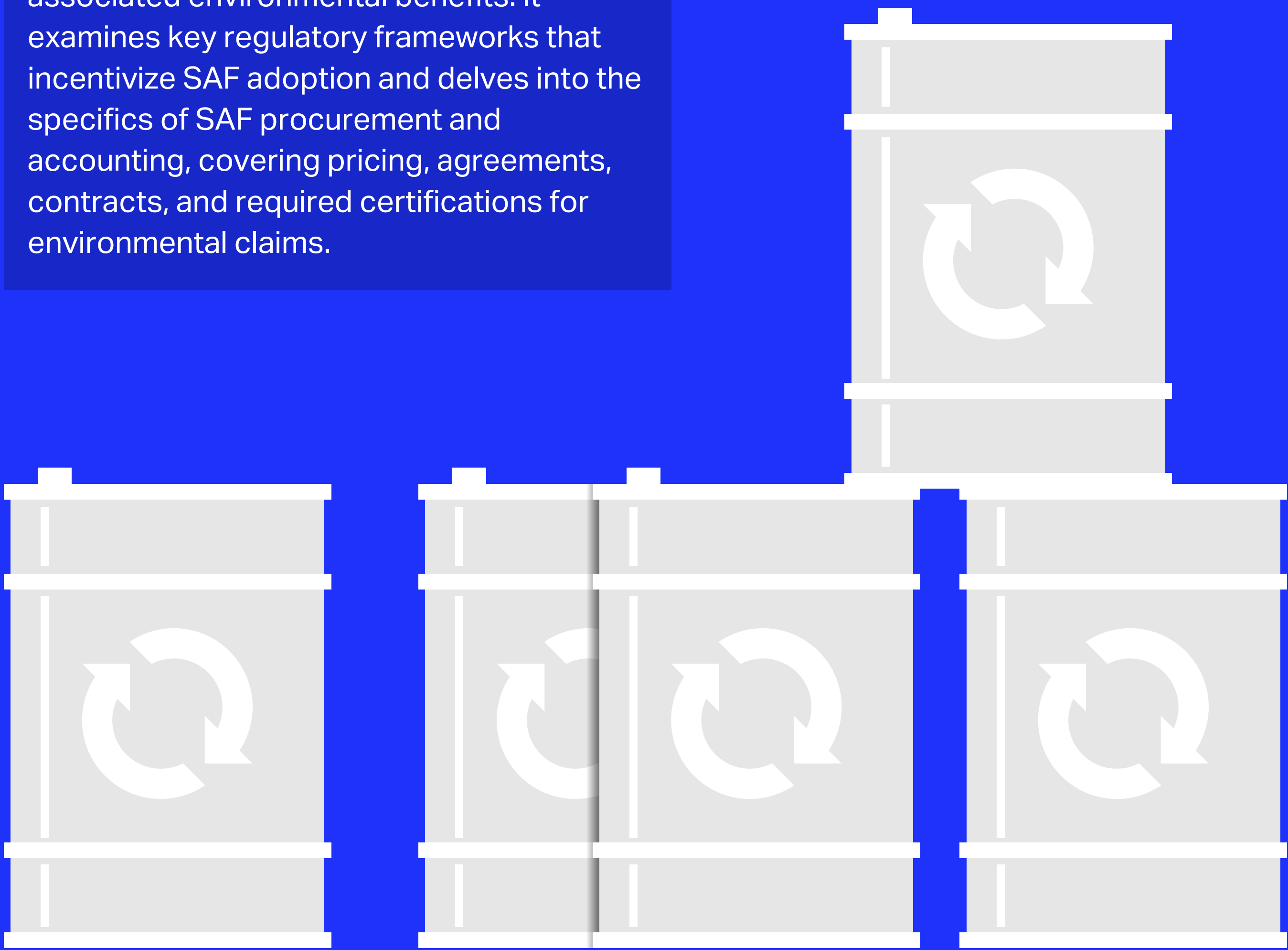
SAF Handbook

May 2024

This Handbook provides guidance to address the main challenges that airlines are faced with when it comes to buying SAF. The Handbook shares a comprehensive overview of SAF, detailing its dual components: the physical fuel and its associated environmental benefits. It examines key regulatory frameworks that incentivize SAF adoption and delves into the specifics of SAF procurement and accounting, covering pricing, agreements, contracts, and required certifications for environmental claims.



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1. INTRODUCTION

IATA's five Net Zero Roadmaps[1], published in June 2023, describe the potential trajectories, covering 130 milestones, to meet aviation's goal of bringing air transportation to net zero carbon emissions by 2050. In all the scenarios and over that full time horizon, Sustainable Aviation Fuels (SAF) play the largest role in aviation's decarbonization. According to the roadmaps, 62% of aviation's carbon emissions reduction by 2050 needs to be realized through SAF. This will require an unprecedented ramp-up of SAF production, both in terms of the speed at which capacity needs to develop and the quantities that will need to be produced between now and 2050, and beyond.

While reaching net zero carbon by 2050 will require broad availability of SAF globally, the pace at which airlines adopt its use and are able to claim the associated benefits will differ depending on factors such as the role that SAF plays in their own decarbonization strategies over time, participation in regulatory or voluntary schemes, stakeholder demands, and specific agreements with corporate customers.

Airlines are at the center of the air transport value chain, and their role in scaling up SAF deployment cannot be underestimated. Buying and using SAF is a complex process that requires collaboration across the sector, including internal and external stakeholders who have traditionally not been an active part of a fuel procurement process or involved in decarbonization initiatives.

This handbook provides guidance to address the main issues that airlines are faced with when confronted with the question: "Should we buy SAF?". It begins by defining SAF and explaining the two distinct goods it encompasses: the physical fuel component, and the environmental attributes associated with it – explaining how the climate benefits are obtained upstream in the process of making SAF, and irrespective of where the fuel is physically used. It then provides an overview of the main existing regulatory frameworks to incentivize SAF uptake. Operational specifics of SAF procurement and SAF accounting are presented in Section 4 and Section 5, including pricing considerations, types of agreements, elements to be captured in a SAF supply contract, and the relevant certification needed for the claiming of SAF's environmental attributes. After describing the stakeholder landscape of SAF, the handbook concludes with a forward-looking section focusing on possibilities for expanding SAF's positive impacts on sustainable development globally.

[1] **IATA Net Zero Roadmaps – Executive Summary**

2. WHAT IS SAF?

Sustainable Aviation Fuels can be any viable aviation fuel that has been certifiably produced in conformity with sustainability criteria, considering both carbon and environmental factors. A viable aviation fuel, as explained in Section 2.1, is fit for safe, operational purposes. In that sense, blended SAF (see definition in 2.1.1) is fully fungible with conventional aviation fuel (CAF), and consequently can be distributed through existing systems as it is fully compatible with all aircraft and engines certified to operate with jet fuel. This is why SAF is referred to as a drop-in fuel.

Given that blended SAF meet the same specifications as CAF, they produce the same amount of CO2 emissions when combusted. The emissions reductions associated with SAF use stem from the fuel production process, i.e., the fact that SAF are made from non-fossil sources, which can include a range of both biogenic and non-biogenic inputs or "feedstock", as explained in Section 2.2.

SAF Definition

2.1. SAF: The Fuel Component

SAF's chemical and physical characteristics are closely related to those of CAF. SAF can be mixed with CAF and once blended, certified to the same standard as conventional jet fuel. This allows the use of the same supply infrastructure and does not require any adaptation of aircraft or engines. Fuels with these properties are called "drop-in fuels" (i.e., fuels that can be directly incorporated into existing airport fueling systems and onboard aircraft).

Given that safety is fundamental in aviation, SAF must meet the requirements described in the relevant fuel specifications to be used on commercial aircraft. Specifications control the chemical and physical properties of aviation turbine fuel (both CAF and SAF) and allow fuel to be checked periodically for compliance as it travels along the distribution infrastructure through to its airport storage destination. Various bodies worldwide, including international associations and government agencies, publish standards and specifications pertaining to these matters. In addition, companies and industry associations issue manuals and other guidance documentation with recommended practices to be adopted when handling the product, to preserve integrity of the fuel as molecules travel through the supply chain

2.1.1 Technical Overview

This section describes the technical certification and handling of CAF and SAF batches. As stated previously, SAF is defined as jet fuel derived from biomass or non-biomass waste and once blended with CAF, meets the relevant specification for use on aircraft, such as ASTM D1655 or Defence Standard 91-091 (Def Stan 91-091), these aspects are explained below.

Key definitions:

Conventional Aviation Fuel (CAF): Aviation fuel produced from conventional hydrocarbons such as those in crude oil, liquid condensates, heavy oil, shale oil, and oil sands.

Synthetic Blending Component (SBC), neat SAF, or unblended SAF: Synthesized hydrocarbons that meet the requirements in any one of the annexes of ASTM D7566, which may then be used as a component in the manufacture of semi-synthetic jet fuel. ASTM D7566 does not include requirements for sustainability. No aircraft are certified to fly on SBC alone at this point in time.

Blended SAF: Depending on pathway, a mix of up to 50% SAF with CAF is allowed, which then meets the requirements set out in ASTM D1655. See Section 2.1.2 for an explanation on blending limits for different pathways.

Bio-component: The fraction in a SAF blend that is derived from biomass or non-biomass waste.

Non-biomass waste: Material of non-biological origin that is a byproduct or a discarded product, including municipal solid waste (MSW) from non-biogenic sources, such as plastics and tire-derived fuels.

Power-to-Liquids (PtL, or "e-fuels"): Typically involve creating jet fuel from carbon sources such as industrial point source waste gases or, in the future, direct air-captured carbon combined with green hydrogen produced using renewable energy-powered electrolyzers. Because these processes do not rely on waste resources or non-food crops, there is theoretically an unlimited supply available, and PtL will likely make up a large proportion of SAF production in the future.

LCAF: Lower carbon aviation fuels (LCAF) are fossil aviation fuels which CO2 emissions are reduced through a variety of technologies and processes such as:

- Energy conservation measures (energy efficient design of plans, increased production efficiencies, improved efficiency monitoring).
- Process gas management (flaring management, venting control, fugitive emissions detection).
- Use of renewable/low carbon electricity, gas and hydrogen.
- Use of carbon capture and storage (CCS).

LCAF can contribute to aviation's decarbonization, particularly in the short to mid-term, while SAF capacity is being built. Both SAF and LCAF are considered CORSIA Eligible Fuels (CEF), though by definition, LCAF are not the same as SAF. To comply with CORSIA requirements, LCAF must demonstrate a lifecycle emissions improvement of at least 10% relative to the average global fossil fuel carbon intensity.

