increased from the 5 % limit by volume in ASTM D1655 to a 30 % by volume limit in DEF STAN 91-091 Issue 18 in December 2024.

NOTE Refer to the most recent issues of ASTM D1655 and DEF STAN 91-091 for the latest information on approved pathways.

6.4.4 Blending SBC to Produce Semi-Synthetic Jet fuel

The permitted SBC pathways are controlled by a separate specification ASTM D7566 “Standard Specification for Aviation Turbine Fuel Containing Synthesised Hydrocarbons”. Blended synthetic or semi-synthetic jet fuel (JET A-1) pathways must meet additional requirements, in particular a minimum aromatic content of 8% or 8.4% depending on the test method used, that is not required for other production pathways. (The requirement for the 8%/8.4% aromatic content is based on industry experience of petroleum derived fuels).

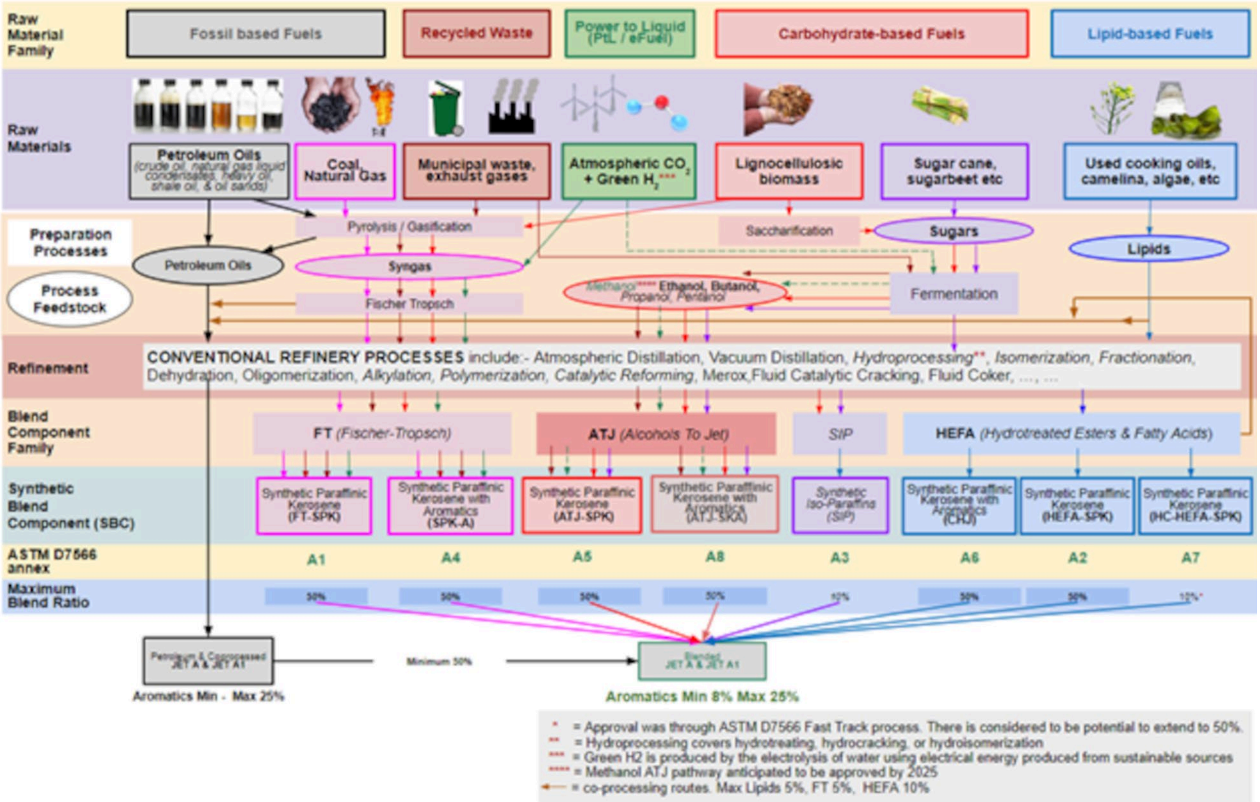
The eight approved pathways and blending limitations are shown in the *Table 5* below approved as of October 2024. For the latest information consult ASTM D7566 latest issue for the most up to date list and details of the specific requirements for each annex.

Table 5 — October 2024 status of Semi-synthetic Fuels Processes Approved in ASTM D7566 and accepted by DEF STAN 91-091 & ASTM D1655

Annex	Name, Material and Manufacture	Blending Limit
A1	Fischer-Tropsch hydroprocessed Synthesised Paraffinic Kerosine (FT-SPK):	50%
A2	Hydroprocessed Esters and Fatty Acids (HEFAs)	50%
A3	Synthesised Iso-Paraffins (SIP):	10%
A4	Fischer-Tropsch hydroprocessed Synthesised Paraffinic Kerosine plus aromatics (FT-SPK/A):	50%
A5	Alcohol-To-Jet Synthetic Paraffinic Kerosene (ATJ-SPK):	50%
A6	Catalytic Hydrothermolysis Jet (CHJ):	50%
A7	Hydroprocessed Hydrocarbons, Esters and Fatty Acids (HC-HEFAs):	10%
A8	Alcohol-To-Jet Synthetic Paraffinic Kerosene with aromatics (ATJ-SKA):	50%
NOTE	*When blended the Jet A-1 fuels produced are fully fungible and miscible with all other Jet A-1 fuels irrespective of their production means.*	

NOTE Refer to the most recent issues of ASTM D1655 and DEF STAN 91-091 for the latest information on approved pathways. ASTM D7566 SBC pathways (annexes A1 to A8) are approved in most international fuel specifications including UK DEF STAN 91-091 JET A-1, French DCSEA 134 (F35 aka JET A-1), Canadian CGSB-3-23 JETA-1, Brazilian QAV1, and ASTM D1655 JET A / A-1. GB 6537 No 3 JET fuel includes FT-SPK and HEFA-SPK only.

