SABA

SUSTAINABLE AVIATION BUYERS ALLIANCE

Sustainable Aviation Fuel Certificate (SAFc) Emissions Accounting and Reporting Guidelines

Consultation Draft Version 2.0
November 2025

Table of Contents

Foreword

The window to limit global warming to 1.5°C is closing. Industrial decarbonization must accelerate. Aviation is responsible for approximately 2.5 to 3 percent of global CO_2 emissions, and up to 4 percent when accounting for non-CO_2 effects such as contrails and nitrogen oxides[i]. It is one of the most difficult sectors to decarbonize due to long technology cycles and limited near-term alternatives.

Sustainable aviation fuel (SAF) is the most viable solution available today. It is compatible with existing aircraft and fueling infrastructure and can reduce life cycle emissions of fuels significantly. Global SAF production is expected to reach ~2 million tonnes (or 2.5 billion litres) in 2025, up from around 100,000 tonnes in 2020[ii]. This progress has been driven by policy, airline offtake agreements, fuel producer investments, and growing corporate demand. Still, SAF represents less than 0.7 percent of global jet fuel supply. Supply remains limited due to high cost and uneven regional availability limiting supply.

SAF certificates (SAFc) have emerged as a critical mechanism to overcome these barriers and mobilize investment to scale up SAF production. By decoupling the environmental attributes of SAF from the physical fuel using a book and claim model, SAFc enables a broader set of aviation stakeholders to invest in SAF production and credibly claim the environmental benefits of SAF.

For SAF certificate book and claim systems to function and scale with integrity, clear and standardized accounting and reporting guidance is essential. Without clarity on who can claim what, under which conditions, and with what safeguards, the risk of double counting and market confusion will grow, undermining confidence and slowing investment in SAF. Accounting and reporting turn action into credible disclosure, allowing companies to communicate their progress consistently and comparably across markets.

The first version of the SAFc emissions accounting and reporting guidelines, released in 2022, addressed this gap.[iii] At the time, SAFc was a novel mechanism, and no comprehensive guidance existed in accounting and reporting standards like the Greenhouse Gas Protocol (GHG Protocol) or the Science Based Targets initiative (SBTi). Developed under the Clean Skies for Tomorrow (CST) initiative at the World Economic Forum, it built on the fundamentals of these standards and introduced a persona-based framework to guide early practitioners.

The scale of SAFc transactions is growing through landmark procurements and registry activity. Each year, more and more corporate customers announce offtake agreements with fuel producers or air transport providers. Joint offtake agreements are also playing a big role in scaling the market. For example, in 2024, the Sustainable Aviation Buyers Alliance (SABA) announced a multi-year commitment spanning 2024 to 2028, involving nearly 20 corporate customers to purchase SAFc corresponding to about 50 million gallons

of SAF, representing an estimated 500,000 tonnes of CO_2e abatement and more than $200 million in forward investment, one of the largest known commitments to date.[iii] These SAF certificates are being delivered and tracked across a number of registries, which work to ensure that SAFc are consistently and credibly tracked. To date, these registries have collectively issued SAFc representing over 280,000 metric tons or 90 million gallons of neat SAF.[1]

As the SAFc ecosystem matures, these guidelines must evolve. Version 2 of these accounting and reporting guidelines responds to increased operational complexity and a broader range of participants. It expands the original framework to include new personas including original equipment manufacturers (OEMs), airports, aircraft lessors, travel management companies, and financial institutions. It provides clearer direction on co-claiming, data documentation, calculation methods, audit readiness, and registry alignment.

This second version of the guidelines is shaped by practitioner experience and ecosystem developments. While Version 1 filled a gap in the absence of formal SAFc guidance from the GHG Protocol and SBTi, Version 2 continues to bridge the gap as these standard setters advance their work. It is designed to align with the direction of those frameworks and support organizations seeking to disclose credible actions today.

We commend the progress made by the GHG Protocol and the SBTi in exploring how market-based mechanisms can be integrated into core accounting, reporting, and target setting frameworks. Their work spans not only aviation, but also other hard-to-abate sectors where similar approaches are being developed. We hope these guidelines can inform and complement that work, and that future versions of these standards will continue to recognize the role of SAFc in enabling scalable, high-integrity climate action.

Ultimately, the integrity and scale of SAFc depends on continued engagement and collaboration across the value chain. We invite all stakeholders to test these guidelines, share feedback, and support implementation. As more organizations procure SAFc, real-world insights will continue to strengthen this framework. By accounting and reporting these actions transparently, companies can translate individual commitments into credible disclosure and shared accountability, reinforcing trust and confidence in the market. Together, we can build the confidence and consistency needed to unlock meaningful investment and climate impact.

[1] This total estimate is the sum of the latest public data from registries with public issuance and retirement data and the most recent press release statistics from those that do not have public databases.

Executive Summary

Decarbonizing aviation is difficult but critical. Sustainable aviation fuel (SAF) is currently the most viable option to reduce emissions in the near term, but its deployment remains limited by high costs, infrastructure constraints, and geographic limitations.

Simultaneously, demand is growing from a broad range of aviation stakeholders, especially corporate aviation customers, who are seeking credible ways to reduce aviation-related emissions, particularly those associated with business travel and freight. This demand can help accelerate SAF deployment if paired with a mechanism that enables their participation beyond direct fuel purchasers.

SAF certificates (SAFc) are that mechanism. SAFc is a market-based instrument that allows the environmental attributes of SAF to be purchased and claimed separately from physical fuel use. In these guidelines, each SAFc represents the attributes associated with one metric tonne of neat (unblended) SAF, with emissions reduction value varying by feedstock type and production pathway (see Appendix 2 for SAFc unit variability and conversion).

SAFc operates through a book and claim system underpinned by independent mass balance certification schemes, which trace the flow of fuels through the value chain and verify facility-level claims about sustainability.

To scale with integrity, SAFc requires robust infrastructure that ensures environmental claims are traceable, unique and verifiable, supported by transparent data systems and consistent reporting. Three core components make up these systems:

- A SAFc Rulebook, which includes detailed specifications on how SAFc can be issued, transferred and retired in a registry.
- A SAFc registry, an IT system that streamlines, verifies and makes transparent the issuance, transfer and retirement of certificates.
- SAFc emissions accounting and reporting guidelines (this document), which support users in applying SAFc consistently in their climate disclosures.

Why Accounting and Reporting Matters

Consistent and transparent accounting and reporting are essential to build confidence in the SAFc market. They ensure that emissions and reductions are measured, verified, and disclosed in a comparable way,

enabling credible claims, informed investment, and sustained market growth. In order to scale, the market needs clarity on:

1. How SAF and SAFc can be accurately accounted for (i.e. who can account for what).
2. Accounting determines which entity is responsible for which portion of the fuel life cycle within an emissions inventory, forming the foundation for valid reporting and claims. It is critical that the environmental attributes of SAF are accounted for correctly. SAF and SAFc should be accounted for in a way that avoids double counting and ensures each user reports emissions and reductions accurately, consistently and transparently. How SAF and SAFc can be reported towards climate targets (i.e., what claims can a company make)

   Once accounting establishes who records which emissions and reductions, reporting determines how those results are communicated and recognized in disclosures. Many companies have procured SAFc and reported associated emission reductions in their climate disclosure. However, there is still no standardized approach for aviation stakeholders to report these environmental attributes in their climate disclosures or to demonstrate their contribution to meeting corporate goals under frameworks such as the Science Based Targets initiative (SBTi). In order to confidently report SAFc claims, corporate aviation customers require greater clarity and standardized guidance to support their SAFc investments.

Purpose of This Document and How It Should Be Used

The SAF and SAFc accounting and reporting guidelines are designed for practitioners in a variety of roles, including those responsible for greenhouse gas inventories, auditing and assurance, fuel procurement, aircraft operations, leasing and finance, travel and logistics coordination, and corporate purchasing of air transport services. These guidelines offer detailed step-by-step instructions including recommended accounting calculation methods and reporting procedures, in the absence of formal global standards.

Specifically, this document provides guidelines for eight key “personas” including: SAF suppliers, aircraft operators, air transport customers, travel and logistics service providers, airports, aircraft lessors, financial institutions, and original equipment manufacturers (OEM).

Each persona section includes:

- Guidelines for emissions calculations to be used in designing and preparing a greenhouse gas emissions inventory.

- Guidelines for publicly reporting greenhouse gas emissions and reductions associated with SAF and SAFc.

These guidelines are developed to ensure that each user of SAF and SAFc is assigned accurate and proportionate emissions and reductions.

Beginning in Section 1: Key SAF and SAFc accounting and reporting concepts, the term "should" describes recommendations for relevant stakeholders to prepare and report a greenhouse gas inventory. These recommendations are intended to prioritize the completeness, relevance, transparency, consistency, and accuracy of existing accounting and reporting standards for SAF and SAFc.

Standards on GHG emissions accounting already exist, and guide accounting and reporting today. These SAF and SAFc accounting and reporting guidelines, as much as possible, use guidance from prevalent standards and other frameworks to ensure compatibility with current best practices.

In particular, these guidelines build from GHG Protocol standards[iv], the SBTi aviation sector target setting guidance[v] and Corporate Net Zero Standard[vi], the Advanced and Indirect Mitigation Platform *Intervention Quality, Accounting, and Reporting Standard*[vii], the International Civil Aviation Organization (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) methodology[viii], the Roundtable on Sustainable Biomaterials (RSB) Book and Claim Manual[ix], the Smart Freight Centre Voluntary Market Based Measures Framework for Logistics Emissions Accounting and Reporting[x], and the Global Logistics Emissions Council (GLEC) framework[xi]. See Appendix 6 for details on each of these normative references. However, as SAFc is a novel accounting and reporting tool, minor modifications to existing accounting approaches are needed to accurately and consistently reflect its distinct characteristics. Ultimately, the intention is that these guidelines can help inform the incorporation of SAFc into the broader corporate emissions accounting and reporting guidance and standards including those from the GHG Protocol and the SBTi.

Importantly, these guidelines apply exclusively to voluntary use and reporting of SAF and SAFc. They are not applicable for SAF used towards compliance frameworks such as SAF blending mandates, which require separate accounting and reporting rules and safeguards. To allow for flexibility, broader use, and consistency with other upcoming standards, these guidelines will be revisited periodically, in view of the experience and knowledge of SAF and SAFc usage.

These guidelines do not comprehensively detail performance criteria for SAFc, nor do they fully detail the function of a SAFc registry. These SAFc accounting and reporting guidelines are designed to work

alongside these criteria and registries, helping users apply SAFc in a consistent and transparent way in reference to emissions inventories and disclosures (see Appendix 3 for more detail on the role of a registry, alignment of timelines, and data consistency).

What's New in Version 2

This second version of the guidelines maintains the foundational structure and principles of Version 1, while incorporating key updates based on practitioner feedback, transactions, and evolving market infrastructure. Key updates include:

- Expanded scope and personas:
    - Adds five new personas: travel and logistics service provider (travel management company, freight forwarder), airport, aircraft lessor, financial institution, and original equipment manufacturer
    - Merges airlines, freight carriers and private jets under the aircraft operator persona.
    - Adds the travel management company persona, combined with the freight forwarder persona under travel and logistics service provider persona.
- Enhanced technical guidance
    - Adds a new accounting approach option (B) that uses an emissions factor substitution method for each persona, alongside the previous emissions reduction calculation approach (A), and clarifies the accounting and reporting context for these options.
    - Clarifies that well-to-wake (WTW) boundaries and recommendations are applicable throughout, consistent with SBTi aviation sector guidance.
    - Provides clearer guidance for Scope 3 co-claiming scenarios.
- Improved system alignment
    - Relocates detailed content on related concepts like sustainability criteria, additionality, radiative forcing, and double counting to Appendix 1.
    - Aligns guidance with the ongoing developments and updates under GHG Protocol, SBTi and other frameworks.
    - Adds appendices on SAFc unit variability and conversions, registry timeline and data consistency, and the substitution accounting method option.

Introduction to SAF and SAFc

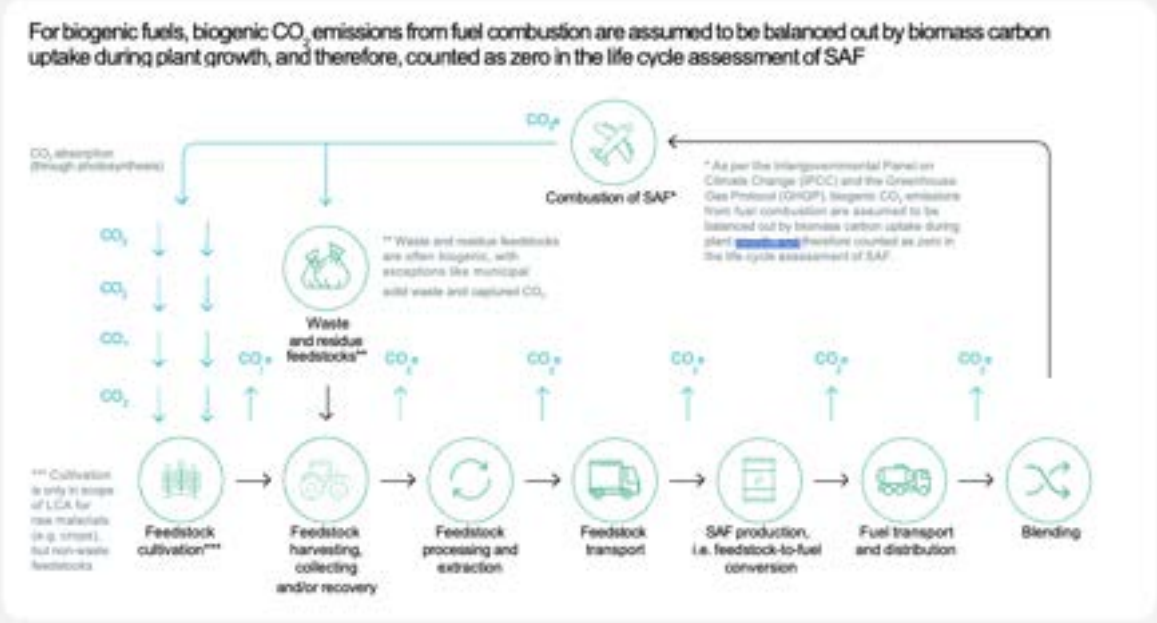
Sustainable Aviation Fuel

Sustainable aviation fuel (SAF) is renewable or waste-derived aviation fuel that meets sustainability criteria, including a life cycle emissions reduction compared to conventional aviation fuel[xii]. SAF is produced from sustainable, renewable feedstocks such as used cooking oils, forestry residues, municipal solid waste and captured CO2.

SAF is chemically equivalent to kerosene and considered to be a “drop-in” fuel, i.e. compatible with today’s typical commercial aircraft engines. Although the greenhouse gas (GHG) emissions from SAF combustion are comparable to those of conventional jet fuel, SAF usage results in significant emissions reductions over its life cycle relative to conventional jet fuel use. SAF can be made from many types of feedstocks (e.g. biomass, residues, waste) and through a variety of production pathways, such as hydro-processed esters and fatty acids (HEFA), alcohol-to-jet (AtJ), gasification Fischer-Tropsch (Gas-FT), and power-to-liquid (PtL)). Each combination has a unique life cycle emissions value.

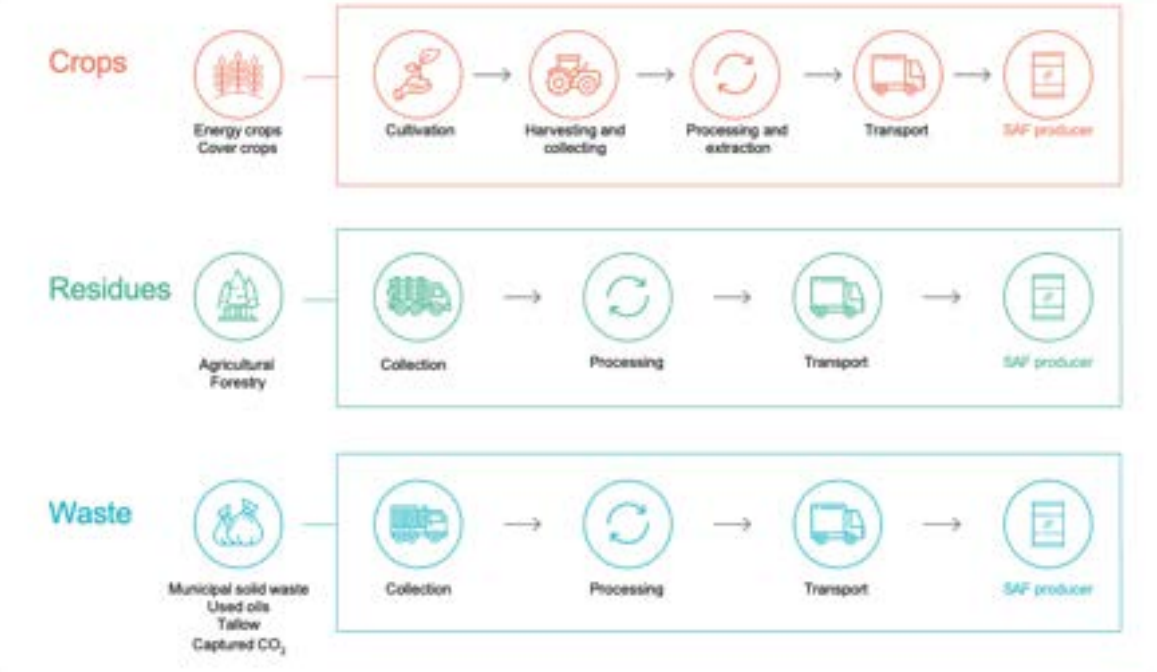
For SAF made from purpose-grown crop feedstocks (including energy and cover crops), cultivation and harvesting are part of the scope of the life cycle assessment in addition to collection, processing, transport, SAF production and blending. For residue- and waste-based feedstocks (including agricultural and forestry residues, municipal solid waste, used cooking oil and inedible tallow), the product life cycle begins at the point of collection.