Co-processing: Mixing a base feedstock (typically fossil crude oil) with a biogenic feedstock (bio-oils, such as vegetable oils, used cooking oil or pyrolysis oil) within a petroleum refinery. The benefit of co-processing is the immediate replacement with renewables of a share of the fossil feedstock, up to a certain limit (see Table 1), without the need for building new or modifying production facilities. The process simply introduces a renewable share into the product slate of the co-processing facility.

Fuel Specifications:

Commonly used specifications for Conventional Aviation Fuel:

- ASTM D1655: "Standard Specification for Aviation Turbine Fuel" (US and international). ASTM specifies two grades: Jet A and Jet A-1, which differ in accepted freezing points.
- UK Defence Standard 91-091: "Turbine Fuel, Aviation Kerosene Type, Jet A-1" (UK and international).
- Joint Inspection Group (JIG): Aviation Fuel Quality Requirements for Jointly Operated Systems (AFQRJOS, or "joint checklist" – international).
- GOST 10227 TS-1: Russia grade fuel.
- Number 3 Jet Fuel: China-grade fuel.
- Others, produced by organizations (engine manufacturers, pipeline operators, etc.) wishing to define fuel to their requirements.

These specifications are very similar because they describe the same product, i.e., aviation kerosene. For instance, ASTM D1655 and Def Stan 91-091 have nearly identical requirements for Jet A-1. Of the approximately thirty test results that must be reported, there are only minor variations in test limits (e.g., acidity level and a parameter related to naphthalene content).

ASTM International, formerly the American Society for Testing and Materials, develops and publishes specifications for various products, including jet fuel. ASTM International follows a consensus-based approach, and its standards are recognized worldwide.

To be used in commercial aviation applications, neat SAF must first meet the requirements described in the relevant annex of ASTM Specification D7566, Standard Specification for Aviation Turbine Fuels containing Synthesized Hydrocarbons. Once a batch has demonstrated compliance with the annex requirements, it is blended with CAF according to the conditions in ASTM D7566 and re-tested to show compliance with ASTM D1655.

A SAF blend manufactured and certified using ASTM's procedure also complies with the UK fuel specification Def Stan 91-091. Aircraft, engines, and other equipment manufactured to operate on jet fuel meeting ASTM D1655 or Def Stan 91-091 may therefore use a SAF blend.

It is essential to highlight that ASTM certification for SAF is a comprehensive process in which many entities participate, especially engine and airframe manufacturers. The original equipment manufacturers (OEMs) spend weeks, if not months, testing hundreds of thousands of gallons of SAF in many test and component rigs to ensure the fuel is compatible with existing fuel infrastructure and equipment. The standard-setting approach is very conservative, and the limits on blending percentages, for example, are set to ensure the fuel blend is fit for purpose in typical operating environments. This should be a consideration for other jurisdictions evaluating which SAF specifications to apply. At a minimum, mutual recognition with ASTM D7566 is recommended.

2.1.2 Blending

As stated previously, according to ASTM D7566, neat SAF must be blended with CAF to meet D1655 requirements. The current maximum blending rate allowed is up to 50% (depending on pathway; see Table 1) to ensure compatibility with aircraft engines of all ages. However, in its pure form, SAF already meets most of the requirements of aviation fuel specifications, except for its aromatic contents, and in some cases parameters such as viscosity and density, which makes the blending necessary.

Before neat SAF can enter the common supply infrastructure, blending and re-certification according to ASTM D1655 must occur. In theory, blending can take place at any point along the supply chain; however, there are several factors to consider when choosing the best location, including:

1. Source of conventional fuel: where and how the CAF for blending is procured is essential. If the refinery where SAF is produced has ready access to CAF, either because it also produces CAF or is located within easy reach of a CAF source, blending at the refinery may be the best solution.
2. If the SAF refinery is not located within easy access to CAF, blending could occur at a suitable point along the supply chain, such as an intermediate storage facility. In this case, the neat SAF must be kept segregated until the blending point. This may increase transportation and handling costs but can be the most practical solution in some cases.
3. Availability of blending and storage infrastructure: access to existing infrastructure for blending reduces cost as new facilities would not be needed. It is essential to consider that three to four tanks may be required for blending: one for the CAF, one for the neat SAF, one for blending, and one for the blended fuel, according to the process illustrated in Chart 1. Depending on the volumes of the respective fuels, additional or larger receiving tanks may be required.
4. Quality of conventional fuel: it is important to note that not all CAF is created equal. The specifications allow for a range of values for the different properties, such as density and aromatic content, which are vital for blending. Thus, before blending, it is essential to understand the quality of the CAF to ensure that the blend meets the ASTM D7566 specification.

While it is widely accepted that neat SAF should not enter the airport fuel farm because it has not yet been certified to meet the ASTM D1655 or Def Stan 91-091 specification, there can be a situation in which the blending location is separate from, but in the proximity of the airport fuel farm to take advantage of the availability of CAF nearby. Once the neat SAF is blended with the CAF upstream of the airport fuel farm storage and certified to the relevant specification, it can be released into the airport fuel storage.

Depending on local conditions at given airports, this blending location could be located within the airport property but separated from the airport fuel farm (intermediate storage facility). In this case, blending would happen on airport property but upstream from the airport fuel storage. Whether this will be permitted is still an open question expected to be resolved as more experience with blending and handling SAF is gained.

Table 1 SAF blending ratios and coprocessing limits

ASTM reference	Conversion Process	Abbreviation	Possible feedstocks	Maximum blend ratio	
ASTM D7566 Annex A1	Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene	FT	Coal, natural gas, biomass	50%	
ASTM D7566 Annex A2	Synthesized paraffinic kerosene from hydroprocessed esters and fatty acids	HEFA	Vegetable oils, animal fats, used cooking oils (UCO)	50%	
ASTM D7566 Annex A3	Synthesized iso-paraffins from hydroprocessed fermented sugars	SIP	Biomass used for sugar production	10%	
ASTM D7566 Annex A4	Synthesized kerosene with aromatics derived by alkylation of light aromatics from non-petroleum sources	FT-SKA	Coal, natural gas, biomass	50%	
ASTM D7566 Annex A5	Alcohol to jet synthetic paraffinic kerosene	AtJ-SPK	Ethanol, isobutanol and isobutene from biomass	50%	
ASTM D7566 Annex A6	Catalytic hydrothermolysis jet fuel	CHJ	Vegetable oils, animal fats, used cooking oils	50%	
ASTM D7566 Annex A7	Synthesized paraffinic kerosene from hydrocarbon - hydroprocessed esters and fatty acids	HC-HEFA-SPK	Algae	10%	
ASTM D7566 Annex A8	Synthetic paraffinic kerosene with aromatics	AtJ-SKA	C2-C5 alcohols from biomass		
	Co-processing	**Possible feedstocks**		**Input limit**	**Output limit**
ASTM D1655 Annex A1	Co-hydroprocessing of esters and fatty acids in a conventional petroleum refinery	Vegetable oils, animal fats, used cooking oils from biomass processed with petroleum		5%	
ASTM D1655 Annex A1	Co-hydroprocessing Fischer-Tropsch hydrocarbons in a conventional petroleum refinery	Fischer-Tropsch hydrocarbons processed with petroleum		5%	
ASTM D1655 Annex A1	Co-processing of HEFA	Hydroprocessed esters/fatty acids from biomass		24%	10%

Source: Adapted from ICAO – Approved conversion processes

2.1.3 Supply Chain Best Practices

The Energy Institute (EI)

The Energy Institute is a professional membership body based in the United Kingdom that provides knowledge and information to the energy sector through conferences and technical publications. EI has published several significant technical documents for the aviation industry, including:

- JIG/EI 1530 Quality assurance requirements for manufacturing, storing, and distributing aviation fuels to airports. This document presents best practices for safely handling jet fuel from the refinery to storage at the airport and has a short section on synthetic fuels. EI 1530 is a joint publication with the Joint Inspection Group (JIG).
- EI 1533 Quality assurance requirements for semi-synthetic jet fuel and synthetic blending components (SBC). This document provides quality assurance requirements and recommendations for the manufacture of synthetic (jet fuel) blending components (in accordance with ASTM D7566), their export and import, blending with conventional jet fuel/jet fuel components to produce semi-synthetic jet fuel (also referred to as Sustainable Aviation Fuel), and the export/import of semi-synthetic jet fuel from its point of origin through to delivery to airports. EI 1533 is a supplement to, and intended to be read in conjunction with, EI/JIG Standard 1530.
- EI 1550 Handbook on equipment to maintain and deliver clean aviation fuel. This document complements JIG/EI 1530 with more in-depth information regarding equipment and best practices to keep aviation fuel clean as it travels along the supply chain.

Joint Inspection Group (JIG)

The Joint Inspection Group was initially established by major oil companies serving large airports worldwide to develop standards for the operation and handling of jet fuel at shared facilities at those airports. JIG continuously updates these standards to reflect the latest understanding of jet fuel quality control practices. The Standards which JIG maintains are:

- JIG 1 – Aviation Fuel Quality Control and Operating Standards for Into-Plane Fuelling Services
- JIG 2 – Aviation Fuel Quality Control and Operating Standards for Airport Depots
- JIG 4 – Aviation Fuel Quality Control and Operating Standards for Smaller Airports

JIG also maintains the Aviation Fuel Quality Requirements for Jointly Operated Systems (AFQRJOS), a checklist with the most stringent requirements from both ASTM D1655 and Def Stan 91-091. As with Def Stan 91-091, synthetic components are permitted but "shall be reported as a percentage by volume of the total fuel in the batch". This checklist is used extensively, especially at airports outside the United States. The IATA Fuel Quality Pool (IFQP) audits fuel companies and infrastructure to ensure compliance with this standard and checklist.

Airlines for America (A4A)

A4A, formerly known as the Air Transport Association or ATA, is the largest trade association for commercial airlines in the United States. With the collaboration of representatives from airlines, oil companies, and fuel handling companies, A4A developed the ATA Spec 103 "Standard for Jet Fuel Quality Control at Airports", which is widely used at airports in the United States.

International Civil Aviation Organization (ICAO)

In 2012, ICAO published the Manual on Civil Aviation Jet Fuel Supply (Doc 9977, AN/489), which summarizes the main recommended practices for safely handling jet fuel along the entire supply chain from the refinery to the aircraft's wing. The manual references guidelines published by other entities such as EI and JIG. This document was created in collaboration with IATA, Airports Council International (ACI), and A4A.

2.1.4 Supply Chain Quality Control Documents

Technical documents demonstrating fuel quality must accompany the product to its destination. The most common of these documents are listed here:

- Refinery Certificate of Quality (RCQ)
- Certificate of Analysis (COA)
- Recertification Test Certificate (RTC)

Refinery Certificate of Quality (RCQ):

The RCQ is the definitive original document describing the quality of an aviation fuel product. It contains the results of measurements made by the product originator’s laboratory of all the properties listed in the latest issue of the relevant specification. It also provides information regarding the use of additives, including both the type and amount of such additives. Moreover, it includes details relating to the identity of the originating refinery and the traceability of the product described. RCQs shall always be dated and signed by an authorized signatory.

