The High-Integrity Sustainable Aviation Fuels Handbook

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Acknowledgments

The author is grateful to: the outstanding input, research assistance, and support from Anna Stratton, who has played a crucial role making this handbook possible; the input, leadership, support and/or inspiration from Annie Petsonk, Ruben Lubowski, Fred Krupp, Julia Fidler, Elizabeth Willmott, Lucas Joppa, Thomas Roetger, Kristin Qui, Oleg Lugovoy, Elena Schmidt, Christine Seifert, Jan Seven, Martin Lange, Mark Brownstein, Beth Trask, Suzi Kerr, Nat Keohane, John Schmitz, Martina Simpkins, Amy Malaki, Jan Mazurek, Nikki Roy, Christa Owens Michelet, Andrei Mungiu, Tim Johnson, Carlos Calvo Ambel, Pietro Caloprisco, James Beard, John Holler, Nikita Pavlenko, Arianna Baldo, Sylvie Banoun, Pierre Caussade, Claire Rais-Assa, Jonathan Gilad, and Inmaculada Gómez Jiménez; the members from the International Coalition for Sustainable Aviation – ICSA –, the United Nations ICAO CAEP Secretariat and ICAO Member States and Observers who have helped shape the thinking informing this handbook and have fought relentlessly for the ICAO CORSIA SAF Framework to contribute to decarbonize aviation with environmental and social integrity; the copy-editing from Christa Ogata and Sommer Yesenofski; and the ClimateWorks Foundation, Breakthrough Energy, and Fundación CLIMA – Laboratorio de Ideas del Medio Ambiente, who generously supported this work.

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Foreword

By Lucas Joppa and Julia Fidler, Microsoft Corporation

Our climate reality is sobering. The burden of climate change is affecting communities and regions around the world more clearly and more severely with each passing year and—as the Intergovernmental Panel on Climate Change recently warned—our window to avert irreversible climate damage is closing fast. Still, there is reason for hope and time yet to act.

At Microsoft, we aspire to build a world better than the one we found, and to help our customers and partners do the same. To deliver on that promise, we are focused on becoming carbon negative by 2030 by making deep cuts in our value chain emissions. This includes continuous efforts to prioritize more accurate and comprehensive data tracking for all emissions—especially Scope 3—to allow for informed decision-making across the company. Furthermore, we have restructured and increased our internal carbon fee to help incentivize more aggressive measures to reduce Scope 3 emissions and better match the underlying cost of carbon abatement. For example, our Scope 3 business travel fee recently increased to $100 per metric ton of carbon dioxide equivalent to support the purchase of sustainable aviation fuel. This fee will continue to increase at an accelerated rate to ensure we can meet our 2030 goals.

Fortunately, we are not alone. There is increased corporate momentum to identify and implement carbon reduction commitments. But for all that energy to help achieve climate stability effectively and transparently, we need to accelerate the maturation and adoption of industry standards for carbon accounting. We all need to help drive the climate transition in the near term and unleash investment to catalyze the long-term transition on a strong foundation.

This handbook brings forward a unique contribution with the kind of holistic focus necessary to spur the debate around sustainability and carbon accounting for sustainable aviation fuels. It makes a critical contribution towards a robust sustainability framework that ensures a level playing field across all sustainable aviation fuel production pathways. This is necessary not only to avoid unintended consequences on ecosystems and livelihoods, but also to safeguard production pathways such as e-fuels so that these can compete on equal footing. Ensuring an equitable balance between e-fuels and sustainable aviation fuels of biological origin is critical for aviation and the broader energy transition alike. Indeed, the climate solutions the world needs to develop to reach net zero are substantial to the decarbonization of aviation, too. These include renewable energy solutions, green hydrogen, direct air capture, and long duration energy storage, all of which are either key components for e-fuels or areas where synergies with e-fuel production would be critical, as is the case with energy storage.

In conclusion, this handbook provides a solid foundation to help build a resilient sustainability and accounting framework for sustainable aviation fuels that can guide investment decisions while avoiding stranded assets and unintended consequences on ecosystems and people. At Microsoft, we are glad to have contributed actively to the thinking behind this handbook through fruitful cooperation with the Environmental Defense Fund since 2019. We hope the outcomes of this collaboration will help foster solutions that help accelerate greater climate action. There is no time to lose.

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List of Abbreviations

ABT	Atmospheric Benefit Test
AFOLU	Agriculture, Forestry and Other Land Use
CARB	California Air Resources Board
CAEP	Committee on Aviation Environmental Protection
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EEA	European Economic Area
EU	European Union
EU ETS	EU Emissions Trading System
EU RED II	The Recast of the EU Renewable Energy Directive
EUA	EU ETS Allowances
FT	Fischer Tropsch
GHG	Greenhouse Gas
GoO	Guarantees of Origin
HEFA-SPK	Hydro-processed Esters and Fatty Acids - Synthetic Paraffinic Kerosene
ICAO	International Civil Aviation Organization
ILUC	Indirect Land Use Change
IMO	International Maritime Organization
ITMO	Internationally Transferred Mitigation Outcomes
IPCC	Intergovernmental Panel on Climate Change
LCFS	Low Carbon Fuel Standard
LEC	Landfill Emissions Credit
REC	Recycling Emissions Credit
MSW	Municipal Solid Waste
NDC	Nationally Determined Contribution(s)
PEMEC	Proton-Exchange Membrane Electrolysis Cells
RD	Renewable Diesel
RFS	Renewable Fuel Standard
RIN	Renewable Identification Numbers
RSB	Roundtable on Sustainable Biomaterials (formally known as)
RTFO	Renewable Transport Fuel Obligations
RTFC	Renewable Transport Fuel Certificates
RWGS	Reverse Water-Gas Shift
SARPs	Standards and Recommended Practices
SAF	Sustainable Aviation Fuel(s)
SBTi	Science-Based Target initiative
SCS	Sustainability Certification Scheme(s)
SOEC	Solid Oxide Electrolysis Cells
ULSD	Ultra-Low Sulfur Diesel
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

COVID-19 has brought civil aviation to an inflection point. A precipitous drop in demand, continued reluctance of many leisure travelers to fly and growing awareness among customers of the need to cut greenhouse gas (GHG) emissions, have all thrown a cloud over the future of passenger aviation. At the same time, new science underscores the larger scale of aviation's role in changing the climate due to non-CO_2 effects, which represent about two-thirds of the net climate impact.[1] These developments present an enormous challenge for the industry. But they also open an opportunity to chart a path forward for civil aviation to embrace the imperative of a net-zero climate impact by 2050.

One key step on that path is a dramatic acceleration of sustainable aviation fuels (SAF) use. SAF, which can be produced using a variety of renewable sources and waste feedstocks, provides a distinct opportunity for aviation to decarbonize rapidly and permanently. To date, the uptake of SAF has been limited but the capacity exists to produce significant volumes in the near-term. However, deploying SAF only makes sense if the SAF actually reduces emissions, meets a high standard of environmental integrity, and is transparently and accurately accounted for. Indeed, not all alternative fuels are equal; some can make environmental problems worse. Deploying SAF without a robust accounting and sustainability framework could negate the entire climate benefits and even increase emissions several-fold compared to fossil jet fuels.

Because they burn more cleanly than fossil fuels, SAF with very low aromatics could also cut air pollution around airports, benefitting the health of people who live and work nearby, and may also help reduce significantly key non-CO_2 climate effects such as contrail cloudiness by significantly reducing the number of aromatics in jet fuel that result in soot particles after combustion.[2] However, SAF alone will not be able to completely eliminate aviation's net warming and public health effects. While SAF could represent a turning point in the aviation sector's journey to decarbonization, complementary measures are necessary to address the full spectrum of aviation's climate impacts, including by balancing the emissions reductions –and eventually net negative emissions— from other sectors.

A step in the right direction

The adoption of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) by the United Nations' (UN) International Civil Aviation Organization (ICAO)

[1] D.S. Lee et al, 2020, "The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018", Atmospheric Environment September 3, 2020.

[2] C. Voigt et al., 2021, "Cleaner burning aviation fuels can reduce contrail cloudiness", Communications Earth & Environment.

means that at the international level, there is a strong feedstock- and pathway-neutral framework for SAF to assess emissions reductions from the use of SAF that is fully operational as of January 1, 2021.

The November 2021 decision by ICAO Council to adopt an expanded set of sustainability criteria for SAF further strengthens this framework. This decision is a major milestone for ICAO, marking the first time a UN body has defined a clear standard for what constitutes sustainability for a mitigation action and operationalized it with a full-fledged monitoring, reporting and third-party verification system.

National actions complement global efforts

The SAF framework based on these ICAO decisions can enable the production of truly climate beneficial SAF if paired with effective national policies that generate the needed economic incentives. However, substantial work remains to improve these national policies to ensure that the incentives are directed to high-integrity SAF rather than to alternatives that make environmental problems worse.

In the interim, air carriers and large corporations committed to net zero climate impact can play a key role by (i) purchasing high-integrity SAF to claim the resulting emission reductions, (ii) pressing their peers to transition to net-zero flight, and (iii) helping to shape strong national SAF policies. Furthermore, air carriers can also help establish robust SAF programs to empower customers to support decarbonization efforts. This handbook shows them how.

In particular, air carriers and large corporations can demonstrate leadership and a commitment to environmental integrity by helping to reform current policies. This is critical because most policies in this area are flawed in three main ways: (1) they allow all biogenic fuels to claim zero climate impact, even though, on a life-cycle basis, some of these fuels are worse than fossil fuels; (2) they allow fuels to be called "sustainable" even if their production hurts ecosystems and communities; and (3) they allow "double counting", when different parties can claim credit for a single set of emission reductions, undermining climate ambition.

The CORSIA SAF framework is a strong step forward in correcting these errors but additional measures are required to fully address all these issues. It accounts for the emissions of the alternative fuels over their life cycle and includes some (but not all) indirect emissions. It has key sustainability criteria in place that address negative social and environmental effects that are not captured by the life-cycle assessment approach (although its scope would need to be extended to also safeguard against indirect negative effects on ecosystems and communities). It also includes initial provisions that could help prevent some instances of double counting of emissions reductions.

Level playing field across SAF pathways

This handbook outlines a series of future-proof recommendations on top of the CORSIA framework that create a robust foundation for the sector to build on. Particular attention is paid to prevent indirect land-use change emissions and the subsequent destruction of ecosystems and livelihoods, as accounting for the GHG emissions, while ignoring the broader environmental and social impacts, is not consistent with the sustainability principles that should guide action. In addition to preventing negative environmental and social consequences, the goal of the proposed recommendations is to ensure a level playing field across pathways that helps channel investments efficiently avoiding distortions. The proposed framework also embodies the relevant Environmental, Social and Governance metrics that financial institutions and investors need to ensure their resources create outcomes that drive value with environmental and social integrity.

Transparent accounting system for avoiding double counting

An integral component of the SAF framework and key design element that has not been fully developed yet is a transparent accounting system and registry. This is critical to trace SAF transactions and claims and avoid double counting, particularly when the underlying motivation is to increase global climate ambition. This handbook provides the guiding principles to design and implement such a transparent and robust accounting system, including a comprehensive framework to avoid double counting of emission reductions, that could be operationalized by means of a book-and-claim system for SAF.

A book-and-claim system can also help enhance flexibility by allowing stakeholders to claim emissions reductions from SAF taking advantage of geographical and/or temporal flexibilities. However, these flexibilities are not compatible with CORSIA and might not be aligned with the needs of air carriers or corporate air travel customers willing to claim emissions reductions in accordance with the GHG accounting principles of, e.g., the "GHG Protocol".

Stakeholders willing to claim emissions reductions from high-integrity SAF with geographical and/or temporal flexibilities could also benefit from additional flexibilities by claiming SAF emissions reductions independently of physical constraints such as SAF blending walls or fuel consumption per air transport service. All these flexibilities could, particularly, boost demand from non-corporate end-customers, accelerating the uptake of SAF.

SAF reporting in the context of the Paris Agreement

Building a robust and transparent registry is a necessary but not sufficient condition for avoiding double counting, as it requires proactive engagement from governments. In the absence of clear guidance and awareness of the breakthrough that represents the approach adopted by ICAO, governments might find it challenging to ensure the avoidance of double counting of the life-cycle emissions reductions, which could, e.g., be claimed twice, by the host country towards its Paris Agreement goals and the air carriers for CORSIA purposes. To date, the lack of guidance has not been an urgent concern because SAF volumes have been insignificant, meaning the associated emissions reductions have been negligible. However, commercially significant volumes are expected to be deployed in the near-term as SAF starts to be used more widely. It is therefore critical that countries prepare to properly account for SAF use and prevent double claiming.

This handbook offers governments with the guidance necessary to ensure that SAF use for either domestic or international aviation is properly reflected in their GHG emissions reports. This guidance builds on the CORSIA accounting system and reconciles the inventory reporting requirements with the imperative of rewarding bioenergy only for its real climate benefits. The recommendations are fully compatible with the dual reporting approach adopted under the Paris Agreement.

Transparent and fair premiums in a complex policy landscape

Once the environmental integrity of SAF claims is properly addressed, air carriers, corporations and other end-customers also need to assess an equally relevant matter: the SAF premium or abatement cost. To shed light on this matter, this handbook provides an overview of the representative SAF premiums and the corresponding abatement costs for the key production pathways. However, the premiums that air carriers, corporations and other end-customers will need to cover changes depending on existing policy and regulatory incentives, which vary by jurisdiction. The relevant indicator is the premium gap after applying existing incentives. These incentives are critical for the deployment of SAF but not all of them would be compatible with emissions reduction claims. To ensure environmental integrity, the compatibility with existing policy support should be evaluated from the perspective of the atmosphere using the guiding principles described in this handbook.

To illustrate how to estimate the premium gap, this handbook assesses the SAF premium in the European Union and California, two jurisdictions where significant incentives exist. In Europe, stakeholders willing to claim SAF emissions reductions would only need to pay a fraction of the abatement cost that, in some cases, would be equivalent to the EU carbon price signal. In California, before the adoption of the Inflation Reduction Act, air carriers and end-customers had to cover a premium gap of at least \$56/tCO_2 in early 2022 (60% of which was driven by the allowance price in California's cap-and-trade system). This premium gap can be easily translated into airfare surcharges, which are easier for end-customers to contextualize. For instance, an end-customer who wanted to use high-integrity SAF to compensate for 100% of the carbon emissions of a San Francisco-New York round trip flight in economy class would have been subject to a minimum extra air ticket cost of \$33.

However, this is about to change as a result of the enactment into law of the Inflation Reduction Act of 2022, which is poised to close the green premium gap in jurisdictions such as California.

Blue-sky opportunity

This handbook provides key stakeholders with a future-proof framework to deploy SAF with environmental integrity, no double counting, and transparent premiums. As more stakeholders adhere to the guidelines in this handbook, the faster we can reach our destination of net-zero aviation. As the aviation sector recovers from the impact of a global pandemic and grapples with a changing climate, it has a wide-open opportunity to jump-start the journey to net zero aviation. If we successfully leverage these critical opportunities, we can put aviation on a new flightpath to reduce its climate impact and air pollution, while protecting ecosystems and communities.

Introduction

The precipitous drop in passenger demand because of COVID-19 and the growing awareness of the need to cut greenhouse gas (GHG) emissions, have thrown a cloud over the future of passenger aviation. At the same time, new science underscores the real scale of aviation's role in changing the climate, with aviation accounting for 3.5% of today's global warming impact[3] and growing.

These developments present an enormous challenge for the industry. But they also open an opportunity to chart a path forward for civil aviation – to embrace the imperative of net-zero climate impact by 2050.[4] One key step on that path is a dramatic increase of sustainable aviation fuel (SAF). SAF is an enabling technology for aviation to decarbonize rapidly and permanently. But cost and availability remain as obstacles, particularly in a time of crisis for the industry. Ironically, while the downturn in demand for passenger aviation caused jet fuel prices to tumble, it opened an opportunity for some large corporate customers of air travel to pool a portion of the money they would have spent on flights, and channel it into SAF.

Building on new work in United Nations' (UN) International Civil Aviation Organization (ICAO) to quantify the climate benefits of SAF on a life-cycle basis and ensure its environmental integrity and sustainability in the context of the Paris Agreement on Climate Change, this handbook provides the foundation for air carriers and large corporate customers of air travel to help drive aviation's energy transition in the near term.

This handbook provides guidance to help accelerate the development and deployment of SAF maintaining environmental integrity building on the potential SAF demand from air carrier's end-customers. The recommendations seek to overcome the "chicken and egg" problem that has hampered widespread development and deployment of alternative fuels: in most markets, SAF costs much more than conventional fuel. Investors, faced with a highly competitive industry with long capital stock lifetimes, sharply reduced revenue streams, and no clear regulatory horizon, have been unwilling to commit the capital needed to bring down the costs of commercially unproven SAF technologies.

Whereas this document is mostly framed as guidance for air travel corporate customers (hereinafter referred to as corporations) and air carriers, it is also applicable more generally to individual end-customers willing to claim emissions reductions from high-integrity SAF.

[3] D.S. Lee et al, 2020, "The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018", Atmospheric Environment September 3, 2020.

[4] Air carriers are slowly beginning to grapple with the new reality. In September 2020, the members of the OneWorld Alliance announced their commitment to net-zero carbon emissions by 2050 "OneWorld Airlines Commit to Net Zero Carbon Emissions by 2050" (September 11, 2020); "13 Global Airlines Commit to Net Zero 2050 Emissions (September 11, 2020)".

This handbook also provides the foundation for air carriers to establish robust SAF programs to empower all their end-customers to contribute to the decarbonization of aviation.

This work builds on over eight years of intensive technical work by many stakeholders, from the governments and experts of the ICAO's Committee on Aviation Environmental Protection (CAEP) and its technical groups and task forces, to the RSB (formally known as Roundtable on Sustainable Biomaterials) and to global, national and regional initiatives.

This handbook is structured as follows. **Part A** of the document provides an introduction to SAF, reviews SAF progress to date, and summarizes the current policy landscape at ICAO and at subnational, national, and regional levels. Part A also examines the limitations in some of these policies, and lessons learned.

Part B provides a framework for high-integrity SAF covering both environmental integrity of the SAF itself and the integrity of the emissions reduction claims. **Section B.1** provides the overarching framework to ensure that SAF delivers real emissions reductions that meet a high standard of sustainability and are not double claimed. Proposed requirements – additional to ICAO's SAF framework— are grouped into three categories: (i) applying a life-cycle assessment approach; (ii) applying robust sustainability criteria; and (iii) avoiding double counting. **Section B.2** focuses in detail on double counting, the area that to date has received the least attention.

Part C, building on the recommendations in Part B, provides a set of recommendations for Sustainability Certification Schemes (SCS) and governments to ensure SAF claims are consistently reflected in the national GHG emissions reports and double counting is avoided. Part C also explores how, building on the lessons learned from this handbook, governments could account correctly for bioenergy –beyond SAF— that is prone to indirect land-use change, and subsequently, take action to phase-out the use of bioenergy that results in the destruction of ecosystems and livelihoods.

Finally, Part D explores the SAF premium from the perspective of air carriers and end-customers in a complex policy landscape. This part of the handbook analyzes the potential premium gap that air carriers, corporations and other end-customers should pay based on the existing policy incentives that are compatible with their pursued environmental goals. This is the first edition of the handbook. As the policy landscape evolves, it will be periodically updated to reflect developments in the ICAO SAF Framework, national SAF policy milestones and relevant United Nations Framework Convention on Climate Change (UNFCCC) decisions.

PART A_Introduction to Sustainable Aviation Fuels

A.1_What is Sustainable Aviation Fuel?

Sustainable Aviation Fuel – SAF – is aviation fuel derived from renewable sources or waste feedstocks, that (1) has been certified by ASTM International as safe for use in the aircraft,[5] (2) achieves significant reductions in greenhouse gas emissions compared to conventional aviation fuel when evaluated on a life-cycle basis –the benefit is not from lower emissions from combustion but from emissions reductions achieved upstream in the fuel value chain—, and (3) meets sustainability criteria.[6] Commercial flights have used SAF on a limited basis since 2008 and as of 2019, over 180,000 commercial flights have used SAF from feedstocks such as used cooking oil, animal fat, jatropha, camelina, algae, and sugarcane.[7]

SAF can include: (1) fuels of biogenic origin; (2) fuels derived from hybrid feedstocks with both fossil and biogenic fractions such as municipal solid waste (MSW); (3) green liquid hydrogen (no drop-in with existing engines);[8] (4) recycled-carbon-based bio-processed fuels from, e.g., off-gases of fossil origin from steelmaking; and (5) electrofuels or e-fuels[9] (also known as power-to-liquids or e-kerosene), including bio e-fuels using a CO_2 source of biogenic origin, and Direct Air Capture (DAC) e-fuels with CO_2 directly captured from the atmosphere. The analyses presented in this handbook are feedstock-neutral, that is, they apply to all potential feedstocks for SAF.

Some SAF, not all, have very low aromatic content and burn more cleanly than fossil fuels, meaning that high-integrity SAF with low aromatic content can deliver local health benefits

[5] ASTM International, formerly known as American Society for Testing and Materials, is a standards organization that develops and publishes technical standards for a wide range of products including SAF and jet fuel specification. ASTM D4054 is the multi-tiered qualification process involving stakeholders across industry and United States government. Through United States' Federal Aviation Administration support, alternative fuels satisfactorily evaluated following ASTM D4054 are annexed in ASTM D7566, the standard specification for aviation turbine containing synthesized hydrocarbons.