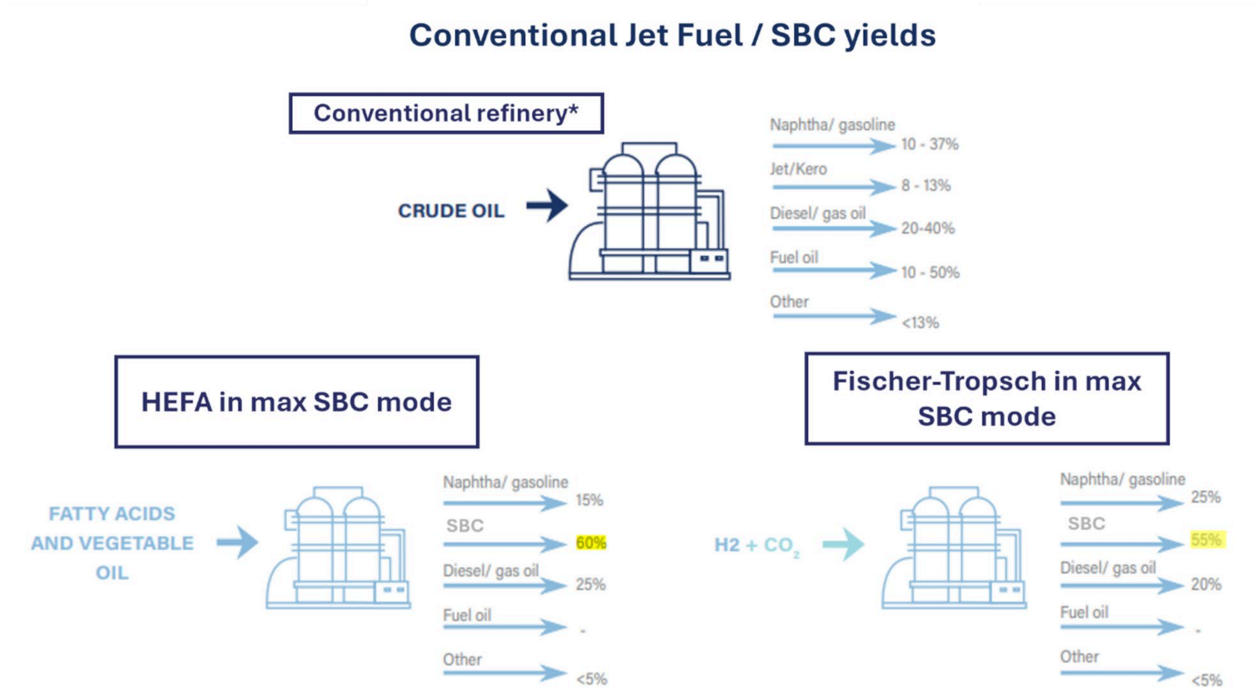
Figure 12 below provides an overview of the different jet fuel feedstocks and production processes:



[Source: Airbus]

Figure 12 — Simplified graphical representation of the different Jet fuel production feedstocks and processes approved in DEF STAN 91-091 and ASTM D1655

For some pathways such as HEFA or FT, it's technically not possible to produce only SBC. During the production and refining process, co-products such as renewable diesel and renewable gasoline/naphtha are also made. These co-products can be valorised in road transport or polymers sectors.



[Source: WORKING GROUP ON MONITORING METHODOLOGIES OF CO2 NEUTRAL FUELS report]

Figure 13 — Illustrative refinery yields

The reason why the presently approved SBCs must be blended with a petroleum product is that some ASTM D7566 Annexes A1, A2, A3, A5 and A7, do not fully mimic petroleum derived fuels in their composition, but more importantly, the industry has not yet fully defined the requirements for a fully formulated 100% synthetic JET A-1 that could potentially qualify under ASTM D7566 Annexes A4, A6 and A8.

Below *Figure 14* graphically shows the principal differences between SBCs and a 100 % petroleum derived JET A-1 fuel.

ASTM D7566 does not specify types or percentages of paraffins in any annex images shown are based on limited data sets:

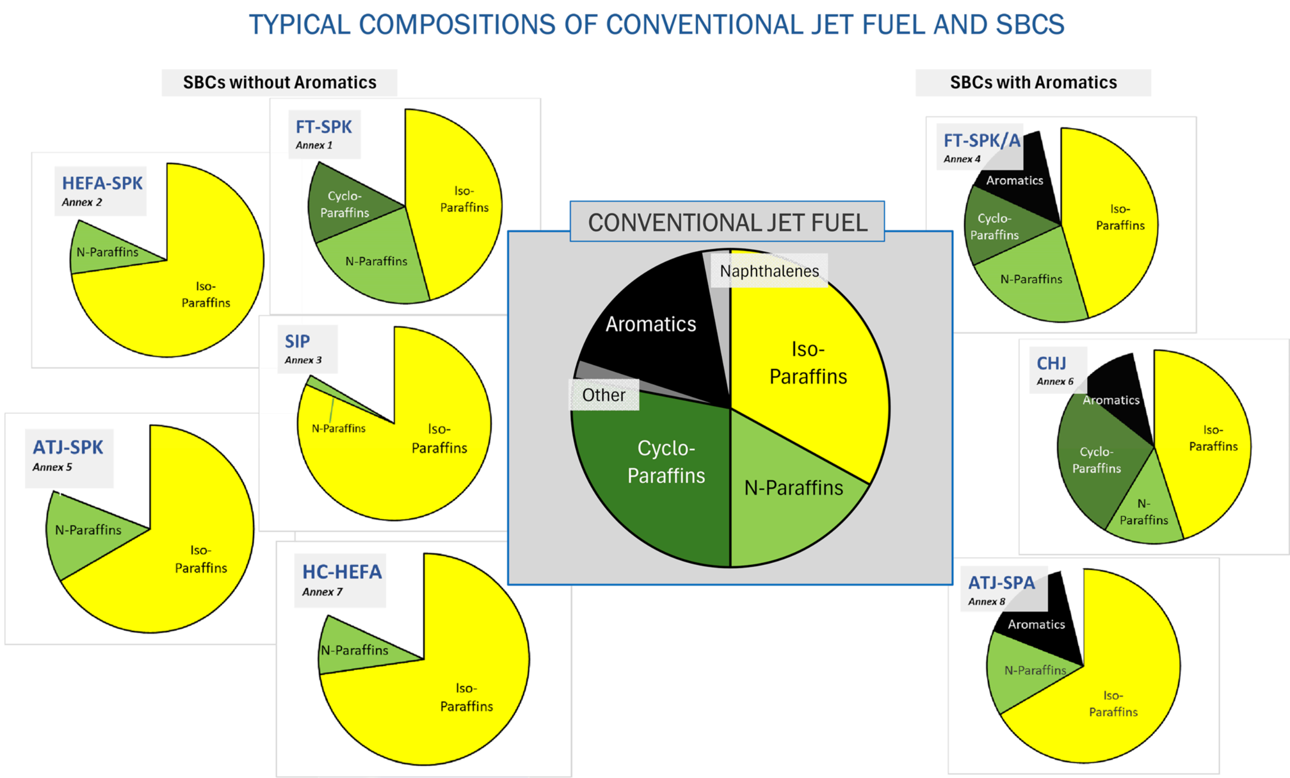


Figure 14 — Simplified graphical representation of illustrative examples composition of JET A-1 and ASTM D7566 SBCs

OEMs are working to define a fully formulated 100% synthetic JET A-1[4], including research on the need for aromatics, with expectations that this could be approved by the end of 2025. This would significantly increase an aircraft operator's ability to reduce its carbon emissions (emission reductions can only be achieved for up to half of fuel volumes consumed currently, due to the 50% blending limitation) when and if a segregated delivery into plane are made possible. (If it is a 100% drop-in it can be delivered to all aircraft, but to large airports such large quantities will not be available for the first many years).