Certificate of Analysis (COA):

A COA may be issued by independent inspectors or laboratories that are certified and accredited, and it contains the results of measurements made of all the properties included in the latest issue of the relevant specification. It does not, however, include details of the additives added previously. It shall consist of more information relating to the originating refiner's identity and the traceability of the product described. It shall be dated and signed by an authorized signatory.

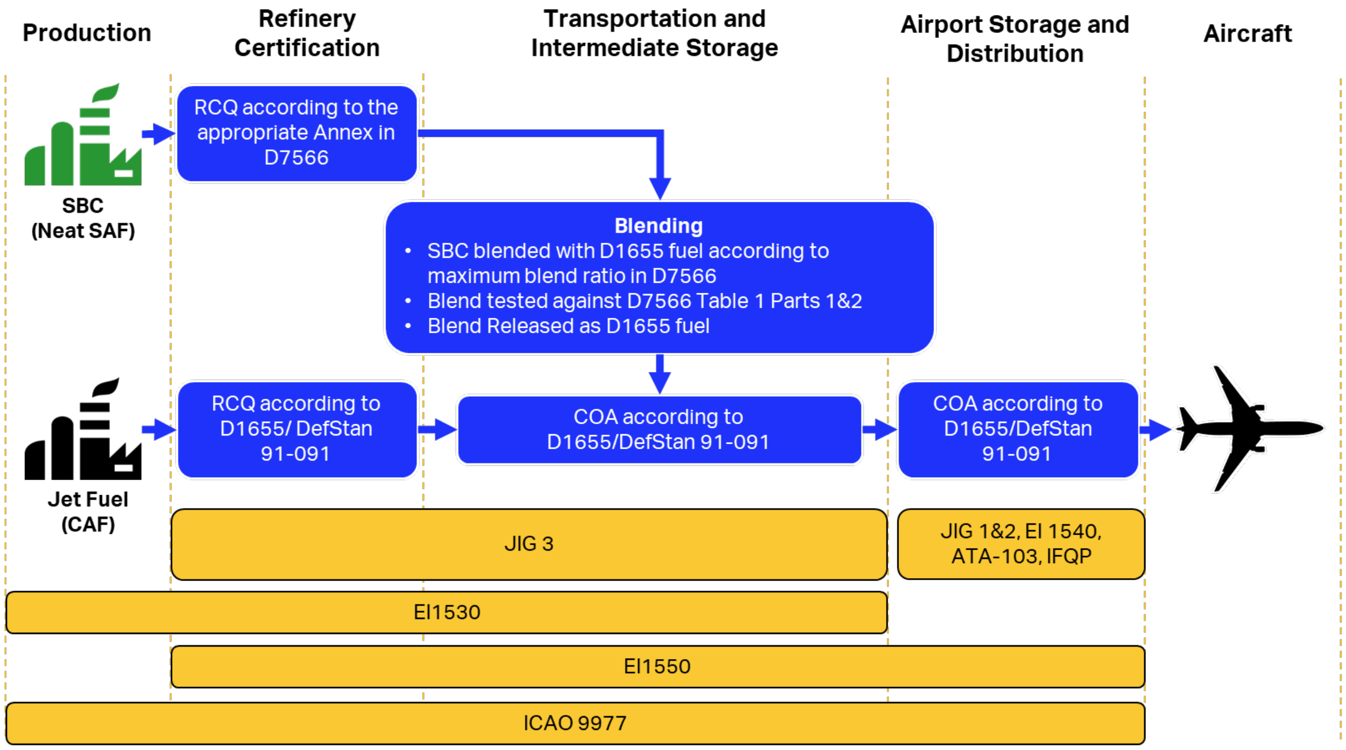
Note: A COA shall not be treated as an RCQ.

Recertification Test Certificate (RTC):

The RTC demonstrates that recertification testing has been carried out to verify that the aviation fuel quality has not changed and remains within the specification limits, for example, after transportation in ocean tankers or multiproduct pipelines. In these cases, where aviation product is transferred to an installation under circumstances that could result in contamination, recertification is necessary before further use or transfer. The RTC shall be dated and signed by an authorized laboratory representative carrying out the testing. The results of all recertification tests shall be checked to confirm that the specification limits are met and that no significant changes have occurred in any of the properties.

A diagram of the main steps in the supply chain, including references to the main specification and other quality documents, is shown in Figure 1.

Figure 1 Supply chain quality control documents relevant by stakeholder



Source: IATA Sustainability & Economics

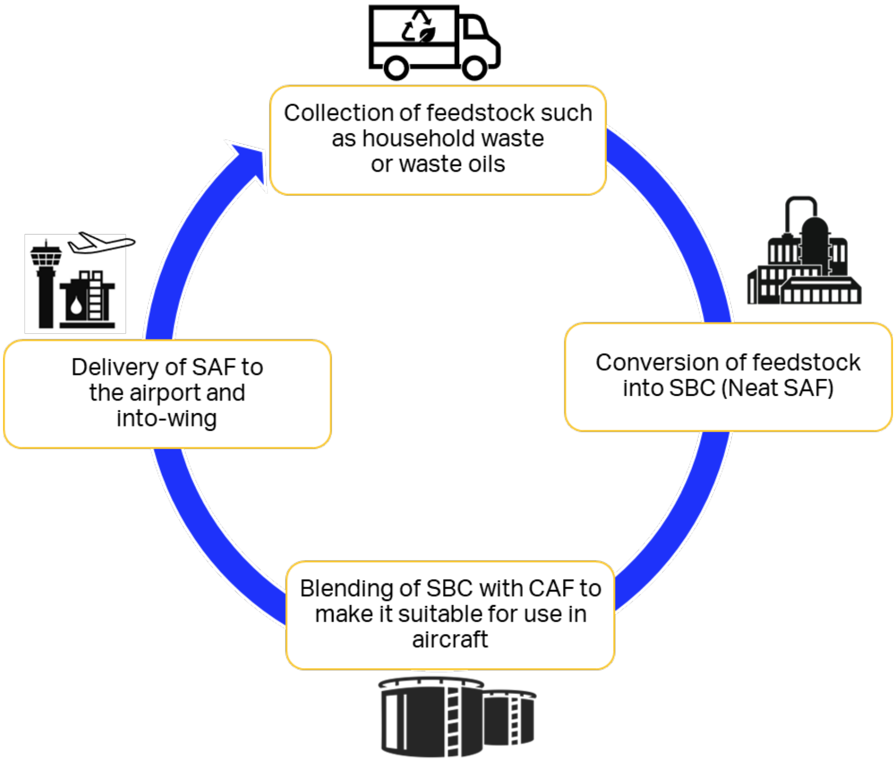
For CAF, the quality process starts with the creation of an RCQ according to the relevant specification. Once the fuel leaves the refinery, it will travel by pipeline, truck, rail, or barge directly into the airport tank farm or an intermediate terminal before reaching the airport. Typically, the fuel will be re-inspected at each transition point, and a Certificate of Analysis (COA) according to the relevant specification will be issued.

The process is similar for neat SAF but has some additional steps, particularly blending. As with CAF, an RCQ will be issued at the refinery, but in this case, it will be according to the appropriate annex in the ASTM D7566 specification and not to ASTM D1655 or Def Stan 91-091. As such, the neat SAF cannot yet enter the supply chain for CAF. First, the neat SAF must be blended with CAF up to the limits specified in ASTM D7566. Once the fuel is blended, it will be tested against ASTM D7566. Once confirmed that the blended fuel meets this specification, it will be released as meeting the ASTM D1655 specification. From then on, the fuel is considered fungible with CAF and could be handled as regular ASTM D1655 fuel.

2.2. SAF: The Environmental Attributes

The overall lifecycle CO2 equivalent emissions of SAF occur from the feedstock growth, collection, transportation, and production, subtracting them from the CO2 equivalent emissions from combustion of SAF in the aircraft. This results in significant life cycle emission savings for SAF compared to traditional fossil-based jet fuel, for which lifecycle carbon emissions are a sum of those generated from crude oil extraction until the fuel is combusted. Figure 2 illustrates SAF's lifecycle.

Figure 2 SAF's carbon lifecycle



Source: IATA Sustainability & Economics

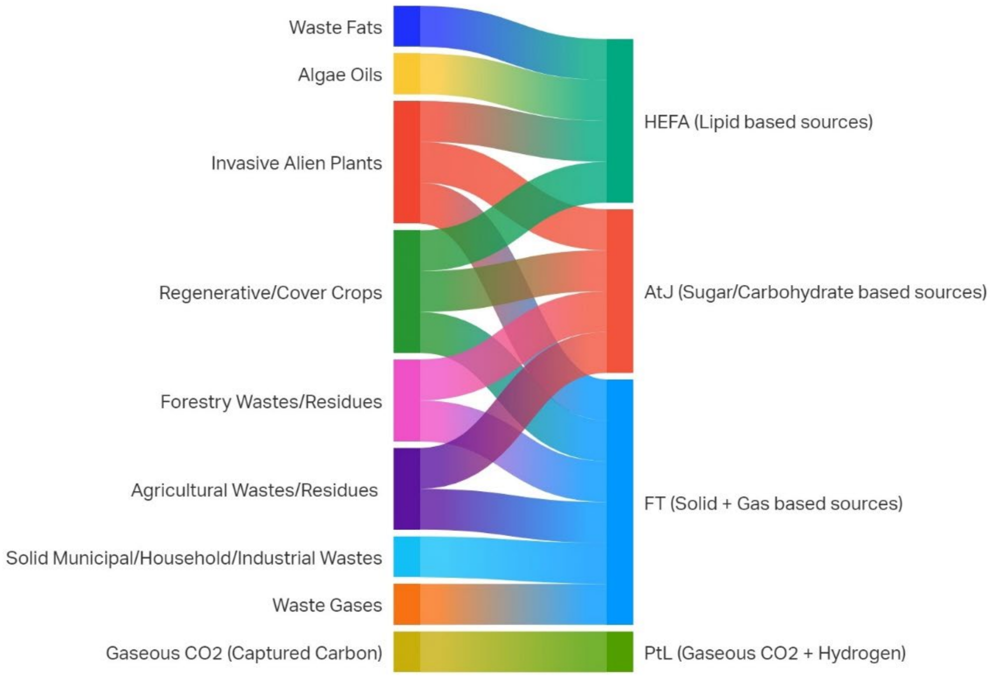
[SAF Production]

2.2.1 SAF Feedstocks

SAF can be made from different technological pathways and feedstock combinations, which means that there are several kinds of SAF. Each SAF variety works with different technologies, cost profiles, carbon abatement profiles, environmental impact, and of course, feedstock. A general overview of feedstocks and associated pathways is provided in the list below and illustrated in Chart 3:

1. Any source of fat, oil, or grease can be converted into a bio-oil, which can in turn be hydro-processed (HEFA technology) into a SAF.
2. Any source of sugar can be converted into either bioethanol or iso-butanol, which in turn can be converted into SAF via a technology referred to as Alcohol-to-Jet (AtJ).
3. Solid biomass such as biogenic municipal waste (including bioplastic), or forestry residues, can be converted into a synthetic-gas intermediary product, which can in turn be converted into SAF using a technology referred to as Fischer-Tropsch (FT).
4. Renewable energy can be used to obtain hydrogen from water and to enable carbon dioxide capture from the atmosphere or from a point emission source. Using synthetic gases as intermediaries, Power-to-Liquid (PtL) SAF can be obtained via the FT or AtJ processes.