FIGURE 1 | The general SAF life cycle from cultivation through combustion



Source: World Economic Forum

FIGURE 2 | Life cycle stages for SAF from crop, residue and waste feedstocks



Source: World Economic Forum

SAF Value Chain Stakeholders

A wide range of stakeholders interact with SAF directly or indirectly. These include:

- **SAF Suppliers** that produce, blend, and distribute SAF (i.e., fuel producers, blenders, distributers, fixed-base operators)
- **Aircraft Operators** including commercial airlines, private or corporate aviation operators, and ferry flight providers that procure and use SAF directly (i.e., airlines, carriers, private or corporate aircraft operator, ferry flight operator)
- **Air Transport Customers** including individual passengers, corporate travelers and freight shippers who purchase and use air transport services (i.e., corporate travelers, shippers)
- **Travel and Logistics Service Providers** including companies that coordinate air transport services for corporate clients (i,e, freight forwarders, travel management companies)
- **Airports** that provide fueling infrastructure, host SAF delivery and blending operations, and support aircraft movements and ground services
- **Aircraft Lessors** that own aircraft and lease them to aircraft operators
- **Financial Institutions** that provide capital and financing to aircraft operators (i.e., banks, investors)
- **Original Equipment Manufacturers (OEMs)** that design and manufacture aircraft and engines

SAF Certificates

Similar to a renewable electricity certificate or guarantee of origin in the production of green electricity, a SAFc represents the environmental attributes of a metric tonne of neat (i.e. unblended) SAF.[2] The associated emissions reduction varies based on the fuel's feedstock, production pathway, and life cycle emissions (see Appendix 2 for more detail on SAFc unit variability and conversions).

SAFc can be either bundled with or unbundled from physical fuel. When unbundled from the physical fuel volume, SAFc can be sold and claimed separately. This enables air transport customers, providers and other key stakeholders without physical access to SAF to invest in and make valid emission reductions claims associated with a given amount of SAF to address their aviation climate impact.

Each SAF certificate has one claim that can be made by an aircraft operator to address operational and upstream emissions from fuel use. Where the physical SAF is used in the provision of services to a third-

[2] Some SAF certificate registries define a unit of SAFc in a volume as opposed to mass of neat SAF (e.g. gallon), however most programs use a metric ton of neat SAF as the unit of a SAFc.

party air transport customer (e.g. business traveler or shipper), a corresponding claim can also be made by the customer. This is determined based on the type of service provided and the role of the entity in the value chain, not on tracing SAF to a specific aircraft or flight.

Additional value chain stakeholders, such as aircraft lessors, OEMs, financial institutions, travel and logistics services providers, may also co-claim SAFc emission reductions under their respective Scope 3 categories with aviation emissions, provided their claims reflect distinct role in the aviation value chain and are transparently reported.

The following two scenarios illustrate how this applies in practice:

Scenario A: Flight with third-party air transport customer

When an aircraft operator uses physical SAF to conduct flights as a service provided to third-party customers (i.e., transporting passengers, cargo, or charter clients), it may issue and transfer SAFc to those customers, as well as to other eligible personas, as long as the transfer aligns with that persona's relevant Scope 3 category and SAFc eligibility.

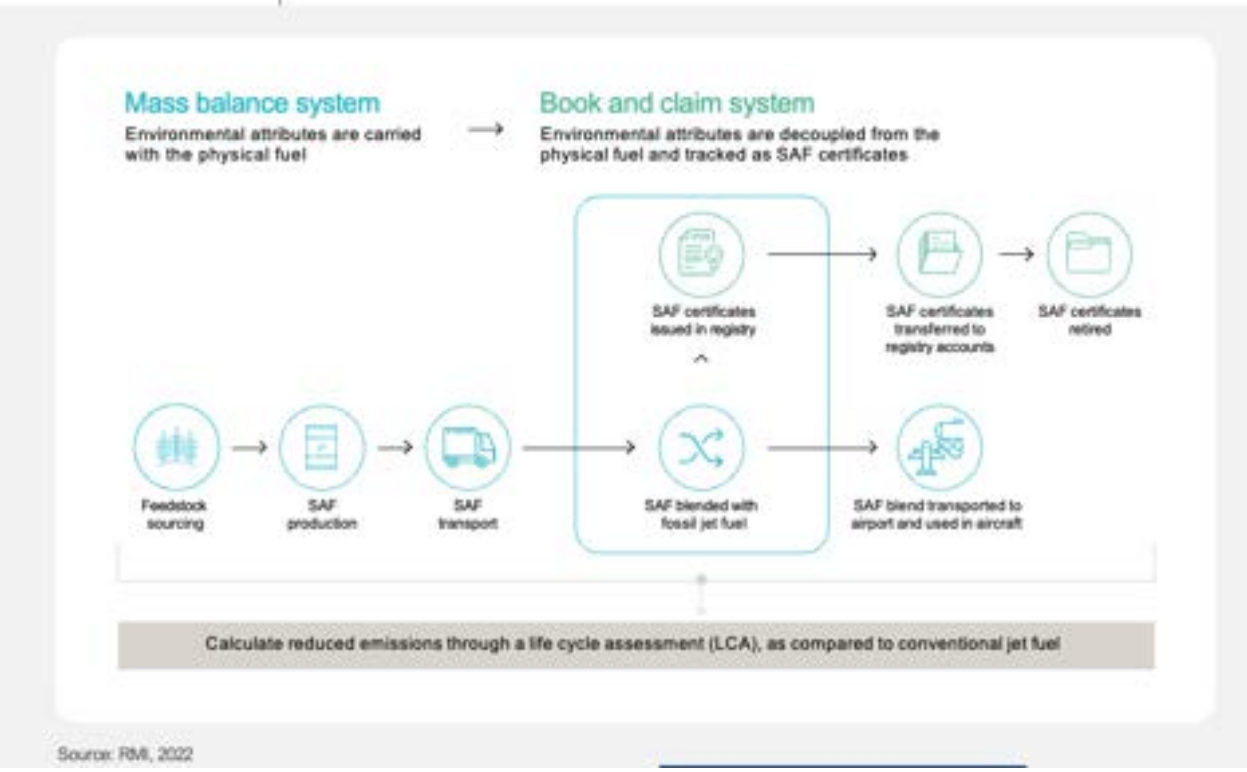
Scenario B: Flight with no third-party air transport customer

When an aircraft operator purchases physical SAF to fly aircraft without third-party air transport customers (i.e., for aircraft repositioning, business travel by internal staff, or OEM test flights), the operator is the end-user of the air transport service.

In these cases, SAFc should not be transferred to air transport customers (e.g., corporate travelers, shippers, or service providers like travel management companies or freight forwarders), as no third-party air transport customer exists to support a valid Scope 3 claim.

However, other personas indirectly associated with the flight (such as OEMs, aircraft lessors, or financial institutions) may still claim emissions reductions against their own Scope 3 inventories, if the SAF use aligns with their role and reporting boundaries. Further guidance on reporting Scope 3 SAFc claims is provided in Section 1.4 SAFc Reporting and in the accompanying table "Overview of SAF and SAFc Accounting and Reporting Inventories by Persona".

FIGURE 3 | SAF certificates represent the environmental attributes of a batch of SAF



This book and claim mechanism builds from robust existing mass balance certification systems for SAF supply chains, and can enable:

- Aircraft operators to share the SAF cost burden with their customers that are willing and able to pay the price premium.
- Stakeholders with air transport footprints who do not purchase jet fuel to contribute to the price premium of SAF. In return they can claim the environmental benefits towards their climate disclosure, and more directly address the climate impacts of their air travel.
- Aircraft operators without physical access to SAF to purchase and claim the environmental benefits of SAF towards their climate disclosure in the same way they would if purchasing physical fuel and bundled SAFc.
- Supply chains to function more efficiently – for instance, allowing for the physical fuel to be delivered at the nearest airport, minimizing supply chain emissions and the associated environmental attributes to be claimed and reported by an entity elsewhere.

To serve these use cases, SAFc requires comprehensive sustainability safeguards, credible registry to streamline and showcase the creation and use of certificates, and clear accounting protocols to avoid the

possibility of double counting the environmental benefits. See Appendix 1 for details on sustainability safeguards, registries, and other key SAF and SAFc considerations.

1. Key SAF and SAFc Accounting and Reporting Concepts

1.1 Accounting SAF GHG Emissions

GHG Emissions Scopes and Boundaries

Scopes 1, 2 and 3 of GHG emissions

Scope 1 emissions are from activities performed directly by the reporting company. Scope 2 emissions are indirect emissions related to purchased energy (primarily electricity) of the reporting company. Scope 3 emissions are all indirect emissions related to activities performed throughout a reporting entity's value chain.[xiii]

FIGURE 4 | Scope 1, scope 2 and scope 3 emissions as covered by the GHGP

Source: GHGP, 2013

Scope 3 emissions categories

Scope 3 corporate value chain emissions are categorized into 15 distinct categories as listed below. These are intended to provide companies with a systematic framework to organize, understand and report on the

diversity of scope 3 activities within a corporate value chain. Each scope 3 category is composed of multiple activities that individually result in emissions.

TABLE 1 | Upstream and downstream scope 3 categories

Upstream or downstream	Scope 3 categories
Upstream emissions	1. Purchased goods and services 2. Capital goods 3. Fuel- and energy-related activities (not included in scope 1 or scope 2) 4. Upstream transportation and distribution 5. Waste generated in operations 6. Business travel 7. Employee commuting 8. Upstream leased assets
Downstream emissions	9. Downstream transportation and distribution 10. Processing of sold products 11. Use of sold products 12. End-of-life treatment of sold products 13. Downstream leased assets 14. Franchises 15. Investments

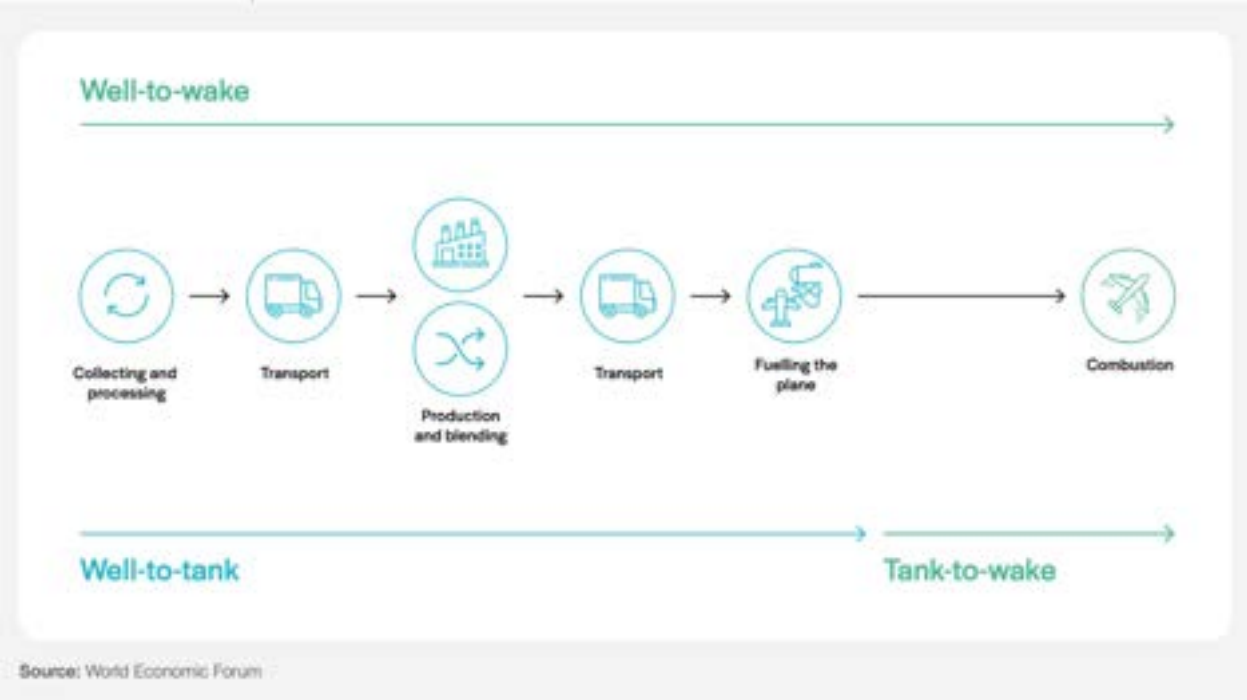
Source: GHGP, 2013

Well-to-tank, tank-to-wake and well-to-wake emissions

Well-to-wake (WTW) emissions represent emissions of the activities across the value chain of jet fuel in the aviation sector. These emissions can be split into two components:

- Well-to-tank (WTT) encompasses emissions from feedstock sourcing, processing and transport to fuel production, and distribution.
- Tank-to-wake (TTW) consists of emissions exclusively from the combustion of fuel.

FIGURE 5 | Example of an indicative well-to-wake process



Source: World Economic Forum

Emissions Calculation Using the GHG Protocol Five-Step Approach

The GHG Protocol prescribes the following five-step sequential approach for companies to identify and calculate their GHG emissions:

1 Identify GHG emissions sources
2 Select a GHG emissions calculation approach
3 Collect activity data and choose emission factors
4 Apply calculation tools
5 Roll up GHG emissions data to corporate level

The five-step approach is applied and explained in detail in the proposed accounting guidelines for each "persona" in the following sections. Specific data requirements and calculation approaches are also included within each "persona". Appendix 4 also includes examples that demonstrate the practical application of the five-step approach.

1.2 SAF Life Cycle Assessment (LCA)

Biogenic and Non-Biogenic GHG Emissions and Removals

Biogenic emissions directly result from the combustion, decomposition or processing of bio- based materials other than fossil fuels, peat and mineral sources of carbon. The combustion of SAF made from biogenic feedstocks generates biogenic CO_2 emissions and a very small mass of nitrous oxide (N_2O) and methane (CH_4). While the CORSIA life cycle assessment (LCA) methodology only accounts for CO_2 emissions from fuel combustion, it does account for other non-CO_2 GHG emissions upstream of combustion. Further, for SAF derived from biomass, biogenic wastes and residues, or biogenic CO_2, emissions from fuel combustion are assumed to be balanced out by the CO_2, uptake via photosynthesis during the growth phase of the biogenic feedstock. For this reason, the CO_2, emissions from the combustion of biogenic fuel are counted as zero in the lifecycle assessment of SAF.

This LCA treatment is consistent with the CORSIA and EU RED II life cycle assessment methodologies, existing GHG Protocol standards, and the Intergovernmental Panel on Climate Change (IPCC) recommendations[xiv] for national GHG inventories. The combustion emissions of petroleum jet fuel consist of 83% (74 gCO_2e/MJ) of its total life cycle GHG emissions, thus avoiding this through the use of SAF provides significant GHG emissions benefits.[xv]

Companies should use the current best-practice accounting treatment for biogenic and non-biogenic emissions and removals as detailed below, recognizing that this area of accounting is expected to evolve. The forthcoming GHG Protocol Land Sector and Removals (LSR) Standard and Guidance[xvi] will introduce more detailed requirements for how organizations account and report biogenic emissions, removals and storage. Future updates of these guidelines will incorporate the finalized LSR provisions to ensure continued alignment with GHG Protocol standards.

Current best-practice accounting treatment:

- Biogenic CO2 emissions from SAF combustion should be reported as zero within Scope 1 by aircraft operators, with separate disclosure of biogenic CO_2 emissions in line with GHG Protocol and forthcoming LSR guidance. Aircraft operators should include all upstream emissions (feedstock, transport, processing) in Scope 3 Category 3. For air transport customers and other personas, their well-to-wake accounting should mirror the aircraft operator's treatment, recognizing biogenic combustion emissions as zero while incorporating upstream emissions in their reported baseline and reductions. ap

- Non-biogenic SAF and SAF with non-biogenic components, such as SAF produced from some municipal solid waste, non-biogenic CO_2 emissions from fuel combustion should be fully accounted for by all personas.
- For power-to-liquid fuels, captured CO_2 may be accounted for as an emissions removal within the life cycle of the fuel only if that removal has not already been claimed by another actor. If an upstream actor (e.g., a DAC facility) claims the removal, the downstream air transport provider should report full combustion emissions without adjustment.

Today, most commercially available SAF is produced from biogenic feedstocks. As non-biogenic SAF pathways begin to scale and the GHG Protocol LSR Standard and Guidance is finalized, this guidance will be updated.