[6] See generally ICAO Secretariat, "An Overview of CORSIA Eligible Fuels", Introduction to Chapter Six in Destination Green: The Next Chapter, ICAO 2019 Environmental Report.

[7] See IATA, 2019, "Sustainable Aviation Fuel: Fact Sheet".

[8] Liquid hydrogen from water electrolysis produced using renewable electricity. Alternative fossil-based pathways include blue hydrogen, which involves steam methane reforming of natural gas combined with carbon dioxide capture and storage. Other pathways to produce hydrogen could emerge in the future including negative emissions technologies such as bioenergy with CCS, which tap on gases of biogenic origin combined with CCS to generate both hydrogen and carbon removals.

[9] Electrofuels are drop-in liquid hydrocarbon fuels suitable for aviation that are produced using renewable electricity, a carbon source from either "Direct Air Capture" or waste carbon of fossil or biogenic origin, and water.

to communities by helping cut air pollution around airports.[10, 11, 12] This can also help reduce some of the non-CO_2 climate effects that cause net warming.[13]

As currently approved by ASTM International, the blend ratio of SAF to conventional jet fuel in the aircraft for drop-in SAF range between 10% and 50%,[14] but the blend ratio could quickly increase once the minimum aromatic content required in drop-in fuels is better understood.[15] However, as SAF supply ramps up, even SAF with a blend ratio of 10% could play a significant role within this decade.

A.2_Future Deployment of SAF

SAF has the potential to provide greater emission reductions than what could be achieved through other technological improvements – but only if the fuels that comprise it meet high standards for environmental integrity, and only if the accounting for their use is transparent and accurate. The combination of biofuels and electrofuels have the potential to help fully decarbonize aviation by 2050. Replacing 100% of international aviation fuel demand with high-integrity SAF could achieve 10 Gt CO_2 of emissions reductions through 2050 (17 Gt CO_2 if domestic flights are included), as depicted in the light blue-shaded area in Figure 1. This is equivalent to 65% of total forecasted CO_2 emissions from international aviation, and assumes electrofuels with zero life-cycle emissions become available and are deployed at scale to lead on the decarbonization of aviation. However, these potentials are theoretical and depend on supply constraints and political support to materialize.

But not all alternative fuels are equal. Some make environmental problems worse. Deploying SAF in the absence of a robust accounting and sustainability framework could negate the entire climate benefits and even increase emissions several-fold compared to fossil fuels. Accurate

[10] Aromatics are hydrocarbons containing a benzene ring and range from benzene, the smallest aromatic compound to others such as toluene, xylene, and naphthalene. Particulate matter emissions from aircraft turbine engines are a function of aromatic content. According to ASTM D7566, the maximum allowable aromatics content for SAF is 25%.

[11] J. Holladay et al., 2020, "Sustainable Aviation Fuel: Review of Technical Pathways", U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, 9 September 2020,

[12] National Academies of Sciences, Engineering, and Medicine, 2018, "State of the Industry Report on Air Quality Emissions from Sustainable Alternative Jet Fuels", Washington, DC: The National Academies Press.

[13] C. Voigt et al., 2021, "Cleaner burning aviation fuels can reduce contrail cloudiness", Communications Earth & Environment.

[14] ASTM International D7566-21. "Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons."

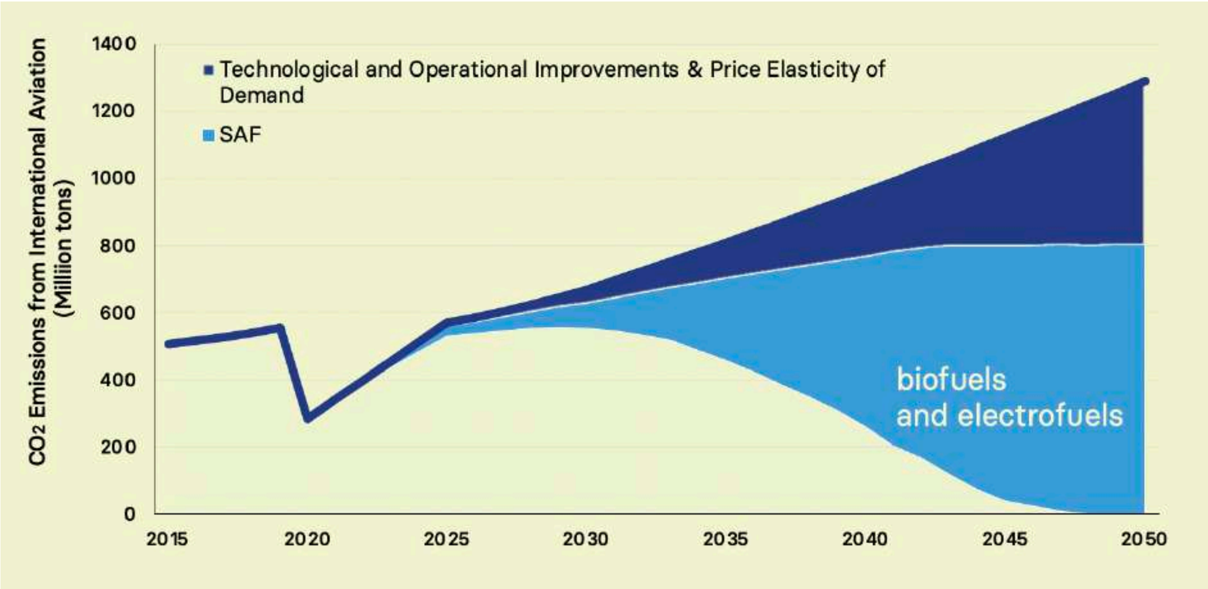
[15] A minimum level of aromatics is desirable to ensure that shrinkage of aged elastomer seals and associated fuel leakage is prevented (ASTM International D7566-21). However, seals that have not been exposed to fuel with high aromatic content do not appear to require aromatics for acceptable performance with 100% SAF without aromatics (Holladay et al., 2020, op. cit.)

[16] ICAO, 2019, Working Paper: ICAO Global Environmental Trends – Present and Future Aircraft Noise and Emissions. Note these estimates are pre-pandemic.

accounting and certification of sustainability needs therefore undergird governmental and private sector SAF engagement going forward.

FIGURE 1

Reductions in atmospheric CO_2 from SAF use for international aviation. Based on ICAO[19] forecasts, enhanced to reflect the notional impact of COVID19 and SAF deployment on price elastic demand and the adoption of technological and operational improvements.



A.3_Current SAF Policy Landscape

The international framework for SAF policy is well developed and operational as of January 1, 2021; however, national, and sub-national policy incentives for aviation alternative fuels are generally embedded in broader alternative fuel/emission reduction policies, which vary in their design and effectiveness.

A.3.1_International Civil Aviation Organization

The International Civil Aviation Organization (ICAO) is the 190+-member country, specialized agency of the United Nations that sets standards for international flights. ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), adopted in 2016, caps the net carbon dioxide emissions of international flights between participating countries at the average of 2019-2020 levels for the years 2021-2035.[17, 18] CORSIA allows air

[17] ICAO Assembly Resolutions 39-3 (2016) and 40-19 (2019).

[18] As originally designed, CORSIA would have capped, at the average of their 2019-2020 emissions, the emissions of international flights on covered routes, with the cap running from 2021-2035. In June 2020, in view of the COVID-19 crisis, ICAO's governing Council changed CORSIA's cap to 2019 levels for its first three years. See ICAO Press release 30 June 2020. "ICAO Council agrees to the safeguard adjustment for CORSIA in light of COVID-19 pandemic". Unless emissions rebound above 2019 levels, air carriers will have no offset obligations during those three years. ICAO's Assembly will decide in 2022 whether to change the cap level for the remaining twelve years of CORSIA. See A. Petsonk, Piris-Cabezas P., McCallister, M., "COVID-19, International Aviation, and Climate Change: How Airlines' Proposed Re-Write of International Civil Aviation Organization Rules Would Undermine the Carbon Offsetting and Reduction Scheme for International Aviation". May 2020. The Environmental Defense Fund.

carriers to meet their caps by reducing emissions directly, by purchasing ICAO-approved offsets, and by using CORSIA-eligible fuels that, on a life-cycle basis, reduce emissions below those of conventional jet fuel. ICAO CAEP has developed an extensive framework of criteria and methodologies for certifying the fuels' sustainability and quantifying their emissions reductions benefits, thereby incentivizing SAF because its use reduces the amount of offsets air carriers must purchase to meet their CORSIA obligations.[19]

Confronted with the need to properly capture the climate contribution of SAF use under CORSIA, ICAO has developed an innovative accounting approach for SAF. This approach combines features of the two main environmental accounting principles currently applied to account for GHG emissions: the producer and consumer accounting principles. Under the consumer accounting principle, the responsibility for emissions lies with the consumer and includes GHG emissions that take place along the whole value chain of the goods or products consumed. Meanwhile under the producer accounting principle, which commonly applies in the context of the UNFCCC, all GHG emissions are the responsibility of the producer and consequently of the country where the emissions take place. Appendix A provides an overview of how SAF is defined as eligible and emissions reductions are quantified under ICAO CORSIA. Part C further explores the implications of ICAO accounting breakthrough.

The CORSIA framework for SAF holds enormous potential to incentivize the production of truly climate beneficial SAF: the market is large; the framework's life-cycle emissions calculation methodologies are comprehensive; and the framework avoids environmental problems that arose with earlier attempts to stimulate alternative fuel development. The CORSIA framework for SAF corrects the accounting error that led other programs, including the EU ETS and California's cap-and-trade system, to allow all biogenic fuels to claim "zero" CO_2 emissions, regardless of the actual life-cycle emissions of the fuels.

National alternative fuel policies, however, are key to successful implementation of the CORSIA SAF framework – as these generate the lion's share of the economic incentives for SAF. The major markets that provide incentives for the production of SAF, though differently structured, are the United States of America and the European Union.

A.3.2_United States of America

In the United States, two federal policies have traditionally incentivize alternative jet fuels deployment: The Biodiesel Tax Credit worth $1/gallon and the Renewable Fuel Standard (RFS), under which alternative jet fuels can generate 1.6 Renewable Identification Numbers

[19] See generally: ICAO Assembly Resolution A40-19; International Standards and Recommended Practices, Annex 16 to the Convention on International Civil Aviation, Volume IV Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA); and ICAO CORSIA Eligible Fuels site.

(RINs) per gallon on an opt-in basis.[20, 21, 22] At the sub-national level, the California Air Resources Board (CARB) allows alternative jet fuel suppliers or importers to opt into the California's Low Carbon Fuel Standard (LCFS) making them eligible to sell the credits they generate from the fuels.[23] The sale of LCFS credits, stacked on top of the federal tax credit and the RINs, provides an economic incentive that significantly reduces the price gap between alternative and conventional jet fuel. Other States have taken a similar approach.

Since 2020, the United States Congress has been actively engaged in designing a complementary SAF tax credit, which would provide an additional direct payment to fuel producers for SAF blended with fossil jet fuel. In parallel, the Biden and Harris Administration is seeking to advance the future of SAF in the United States with a SAF tax credit as part of the Build Back Better Agenda and the SAF Grand Challenge. In August 2022, the Inflation Reduction Act was enacted into law including credits for SAF that are poised to effectively address the difference in incentives between renewable diesel and SAF.

A.3.3_European Union

The European Union has two policy measures that incentivize alternative jet fuel use: The Recast of the EU Renewable Energy Directive (EU RED II), effective 2021, and the EU Emissions Trading System (EU ETS).

EU RED II requires that by 2030, 14% of all energy supplied to road and rail transport sectors come from renewable sources, with an opt-in for aviation. EU RED II includes an optional multiplier for alternative jet fuels of 1.2 times the energy content, provided feedstocks are not food or feed crops, except for intermediate crops (e.g., cover crops) that do not trigger additional demand for land.[24] The multiplier, which is not applied to road transport, creates an incentive for alternative fuels to be directed away from road transport to the aviation sector.

The EU ETS is a cap-and-trade system that includes all flights within the European Economic Area (EEA) in its current configuration. Industries whose emissions are capped, including aviation, are issued and can purchase emissions allowances, with each allowance providing a permission to emit one ton of CO_2. Air carriers must limit their emissions to their capped levels and can buy allowances if they need to emit more. A rule in the EU ETS states that all biofuels have net zero CO_2 combustion emissions. This rule generates

[20] 26 U.S. Code § 40A - Biodiesel and renewable diesel used as fuel.

[21] Airlines for America 2019. "Deployment of Aviation Fuel in the United States: Federal Renewable Fuel Standard (RFS) Financial "RIN" Incentive".

[22] RINs are credits used for compliance purposes under the RFS program.

[23] 17 CCR §9548- Fuel Reporting Entities. Specifics for Alternative Jet Fuel.

[24] Directive (EU) 2018/2001, Article 27 paragraph 2(c).

incentives for the use of biofuels, as air carriers that use them can reduce the number of allowances they have to otherwise purchase to cover their emissions. If the allowances cost more than the biofuel, the air carriers will save money by using the biofuels.[25]

Finally, in 2020, the European Commission launched a legislative process to establish EU-wide mandates under ReFuelEU Aviation regulation beginning 2025. The ReFuelEU Aviation regulation is a key component of the "fit for 55" legislation package proposal released in 2021.[26]

A.4_Market Penetration and Barriers

In 2019, despite the economic incentives noted above, fewer than 200,000 metric tons of SAF were produced, a small fraction (less than 0.1%) of the 300 million tons of conventional jet fuel used by commercial air carriers in the same year.[27]

Three issues have slowed the deployment of SAF:

1. **Technology.** While seven production pathways have been approved for blending with fossil jet fuel, only one is technically mature and commercialized to date.
2. **Premium.** Conventional jet fuel is already the largest overhead expense for air carriers despite the fact that jet kerosene is virtually untaxed. Replacing conventional jet fuel with significantly more expensive SAF is currently cost-prohibitive for most air carriers, even after accounting for the existing economic incentives in some jurisdictions. See Appendix B for an overview of SAF costs.
3. **Near-term availability**. Even with relatively limited use, demand for SAF already exceeds production capacity, a problem exacerbated by the fact that globally, until recently only one facility produced SAF on a continual basis, with other facilities instead producing batches based on demand. However, there is capacity to produce larger volumes of SAF for aviation in the near-term provided the right incentives are in place. But, not all this potential would qualify as having high-integrity.[28] Still, tapping on the already installed capacity originally deployed for fulfilling biofuel volume mandates for road transport could quickly multiply available high-integrity SAF volumes in the near-term if (a) existing volumes currently sold blended with renewable diesel for road transport move to the aviation sector, and (b) a new 10% blend of hydro-processed esters

[25] Directive (EU) 2003/87/EC, Annex IV, Part B- Monitoring and reporting of emissions from aviation activities.

[26] See here.

[27] World Economic Forum and McKinsey & Company, 2020. Clean Skies for Tomorrow: Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation. Insight Report.

[28] See for instance this groundbreaking contribution assessing the potential in France: Sylvie Banoun, Pierre Caussade and Claude Roy, 2015, "Les biocarburants aéronautiques en France: Perspectives de développement de leur production et de leur usage à l'horizon 2020", Conseil Général de l'Environement et du Développement Durable, Conseil Général de l'Alimentation de l'Agriculture et des Espaces Ruraux, Novembre 2015.

and fatty acids renewable diesel is certified under the fast-track procedure under the ASTM Fuel Evaluation Process (see Appendix C for more detail).

Policy developments in major markets such as the United States of America and the European Union, combined with vigorous demand signals from end-customers are poised to overcome these barriers and represent a turning point in the sector's journey to decarbonization. But for this potential to come to fruition strong leadership is needed to ensure existing flawed policies are fixed to ensure the environmental integrity of SAF.

A.5_Lessons Learned to Safeguard Environmental Integrity of SAF claims

One of the major flaws with existing policies is their failure to properly assess and safeguard the environmental integrity of fuels. This has resulted in the deployment of alternative fuels with significant negative environmental impacts. An air carrier, a corporation or other end-customer that wants to procure SAF that generates real emissions reductions and safeguards environmental sustainability, must be aware of three key concepts: (1) life-cycle assessment approach; (2) sustainability criteria; and (3) avoidance of double counting.

A.5.1_Life-Cycle Assessment Approach

ICAO's CORSIA framework for SAF corrects the accounting error that led other programs, including the EU ETS and California's cap-and-trade system, to allow all biogenic fuels to claim "zero" CO_2 emissions, regardless of the actual life-cycle emissions of the fuels.[29] This error is based on the fact that CO_2 combustion emissions are equivalent to CO_2 uptake during feedstock growth, but ignores emissions from land use changes for feedstock cultivation, the timeframe of when growth occurred/will occur relative to emissions, transport, conversion and distribution.[30]

Assuming biofuels are carbon neutral is particularly problematic given that when all life-cycle emissions are accounted for, some biofuels have substantially greater life-cycle emissions than the conventional fossil fuel they are intended to replace (e.g., palm oil-based biofuels from existing agriculture land results in large displacement emissions from peatland oxidation and rainforest destruction). Therefore, a more accurate approach to estimating emissions is the life-cycle assessment approach, as used by ICAO for CORSIA.

A life-cycle assessment approach requires that all emissions along the supply chain, from production to final use, are accounted for. It includes emissions from **direct effects** (e.g.,

[29] Searchinger et al., 2009, "Fixing a Critical Climate Accounting Error", Science 23 Oct 2009: Vol. 326, Issue 5952, pp. 527-528.

[30] EPA's Science Advisory Board (SAB), 2019, "SAB review of Framework for Assessing Biogenic CO2 emissions from Stationary Sources (2014)", EPA-SAB-19-002.

emissions from operating the refinery where the fuel is produced) and **indirect effects** (e.g., emissions from deforestation that may occur if feedstock cultivation for energy displaces food and feed crops, meaning new lands must be brought into production). The most common source of indirect emissions is **indirect land-use change (ILUC)**, i.e., land use change not as a direct result of the feedstock cultivation but arising from displacement effects. ILUC is often excluded from life-cycle emissions estimates, such as in the EU RED II. Its exclusion belies the fact that ILUC emissions can be significant enough to cancel out the emissions reductions from the fuel (in some cases the resulting emissions can be substantially greater emissions than the emissions from the fossil fuel that it is meant to be displaced), and in some cases entail the destruction of biodiversity hotspots and livelihoods.

But estimating and accounting for ILUC emissions is only the first step towards addressing the full scope of ILUC's environmental and social consequences that are not captured by the life-cycle assessment approach (see Section B.1).

A.5.2_Sustainability Criteria

The role of sustainability criteria is to safeguard against direct and indirect negative effects on ecosystems and communities that are not captured or are underestimated by the life-cycle assessment approach. Building on the sustainability framework originally developed for EU RED II, the sustainability criteria approved by ICAO demonstrate what a robust set of criteria should include. Provisions pertain to water, soil, air, conservation, waste and chemicals, human and labour rights, land use rights and land use, water use rights, local and social development, and food security (see table 1).

To be eligible under ICAO's CORSIA, SAF needs to meet the following overarching goals across its supply chain:

1) **Reduce greenhouse gas emissions compared to fossil jet fuel on a life-cycle basis**. The criteria ensure that SAF provides meaningful emissions reductions, counted across the full life cycle of the fuel from feedstock to flight, and including key indirect environmental effects such as indirect land use change. ICAO requires a 10% minimum emissions reduction. This is only intended as a safeguard to ensure that any emission reduction claim in CORSIA is backed up with real emissions reductions that go beyond the uncertainties associated to the life-cycle assessment methodology. Independently, only SAF that delivers large emissions reductions would make sense economically and environmentally, which means that SAF with large land use change emissions is implicitly disqualified as a viable production pathway.
2) **Protect ecosystems and natural resources.** The robust set of sustainability criteria also includes environmental safeguards against negative environmental

effects that are not captured by the life-cycle emissions assessment—defending water quality, soil health, air quality, biodiversity and conservation values.

3) **Present no risks to human rights, food security, or local economies.** Ensuring that SAF feedstock production does not present social risks, ICAO prioritized the inclusion of human and labor rights, land use rights and water use rights for local and indigenous communities.

4) **Promote the achievement of the UN Sustainable Development Goals.** As a United Nations body, the ICAO championed these sustainability criteria aiming for SAF to contribute to the achievement of UN Sustainable Development Goals, including eliminating poverty and promoting food security.

The ICAO sustainability framework works as an umbrella standard that relies on ICAO-approved independent Sustainability Certification Schemes (SCS) for its implementation. These organizations define the sustainability certification requirements including the indicators and metrics to evaluate compliance with the criteria, set the requirements for certification bodies, auditors and accreditation bodies, and monitor the effectiveness of the assurance system. To become ICAO-approved SCS must undergo a thorough evaluation process and meet a comprehensive set of requirements in line with ICAO's eligibility framework for SCS.

The sustainability criteria take a robust and equitable approach, placing environmental and social safeguards on the production of SAF across its entire supply chain. The criteria also provide a harmonized approach to ensure that air carriers across the world strive for these same values of climate ambition, environmental integrity, human rights, and social equity.