Figure 3 SAF production pathways and associated feedstocks

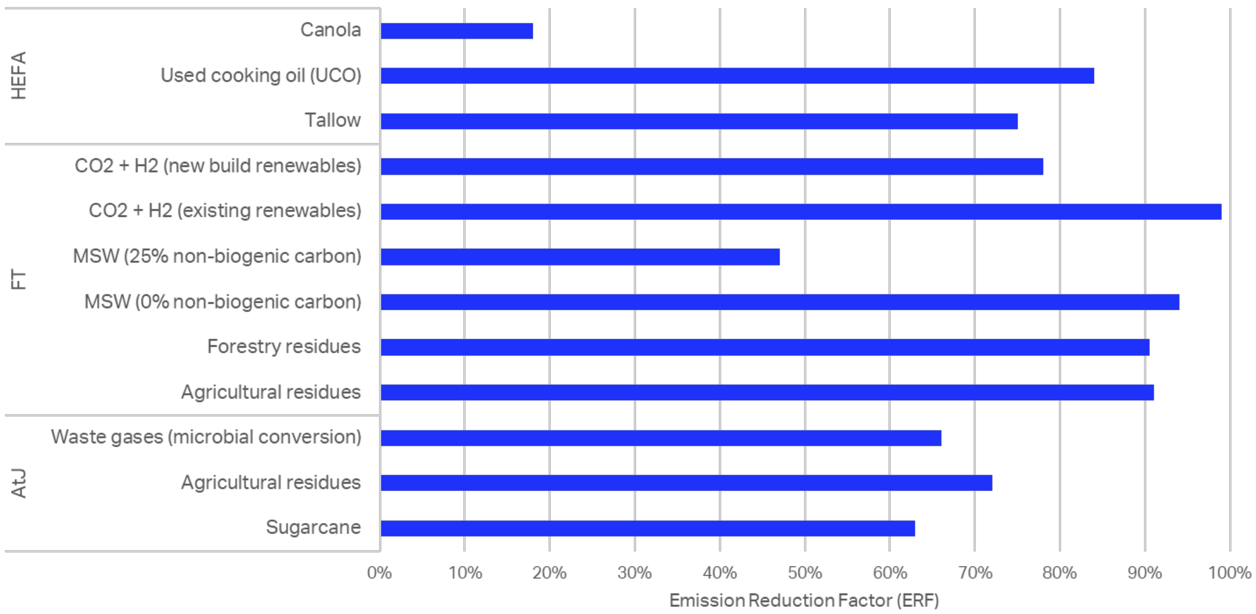


Source: IATA Sustainability & Economics

The emission reduction factors of the SAF output will vary in function of the feedstock and technology pathways. Therefore, the scaling up of SAF production is less a question of maximizing volume than targeting the SAF with the greatest carbon abatement. If a fuel delivers twice the amount of carbon savings relative to another, half the volume would be needed to achieve the same ultimate carbon abatement goal.

Figure 4 shows typical emission reduction factor (ERF) values across HEFA, Alcohol-to-Jet, and Fischer-Tropsch pathways, per type of feedstock.

Figure 4 ERF from different combinations of SAF feedstocks and technology pathways



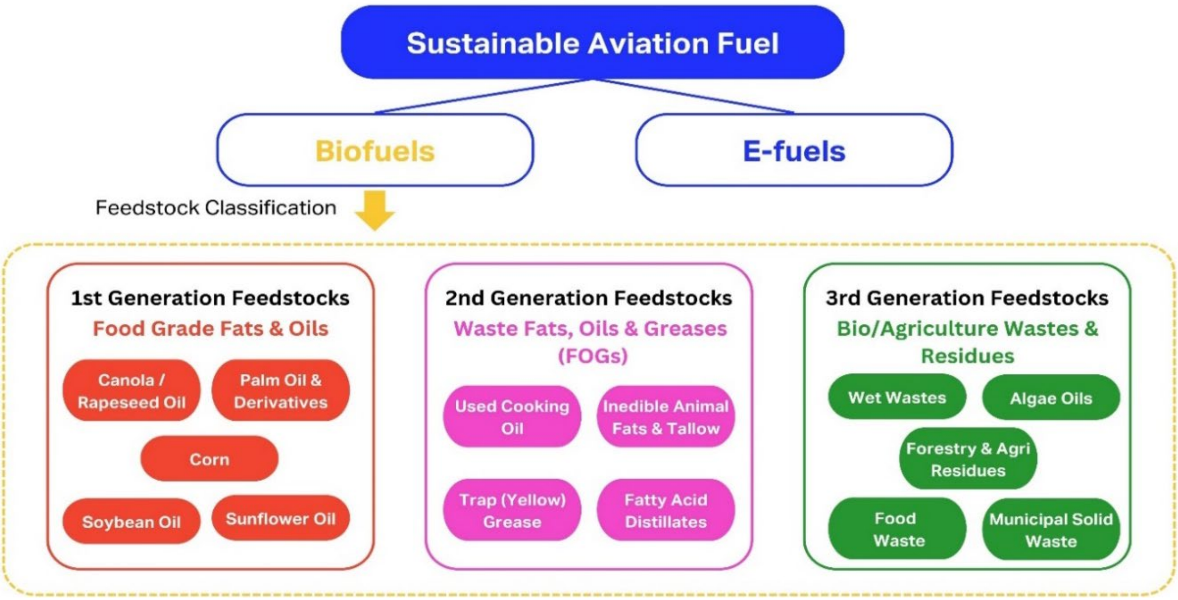
Source: Adapted from [EASA – Charts and tables]

2.2.2 Feedstock Generations

Depending on the following factors, three broad generations of feedstocks have been defined, as illustrated in Figure 5. A break-down of different considerations for each generation is provided in Figure 6.

1. The chronology in which they have been used by the industry
2. Emission reduction potential
3. Ability to meet broader sustainability criteria
4. Ability to achieve restorative or regenerative outcomes in their associated environment
5. Global availability and abundance

Figure 5 Classifying feedstock generations



Source: IATA Sustainability & Economics

First Generation (1G) – Food Grade Fats and Oils: These include canola, rapeseed, palm and palm derivatives, corn, soybean, etc. As the process of converting such oils into fuels is technologically mature, 1G feedstock has already "scaled" commercially and can be produced at a relatively lower cost in comparison to other sources. The major challenge associated with many 1G feedstock lies with their trade-off with global food supply, and broader sustainability issues, such as high levels of required arable land usage, and in some extreme cases, deforestation. For the most part, the airline industry is moving away from 1G feedstock, aside from some specific exceptions where sustainable farming practices have been verified and showcased, to prove the integrity of sustainability claims.

Second Generation (2G) – Waste Fats, Oils, and Greases: This group includes non-edible waste fats, oils, and greases (FOGs), such as used cooking oil, inedible animal fats and tallow, as well as industrial waste greases, and biomass. The use of 2G feedstock is typically more sustainable than 1G, as they achieve a higher reduction in greenhouse gas emission abatement, without requiring additional land usage. However, 2G feedstocks are commonly the most expensive among the three categories, as they are wastes tied to industrial processes, implying constrained supply. Today, these waste fats, oils, and greases are the most common feedstock, aligning with the most technologically mature production pathway, HEFA. As 2G feedstock supplies become increasingly scarce, other feedstocks will likely come to market. HEFA production plants will still be relevant, as various bio-crude (conversion technology) solutions mature.

Third Generation (3G) – Biological/Agricultural Wastes and Energy Crops from Degraded Land: Here we find municipal solid waste, forestry residues, woody biomass, agricultural waste from harvest cycles, algae oils, wet waste, as well as specifically grown energy crops on degraded, marginal, or fallow land. This also includes cover crops, which are grown outside of typical harvest seasons, when that farmland would otherwise not be utilized. 3G feedstocks are abundant in nature and therefore benefit from lower associated costs relative to the constrained supply set of 2G feedstock, although the needed supply chains are not robust. 3G feedstocks also have the most positive environmental impact potential, relative to 1G and 2G, as they constitute by-products and wastes that otherwise would have to be disposed of, which would generate additional emissions. Processing 3G feedstocks requires advanced technologies such as Gasification-FT and hydrothermal liquefaction (HTL).

Figure 6 Breaking down the parameters of feedstock classification

Feedstock type	Emissions reduction potential	Sustainability	Cost	Investment for commercial readiness
1st generation feedstocks	Mid	Low	Mid	Low
2nd generation feedstocks	High	Mid	High	Low
3rd generation feedstocks	High	High	Low	High

Source: IATA Sustainability & Economics

2.2.3 Advanced Biofuels

Fuels produced from 2G and 3G feedstocks are collectively referred to as Advanced Biofuels. These are expected to make up most of aviation's SAF supply for at least the next 10 to 15 years.

In general, feedstocks to produce Advanced Biofuels will include carbon rich waste material, low-value by-products, or purpose-grown energy crop that has been cultivated on degraded or marginal land. The use of food crops for SAF is not allowed under most relevant regulatory schemes (see Section 3). Rather, the essence of waste feedstock is to repurpose surplus materials, which are derived from pre-existing processes or cycles. These waste feedstocks do not require the use of any additional resources such as agricultural land (or land clearing), water, fertilizer, etc.

Some energy crops are purpose-grown on marginal or degraded land, otherwise unfit for agricultural use. This brings the benefits of expanding land use and improving the overall quality of these lands. Not utilizing these degraded lands can result in further soil productivity loss, biodiversity loss, and raise salinity levels (see Table 2).