Induced or Indirect Land Use Change

Induced or indirect land use change (ILUC) describes the potential unintended consequences of biofuels production on land use, quantified in terms of GHG emissions. For instance, if forested land is cleared to produce crop-based fuel, this fuel may cause a net increase as opposed to a decrease in GHG emissions. Including ILUC values (as determined through techno-economic models) in LCA calculations enables users of SAF to understand a broader range of supply chain implications associated with biofuels production and consumption.

In the CORSIA methodology, the LCA for any given SAF is calculated as the sum of the core LCA and ILUC, i.e. direct and indirect emissions values, and then compared with the LCA of conventional jet fuel to determine its life cycle emissions benefits.

According to the CORSIA methodology, SAF produced with waste or residue feedstocks by default do not result in ILUC impacts; however, additional certifications can help verify this.

Use of Default vs Actual LCA Values

These guidelines primarily refer to the CORSIA LCA methodology for the calculation of the life cycle GHG emissions of SAF. However, other recognized LCA methodologies such as EU RED may also be used to determine SAF's lifecycle emissions impact. The system boundary of the CORSIA LCA methodology covers the full value chain of SAF. SAF life cycle emissions are calculated as the sum of emissions from all

attributed processes along the supply chain (the core LCA) and the modelled induced or indirect land use change (ILUC) value.

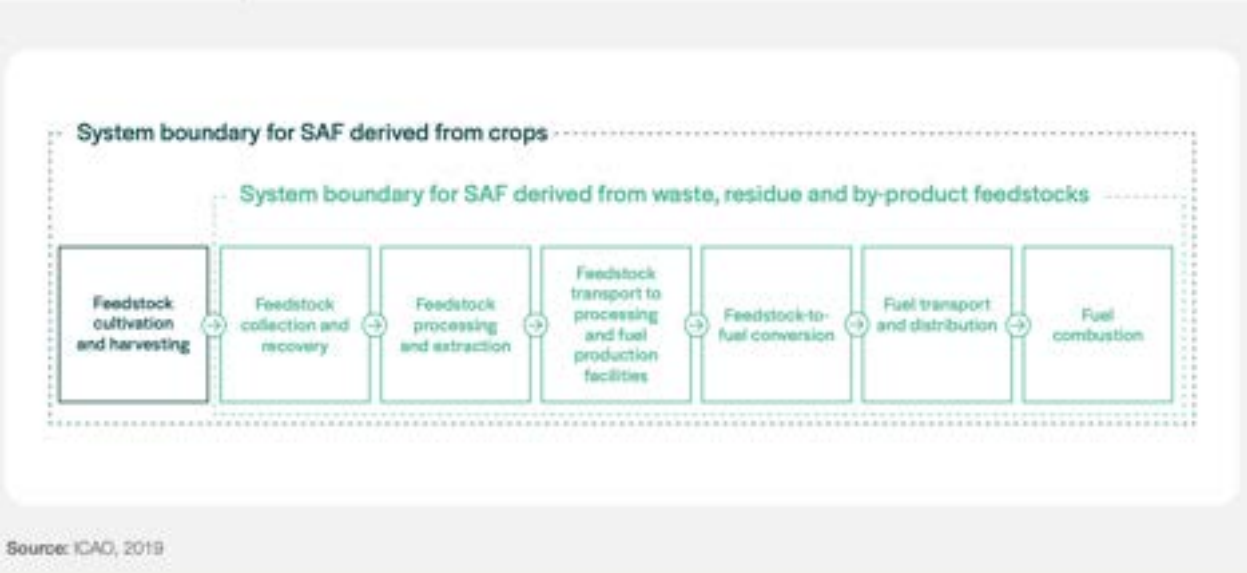
The core life cycle GHG emissions of SAF are calculated using a process-based attributional LCA approach. This method accounts for the product's mass and energy flows along the whole value chain of SAF. When using attributional analysis for the core LCA GHG emissions calculations, emissions are allocated as the sum of emissions from each stage of the value chain and allocated between co-products based on the products' embodied energy content.

As detailed within the CORSIA standard and the SBTi aviation sector guidance, participating operators can either use default life cycle emission factors or may alternatively use an actual core life cycle value certified through an ICAO-approved SCS.

SAF core LCA [gCO_2e/MJ] = Feedstock cultivation + feedstock harvesting and collection + feedstock processing + feedstock transportation + feedstock to fuelconversion + fuel transport and distribution + fuel combustion

As the life cycle of each batch of SAF varies by feedstock type and conversion pathway, so will the component elements of the core LCA calculation. For instance, SAF derived from agricultural crops will include the following core LCA components:

FIGURE 6 **Core LCA calculation system boundaries differ by feedstock type**

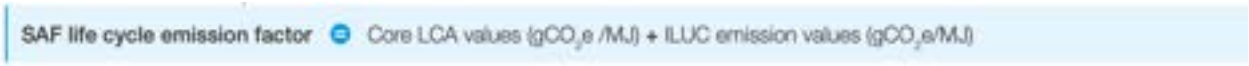


Source: ICAO, 2019

For ILUC emissions, a consequential approach is taken that estimates how global environmental burdens are affected by the production and use of the SAF.

Total life cycle GHG emission values for a given SAF are a sum of the "core LCA" emissions calculated and the ILUC emission value.

CO_2, CH_4 and N_2O are the only relevant GHG emissions in the life cycle assessment of SAF.



1.3 Reporting SAF GHG Emissions

SAF Reporting Best Practices and Transparency

GHG emissions are reported by businesses as part of their publicly available sustainability or annual reports. Businesses also provide emissions data to other global environmental disclosures, such as the CDP (formerly Carbon Disclosure Project)[xvii], and increasingly to regulatory climate disclosure programs in some jurisdictions.

Where possible, the reporting suggestions in these guidelines are built on existing GHG Protocol standards. Revisions and supplements are proposed to promote transparency and consistency. In accordance with the GHG Protocol, a corporate public emissions report published by the SAF and/or SAFc user will include the following:

- An outline of the organizational and operational boundaries chosen by the reporting company.
- For Scope 3, a list specifying the types of categories/activities covered.
- The reporting period covered.
- Methodologies/calculation tools used to calculate Scope 1, 2 and 3 emissions.
- The year chosen as the base year to which current emissions can be compared.
- In case any significant changes within the reporting boundaries occur, a recalculation of the base year emissions.
- Any specific exclusion of sources, facilities, or operations within the reporting period.
- Details of the company's GHG emissions inventory, including total emissions by scope and category, consistent with company's base year and recalculation policy.

Well-to-Wake Accounting and Reporting

The treatment of aviation emissions remains inconsistent between SAF standards, inventory accounting, reporting, and target-setting frameworks, meaning that reporting companies need to adjust their accounting and reporting practices to ensure consistency and accuracy.

Under the GHG Protocol today, aircraft operators report full well-to-wake (WTW) emissions, separated between tank-to-wake (TTW) emissions from jet fuel combustion under Scope 1 and upstream fuel emissions (WTT) in Scope 3 category 3. However, for actors that only account for aviation-related emissions within a given scope 3 category, the GHG Protocol only requires that they report tank-to-wake emissions (TTW), as the minimum boundary. This means that it is common for corporate travelers, air freight customers, and others to only report TTW emissions, omitting the WTT emissions which enable an accurate comparison with SAF lifecycle emissions benefits.

In contrast, the SBTi Aviation Sector Guidance requires companies to account for the full well-to-wake (WTW) impact of aviation fuels within their target boundaries. This ensures comprehensive life-cycle coverage of both upstream and combustion emissions, improving comparability across actors in the aviation value chain.

To ensure consistency and reduce confusion, these guidelines recommend alignment with the SBTi Aviation Sector Guidance, which is consistent with the SAF LCA boundary. Companies should apply a WTW boundary for SAF and SAFc accounting across all personas:

- Aircraft operators should report TTW emissions in Scope 1 and WTT emissions in Scope 3 Category 3, and disclose biogenic CO_2 from combustion outside of scopes.
- Air transport customers and other personas should report the combustion and upstream fuel emissions (the aircraft operator's combined Scope 1 Scope 1 and Scope 3 Category 3 emissions) within their corresponding Scope 3 categories.

1.4 SAFc Accounting and Reporting

Activity Boundary

SAFc should only be used to address emissions from aviation activity in a company's inventory. It should not be used to address emissions from other non-aviation activities, and should not over-compensate for aviation activity in any given year to reflect a negative aviation emissions footprint.

Further, companies should ensure that SAFc emissions outcomes (the emissions profile and/or emissions reductions conveyed by the SAF certificate) they report in relation to their aviation activity reflects – and does not exceed - the decarbonization potential of the SAF. For example, if a company purchased SAFc to address its entire aviation footprint in terms of effective fuel consumption, and all of that SAFc represented a 60% emissions reduction of SAF compared to conventional jet fuel, the company should at maximum claim 60% lower market-based aviation emissions as compared to their physical aviation emissions footprint in any given reporting year.

SAFc Accounting Approaches

As detailed in Section 1.2 on lifecycle assessment, the emissions profile of both SAF and conventional jet fuel are established using an attributional accounting approach, where each lifecycle emissions component from feedstock production or collection, to fuel production, to fuel combustion, are measured or modeled and summed together. The estimated emissions reduction from the use of SAF is a comparison between these two attributional values (the carbon intensity of SAF and conventional jet fuel, respectively).[3]

All SAF and SAFc accounting recommendations in this document are designed to align with GHG Protocol's inventory reporting framework and sectoral lifecycle assessment norms. As such, these guidelines apply an attributional approach. Consequential methods can provide useful insights into the broader climate impacts of SAF, but such analysis should be reported separately from any attributionally accounted emissions, and not as a substitute for attributional inventory disclosures.

[3] While SAF lifecycle assessments overall take an attributional accounting approach, some LCA methods include consequential elements such as induced land use change (ILUC) and avoided emissions credits (such as LECs and RECs under the CORSIA methodology for municipal solid waste), which are added to the core SAF LCA. So while all SAF LCAs may not be purely attributional, SAF is accounted using a predominantly attributional approach, which should guide its broader accounting treatment. Disclosure of these LCA components in a disaggregated manner by SAF providers can enhance transparency about the relative contribution of these components in practice to SAF emissions outcomes, and inform more accurate disclosure.

Attributional and Consequential Accounting

The GHG Protocol recognizes two complementary approaches to greenhouse gas accounting:

- **Attributional accounting** assigns emissions to a product or service based on direct inputs and outputs, typically using average or supplier-specific life cycle assessment (LCA) values. This approach is applied in corporate Scope 1, 2, and 3 inventories.
- **Consequential accounting** estimates the broader system-wide change in emissions that results from a decision, such as scaling SAF production or increasing SAF demand. It uses marginal or scenario-based data and can help companies or policymakers understand the avoided emissions or market impacts of their decisions. Consequential methods are detailed in GHG Protocol's Project Accounting Standard, but are not currently part of the GHG Protocol's corporate inventory framework, and if used, should be reported separately.

Ongoing work under the GHG Protocol Actions and Market Instruments (AMI) Technical Working Group is developing guidance for both attributional and consequential reporting of actions and market instruments like SAFc.

Companies have two valid options for attributional SAFc accounting:

A. **Calculate the emissions reductions associated with purchased SAFc**, by comparing the SAF and conventional jet fuel carbon intensities, and multiplying that difference by the amount of SAF.
B. **Use the emissions profile of the SAF directly** to disclose market-based emissions, which can be substituted in for the emissions profile of conventional jet fuel and converted into the relevant inventory activity data metric to estimate total market-based emissions by scope and category.

These guidelines reflect both options in each persona section, and provide additional context for these method options in Appendix 5: Substitution Accounting and Reporting Approach.

SAFc Reporting

To ensure transparent and credible reporting, companies using SAFc should publicly disclose both:

- Their total physical inventory emissions from aviation activities, by scope and category, and

- The emissions outcomes associated with retired SAFc – in terms of emissions reduction as compared to conventional jet fuel (option A) or emissions profile (option B).

Companies should report a complete physical emissions inventory in order to transparently disclose their physical aviation emissions footprint. Companies should report total physical inventory emissions in line with current Scope boundaries (e.g., Scope 1 and Scope 3 Category 3 for aircraft operators; Scope 3 Category 6 for corporate travelers).

Specifically, companies should calculate and disclose total aviation emissions based on the use of conventional jet fuel, on a WTW basis. This includes both:

a. TTW combustion emissions
b. WTT upstream emissions from fuel production and distribution

Any emissions outcomes associated with SAFc should be reported separately from, but in reference to, specific scopes and categories within the physical inventory for transparency. SAFc emissions outcomes should be disclosed separately as a market-based adjustment, rather than as a substitute for gross emissions. This dual reporting approach aligns with current GHG Protocol guidance for market-based instruments (e.g., Scope 2) and is recommended for all Scope 1 and Scope 3 SAFc claims until formal GHG Protocol and SBTi guidance is available. This approach builds trust with auditors, stakeholders, and customers by transparently presenting the relative contributions of total aviation activity and market-based measures.

Companies should calculate and disclose emissions outcomes represented by SAFc retired in a SAFc registry (including disclosing retirement records, which should include fuel and baseline carbon intensity and sustainability certification details).

Companies should either disclose aggregate SAFc emissions outcomes as a total emissions reduction estimate in reference to any given scope and category (consistent with SAFc accounting option A above), or as a total market-based emissions estimate in reference to the same (consistent with accounting option B).

Companies can either disclose these outcomes simply as a line item in reference to a relevant scope 3 category, with supplemental details, or in a separate market-based ledger in parallel to the physical emissions inventory. This latter option may be an ideal choice in the near term for companies using their own management criteria or alternative guidance like the AIM Platform Standard[xviii] or the Taskforce for

Climate Action Transparency Guidance[xix] to inform disclosure best practices prior to GHG Protocol changes, and especially those who are supporting additional types of market-based interventions beyond SAFc.

See Appendix 5 for more details on these SAFc accounting and reporting options.

Scope 3 Co-Claiming Scenarios

To prevent double counting of emissions, the GHG Protocol corporate standard defines Scope 1 and Scope 2 emissions to ensure that two or more companies do not account for the same emissions within the same scope. However, Scope 3 is designed to recognize multiple entities in a value chain who account for the same emissions source and claim corresponding emissions outcomes (both across scope 3 categories as well as across scopes), reinforcing collaboration to reduce emissions across society.

In all cases, scope 1 emissions and scope 3 emissions outcomes may be co-claimed. Within scope 3, more than one entity may be eligible to co-claim the emissions outcomes associated with a discrete volume of SAF represented by a single SAFc, provided each entity plays a distinct role in the aviation value chain and each maintains a complete Scope 3 inventory tied to the aviation activity. In line with the GHG Protocol's treatment of Scope 3 emissions, multiple companies may report emissions from the same physical activity, provided their claims are made from different value chain positions (GHG Protocol Scope 3 standard section 5.1).

In some cases, co-claiming entities may report **under the same Scope 3 category**. For example, in an air freight scenario, a logistics service provider that contracts a shipping service may co-claim SAFc alongside the end-use customer (cargo owner or shipper) against Category 4 (upstream transportation and distribution) emissions, provided their roles and emissions boundaries are distinct. In the case of passenger travel, the travel management company and the corporate traveler may both claim reductions under Category 6 (business travel).

In other cases, co-claiming may occur **across different Scope 3 categories**, involving entities further upstream in the aviation value chain. For instance, if an OEM sells an aircraft that is financed by a bank and leased to an airline, an OEM may report against Scope 3 Category 11 (use of sold products), a financial institution may report against Category 15 (financed emissions), and a lessor may claim against Category 13 (use of leased assets).

In all cases, any SAFc co-claimed between parties should be mutually agreed upon, formalized in contractual documentation, and transparently recorded in a SAFc registry. Claims should clearly reflect

each party's role in the aviation value chain (e.g. aircraft operator, business travel end user, etc.) as well as the scope and category of emissions the SAFc is addressing for each co-claimant, and should align with the persona-specific guidance in this document.