TABLE 1

ICAO Document CORSIA Sustainability Criteria for CORSIA Eligible Fuels, Chapter 2. CORSIA sustainability criteria applicable for batches of CORSIA SAF produced by a certified fuel producer on or after 1 January 2024.

Theme	Principle	Criteria
1. Greenhouse Gases (GHG)	Principle: CORSIA SAF should generate lower carbon emissions on a life-cycle basis.	Criterion 1.1: CORSIA SAF will achieve net greenhouse gas emissions reductions of at least 10% compared to the baseline life-cycle emissions values for aviation fuel on a life-cycle basis.
2. Carbon stock	Principle: CORSIA SAF should not be made from biomass obtained from land with high carbon stock.	Criterion 2.1: CORSIA SAF will not be made from biomass obtained from land converted after 1 January 2008 that was primary forests, wetlands, or peat lands and/or contributors to degradation of the carbon stock in primary forests, wetlands, or peat lands as these lands all have high carbon stocks.

Table 1 Cont.

Theme	Principle	Criteria
		Criterion 2.2: In the event of land use conversion after 1 January 2008, as defined based on the Intergovernmental Panel on Climate Change (IPCC) land categories, direct land use charge (DLUC) emissions will be calculated. If DLUC greenhouse gas emissions exceed the default induced land use change (ILUC) value, the DLUC value will replace the default ILUC value.
3. Water	Principle: Production of CORSIA SAF should maintain or enhance water quality and availability.	Criterion 3.1: Operational practices will be implemented to maintain or enhance water quality. Criterion 3.2: Operational practices will be implemented to use water efficiently and to avoid the depletion of surface or groundwater resources beyond replenishment capacities.
4. Soil	Principle: Production of CORSIA SAF should maintain or enhance soil health.	Criterion 4.1: Agricultural and forestry best management practices for feedstock production or residue collection will be implemented to maintain or enhance soil health, such as physical, chemical and biological conditions.
5. Air	Principle: Production of CORSIA SAF should minimize negative effects on air quality.	Criterion 5.1: Air pollution emissions will be limited.
6. Conservation	Principle: Production of CORSIA SAF should maintain or enhance biodiversity, conservation value and ecosystem services.	Criterion 6.1: CORSIA SAF will not be made from biomass obtained from areas that, due to their biodiversity, conservation value, or ecosystems services, are protected by the State having jurisdiction over that area, unless evidence is provided that shows the activity does not interfere with the protection purposes. Criterion 6.2: Low invasive-risk feedstock will be selected for cultivation and appropriate controls will be adopted with the intention of preventing the uncontrolled spear of cultivated non-native species and modified microorganisms.

Table 1 Cont.

Theme	Principle	Criteria
		Criterion 6.3: Operational practices will be implemented to avoid adverse effects on areas that, due to their biodiversity, conservation value, or ecosystem services, are protected by the State having jurisdiction over that area.
7. Waste and Chemicals	Principle: Production of CORSIA SAF should promote responsible management of waste and use of chemicals.	Criterion 7.1: Operational practices will be implemented to ensure that waste arising from production processes as well as chemicals used are stored, handled and disposed of responsibly. Criterion 7.2: Responsible and science-based operational practices will be implemented to limit or reduce pesticide use.
8. Human and labour rights	Principle: Production of CORSIA SAF should respect human and labour rights.	Criterion 8.1: CORSIA SAF production will respect human and labour rights.
9. Land use rights and land use	Principle: Production of CORSIA SAF should respect land rights and land use rights including indigenous and/or customary rights.	Criterion 9.1: CORSIA SAF production will respect existing land rights and land use rights including indigenous people's rights, both formal and informal.
10. Water use rights	Principle: Production of CORSIA SAF should respect prior formal or customary water use rights.	Criterion 10.1: CORSIA SAF production will respect the existing water use rights of local and indigenous communities.
11. Local and social development	Principle: Production of CORSIA SAF should contribute to social and economic development in regions of poverty.	Criterion 11.1: CORSIA SAF production will strive to, in regions of poverty, improve the socioeconomic conditions of the communities affected by the operations.
12. Food security	Principle: Production of CORSIA SAF fuel should promote food security in food insecure regions.	Criterion 1: CORSIA SAF production will, in food insecure regions, strive to enhance the local food security of directly affected stakeholders.

A.5.3_Avoidance of Double Counting

In general, the risk of double counting is the potential for emissions reductions to be counted more than once towards a climate change mitigation effort. This would lead to a misrepresentation of real emissions reductions and subsequently higher emissions in the atmosphere, undermining the effectiveness of policies.

ICAO's CORSIA Emissions Units Criteria specify that in order to be eligible for use in CORSIA, emissions unit programs must have in place provisions to ensure that emissions units "are only counted once towards a mitigation obligation". [31] Measures must be in place to avoid:

a) **Double issuance** (which occurs if more than one unit is issued for the same emissions or emissions reduction).

b) **Double use** (which occurs when the same issued unit is used twice, for example, if a unit is duplicated in registries).

c) **Double claiming** (which occurs if the same emissions reduction is counted twice by both the buyer and the seller (i.e., counted towards the climate change mitigation effort of both an air carrier and the host country of the emissions reduction activity)). In order to prevent double claiming, eligible programs should require and demonstrate that host countries of emissions reduction activities agree to account for any offset units issued as a result of those activities such that double claiming does not occur between the air carrier and the host country of the emissions reduction activity."

As a matter of climate science and carbon accounting, SAF in the context of CORSIA is equivalent to, and essentially fungible with, carbon offset credits. That is, whether an air carrier is burning conventional fuel or alternative fuel, in both cases, carbon dioxide emissions out of the back of the aircraft engine are basically the same. In both cases the emissions going into the atmosphere need to be compensated by actual reductions achieved elsewhere.

Just as an air carrier might use an emission reduction unit achieved elsewhere to comply with its offsetting obligation under CORSIA, it may also use a mitigation outcome achieved during the life cycle of alternative fuels production/transport to comply with its CORSIA offsetting obligation. This concept of fungibility of carbon offsets with alternative fuels –in CORSIA or in any other program utilizing alternative fuels for purposes of claiming atmospheric benefits post-2020— is firmly grounded in the science of carbon accounting.[32] It is also enshrined in Paragraph 6 of the 2016 Resolution establishing CORSIA.[33] And it is fundamental to understanding the safeguards –like avoidance of double claiming— which need to be

[31] ICAO document "CORSIA Emissions Unit Eligibility Criteria", March 2019.

[32] Searchinger et al., 2009, (op. cit.).

[33] The ICAO Assembly: "6. Requests the Council to continue to ensure all efforts to make further progress on aircraft technologies, operational improvements and sustainable alternative fuels be taken by Member States and reflected in their action plans to address CO_2 emissions from international aviation, and to monitor and report the progress on implementation of action plans, and that a methodology should be developed to ensure that an aircraft operator's offsetting requirements under the scheme in a given year can be reduced through the use of sustainable alternative fuels, so that all elements of the basket of measures are reflected." ICAO Assembly Resolution 39-3 (October 2016), paragraph 6, (op. cit.)

included in all programs allowing for the international transfer of mitigation outcomes whether those are denominated as emissions credits or as alternative fuels.

None of the existing alternative fuels policies, however, provide adequate guidance to prevent double counting of emissions reductions from SAF used internationally. ICAO's CORSIA framework for SAF includes some initial provisions that could help prevent double-counting but final guidance has not been released as of this publication. In this context, air carriers and corporations will have to carefully consider the policy context where they make their purchase, to determine how to avoid double counting. Sections B.2 and B.3 propose guidance on how to achieve it.

But action by air carriers and end-customers need to be complemented by proper accounting by countries. To that end, Part C provides the otherwise missing guidance to SCS and governments that will ensure SAF claims from air carriers and corporations are consistently and transparently reflected in national GHG emissions reports to prevent double claiming with host countries.

PART B_Guidance for High-Integrity SAF

B.1_Requirements for SAF

Air carriers, corporations and other end-customers should ensure any SAF they procure delivers real emissions reductions that meet a high standard of sustainability and are not double counted. Table 2 outlines a series of additional requirements on top of ICAO's framework to achieve this outcome, grouped into three categories: (i) applying a life-cycle assessment approach; (ii) applying robust sustainability criteria; and (iii) avoiding double counting.

These recommendations are an enhanced version of the rigorous, scientifically grounded work done by ICAO's technical committees and its governing Council to develop a framework for assessing emissions reductions from SAF.[34] The additional requirements are aimed at incorporating best practices to address the numerous areas of the CORSIA SAF methodology currently under refinement in ICAO, and thereby provide the necessary future-proof guidance without further delays. These recommendations also represent a significant enhancement – albeit mostly compatible – as compared with the guidance outlined in the "Science-based Target Setting for the Aviation Sector"[35] under the Science-Based Target initiative (SBTi).

(i) Life-cycle assessment approach

Under the life-cycle assessment approach category, particular attention is needed to prevent ILUC because it can not only cancel out the SAF emissions reductions but also entail the destruction of ecosystems and livelihoods, undermining the purpose of the sustainability criteria adopted by ICAO Council in November 2021.

Maintaining or enhancing biodiversity, conservation value and ecosystem services as enshrined in Sustainability Theme # 6 is not compatible with ILUC emissions. ILUC and the associated market mediated responses leading to reduced food demand are also incompatible with the need to respect human rights, land rights and land use rights including indigenous, customary rights, prior formal or customary water use rights, and promote food security. Therefore, where a feedstock has ILUC risk, it should be automatically ineligible, except

[34] For reference, the methodology developed by ICAO's technical bodies and adopted by ICAO's Council is contained in Annex 16, Volume IV of the Chicago Convention on International Civil Aviation, with the Standards and Recommended Practices and its supporting documents - they are the first and only set of multilaterally agreed methodologies for SAF.

[35] "Science-based Target Setting for the Aviation Sector" Version 1.0, August 2021.

where feedstock producers have implemented sufficient measures for the feedstocks to be deemed low ILUC risk.

The models used in ICAO for estimating ILUC incorporate three main market-mediated responses, namely, intensification, extensification and reduced food and feed demand. As a result, the ILUC values only capture the land-use impact of extensification after considering (1) the – often overoptimistic — yield increases driven by higher market demand to meet, e.g., biofuel volume mandates, and (2) the displacement of food demand that results from the associated higher market food prices. In this context, requesting the implementation of low ILUC risk land management practices for land-based feedstocks – that are currently optional under CORSIA — is equivalent to constraining the contribution of these feedstocks to intensification, i.e., preventing feedstocks that result in ILUC and affect food security. Still, this approach allows farmers to play a significant role in the decarbonization of aviation while preventing the unintended consequences that emerged when biofuels were deployed for ground transport.

The need to demonstrate low ILUC risk also applies to wastes, residues and by-products, although in a different way. These have been designated by ICAO CORSIA as having zero ILUC value because some of these do have low ILUC risk. But displacement effects resulting, inter allia, in ILUC may occur when certain waste-, residue-, and byproduct-based feedstocks for SAF displace other existing uses, e.g., for the oleochemical industry or food and feed industry. In this case the certification requirement in Table 2 stems from the need to demonstrate that the zero ILUC value designation is appropriate. Wastes, residues, and by-products having ILUC risk should be automatically ineligible. The rationale for these requirements is explored in further detail in Appendix D.1, which also includes guidance on the necessary refinements to ICAO CORSIA's related methodologies.

Under ICAO CORSIA, life-cycle emissions values may include some avoided emissions and removals from activities associated with SAF production even when they are not part of the SAF itself. This approach is accepted under ICAO because air carriers can meet the offsetting obligations using either emissions reductions from SAF or offsets but might be at odds with accounting protocols that exclude compensation of emissions with activities taking place beyond their value chain. It is therefore critical to distinguish clearly between emission reductions embodied in the fuel itself and the associated avoided emissions or removals. This is a necessary step for avoiding double claiming, as the different nature of these claims implies different reporting requirements and adjustments considering Article 13 of the Paris Agreement (see detailed description in Part C).

It is also critical that the methodologies approved for avoided emissions and removals are consistent with UNFCCC accounting rules. For instance, in the case of SAF produced from MSW, fuel producers may generate avoided Landfill Emissions Credits (LEC) and Recycling

Emissions Credits (REC). Meanwhile the methodology for REC adopted for CORSIA purposes is consistent with UNFCCC accounting, the same cannot be said about the methodology for LEC.[36] This advises caution and calls for rightfully aligning the CORSIA LEC methodology with the standard LEC methodologies that would be entitled to generate units for CORSIA consistent with UNFCCC accounting (see Appendix D.2 for a detail description). A fix that is also necessary in the context of California's LCFS. This is not a minor issue because a substantial share of the environmental benefits claimed with MSW-based SAF will likely come from changes in waste management rather than attributional life-cycle emissions reductions. The absence of a valid way forward for LEC in CORSIA does not mean MSW cannot contribute effectively. ICAO CORSIA allows for fuel producers to claim the environmental benefits of the biogenic MSW fraction independently of the fossil-based fraction from plastics. This is like the approach considered in the RFS in the United States.

(ii) Sustainability criteria

The full set of sustainability criteria approved by ICAO Council in November 2021 should also apply, regardless of the Council's decision to enforce it after 2023. It is important to emphasize that, for the sustainability criteria to be meaningful, SCS would need to assess and certify compliance for every single economic operator along the SAF supply chain. The sustainability criteria apply beyond the feedstock producers and generates liabilities across the entire supply chain; a provision that is often misinterpreted.

Among the additional requirements falling under the sustainability criteria category, there is not an explicit call for a tighter emissions reduction threshold than the 10% minimum reduction threshold[37] already considered by ICAO CORSIA. These thresholds could be envisioned as (1) a tool to make it harder for SAF pathways with large ILUC emissions to qualify and (2) to ensure that SAF provides meaningful emissions reductions. ICAO's minimum reduction threshold delivers a different outcome as it is only intended as a safeguard to ensure that any emission reduction claim in CORSIA is backed by real emissions reductions that go beyond the uncertainties associated with the life-cycle assessment methodology. However, as this handbook proposes to address the ILUC risk using low ILUC risk certification the purpose of the minimum reduction threshold would be limited to ensure that SAF delivers significant emissions reductions. Since only SAF that delivers large emissions reductions would make sense economically and environmentally, there is no need for more stringent emissions reduction threshold because SAF with insignificant reductions would be disqualified as a viable production pathway.

[36] The ICAO CORSIA LEC methodology assumes emissions as a function of 100-year life-cycle business as usual scenario that is not re-evaluated to match real world evolving conditions, granting emissions reductions that would only have happened –if at all— over the 100 years after MSW-based SAF use.

[37] Minimum reduction thresholds require life-cycle emissions values to be a given percentage lower than the fossil jet fuel baseline of 89 gCO_2e /MJ.

(iii) Avoiding double counting

Finally, under the avoiding double counting category, table 2 provides the overarching set of requirements to ensure claims are not double counted. This is the area of the CORSIA SAF methodology that requires the most guidance, which justifies the need for this handbook to devote further attention to this matter. Section B.2 provides the basis for the necessary infrastructure for building a robust and fully transparent reporting system to be able to (1) trace SAF once it is blended with fossil jet fuel and enters the jet fuel system, and (2) designate end-customer entitlements. Part C provides the necessary guidance for both SCS and governments to ensure that SAF use claims are properly captured in the national GHG emissions inventory reports and associated reports.

TABLE 2

Future-proof requirements to ensure any SAF procurement results in real emissions reductions that meet a high standard of sustainability and are not double counted.

Additional Requirements Needed to Ensure Integrity

Life-Cycle Assessment Approach	SAF from food and feed crops: • SAF should be evaluated using RSB-CORSIA[38] or equivalent standard. • Where a feedstock has ILUC risk, it should be automatically ineligible. Exceptions should only be made in instances where feedstock producers have implemented measures sufficient for the feedstock to be deemed low ILUC risk as per Commission Delegated Regulation 2019/807[39] and prove compliance with RSB's low ILUC Risk Biomass Criteria (RSB-STD-04-001),[40] or equivalent. • Where a feedstock is entitled to claim negative LUC emissions from removals (subject to the development and adoption of a high-integrity methodology, including provisions addressing non-permanence), the feedstock producer should demonstrate compliance with RSB's low ILUC Risk Biomass Criteria (RSB-STD-04-001), or equivalent. • Where a feedstock is entitled to claim a negative ILUC value unrelated to removals, the feedstock producer should demonstrate compliance with RSB's low ILUC Risk Biomass Criteria (RSB-STD-04-001), or equivalent.

Table 2 Cont.

38 The RSB certifies that economic operators meet a certain standard of sustainability. Using the RSB-CORSIA standard is more stringent than the regular RSB or RSB-RED standards.

39 "Commission Delegated Regulation 2019/807 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council as regards the determination of high indirect land-use change-risk feedstock for which a significant expansion of the production area into land with high carbon stock is observed and the certification of low indirect land-use change-risk biofuels, bioliquids and biomass fuels", 2019, Official Journal L133.

40 "RSB Low ILUC Risk Biomass Criteria and Compliance Indicators", 2015.

Additional Requirements Needed to Ensure Integrity

Life-Cycle Assessment Approach	SAF from wastes, residues and by-product feedstocks: • Where a fuel producer claims zero ILUC values, the producer should prove that claim by demonstrating compliance with RSB's low ILUC Risk Biomass Criteria (RSB-STD-04-001). • When a fuel producer cannot demonstrate low displacement emissions other than from ILUC, the fuel producer should estimate and add the displacement emissions [41] to the life-cycle value. For estimating these displacement emissions, fuel producers should use RSB's Methodology for Displacement Emissions (RSB-STD-04-002).[42] Where a feedstock is shown to have ILUC risk, it should be automatically ineligible. • For SAF from MSW feedstocks entitled to LEC and REC: the REC could be generated using the ICAO SAF framework, but LEC should only be generated by means of (a) a CORSIA eligible offsets program that meets CORSIA Emissions Unit Criteria, or (b) using ICAO's SAF framework, but only once ICAO provides a valid way forward consistent with, e.g., the approach described in Appendix D.3.
	SAF with carbon capture and sequestration (CCS): • Where a fuel producer captures and sequesters CO_2 from SAF production in geological formations, the producer should use a high-integrity methodology including provisions addressing non-permanence. CCS projects sequestering CO_2 in oil and gas reservoirs for enhanced oil recovery purposes should not be eligible.
	SAF derived from renewable electricity and recycled carbon (e-fuels): • SAF producers should demonstrate that only otherwise curtailed or surplus renewable electricity (as described in Appendix E) is used to produce the fuel.
Sustain-ability Criteria	All economic operators, i.e., not limited to feedstock providers, involved in the SAF supply chain should comply with ICAO's full list of Sustainability Criteria (Table 1), regardless of ICAO Council's decision to apply them after 2023.
Avoiding Double Counting	• Air carriers, corporations and other end-customers should only purchase emissions reduction units from SAF (1) from fuel producers certified by an ICAO CORSIA approved SCS whose Traceability Standard is enhanced with a robust and fully transparent reporting system for SAF by means of, e.g., a book-and-claim system consistent with guidance provided in Section B.2, and (2) from fuel producers that have obtained a letter of attestation that commits the host country to avoid double claiming, as described in Section C.2. • Corporations and other end-customers should only purchase emissions reduction units from SAF when the transaction involves an air-carrier partner that can deploy SAF and engages to report but not claim the SAF towards its own compliance obligations and commitments.

[41] Not all displacements result in displacement emissions, e.g., when the displacement occurs in a sector that is covered under a cap-and-trade system.

[42] "RSB Methodology for Displacement Emissions", 2018.

B.2_Avoiding Double Claiming

This section outlines approaches to prevent an outcome where the emissions reductions from SAF are erroneously claimed by air carriers, corporations other end-customers and/or the host country, which can lead to multiple claimings that could undermine global climate ambition.

Avoiding double claiming and ensuring the integrity of SAF claims in a context of overlapping GHG-emissions inventories, life-cycle emissions claims and lack of transparency might be challenging unless stakeholders carefully define the nature of the claims and follow adequate procedures. The nature of the SAF claims can vary widely, including, e.g., from stakeholders seeking to enhance global climate ambition to stakeholders willing to send a demand signal or contribute to the achievement of existing Nationally Determined Contributions (NDC) under the Paris Agreement.

This section focuses on the scenario where air carriers, corporations and other end-customers are motivated to purchase high-integrity SAF in order to claim the associated emissions reductions towards either (1) their domestic or international compliance obligations (applicable to air carriers and corporations who own air cargo or business jet fleets), or (2) their own voluntary emissions reduction targets aimed at increasing global climate ambition beyond existing climate goals (applicable to all).

In this context, air carriers, corporations and other end-customers should ensure the emissions reductions they claim represent a tangible atmospheric benefit, meaning that:

(a) emissions reductions are not double claimed by the State where the SAF was uplifted or host country (**avoiding double claiming with host country**), and

(b) the corporations and other end-customers are eligible to claim the emissions reductions from SAF because they go beyond reductions that would have occurred as a result of a climate emissions reduction obligation on air carriers such as CORSIA and the EU ETS or beyond voluntary pledges by air carriers (**avoiding double claiming with air carriers' obligations and commitments**).