In parallel the OEM community is also working on a new fuel specification and fuel grade to address not only the environmental effects related to CO_2 but also the other engine emissions (e.g., non-volatile particulate matter, sulphur), that act as catalysts in the formation of contrails that also contribute to aviation's environmental impact.

[4] DEF STAN 91-091 and ASTM D1655 already approve a 100% synthetic JET A1 but this is limited to only one specific producer and is made from coal and is therefore not sustainable.

6.5 Fuel Supply Chain

6.5.1 Aviation Fuel Standards for handling fuel from refinery to aircraft

In the same way as aviation fuels are certified and approved for use in aircraft, as described in section 6.1.2, the infrastructure and procedural requirements to ensure that fuel is provided on specification at the point of delivery to aircraft are defined in various Aviation Fuel Quality Controls and Operating Standards used worldwide.

The standards used by the global aviation fuel supply and distribution industry are listed in ICAO 9977(Manual of Civil Aviation Jet fuel Supply), with references to publications by the Energy Institute (EI) and Joint Inspection Group (JIG).

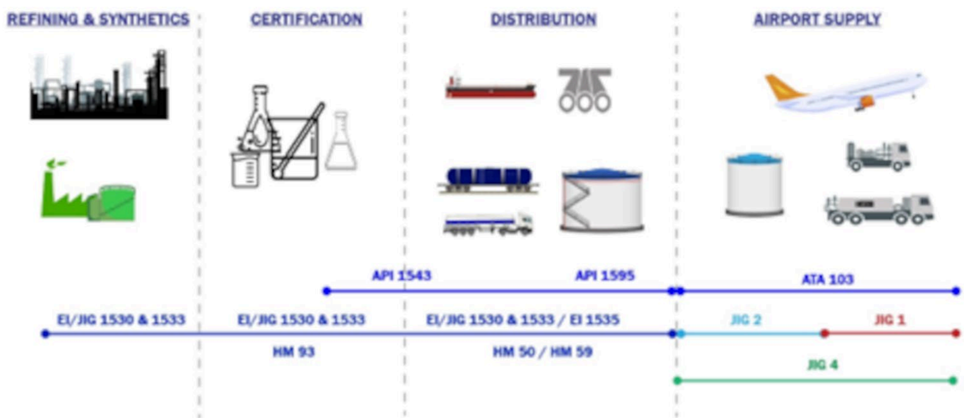
The existing Aviation Fuel Quality Controls and Operating Standards are designed to handle all aviation fuels that are in compliance with the prevailing Fuel Specifications, conventional and semi-synthetic fuels. These Standards ensure aviation fuel cleanliness, with well-defined controls of contamination (water, particle matter and microbiological growth). This is achieved by using filtration systems, doing regular sampling, and having testing protocols that prevent contamination during storage and distribution. Additional safety measures are defined to minimize static electricity buildup during transportation (grounding and bonding of equipment) and prevent leaks and contain spills.

There is consequently no need for specific supply chain and on-airport handling requirements for semi-1492 synthetic Jet fuels conforming to the currently approved Specifications (e.g. DEF STAN 91-091 for Jet A1). However, these standards organization do provide procedures for the blending and handling operation of synthetic blending components necessary to produce a semi-synthetic jet fuel.

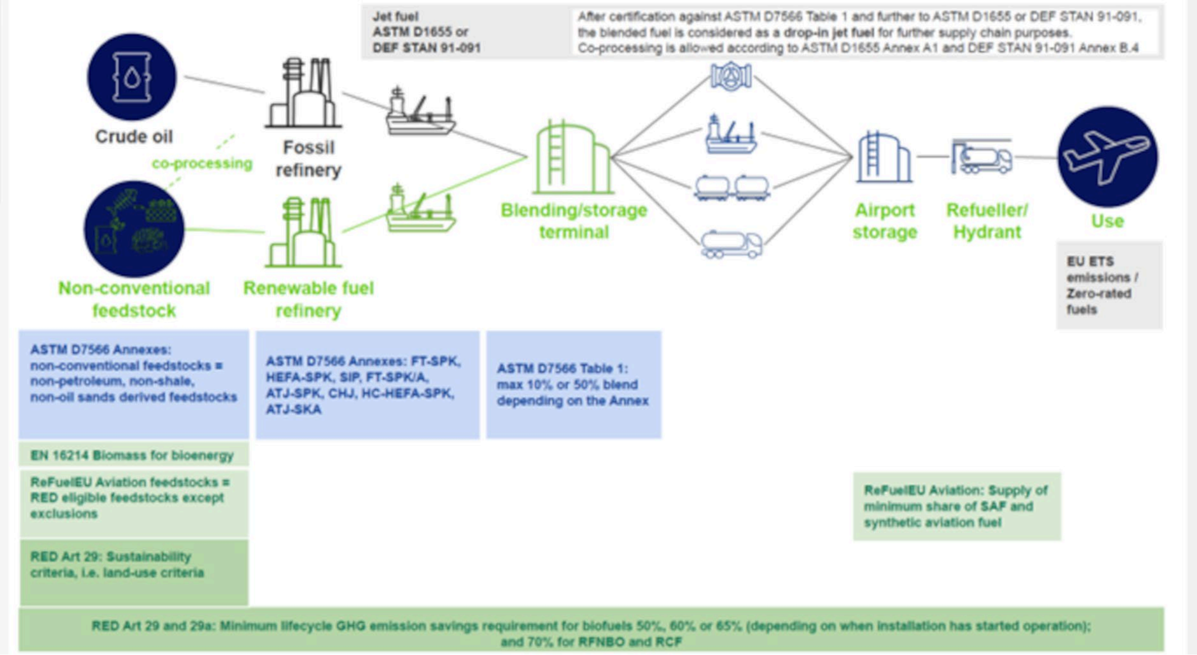
Energy Institute: The Energy Institute (EI) is a leading global professional body and membership organization that brings together expertise in energy from across the world. It aims to promote safe, efficient, and sustainable energy practices by providing technical guidance, education, and professional development. In the aviation fuel industry, the EI plays a pivotal role by developing internationally recognized standards and specifications. Additionally, the EI fosters collaboration between industry stakeholders, drives innovation through research and technical expertise, and promotes knowledge-sharing to address emerging challenges in aviation energy management and sustainability.