Overview of SAF and SAFc accounting and reporting inventories by persona

		Fuel Emissions		SAFc Claims
Persona	**Use Case**	**Scope 1 (WTT)**	**Scope 3 Category (TTW)**	***to be further discussed**
SAF Supplier (Fuel Producer, Blender, Distributor, Fixed-Based Operator)	Sell and deliver physical SAF as fuel providers		Cat. 11 Use of sold products (fuel)	
Aircraft Operator (Airlines, Carriers, Private Aviation)	Operate aircraft with Scope 3 end-user (i.e., corporate charter for another company, aircraft repositioning for airline/carrier)	Fuel combustion	Cat. 3 Fuel & energy	Scope 1 SAFc
	Operate aircraft without Scope 3 end-user (i.e., fly own employees, repositioning own aircraft, OEM engine testing)	Fuel combustion	Cat. 3 Fuel & energy	Scope 1 SAFc *Physical SAF used by operators cannot generate Scope 3 SAFc
Air Transport Customer (Corporate Traveler, Shipper)	Use air travel or transport services		Cat. 6 Business travel (Corporate traveler) Cat. 4 Upstream transportation (Shipper)	Scope 3 SAFc
Travel and Logistics Service Provider (Travel Management Company, Freight Forwarder)	Operates entire flights *same as aircraft operator	Fuel combustion	Cat. 3 Fuel & energy	Scope 1 SAFc
	Contracts with airlines or carriers and sells travel or logistics services to corporates		Cat. 6 Business travel (TMC) Cat. 4 Upstream transportation (FF)	Scope 3 SAFc
	Books flights for others without direct contracting airlines (i.e., client pays the airline or carriers directly)			*TBD, wait for SBTi guidance in the coming years
Airport	Airport cannot facilitate local SAF delivery		Cat. 11 Use of sold products: access to airport infrastructure	Scope 3 SAFc
Aircraft Lessor	Dry lease: lessee (airline) has operational control		Cat. 13 Downstream leased assets (Aircrafts)	*Scope 3 SAFc
	Wet lease: lessor has operational control *same as aircraft operator	Fuel combustion	Cat. 3 Fuel & energy	Scope 1 SAFc
Financial Institution	Provide loans or leases to aircraft operator		Cat. 15 Investments	*Scope 3 SAFc
Original Equipment Manufacturer (OEM)	Fuel-based activities (R&D, engine testing…) *same as aircraft operator	Fuel combustion	Cat. 3 Fuel & energy	Scope 1 SAFc *Physical SAF used by operators cannot generate Scope 3 SAFc

	Account for fuel emissions from sold aircraft		Cat. 11 Use of sold products (Aircraft)	*Scope 3 SAFc

2. SAF Supplier

SAF suppliers encompass all actors between production and delivery of fuel, upstream of fuel use in the value chain of SAF. These may include:

- Fuel producers, who convert feedstocks into neat SAF
- Fuel blenders, who blend neat SAF with conventional jet fuel
- Fuel distributors, who deliver physical fuel to airports/storage facilities
- Fixed-based operators (FBOs), who serve as retail fuel providers.

These actors collectively source feedstock and produce and supply SAF to commercial aircraft operators. Yet, many suppliers only play a subset of these roles in SAF supply chains.

SAF is sourced from sustainable resources including waste oils of biological origin, biomass raw materials, direct air capture (DAC) CO_2, forestry and agricultural residues, or municipal solid waste. Suppliers seek sustainability certification of the supply chain of SAF they provide to enable consumers to understand and claim the environmental attributes of their products. Eligibility for sustainability certification is determined and confirmed via third-party audits to a sustainability certification scheme (SCS) such as RSB and ISCC's CORSIA standards (see Appendix 1.1 for more details).

Inventory Boundary

The corporate emissions inventory boundary and the accounting treatment of a SAF supplier are dependent on its organizational and operational boundary, as well as business context, which can vary widely.

The choice of inventory boundary will depend on the business characteristics of a given supplier. All relevant emissions sources within the chosen inventory boundary should be accounted for so that a comprehensive and meaningful inventory is compiled.

SAF suppliers should include all well-to-wake (WTW) emissions including direct scope 1 and scope 2 emissions, and indirect scope 3 emissions as part of GHG emissions inventories.

2.1 Emissions Accounting

This section explains emissions accounting for a typical SAF supplier using the GHG Protocol five-step approach in identifying and calculating GHG emissions.

Here, the SAF supplier's assumed organizational boundary only includes fuel production/conversion from various types of sustainable feedstocks, including biomass or waste resources. See Appendix 4 for a sample calculation.

Step 1. Identify and map emissions sources to inventory

- **Scope 1**: Emissions associated with the production of SAF from the feedstock
- **Scope 2**: Emissions associated with the generation of purchased electricity consumed during production
- **Scope 3 Category 1**: Upstream emissions associated with feedstock cultivation, harvesting, collection, processing, and extraction
- **Scope 3 Category 4**: Upstream transport and distribution of the feedstock and/or fuel
- **Scope 3 Category 9**: Downstream emissions from outbound transport and distribution of SAF to airports/storage facilities
- **Scope 3 Category 11**: Downstream emissions from fuel combustion (end use of goods and services)

Step 2. Select a GHG Emission Calculation Approach

As per the GHG Protocol standards, the selection of an emission calculation approach should consider the availability and source of activity data as well as the applicable emission factor.

- Data should be activity- and supplier-specific, based on the raw material acquired and jet fuel produced and distributed.
- Emission factors should be based on total life cycle emissions of SAF using either the CORSIA default factor for a given feedstock type and conversion pathway, or an actual calculated LCA value as certified through a SCS.

Step 3. Collect activity data and choose emission factors

Emissions data should be identified and collected on a well-to-wake (WTW) life cycle basis.

Upstream emissions data	**Primary data sourced from the supplier,** based on the mass (kg) of feedstock acquired from the feedstock supplier
Process emissions data	**Primary activity data,** based on production data
Downstream emissions data	**Primary supplier-specific data,** based on transport and distribution data **Secondary data sourced from atmospheric emission databases,** for example UK Department for Business, Energy and Industrial Strategy (BEIS) and US Environmental Protection Agency (EPA) emissions databases

The applicable LCA emission factor will vary depending on the underlying SAF feedstock and the conversion pathway.

Step 4. Apply calculation approach

The system boundary of the LCA methodology consists of the full value chain of SAF. SAF life cycle emissions should be calculated as the sum of the LCA values of all attributed processes — adding up direct emissions along the supply chain and the estimated ILUC values.

For SAF derived from biomass and biogenic waste and residues, biogenic CO_2 emissions from fuel combustion in the aircraft engine are assumed to be balanced out by carbon uptake during growth (please refer to key concepts section of this paper), and therefore, counted as zero in the core LCA of SAF.

Core LCA [gCO_2e/MJ]	=	Feedstock cultivation + feedstock harvesting, collection and recovery + feedstock processing and extraction + feedstock transport to processing and fuel production + feedstock to fuel conversion + fuel transport and distribution to the blend point + fuel blending + fuel combustion in an aircraft engine
		SAF life cycle emissions are calculated as the sum of the "core LCA" and the estimated ILUC emission values.
Total SAF life cycle emissions	=	Core LCA values (gCO_2e/MJ) + ILUC emissions values (gCO_2e/MJ)

Step 5. Aggregate emissions data to the corporate level

To report total corporate-wide SAF emissions, a SAF supplier should gather and total the life cycle emissions for all batches of SAF produced, processed, or distributed.

This includes SAF batches produced in different locations during the reporting period.

As proof of sustainability documentation of certified batches can vary, a SAF supplier should use a decentralized approach to aggregate and report the GHG life cycle emissions data to the corporate level.

2.2 SAF Reporting

A public GHG emissions report for a SAF supplier should include emissions data reported for scope 1, scope 2 and scope 3, based on organizational and operational boundaries and the used raw materials, including:

- **Scope 1:** All relevant GHG emissions related to the supplier's activities in their operational boundary, reported *within the scope.*
- **Scope 2:** All relevant GHG emissions attributed to the production of electricity used during the production of SAF, reported *within the scope.*
- **Scope 3:** All relevant GHG emissions associated with downstream activities, including fuel transport and processing, and the combustion of supplier's SAF during flight operations, reported *within the scope,* and all relevant GHG emissions associated with the upstream sourcing of feedstock by the SAF supplier, reported *within the scope.*
- Other SAF sustainability criteria verified through SCS certification and conveyed through proof of sustainability documentation.
- Name of the certification scheme(s), certification body or bodies and certification identification numbers.

3. Aircraft Operator (Airlines, Carriers, and Private aviation)

Aircraft operators are entities that operate aircraft and directly combust aviation fuel. Aircraft operators use aircraft either owned by or leased to them, often on a long-term basis.

This persona includes a wide range of operator types, such as:

- **Airlines** serving commercial passenger routes
- **Air freight carriers** transporting goods on behalf of shippers and/or logistics providers
- **Corporate operators** flying aircraft for internal business use
- **Private/charter operators** providing flights to paying clients
- **Ferry flight operators** repositioning aircraft for delivery or maintenance
- **OEMs** conducting engine testing, research and development, demonstration activities or aircraft delivery.

Aircraft operators are responsible for reporting emissions from flight operations. To reduce their life cycle emissions, aircraft operators may procure and use physical SAF as an alternative to conventional jet fuel, which is their largest GHG emissions source. Alternatively, aircraft operators can purchase and retire unbundled SAFc via a registry to claim emissions reductions associated with their activities. This can enable aircraft operators in regions with limited physical access to SAF to invest in the nascent industry and make valid emissions reduction claims.

3.1 Emissions Accounting

Inventory Boundary

The corporate emissions inventory boundary and the accounting treatment of an aircraft operator are dependent on its organizational and operational boundary as well as business context, which can vary widely.

For SAF, the inclusion of emissions attributed to fuel production, transport and distribution is important as emissions reductions occur both from upstream processes and the treatment of fuel combustion emissions. Therefore, to claim an accurate emissions reduction and for a direct comparison with emissions from their SAF usage, aircraft operators also need to account for and report fossil fuel upstream emissions on a WTW basis.

Step 1. Identify and map emission sources to inventory

In view of the proposed boundary above, aircraft operators should include complete WTW life cycle emissions including direct scope 1 and indirect scope 3 category 3 emissions as part of GHG emissions inventories.

- Scope 1 emissions include emissions from the combustion of fuel during flight operations.
- Scope 3 category 3 includes upstream fuel and energy-related activities including emissions from production and distribution of SAF.

Step 2. Select a GHG emissions calculation approach

As per the existing GHG Protocol standards, the selection of an emissions calculation approach should consider the availability and source of activity data, as well as the applicable emission factor.

- Primary activity data based on the mass or volume of SAF procured by the aircraft operator for flight operations, sourced from fuel purchase receipts and internal purchase records.
- Actual supplier and SAF-specific emission factors, based on life cycle assessment, obtained from the fuel supplier.

The applicable LCA emission factor will vary depending on the underlying feedstock type and the production pathway.

Step 3. Collect activity data and choose emission factor

Emissions data should be collected on a well-to-wake basis, the sum of both scope 1 emissions from SAF combustion and scope 3 category 3 fuel and energy-related activities emissions from upstream production and distribution of SAF.

SAF suppliers will provide an LCA emission factor – the sum per unit of fuel for all the GHG emissions released into the atmosphere during the cultivation, harvesting, collection, processing and extraction, feedstock transport, feedstock to jet fuel conversion, jet fuel transport and distribution, and fuel combustion — as well as the ILUC value if applicable to the type of feedstock via proof of sustainability documentation verified through SCS certification.

Step 4. Apply calculation approach

As recommended by the SBTi aviation sector guidance, to recognize that the choice of fuel can influence both the upstream and combustion emissions, aircraft operators should account for their emissions on a WTW basis.

The outcome of the above calculation will be the per-flight well-to-wake emissions of the aircraft operator, based on the life cycle emissions of neat SAF. By accounting for SAF life cycle emissions using LCA-based emission factors or alternate approved LCA values, an aircraft operator can account for reduced value chain emissions.

As SAF is blended with conventional jet fuel, aircraft operators should keep a record of the effective amount of neat SAF purchased and consumed for flight operations during the reporting period. This data can be obtained from the purchase invoices of SAF or product transfer documentation from SAF suppliers to determine the amount of neat fuel consumed during the flights throughout the year.

Aircraft operators should use a registry to maintain a record of their retired SAFc — both bundled and unbundled — and the emissions reductions they represent.

SAF WTW emissions	=	**Scope 1 combustion emissions** based on TTW emission factor or approved LCA values ($kgCO_2e/kg$) **x** SAF consumption (kg) **+ Scope 3 category 3 emissions** based on based on WTT emission factor or approved LCA values ($kgCO_2e/kg$) **x** SAF consumption (kg)

Step 5. Aggregate emissions data to the corporate level and roll up

As described in the GHG Protocol standards, to report total corporate-wide emissions, an aircraft operator should gather and sum up the data for all its flight operations during the reporting period.

An aircraft operator's GHG emissions inventory should include life cycle emissions from neat SAF as well as conventional jet fuel use. The sum of the life cycle emissions of the two categories of fuel will be the total life cycle emissions of flight operations during the reporting period.

To fulfil their SAF demand, aircraft operators may rely on multiple suppliers operating across varying jurisdictions, and therefore, SAF produced from a variety of feedstocks and production pathways.

In view of the limited production capacity and the impact of local regulations on SAF production and reporting, aircraft operators should use a decentralized approach to total GHG life cycle emissions data. Under a decentralized approach, fleet and fuel management should collect fuel purchase and fuel consumption data for all flight operations to calculate emissions. When possible, aircraft operators should use life cycle emission factors provided by suppliers and report the emissions data to the corporate level.

3.2 SAFc Accounting

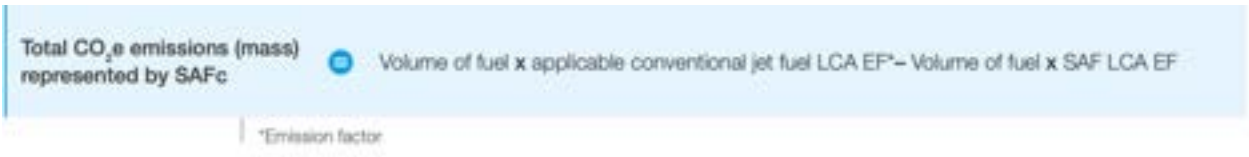
Aircraft operators without the ability to purchase physical fuel can also purchase and retire unbundled SAFc to claim SAF's environmental attributes. This allows aircraft operators in regions with limited physical access to SAF to invest in the nascent industry and make valid emissions reduction claims.

Aircraft operators should account for and report the emissions outcomes of their SAFc usage using one of two options (A or B), described below.

Option A: Calculate Reduction

Subtract the mass of CO_2e represented on the retired SAFc from scope 1 and scope 3 category 3 emissions. The CO_2e represented by SAFc is based on the life cycle emissions of the SAF, relative to conventional jet fuel.

Each SAFc represents a CO_2e mass value explained in the equation below:



Option B: Calculate and Substitute Emissions Profile

Use the emissions profile of the SAF (in gCO2e/MJ) to calculate the total emissions profile of SAF per unit of activity data (e.g. converting MJ, as needed, to volume of fuel). Separately from the physical inventory (e.g. in a parallel market-based emissions ledger), apply this emissions profile as a substitute for the physical inventory emissions factor, for the amount of SAF represented by the SAFc purchase (converting metric tons or other units, as needed, to volume of fuel). Air transport operators should apply the WTT component of the emissions profile to their scope 3 category 3 emissions footprint, and the TTW component of the emissions profile to their scope 1 emissions footprint to accurately account for the relative impact of each component throughout the SAF lifecycle.

For example, if an aircraft operator purchases SAFc representing 100 MJ of biogenic SAF, with a WTW emissions profile of 15 gCO2e/MJ, they would:

- *Separate the WTW 15 gCO2e/MJ into WTT and TTW emissions profiles. Because this is a biogenic fuel, combustion emissions (TTW) should be accounted as 0 gCO2e/MJ in relation to the scopes, but biogenic combustion emissions would be reported separately, outside of the scopes. The WTT emissions are then 15gCO2e/MJ.*
- *Convert 15 gCO2e/MJ to the unit they use for activity data emissions intensity in their physical inventory (e.g. tons of CO2e per gallon).*
- *Convert 100 MJ of SAF to the unit they use for activity data in each category (e.g. gallons)*
- *Apply the WTT and TTW SAF emissions factors in updated inventory activity units (e.g. tons of CO2e per gallon), substituting for the conventional jet fuel emissions factor used for the amount of SAF represented by the SAF certificates (e.g. 100 MJ, converted to gallons), to scope 3 category 3 (using the WTT factor) and scope 1 (using the TTW factor).*
- *Report these total market-based emissions for scope 1 and scope 3 separately from the physical inventory (optionally, in a separate market-based emissions ledger).*

3.3 SAFc Reporting

A public GHG emissions report for aircraft operators using SAF and/or SAFc to manage their aviation emissions should include the following information:

- **Total flight operations life cycle emissions** based on different data sets for all the batches of SAF and conventional jet fuel reported separately for both:
    - **Scope 1 (TTW):** direct emissions attributed to fuel consumption during flight operations.
    - **Scope 3 category 3 (WTT):** upstream emissions attributed to activities in the life cycle of SAF and conventional jet fuel production.
    - Combustion and upstream emissions data for biogenic CO_2 and other Kyoto Protocol emissions reported within the scopes in metric tonnes and in metric tonnes of CO_2 equivalent.
- **SAFc emissions outcomes:** Disclose the emission reductions (option A) or emissions profile and amount (option B) associated with purchased and retired SAFc.
- **Dual reporting:** Report total aviation emissions and any emissions outcomes associated with purchased and retired SAFc during the reporting year, separately.

- **Supporting documentation**: Reference the registry retirement records of the SAFc (i.e., certificate IDs, retirement dates, associated fuel batch LCA data), proof of sustainability certification (e.g., RSB, ISCC).

4. Air Transport Customer (Corporate Traveler, Shipper)

Air transport customers are organizations that procure air transport services for their employees (passenger travel) or for goods (freight shipments), but do not directly operate aircraft or purchase fuel. This includes:

- **Corporate travelers**, representing companies purchasing air travel services for business travel
- **Freight shippers**, representing companies whose goods are transported by air as part of freight or logistics operations.