Avoiding double claiming with the host country has two possible dimensions depending on the applicable jurisdiction (domestic or international). Either way, avoiding double claiming requires countries to perform adjustments under the modalities, procedures and guidelines for the transparency framework for action and support, referred to in Article 13 of the Paris Agreement. The adjustments include corresponding adjustments to Emissions Balances as well as adjustments to the indicators that countries will select for tracking progress towards their NDC. The extent to which such adjustments are necessary depends on the nature of the claims, as described in Section B.2.2. Part C.

In the case of SAF used on **international flights**, the need to perform adjustments would be driven by a potential mismatch in how SAF use is reported by the country where SAF is uplifted (the host country). This mismatch occurs when SAF used internationally is reported as biofuel used for domestic purposes in the National Inventory Report, instead of reporting SAF as international bunker, due to asymmetry of information, i.e., the country is not necessarily aware SAF is being claimed internationally. As a result, the host country could end up claiming zero CO_2 combustion emissions from the use of SAF for domestic aviation, capturing a reduction in its inventory while at the same time allocating the fossil fuel that was used for domestic aviation to international aviation instead, when it was the other way around.

When such an accounting mismatch occurs, host countries should still be able to address it by making an adjustment later on in the context of the information used to track progress made in implementing and achieving their NDC. To that end, the host country would need to identify the appropriate indicators and describe the underlying methodology and accounting approach used. This way host countries would be able to ensure the integrity of their Paris pledges in accordance with the modalities, procedures and guidelines for the transparency framework referred to in Article 13 of the Paris Agreement. Part C provides a detailed description on the necessary adjustment.

It is important to underscore that the nature of this adjustment is different from the corresponding adjustments applicable in the case of cooperative approaches under Article 6 of the Paris Agreement, which do not apply in that context but would still be necessary in the context of international aviation. Indeed, when SAF involves landfill emissions credits, recycling emissions credits, carbon sequestration credits, waste CO_2 credits and similar future credits embedded/bundled in the SAF life-cycle value, a corresponding adjustment will also be required.

In the case of **domestic aviation**, the adjustments would be intended to ensure that SAF emissions reductions are not claimed towards the host country's NDC. To that end, the host country would need to identify the appropriate indicators and describe the underlying methodology and accounting approach used in accordance with the modalities, procedures and guidelines for the transparency framework referred to in Article 13 of the Paris Agreement.

This way, air carriers, corporations and other end-customers would have the certainty that their contribution delivers an atmospheric benefit that goes beyond other climate pledges, if that is their motivation. In addition to these adjustments, it might be necessary to make corresponding adjustments in accordance with Article 6's rulebook when credits embedded in the life-cycle value are involved. This applies to landfill emissions credits, recycling emissions credits, carbon sequestration credits, waste CO_2 credits and similar future credits that could make its way into the CORSIA SAF Framework.

The necessary adjustments for both domestic and international aviation will need an active engagement by the host country or the country where the emissions credits originate from. As noted in Part C, the countries involved should issue a letter of assurance and authorization to the fuel producer. That would increase the awareness and accountability of countries. However, in the case of domestic aviation, it will also require an enhanced communication mechanism to ensure countries take note of air carriers' SAF use claims for domestic purposes if the air carrier/end-customer is seeking to go beyond existing climate goals, something easier to operationalize in the case of international aviation.

Avoiding double claiming with air carriers' obligations and commitments, the second type of double claiming considered here, requires partner air carriers to report the use but not claim SAF emissions reductions towards their own compliance obligations or commitments, i.e., the air carrier cannot claim the emissions reductions towards regulatory compliance or its own voluntary pledges but can capture them in its emissions inventory.[43] Emissions reductions claimed by an end-customer that appear in the air carrier's emissions inventory, or associated communications, should be clearly marked as "belonging" to the end-customer so that other end-customers are aware they cannot claim the resulting lower carbon intensity aviation services. The same approach applies to upstream economic operators such as fuel suppliers with climate goals. The purpose of end-customer action should be to supplement existing pledges and obligations to address unchecked emissions.

B.2.1_Implementing a Robust and Fully Transparent Reporting System

This Section provides the basis for establishing a robust and fully transparent reporting system for avoiding double claiming. It builds on a flexible book-and-claim system as a complement to the existing traceability systems to be able to trace end-customer designations and provide the optional flexibilities that a book-and-claim system provides. The main purpose of this Section is to provide guidance – by means of an illustrative approach — on how to (1) transparently trace SAF once it is blended with fossil jet fuel and enters the jet fuel system, (2) designate univocally end-customer entitlements, and (3) avoid all types of double claiming.

To illustrate the approach to avoid double claiming under such a transparent reporting system, we consider (i) a corporation using SAF to reduce emissions from an international

[43] Whether climate benefits from SAF that is deployed for a particular customer can be claimed towards the air carrier's voluntary GHG emissions reduction goal is a function of how the goal is articulated. However, generally, such goals are interpreted and expressed as a reduction in the carbon intensity of the air carrier services that will benefit all customers, not a particular customer.

flight covered by CORSIA and (ii) that the air carrier will uplift SAF for consumption in a country different from where the air carrier is based, meaning that the air carrier will report to another country following ICAO CORSIA rules (according to which air carriers report, in general, to the country which issued the Air Operator Certificate). This is the most complex case air carriers and corporations are likely to face, meaning that in other instances, not every step outlined in this approach needs to be followed.

This illustrative approach also makes the following assumptions: (1) SAF purchases occur starting in 2022, with CORSIA and the Paris Agreement fully operational; (2) the corporation (end customer) is purchasing the SAF environmental attributes and will claim emissions reductions towards its own voluntary targets – such as those outlined under the SBTi — with the goal of increasing global climate ambition; and (3) the corporation will purchase "high-integrity SAF" defined here as SAF that meets the requirements outlined in section B.1.

B.2.1.1_High-Integrity SAF Traceability

The foundation for proper accounting relies on a robust and transparent traceability system. In accordance with best practices, all economic operators involved in SAF along the supply chain from production to blending with fossil jet fuel need to implement a mass-balance system.[44] While the mass-balance traceability system could also apply throughout the supply chain, from blending onwards, the traceability system could transition to a book-and-claim system (see Figure 2). Under a book-and-claim system, the physical volumes of SAF are detached from the SAF environmental attributes (hereinafter the **SAF credit**, as it is credited into the book-and-claim system), which encompasses all the environmental attributes of the SAF. For accounting purposes, the blended physical volumes are treated as jet fuel without any environmental attributes. Alternatively, if there were a requirement to trace SAF to the airports, the mass balance system could be extended through the airport fuel farm and transition, at that point, from a mass-balance traceability system to the book-and-claim system.

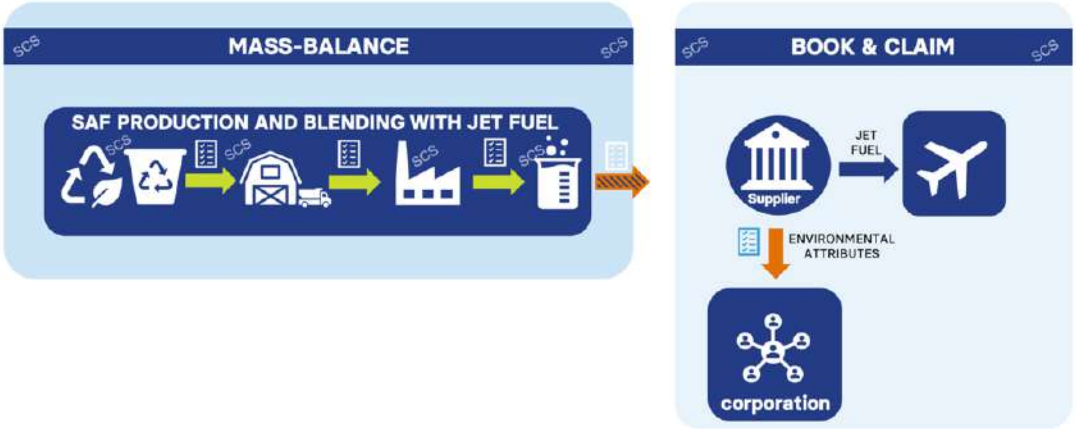
Is this approach compatible with CORSIA? For SAF to become eligible under CORSIA fuel producers must be certified by an ICAO-approved SCS. It also requires mass-balance traceability through at least the blending point with fossil jet fuel. However, the ICAO rules are vague on the traceability requirements applicable after blending, which could be interpreted as an informal book-and-claim system outside the scope of the SCS. Such book-

[44] A mass-balance system allows batches of sustainable materials with differing sustainability characteristics to be mixed for as long as the sum of all consignments withdrawn from the mixture to be described as having the same sustainability characteristics, in the same quantities, as the sum of all consignments added to the mixture. For a full description of mass-balance traceability requirements see table 3 in ICAO document "CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes", First edition, November 25, 2019.

and-claim system would have geographical flexibility constrained by the need to demonstrate SAF use.

FIGURE 2

Transition from a mass-balance system for physical SAF volumes to a book-and-claim system where the physical volume is separated from the SAF environmental attributes.



Under CORSIA rules, fuel purchases and transaction reports, together with fuel blending records and sustainability credentials, constitute the documentary proof for the purpose of verification of SAF claims. To claim emissions reductions the air carrier shall (1) report a set of detailed information to its ICAO State by the end of the compliance period for net purchases of SAF, and (2) declare that it has not made claims for the same SAF under any other GHG scheme, such as for domestic flights covered under the EU ETS. These claims are verified by a "verification body" directly hired by the air carrier to perform the verification of the air-carrier's emissions report.[45] The scope of verification is limited though and not necessarily connected to the assurance system designed by ICAO-approved SCS.[46]

Verification of SAF claims under CORSIA is only meant to ensure that (1) the air carrier is not claiming the use of SAF under another mandatory or voluntary scheme it participates in, and (2) SAF emissions reductions claims are (i) materially fair, (ii) an accurate representation and (iii) consistent with the CORSIA Standards and Recommended Practices (SARPs). Air carriers are required to have audit rights of the production records of SAF but executing these rights is envisioned as a last resort action. This represents a vulnerability that is exacerbated by the fact that the information publicly available in the CORSIA Central Registry with CORSIA's compliance information is not sufficient to ensure the integrity of the claims. Key pieces of information are missing, including information on the host country, which can be different from the country where SAF is produced, making it very difficult for countries to prevent double claiming. But, also, the break-down of the life-cycle values, which makes it hard for corporations to estimate the life-cycle value connected to its value chain and avoid

45 See ICAO CORSIA SARPs Volume IV, Appendix 6 on Verification (op. cit.)

46 See Appendix 6 on Verification, Section 3.3 Scope (ISO 14064-3:2006 section 4.3.4) in ICAO CORSIA SARPs Volume IV (op. cit.)

claiming, e.g., Landfill Emissions Credits in the context of accounting protocols that exclude compensation of emissions.

To prevent financial and reputational risks, air carriers should only purchase SAF from SCS-certified economic operators to ensure that the SAF chain of custody is not broken and that the SAF claims represent real emissions reductions. This can be achieved by means of a mass-balance system applied throughout the supply chain or by the combination of a mass-balance system – through at least the blending point as requested under CORSIA — with a book-and-claim system operated by an ICAO CORSIA approved SCS.

The main role of the book-and-claim system is to provide a transparent accounting system to trace transactions and claims. But a book-and-claim system can also help facilitate SAF claims by allowing stakeholder to claim SAF benefiting from either geographical or temporal flexibility, or both. However, these flexibilities are neither necessarily compatible with the CORSIA SAF framework nor with the needs of corporations willing to claim emissions reductions directly connected to their value chains. Aircraft operators willing to claim SAF under CORSIA and corporations seeking emissions reductions consistent with accounting protocols that exclude compensation of emissions might not be entitled to fully benefit from the geographical and temporal flexibilities. Only aircraft operators, corporations and end-customers that have the autonomy to claim SAF environmental benefits without constraints (including emissions reductions beyond the corporation's value chain) might be able to benefit from the geographical and temporal flexibilities. Still, the flexibility that a book-and-claim system provides could boost demand from non-corporate end-customers in particular, which could accelerate the uptake of SAF globally.

B.2.1.2_Book-and-claim System operated by a CORSIA Approved SCS

Under a book-and-claim system operated by a SCS (Figure 3), any SAF from a SCS-certified fuel producer or supplier gets logged or registered as a single SAF credit in the SCS's designated registry.[47] Information for each SAF credit includes a serialized batch number to identify ownership and all environmental attributes. The inclusion of SAF environmental attributes beyond GHG emissions reductions demonstrates that the associated mitigation outcome promotes sustainable development and ensures environmental integrity and transparency.

While this illustration focuses on the case where the book-and-claim system is operated by a SCS, it should be noted that the option exists for the book-and-claim system to be operated by economic operators such as air carriers for as long as these are SCS-certified as following the same book-and-claim procedures.

[47] This approach builds on RSB's groundwork to develop a draft book-and-claim manual in 2016.

FIGURE 3

Summary of illustrative book-and-claim system for SAF credits operated by a SCS. While it depicts the case where an airline retires the SAF credit on behalf of a corporation, a book-and-claim system would also allow for the corporation itself –as an account holder— to retire the SAF credit in partnership with the associated airline responsible for SAF reporting requirements.

1. After blending, the physical volumes of SAF are detached from the environmental attributes (SAF credit).
   - ✓ SAF credit should be registered in the SCS's designated public registry with a serialized batch number, identifying all environmental attributes.

2. Suppliers need to:
   - ✓ Be certified by an approved SCS.
   - ✓ Hold a letter of attestation –or equivalent— from the SAF host country (commitment to avoid double claiming).
   - ✓ Have partnership with an air carrier that can deploy SAF.

3. The air carrier, acting on behalf of the end-customer, should retire the SAF credits from the SCS registry: "SAF credit retired by air carrier X on behalf of end-customer Y".

Corporations can purchase registered SAF credits or directly purchase them through the intermediary of an air-carrier partner that would retire credits on behalf of the corporation. Either way, the corporation will need an air-carrier partner who will be responsible for reporting SAF use for CORSIA purposes. Given their SAF end-customer status in the supply chain, corporations and air carriers operating under a book-and-claim system only need to get registered as account holders, i.e., no SCS certification is necessary as it is the case of all other economic operators entitled to trade SAF. SAF credit transactions are reported to the SCS who will note them accordingly in the registry, or directly capture them in an automated registry.

Generally, end-customers should only purchase SAF credits from a supplier that is: (i) certified by a SCS; (ii) has a letter of attestation – or equivalent — from the host country where the SAF is uplifted, with the commitment to avoid double claiming with the host country climate targets, where necessary; and (iii) an air-carrier partner that can deploy SAF and act on their behalf.

Finally, the partner air carrier, acting on behalf of the corporation, will retire SAF credits from the SCS registry (Figure 3). Once the SAF credit has been retired, the SCS will issue a retirement statement or declaration including the details of the claim and clearly stating "SAF credit retired by air carrier X on behalf of end-customer Y". To ensure transparency, the SAF certificates would need to be made publicly available (see Part C for further guidance to SCS). A book-and-claim system would also allow for the corporation itself –as an account holder— to retire the SAF credit by making explicit the partnership with the associated airline, in which case the retirement statement will read "SAF credit retired by end-customer

Y in partnership with air carrier X". The retirement statement could be further simplified by simply listing the airline carrier and the corporation entitled to claim SAF use.

Since a book-and-claim system operating consistently with the CORSIA SAF framework cannot provide temporal flexibility beyond the calendar year to ensure proper accounting by host countries as described in Section D.2, end-customers could still benefit from this flexibility if the book-and-claim system allowed for the postponement of the end-customer designation. In such a case, the retirement statement will indicate that a particular customer or group of end-customers entitled to claim the SAF credit will be selected at a later stage. If this flexibility is combined with a clear GHG emissions reduction denomination for the SAF credit in accordance with Section B.1 and Appendix A, it could contribute to create a robust market that could boost SAF demand, and at the same time empower end-customers to address their air travel carbon footprint.

The SCS would need to have clear requirements for SAF claims to ensure avoidance of double counting towards existing compliance obligations and commitments. This step will ensure that the corporation can claim the associated emissions reductions towards its own voluntary emissions reduction target. The air-carrier partner could reflect the emissions reductions in its emissions inventory but not count them towards its own obligations or voluntary pledge. The emissions reductions in the air carrier's emissions inventory should be clearly marked as "belonging" to the corporation so that other end-customers are aware they cannot claim them. Other economic operators involved in the supply chain would also be entitled to report downstream supply-chain emissions reductions for as long as it is reported as climate action beyond their obligations and/or voluntary pledges. The same publicly available retirement statement or declaration should be used by, e.g., the fuel supplier, the air carrier and the corporate customer involved in the transaction.

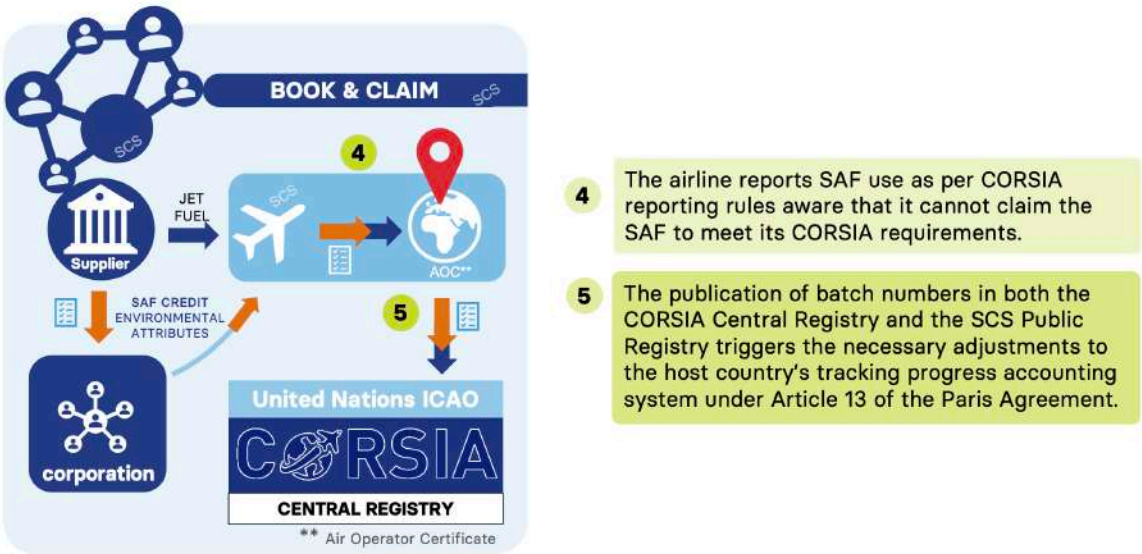
B.2.1.3_Reporting SAF Use by the Air Carrier

Once SAF credits are retired in the SCS public registry, the air carrier will proceed to report the SAF following CORSIA rules, being aware that it cannot claim the SAF to meet its own CORSIA requirements (Figure 4). From the perspective of ICAO, the SAF credits claimed by corporations will show as overcompliance of the air carrier with its CORSIA obligation in the ICAO CORSIA registry, contributing to the enhanced transparency framework of the Paris Agreement, which is critical for avoiding double claiming as noted in Part C.

Under CORSIA rules, air carriers report to the country which grants their Air Operator Certificate, which then reports to ICAO. ICAO publishes CORSIA aggregated data in the CORSIA Central Registry. The CORSIA Central Registry does not distinguish between: (i) SAF credits claimed by the air carrier, and (ii) SAF credits claimed by the air carrier on behalf of the corporation and other end-customers.

FIGURE 4

Summary of the SAF credit reporting and publication necessary to trigger an adjustment for the case where the host country follows the tracking-progress adjustment approach as described in Section D.3.2. If the host country follows the international-bunker adjustment approach instead, the allocation to international aviation contained on the temporally constrained SAF credit retirement statement would be sufficient to trigger its designation as international bunker in the host country's emissions inventory.



The publication of batch numbers in both the CORSIA Central Registry and the SCS Registry, will alert the host country where SAF is uplifted from – which can be different from the country the air carrier reports to — to the need to make an adjustment to its tracking progress accounting system under Article 13 of the Paris Agreement, avoiding double claiming (see Figure 5). Without the publication requirements the host country might consider that the SAF was used for domestic purposes (either for aviation or for ground transport) and erroneously claim it towards its Paris Agreement commitments, resulting in double claiming.

This procedure is consistent with the case where the host country applies the *tracking-progress adjustment approach* as described in Section D.3.2. If the host country follows the *international-bunker approach* instead, the allocation to international aviation contained on the SAF credit retirement statement should be sufficient to trigger its designation as international bunker in the host country's emissions inventory. See Part C for a full discussion and recommended guidance for SCS and governments.

Finally, Figure 6 provides a complete graphical overview of the illustrative approach to avoid double claiming of SAF credits by ensuring transparency and proper emissions reduction accounting. This approach can be applied in different jurisdictions with modifications based on the policies in place.