Joint Inspection Group: The Joint Inspection Group (JIG) was originally formed in the 1970s to coordinate inspections at Joint Venture (JV) locations. To manage that inspection process commonly, JIG developed guidelines in 1974. Those guidelines are today the JIG Standards, endorsed by IATA since 2001, and that are followed around the world, with the exception of the USA (which uses ATA 103), and some countries (e.g. China and Russia) that follow their National Standards. The Jet fuel Specifications (DEF STAN 91-091 and ASTM D1655) refer to JIG Bulletins and documents in regard of Testing Water Separation Properties of Jet fuel (MSEP), FAME (Fatty Acid Methyl Ester) contamination risks and recognised Operational Standards. In addition, JIG coordinates a systematic inspection programme carried out by highly trained and experienced JIG Inspectors. JIG tracks inspection findings to review compliance and encourage continuous improvement in the operations at airport facilities and into-plane activities. Furthermore, JIG contributes to the aviation fuelling industry by sharing lessons learned from incidents, incident statistics, inspection trends, and data from its inspections.

The key standards that apply throughout jet fuel supply chains are illustrated in Figure 15 below:



[Source: Joint Inspection Group]



[Source:Neste]

Figure 15 — Key standards and regulations that apply throughout jet fuel supply chains in the EU

It should be noted that these Standards have been in application for several decades and are regularly updated to reflect latest industry knowledge and learning. Whilst many were originally created to manage conventional jet fuel, their requirements are equally applicable to semi-synthetic Jet fuels and SBCs, for the last ones, specific requirements have been defined in EI 1533, an amendment of EI/JIG 1530.

The principal operating standards for the supply chain from refinery to the airport is the EI/JIG 1530, *Quality assurance requirements for the manufacture, storage and distribution of aviation fuel to airports* (jointly produced and published by JIG and the Energy Institute), used in all the world. EI/JIG 1530 has a specific Addendum – EI 1533, *Quality assurance requirements for semi-synthetic jet fuel and synthetic blending components* – that lists the additional operating and handling requirements for synthetic blending components (SBC) and semi-synthetic jet fuel (SSJF)l. The supply chain documents are supported by several other Energy Institute documents such as *HM 59 Guidelines for the cleaning of rail tank cars carrying petroleum and refined products*, *HM 50 Guidelines for the preparation of tanks and lines for marine tank vessels carrying petroleum and refined products*, *HM 93 A guide to manual sampling of hydrocarbon liquids,* etc.

JIG 1, *Aviation Fuel Quality Controls and Operating Standards for Into-Plane Fuelling Services*, JIG 2, *Aviation Fuel Quality Controls and Operating Standards for Airport Depots and Hydrants*, and JIG 4, *Aviation Fuel Quality Control and Operating Standards for Smaller Airports* (published by Joint Inspection Group) apply in all the rest of the World.

[Source:JIG]

Figure 16 — Worldwide use of Airport operating standards

With the number of actors involved in the manufacture and handling of SBC and semi-synthetic Jet fuels rapidly expanding, the potential risk to fuel quality delivered to aircraft, is increasing. Due to this, following the operational standards is paramount to maintain fuel specification in all the supply chain, until the wingtip.

The fundamental principles of aviation fuel handling

After production, a sample from a jet fuel batch is laboratory tested to ensure it meets the Fuel Specification properties, as well as the requirements for composition and manufacture. During the transportation of the aviation fuel from the refinery to the wingtip of the plane, Operational Standards such JIG, define the requirements to ensure the fuel quality is always on Specification. In order to this, Operational Standards cover different processes and procedures, as described below, and this includes doing additional laboratory testing as the fuel moves through the Supply Chain.

Infrastructure Materials and Design

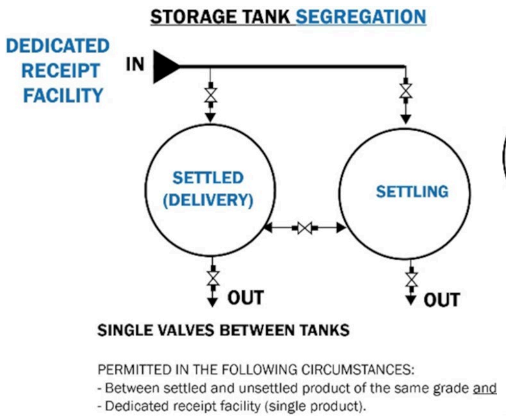
The first feature of handling and operating standards is to define how infrastructure and equipment has to be built, and what materials must be used. The design requirements are defined in JIG 2, EI/JIG 1530 and in the Energy, Institute documents, i.e.: EI 1540, *Design, construction, commissioning, maintenance and testing of aviation fuelling facilities*, and EI 1560, *Recommended practice for the operation, inspection, maintenance and commissioning of aviation fuel hydrant systems and hydrant system extensions*. These requirements extend to means of transport used to move aviation fuels between points of production and consumption. The design of fuel handling facilities is intended to ensure that no accidental contamination can take place during usual operations. These provisions apply equally for jet fuel and synthetic blending components (SBC) as they do for finished fuels including semi-synthetic Jet fuel. To our knowledge most country regulations worldwide mirror the basic principles of these documents, with occasional variations due mainly to differing Fire Regulations or environmental protection.