Air transport customers are responsible for reporting these aviation-related emissions in their Scope 3 inventories. They may purchase and retire SAFc to address their aviation emissions footprint.

Some organizations may also operate private or charter aircraft in addition to purchasing commercial air transport services. In such cases, they should apply the Aircraft Operator persona guidance for their operated private aviation activity and the Air Transport Customer persona guidance for their commercial travel and freight services.

4.1 Emissions Accounting

Inventory Boundary

Air transport customers should include **well-to-wake (WTW)** emissions, both direct fuel combustion and upstream emissions from fuel production and distribution, in their relevant scope 3 emissions category (See more details on this recommendation in Section 1.3 SAFc Reporting, Well-to-Wake Reporting).

Step 1. Identify and map emission sources to inventory

Corporate travelers:

Scope 3 Category 6 Upstream emissions associated with business air travel

Freight shippers:

Scope 3 Category 4 upstream emissions from transportation and distribution of goods shipped by air.

Step 2. Select a GHG emissions calculation approach

GHG Protocol recommends using one of three calculation methods to calculate air transport GHG emissions:

- Distance-based method, which involves determining the distance and mode of air transportation, then applying the appropriate emission factor for the mode used.
- Fuel-based method, which involves determining the amount of fuel consumed during air transport and applying the appropriate emission factor for that fuel.
- Spend-based method, which involves determining the amount of money spent on each mode of air transport and applying secondary (environmentally extended input-output) emission factors.

According to the GHG Protocol, the fuel-based method for calculating travel emissions is the most accurate as it involves determining the amount of fuel consumed and applying the related emission factor. However, the distance-based method is often the most practical approach for air transport customers today to calculate their aviation emissions because:

- The data required to accurately estimate emissions with the fuel-based method is not always readily available.
- The distance-based method is most consistent with the prevalent accounting and reporting practices.
- Distance is the most available data within corporate customers' internal data set, unless they work directly with aircraft operators to receive more accurate, fuel-based data.
    - In some cases, corporates may access summarized fuel-based emissions data through tools such as IATA's CO_2 Connect, which uses airline-supplied operational data. As of 2025, the tool also incorporates SAF-related reductions, though these are applied at a network-wide level rather than flight-specific, and coverage is currently limited to participating airlines.

These guidelines recommend the following approach:

- Corporate travelers: distance-based or fuel-based approach, encouraging the adoption of fuel-based method as datasets become increasingly available.
- Freight shippers: distance-based approach given availability of data and common industry practice

Although the spend-based method is effective for screening purposes, it can be highly inaccurate. For this reason, the spend-based method is the least preferred while calculating and reporting emissions and is not detailed here.

Step 3. Collect activity data and choose emission factor

The emissions calculation should be based on activity data: jet fuel consumption for the fuel-based method or distance travelled for the distance-based method. The activity data and emission factors used to calculate air transport emissions will depend on the choice of the calculation methods explained above.

Corporate travelers:

Distance-based:

Activity data includes the number of kilometers travelled per person (passenger-kilometers, abbreviated as p-km) for a particular aircraft type.

Total distance (p-km) travelled by mode of air transport (type of aircraft, travel class etc.) for employees in the reporting period can be calculated or collected from the following:

1. Automatic tracking of distance travelled by aircraft through a travel agency or other sources
2. Travel reports provided by aircraft operator
3. Annual surveys/questionnaires/reporting manual of employees

Irrespective of the fuel type used by their associated aircraft operators, air transport customers should use secondary emission factors for conventional jet fuel. These are based on the default databases of regional or national emission factors of various travel types (short, medium or long haul and economy, business or first), represented as kilograms of CO_2e emitted per kilometer or passenger-kilometer. Examples of entities with published emission factor databases include the **UK BEIS** (Department for Environment, Food and Rural Affairs (DEFRA)), the **US EPA**, and the **Dutch Emissions Authority**.

Fuel-based:

Activity data includes mass (kg or tonnes) or volume (liters or gallons) of fuel consumed by an associated aircraft operator allocated to the reporting company's corporate travels. As this data is not commonly shared with corporate travelers today, this version of the guidelines does not include a suggestion on the sourcing of the data for the fuel-based method.

Freight shippers:

Distance-based:

Based on the availability of data and common industry practice, shippers should use the distance-based method to calculate their scope 3 emissions.

Activity data includes the distance traveled, based on onboard systems or Great Circle Mapper, and the total mass of the shipment.

The emission factor used should be the default CORSIA LCA emission factor of the conventional jet fuel baseline or jurisdiction-specific equivalent based on LCA.

Default factors should include fuel efficiency and fuel intensity.

Step 4. Apply calculation approach

Corporate travelers:

Distance-based:

The distance-based method uses the applicable conventional jet fuel LCA emission factor ($kgCO_2e$/p-km) and flight distance (p-km) to calculate category 6: business travel emissions for corporate travelers or category 4: upstream transportation and distribution for freight forwarders

$$\sum (\text{Distance per air travel (km)}) \times \text{conventional jet fuel WTW emission factor } (kgCO_2e/\text{p-km})$$

In calculating the total emissions for the reporting period, the activity data should be summed to obtain the total annual kilometers travelled with aircraft operators.

In Appendix 4 examples, secondary emission factors published by BEIS (DEFRA) have been used to calculate distance-based emissions.

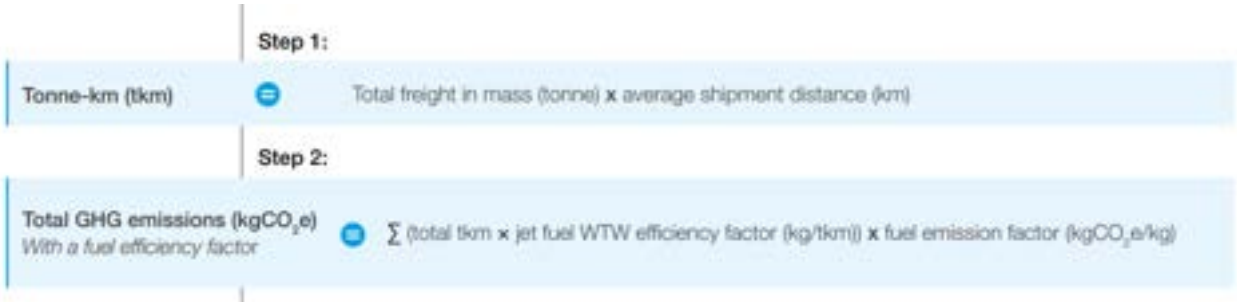
Fuel-based:

The fuel-based method uses fuel consumption data (kg) and the applicable conventional jet fuel LCA emission factor ($kgCO_2e$/p-km).

$$\sum (\text{Mass of fuel consumption (kg)}) \times \text{conventional jet fuel WTW emission factor } (kgCO_2e/\text{kg fuel})$$

Freight shippers:

Distance-based:



Step 5. Aggregate emissions data to the corporate level and roll up

To report total air transport emissions, the reporting company will gather and sum up the emissions data for all aviation emissions for the reporting period, on a life cycle or WTW basis.

Most air transport customers report their aviation emissions using a centralized approach. However, the reporting company should select the approach best suited to them.

4.2 SAFc Accounting

Air transport customers should account for and report the emissions outcomes of their SAFc usage using one of two options (A or B), described below.

Option A: Calculate Reduction

Subtract the mass of CO_2e emissions represented by retired SAFc from scope 3 category 6 (business travel) or scope 3 category 4 (upstream transportation and distribution) emissions. The CO_2e reductions represented by SAFc are based on the life cycle emissions of the SAF, relative to conventional jet fuel.

Each unit of SAFc represents a CO_2e reduction (kg or tonnes) explained in the equation below:

Option B: Calculate and Substitute Emissions Profile

Use the emissions profile of the SAF (in gCO2e/MJ) to calculate the total emissions profile of SAF per unit of activity data (e.g. converting MJ, as needed, to distance travelled or volume of fuel). Separately from the physical inventory (e.g. in a parallel market-based emissions ledger), apply this emissions profile as a substitute for the physical inventory emissions factor, for the amount of SAF represented by the SAFc purchase (converting metric tons or other units, as needed, to distance travelled or volume of fuel). Air transport customers should apply the full WTW emissions profile to their relevant scope 3 category emissions footprint.

For example, an air transport customer purchases SAFc to address its business travel emissions. The SAFc it purchases represents 100 MJ of biogenic SAF, with a WTW emissions profile of 15 gCO2e/MJ. To account for this, they would:

- *Convert 15 gCO2e/MJ to the unit they use for activity data emissions intensity in their physical inventory (e.g. tons of CO2e per p-km, or tons of CO2e per gallon).*
- *Convert 100 MJ of SAF to the unit they use for activity data in each category (e.g. p-km or gallons)*
- *Apply the WTW SAF emissions factor in updated inventory activity units (e.g. tons of CO2e per p-km or tons of CO2e per gallon), substituting for the conventional jet fuel emissions factor used for the amount of SAF represented by the SAF certificates (e.g. 100 MJ, converted to p-km or gallons), to scope 3 category 6.*
- *Report these total market-based emissions scope 3 category 6 separately from the physical inventory (either in a complete separate market-based emissions ledger or as a supplementary disclosure line item).*

4.3 SAFc Reporting

Air transport customers should use a SAFc registry with their associated fuel supplier, aircraft operators, and any other co-claimants to streamline the SAFc issuance, transfer and retirement process. This system will require that fuel suppliers upload proof of sustainability documentation linked to an active certification to substantiate certificate issuance. SAFc buyers should only make claims on SAFc after a unit has been retired in their name within the registry.

A public GHG emissions report for air transport customers purchasing SAFc to reduce its aviation travel emissions should include the following information:

- **Total aviation emissions in Scope 3 Category 4 or 6:** Disclose total aviation-related emissions, using conventional jet fuel, on a full well-to-wake (WTW) basis within Scope 3 Category 4 (upstream transportation and distribution) or Category 6 (business travel), depending on the nature of services provided.
- **SAFc emissions outcomes:** Disclose the emission reductions (option A) or emissions profile and amount (option B) associated with purchased and retired SAFc.
- **Dual reporting:** Report both total aviation emissions and total emissions outcomes associated with purchased and retired SAFc during the reporting year, separately.
- **Supporting documentation:** Reference registry retirement records substantiating SAFc claims (i.e., certificate IDs, retirement dates, fuel carbon intensity) and sustainability certifications.
- **Co-claim transparency:** When co-claiming SAFc alongside partners (e.g., travel management companies, or freight forwarders), companies should further specify:
    - The type of counterparty to the co-claim (e.g. a logistics service provider), and name that beneficiary entity if possible
    - The scope and category where the co-claim is applied

5. Travel and Logistics Service Provider (Travel Management Company, Freight Forwarder)

Travel and logistics service providers act as intermediaries between aviation operators and air transport customers. Specifically:

- **Freight forwarders (FFs)** book air cargo space on behalf of shippers and coordinate shipment routing
- **Travel management companies (TMCs)** manage business air travel for corporate clients through booking and reporting platforms

Travel and logistics service providers can operate under a range of commercial models, and their emissions accounting and SAFc treatment depend on the level of control and financial risk they assume in each case. In some cases, travel and logistics service providers may also operate flights. In this case, the travel and logistics service provider is also functioning as an aircraft operator, and should follow the accounting and reporting guidance provided in the **Aircraft Operator persona** for that aircraft operation activity.

These guidelines identify two distinct travel and logistics service provider scenarios:

- Contracting with aircraft operators and selling air transport to clients
- Booking flights for clients without contracting with aircraft operators directly

Each of these scenarios is addressed below.

Scenario 1: Travel and Logistics Service Providers Contracts with Aircraft Operators and Resells Services

In this scenario, the travel and logistics service providers **purchase air transport services from a carrier** and resell the combined services to the customer. This is common in both the freight forwarding and TMC industries. For instance, when a forwarder books space on a flight and invoices the shipper, or when a TMC builds and sells business travel packages.

The emissions associated with these services fall within the travel and logistics service provider's Scope 3 inventory, typically:

- **Scope 3 Category 4**: For freight-related transport and distribution (freight forwarders)
- **Scope 3 Category 6**: For business travel (travel management companies)

In this context, the travel and logistics service provider may co-claim SAFc alongside their corporate clients (i.e. corporate traveler or shipper) to reduce its own Scope 3 emissions, based on

- Mutual agreement
- Retirement records showing no duplication
- A registry that supports co-claiming

SAFc co-claiming should only be pursued if safeguards are in place to ensure claims are verifiable and unique. Specifically, travel management companies or freight forwarders and their co-claimants should use a registry that enables transparent and robust co-claiming.

Scenario 2: Travel and Logistics Service Provider Books Flights for Others Without Contracting Directly

In this scenario, the travel and logistics service provider provides **booking services only**, without contracting directly with the aircraft operator. The client — either a business traveler or freight shipper — pays the aircraft operator directly, while the travel and logistics service provider acts purely as a facilitator.

Since the travel and logistics service provider does not contract directly for the flight or assume financial responsibility, the emissions associated with the flight do not appear in the travel and logistics service provider's inventory. These emissions, and any associated SAFc claims, belong entirely to the client.

Travel and logistics service providers should not claim any portion of the emissions reduction in their own inventory unless they are the contracting party or air transport customer (see chapter on air transport customer persona).

5.1 Emissions Accounting

Inventory Boundary and Scope Allocation

Under Scenario 1, travel and logistics service providers should account for GHG emissions associated with the air transport services they resell. These emissions fall within Scope 3, under the following categories:

- **Scope 3, Category 4** – Upstream transportation and distribution (for freight-related services)
- **Scope 3, Category 6** – Business travel (for passenger-related services)

Emissions should be included when the travel and logistics service provider:

- Contracts directly with the aircraft operator
- Invoices the end customer for the transport service
- Assumes financial risk associated with the transport

If these conditions are not met, the travel and logistics service provider may fall under Scenario 2 (facilitator only) and should not include emissions in their inventory.

This section covers emissions accounting for travel and logistics service providers under Scenario 1 using the GHG Protocol five-step approach. While travel and logistics service providers may use any of the three GHG Protocol methods (fuel-based, distance-based, or spend-based), distance-based is the most commonly used and recommended method for both travel and logistics service providers, consistent with existing guidance from GLEC and the Smart Freight Centre.

The emission factor used in the calculation of SAF-related emissions should be based on consumption (mass and/or volume) and life cycle emissions of the SAF. The applicable LCA emission factor will vary depending on the underlying SAF feedstock and the conversion pathway.

Step 1. Identify and map emission sources to inventory

Freight forwarder:

Scope 3, Category 4: Upstream transport and distribution (outsourced fuel consumption by carriers for air freight services).

Travel Management Company:

Scope 3, Category 6: Business travel arranged by the travel and logistics service provider on behalf of clients, using air transport services purchased from carriers.

Step 2 and 3. Select a GHG emissions calculation approach, collect activity data and choose emission factor

Although travel and logistics service providers can use fuel-based, distance-based, or spend-based methods, the distance-based method is the most commonly used and widely accepted by the industry, as noted in GLEC and Smart Freight Centre guidance.

Activity data:

- Distance travelled, based on onboard systems or Great Circle Mapper
- Mass of shipment (for freight) or number of passengers and class of service (TMCs)

Emission factor:

- Default CORSIA LCA emission factor of conventional jet fuel baseline or jurisdiction-specific equivalent based on LCA

Default factors:

- Fuel efficiency (International Air Transport Association (IATA) RP1678 or EN 16258)
- Fuel intensity (IATA RP1678 or EN 16258)

Explanatory note for freight forwarders:

For freight forwarders, the distance-based method uses mass to quantify the amount of cargo transported or processed. Mass is selected due to its consistent application across the supply chain, and also because it is widely accepted in published methodologies.

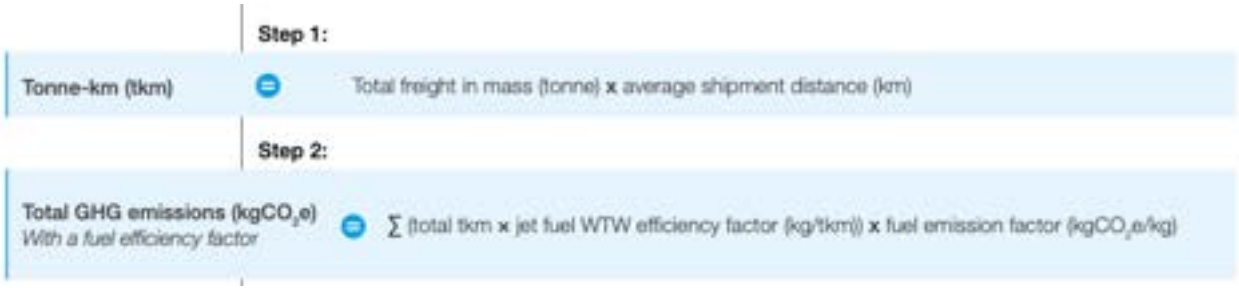
The distance a shipment is transported is measured from the point at which the shipper hands it over to the carrier and ends with the hand-over of the shipment to another carrier or the end receiver, for example, a household or another business.