Table 2 Implications of not repurposing feedstocks

Feedstock	Socio-economic implications of not repurposing feedstocks
Waste fats, oils, and greases	Incineration or landfill
Agricultural waste	Toxifies waterways, damages soil productivity, incineration
Forestry waste	Incineration; catalyst for forest fires
Urban landfill	Methane and nitrous oxide emissions
Wet waste	Exhausts sewage systems; toxifies waterways

Source: IATA Sustainability & Economics

Advanced biofuels can help:

- Achieve land restoration and/or regeneration
- Promote and foster biodiversity
- Develop sustainable supply chains at the regional level
- Create local income and employment
- Improve energy independence and security

2.2.4 Aviation's fair share of feedstock

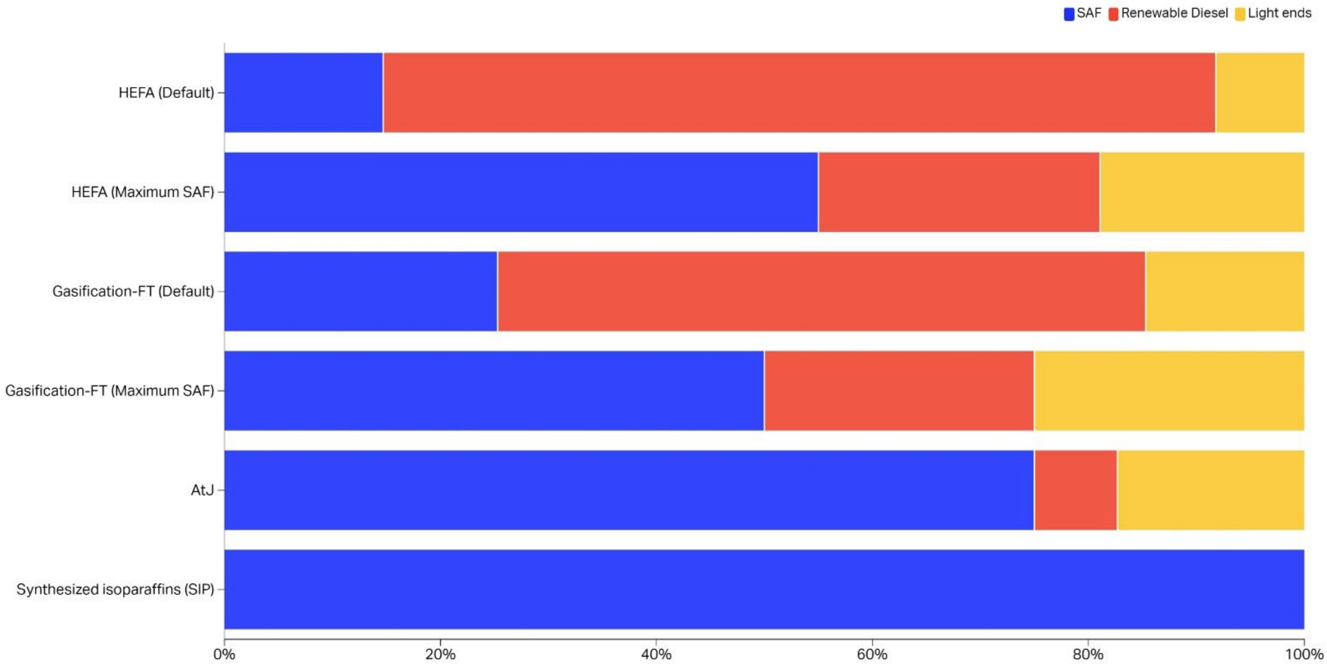
Under the current SAF production ecosystem, which is almost entirely associated with fuels from biological origin, facilities producing SAF are simultaneously producing several other co-products from the same feedstock, such as renewable diesel, biogas, and naphtha. As such, it is not a given that any SAF will be derived from these facilities, as producers optimize their product mix in function of supply and demand, and potential profits.

In the interest of airlines' ability to meet decarbonization obligations and achieve their net zero commitment, two key factors must be considered:

1. The global availability of sustainable fuels refineries capable of producing SAF.
2. The optimum SAF percentage fraction derived from renewable fuel production facilities.

The maximum theoretical threshold for the SAF percentage fraction in the refinery depends on the technological pathway. HEFA, for example, can deliver a SAF fraction between 15-50%, while Fischer-Tropsch can yield 25-40% SAF of the refinery's total output. The SAF yield at AtJ plants can range between 70-90% SAF. Figure 7 shows typical product yields for the key SAF conversion pathways, and the yields while maximizing the SAF output for the HEFA and FT pathways, for comparison.

Figure 7 Product yields for key SAF conversion pathways



Source: Adapted from [ICCT – The cost of supporting alternative jet fuels in the European Union]

While technologies can enable the adjustment of product slates, this often comes at the expense of overall yields. The choice and diversification of SAF pathways and the economic feasibility of SAF production require careful study. At this early stage of the market's creation, policy is the key enabler.

Balanced incentives to support optimum outputs from the refining process and fairly supporting all renewable fuels are key to facilitating the energy transition.

A Deep Dive into SAF Feedstock

2.2.5 Power-to-Liquids (PtL) or “E-fuels”

E-fuels are produced with electricity which if generated by renewable energy such as wind or solar, makes them less carbon intensive. The renewable energy is used to power the capture of carbon dioxide, either directly from the atmosphere or from an emission source. It is also used to power the production of green hydrogen which can be used as a liquid fuel itself or synthesized with the captured carbon dioxide. This synthetic gas can be converted into a liquid SAF solution known as Power-to-Liquid SAF via Fischer-Tropsch process. PtL SAF will likely play a pivotal role in aviation’s decarbonization strategy. However, it will have to contend with multiple challenges, technologies, and over longer timelines than advanced biofuels. E-fuels might only begin to scale and complement advanced biofuels from the mid-2030s. Moreover, achieving such scale in e-fuels will require greatly increased global production of renewable electricity to power the carbon dioxide capture process, and to produce the hydrogen for PtL fuels. There is also a need to scale the number and capacity of carbon capture facilities.

Despite the considerable challenges, PtL SAF lends itself to becoming one of the strongest contributors to airlines’ energy transition in the long-term.

3. REGULATORY FRAMEWORKS AND CERTIFICATION SCHEMES

Government policy has an instrumental role to play in the deployment of SAF. Beyond policies such as local or regional incentives and mandates, which are typically directed to SAF producers and fuel suppliers, there are currently two main regulations directly affecting airlines which plan to or use SAF to reduce their obligations to offset or to purchase allowances to compensate for their carbon emissions: CORSIA and the EU ETS.

3.1. CORSIA

ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), established in October 2016 at the 39th ICAO Assembly, marked the first time that an entire industry agreed to a global market-based measure in the climate change field. Under CORSIA, airlines (defined as "aeroplane operators") must purchase and cancel"emissions units" to offset and reduce the increase in CO2 emissions covered by the scheme over a given baseline.

In addition, under CORSIA, airlines are entitled to claim emissions reductions from fuels that meet defined sustainability criteria and are certified by an approved certification scheme. These "CORSIA eligible fuels" (CEF) include SAF, which are renewable or waste-derived fuels, as well as LCAF, which are fossil-based fuels (see Section 2.1.1).

To meet CORSIA's sustainability criteria, a specific CEF needs to achieve net greenhouse gas emission reductions of at least 10% compared to conventional jet fuel on a life cycle basis. Furthermore, a CORSIA eligible fuel must not be made from biomass obtained from land with high carbon stock. Additional sustainability criteria applicable for CORSIA eligible SAF from certified fuel producers on or after 1 January 2024 were recently adopted by the ICAO Council, considering broader social and environmental impacts in addition to carbon reduction. These are listed in Table 3.

Table 3 CORSIA sustainability themes and principles for CEF eligibility criteria

Sustainability Themes		Principle for Eligible Fuels
Carbon Reduction	1. Greenhouse gases (GHG)	Should generate lower carbon emissions on a life cycle basis.
	2. Carbon stock	Should not be made from biomass obtained from land with high carbon stock.
	3. GHG reduction permanence	Should ensure carbon reductions are not reversed.
Environment	4. Water	Production should not pollute waterways or impede availability.
	5. Soil	Production should maintain or enhance soil health.
	6. Air	Production should minimize negative effects on air quality.
	7. Conservation	Production should maintain biodiversity, conservation value, and ecosystems.
	8. Waste and chemicals	Production should promote responsible waste management and chemical use.

	9. Seismic and Vibrational Impacts	Not applicable
Socio-Economic	10. Human and labor rights	Production should respect human and labor rights.
	11. Land use rights and land use	Production should respect land rights including indigenous and customary.
	12. Water use rights	Production should respect prior formal or customary water use rights.
	13. Local and social development	Production should contribute to localized socio-economic development.
	14. Food security	Production should not impede food-crop harvest and promote food security.

As per ICAO document "CORSIA sustainability criteria for CORSIA eligible fuels", compliance with Themes 1 to 8 will be assessed by the SCS; compliance with Themes 10, 11, 12 can be demonstrated to the SCS by a national attestation from the State in whose territory the SAF is produced, without further assessment by the SCS; and compliance with Themes 13 and 14 will be demonstrated to the SCS by the economic operator reporting to the SCS the action being taken to meet the related criteria, without further judgment of those actions by the SCS.

The accounting of SAF under CORSIA is based on purchasing and blending records, excluding fuels sold to a third party or claimed under other greenhouse gas emissions schemes. This means that CEF can be produced and uplifted anywhere in the world using a trusted chain-of-custody method to enable airlines' claims (see section 4.7). SAF used on domestic flights may be claimed under CORSIA, provided they are not claimed under any other greenhouse gas (GHG) emissions schemes. According to purchasing and blending records, claims of emissions reductions by an operator from SAF use are derived and computed based on mass, with their lifecycle emissions compared to CAF's to define effective reductions.

3.2. EU ETS

CO2 emissions from aviation have been included in the European Union's Emissions Trading System (EU ETS) since 2012. Under the EU ETS, all airlines operating in Europe, European and non-European alike, are required to monitor, report, and verify (MRV) their emissions, and to surrender allowances against those emissions. They receive tradeable allowances covering a certain level of emissions from their flights per year.

SAF under EU ETS are considered to have zero emissions and are exempt from the obligation to surrender CO2 allowances, if they are certified as compliant with the European Union's Renewable Energy Directive (EU RED). To provide a further incentive to airlines, between 2024 and 2030, 20 million ETS allowances will be made available to airlines for the use of SAF to bridge the price difference between the use of fossil fuels and SAF.

Renewable Energy Directive III[2]: Targets 42% clean energy usage in the EU by 2030. Annex 9 lists allowable SAF feedstocks under the program, which covers second and third generation SAF feedstocks, whilst largely banning first generation ones.