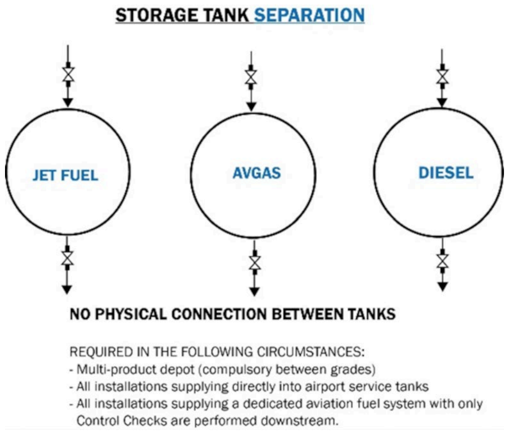
Segregation and Separation of products

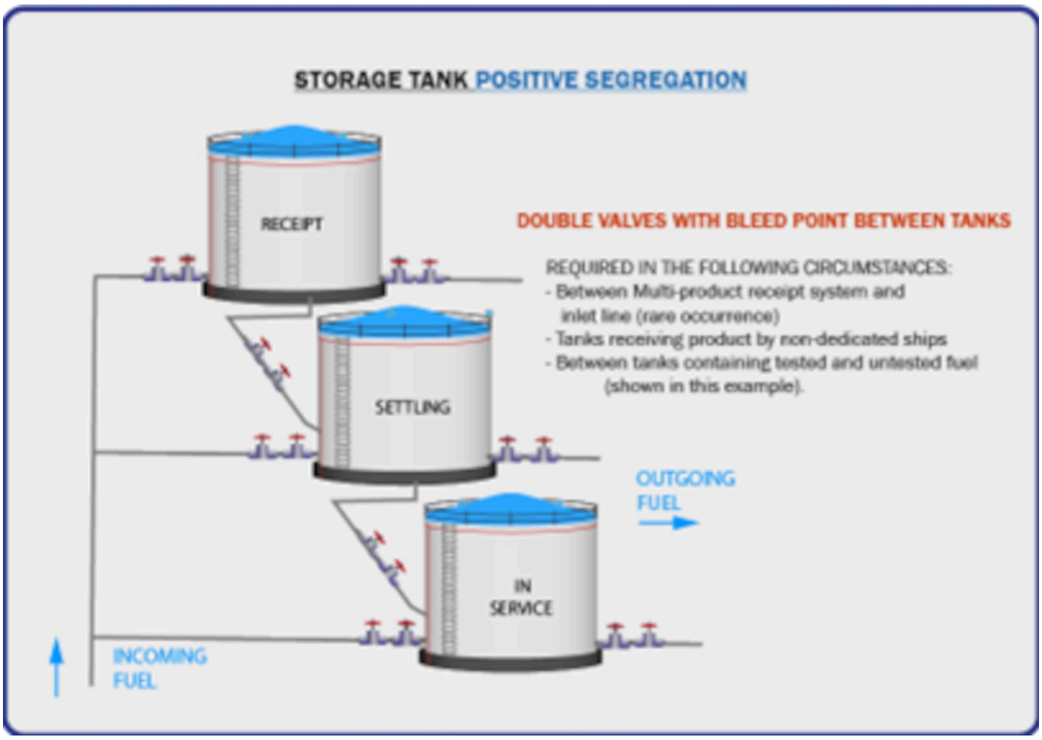
The design of fuel handling facilities is intended to ensure that no accidental contamination can take place during usual operations. These provisions apply equally for jet fuel synthetic blending components (SBC) as they do for finished fuels including semi-synthetic Jet fuel. Cases of cross contamination with different fuels have been observed in the past in multiproduct supply chains, and due to that Operational Standards are well detailed defining where segregation and separation of products are required. This is a key feature of these facilities; they are designed to be able to handle the aviation fuel without cross-contamination. Indeed, the DEF STAN 91-091 Specification specifically prohibits the handling of non-aviation fuels in airport fuel handling facilities.

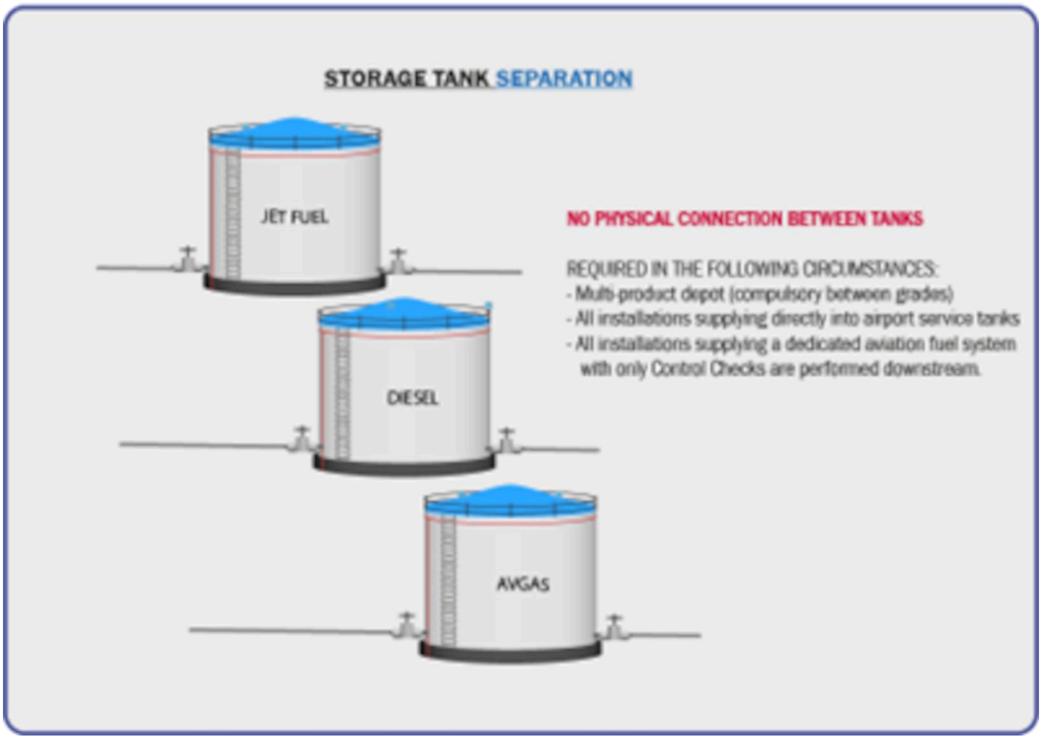
The Jet fuel and blending components are often transported and stored with other products, and due to that there is a risk of cross-contamination. The Operational Standards consequently describe in detail how multi-fuel facilities have to be constructed and pipelines, valves and pumps configured to ensure that the aviation fuels can be maintained on specification.

Figure 17 illustrates the distinction between segregation and separation:


STORAGE TANK SEGREGATION
DEDICATED RECEIPT FACILITY
IN
SETTLED (DELIVERY)
SETTLING
OUT
OUT
SINGLE VALVES BETWEEN TANKS
PERMITTED IN THE FOLLOWING CIRCUMSTANCES:
- Between settled and unsettled product of the same grade and
- Dedicated receipt facility (single product).


STORAGE TANK SEPARATION
JET FUEL
AVGAS
DIESEL
NO PHYSICAL CONNECTION BETWEEN TANKS
REQUIRED IN THE FOLLOWING CIRCUMSTANCES:
- Multi-product depot (compulsory between grades)
- All installations supplying directly into airport service tanks
- All installations supplying a dedicated aviation fuel system with only Control Checks are performed downstream.


STORAGE TANK POSITIVE SEGREGATION
RECEIPT
DOUBLE VALVES WITH BLEED POINT BETWEEN TANKS
REQUIRED IN THE FOLLOWING CIRCUMSTANCES:
- Between Multi-product receipt system and inlet line (rare occurrence)
- Tanks receiving product by non-dedicated ships
- Between tanks containing tested and untested fuel (shown in this example).
SETTLING
OUTGOING FUEL
IN SERVICE
INCOMING FUEL