For freight forwarders, note that while distance-based is the **GLEC prescribed and most commonly used method**, depending on the availability of activity data (fuel use or invoices for fuel purchase) and operational or jurisdictional guidelines, a freight forwarder can also use the fuel- or spend-based method.

For all three methodologies, calculation approaches should be in line with the **GHG Protocol and GLEC frameworks**.

Step 4. Apply calculation approach

Freight forwarder: Distance-based



Emissions = Distance (km) × Shipment Mass (kg) × Emission Factor (kg CO_2e / tonne-km)

Travel Management Company:

Emissions = Distance (km) × Passenger Count × Class-specific Emission Factor (kg CO_2e / pkm)

Step 5. Aggregate emissions data to the corporate level and roll up

The total emissions based on the applicable activity data should be summed for the reporting period to calculate distance-based emissions.

5.2 SAFc Accounting

To claim SAFc emissions outcomes to address their scope 3 aviation emissions, travel and logistics service providers should account for and report the emissions outcomes of their SAFc usage using one of two options (A or B), described below.

Option A: Calculate Reduction

Subtract the mass of CO_2e represented on the retired SAFc from scope 3 category 4 or scope 3 category 6 emissions. The CO_2e reductions represented by SAFc are based on the life cycle emissions of the SAF, relative to conventional jet fuel.

Each SAFc represents a CO_2e mass value explained in the equation below:

Option B: Calculate and Substitute Emissions Profile

Use the emissions profile of the SAF (in gCO2e/MJ) to calculate the total emissions profile of SAF per unit of activity data (e.g. converting MJ, as needed, to distance travelled). Separately from the physical inventory (e.g. in a parallel market-based emissions ledger), apply this emissions profile as a substitute for the physical inventory emissions factor, for the amount of SAF represented by the SAFc purchase (converting metric tons or other units, as needed, to distance travelled). Travel and logistics service providers should apply the full WTW emissions profile to their relevant scope 3 category emissions footprint.

For example, a logistics service provider purchases SAFc to address its emissions from facilitating air freight. The SAFc it purchases represents 100 MJ of biogenic SAF, with a WTW emissions profile of 15 gCO2e/MJ. To account for this, they would:

- *Convert 15 gCO2e/MJ to the unit they use for activity data emissions intensity in their physical inventory (e.g. tons of CO2e per t-km).*
- *Convert 100 MJ of SAF to the unit they use for activity data in each category (e.g. t-km)*
- *Apply the WTW SAF emissions factor in updated inventory activity units (e.g. tons of CO2e per t-km), substituting for the conventional jet fuel emissions factor used for the amount of SAF represented by the SAF certificates (e.g. 100 MJ, converted t-km), to scope 3 category 4.*
- *Report these total market-based emissions scope 3 category 4 separately from the physical inventory (either in a complete separate market-based emissions ledger or as a supplementary disclosure line item).*

5.3 SAFc Reporting

A public GHG emissions report for travel and logistics service providers retiring SAFc to reduce aviation-related emissions should include the following:

- **Total aviation emissions in Scope 3 Category 4 or 6**: Disclose total aviation-related emissions, using conventional jet fuel, on a full well-to-wake (WTW) basis within Scope 3 Category 4 (upstream transportation and distribution) or Category 6 (business travel), depending on the nature of services provided.

- **SAFc emissions outcomes:** Disclose the emission reductions (option A) or emissions profile and amount (option B) associated with purchased and retired SAFc.
- **Dual reporting:** Report both total aviation emissions and the total emissions outcomes associated with SAFc retired in a registry during the reporting year, separately.
- **Supporting documentation:** Reference registry retirement records substantiating SAFc claims (i.e., certificate IDs, retirement dates, associated fuel batch LCA data) and sustainability certifications.
- **Co-claim transparency:** When co-claiming SAFc alongside clients (e.g., shippers or corporate travelers), clearly specify:
    - The type of counterparty to the co-claim (e.g. a shipper), and name that beneficiary entity if possible
    - The scope and category where the co-claim is applied.

6. Airport

Airports serve as infrastructure hubs that facilitate aircraft operations, including fueling, takeoff, landing, and ground services. While they do not directly consume jet fuel or operate aircraft, they play a key role in enabling fuel logistics, hosting SAF blending and storage, and supporting the broader aviation decarbonization ecosystem.

Airports may choose to report indirect emissions associated with aircraft activities they enable. Specifically, airports may report emissions from aircraft fuel combustion that occurs within the airport boundary.

According to the *Airport Carbon Accreditation (ACA) Application Manual, Issue 14 (Dec 2023)*, airports at Level 3 and above are expected to quantify and report aircraft emissions associated with their infrastructure, such as emissions from landing, taxiing, takeoff, and auxiliary power units (APUs). At level 4 and above, airports are expected to report emissions from cruise-phase or full-flight operations.

These indirect emissions can be reduced through airport-facilitated use of sustainable aviation fuel (SAF), in addition to other efforts made to improve efficiency of landing/takeoff and taxiing movements, infrastructure and policies to reduce APU usage, and incentivization of more fuel-efficient aircraft that are not covered within the scope of the guidelines.

Optional Disclosure of SAF Co-benefits (Non-GHG Impacts)

While not counted toward GHG inventories, airports may also choose to qualitatively disclose non-GHG co-benefits of SAF use, including:

- Improved local air quality, such as reductions in NOx, SOx, and particulate matter from SAF combustion as compared to conventional jet fuel, due to lower presence of aromatics
- Lower contrail formation potential, which can reduce short-term radiative forcing under certain flight conditions

Note that unbundled SAFc purchases (e.g. SAFc purchases that do not represent SAF uplifted at the airport) cannot substantiate local non-GHG emissions or radiative forcing claims.

6.1 Emissions Accounting

Inventory Boundary

Airports should report fuel lifecycle emissions in Scope 3 Category 11 (Use of Sold Products).

Step 1. Identify and map emission sources to inventory

Airports may choose to include a portion or all of the following Scope 3 Category 11 sources:

- Aircraft emissions during the Landing and Take-off (LTO) cycle, including taxi-in/out, takeoff, and climb to 3000 feet (ACA Level 3 and above)
- Cruise-phase or full-flights emissions for flights departing the airport (ACA Level 4 and above only)
- Auxiliary power unit (APU) and engine testing emissions during ground operations
- Emissions from fuel sold to aircraft, if the airport or its fuel partner manages fuel service

Step 2. Select a GHG emissions calculation approach

LTO emissions:

Airports should use mode-based fuel flow modeling to calculate emissions during LTO cycle.

Cruise-phase or full-flight emissions:

Airport may use fuel-based or distance-based approach to estimate aircraft emissions. This should align with approaches outlined in the aircraft operator persona. Where available, airports may use actual or modeled fuel use data provided by aircraft operators.

Step 3. Collect activity data and choose emission factor

LTO emissions:

- **Activity data**:
    - Aircraft movement data (number/type of aircraft, engine, combustor configuration)
    - Actual time-in-mode for each aircraft phase (taxi, idle, take-off, climb)
    - Engine operation data (number of engines per aircraft type
- **Emission factors**:
    - Fuel flow rates per mode from ICAO engine databases[xx]
    - For cruise-phase or full-flights emissions from departing aircrafts, airport should use WTW LCA emission factors to capture upstream and combustion emissions of fuels.

Cruise-phase or full-flight emissions:

- **Activity data**:
    - Aircraft movement data and type (same as listed in LTO but with distance per route)
    - Flight distance data
    - Modeled fuel use based on aircraft type, payload and distance
    - Fuel uplift data, if representative (may need adjustment for multi-leg flights)
- **Emission factors**:
    - WTW LCA emission factors to capture upstream and combustion emissions of fuels.

Step 4. Apply calculation approach

LTO emissions:

Emissions = Fuel $Flow_{mode}$ × Time-in-mode x Emission Factor

Cruise-phase or full-flight emissions:

Emissions = Fuel Volume x Emission Factor

Airports should calculate total WTW aircraft emissions associated with Category 11 sources based on selected methodology.

Fuel uplift: Emissions=Fuel Volume × EF

SAF emissions outcomes = SAF Volume x (SAF EF – Conventional jet fuel EF) **(Option A)**

OR = SAF Volume × SAF EF **(Option B)**

Step 5. Aggregate emissions to corporate level

Emissions data should be aggregated across all relevant aircraft fueling and flight movement activity.

6.2 Emissions Reporting

If an airport chooses to report emissions under Scope 3 Category 11, its public emissions disclosure should include:

- Scope 3 Category 11 emissions from aircraft activity enabled by airport infrastructure

Optionally, airports may also choose to disclose, as applicable:

A qualitative description of the airport's role in facilitating SAF deployment (e.g., on-site blending, fueling logistics, registry partnerships), without making emissions reduction claims

- A narrative on co-benefits of SAF, such as:
    - Local air quality improvements (e.g., reduced NOx or particulate matter)
    - Reduced contrail formation and effective radiative forcing from SAF use

7. Aircraft Lessor

Aircraft lessors provide aircraft to operators through leasing arrangements. The emissions accounting and use of SAF certificates (SAFc) differ based on whether the lease is **dry** (lessee controls operations) or **wet** (lessor maintains operational control, including crew and fuel use).

- In a **dry lease**, the lessee (typically an airline) is responsible for fuel procurement, operations, and associated emissions. The lessor holds no direct control over fuel use and therefore does not report fuel combustion emissions from the aircraft.
- In a **wet lease**, the lessor has operational control of the aircraft on behalf of a third party and is directly responsible for fuel use. In this case, the lessor should account for upstream fuel and combustion emissions.

This section provides accounting and reporting guidance for dry leases. In wet lease scenarios, the lessor should follow the aircraft operator persona for full accounting and reporting guidelines.

7.1 Emissions Accounting

Step 1. Identify and map emission sources to inventory

For dry lease arrangements, aircraft lessors should include emissions from jet fuel combustion and upstream fuel lifecycle by aircraft leased to third parties in their GHG inventory:

- **Scope 3, Category 13** – Use of downstream leased aircraft

Step 2. Select a GHG emissions calculation approach

Aircraft lessors should use a **fuel-based method**, informed by:

- If available, lessee-provided flight or fuel use data
- Modeled utilization patterns (e.g., flight hours, sectors, typical missions)
- Aircraft type and fuel burn rates

Step 3. Collect activity data and choose emission factor

- Activity data:
    - Number of aircraft under lease
    - Aircraft type and expected utilization rates, informed by lessee data or fleet performance databases
    - Lessee-provided fuel burn or flight hour data, if available
- Emission factors should use:
    - Standard WTW values for conventional jet fuel (e.g., CORSIA defaults)
    - Supplier-specific LCA values if SAF is included

Step 4. Apply calculation approach

Category 13 Emissions = ∑ (Units leased × Estimated annual fuel use per unit × Emission factor)

Step 5. Aggregate emissions to corporate level

Emissions should be aggregated across all applicable dry leases and categorized as Scope 3 Category 13.

7.2 SAFc Accounting

Aircraft lessor may co-claim emissions outcomes from SAFc alongside other organizations with other roles in the aviation value chain, if appropriate (see co-claim scenarios in introduction section).

7.3 SAFc Reporting

A public GHG report for an aircraft lessor co-claiming SAFc emissions outcomes should include:

- **Scope 3 Category 13:** Disclose total emissions from the use of leased aircraft on a full well-to-wake (WTW) basis, calculated using conventional jet fuel.
- **SAFc emissions outcomes:** Disclose the emission reductions (option A) or emissions profile and amount (option B) associated with purchased and retired SAFc.
- **Dual reporting:** Report both total aviation emissions and the total emissions outcomes associated with SAFc retired in a registry during the reporting year, separately.
- **Supporting documentation**: Reference the registry retirement records of the SAFc (i.e., certificate IDs, retirement dates, associated fuel batch LCA data), proof of sustainability certification (e.g., RSB, ISCC).

- **Co-claim transparency:** When co-claiming SAFc alongside partners (e.g., business travelers), companies should further specify:
    - The type of counterparty to the co-claim (e.g. a business traveler), and name that beneficiary entity if possible
    - The scope and category where the co-claim is applied

8. Financial Institution

Financial institutions (FIs) support the aviation sector through capital, loans, or other types of investment for aircraft operators. While they do not own or operate commercial aircraft, they may maintain indirect influence over aviation-related emissions through their portfolios and capital allocations. Some financial institutions may own and operate private aircraft for their own business travel use. In this case, companies should reference the Aircraft Operator persona.

These guidelines provide a pathway for FIs to account for and report financed emissions from investment in aircraft operators.

8.1 Emissions Accounting

Inventory Boundary

Financial institutions may include the following emission sources in their inventory:

- Scope 3 Category 15: Financed emissions from loans, leases, or investments in aviation entities (e.g., airlines, cargo operators, aircraft assets)

The calculation boundary and attribution method should follow relevant guidance, such as:

- PCAF Global GHG Accounting and Reporting Standard for the Financial Industry
- GHG Protocol Scope 3 Standard, Category 15: Investments

Step 1. Identify and map emission sources to inventory

- Scope: Scope 3, Category 15 – Financed emissions from aviation-related loans, leases, or equity holdings
- Emission source: Jet fuel combustion and upstream fuel lifecycle emissions from financed aircraft operators or assets
- Boundary: All relevant aviation clients or assets financed in the reporting year

Step 2. Select a GHG emissions calculation approach

FIs should use a proportional emissions attribution method, such as:

- Share of total emissions from the borrower/operator (e.g., from CDP or company reports)
- Modeled emissions based on fuel use, flight hours, or aircraft type
- Default emissions factors (e.g., ICAO CORSIA) where specific data is not available

PCAF provides formulas and allocation guidance for each asset class.

Step 3. Collect activity data and choose emission factor

Data Type	Source
Financed emissions	Borrower emissions reports, modeled aircraft usage, PCAF or SBTi tools
Aviation activity data	Aircraft utilization, fuel use, or modeled flight data
SAFc attribution	Registry documentation, co-claim agreement with borrower
Emission factors	Supplier-specific or default LCA values (e.g., CORSIA)

Step 4. Apply calculation approach

Financed Emissions = Financed share (%) × Total aviation emissions of borrower

Step 5. Aggregate to corporate level

Aggregate financed emissions across all relevant aviation-related assets and portfolios.

8.2 SAFc Accounting

FIs may account for emission reductions from SAFc indirectly, in proportion to financed share of an aviation entity's SAFc retirement.

$$\text{SAFc Emissions Outcome}_{FI} = \text{Financing Share (\%)} \times \text{Borrower's SAFc Outcome } (tCO_2e \text{ or } tCO2e/\text{activity unit})$$

8.3 SAFc Reporting

A public GHG report for a financial institution claiming emission reductions from SAFc should include:

- **Scope 3 Category 15:** Disclose total financed aviation emissions, using conventional jet fuel, on a full well-to-wake (WTW) basis.
- **SAFc emissions outcomes:** Disclose the emission reductions (option A) or emissions profile and amount (option B) associated with purchased and retired SAFc.
- **Dual reporting:** Report both total aviation emissions and the total emissions outcomes associated with SAFc retired in a registry during the reporting year, separately.
- **Supporting documentation**: Reference the registry retirement records of the SAFc (i.e., certificate IDs, retirement dates, associated fuel batch LCA data), proof of sustainability certification (e.g., RSB, ISCC).
- **Co-claim transparency:** When co-claiming SAFc alongside borrowers, financial institutions should further specify:
    - The type of counterparty to the co-claim (e.g. a logistics service provider), and name that beneficiary entity if possible
    - The scope and category where the co-claim is applied

9. Original Equipment Manufacturer (OEM)

Original Equipment Manufacturers (OEMs) design, manufacture, and sell aircraft and engines that will be operated by other entities over their lifetime.

Although OEMs do not commercially operate aircraft, they engage in fuel-based activities (i.e. research & development, engine testing, flight demonstration, aircraft delivery) that generate fuel combustion and upstream fuel lifecycle emissions. In this scenario, OEM should follow the aircraft operator persona.

Similarly, emissions associated with employee business travel should be accounted for and reported following air transport customer (corporate traveler) persona.

This section focuses exclusively on OEMs accounting for and reporting use-phase emissions from the use of sold aircraft and aircraft components, which may be included in the company's indirect emissions reporting to reflect the downstream impact of the OEM's products.

9.1 Emissions Accounting

Inventory Boundary

For OEMs choosing to report downstream emissions, the relevant inventory category is:

- **Scope 3 Category 11:** Downstream emissions from the use of sold aircraft

Emissions from the use of sold aircraft and engines should be calculated based on each aircraft or engine's lifetime fuel consumption and life cycle emissions of conventional jet fuel. This calculation reflects the expected operational emissions of products sold in the reporting year, following the Scope 3, Category 11 guidance from the GHG Protocol.

Step 1. Identify and map emission sources to inventory

- Scope 3, Category 11 – Use of Sold Products
- Emission source: Jet fuel combustion and upstream fuel lifecycle emissions from aircraft or engines sold by the OEM and used by downstream customers (e.g., airlines) during the expected lifetime of the product.

- Boundary: Covers all units sold in the reporting year and their expected lifetime emissions from conventional jet fuel use based on modeled assumptions.