FIGURE 5

Overview of the adjustment made by the host country, for the case where the host country follows the tracking-progress adjustment approach as described in Section D.3.2

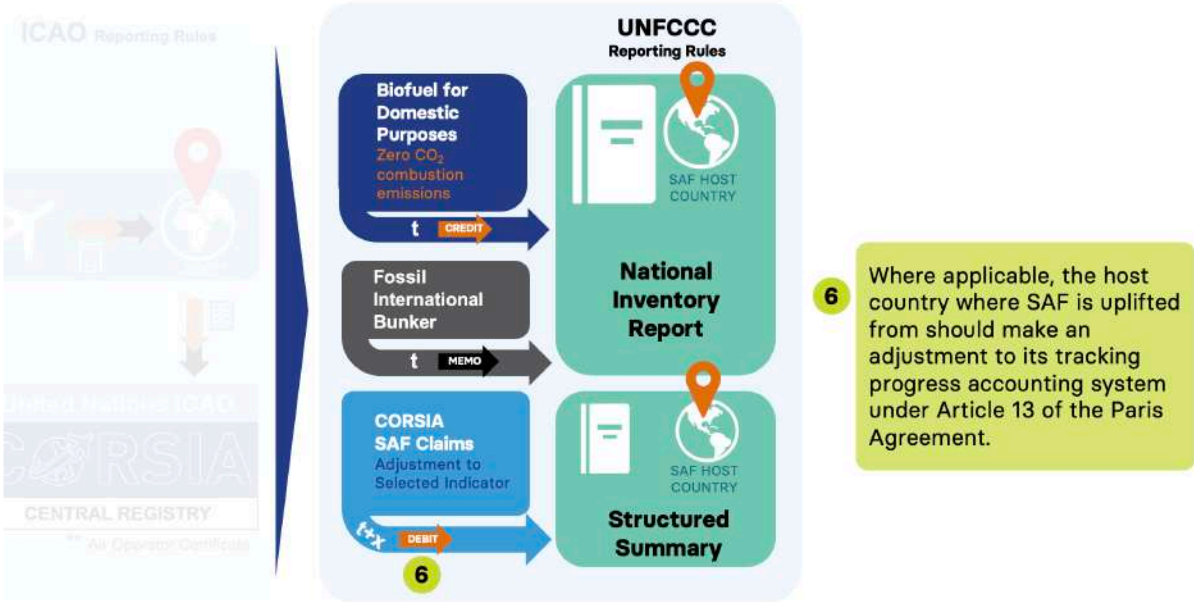
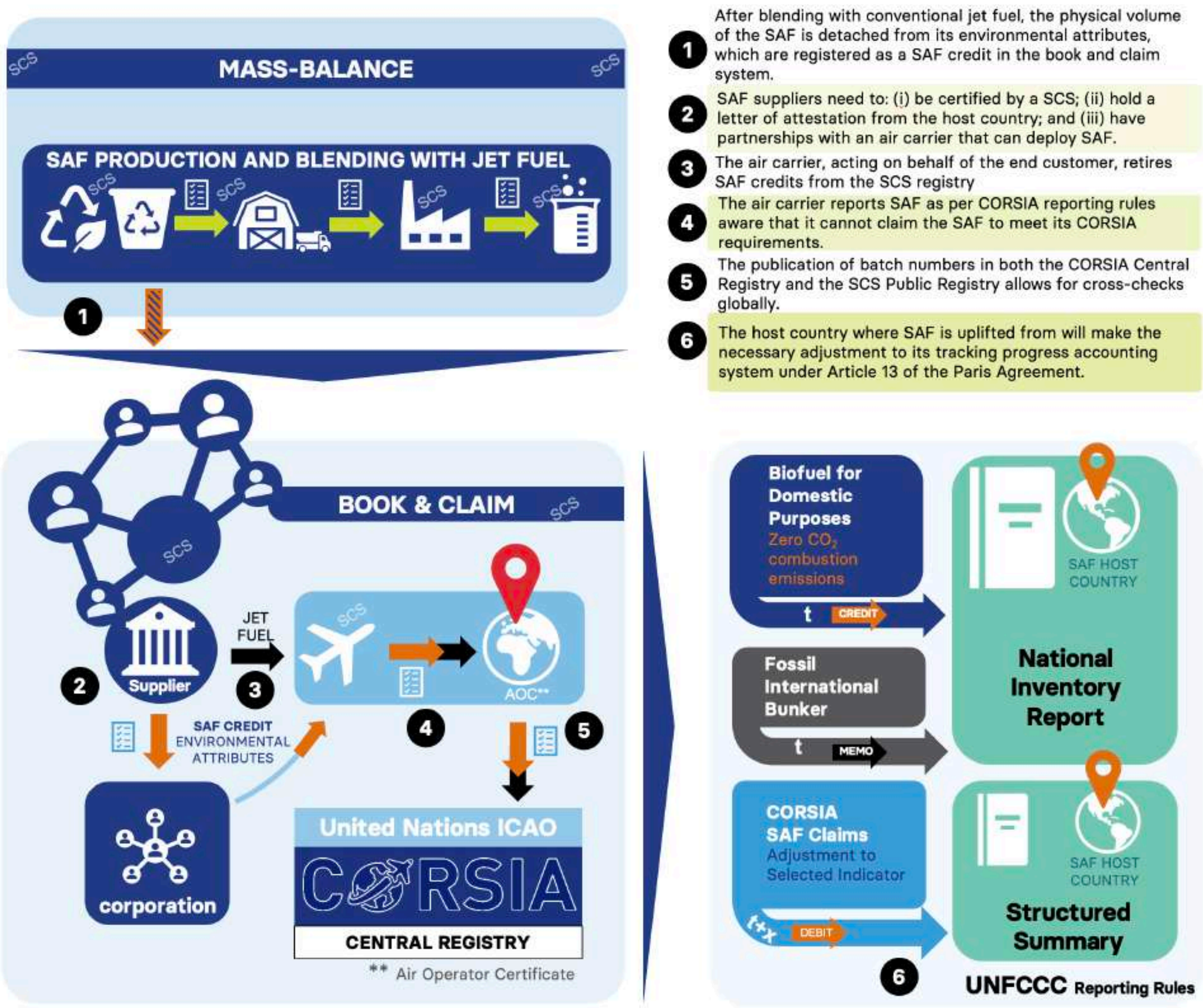


FIGURE 6

Overview of the illustrative approach to avoid aouble claiming of SAF.



B.2.2_Eligibility to Claim SAF as Value-Chain Emissions Reductions

Determining how and to what extent SAF emissions reduction claims are value-chain reductions is a function of (i) the nature of the claim, i.e., whether it is an emissions reduction directly connected to the value chain or not, (ii) the scope of emissions covered under the GHG emissions inventory, (iii) the motivation of the air carriers, corporations, or other end-customers, and (iv) the transparent allocation of the reductions among end-customers.

First, the extent to which SAF represents an emissions reduction connected to the value chain of air carriers, corporations, or other end-customers[48] would need to be determined by geographical, temporal, and physical constraints. Only when a corporation can demonstrate having used air travel services that are compatible both geographically and temporally with the SAF, it will be able to claim, without ambiguity, direct emissions reductions in its value chain.

Alternatives exist for claiming SAF climate benefits where only SAF combustion emissions are considered. But this would result in the claim being equivalent to that of an offset, where combustion emissions are compensated with reductions that take place upstream in the value chain. Claiming SAF as an offset, even if fully connected to the value chain, might have implications depending on the accounting protocol followed.

Air carriers, corporations and other end-customers might also opt to take advantage of either geographical, temporal and/or physical flexibilities.[49] In that case, the SAF emissions reductions will be equivalent to, and essentially fungible with, offsets too. But only for as long as it reduces emissions, meets a high standard of environmental integrity and is transparently and accurately accounted for.

Second, corporations and other end-customers who want to claim SAF as an emissions reduction in value-chain emissions would need to account for the full supply chain emissions of transport fuels instead of just combustion emissions.[50] Since Jet-A fuel / Jet-A1 fuel's combustion emissions (tank-to-wake) amount to around 82% of total life-cycle emissions (well-to-wake) of the fuel, air carriers, corporations and other end-customers that reported only combustion emissions will now have to account for an increase of about 22% in emissions to account for the missing 18% well-to-tank emissions. This approach is not only

[48] Value chain emissions are defined as a corporation's scope 1, 2, and 3 emissions as defined by the GHG Protocol (SBTI Corporate Net-Zero Standard, October 2021)

[49] Relaxing the physical constraints would allow for compensating, e.g., 100% of the emissions by claiming more SAF than is necessary for flying.

[50] This is a provision that was not envisaged in CORSIA by design, as CORSIA only focusses on combustion emissions, but that air carriers and corporations should consider in the context of their climate pledges and emissions inventories.

fully compatible with accounting protocols like the GHG Protocol, it also corrects a critical accounting error and represents best practice.[51]

Third, whether the SAF emissions reductions can be claimed as such by air carriers, corporations and other end-customers is also a function of the policy context and the goal that motivates the deployment of SAF. This will, in turn, require accurate reporting to prevent double claiming. For instance, a corporation or end-customer that purchases SAF environmental attributes to claim the associated emissions reductions towards its voluntary target will be able to prevent double claiming provided a partner air-carrier reports but does not claim SAF use and the host country reports as international bunker or makes the necessary adjustments to the host country's GHG emissions reports under Article 13 of the Paris Agreement. Similarly, an air carrier that deploys SAF to claim the emissions reductions towards its compliance obligations or its voluntary target can prevent double claiming provided it reports it transparently for the host country to be able to fulfill its reporting obligations. The nature and scope of these adjustments are detailed in Part C.

But the need for an adjustment depends on the policy context and goal the corporation, end-customer or air carrier may have. For instance, rather than claiming emissions reductions, a corporation might want to simply send out a demand signal for SAF, facilitate the achievement of national climate goals or air carrier's compliance obligations under CORSIA, in which case no adjustments would be necessary because the corporation is not claiming the reductions.

Finally, on the need for air carriers to transparently allocate reductions among their end-customers, when an air carrier claims SAF emissions reductions towards its compliance or voluntary targets, the reductions should benefit all the end-customers of the air carrier and should not be allocated to particular end-customers. Indeed, air carriers should go beyond their compliance obligations and allocate the reductions to all their customers as a mechanism to, e.g., reduce the carbon intensity of the services they offer. If instead reductions have been supported and will be claimed by a particular end-customer or group of end-customers, air carriers should only be able to report the emissions reductions in their inventories for as long as these go beyond compliance obligations and voluntary targets. As

[51] The GHG Protocol sets frameworks to inventory GHG emissions, which are divided in three categories: Scope 1 direct emissions from sources owned or controlled by the reporting company; Scope 2 indirect emissions from electricity purchases; Scope 3 indirect emissions including both upstream and downstream sources. The Protocol establishes Scope 1 as minimum requirements for air travel services (for fuel use under category 6 for business travel and category 9 for downstream transportation and distribution), but the system boundary can be extended to cover upstream Scope 3 emissions, i.e., to include full life-cycle emissions. The GHG Protocol further directs corporations not to include in the "scopes" the biogenic CO_2 emissions that occur in the value chain but separately report them in the corporation public report. While this is consistent with the 2006 IPCC Guidelines applicable to country inventories, it leads to the same accounting error this handbook corrects. Reporting "zero" CO_2 combustion emissions is only appropriate when full life-cycle emissions are considered.

noted above, the purpose of end-customer action should be to supplement existing pledges and obligations to address unchecked emissions.

Alternatively, if air carriers allocate SAF emissions reductions to a particular end-customer while these same reductions have also been used for meeting the air carrier's compliance obligations, e.g., under CORSIA, the end-customer should not claim any emissions reductions because its action will not generate any atmospheric benefit beyond what was going to be achieved anyway under CORSIA. Instead, it may claim it is sending a market signal about end-customer preferences to incentivize the uptake of SAF.

Sections B.2.2.1 and B.2.2.2 illustrate how (1) the need for adjustments changes depending on the policy context and the underlying motivation, and (2) the eligibility to claim the emissions reduction depends on the interaction with air carrier's obligations. Section B.2.2.1 focuses on the case where there is a commitment to reduce direct emissions from air carrier's commercial services and/or a corporation's own air cargo or business jet fleet, i.e., direct operational emissions from its value chain. Section B.2.2.2 focuses on a corporation committed to reduce its indirect emissions from business travel or air freight, i.e., its indirect value chain emissions.

B.2.2.1_Emissions Reductions from Air Carriers

This case assumes air carriers, i.e., commercial aviation operators, or corporations who own air cargo or business jet fleets, have chosen to deploy SAF to reduce emissions. This case also assumes that air carriers have compliance obligations to fulfill (e.g., EU ETS, CORSIA) and illustrates how to allocate emissions reductions to their end-customers, when applicable. Table 3 provides an overview of the variables and outcomes for this case, including whether the air service is domestic or international; whether the air carrier intends to claim emissions reductions towards a voluntary target; and the eligibility to claim emissions.

In the case where the SAF is used for domestic aviation purposes, if the air carrier decides to use SAF towards domestic policy compliance, it can transparently claim life-cycle emissions reductions, reducing the carbon intensity of its fleet operations (**Example 1.A** in Table 3). In this case, there is no need for an adjustment. All the air carrier's end-customers could reflect the reduced carbon intensity in their emissions inventories.

If the air carrier decides to go beyond domestic policy compliance obligations and lead on global ambition (**Example 1.B** in Table 3), an adjustment would be required.[52] As for the previous example, all the air carrier's end-customers could reflect the reduced carbon intensity in their emissions inventories.

[52] This adjustment should be performed following the procedure described in Section D.3.2 for international aviation.

TABLE 3

Options for an air carrier deploying SAF to reduce emissions, where air carriers can only claim emissions reductions as an increase in global ambition when these represent a tangible atmospheric benefit. In the case of international flights, the adjustments are only required in the case the host country does not report the SAF use as international bunker.

Example	Flight Type	Goal	Adjustment required	Emissions Reductions Claim Eligibility
1.A	Domestic	Claim emissions reductions towards compliance obligations	No	○ The air carrier can claim emissions reductions towards compliance obligations. ○ All the air carrier's end-customers can reflect the reduced carbon intensity in their emissions inventories.
1.B	Domestic	Beyond compliance obligations to claim emissions reductions towards voluntary target	Yes	○ The air carrier can claim emissions reductions towards voluntary target as an increase in global ambition. ○ All the air carrier's end-customers can reflect the reduced carbon intensity in their emissions inventories.
1.C	Domestic	Beyond compliance obligations to support host country NDC achievement	No	○ The air carrier cannot claim emissions reductions towards voluntary target as an increase in global ambition. ○ The carbon intensity of the air carrier does not change, and its end-customers cannot benefit from it.
1.D	International	Claim emissions reductions towards compliance obligations (CORSIA/EU ETS)	Yes	○ The air carrier can claim emissions reductions towards compliance obligations. ○ All the air carrier's end-customers can reflect the reduced carbon intensity in their emissions inventories.
1.E	International	Beyond compliance obligations to claim emissions reduction towards voluntary target	Yes	○ The air carrier can claim emissions reductions towards voluntary target as an increase in global ambition. ○ All the air carrier's end-customers can reflect the reduced carbon intensity in their emissions inventories.

If the air carrier decides to go beyond domestic policy compliance obligations to support the achievement of the host country's NDC (**Example 1.C** in Table 3), no adjustment would be required. However, neither the air carrier nor its end-customers could claim the emissions reductions towards their own targets as an increase in global ambition. Example 1.C is equivalent to structuring SAF credits as "guarantees of origin" (GoO), which would send a market signal about end-customer preferences but would not generate any environmental benefit beyond what was going to be achieved anyway.

The GoO are an instrument originally envisioned for allocating the renewable energy from mandated production quotas in the European Union among end-customers. The GoO were established under the EU Renewable Energy Directive in 2009 for stimulating demand for renewable electricity. Hence, GoO are conceived to send a market signal about end-customer preferences, but it does not generate any atmospheric benefit beyond what was going to be achieved anyway, as mandated by law as a means to achieve NDC targets. GoO should not be confused with other European green certificates used to demonstrate compliance with production quotas by utilities and that can also be used to go beyond mandates.

In the context of international flights, if the air carrier decides to use SAF for international policy compliance obligations such as CORSIA or international flights covered under the EU ETS (**Example 1.D** in Table 3), it would need to be transparently reported in order for the host country to report it as an international bunker or –if the country reports the SAF in its National Inventory Report as used for domestic purposes— make an adjustment to its tracking progress accounting system under Article 13 of the Paris Agreement, as described in Part C. The air carrier will be eligible to claim life-cycle emission reductions from SAF, reducing the carbon intensity of its fleet operations. All the air carrier's end-customers could reflect the reduced carbon intensity in their emissions inventories.

Finally, if the air carrier decides to go beyond international compliance obligations (**Example 1.E** in Table 3), SAF would need to be transparently reported so the host country can report it as an international bunker or make an adjustment. The air carrier will report the use of SAF in accordance with CORSIA regulation while exceeding its compliance obligations under CORSIA to capture the supplemental emissions reductions. The air carrier would obviously be eligible to claim emissions reductions towards its voluntary target as an increase in global ambition. All the air carrier's end-customers could reflect the reduced carbon intensity in their emissions inventories.

B.2.2.2_ Emissions Reductions from Business Travel and Air Cargo Services

This case assumes a corporation has chosen to deploy SAF to reduce emissions from business travel or air cargo services with a partner air carrier uplifting the SAF. Table 4 below provides an overview of the variables and outcomes for this case, including whether the trip is domestic or international and whether the corporation intends to claim emissions reductions that deliver an atmospheric benefit.

TABLE 4

Options for a corporation deploying SAF to reduce emissions from business travel, where corporations can only claim emissions reductions as an increase in global ambition when these represent a tangible atmospheric benefit. In the case of international flights, the adjustments are only necessary in the case the host country does not report SAF use as an international bunker.

Example	Flight Type	Goal	Adjustment Required	Emissions Reductions Claim Eligibility
2.A	Domestic	Go beyond domestic policy compliance obligations and lead on global ambition	Yes	○ The corporation can claim emissions reductions towards voluntary target as an increase in global ambition. ○ The air-carrier partner reflects the emissions reductions in its emissions inventory but does count them towards its own voluntary pledges.
2.B	Domestic	Facilitate NDC achievement (potentially including EU ETS domestic obligations)	No	○ The corporation cannot claim emissions reductions towards voluntary target as an increase in global ambition. ○ The air-carrier partner captures the emissions reductions in its emissions inventory and should be entitled to claim them. This would reduce the carbon intensity of the air carrier services, which eventually benefit all its end-customers.
2.C	International	Go beyond international policy compliance and lead on global ambition	Yes	○ The corporation can claim emissions reductions towards voluntary target as an increase in global ambition. ○ The air-carrier partner reflects the emissions reductions in its emissions inventory but does not count them towards its own voluntary pledges.
2.D	International	Facilitate international compliance (CORSIA/EU ETS)	Yes	○ The corporation cannot claim emissions reductions towards voluntary target as an increase in global ambition. ○ The air-carrier partner captures the emissions reductions in its emissions inventory and uses them towards its own obligations. This reduces the carbon intensity of the air carrier services, which benefits all its end-customers.

In the case where the SAF is used for domestic aviation purposes, and when the corporation decides to go beyond domestic policy compliance obligations and lead on global ambition (**Example 2.A** in Table 4), an adjustment by the host country would be required. This adjustment will help ensure emissions reductions go beyond compliance and are not claimed towards a host country NDC.[53]

However, if the corporation decides to facilitate NDC achievement, no adjustment would be required (**Example 2.B** in Table 4). In this case the corporation would not be entitled to claim these emissions reductions towards its own target as an increase in global ambition though, as that would be double claiming. The corporation would need to make the emissions reduction claim as a contribution to support host country NDC. Example 2.B is equivalent to structuring SAF claims as GoO. As noted in B.2.2.1, SAF credits structured as GoO would send a market signal about end-customer preferences but would not generate any environmental benefit beyond what was going to be achieved anyway.

In the case where the SAF is used for international purposes, if the corporation decides to go beyond international policy compliance (**Example 2.C** in Table 4), the carrier will need to transparently report SAF in accordance with the policy requirements, but not claim it towards its own obligations, delivering so an increase in global ambition. This will trigger an adjustment by the host country, where applicable, in accordance with guidance in Part C. Finally, the air-carrier partner will reflect the emissions reductions in its emissions inventory but will not count them towards its own voluntary pledges.

If the corporation decides to simply send a market signal about end-customer preferences and facilitate CORSIA/EU ETS achievement (**Example 2.D** in Table 4), the air carrier will need to transparently report and claim SAF in accordance with the policy requirements. Such a claim would trigger an adjustment by the host country, where applicable. However, the corporation could not claim these emissions reductions towards its own voluntary contribution as an increase in global ambition, as that would result in double claiming.

B.2.3_Contextualizing SAF Claims in Corporate GHG Emissions Inventories

Finally, it is relevant for air carriers and corporations to be able to properly contextualize their SAF claims in their GHG emissions inventories, and likewise, for other end-customers who do not maintain emissions inventories. To that end, stakeholders would need to consider the interaction and potential overlap of their claims with the broader climate policy landscape.