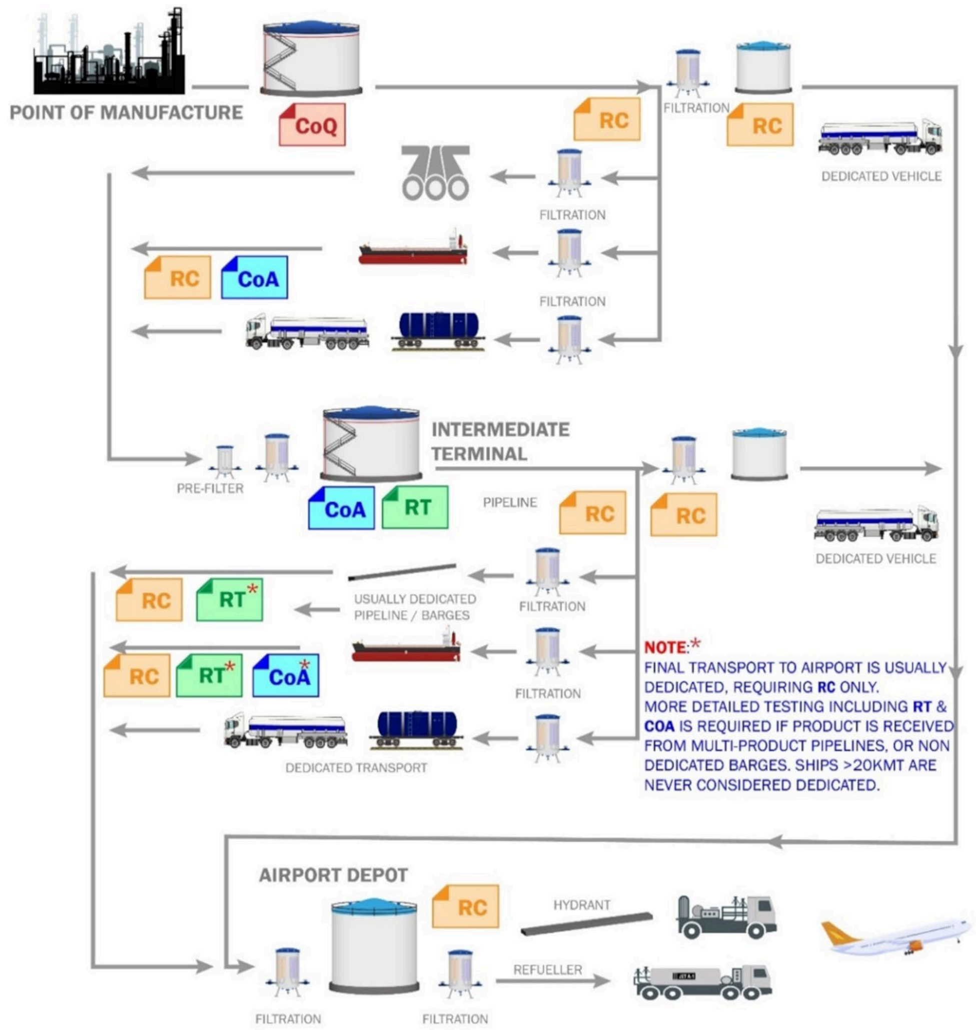
Source: Joint Inspection Group

Figure 17 — Distinction between segregation and separation

Operational Procedures and Quality Testing

The physical infrastructure requirements work hand in hand with operating procedures (Operational Standards) that ensure that all checks are made at various stages during transport, and that the infrastructure is used in accordance with its design. Specific procedures are included for the handling of multiple products. There are also procedures for cleaning and testing of non-dedicated transport means, to ensure they are fit for transporting jet fuel.

Aviation fuels are subjected to a testing regime at different stages in the supply chain that often require comparisons to be made with previous Certificates of Quality or/and Certificate of Analysis, to ensure that fuel being delivered to airports and into aircraft remains on specification. The Operating Standards also include specific protocols to test fuel characteristics (such as Water Separation and presence of surfactants, for example) that are defined in the Fuel Specifications and for which testing is especially relevant downstream of manufacture. These requirements are covered by JIG Bulletins as for example *JIG Bulletin 149 Testing water separation properties of jet fuel downstream of point of manufacture (revised MSEP protocol). All these Bulletins are clearly stated in DEF STAN and ASTM Fuel Specifications.*



[Source: Joint Inspection Group]

Figure 18 — Operational Procedures and Quality Testing

6.5.2 Airport infrastructure and into-plane operations with semi-synthetic Jet fuel

Fuel handling facilities are managed according to the airport Operating Standards (JIG & ATA) that list the operating and quality control procedures necessary to maintain the fuel on Specification.

Most airports are equipped with fixed storage tanks to receive, store and supply aviation fuels, and a fleet of fuelling vehicles to deliver to aircraft. Large airports are further equipped with "hydrant systems" an underground system of pipeline that could be several kilometres long that transport fuel directly to airport parking stands and thereby avoid the use of large fueller trucks in congested areas.

When semi-synthetic jet fuel is produced and certified for use in aircraft, as stated in section 6.2 above, it meets the requirements of the prevailing governing specification (DEF STAN or ASTM) and is transported in the same manner. This means that airports receiving semi-synthetic jet fuel may not know it is indeed semi-synthetic jet fuel and will handle it – as specified in the Operating Standards – in the same way as conventional fuel in existing facilities. It does not require special handling, storage or testing upon arrival.

Fuelling of aircraft with semi-synthetic jet fuel

The procedures for fuelling of aircraft are defined in the same Operational Standards as those for fuelling facilities. There are no differences in procedures or equipment for refuelling with semi-synthetic Jet fuel

6.6 The development of non-blended synthetic fuels

There are two ongoing industry projects within ASTM International to investigate whether aircraft would be capable of handling 100% fully synthetic Jet fuel:

- The first is a fully synthetic Jet A/A1 fuel (i.e. DEF STAN 91-091 or ASTM D1655) with synthesized paraffins and aromatics that would remove the requirement to blend with a fossil fuel. This fuel would be treated as any other Jet A/A1 fuel transported and stored with all other Jet A/A1 fuels with no new infrastructure required. This solution could potentially be defined by 2026.

- The second project is looking at a completely new fuel specification, (nominally called Jet "x") that would be fully paraffinic fuel, (i.e. zero or near zero aromatics) that would reduce the non-CO2 emissions. This fuel would not be compatible with all existing aircraft and would require new infrastructure for storage and delivery to the aircraft to mitigate the potential for misfuelling. This is very much an experimental specification at the moment and there is no clear date when it could be finalised.

A full cost benefit analysis of both potential 100% synthetic fuel solutions and including their introduction into service is being studied under the EU ALIGHT project.

7 Recommendations and perspective

7.1 Introduction

The aim of this chapter is to help users of this CWA into implementing SAF in accordance to their context and applicable regulation, as well as making recommendations towards improving and ensuring coherence among the different pieces of regulation, as well as improving and developing standards in support of SAF market and EU targets and milestones.

In addition, further support to Research, development and Innovation is recommended towards raising maturity of innovative solutions and systems to boost market deployment and consideration at standardization level.

While at EU member states level, compliance with the EU regulation is mandatory, some local regulations and policies may exist and thus be considered for compliance with.

Jet fuel specifications are identified as an aircraft operating limitations listed in the Airworthiness Authority (e.g. EASA) Type Certificate Data Sheet (TCDS) and in the aircraft operational documentation (e.g. Aircraft Flight Manual AFM). It is the aircraft/engine manufacturers responsibilities to define the fuel specifications approved for their respective equipment and identify the operational limitations. It is the aircraft operator's responsibility to ensure they only uplift fuel compliant with the specifications defined in the aircraft TCDS, AFM etc.