Step 2. Select a GHG emissions calculation approach

OEMs typically do not have direct fuel consumption data from their customers (aircraft operators). Instead, they apply technical use-phase modeling to estimate lifetime fuel use for each product sold. This modeling may include:

- Simulated or tested fuel burn per flight hour or cycle
- Assumptions for annual utilization and years in service

Differentiation by aircraft or engine type, emission profile, and operator class (e.g., commercial, cargo)

Step 3. Collect activity data and choose emission factor

- Activity data (by aircraft or engine type):
    - Number of units sold during the reporting year
    - Expected years in service
    - Average annual fuel consumption, estimated through:
        - modeled flight hours × fuel burn rate
        - real-world operational benchmarks
- Emission factor:
    - Use well-to-wake (WTW) life cycle emission factors for conventional jet fuel

Step 4. Apply calculation approach

Category 11 Emissions = ∑ (Number of units sold × Estimated lifetime fuel use per unit × Emission factor)

OEMs should report the full WTW emissions associated with the product's expected use-phase.

Step 5. Aggregate emissions to corporate level

OEMs should sum all Scope 3 Category 11 emissions from aircraft sold during the reporting period.

9.2 SAFc Accounting

OEMs may attribute a portion of SAFc emissions outcomes under Scope 3 Category 11 (Use of sold products) when:

- Aircraft operators using their products have purchased and retired SAFc in a registry;
- The OEM has established a transparent, mutually agreed co-claim arrangement with the operator or lessor; and
- The OEM's claim reflects its distinct role in the aviation value chain and does not duplicate claims by the fuel user.

OEMs may attribute a proportional share of the operator's or lessor's SAFc outcomes using the following equation:

SAFc Outcomes = Product Utilization Share (%) × Operator's SAFc Outcomes (tCO_2e or tCO2e/amount of activity)

9.3 SAFc Reporting

A public GHG report for an OEM claiming emissions outcomes from SAFc should include:

- **Scope 3 Category 11:** Disclose total use-phase emissions from sold aircraft and engines, using conventional jet fuel, on a full well-to-wake (WTW) basis.
- **SAFc emissions outcomes:** Disclose the emission reductions (option A) or emissions profile and amount (option B) associated with purchased and retired SAFc.
- **Dual reporting:** Report both total aviation emissions and the total emissions outcomes associated with SAFc retired in a registry during the reporting year, separately.
- **Supporting documentation**: Reference the registry retirement records of the SAFc (i.e., certificate IDs, retirement dates, associated fuel batch LCA data), proof of sustainability certification (e.g., RSB, ISCC).
- **Co-claim transparency:** When co-claiming SAFc alongside partners, companies should further specify:
    - The type of counterparty to the co-claim (e.g. an aircraft lessor), and name that beneficiary entity if possible
    - The scope and category where the co-claim is applied.

Key Recommendations and Next Steps

The SAFc ecosystem continues to grow and evolve as stakeholders across the aviation value chain gain experience implementing book and claim systems and integrating SAFc into climate reporting and procurement practices.

As global standards such as the GHG Protocol and the SBTi continue to advance guidance on accounting and reporting the use of market-based instruments and book and claim systems, this document will continue to evolve to remain aligned with those frameworks and broader climate disclosure practices.

The key recommendations made in these guidelines are:

- All users of SAF and SAFc should account for and report their use – as well as their use of conventional jet fuel – on a well-to-wake basis. Accounting for the life cycle emissions of both conventional jet fuel and SAF with the same full life cycle scope will enable every actor to compare the lifecycle emissions of these fuels more holistically and accurately.
- The emissions outcomes associated with SAF certificates should be reported separately from, but in reference to, the specific scopes and categories where they account for aviation emissions (Scope 1 for aircraft operators, Scope 3 Category 6 for corporate travelers, Scope 3 Category 3 and 4 for freight forwarders and shippers, etc).
- Companies may either account and report for SAFc emissions outcomes by estimating total emissions reductions (Option A), or by substituting in SAF emissions profiles into their aviation activity data to estimate total market-based emissions (Option B).

Next steps

These guidelines reflect the continued growth of the SAFc ecosystem, which is shifting from early adoption toward broader implementation. The next phase of work will focus on strengthening consistency, transparency, and alignment as organizations across the aviation value chain increasingly apply these accounting and reporting principles in practice.

Future updates to this document will integrate lessons learned from implementation and ensure continued alignment with evolving global standards, including forthcoming guidance from the GHG Protocol, the Science Based Targets initiative (SBTi), and other critical frameworks.

Progress to scale SAF through SAFc will depend on sustained collaboration across the entire value chain—fuel producers and suppliers, aircraft operators, airports, lessors, original equipment manufacturers (OEMs),

financial institutions, travel and logistics service providers, corporate customers, registry operators, and standard setters. Together, these actors can refine common practices, build interoperability across systems, and strengthen assurance and verification processes that underpin trust in SAFc claims.

Ultimately, these guidelines aim to foster a shared, credible foundation for how SAF and SAFc accounting and reporting can be applied consistently and transparently, to support investment, accelerate adoption, and advance global progress toward net-zero aviation.

Appendix 1: SAF and SAFc Supplemental Concepts

A1.1 SAF and SAFc Sustainability Criteria

The environmental attributes of SAF are certified at a facility level under mass balance sustainability certification schemes (SCS) throughout SAF supply chains. These SCSs or standards are currently held by the RSB[xxi] and the International Sustainability and Carbon Certification (ISCC) system[xxii]. These SCSs define sustainability criteria that are checked by accredited third-party auditors. Auditors certify facilities throughout SAF supply chains against these SCSs, evaluating the environmental attributes of the feedstocks and produced, transported and blended fuels. Certification to any of these SCSs can substantiate a SAF certificate. These certifications define and verify the environmental attributes of SAFc.

ISCC and RSB hold a range of certification standards. Some of these are approved under specific regulations, such as the ICAO's CORSIA and the EU's renewable energy directive (RED) standards. Others, including ISCC PLUS and RSB global standards, are designed to support the broader SAF market.

In addition to SCS certification, many SAFc buyers have indicated a preference that SAF should achieve, at minimum, a 60% life cycle CO_2e (carbon dioxide equivalent) emissions reduction relative to conventional jet fuel to substantiate a certificate. This threshold was proposed by the CST coalition in its 2021 SAFc framework[xxiii] and also set out in the SABA's sustainability framework[xxiv]. This reduction threshold does not consider non-Kyoto Protocol GHGs[xxv]. Most of today's SAF meets this life cycle emissions reduction threshold. Importantly, SAF production actors should be mindful of broader sustainability considerations, including potential impacts on food systems, land use, and production emissions.

SAF constitutes a very small percentage of global aviation fuel use today. Therefore, using a conventional jet fuel baseline like CORSIA's default value of 89 grams of CO_2e per megajoule (gCO_2e/ MJ) or a jurisdiction-specific equivalent to determine the effective emissions reduction from the use of SAF accurately represents the impact of SAF and SAFc usage in emissions accounting and reporting.

In the future, when SAF will constitute a higher percentage of global aviation fuel usage, this baseline may need to be revised to account for the baseline share of SAF in the fuel mix, likely differentiated by voluntary and mandated SAF in different jurisdictions. Mixed baselines may ultimately allow users of SAF and SAFc to more accurately account and report emissions reductions and should be the subject of future analysis.

A1.2 SAFc Registries

Registries are the core piece of infrastructure for implementing SAFc. They record the issuance, transfer and retirement of certificates, ensuring that environmental attributes are unique, traceable and not double counted.

SAFc can be issued in a registry to a fuel supplier after the neat SAF is blended with conventional jet fuel. Then, any given SAFc can be transferred to and retired by aircraft operators and air transport customers. Aircraft operators can claim SAFc either when bundled with or when unbundled from the physical fuel volume. SAFc can then be claimed towards climate disclosure once retired. When the attributes are unbundled, the physical fuel should be sold as conventional jet fuel to avoid double counting.

As the market grows, a variety of registries have emerged with different governance structures, technical functionality and degrees of oversight. Consistent alignment with shared principles will be critical to maintain integrity and interoperability across systems. The Book and Claim Community's *Principles and Best Practices for Book and Claim Systems in Heavy Transport* provide useful guidance for credible registry criteria.[xxvi]

The accounting and reporting guidelines do not prescribe how registries should function or be governed. Instead, this document has identified the following two key interactions that connect registries with these accounting and reporting guidelines:

1) Alignment of timeline across physical SAF blending and delivery, SAFc issuance, transfer and retirement in a registry, and emission reporting.
2) Translation of SAFc data from a registry into GHG inventories and public disclosures.

Further recommendations on these two elements are provided in Appendix 2.

A1.3 Prevent Double Counting

Double counting occurs when the same environmental attribute or emission reductions from a given unit of physical SAF is claimed more than once. In practice, this may take place through:

- Double issuance, when multiple certificates are created representing the same physical SAF
- Double selling, when the SAF attributes are sold multiple times (e.g. if the physical fuel and the linked SAF certificate are both sold with attributes)

- Double claiming, when more than one entity claims the same certificate[4] Double use, when a single entity applies the same certificate towards multiple purposes

These guidelines define persona-specific claim eligibility and scenarios to support consistent and transparent treatment of SAF and SAFc. However, additional safeguards across the broader system are necessary to fully prevent double counting. Some best practices include:

- Suppliers should sell physical fuel as conventional jet fuel in contract terms when SAF environmental attributes are unbundled from the physical SAF
- Suppliers should ensure – for instance through an independent audit – that they have adopted internal recordkeeping protocols to avoid double selling
- Registries should ensure that each certificate is uniquely issued within their own system, and should work to coordinate across systems to identify cases of double issuance between registries
- Entities making claims should verify that reported SAFc claims correspond to certificates retired by them or on their behalf, supported by transparent documentation or third-party assurance.

A1.4 Additionality

The concept of additionality - ensuring that claimed emissions reductions would not have occurred without the intervention – is an important consideration in the context of SAF and SAFc. As these guidelines focus on voluntary emission accounting and reporting, additionality plays a central role in the credibility of voluntary climate disclosures.

These guidelines do not prescribe specific rules or tests for additionality, but users may consider two commonly referenced approaches. Regulatory additionality focuses on whether SAF supply goes beyond existing compliance or policy requirements. Financial additionality considers whether the SAFc transaction contributes new or incremental funding to SAF production. These approaches can help inform how stakeholders interpret credibility of SAFc claims.

To strengthen transparency and build market trust, SAFc users are encouraged to

- Establish a shared understanding of, and any requirements for, additionality through their contractual agreements

[4] Co-claiming, where two or more entities have distinct roles and claims on the same SAF volume, is permitted under defined conditions and does not constitute double claiming. See section 1.4 SAFc Reporting for further guidance on Scope 3 co-claiming scenarios.

- Disclose whether SAFc claims are associated with SAF used for regulatory compliance such as incentives and obligations.
- Align with emerging best practices from the SAFc community, such as SABA's atmospheric benefit principle[xxvii].

A1.5 SAF and Global Effective Radiative Forcing

Air transport impacts global climate in other ways than through its direct CO_2 contribution. While CO_2, N_2O and CH_4 are known to be the main contributors to aviation emissions, their contribution to the global effective radiative forcing (ERF) is estimated to be only a fraction – approximately half[xxviii] – of the industry's total impact.

Emerging research indicates that other emissions from jet engine combustion at cruising altitude can cause further global warming beyond the impact of GHGs. For example, particulate matter has been linked with contrail-induced cirrus clouds that form in ice supersaturated regions (ISSR). Particulate matter can trap heat from the earth's surface in certain atmospheric conditions.

However, GHG emissions, in particular CO_2 emissions during air operations, are the only ones that are directly proportional to the fuel burned during flight operations. The total climate impact of non-GHG emissions from aviation is significant and very uncertain.

A scientific publication[xxix] estimates that while the impact of non-GHG emissions from aviation was about 66% of the aviation net ERF in 2018, the range of uncertainty of this impact is eight times higher than that of CO_2 alone. A European Council report[xxx] also indicates, "the nature of ERF, in any form, is 'backward looking' and informs on the current perturbation of the radiation budget from historical and current-day emissions". It goes on further to suggest that ERF does not inform on potential future changes, and neither does it provide any direct emission equivalence on the climate impact of GHG and non-GHG emissions. For this reason, the European Council report concluded that while ERF is relevant for understanding science, it is not suitable for direct use in regulation that considers emissions equivalency.

In view of the above and in line with the SBTi aviation sector guidance, these guidelines focus exclusively on the impact of Kyoto GHG emissions for SAF accounting as there is even less scientific certainty about SAF's impact on radiative forcing than there is for conventional jet fuel. When scientific uncertainties associated with non-GHG emissions are resolved, these guidelines should be revisited to reflect these impacts on SAF accounting and reporting.

Some companies are starting to factor radiative forcing effects into their air transport inventories today to capture their climate impacts as accurately as possible. This is a commendable practice.

Appendix 2: SAFc Units and Conversions

In these guidelines, a SAF certificate (SAFc) is defined as representing the environmental attributes of one metric tonne of neat (unblended) SAF. However, in practice, different registries, programs, and users may encounter variability in how SAFc units are denominated, tracked, and applied to emissions accounting.

This appendix explains what SAFc unit variability means and how to convert between mass, energy and emissions when preparing GHG inventories.

A2.1 Mass vs Energy vs Emissions

Unit Type	Typical Use in SAFc Systems	Notes
Mass (tonne SAF)	Denomination of the SAFc certificate	One certificate = 1 metric tonne of neat SAF
Energy (MJ)	Used in LCA and emissions calculations	Energy content varies by fuel type
Emissions (kg CO_2e)	Used in emissions inventories and reporting claims	Depends on LCA value of SAF batch
Volume (litres or gallons SAF)	Sometimes used in registries as an alternative unit	Should be converted to mass or energy for consistency, density varies by fuel type[5]

A2.2 Unit Conversions Example

Assume a batch of HEFA SAF made from used cooking oil has a WTW life cycle emissions factor of 20 gCO_2e/MJ, compared to 89 gCO_2e/MJ for conventional jet fuel (CORSIA default). Each kilogram of SAF contains ~43 MJ of energy.

[5] While all SAF must meet energy density specifications to ensure drop-in equivalence with Jet A/Jet A-1, slight variations in density and energy content may occur between production pathways. For more information, see *Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons*, ASTM International, West Conshohocken, PA, 2024. Available at: https://www.astm.org/d7566.html

Step-by-step:

1) 1 tonne of SAF = 1,000 kg
2) 1,000 kg × 43 MJ/kg = 43,000 MJ
3) Conventional jet fuel emission baseline = 43,000 MJ × 89 gCO_2e/MJ = 3.83 t CO_2e
4) SAF emissions = 43,000 MJ × 20 gCO_2e/MJ = 0.86 t CO_2e
5) Emissions reduction = 3.83 – 0.86 = 2.97 t CO_2e per SAFc

In this example, one SAFc corresponds to a reduction of 2.97 tonnes of CO_2e.

Appendix 3: Registry Timeline Alignment and Data Consistency

A3.1 Role of a SAFc Registry

A SAFc registry is a digital system that records the issuance, transfer, and retirement of sustainable aviation fuel certificates (SAFc). Registries play a critical role in maintaining the environmental integrity of the SAFc system by ensuring that:

- Each certificate is issued once, based on verified SAF production
- Certificates are traceable to a specific batch of fuel
- Each certificate is retired, confirming that a specific beneficiary can claim or co-claim (by entities with eligible, distinct roles) environmental attributes
- Transfers and retirements are documented and auditable

Registries function as the **system of record** for SAFc claims and are essential for preventing double counting, enabling market transparency, and supporting credible corporate disclosure.

A3.2 Disclosure Timing and Registry Interaction

SAFc claims are most credible when they are both retired in a registry and timely (linked to actual emissions reductions). To support this, these guidelines emphasize two key principles

- Emissions disclosure should follow SAFc retirement in a registry
- Disclosure should align as closely as possible with when SAF was physically delivered and combusted.

However, in practice, the SAF supply chains and registry processes can introduce timing complexity. Registry rules, supplier timelines and reporting cycles may not always align neatly.

The table below outlines two common timing misalignments and how to manage them:

Scenario	Potential causes	Best Practice
SAF delivery in year 1, SAFc retirement in year 2	Registry issuance delay, documentation processing, SAFc transfer delay	Report in year 2; disclose the year 1 delivery date in inventory notes
SAFc retirement in year 1, SAF used in year 2	Lag in fuel blending or uplift, early retirement	Report in year 2 when SAF is delivered; if reporting in year 1, clearly explain timing and risk in disclosure

Users should maintain documentation, including registry retirement records and fuel delivery information when available to support alignment and auditability.