For instance, a corporation's emissions reduction goal for operational and/or other value

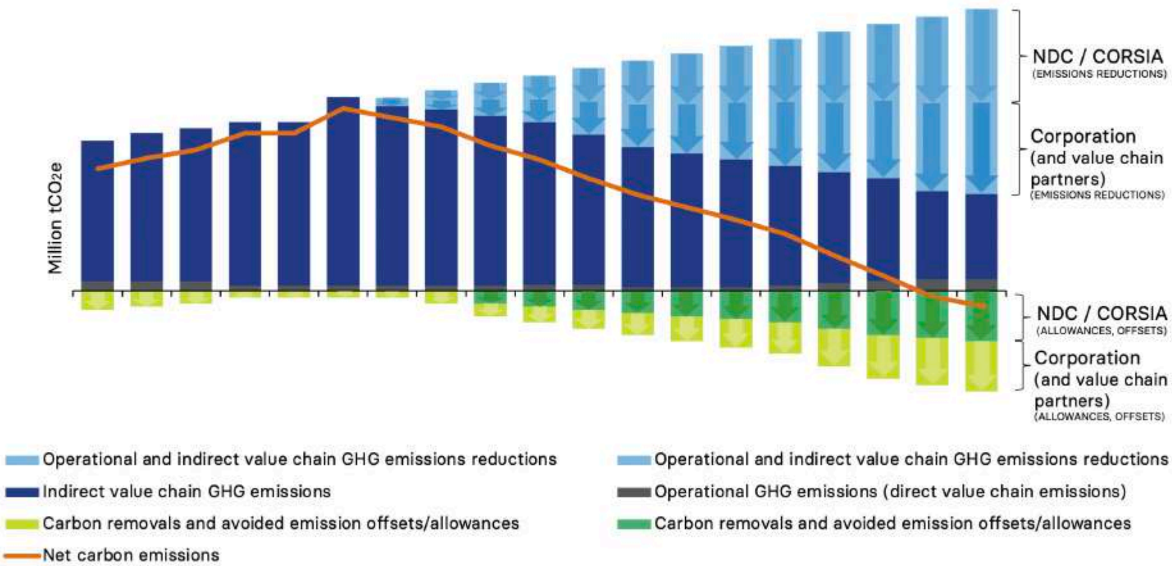
[53] This adjustment should be performed following the procedure described in Section D.3.2 for international aviation.

chain emissions will happen in tandem with countries pursuing their own climate ambition under the Paris Agreement, as well as other climate policies such as CORSIA. Therefore, to properly contextualize corporate emissions reduction goals, corporations need to account for the emissions reductions resulting from NDC implementation and CORSIA separately to their own voluntary commitments that go beyond these, i.e., the voluntary emissions reductions that are meant to enhance global climate ambition.[54] This approach applies both to voluntary action that corporations will achieve in cooperation with value-chain partners and voluntary goals applicable to the corporations' operational emissions.

This breakdown of emissions reductions in two distinct categories is depicted in Figure 7 that shows the evolving value chain GHG emissions for a hypothetical corporation with net zero goals. While the hypothetical corporation illustrated here has relatively small operational emissions compared to its non-operational value chain emissions, it is still representative for alternative configurations. The focus here is on the emissions reductions, which are clustered together independently of where these take place in the corporation's value chain.

FIGURE 7

A corporate emissions reduction goal including the contribution from NDCs/Climate policies. Illustrative of a corporation with relatively small operational emissions but with large value chain emissions. Based on Microsoft's Pathway to Carbon Negative by 2030.[55]



Climate action by the corporation is captured in two distinctive areas: emissions reductions that take place in its value chain and compensation of emissions. Value chain emissions reductions are depicted in the light green bars with downwards pointing arrows. The lighter green bars and arrows apply to reductions driven by NDC implementation and climate

[54] It is important to note here the difference between an overarching voluntary pledge under, e.g., the SBTi, which encompasses compliance and voluntary commitments, and the voluntary emissions reductions that go beyond compliance obligations.

[55] See here.

policies such as CORSIA. The darker ones correspond to the voluntary emissions reductions intended to enhance global ambition. Compensation is depicted in the yellow-green and green bars with arrows. The green bars capture offsets and allowances used to meet NDC or climate policies such as CORSIA. The yellow-green bars capture the offsets and allowances purchased by the corporation to meet its own voluntary goals that go beyond NDC and, e.g., CORSIA.

If, for instance, an air carrier with compliance obligations under CORSIA deploys SAF and chooses to go beyond CORSIA, the SAF emissions reductions will be reflected in the darker blue arrows in Figure 7. If instead an air carrier uses SAF emissions reductions to meet its CORSIA compliance obligations, these would be reflected in the lighter blue arrows. Alternatively, if the air carrier uses eligible CORSIA offsets (or EU allowances under EU ETS) these would be reflected as reductions taking place beyond the value chain in the relevant "NDC/CORSIA" grouping in green in Figure 7.[56]

Figure 7 would reflect the emissions reductions from direct value chain emissions from Examples 1.B and 1.E as part of the grouping "Corporation (and value chain partners)". However, emissions reductions from Example 1.A, 1.C and 1.D would be included as part of the grouping "NDC/CORSIA".

Emissions reductions from Example 2.A (indirect value chain GHG emissions) would be included as part of the groupings "Corporation (and value chain partners)". However, emissions reductions from Example 2.B involving GoO would be included as part of the grouping "NDC/CORSIA".

Likewise, emissions reductions from Examples 2.C and 2.D would be captured as part of the groupings "Corporation (and value chain partners)" and "NDC/CORSIA", respectively. However, in the case of example 2.D (and 2.B), it would only reflect a small fraction of the reductions because all end-customers of the carrier, including the corporation, would benefit from the reduction in carbon intensity.

B.2.4_Compatibility with Existing Incentives: The Atmospheric Benefit Test

Some jurisdictions already have regulations in place to reduce emissions and/or incentivize alternative fuel use. For these incentives to be compatible with SAF emissions reduction claims towards voluntary climate targets, the incentives need to generate emissions reductions beyond those already incentivized by compliance obligations. This ensures they create an atmospheric benefit, meaning they generate an emissions reduction that would not have otherwise occurred.

[56] Not all allowances surrendered by an air carrier under the EU ETS represent emissions reductions. Only those above the share of available aviation allowances pertaining to an air carrier can be claimed as such.

For SAF claims to be compatible with existing SAF policy incentives that can bring down the SAF premium gap, in addition to the requirements outlined in previous sections (a letter of attestation that commits the host country to avoid double claiming), SAF needs to pass the atmospheric benefit test (ABT). The test consists of the following requirements:

a) **Economic incentives from carbon markets such as CORSIA**. This kind of incentives passes the ABT when a particular end-customer or group of end-customers are claiming SAF reductions towards a voluntary climate target expressed as an increase in global ambition, and it is not also used by an air carrier to meet a regulatory emission reduction obligation.

b) **Economic incentives from opt-ins**. This kind of incentives passes the ABT when SAF is used to meet a low carbon fuel standard for road transport, or equivalent, with an opt-in for aviation in a jurisdiction that does have a regulatory GHG emission reduction obligation covering road transport emissions, such as the California cap-and-trade system, or equivalent. Absent a jurisdictional GHG emission reduction obligation, only SAF from host countries that are Parties to the Paris Agreement and have adopted a multi-year or single-year NDC and calculate "a multi-year GHG emissions trajectory, trajectories or budget" consistent with the NDC[57] would satisfy this requirement, as these are equivalent to GHG emission reduction obligations.

c) **Economic incentives from SAF use mandates (expressed either as SAF volumes or GHG emissions reduction goals).** This kind of incentives passes the ABT when the aviation emissions are covered under a regulatory GHG emission reduction obligation such as the EU ETS. In that case, the air carriers could claim the reductions towards a voluntary target if not already used to meet the regulatory GHG emission reduction obligation.

Part D illustrates the ABT for SAF uplifted in California and the EU, where compatible incentives exist. This is further detailed in Appendix F for the case of the United Kingdom, where a transitory opt-in for aviation under the road transport alternative fuel policy is available for SAF producers.

[57] Where a country has a single-year NDC and calculates average annual adjustments in accordance with the guidance on cooperative approaches referred to in Article 6, paragraph 2, of the Paris Agreement, there is a significant risk of underestimating the size of the necessary adjustments applicable to the single-year target, resulting in double counting.

PART C_Guidance for Governments for Avoiding Double Claiming

Confronted with the need to properly capture the climate contribution of SAF use under CORSIA, ICAO developed an innovative accounting approach for SAF. This approach combines features of the two main environmental accounting principles currently applied to account for GHG emissions: the producer and consumer accounting principles.[58]

Under the consumer accounting principle, commonly used in the context of life-cycle analysis, the responsibility for emissions lies with the consumer and includes GHG emissions that take place along the whole value chain of the goods or products consumed. Under the producer accounting principle applicable in the context of the UNFCCC, all GHG emissions are – in line with the polluter pays principle — the responsibility of the producer and consequently of the country where the emissions take place.

When countries apply the producer accounting principle combined with "zero" CO_2 emissions rating commonly applied to bioenergy – following the Intergovernmental Panel on Climate Change (IPCC) guidelines[59] — the result is a misrepresentation of its actual environmental footprint. This is especially the case in the context of international transport.

To avoid misrepresentations, ICAO decided to build on the consumer accounting principle for estimating the life-cycle emissions of SAF but reconciling it with the producer accounting principle to account for the fact that ICAO's goals are aligned with the producer accounting principle and therefore account only for jet fuel combustion emissions and not jet-fuel production emissions. In other words, ICAO determined that the emissions reduction obligations would apply only to the combustion emissions –in line with the producer accounting principle— rather than the full life-cycle emissions of the fuels – as the consumer accounting principle directs. As a result, air carriers can only claim emissions reductions against the combustion emissions,[60] but for as long as these take place on a life-cycle basis.

[58]For a full discussion on the producer and consumer principles see for instance: Wilting, Harry and Vringer, Kees. 2007, Environmental Accounting from a Producer or a Consumer Principle: An Empirical Examination covering the World, Conference Paper: 16th International Input-Output Conference.

[59] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 3: Mobile Combustion. Section 3.2.1.1 Choice of Method.

[60] In an attempt to constraint the emissions reductions to the SAF CO_2 combustion emissions, the current version of the ICAO approach ended rewarding only around 82% of the total emissions reductions. As noted in Appendix A, the ICAO approach could be enhanced by ensuring that it rewards all the life-cycle emissions reductions from SAF use, for as long as these are smaller or equal to the total combustion emissions. Emissions reduction and removal credits should be rewarded separately.

This is enshrined in Paragraph 6 of the Assembly Resolution A39-3 and in SARPs Volume IV, Chapter 3, para. 3.3 on "Emissions reductions from the use of sustainable aviation fuels".

This new approach represents the necessary departure from IPCC guidelines for national GHG emissions inventories, which up until now have also been applied to GHG emissions regulations like CORSIA. The IPCC Guidelines for national GHG emissions inventories provide that CO_2 emissions from the combustion of biogenic carbon should be reported separately as an information item, but not counted towards national totals. This is based on the assumption that, for inventory purposes, net CO_2 emissions[61] from the combustion of biogenic carbon, if any, are reported in the agriculture, forestry and other land use (AFOLU) sector (see Box 1 for an overview).[62]

The IPCC approach is best practice solely for purposes of inventories but is not acceptable for purposes of GHG regulations limiting emissions, including NDC. Claiming CO_2 emissions from the combustion of biogenic carbon without considering the life-cycle emissions under, e.g., a cap-and-trade system, could generate perverse incentives and undermine the integrity of the system. Such programs should only count as lower carbon emissions the combustion of biogenic carbon to the extent that emissions reductions exist on a life-cycle basis, including indirect effects, as determined by ICAO.

The need to reconcile GHG emissions inventory reporting requirements with rewarding bioenergy only for its real climate benefits is compatible with the dual reporting approach adopted under the Paris Agreement. Under the new global climate regime, Parties report – as part of their Biennial Transparency Reports — both (1) **National Inventory Reports** and (2) "**information necessary to track progress made in implementing and achieving their NDC"** in their structured summaries under the modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement. The National Inventory Report follows IPCC guidelines to provide a GHG emissions inventory of the Party; different from the information that will be provided to track real progress towards emissions reduction goals.

[61] Net emissions are zero if CO_2 combustion emissions are balanced in the AFOLU sectors by carbon uptake prior to harvest. If these emissions are not balanced by a carbon removal from the atmosphere, this net emission or removal should, according to 2006 IPCC guidelines be included in the emission and removal estimates for AFOLU sector through carbon stock change estimates.

[62] 2006 IPCC guidelines (op. cit.), Volume 2, Chapter 3, Section 3.2 on road transportation presents the methodologies for estimating GHG emissions from road vehicles, and Section 3.2.1.2 provides particular guidance for accounting CO_2 emissions from biofuels.

BOX 1

IIPCC guidelines for national GHG emissions inventories.

Why are combustion emissions of biofuels zero-rated under IPCC guidance? According to IPCC (2006), carbon dioxide from the combustion or decay of short-lived biogenic material removed from where it was grown is reported as zero in the Energy, Industrial Processes and Product Use, and Waste Sectors.[63,64] This assumes that combustion emissions are balanced out in the AFOLU sectors by carbon uptake prior to harvest so the net emissions are zero. If these emissions are not balanced out by a carbon removal from the atmosphere, this net emission or removal should be included in the emission and removal estimates for AFOLU sectors through carbon stock change estimates.[65]

How are biofuel combustion emissions reported? According to the IPCC guidelines, CO_2 emissions from the use of biofuels in the State are not included in the national total. These are only reported as an information item in the inventory for quality assurance and quality control purposes.

How are international bunkers accounted for under IPCC guidelines? All emissions from fuels used for international aviation (international bunkers)[66] and multilateral operations pursuant to the UN Charter are to be excluded from national totals, and reported separately as memo items.[67,68]

The approach adopted by ICAO is consistent with the dual Paris Agreement approach as it consists of both (1) an underlying Inventory Report coherent with IPCC guidelines and (2) the CORSIA accounting system, which will capture all measures implemented to achieve CORSIA's climate goals that are either not captured (emissions units from other sectors) or misrepresented (SAF) in the Inventory Report. Hence, the CORSIA accounting system is equivalent to the set of information that countries will compile in their structured summary information tables, which combines, inter alia, the selected indicators determined by the Parties to the Paris Agreement to track real progress towards their NDC (including potentially proper accounting of bioenergy) and the emissions balances for internationally transferred mitigation outcomes (ITMO) for Parties using voluntary cooperation under Article 6.

63 IPCC, 2006 (op. cit.) volume 1, Chapter 1.

64 CO_2 emissions from the combustion of biogenic carbon used in road transportation should be reported separately as an information item but not counted towards national totals. To avoid double counting of emissions, the inventory compiler should determine the proportions of fossil versus biogenic carbon in any fuel-mix is deemed commercially relevant and therefore to be included in the inventory. The existing guidance for railways, water-borne navigation and civil aviation does not mention explicitly the potential implications of biofuels for these sectors. In the absence of guidance, it could be interpreted that the guidance applying to road transportation could be generalized to all mobile combustion applications if necessary.

65 IPCC (2006), op. cit.

66 Note that the concept of international bunker is by default conventional fuel and the IPCC guidelines do not make a recommendation on the use of sub-accounts to discriminate between conventional and alternative fuels

67 IPCC (2006), op. cit.

68 Table 3-12: "CO_2 Emissions from Fossil Fuel Combustion in Transportation End-Use Sector 3 (MMT CO_2 Eq.)," included in U.S. GHG emissions inventory provides an illustration on how CO_2 emissions from combustion are reported. Meanwhile there is a category for biofuels reported for information purposes only, these do not include biofuels used for international bunkers, which have its own entry and only reflect fossil fuel combustion. According to U.S. EPA, commercial jet fuel use is obtained from FAA. U.S. EPA's description of the methodology applied by FAA, which relies on modelling to accurately estimate international aviation emissions (FAA relies on the Aviation Environmental Design Tool, which uses radar-informed data.

In the absence of clear guidance and awareness of the relevance of the approach adopted by ICAO, governments might find it challenging to reconcile the ICAO accounting approach with the producer accounting principle applicable to their GHG emissions inventories, resulting in double counting.

In this context, implementing measures to avoid double counting, and in particular double claiming, becomes critical. While avoiding double counting of ITMO used for CORSIA purposes is relatively easy conceptually, and it has already been addressed at the UNFCCC level, the same cannot be said about SAF, which involves abstract life-cycle emissions reductions and a tangled accounting system that currently lacks transparency.

When it comes to SAF, the risk of double claiming results from both (1) the inadequate information that is publicly available to countries under the CORSIA Central Registry, which captures aggregate emissions from international aviation and compliance offsetting reports, but only limited information on SAF use claims under CORSIA, making it hard for countries to distinguish between domestic and international uses, and (2) the absence of clear guidance for capturing SAF used for international aviation purposes in the National Inventory Reports to UNFCCC.

In the same line, neither the 2006 IPCC guidelines nor their 2019 revision addressed how to unfold the concept of international bunkers beyond fossil fuels to reflect the use of bioenergy for international transport. Furthermore, the Paris Agreement Rulebook does not make any explicit reference to how to report the use of bioenergy towards meeting the national GHG regulations enshrined in the NDC of the host country. As a result, host countries would most likely draw on domestic biofuel production statistics, plus imports minus exports, for estimating biofuel combustion emissions in their inventories.[69] This approach proves completely unreliable in a scenario involving significant deployment of SAF for international aviation as international bunkers under the framework of CORSIA.

To date, the lack of accounting guidance has not been an urgent concern because SAF volumes have been insignificant, meaning the associated emissions reductions have been negligible. However, commercially significant volumes are expected to be deployed in the near-term as SAF starts to be used more widely. It is therefore critical that countries prepare to properly account for SAF use and prevent double claiming. This section aims to show them how.

First, Section C.1 describes the two ways for countries to address double claiming of SAF emissions reductions in the context of international aviation: (1) the *tracking-progress adjustment approach*, and (2) the *international-bunker approach*. Second, Section C.2

[69] For illustration purposes see an overview of the data used in U.S. GHG emissions inventory for ethanol based on U.S. Energy Information Administration monthly reviews, here.

provides guidance for SCS to fulfill their reporting obligations under CORSIA and enhance transparency broadly, including for SAF domestic use. Finally, Section C.3 provides specific guidance for governments aimed at adapting the procedures to report the use of SAF for both domestic and international purposes – and biofuels more generally — to avoid double counting and promote environmental integrity, transparency, accuracy, completeness, comparability and consistency, as preconized in Article 4.13 of the Paris Agreement.

C.1_Approaches for Governments to Avoid Double Claiming with CORSIA

Among the two alternative approaches to avoid double claiming, the simplest and most straightforward requires the host country to report SAF use as an international bunker (hereinafter international-bunker approach). It has the advantage that it requires no adjustments other than those applicable to the LEC or removals, as further explained below. Its complex alternative requires numerous adjustments to avoid double claiming and accounting errors, but the host country allows air carriers some flexibility on when they report the use of SAF (hereinafter tracking-progress adjustment approach). The latter is still relevant because it is the default approach under CORSIA, and in the absence of transparency and the adoption of the guidance presented in this handbook, avoiding double claiming would be challenging.

C.1.1_Tracking-Progress Adjustment Approach

Under current CORSIA reporting rules for SAF claims, the host country is not necessarily aware of SAF claims when it compiles and reports its national GHG emissions inventory to the UNFCCC. This is because CORSIA allows air carriers some flexibility on when they report the use of SAF, which can create a **time lag**[70] of up to three years between SAF use and reporting. In this context the host country will likely assume that the SAF was used for domestic purposes (reporting "zero" CO_2 combustion emissions as per IPCC guidelines) and consider that the air carrier uplifted conventional fossil fuel instead of SAF. In addition to the time lag concern, the host country might be unaware of CORSIA SAF claims if the air carrier reported SAF to a different state from where the SAF was uplifted, in which case the information eventually made public in the CORSIA Central Registry would be insufficient. In accordance with CORSIA reporting rules, air carriers report, in general, to the country which issued their Air Operator Certificate, which can be different from the host country.

As a result of these accounting issues, the host country could incorrectly capture the SAF claimed internationally in its national GHG emissions inventories as domestic consumption instead of reporting it as international bunker, while at the same time allocate the fossil fuel

[70] While the air carriers should make SAF claims on an annual basis, they have the option to decide when to make a SAF claim within a given compliance period (International Standards and Recommended Practices. Annex 16 to the Convention on International Civil Aviation. Volume IV CORSIA. Chapter 2, Paragraph 2.3.3.4.

used for domestic purposes to the international bunker account. This information will then be wrongly captured in its National Inventory Report following the modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, resulting in double claiming of emissions reductions.

To avoid double claiming in this case, the host country would need to supplement its National Inventory Report with the necessary information to properly track progress made in implementing and achieving its NDC under Article 4 of the Paris Agreement. As noted above, this is consistent with the dual approach under the Paris Agreement, where Parties report both National Inventory Reports and the information necessary to track progress. However, the necessary information is not always available.

In the case of claims that involve only one country (i.e., the host country is also the country that gets the SAF use report), the host country can avoid double claiming of emissions reductions if it makes an adjustment to its tracking progress accounting system as soon as the air carrier reports SAF use in the context of CORSIA. This is the case because host countries are responsible for receiving and reporting air carrier emissions and SAF use to ICAO.