Today the major aircraft / engine manufacturers and Airworthiness Authorities, such as EASA and the FAA, work collaboratively through ASTM International and the UK DEFSTAN jet fuel specifications to ensure aircraft safety with defined protocols and procedures to monitor and control any evolution of the ASTM D1655 and DEF STAN 91-091 jet fuel specifications, that are recognized around the world as the global reference specifications.

Jet fuel quality, both conventional and synthetic fuels, (sic SAF), is ensured through clear industry standards EI, JIG and ATA103 as listed in the ICAO Manual on Civil Aviation Jet Fuel Supply Doc 9977.

7.2 Identified gaps / mismatch

Table 6

Identified gap / inconsistency	Proposed solution / recommendation
Inconsistent language between ReFuelEU Aviation and fuel specifications, such as ASTM and DEF STAN, and aviation fuel quality operating standards, such as EI & JIG	Ad (1) ReFuelEU Aviation should reflect already established terms, such as “synthetic blending component” (SBC)[71], and ideally refer to ASTM, DEF STAN, JIG and EI. Ad (2) Use the definition of batch consistently with JIG standard.
Inconsistent language between ReFuelEU and EU ETS With the last revision of EU ETS, a financing mechanism for “eligible aviation fuels” was introduced. While it intends to promote all fuels eligible to meet the ReFuelEU targets, except for recycled carbon fuels, it does not use the same language and defined terms as in ReFuelEU. Non-consistent use of language creates unclarity (1) Article 3c para 6 of Directive 2003/87/EC refers to a regulation on ensuring a level playing field for sustainable air transport, while it means ReFuelEU. (2) It excludes aviation fuels that are not derived from fossil fuels from “eligible aviation fuels” which reads overly complicated. (3) It uses the term “renewable fuels of non-biological origin”, even though renewable fuels of non-biological origin for aviation are called “synthetic aviation fuels” in ReFuelEU. (4) Article 3c para 6 of Directive 2003/87/EC provides a support level of 100 % of the remaining price differential for usage of eligible aviation fuels at, amongst others, "airports which are insufficiently large to be defined as Union airports in accordance with a regulation on ensuring a level playing field for sustainable air transport and at airports located in an outermost region” while Union airports are defined as airports of a certain size and that are not situated in an outermost region	(1) Make a clear reference in Article 3c para 6of Directive 2003/87/EC to ReFuelEU (“Regulation (EU) 2023/2405”). (2) Explicitly exclude recycled carbon fuels. (3) Replace “renewable fuels of non-biological origin” with “synthetic aviation fuels”. (4) As above, explicit reference to ReFuelEU Aviation would be an easier read, Therefore, when defining the 100% support level, we would recommend referring to “airports that do not fall under the definition of ‘Union airport’ as defined in Article 3(1) of Regulation (EU) 2023/2405”.
ReFuelEU lacks a clear definition for ‘aviation fuel supplier’. Instead of defining the aviation fuel supplier in a uniform manner in ReFuelEU, it refers to the fuel supplier definition in RED which does not only provide several options but is also up to Member State	Introduce an uniform aviation fuel supplier definition in RefuelEU, rather than cross-reference to RED, and thus requirement for national transposition. Also, it must be clear at which point in the

[71] **Synthetic blending component (SBC):** Synthesized hydrocarbons that meet the requirements in any one of the annexes of ASTM D7566, or as specified in GB 6537-2018, which may then be used as a component in the manufacture of semi synthetic jet fuel.

interpretation. This leads not only to potentially delayed but especially to scattered interpretations of aviation fuel suppliers across the Member States. There is no clarity if the obligation is triggered through supply at the airport (into-plane) or to the airport (into-tank) or further upstream, and different interpretations are possible there. All in all, the above leads to great uncertainty about who shall qualify as an aviation fuel supplier and meet corresponding obligations. The fact that the flexibility mechanism is tied to the different (national) aviation fuel supplier definitions makes the mandate even more complex to understand but might also not lead to a level playing field.	supply chain the SAF supply and reporting obligations for aviation fuel suppliers are triggered.
The definition of a Union airport is based on a threshold of annual passenger numbers or freight tonnage from the preceding reporting period. Even though the Commission publishes an annual list of airports qualifying as Union airports, this list is merely indicative and has no legal effect. All that matters are the figures. For airports whose figures are close to these thresholds but haven't yet surpassed them, it means that their classification as a Union airport (and definitive knowledge thereof) might only be determined on the very last day of the preceding reporting year or the first day of the reporting year —in other words, the date when the corresponding obligations for that airport as Union Airport begin. What does the classification of a Union airport entail? The definition as a Union airport is not only associated with the obligation of aviation fuel suppliers to supply a minimum share of SAF, but also with the refuelling obligation of aircraft operators. Aviation fuel suppliers must plan their supply chain and ensure that both the SAF supply obligation, and the reporting obligation are complied with. Aviation fuel suppliers and airport refuelling infrastructure must be able to ensure sufficient capacity and availability of aviation fuel to enable aircraft operators to meet their refuelling obligations. In addition, aircraft operators and aviation fuel suppliers have a legitimate interest in knowing which airports qualify as Union airports, as under the EU ETS the highest level of support to cover the price gap for eligible aviation fuels is linked airports falling outside the definition of Union airports (irrespective of the type of eligible aviation fuel), while the level of support for the use of eligible aviation fuel at Union airports depends on the type of eligible aviation fuel and is potentially much lower.	To allow at least one year of preparation, it would be crucial to change the definition of "Union airport" to refer to the "year before the previous reporting period" and not just the "previous reporting period".
ReFuelEU Aviation combines a more or less linearly increasing sub-target for synthetic aviation fuels in a five-year period with an overall SAF target that remains at the same level over that period. This leads to a relative decrease in demand for eligible aviation fuels other than synthetic aviation fuels from 4.8-5.3% in 2030 to 4% in	Unless there is a clear and concrete intention to phase out a technology, the trajectory of an overall target and its sub-targets need to be aligned. For example, linear sub-goals only make sense if they go hand in hand with linear overall goals.