[2] Directive (EU) 2023/2413: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302413

3.3. Sustainability Certification Schemes (SCS)

Sustainability certification schemes have been developed for SAF, including but not limited to those provided by the Roundtable on Sustainable Biomaterials[3] (RSB) and the International Sustainability and Carbon Certification[4] (ISCC) organizations. RSB and ISCC consider several sustainability principles, including:

- Lifecycle greenhouse gas emissions
- Direct and induced land-use change
- Water supplies
- High conservation value area and biodiversity
- Socio-economic conditions of farmers and local population
- Ensuring food security

The organizations that provide SCS are responsible for verifying the sustainability criteria set out by individual governments and regulations concerning SAF, including the EU Renewable Energy Directive and ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

These schemes are based on a common set of internationally recognized standards to ensure all SAF meet the criteria to be considered truly sustainable. In some countries, particularly in the US and in EU Member States, governments offer financial incentives for alternative fuels that meet specific sustainability criteria, and a document confirming sustainability is one of the prerequisites to demonstrate eligibility. Moreover, in the US, France, and the Netherlands (with more EU States potentially to follow), the deployment of alternative fuel can contribute towards the overall national targets for renewable transport.

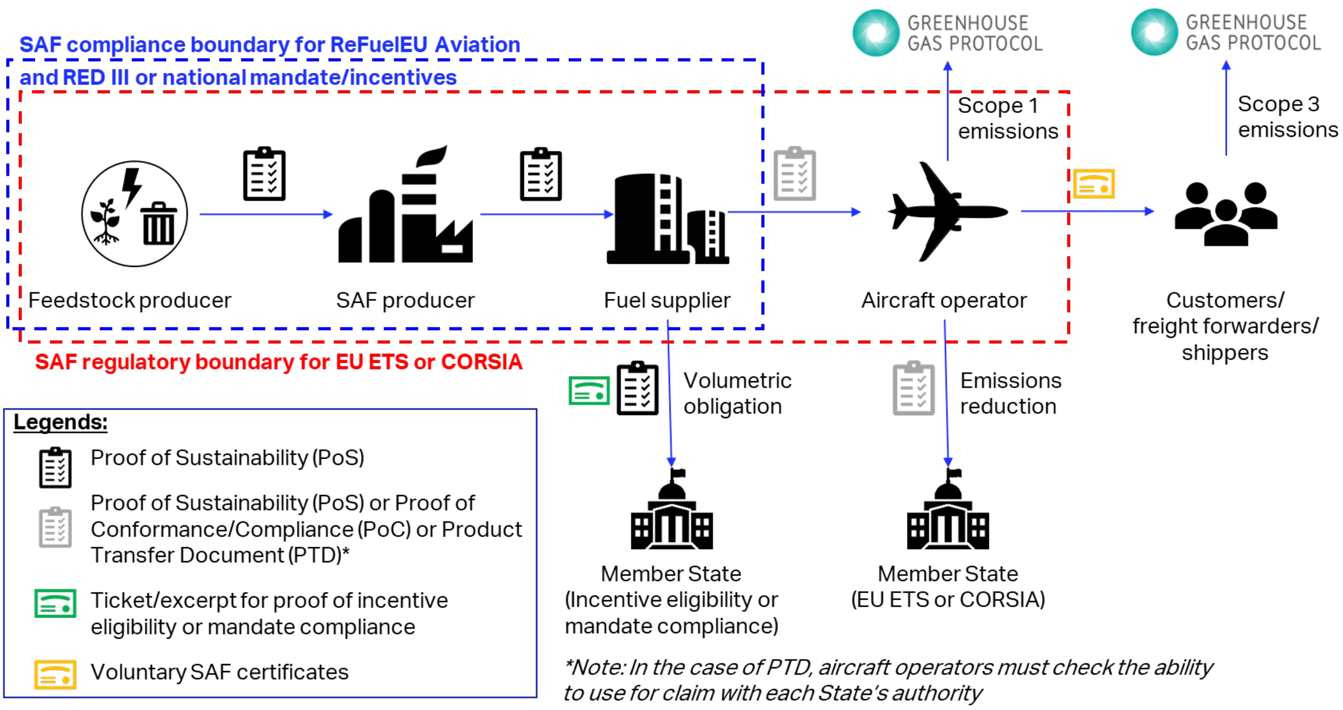
To ensure a robust chain of custody for and the traceability of sustainable materials, entities along the supply chain must be certified. Certification allows the entity to issue a traceable document that proves the sustainability attributes of the sustainable material. Entities along the supply chain that need to be certified are those where significant changes to the properties and environmental attributes take place as the sustainable material passes through their custody. These entities include feedstock producers and providers, feedstock transporters, feedstock traders, SAF producers, SAF blenders and SAF suppliers. For a comprehensive view of SCS's role in the supply chain, see Figure 10.

[3] **RSB: https://rsb.org/**
[4] **ISCC: https://iscc-system.org/**

4. SAF ACCOUNTING

Once SAF enters the jet fuel supply chain and becomes fungible with conventional jet fuel, it is imperative to have a robust accounting mechanism in place for airlines to be able to track and claim the environmental benefit of their SAF purchases against their various decarbonization obligations. Moreover, such an accounting system enables the separation of the environmental claims from the physical journey of the fuel – a critical element for the scaling up of SAF. Such SAF accounting should also allow aircraft operators and their customers to address their shared emissions responsibility together, while avoiding double counting and double claiming of emissions reductions thanks to transparent and credible registry systems. The general functionality of a SAF accounting system is depicted in Figure 8.

Figure 8 Generic SAF accounting workflow

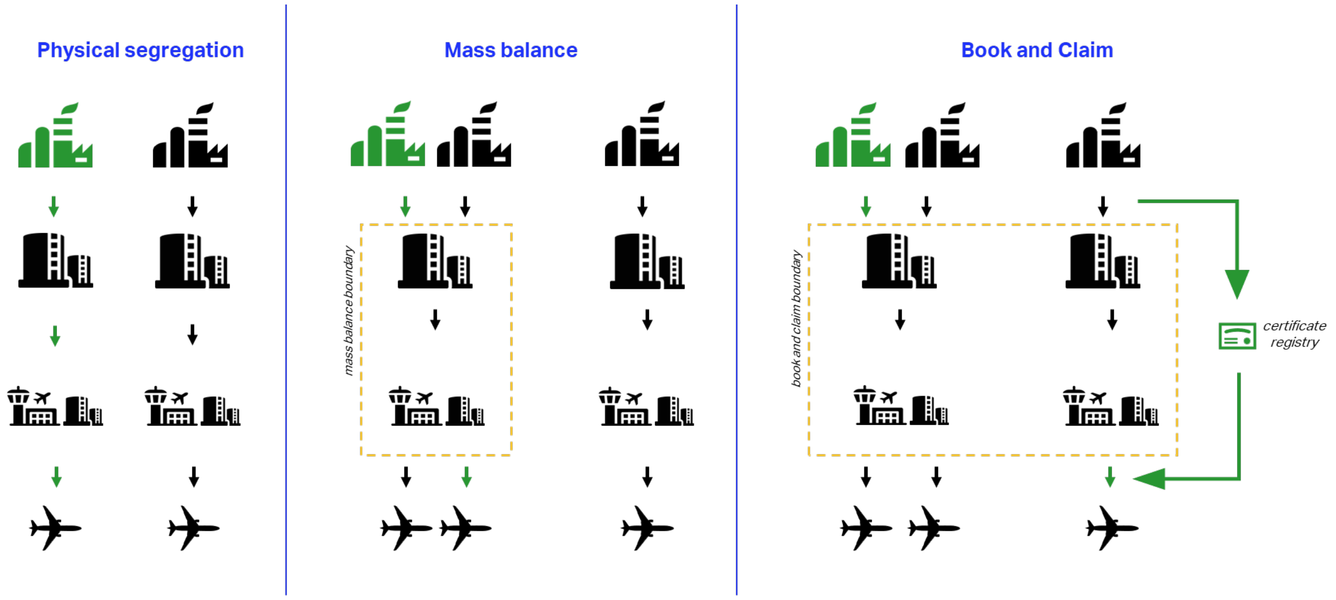


Source: IATA Sustainability & Economics

To ensure that the sustainability attributes of SAF are appropriately accounted for, traced, transmitted, and communicated, a tracking mechanism is required. This is necessary because SAF is only approved for use blended with CAF, and once they are co-mingled and used in existing distribution and fueling infrastructure along the supply chain, SAF molecules can no longer be traced independently. In the absence of an adequate accounting mechanism, the sustainability attributes can only be ascertained if the SAF remains physically segregated from the CAF, from the point of origin to the wing of the aircraft. Hence, the emissions reductions associated with SAF need to be accounted for separately from the physical product, while remaining allocated to their rightful owner (i.e., airlines and their customers). This can be ensured and safeguarded with a robust SAF accounting mechanism[5] based on trusted chain of custody (CoC) approaches, which have indeed been in use for jet fuel accounting for a long time and are described in Figure 9.

[5] IATA – SAF Accounting Principles

Figure 9 Fuel accounting based on Chain of Custody (CoC) approaches



Source: Adapted from Lufthansa Group

4.1. The Case for Book and Claim

There are different ways to account for the SAF. Two frequently referred to CoC options are mass balance, and book and claim. Mass balance allows co-mingling of SAF and CAF into common infrastructure, bur requires users to physically uplift fuel from this infrastructure. As we are now in the very early stages of SAF market development with SAF production occurring only in a restricted number of locations, mass balance accounting will tend to preserve the current uneven distribution of SAF. This disadvantages all airlines with limited access to physical SAF. Book and claim complements mass balancing and gives access to SAF to all aircraft operators, while allowing cost efficient SAF deployment in all locations, maximizing the environmental benefits of SAF and accelerating aviation's decarbonization.

By providing a global market for SAF, the use of book and claim can[6]:

- Enable SAF production where it is most efficient
- Minimize logistics costs
- Help avoid additional emissions from transport
- Promote competition

In addition, transparent differentiation of SAF based on feedstocks, technologies, and GHG intensity would be possible, creating clear supply and demand signals for different types of SAF. Consequently, the use of book and claim would accelerate SAF production and deployment. CORSIA already recognizes the use of book and claim by allowing SAF use reporting based on purchase records (see section 4.1).

[6] IATA – Unlocking Geographical Constrains for SAF Deployment

5. SAF PROCUREMENT

The SAF industry is complex and fast-changing, which presents challenges for airlines looking to start procuring SAF. Third-party entities can assist airlines in obtaining intelligence on the SAF market and where to source supply. IATA and ICAO provide details of global SAF supply and projected volumes, which can be easily accessed online to assist in the process of identifying potential suppliers.

This section discusses issues related to the purchase of SAF by airlines and identifies the changes required in the procurement cycle. For these purposes, the fuel seller is assumed to be one of the following four parties: SAF producer, petroleum refinery, blender, and oil and fuel trader. In all cases, purchase agreements should list (but not be limited to) the agreed conditions for fuel specification, sustainability certification, pricing, and the assignment of any renewable energy and minimum GHG emissions reduction requirements via a robust SAF accounting mechanism.