A3.3 Translating Registry Data into Inventory Accounting and Reporting

To ensure consistent, accurate and verifiable emissions reporting, SAFc users should translate registry data into inventory disclosures using standardized data points. While data fields and formats may vary across registries, the following elements are essential to support credible accounting claims:

Data Field	Use in Reporting
Certificate ID & Batch ID	Links each SAFc to a specific registry record and physical fuel batch
Retirement date	Anchors the claim to the appropriate reporting year
SAF mass (or volume)	Basis for calculating emissions reductions per SAFc
Energy content (MJ, if available)	Supports conversion to energy-based metrics when needed

SAF LCA value (g CO_2e/MJ)	Used to calculate emissions reductions relative to baseline fuel
Conventional jet fuel LCA value (gCO2e/MJ)	Used to calculate emissions reductions as comparator for SAF LCA value
Sustainability certification	Confirms that the sustainability criteria of the SAF that form the basis for SAFc attributes have been assessed by an auditor
Additionality declaration	Confirms if the SAF is being used towards regulatory requirements (incentives, obligations or other programs)

These guidelines recommend users to:

- Retain retirement confirmation and batch-level metadata (including certificate ID, LCA data, and delivery documentation) in your audit trail
- Ensure Scope 1 vs. Scope 3 claims allocation is clearly supported by SAFc documentation and persona-specific guidance
- Align SAFc retirement with your GHG reporting year where feasible
- Refer to Appendix 1 for guidance on calculating emissions reductions per SAFc using energy content and LCA data

Appendix 4: Sample Calculations

A Sustainable aviation fuel (SAF) supplier sample calculation using corn oil and hydro-processed esters and fatty acids (HEFA) pathway

SAF life cycle emissions are calculated as the sum of the "core life cycle assessment (LCA)" and the estimated induced land use change (ILUC) emission values.

Total SAF life cycle emissions = Core LCA values (gCO_2e/MJ) + ILUC emissions values (gCO_2e/MJ)

SAF core LCA values = EF (cultivation) x kg of feedstock + EF (harvesting and collecting) x kg of feedstock acquired + EF (processing and extraction) x kg of feedstock + EF (feedstock transportation) x (kg of feedstock x distance) + EF (fuel production) x kg of SAF + EF (SAF transport and distribution) x (kg of SAF x distance)

Data used:	
Mass of corn oil purchased by the SAF supplier	1,000 tonnes or 1,000,000 kg
LCA values for corn oil based on MIT-GREET model[xx]	
Feedstock cultivation and collection	0.0025 $kgCO_2e/MJ$
Feedstock transport	0.0005 $kgCO_2e/MJ$
Feedstock to fuel conversion	0.014 $kgCO_2e/MJ$
Fuel transport	0.0005 $kgCO_2e/MJ$
Midpoint carbon intensity value	0.0172 $kgCO_2e/MJ$[xi]
Corn oil ILUC LCA value[xii]	0
Combustion emission factor (For biomass-derived fuels, CO_2 emissions from fuel combustion are assumed to be offset, therefore counted as zero in the LCA of SAF)	0
Energy density/content by mass of hydro-processed oil of biomass origin, to be used for replacement of jet fuel[xi]	44 MJ/kg

Calculating GHG emissions for SAF suppliers

Corn oil purchased kg	Feedstock cultivation and collection $kgCO_2e/MJ$	Feedstock cultivation and collection $kgCO_2e/kg$	Emissions $kgCO_2e$
1,000,000	0.0025	0.11	110,000
Corn oil purchased kg	**Feedstock transport gCO_2e/MJ**	**Feedstock transport $kgCO_2e/kg$**	**Emissions kg CO_2e**
1,000,000	0.0005	0.022	22,000
Corn oil purchased kg	**Feedstock to fuel conversion gCO_2e/MJ**	**Feedstock to fuel conversion $kgCO_2e/kg$**	**Emissions $kgCO_2e$**
1,000,000	0.014	0.616	616,000
Corn oil purchased kg	**Fuel transport gCO_2e/MJ**	**Fuel transport $kgCO_2e/kg$**	**Emissions $kgCO_2e$**
1,000,000	0.0005	0.022	22,000
Fuel transported kg		**Fuel combustion $kgCO_2e/kg$**	**Emissions $kgCO_2e$**
1,000,000		0	0
		Total LCA emissions	**770,000**

Note: LCA values are converted from $kgCO_2e/MJ$ to $kgCO_2e/kg$ by multiplying the former with the energy density/content of SAF in MJ/kg.
For example: 0.0025 $kgCO_2e/MJ$ X 44 MJ/kg = 0.11 $kgCO_2e/kg$

B Airline sample calculation using total SAF WTW emissions using the Fischer-Tropsch pathway

Total SAF WTW emission = Scope 1 combustion emission (LCA based TTW emission factor or approved LCA values: $kgCO_2e/kg$) x SAF consumption (kg) + scope 3 category 3 emission (LCA based WTT emission factor or approved LCA values: $kgCO_2e/kg$) x SAF consumption (kg)

Data used:	
Type of SAF consumed	Agriculture residue
Total SAF consumed during reporting period	1,000,000 tonnes or 1,000,000,000 kg
Agriculture residue GHG intensity[a]	0.0077 $kgCO_2/MJ$[a]
Energy density (energy content) by mass	44 MJ/kg
Agriculture residue emission factor (WTT) (Agriculture residue emission factor (WTT) = agriculture residue GHG intensity x energy density (energy content) by mass)	0.34 $kgCO_2e/kg$
Combustion emission factor (TTW)	0

Calculating GHG emissions for airline using SAF

SAF consumption (kg)	Emission factor (TTW) $kgCO_2e/kg$ (a)	SAF TTW emissions ($kgCO_2e$)
1,000,000,000	0	0
SAF consumption (kg)	**Emission factor (WTT) $kgCO_2e/kg$ (b)**	**SAF WTT emissions ($kgCO_2e$)**
1,000,000,000	0.34	340,000,000

SAF WTT emissions (tCO_2e)*	SAF TTW emissions (tCO_2e)	SAF WTW emissions (tCO_2e)
340,000	0	340,000

* Unit conversion from tonne to kg (1 t = 1000 kg)

C Corporate traveller sample calculation using the distance-based method

Example of distance-based emissions calculation approach based on the applicable well-to-wake emission factor.

The method uses the applicable secondary emission factor of conventional jet fuel denominated in passenger kilometres ($kgCO_2e/p\text{-}km$).

∑ (Distance per air travel (short, medium and long haul + travel class) + applicable WTW jet fuel emission factor ($kgCO_2e/p\text{-}km$)

Data used to calculate emissions from corporate traveller flying from London Heathrow (LHR) to Rome Fiumicino Airport (FCO) using BEIS emission factor

Distance as per Great Circle Mapper	1,446 kilometers
BEIS sourced WTT emission factor from short-haul flights to and from the UK	
WTT	0.01681 $kgCO_2e/p\text{-}km$
TTW	0.01681 $kgCO_2e/p\text{-}km$
WTW	0.17034 $kgCO_2e/p\text{-}km$

Travel activity (km)	WTW emission factor ($kgCO_2e/p\text{-}km$)	Total WTW emissions ($kgCO_2e$)
1,446	0.17034	246

D Example calculation of SAFc accounting and reporting treatment

To calculate the total scope 3.6 emissions of the corporate traveller for the reporting period, the total WTW emissions of each air business travel are calculated and summed up.

In the below example, it is assumed that employees of the reporting company travelled twice for business during the reporting period.

Flight	Associated jet A energy (MJ)	CORSIA based energy intensity ($kgCO_2e$/MJ)	Total emissions including WTW ($kgCO_2e$)
LHR-FCO	2,875	0.089	0.256
LHR-JFK	13,504	0.089	1,202
			1,458

In order to account for and report its air travel-related scope 3.6 emissions inventory, the corporate traveller in this example subtracts their business travel emissions by 0.75 t CO_2e represented by the retired SAFc.

Total emissions including WTW (tCO_2e) during the reporting period	tCO2e representation in the retired SAFc	Scope 3.6 emissions (tCO_2e) during the reporting period
1.4578*	0.75	0.708

*1 t/kt conversion from tonne to kg (1 t = 1000 kg)

The same calculation applies to any other "persona", for example, airlines or businesses using private jets, purchasing and retiring SAFc via the book and claim system, although the scope will vary.

E Corporate traveller sample calculation using the fuel-based method

Data used to calculate fuel-based emissions for corporate traveller flying from LHR to JFK	
Fuel consumed during flight from London Heathrow (LCR) to John F. Kennedy International Airport (JFK)	70,000 litres (approximation)
CORSIA default conventional jet fuel LCA baseline	0.089 $kgCO_2e$/MJ
Jet A fuel density by volume	0.820 kg/litres
Jet A fuel energy content by volume	35.4 MJ/litre
Jet A LCA emission factor (volume)**	WTW 3.20 $kgCO_2e$/litre jet fuel

Corporate travel emissions calculated using CORSIA default conventional jet fuel LCA baseline:

∑ (quantity of fuel consumed (litres)) × jet fuel energy content (MJ/litres) × CORSIA baseline emission factor of the fuel (e.g. $kgCO_2e$/MJ)

Fuel (litres)	Jet A fuel energy density (MJ/litre)	CORSIA baseline ($kgCO_2e$/MJ)	Total WTW emissions ($kgCO_2e$)
70,000	35.4	0.089	220,542

Corporate travel emissions calculated using jet A LCA emission factor:

∑ (quantity of fuel consumed (litres)) × jet fuel density (kg/litres) × emission factor of the fuel (e.g. $kgCO_2e$/litre)

Fuel (litres)	LCA emission factor jet A ($kgCO_2e$/litre)	Total fuel-based emissions ($kgCO_2e$)
70,000	3.20	224,000

The data required to accurately estimate emissions with the fuel-based method is not always readily available. Hence the fuel-based method, despite being most accurate, is currently not practicable.

The fuel-based method may become more suitable when the requisite datasets become accessible. Therefore, these guidelines provide the reader with a sample fuel-based calculation approach.

Step-by-step calculation guide for corporate traveller emissions accounting

Distance-based method	km x DEFRA EF $kgCO_2e$/km = $kgCO_2e$
Fuel-based method	L (fuel) x density kg/L = kg
	kg x energy content MJ/kg = MJ
	MJ x $kgCO_2e$/MJ = $kgCO_2e$

Appendix 5: Substitution Accounting and Reporting Approach

These guidelines outline two accounting approaches that can be used to accurately account and report the emissions outcomes of SAFc to address aviation emissions in a company's inventory. These options are both valid because their total emissions outcomes are equivalent, just reported in different ways. While Option A is simpler (and precedented from version 1 of these guidelines), Option B may be a better option for organizations seeking to align more closely with the GHG Protocol and SBTi direction of travel, and those already investing in and reporting the emissions outcomes of other market-based instruments to address their emissions footprint across other activities beyond aviation.

Option A takes a subtraction accounting approach to estimate the emissions reduction impact of any given volume of SAF supported through a SAF certificate relative to conventional jet fuel. This estimated emissions reduction is then reported separately from, but in reference to a specific scope and category of aviation emissions.

While simple and accurate, this method does not necessarily address all use cases, and in particular:

- Optically, subtraction may not appear to be a fully attributional approach, or a suitably attributional approach to be directly compared to an attributional GHG inventory, in view of upcoming formal standards from the GHG Protocol and Science-Based Targets Initiative,
- Without appropriate guardrails, companies may inadvertently over-state how much SAF could – if applied to their aviation footprint physically – actually decarbonize their footprint on an activity basis, which could be misleading at scale, and
- A subtraction approach may not adequately clarify how subcomponents of a fuel's lifecycle should be accurately attributed across multiple scopes or categories (e.g. the well to tank vs tank to wake components across scope 3 category 3 and scope 1 for an aircraft operator).

In order to address these potential challenges, companies looking to account and report their use of SAF certificates can consider **Option B** as an alternative substitution-based accounting and reporting approach.

Here, instead of – or in addition to - simply reporting an emissions reduction value as compared to a baseline, companies instead use the emissions intensity of the SAF represented by their purchased and retired SAFc as the basis for their emissions accounting, where:

(SAF CO2e/MJ) * (MJ/activity metric) = CO2e/activity metric

Companies can then use this SAF-based emissions factor to directly substitute for the amount of conventional jet fuel-based aviation activity that corresponds to the amount of retired SAFc.

This new total should be reported separately from a complete physical emissions inventory, either as a second parallel “market-based” emissions inventory organized by the same scopes and categories or as simply supplementary disclosure of total market-based emissions for that aviation activity.

For more information about this alternative approach, see the Advanced and Indirect Mitigation Platform Intervention Quality, Accounting, and Reporting Standard. In particular, see Chapter 10 (Accounting Method, page 49) and Chapter 14 (Separate Reporting, page 61).

Appendix 6: Normative References

The proposed SAF certificate (SAFc) accounting and reporting guidelines attempt to align as much as possible with other standards on carbon accounting for the aviation sector, business travel and freight. These guidelines build on the below-listed publications, which contextualize and inform this document.

Owing to the relative nascency of the SAF and SAFc industry and system, the listed resources offer diverse perspectives on key issues. The proposed guidelines, therefore, compare these resources and make appropriate suggestions to maximize compatibility while also streamlining data collection, accounting and reporting efforts.

The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard

– This corporate standard establishes the requirements and guidance for organizations and companies who wish to prepare a corporate-level greenhouse gas emissions inventory.

The Greenhouse Gas Protocol – Scope 2 Guidance

– The Scope 2 Guidance standardizes how corporations estimate emissions from purchasing or acquiring various types of energy. Importantly it includes requirements for accounting of emissions from energy contracts and instruments such as electricity EACs in GHG inventories.

The Greenhouse Gas Protocol – Corporate Value Chain (Scope 3) Accounting and Reporting Standard

– The Corporate Value Chain (Scope 3) Accounting and Reporting Standard establishes guidance for companies to assess emissions impact across their entire value chain and thus determine an effective strategy for focusing their emissions reduction activities.

The Greenhouse Gas Protocol – Technical Guidance for Calculating Scope 3 Emissions

– The Technical Guidance for Calculating Scope 3 Emissions guides businesses in completing their scope 3 inventories. It provides methods for calculating GHG emissions for each of the fifteen scope 3 categories, data sources and worked examples.

The Greenhouse Gas Protocol – Product Life Cycle Accounting and Reporting Standard

– The product standard articulates a methodology that can be used to understand the full life cycle emissions of a product and thus provides companies and organizations with insight as to where best to focus their emissions reduction activities.

Science-Based Targets initiative – Science-based Target Setting For the Aviation Sector

– This SBTi guidance outlines a target-setting method for airlines to meet the sector's Paris-aligned GHG intensity by 2050. It provides guidance for using SAF towards a science-based target but acknowledges that there is no clear guidance as of yet for SAFc accounting under the GHG Protocol.

ICAO – CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels

– ICAO's CORSIA gives default life cycle emissions values that may be used by an aircraft operator to claim emissions reductions from the use of CORSIA-eligible fuels each year. CORSIA also provides an actual life cycle emissions methodology for SAF suppliers whose supply chains may not be accurately represented by the default values.

RSB Book and Claim Manual

– This draft manual proposes the framework for a robust book and claim system by describing the necessary prerequisites for registration, transfer and retirement of units or certificates in a registry. The SAF certificate rulebook and registry that SABA is developing are designed to be compatible with the draft RSB Book and Claim Manual.

Powering Sustainable Aviation Through Consumer Demand: The Clean Skies for Tomorrow Sustainable Fuel Certificate (SAFc) Framework

– The previous report developed by the World Economic Forum's Clean Skies for Tomorrow initiative introduces the SAFc framework. The report explains the need for, purpose of, initial steps towards and general functionality of SAFc.

Smart Freight Centre – SAF Greenhouse Gas Emissions Accounting and Insetting Guidelines

– Smart Freight Centre's guidelines guide stakeholders in SAF emissions accounting and lay out principles for a book and claim chain of custody system for SAF insets.

Smart Freight Centre – Framework to Incentivize Freight Transportation Greenhouse Gas Emission Reduction Activities

– Smart Freight Centre's draft framework lays out how companies can incentivize GHG emission reduction activities across freight transport supply chains through book and claim mechanisms. It addresses barriers to broader partnerships around freight transport decarbonization and outlines a way for shippers,

forwarders, carriers and providers of low-emission transport solutions to share the costs of decarbonizing freight transport.

Global Emissions Logistics Council (GLEC) Framework

– GLEC has put together a globally recognized methodology for harmonized calculation and reporting of logistics GHG footprints across multi-modal supply chains. It can be implemented by shippers, carriers and logistics service providers. The calculations in the GLEC framework are complemented by the following tools:

International Air Transport Association (IATA) – Recommended Practice 1678

– IATA provides a standard methodology by which an airline or any third party can calculate CO_2 emissions generated by air cargo at the shipment level. It aims to serve as an industry-wide solution to address the challenges of air cargo carbon footprint measurement and reporting.

US Environmental Protection Agency (EPA) – 2018 SmartWay Air Carrier Partner Tool: User Guide

– SmartWay Air Carriers represents a set of member organizations that measure, benchmark and report emissions, and improve their sustainability performance on an annual basis. Users should timely submit a completed and accurate SmartWay Air Tool to the US EPA to make sure data is in the EPA partner database.

International Standards – ISO 14083:2023

– ISO 14083:2023 establishes general principles, definitions, system boundaries, and calculation methods for quantifying and reporting greenhouse gas emissions associated with transport operations and logistics chains. It provides a harmonized global framework for assessing emissions across all transport modes and hubs, replacing and expanding upon the earlier European Standard EN 16258.

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Endnotes

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