2034, just before the overall SAF target rises sharply to 20% in 2035. Such a demand forecast does not only lack the spirit of a level playing field and will prevent investment in production.	This should not require reopening the overall targets but rather could be addressed by adding stepping stones in between the 5-year target milestones.
ReFuelEU Aviation started its SAF mandate in 2025 at a low annual target level of 2% with a significant increase every five years. Between those increases, the target level stays flat for five years each. However, SAF production is a heavy industry undertaking, demanding significant capital expenditure and extended lead times for new infrastructure, and production capacity can inevitably be brought on stream only gradually. It will not be possible to bring the capacities online to the required extent in 100% accordance with the currently in place target level increases, as the leaps between the target levels are too big. If new capacity were made available ahead of the increase, it would suffer from lack of demand and thus profitability. The present set-up has therefore great potential to delay the ramp-up. The challenge will be exacerbated by the predicted growth of the aviation sector increasing the total jet fuel demand and the number of airports qualifying as Union airports. The corresponding increase in the absolute volume of SAF will make the non-linear target increases even more demanding to achieve.	The minimum shares of SAF in ReFuelEU Aviation should increase in a more linear manner. The current target levels provide great waypoint targets. However, should improvements be required for the effective uptake of SAF following the Commission review of ReFuelEU Aviation , yearly step increases chould be considered between those waypoint targets. This would facilitate compliance with the targets and thereby further strengthen the commitment to the objectives of ReFuelEU Aviation.
Feedstock requirements in ReFuelEU The RED defines EU sustainability criteria for renewable energy eligible to be counted towards decarbonization targets for all transport sectors, including aviation. The ReFuelEU Aviation definition of aviation biofuel refers to biofuels which comply with the sustainability and lifecycle emissions savings criteria laid down in the RED Article 29 and are certified in compliance with Article 30 of the RED. However, SAF produced from the following feedstocks is excluded from the calculation of the minimum shares of SAF set out in the ReFuelEU Aviation: food and feed crops as defined in the RED, and intermediate crops, palm fatty acid distillate and palm and soy-derived materials, and soap stock and its derivatives unless they are included in the RED Annex IX. The exclusion from ReFuelEU Aviation of feedstocks compliant with the RED sustainability criteria leads therefore to inconsistency between the two pieces of legislation.	Harmonisation of the list of eligible SAF feedstocks under ReFuelEU Aviation is needed to ensure full consistency with the provisions of Article 29 of the RED. Note: Two participants T&E and ECODES opted out on this recommendation.
Updating the standard EN 16214: “Sustainability criteria for the production of biofuels and bioliquids for energy applications - Principles, criteria, indicators and verifiers”	The standard is not updated to the latest amendments by RED III. It provides assistance in considering the RED biofuel sustainability and GHG emissions saving criteria. An update of the standard could provide clarity and assistance for economic operators when they search for

	sustainable feedstocks for the various obligations and targets referring to the RED biofuel sustainability criteria.
Improve coordination between Regulatory bodies for aircraft airworthiness and implementation of SAF regulations	Improve the coordination between regulatory bodies related to aircraft airworthiness certification and new regulations development to increase the usage of SAF by engaging the organizations that manages the governing fuel specifications.
Use appropriate terminology for “fuel components” and “blending components”	Regulators to use appropriate terminology, aligned with governing fuel specifications bodies as ASTM, DEF STAN and industry recognized operational standards as JIG, to avoid misuse of terminology that might be inappropriate used, or wrongly.

7.3 Recommendation for other e-fuels

The CWA recommends to have a similar value chain approach identifying the regulatory context, the existing certification schemes and mapping gaps providing recommendations to fill these gaps as well as towards optimizing regulatory context.

Annex A
(informative)

Overview aviation fuel, SAF and emissions reporting

Table A.1 — Overview aviation fuel, SAF and emissions reporting

	RED fuel supplier reporting	**ReFuelEU fuel supplier reporting**	**ReFuelEU aircraft operator reporting**	**EU ETS aircraft operator reporting**	**CORSIA aircraft operator reporting**
Where	Union Database	Union Database	Digital Reporting Tool	[ETS] Emissions report	[CORSIA] Emissions report
Deadline / cadence		By 14 February of each reporting year, annually	By 31 March of each reporting year, annually	The emissions data for a given year must be verified by an accredited verifier by 31 March of the following year.	By 30 April of the following year, annually.
What		Amount of aviation fuel supplied at each Union airport in tones	Total amount of aviation fuel uplifted at each Union airport in tonnes	Estimated CO2 emissions per fuel type [72]	Estimated CO2 emissions per fuel type, including the use of CORSIA eligible fuels
			yearly aviation fuel required, per Union airport in tonnes		
			yearly non-tanked quantity, per		

[72] https://climate.ec.europa.eu/document/download/1bc29dfb-d77e-43bd-ba43-d0e685b7eb2a_en?filename=exemplar_mp_aem_fin_en.xls

			Union airport in tonnes		
			yearly tanked quantity, per Union airport in tonnes		
		Amount of SAF supplied at each Union airport in tonnes	Total amount of SAF purchased from aviation fuel suppliers in tonnes	x	
		For each type of SAF: -conversion process, -the characteristics and origin of the feedstock used for production, -and the lifecycle emissions of each type of SAF supplied at Union airports	For each purchase of SAF: -name of the aviation fuel supplier, -the amount purchased expressed in tonnes, -t he conversion process, -the characteristics and origin of the feedstock used for production, -and the lifecycle emissions of the SAF, -and, where one purchase includes different types of SAF with differing characteristics, providing that information for each type of SAF	x	

		Content -of aromatics and naphthalenes by percentage volume -and of sulphur by percentage mass in aviation fuel supplied per batch, per Union airport and at Union level - total volume and mass of each batch; test method applied to measure the content of each substance at batch level		Non-CO2 aviation effects	
		Aviation fuel and SAF supplied at each Union airport, energy content for each type of fuel.			

Bibliography

Renewable Energy Directive: Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652

ReFuelEU Aviation: Regulation (EU) 2023/2405 on ensuring a level playing field for sustainable air transport (refuelEU aviation)

EU ETS: European Union Emissions Trading System

CORSIA: Carbon Offsetting and Reduction Scheme for International Aviation

Biofuel Standard: EN 14214, *Liquid petroleum products - Fatty acid methyl esters (FAME) for use in diesel engines and heating applications - Requirements and test methods*

Gas Directive: Directive (EU) 2024/1788 of the European Parliament and of the Council of 13 June 2024 on common rules for the internal markets for renewable gas, natural gas and hydrogen, amending Directive (EU) 2023/1791 and repealing Directive 2009/73/EC (recast)

ASTM D4054, *Standard Practice for Evaluation of New Aviation Turbine Fuels and Additives*

EI/JIG 1530, *Quality Assurance Requirements for the Manufacture, Storage and distribution of Aviation Fuels to Airports*

EI 1533, *Quality Assurance Requirements for Semi-Synthetic Jet Fuel and Synthetic Blending Components (SBC)*

EI 1540, *Design, construction, commissioning, maintenance and testing of aviation fuelling facilities*

EI 1560, *Recommended practice for the operation, inspection, maintenance and commissioning of aviation fuel hydrant systems and hydrant system extensions*

ICAO doc 9977, *Manual of Civil Aviation Jet Fuel Supply*

JIG 1, *Aviation Fuel Quality Controls and Operating Standards for Into-Plane Refuelling Services*

JIG 2, *Aviation Fuel Quality Controls and Operating Standards for Airport Depots and Hydrants*

JIG 4, *Aviation Fuel Quality Controls and Operating Standards for Smaller Airport*