5.1. SAF Documentation Requirements

The SAF procurement process must ensure that SAF suppliers provide specific documentation to enable airlines and their customers to claim the environmental attributes and prove they meet the eligibility criteria of specific regulatory schemes, financial incentive programs, and other carbon reduction programs in accordance with guidance set by the Greenhouse Gas Protocol[7] (GHGP) as described in Section 6.1. Without this documentation, the buyer may be unable to claim the environmental attributes associated with the batch of SAF purchased.

In sum, the following documents, at a minimum, should always be specified in a SAF procurement contract.

POS – Proof of Sustainability

A delivery document issued by a supplier and certified under a relevant certification scheme, such as CORSIA Approved Sustainability Certification Scheme or EU RED Sustainability Certification Scheme, by SCSs as described in Section 3.3, for each delivery of sustainable material. The delivery document includes relevant information about the sustainable material that will be delivered, which is SAF.

POC – Proof of Compliance

A delivery document issued by a supplier and certified under the EU RED Sustainability Certification Scheme, by a certifying organization such as ISCC and RSB, for delivery of sustainable material, in a situation where the associated Proof of Sustainability document is required to be surrendered to the relevant regulatory authority. (Note: At the time of writing of this handbook, eligibility of the POC has yet to be implemented.)

PTD- Product Transfer Document

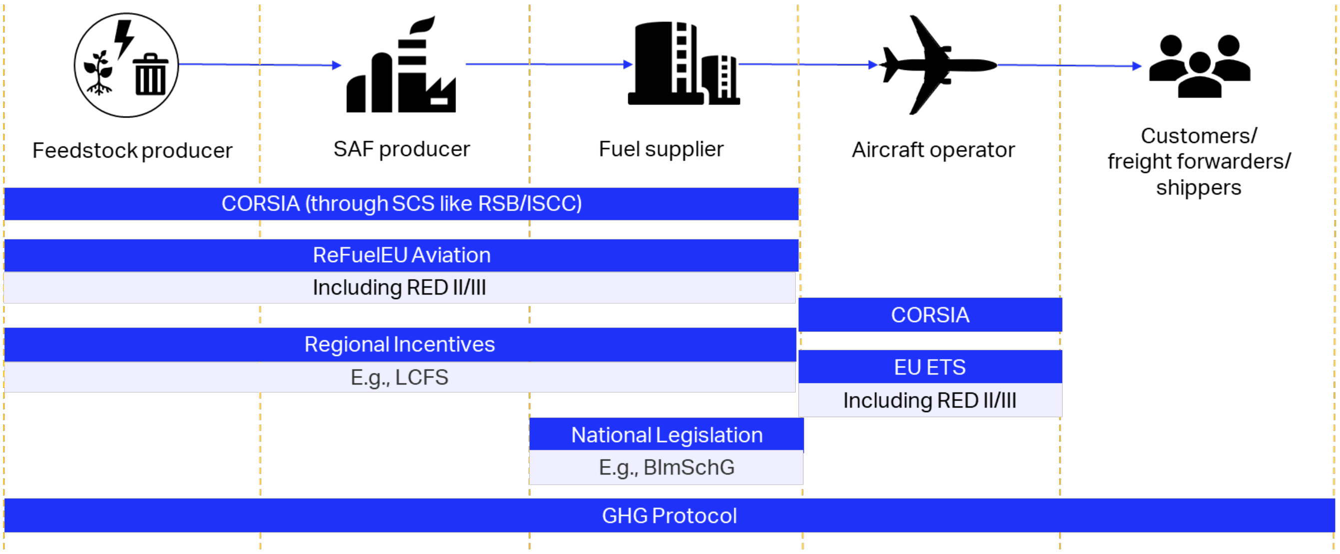
A delivery document that authenticates the transfer of ownership of the SAF from the Seller to the Buyer.

Airlines need to pay close attention to what documentation suppliers are willing to include in the contract; in some circumstances, a POS will not flow through to the Buyer; A PTD or POC (mandated volumes) could be offered as a substitute, but airlines need to verify that these are acceptable for claiming the environmental attributes under specific regulatory schemes in a particular jurisdiction.

[7] **GHGP: https://ghgprotocol.org/**

Specific sustainability documentation will be needed for compliance under different regulatory and voluntary schemes, some of which are illustrated in Figure 10 for quick reference.

Figure 10 SAF related schemes and regulations along the supply chain



Source: Adapted from Lufthansa Group

5.2. SAF Production Costs

One of the main deterrents to broader SAF deployment today is their high price, largely explained by high feedstock and production costs. SAF prices can range between 2 to 5 times that of CAF, depending on the technology pathway and chosen feedstock. Some innovative business models have been reported to produce and sell SAF at prices competitive with CAF (see Section 5.3.2). With effective policy and commercial innovation from both the demand and supply sides, it is possible to increase supply options and achieve more competitive SAF prices as the SAF industry develops. However, in the medium term, stronger policy support will be critical to ensure the development and scale-up of SAF production by addressing the following main cost drivers:

- feedstock cost and composition
- the capital cost of a proposed process
- overall yield (conversion)
- quality and composition of the produced SAF
- operating expenses
- financial requirements
- logistics
- initial resources

Table 4 outlines the different elements that may drive the cost of future SAF per different pathways and feedstocks.

Table 4 Breakdown of cost structure and challenges per SAF pathway

Pathway/Feedstock	Operational Cost	Capital Cost	Comments
HEFA: Waste Fats/Oils/Greases	**High** Constrained feedstock	**Low** Existing renewable fuel production capacity	Requires incentives, policies to reduce operational costs, linked to high feedstock costs.
Alcohol-to-Jet + FT: Agriculture & Forestry Wastes	**Low/Medium** Abundant waste-based feedstock; low value	**High** New renewable fuel production capacity required	Risk capital required to enable new biorefining ventures. Once capital cost is absorbed, cost of production benefit from lower Feedstock costs.
Fischer-Tropsch: Agriculture & Municipal Solid Waste (MSW)	**Low/Medium** Abundant waste-based feedstock; low value	**High** New renewable fuel production capacity required	In addition to above, higher tipping fee for waste collection can be a further incentive to leverage these feedstocks.
Power-to-Liquid: Industrial Waste CO_2	**Low/Medium** Abundant synthetic carbon source from existing processes	**High** New renewable fuel production capacity required	Requires a concentrated CO_2 source of synthetic carbon, but questions remain over their fossil origin sources and thus use in SAF production.
Power-to-Liquid: Direct Air Capture CO_2	**High** Abundant synthetic carbon source, but requires further technological maturing	**Very High** New renewable fuel production capacity required	The most abundant source of synthetic carbon, but limited today by current technology immaturity; significantly high capital intensity and renewable energy requirements.

Source: IATA Sustainability & Economics

5.3. SAF Pricing Options

During the procurement process, the suppliers of SAF (neat SAF producers and oil companies) may have different preferences and methodologies regarding how to price SAF. These preferences can determine which party will take on more risk within the agreement. It is therefore necessary to understand these differences before entering a contract with a SAF supplier. Ultimately, the selection of a pricing structure will be part of the negotiations to enter a commercial agreement.

5.3.1 SAF Premium Marked to a CAF Index

The SAF premium can be represented as a percentage or fixed total; in most cases, it will also include a fee for logistics and other third-party charges.

E.g., **MOPS (USD/USG) + SAF Premium (0.20 X MOPS USD/USG) + logistics (0.10 USD/USG)**

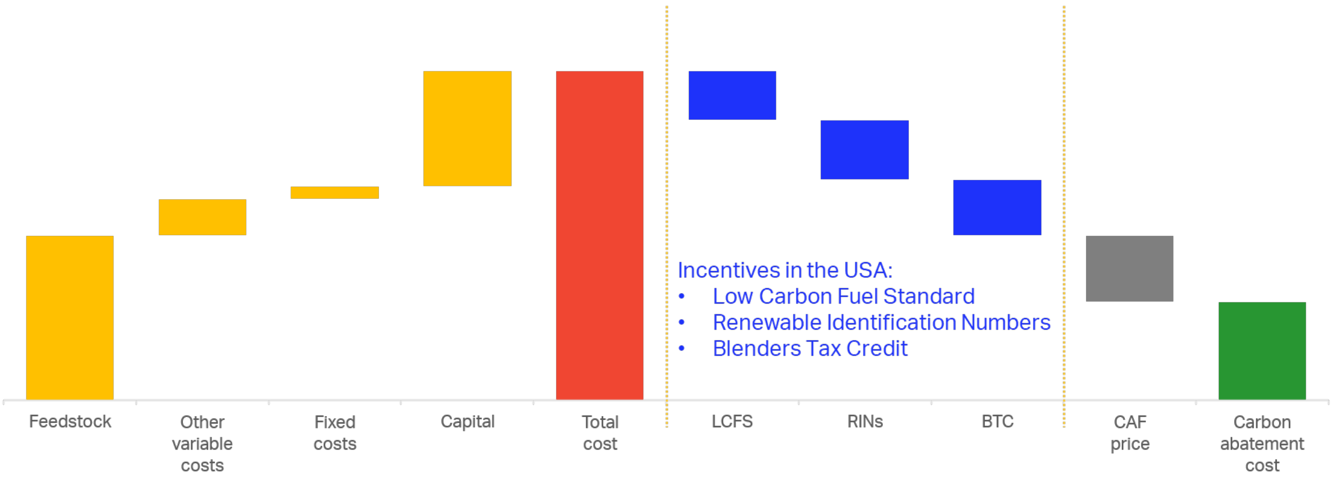
This shifts the risk linked to feedstock price fluctuations to the supplier. Airlines are left with the risk pertaining to CAF price volatility. This approach can make it easier for internal departments to forecast an airline's yearly premium over their original jet fuel price budget, due to the link to a CAF price index.

5.3.2 Cost + Model

A cost + model represents a build-up of forecasted costs that a supplier assumes they will incur to produce the SAF for the customer. Depending on the location and if incentives are applicable, the cost + model will subtract any rebates (tax credits and incentives) and include a refiner's margin (supplier profit).

The cost + model will transfer the risk associated with price volatility of variable costs to the customer, including feedstock pricing. For a HEFA-based SAF, the example illustrated in Figure 11 describes what airlines may see from a supplier with incentives applied. This model will, on the other hand, not expose the airline to CAF price volatility.

Figure 11 Cost + Model example for a HEFA-based SAF, including US incentives



Source: IATA Member Airlines, IATA Sustainability & Economics

5.3.3 Differences Between HEFA Cost+ Model and Alternate Pathways

For emerging pathways such as Alcohol to Jet and Fischer Tropsch, the Cost+ Model will look different from that of a HEFA pathway. By leveraging third generation feedstock, which is more naturally abundant than HEFA's second generation feedstock, the associated cost will be lower. However, capital expenditure (CAPEX) will be higher due to the significant cost of building new refineries. This contrasts with HEFA facilities, which most commonly are retrofitted refineries rather than new facilities.