However, when SAF claims involve two countries, the host country may inadvertently double claim SAF emissions reductions, unless (1) the CORSIA Central Registry increases transparency (a solution that requires an amendment to the ICAO CORSIA SARPs), or (2) there is an alternate mechanism in place which makes the necessary information available.

In this case, only once a host-country gets access to the SAF claims reported to other countries under CORSIA it will be able to make an adjustment to ensure the information they provide to track progress towards their NDC, as required by Article 13 of the Paris Agreement, is accurate. Absent an amendment to the CORSIA SARPs (for enhancing transparency and fixing the reporting time-lag), SCS need to play a critical role by enhancing transparency of claims and facilitating the information countries need to perform the necessary adjustments.

The concept of an adjustment is based on the "corresponding adjustment" introduced during Paris Agreement negotiations, which requires countries to adjust their Emissions Balance Accounts to reflect internationally transferred emissions reduction or removal credits using voluntary cooperation under Article 6 of the Paris Agreement.[71] This prevents countries from double counting emissions reductions and therefore from undermining their own national

[71] In 2018, the Parties to the Paris Agreement adopted a decision requiring each Party that authorizes the use of mitigation outcomes for international mitigation purposes to provide a "structured summary" in which an emissions balance reflecting the level of anthropogenic emissions by sources and removals by sinks covered by its NDC is adjusted by effecting an addition for mitigation outcomes transferred from it (paragraph 77.d).

targets.[72] However, the nature of the applicable adjustments made to properly track progress towards an NDC is different from that considered in Article 6 of the Paris Agreement. Rather than a corresponding adjustment, which is constrained to cooperative approaches, host countries should be able to report the necessary adjustments to their selected indicators as part of the information necessary to track progress made in implementing and achieving their NDC under Article 4 of the Paris Agreement and as per Article 13 guidance. To that end, the host countries should (1) identify the appropriate indicators and describe the underlying methodology and accounting approach used, and (2) develop a supplementary table to the common tabular formats with the structured summary information tables. This supplementary table should capture the detail of the adjustments to the indicators as described in Section D.3 below.

Host countries should then be able to ensure the integrity of their NDC pledges by combining (i) the information on the indicators that reflect the necessary adjustments with (ii) the information from the contribution from the LULUCF sector if not already included in the total "GHG emissions and removals" under the indicators, and (iii) the Emissions Balance reflecting the additions and subtractions for Parties using voluntary cooperation under Article 6.[73]

Finally, it should be noted that LEC, REC, carbon sequestration credits, waste CO_2 credits (e.g., off-gases from steelmaking) and other future emissions avoidance and removal credits potentially embedded in the CORSIA life-cycle emissions value would still need to follow the same procedures applicable to any other emissions units eligible under CORSIA. These are subject to corresponding adjustments, similar to existing requirements for emissions units eligible for CORSIA compliance purposes. For example, a concerned country (which could be a country other than the SAF host country) will need to make an adjustment to its Emissions Balance Account to prevent double claiming these credits.

But this is not the only shortcoming. For the tracking-progress adjustment approach to work properly it also requires host countries to have adopted a multi-year GHG emissions annual trajectory or equivalent under the Paris Agreement, i.e., Parties that have translated their multi-year or single-year NDC into a multi-year GHG emissions annual trajectory (or trajectories or budget) consistent with their NDC. Otherwise, these countries would not be able to record SAF emissions reduction transfers with full integrity. This is the case because the Paris Agreement's rulebook allows for countries with a single-year NDC to calculate average annual corresponding adjustments for ITMO in accordance with the guidance on

[72] Parties to the Paris Agreement are required to avoid double counting ITMO towards their NDC by making a "corresponding adjustment" to their Emissions Balances, reflecting any emissions or removals that will be claimed by another country.

[73] As further explained in Section D.3.3., this approach only works properly when the SAF host country has adopted a multi-year or single-year NDC that are implemented as a GHG emissions trajectory or budget.

cooperative approaches referred to in Article 6, paragraph 2, of the Paris Agreement. However, under this alternative approach there is significant risk of underestimating the size of the necessary adjustments applicable to the single-year target, resulting in double claiming.[74]

Since a similar unreliable methodology would also be applicable for the adjustments necessary under the tracking-progress adjustment approach, countries with single-year NDC which decide not to provide an indicative multi-year emissions trajectory, trajectories or budget for their NDC should not use the tracking-progress adjustment approach. See Section C.3.3 for a discussion on the implications and recommendations for the quality of the corresponding adjustments pertaining to, e.g., LEC and removals, which applied to both the tracking-progress adjustment approach and to the international-bunker approach.

C.1.2_International-Bunker Approach

The international-bunker approach represents the most appropriate way to report SAF use by host countries and as such should be prioritized as the mainstream approach in detriment of the tracking-progress adjustment approach. It involves air carriers **annually** reporting their SAF use (as recommended – but not requested — in the CORSIA SARPs) to prevent the time lag discussed in section C.1.1.

Under the international-bunker approach, host countries simply report combustion emissions from SAF that was used for international purposes as international bunker in their GHG emissions inventories. In this case, no adjustments are necessary because the host countries are properly reporting the use of SAF.

For countries to implement this approach, SCS would need to establish or designate a public registry that records SAF-use claims for international aviation purposes. These transparent, annual claims would allow the host countries to report the use of SAF as international bunker in its national GHG emissions inventories. Ideally, the host countries would provide additional transparency in their emissions inventory and break down the international bunker item as fossil jet fuel or SAF. This would also allow for useful cross-checks.

Finally, LEC, REC, removals, waste CO_2 credits and other future emissions avoidance and removal credits embedded in the CORSIA life-cycle emissions value would still need to follow the same procedure applicable to any other emissions unit eligible under CORSIA. This will trigger an adjustment to the Emissions Balance Account of the country where these credits take place (which could be a country other than the SAF host country).

[74] Lambert Schneider, 2021, "#COP26 in Glasgow delivered rules for international carbon markets – how good or bad are they?", 15 November 2021, Blog OEKO Institute.

SCS will play a critical role by enhancing transparency of all these claims and facilitating the information countries need in order to perform the necessary adjustments. Section C.2 shows how.

C.2_Recommended Guidance for SCS

Regardless of the approach adopted by the host country, preventing double claiming will require enhanced transparency to ensure that all countries involved are aware of all claims. Only then will countries be able to make adjustments to their emissions balances, or take equivalent measures, as needed.

The first step to address double claiming relies on the SCS to fill in the existing information gaps. In principle, the SCS already has an obligation to fulfill this task, as per the CORSIA eligibility framework which states SCS will "provide any information required by the relevant national authority related to GHG reporting".[75] However, in the absence of additional guidance, SCS will have difficulties adopting the appropriate procedures to fulfill this requirement.

With the proper guidance, the information collected and made publicly available by SCS (summarized in Table 5) should enable host countries to accurately report GHG emissions in accordance with the enhanced transparency framework under the Paris Agreement, and prevent double claiming.

To fulfill these reporting requirements SCS will need to request economic operators (fuel producers or suppliers, including traders) who sell SAF to air carriers to collect, report and publicly publish the information listed in Table 5 as soon as it becomes available but always within the calendar year.

Among these additional data requirements, the innovative "**international or domestic aviation use" declaration** will allow countries to have the necessary information on a timely matter. This will enable them to implement the most suitable accounting approach (the international-bunker approach or the tracking-progress adjustment approach) that best suits their needs without data constraints. This requirement implies there is no time lag between SAF use and SAF emissions reduction claims. In the context of the book-and-claim system described in Section B.2.1, this means that air carriers will retire the SAF credit and declare the jurisdiction at the same time, bearing in mind that, under the book-and-claim system, SAF use takes place the same calendar year the SAF is blended and registered. Air carriers can then choose to claim it for ICAO CORSIA purposes. This allows them to take advantage of the CORSIA temporal flexibility, according to which claims can be made within

75 See Requirement #12 in Table 1 with Requirements for SCS in ICAO Document Eligibility Framework and Requirements for Sustainability Certification Schemes (2019).

the same compliance period. The adoption of this declaration does not alter any of the flexibilities under CORSIA, but instead simply enhances transparency.

The combination of this information – publicly available in the SCS designated registries (and the SCS-associated registries operated by, e.g., air carriers) — and the CORSIA Central Registry will allow for SAF claims to be cross-checked globally. This minimizes the risk that countries will claim emissions reductions belonging to international aviation.

TABLE 5

Additional SAF data requirements SCS need to collect and make publicly available for cross checks and transparency.

Additional Data Requirements For Cross Checks and Transparency	
SAF Features	• SAF producer, type of fuel, feedstock, conversion process and applicable ASTM D7566 Annex. • SAF production year. • SAF year of registration (same as year of retirement).[76] • SAF supplier. • Batch number and amount in mass claimed by batch number. • Country of SAF production (including feedstock origin if different). • Country of SAF uplift (country of origin).[77] • Actual or default life-cycle emissions value with detailed information on carbon intensity credits from LEC, REC, removals, and waste CO_2 credits[78] including the country of origin.
Authorizations and Declarations	• International or domestic aviation use declaration. • Disclosure of economic incentives from alternative fuel programs and direct SAF subsidies. • Letter of assurance and authorization from host countries: ○ authorizing the use of mitigation outcomes from SAF and/or associated emissions reductions and removals for CORSIA compliance purposes, and declaring that the host-country will account for SAF emissions reductions claims and/or associated emissions reductions and removals by applying the necessary adjustments.

Table 5 also includes a **letter of assurance and authorization** (or letter of attestation). This is meant to increase the awareness and accountability of countries. SCS should require fuel producers to obtain a letter of assurance and authorization from host countries. This

[76] If the SAF, after getting blended with fossil jet fuel, is intended for storage for future use beyond the calendar year, registration under the book-and-claim system would need to be postponed accordingly.

[77] Country of origin is defined as the country where the neat SAF is blended with conventional aviation fuel and/or enters the aviation fuel supply system. This reflects the fact that SAF is not always blended for aviation purposes in the country where it was produced. However, international trade of biofuels results in the transfer of the right to claim zero CO_2 emissions from combustion. Therefore, it also results in the transfer of the responsibility to make the adjustments, if necessary, when SAF is claimed for CORSIA purposes. Thus, the "country of origin" acquires the obligation to make the necessary adjustments.

[78] In the case of waste CO_2 the carbon intensity credits would be equal to the SAF combustion emissions plus any waste CO_2 that is released during production.

letter should (1) authorize the use of mitigation outcomes from SAF and/or associated emissions reductions and removals for CORSIA compliance purposes, and (2) declare that the host-country will account for SAF emissions reduction claims and/or associated emissions reductions and removals by applying the necessary adjustments, where necessary, to ensure accurate reporting towards an NDC. This includes both adjustments to its Emissions Balance Account for ITMO as well as the tracking progress adjustments, where applicable.

The letter of assurance and authorization also covers landfill emissions credits, recycling emissions credits, carbon sequestration credits, waste CO_2 credits and similar future credits embedded in the life-cycle value. However, as noted above, in this case the concerned country could be a country other than the SAF host country where the SAF is uplifted.

Finally, SCS will also play a crucial role certifying that fuel producers and any other economic operator along the supply chain demonstrate avoidance of both **double use and double issuance.**[79] The role of SCS will be particularly important in the case of double issuance, as the materiality of this risk is significant. This is the case because there are, for example, Clean Development Mechanism (CDM) project activities that generate emissions reduction units that have already been credited in the life-cycle emissions factor of a CORSIA eligible fuel. For instance, the avoidance of methane landfill emissions, or methane destruction from palm oil mill effluents.

C.3_Recommended Guidance for Governments

In addition to voluntarily engaging with fuel producers and providing, when applicable, letters of assurance and authorization for SAF, governments will need to implement ad-hoc procedures to avoid double claiming. Action by governments ranges widely depending on the approach considered to account for SAF use (either the international-bunker approach or the tracking-progress adjustment approach) and whether the claims are made in the context of domestic or international aviation. This Section describes the rationale behind these adjustments and provides guidance on best practices to guide governments as they adapt their accounting systems to reflect SAF use for both domestic and international aviation — but also more generally for ground and maritime transport or power generation.

This guidance applies to the CORSIA SAF methodology, which includes SAF incurring ILUC emissions, i.e., SAF that does not meet the high-integrity SAF requirements as defined in Section B.1. Hence the emphasis in Section C.3.1 and C.3.2 focuses on the adjustments applicable for ILUC emissions. This guidance is particularly relevant for countries having deployed bioenergy for road transport without the necessary safeguards, or for countries with

[79] See Section A.5.3

existing incentives that will drive the deployment of SAF using the CORSIA SAF framework without the refinements recommended in Section B.1.

To describe how governments can address the risk of double claiming, we consider two notional cases involving (1) SAF used for domestic aviation (Section C.3.1) and (2) SAF used for international aviation (Section C.3.2). The domestic aviation case is covered first because it provides a simplified illustration that helps frame the international aviation case. Furthermore, it provides the opportunity to explore the implications of the lessons learned from the CORSIA SAF framework for domestic aviation and beyond.

The key lessons learned from CORSIA that are applicable beyond international aviation include:

(i) The need for countries to consider indirect GHG emissions that are out of the scope of their inventories, especially for feedstocks that are prone to ILUC emissions, independently of whether these are grown domestically or abroad. But also, the need for countries to understand and address the environmental and social implications beyond GHG emissions of incentivizing feedstocks that thereby become drivers of ecosystem and livelihood destruction, whose impact is not captured in Sections C.3.1 and C.3.2.

(ii) The need for countries importing bioenergy alongside with the right to claim “zero” CO_2 emissions from combustion to understand the implications that this accounting error entails in the context of the Paris Agreement. For instance, transferring internationally the right to claim zero CO_2 emissions results in not only the transfer of the life-cycle emissions reductions (if any), but also the transfer of a portion of the GHG emissions budget of the exporting country. This makes it harder for the exporting country to meet its NDC, notably when involving land use change.

(iii) The need for countries to address the unintended consequences of granting air carriers and other entities covered under GHG emissions limitation programs such as the EU ETS or California’s cap-and-trade system with the right to claim “zero” CO_2 emissions from the combustion of bioenergy. Doing so unduly loosens the stringency of the programs, notably when implemented in conjunction with bioenergy mandates that spur supply. In addition, as carbon price signals under such programs increase to eventually become the main incentive, granting “zero” CO_2 combustion emissions – largely independently of the actual environmental attributes — would become the main driver resulting in land use change.

C.3.1_Domestic aviation

To illustrate the domestic aviation case, we first consider a stylized one-country model where all GHG emissions associated with the production of the fuels (both SAF and conventional jet fuel) are generated in the country and captured in its national GHG emissions inventory (Figure 8). For the sake of simplicity, we do not consider any carbon sequestration credits, LEC, REC or waste CO_2 credits in these illustrations. We then extend the model to capture emissions that are reflected in other inventories. This includes indirect emissions such as ILUC and attributional (direct) life-cycle emissions being captured in the country where the SAF originates. If the feedstocks and/or SAF have been shipped internationally, it is also reflected in the International Maritime Organization (IMO)'s inventory.

The two bars on the left of Figure 8 depict the life-cycle emissions of a conventional fuel and SAF, as captured in the national GHG emissions inventory of the country. These bars reflect well-to-wake emissions associated with the production of the fuels, including CO_2 emissions from combustion. The biofuel reports "net zero" combustion emissions because by convention CO_2 combustion emissions are balanced by carbon uptake during feedstock growth. While not depicted here for simplicity, carbon sequestration and/or land use change emissions, if any, would also have been reflected in the SAF life-cycle emissions bar for SAF using ICAO CORSIA's amortization period.[80] If the CO_2 combustion emissions were not balanced by a carbon removal from the atmosphere, a net emission would be included in the AFOLU sectors through carbon-stock change resulting from land-use change and reflected in the bar depicting the life-cycle emissions of the alternative fuel. When, as in the case for the case depicted in Figure 8, the SAF has lower life-cycle emissions than the conventional fuel, the difference in height would provide the actual emissions reductions associated with the use of SAF when displacing a conventional jet fuel. In this case involving only one country, the national GHG emissions inventory would report fewer CO_2 emissions than in the case of using conventional jet fuel. But, of course, this is the case where SAF delivers an emissions reduction. In some other cases, SAF could exceed the life-cycle emissions from conventional jet fuel.

The bar on the right-hand side of Figure 8 depicts how CO_2 emissions from the combustion of the SAF are accounted for in the national GHG emissions inventory (other life-cycle emissions will appear elsewhere in inventory). These amount to around 82% of total life-cycle emissions for both SAF and conventional jet fuel (assuming similar chemical composition, which is not always the case as SAF can be produced with lower aromatics, resulting in

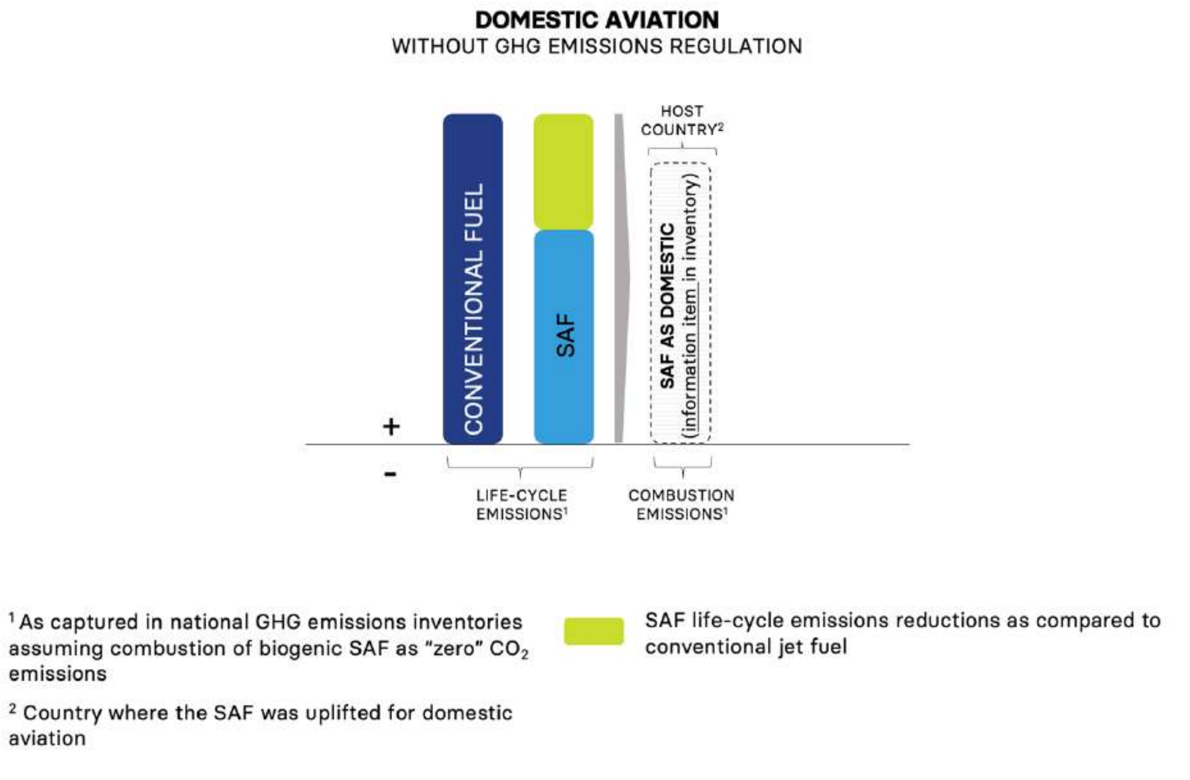
[80] As noted later in this Section, in the context of the ILUC adjustment, there would be a temporal mismatch between carbon released into the atmosphere or sequestered, and the timing of the annualized values used for the adjustment.

greater energy content).[81] These CO_2 emissions are reported as an information item in the national GHG inventory but not counted towards national totals, following the IPCC guidelines. This is consistent with the underlying assumption for computing the actual life-cycle emissions as described above.

Hence, when the airline switches from a conventional jet fuel to SAF with lower life-cycle emissions in the context of domestic aviation, the inventory totals properly reflect the associated emissions reductions. "Zero" CO_2 emissions reduction claims in the national inventory ledger for domestic aviation are partially balanced by upstream (well-to-tank) emissions. However, while this accounting approach is accurate from the perspective of the inventory, it poorly reflects the actual emissions reductions resulting from aviation switching from conventional jet fuel to SAF. This creates the perception that all biofuels are carbon neutral. It also potentially leaves indirect emissions out of the scope of the GHG emissions inventory of the country, as it is the case when these emissions occur outside the country.

FIGURE 8

Domestic aviation case without GHG emissions regulation.