5.3.4 Assessments by Price Reporting Agencies (PRA)

Companies such as S&P Global Commodity Insights (i.e., Platts) and Argus report SAF pricing based on market demand and production. Suppliers may select this pricing marker for smaller spot buys or even offtake agreements. In general, this type of pricing will be more expensive than the above examples, until such time that the SAF market has become mature and offers liquid and transparent pricing.

5.4. Types of SAF Purchasing Agreements

Spot-Buy:

A purchase agreement can be classified as ad hoc and might not involve strategic sourcing principles. In most cases, SAF volumes purchased will be small and delivered in one batch or multiple batches over a short period of time compared to a standard jet fuel agreement. A spot buy usually attracts a higher market price warranted by the supply certainty. Suppliers would generally apply a simple market pricing index to this type of SAF (e.g., Argus flat pricing).

Offtake Agreement:

An offtake agreement can be classified as a long-term contract, often spanning two to ten years or even longer. Traditionally, jet fuel contracts will cover a one- to three-year period. However, the current SAF market may require a buyer to enter into a more extended agreement to allow the supplier to obtain finance (neat SAF suppliers) and, in turn, may provide preferential pricing to the customer. In many cases, oil companies will not need financing; however, the oil majors' lack of feedstock and SAF production may also require longer contracts to guarantee supply.

Equity Stake Investment:

Due to the lack of SAF supply and the possibility of feedstock shortages in the short to medium term, some airlines have taken equity stakes in SAF suppliers. The airline can in this way benefit from guaranteed supply and preferential pricing. It is a strategy, however, that is reserved for airlines with balance sheets that allow for such capital investments. Those in this privileged position can gain significant control over their largest cost component – fuel – and arguably radically evolve their business models.

Joint Purchasing (procurement) Agreement:

Given the current price of SAF, some airlines are starting to enter joint procurement discussions with other airlines as part of broader alliance activities. The benefit of joint procurement is that it allows multiple customers to pool their volume and provide greater demand certainty to potential suppliers. It is a concern that smaller airlines find themselves priced out of access to a market that is still structurally under-supplied, and that supply remains constrained if purchase volumes are insufficiently large.

5.5. Aviation Fuel Supply Model Agreement (AFSMA) Review

The Aviation Fuel Supply Model Agreement (AFSMA) is a specimen agreement that can be used as the starting point for negotiation of a fuel supply contract between and airline and a supplier. AFSMA establishes the overall framework of a fuel purchase agreement, including (but not limited to) scope, parties, duration, pricing mechanism, point of delivery, and insurance. In addition to the master agreement portion (General Terms and Conditions), it includes all annexes by reference. The advantage of this structure is that it allows for changes to the annexes without having to re-negotiate the entire agreement; this is particularly helpful concerning the Location Agreements (an annex to the master agreement that contains the supplementary contractual terms for a specific airport), as these are likely to be modified from year to year to reflect changes in the operation of the airline such as contracted volumes and prices.

The latest version of AFSMA[8] (edition 5.1, July 2023) incorporates additional clauses suitable for procurement of a SAF blend such as the rights to environmental attributes of the SAF.

[8] **Aviation Fuel Supply Model Agreement: https://www.iata.org/en/programs/ops-infra/fuel/**

6. STAKEHOLDER ENGAGEMENT

Whereas no radical changes are needed in current fuel quality control practices for introducing SAF to an airline's operation due to their drop-in nature, the recommendations below can help ensure involvement and buy-in from both internal and external stakeholders who may be involved in a SAF project.

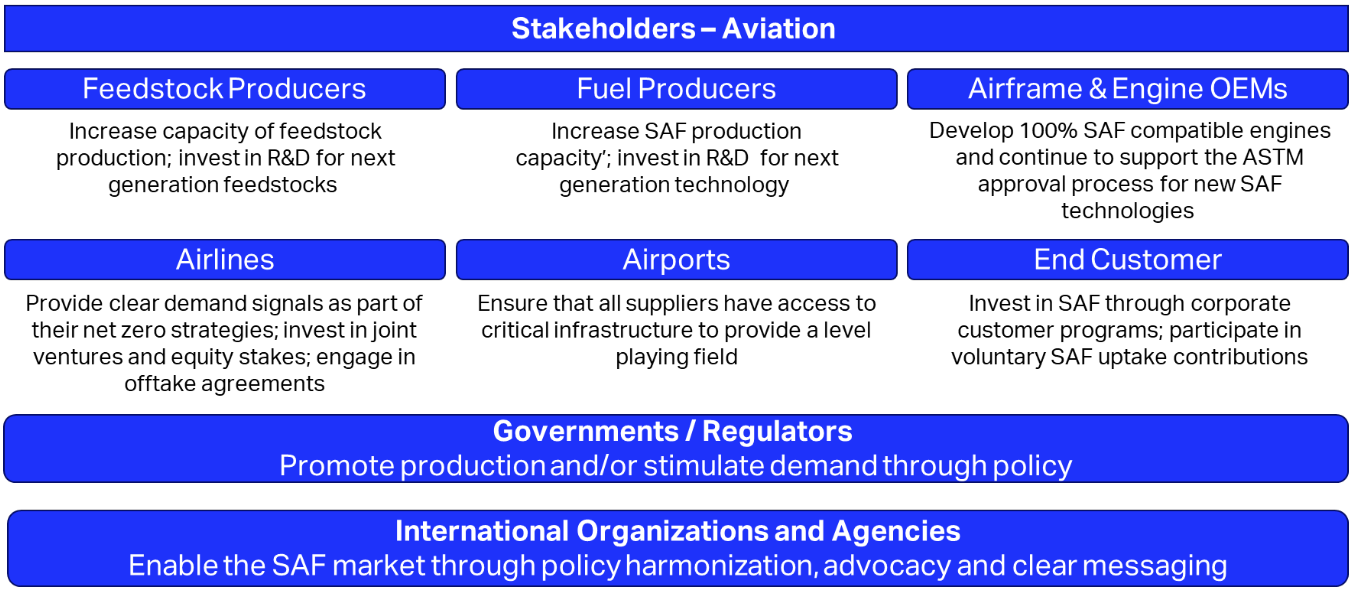
At the airline level, different stakeholders who should be aware of a SAF procurement include:

- Environment and sustainability team
- Fuel Procurement
- Legal
- Corporate communications
- Treasury and Finance
- Government Affairs
- Revenue and Route planning
- Engineering and maintenance
- Flight Operations

Each airline department will need to be engaged in developing and implementing a sustainable aviation fuel project or strategy. Lack of effective internal coordination and communication may cause unnecessary project delays and impediments.

Regarding external stakeholder engagement, Figure 12 provides an overview of the main counterparts to approach and a brief description of their recommended level of involvement. Given their key importance in SAF deployment, the following subsections elaborate on corporate customers and airports in particular.

Figure 12 Stakeholder involvement



Source: IATA Sustainability & Economics

6.1. Corporate SAF Programs

A corporate SAF program is an initiative that airlines can include in their SAF strategy, which establishes a transparent mechanism allowing corporate customers to participate in the transition and claim scope 3 emissions reductions. Participating corporates receive a scope 3 emissions reduction certificate, which can be reported according to guidelines set by the Greenhouse Gas Protocol (GHGP) and other initiatives. These claims must be verified by an independent third-party carbon auditor (i.e., a "verifier"). How these programs are developed and executed will always be airline-specific and part of a broader commercial strategy including decarbonization. However, the main objectives of this type of initiative are:

- Accelerating the global and regional transition to SAF through increased demand from users of air transport services.
- Providing corporate customers with the option to reduce their scope 3 emissions.
- Corporate customers can communicate a willingness to contribute to a sustainable future (brand enhancement) and share in shouldering its costs.

Corporate programs require significant documentation to verify emissions reductions and proof of sustainability, which should be enabled by a robust SAF accounting mechanism.

6.2. Access to Airport Fuel Infrastructure

Like many stakeholders in the air transport value chain, airport operators are increasingly seeking to improve their environmental performance. Some airports show interest in introducing or encouraging SAF locally. How that can occur depends at least in part on the ownership structure of the fuel facilities at the airport. Such facilities can be owned by fuel providers, airlines, or consortia, and the airport operator often owns at least some distribution infrastructure. Airports can lease it to other stakeholders or operate it directly. Supplying jet fuel as an activity, however, has never been a core function for airport operators and this should remain the case with SAF supply.

Given that the lifecycle reduction in carbon emissions takes place upstream, none of the climate benefits of introducing SAF at an airport are experienced locally. Should a large-scale deployment occur at an airport, there could be some local air quality benefits from the landing and take-off cycle, but the extent of this impact using blended SAF is yet to be defined, and secondary to the challenge of reaching net zero carbon emissions.

As airports do not face any additional infrastructure costs from the introduction of SAF, and modulations and incentive programs are generally ineffective and carry a high risk of discrimination, there should not be any modifications in airport charges based on SAF at the airport.

Airlines, increasingly under obligation to use SAF, must be able to rely on open access for SAF to the fuel infrastructure that brings the fuel to the airplane via the airports' fuel farms. Restrictions or preferences as to who can provide jet fuel or SAF at an airport interferes with a competitive market. Should an airport operator engage in the provision of fuel or SAF, such activities need to be clearly separated from the airport's role in the ownership of fuel infrastructure.

7. ADDITIONAL RESOURCES

Aviation's decarbonization depends critically upon the significant scale-up of SAF production – by a factor of 1,000 between 2023 and 2050. Infrastructure will need to be built, commercial partnerships developed, and standardized processes established. Moreover, rapid technology developments in the future should reduce the cost of producing SAF. Improvements in supply chains, production processes, and the installation of carbon capture and sequestration facilities will increase the carbon reduction achieved by SAF. Nonetheless, it is estimated that aviation will require thousands of new or converted renewable fuel production facilities by 2050.

To that end, the SAF industry will have to use feedstocks from across the globe, which represents a singular opportunity to improve energy security, independence, and resilience. This will enable the optimization of both value and supply chains, the leveraging of local feedstocks, the development of domestic SAF industries, and in turn, the ability to physically supply more airports with SAF, in contrast to the more concentrated hub of fuel supply we see today. It is estimated that in total, the transition to new energy systems and fuels could create and sustain around 14 million jobs worldwide[9].

To support global SAF deployment, this handbook provides basic guidelines to assist airlines exploring SAF procurement as part of their decarbonization strategies, but the SAF market is quickly evolving to catch up with increasing demand. Consequently, IATA constantly releases and updates numerous resources to assist airlines in their quest to reach net zero. These can be found on IATA's website[10] and on FlyAware[11].

[9] International Energy Agency (IEA)
[10] IATA's Sustainability Webpage
[11] https://flyaware.iata.org/

SAF Handbook

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