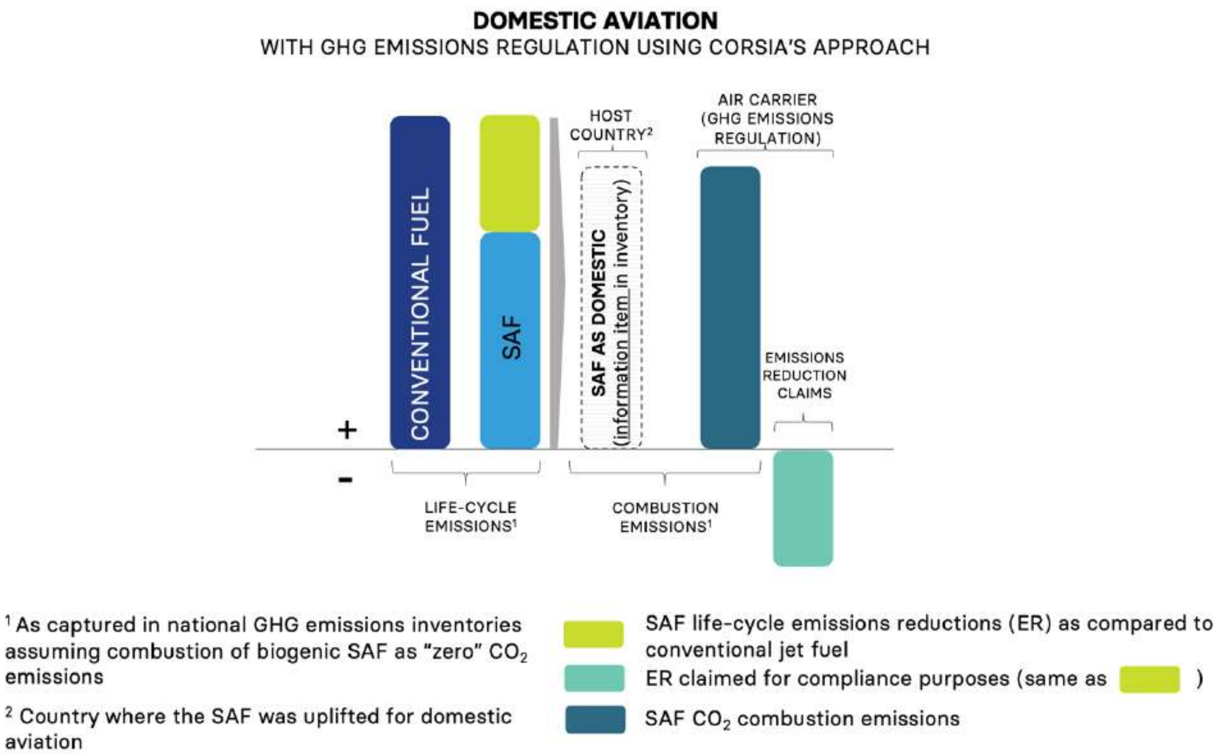
To not unduly claim emissions reductions, countries should only credit the combustion of biogenic carbon with the emissions reductions that are achieved on a life-cycle basis. Critically, the life-cycle calculation needs to include an estimation of indirect effects in line

[81] The carbon intensity of jet fuel CO_2 combustion emissions is 73 gCO_2e/MJ according to 2006 IPCC guidelines (op. cit.) and its life-cycle emissions including CO_2 combustion emissions are 89 gCO_2e/MJ.

with, e.g., the methodology for estimating life-cycle emissions for SAF in ICAO CORSIA. Although, ideally, biofuels with ILUC risk should not be incentivized and phased out.

This accounting approach is easy to implement when domestic aviation has compliance obligations under an emissions trading system such as the EU ETS. In that case, the host country should not grant air carriers the right to claim "zero" CO_2 emissions from combustion of biofuels ("carbon neutrality"). Instead, countries should consider a life-cycle approach equivalent to that adopted for CORSIA as depicted in Figure 9, i.e., adopt the same high-integrity requirements for domestic policy as for international aviation. Otherwise, the host country would be unduly loosening the stringency of the emissions limitation program. Similar treatment shall also apply across the board, including for biogenic CO_2 emissions from stationary sources that use woody biomass for energy production covered under an emissions trading system. These entities should only be entitled to claim an estimation of the actual emissions reductions embedded in the biofuel or forest biomass.

FIGURE 9
Domestic aviation case with GHG emissions regulation using the same approach for SAF claims as ICAO's.



NOTE: For simplicity this case assumes that air carriers can claim all life-cycle emissions reductions rather than just around 82% of the total, as it is currently the case in ICAO.

By the same token, granting the right to claim "zero" CO_2 emissions from combustion for meeting an NDC goal under the Paris Agreement would be inappropriate if both direct and indirect land use change emissions are excluded under the same NDC or the NDC of other countries. Indeed, in the case of food, feed and other land-based SAF, the risk of ILUC will be high for as long as all countries have not properly communicated the highest possible ambition in line with Article 4.3 of the Paris Agreement, and for as long as the AFOLU sectors in some key countries fall out of the scope of the countries' NDCs.

ILUC adjustments

To properly reflect domestic bioenergy that is prone to ILUC emissions, countries should make the necessary adjustments, as they track progress towards their NDC under Article 13 of the Paris Agreement, to account for the risk of indirect effects beyond their borders. The nature of the adjustment is similar is the described in C.1.1, in which tracking real progress towards emissions reduction goals when SAF use for international purposes has also been reported as domestic consumption. However, this time the purpose of the adjustment is to ensure that the host country does not claim emissions reductions from SAF that results in ILUC emissions that are not captured in its inventory.

Quantifying ILUC emissions could be done using the same approach as for ICAO CORSIA, where default ILUC emissions per unit of bioenergy are estimated using land-use models and amortized over a period of 25 years.[82] Although there would be a temporal mismatch between carbon released into the atmosphere due to of land use change, and the timing of the annualized values used for the adjustment, the aim of the adjustment is to (1) discourage the deployment of SAF with significant ILUC risk and, where ILUC materializes, (2) create a buffer against which ILUC emissions would be compensated over time.

Figure 10 illustrates the progress tracking adjustments necessary for ILUC emissions. These adjustments are necessary based on the assumption that ILUC emissions are not captured yet in the national GHG emissions inventory of the host country, as will be the case for most countries.[83] The applicable adjustments are the same independently of (1) whether aviation emissions fall under a GHG emissions regulation or not, and (2) the approach adopted by the country for accounting of SAF use in the GHG emissions regulation. The adjustments would also be the same even if the host country grants "zero" CO_2 combustion emissions to bioenergy in its GHG emissions regulation. Ideally the host country should amend the GHG emissions regulation to correct the accounting error leading to inappropriate incentives.

Governments accounting correctly for bioenergy that is prone to ILUC is only the first step. Governments should act to phase-out the use of bioenergy that results in the destruction of ecosystems and livelihoods.

[82] See the CORSIA Supporting Document "CORSIA Eligible Fuels - Life Cycle Assessment Methodology", page 85.

[83] Host countries with high deforestation rates would not need to add additional ILUC emissions as ILUC emissions are already captured in their tracking progress accounting.

Other adjustments for life-cycle emissions captured elsewhere

The ILUC adjustment is not the only necessary provision. A number of other possibilities might require adjustments: The country where the SAF is uplifted (the host country) could import SAF or the feedstocks to produce it, which would result in core life-cycle emissions being captured in the country where the SAF originates instead of the host country – and in the IMO's inventory if shipped internationally. In this case, the standard accounting approach based on the IPCC guidance would deliver the right accounting outcome in the aggregate, i.e., when considering both inventories together. However, this relies on the fact that the exporting country also transfers the right to account for "zero" CO_2 emissions from combustion. This leads to a transfer of emissions reduction entitlements that generally go beyond the actual life-cycle emissions reductions.

In other words, exporting bioenergy alongside with the right to claim "zero" CO_2 emissions from combustion results, in not only (1) an international transfer of the life-cycle emissions reductions (if any), but also, de facto, (2) an international transfer of a portion of the GHG emissions budget of the exporting country (assuming the country has an enforceable NDC). This makes it harder for that country to meet its NDC, notably when involving land use change. The latter would be equivalent in nature to a "credit" that amounts to the difference between "the total SAF CO_2 combustion emissions" and "the actual life-cycle emissions reductions". This credit can be sizable, notably when the life-cycle emissions reductions are very small or non-existent.

Bioenergy imports should be scrutinized in accordance with the principles guiding ITMO under Article 6.2 of the Paris Agreement. The claims should be constrained to the estimated life-cycle emissions reductions after accounting for indirect effects, as it is the case for SAF in ICAO CORSIA. Otherwise, the importing country claims will be made regardless of whether the biomass source involves activities such as converting forests into cropland for bioenergy production, resulting in the well-documented, far-reaching accounting error[84] described in Part A of this handbook.

To avoid this, the host country should perform an additional adjustment to account for the core life-cycle emissions – i.e., the core attributional life-cycle emissions and the direct LUC emission when applicable[85] — captured in the exporting country's inventory (and in the IMO's when international maritime transport is involved). This way the host country would avoid claiming non-existent emissions reductions (see Figure 10a). This adjustment is limited to those emissions because the rest of the core life-cycle emissions are already captured in the host country's inventory. This adjustment is needed regardless of GHG regulation in the host

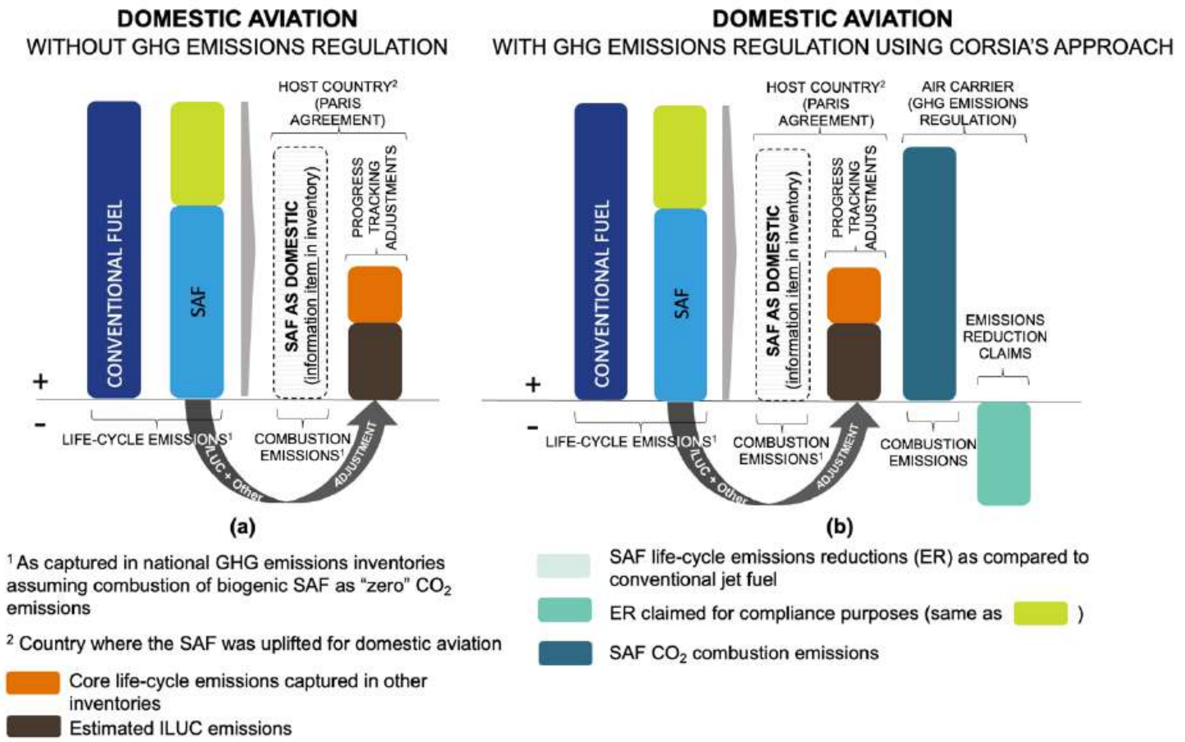
[84] See Searchinger et al., 2009, (op. cit.).

[85] As per ICAO CORSIA Sustainability Criteria Theme 2 Criterion 2, direct LUC emissions shall be considered here when these are greater than the default ILUC values, in which case not ILUC adjustment would be necessary.

country. It would apply both to the case without GHG regulation in Figure 9a and to the case involving a GHG emissions regulation such as the EU ETS as depicted in Figure 10b.

FIGURE 10

Domestic aviation case. Adjustments under the "progress tracking adjustment" approach for ILUC risk and core life-cycle emissions not captured in the host country's inventory, (a) when there is not a GHG emissions regulation, and (b) when there is a GHG emissions regulation using same approach for SAF claims as ICAO's.



NOTE: For simplicity this case assumes that air carriers can claim all life-cycle emissions reductions rather than just around 82% of the total, as it is currently the case in ICAO. If the GHG emissions regulation only accounted for the emissions reductions following ICAO rules or granted "zero" CO2 combustion emissions to SAF, the progress accounting system would still properly capture the total life-cycle emissions reductions.

To compute the size of the adjustment corresponding to the core life-cycle emissions that are not captured in the host country's inventory, host countries should use the information from the ICAO default core life-cycle emissions values. The values are broken down into the most relevant life-cycle steps, including: feedstock cultivation; feedstock harvesting, collection and recovery; feedstock processing and extraction; feedstock transportation to processing and fuel production facilities; feedstock-to-fuel conversion processes; and fuel transportation and distribution for aviation purposes.

The default emissions for these life-cycle steps are available in the CORSIA Supporting Document "CORSIA Eligible Fuels - Life Cycle Assessment Methodology", which provides, inter alia, technical information regarding the ICAO document "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels".

To estimate the relevant adjustments, governments would simply need to use the default values of the applicable life-cycle steps (using the midpoint values as per ICAO's methodology for estimating the core life-cycle values) based on the information available in the ICAO Supporting Document.[86] Alternatively, governments could also rely on the information revealed for the actual life-cycle values calculated in accordance with the ICAO document "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values".

C.3.2_International aviation

As noted in Section C.1, there are the two approaches countries could implement to address double claiming: (a) the tracking-progress adjustment approach (Figure 11), and (b) the international-bunker approach (Figure 12).

Regardless of the adopted approach, LEC, REC, removals, waste CO_2 credits and other future emissions avoidance and removal credits embedded in the CORSIA life-cycle emissions value would trigger a corresponding adjustment to the Emissions Balance Account of the country where these credits take place.[87] For simplicity, these adjustments are not reflected in Figures 11 and 12.

Tracking-Progress Adjustment Approach

Figure 11 depicts the case where the host country reports SAF use as domestic and then performs the necessary tracking-progress adjustments. The two bars on the left in Figure 11 depict the full life-cycle emissions (well to wake) of a conventional fuel and a hypothetical SAF, independent of the country where the emissions take place. These bars capture well-to-wake emissions associated with the production of the fuels, i.e., including CO_2 emissions from combustion, which are net zero by convention for biofuels. The difference in height between the two bars represents the emissions reductions associated with the use of SAF compared to the conventional fuel baseline, similar to those that air carriers are entitled to claim under CORSIA.[88]

The bars on the right depict how CO_2 emissions from the combustion of the biofuel and the conventional fossil fuel are accounted for in the national GHG emissions inventory. In Figure 11, the CO_2 emissions from SAF are reported as an information item, i.e., as domestic consumption, capturing the life-cycle emissions reductions in the national inventory. The uplifted jet fuel is considered conventional fossil fuel and reported as conventional international bunker. Accordingly, its CO_2 combustion emissions are reported as a memo

[86] CORSIA Supporting Document "CORSIA Eligible Fuels - Life Cycle Assessment Methodology".

[87] In the case of waste CO_2 credits, the size of the adjustment will be equivalent to the SAF combustion emissions. Any waste CO_2 released during production should be reported by the concerned country as per IPCC guidelines. As a result, no additional adjustment would be required.

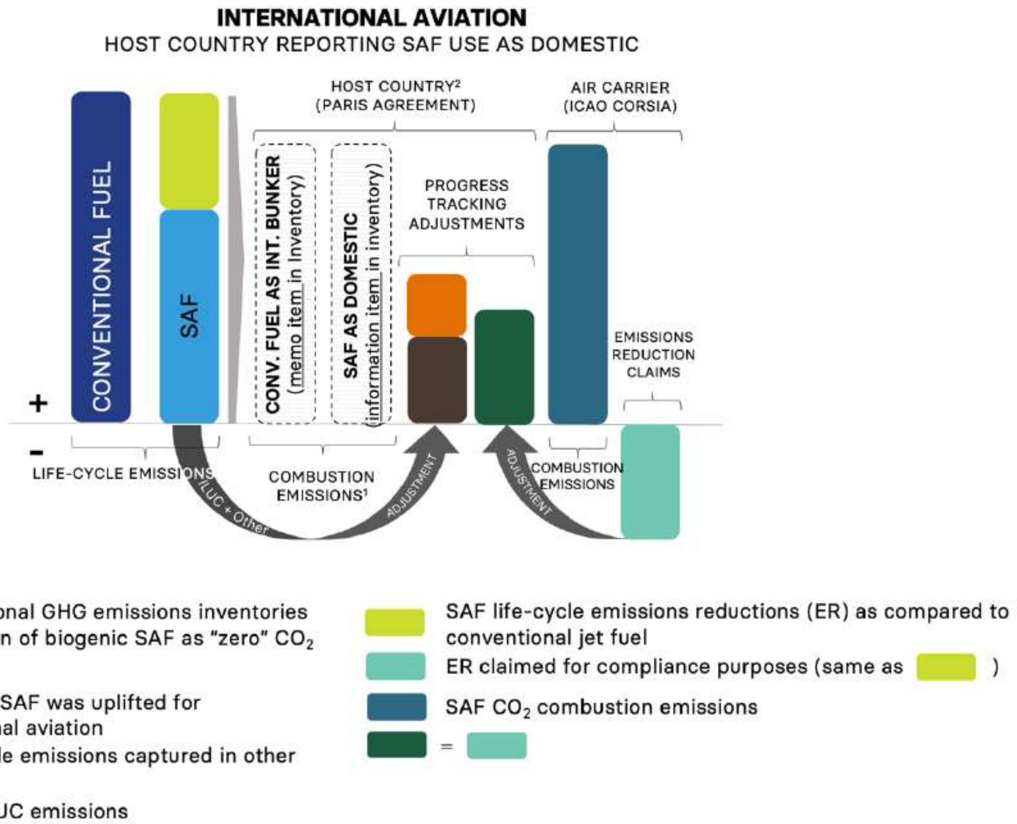
[88] For simplicity we assume that air carriers can claim all life-cycle emissions reductions rather than just around 82% of the total, as it is currently the case in ICAO. See discussion in footnote in Appendix A.

item. In parallel, the air carrier reports the use of SAF for CORSIA purposes and claims the associated emissions reductions.

In the more complex cases involving more than one country and ILUC, there would be the need to make additional adjustments. To properly reflect the use of domestic bioenergy prone to ILUC, and for which no land management practices have been implemented to mitigate ILUC risk, countries where SAF is uplifted for international aviation would need to make adjustments to their tracking progress accounting systems to account for the risk of indirect effects beyond their borders. To that end, for consistency, countries should use CORSIA's default ILUC values and perform the adjustments as depicted in Figure 11 (see "estimated ILUC emissions"). When the SAF – or the bioenergy feedstock used for producing it — was imported from a different country, host countries should consider bioenergy imports in light of the principles guiding Article 6.2 of the Paris Agreement. They should constrain the claims to the estimated life-cycle emissions reductions after accounting for indirect effects, as is the case for SAF under CORSIA.

FIGURE 11

International aviation case. Necessary adjustments under the "progress tracking adjustment" approach, including the ILUC adjustment for SAF with ILUC risk and the core emissions capture in other inventories.



NOTE: For simplicity this case assumes that air carriers can claim all life-cycle emissions reductions rather than just around 82% of the total, as it is currently the case in ICAO. If the GHG emissions regulation only accounted for the emissions reductions following ICAO rules, the progress accounting system would still properly capture the total life-cycle emissions reductions.

But for the tracking-progress adjustment approach to work properly it also requires host countries to have adopted a multi-year GHG emissions annual trajectory or equivalent under the Paris Agreement, i.e., translate their multi-year or single-year NDC into a multi-year GHG emissions annual trajectory (or trajectories or budget) consistent with the NDC. Otherwise, these countries would not be able to record SAF emissions reduction transfers with integrity. This is the case because the Paris Agreement's Rulebook allows for countries with a single-year NDC to calculate average annual corresponding adjustments for ITMO, in accordance with the guidance on cooperative approaches referred to in Article 6, paragraph 2, of the Paris Agreement. However, under this alternative approach there is – as noted in Section C.1.1 — a significant risk of underestimating the size of the necessary adjustments applicable to the single-year target, resulting in double claiming. Since a similar unreliable methodology would also be applicable for the adjustments necessary under the tracking-progress adjustment approach, countries with single-year NDC who decide not to provide an indicative multi-year emissions trajectory, trajectories or budget for their NDC should not use this tracking approach.

It is important to note, however, that only SAF from Parties with a multi-year GHG emissions annual trajectory or equivalent under the Paris Agreement – i.e., Parties having translated their multi-year or single-year NDC into a multi-year GHG emissions annual trajectory (or trajectories or budget) consistent with the NDC — would be able to record SAF emissions reduction transfers with integrity. Where a country has a single-year NDC and calculates average annual corresponding adjustments in accordance with the guidance on cooperative approaches referred to in Article 6, paragraph 2, of the Paris Agreement, there is a significant risk of underestimating the size of the necessary adjustments applicable to the single-year target, resulting in double claiming. A similar unreliable methodology would also be applicable for the corresponding adjustments necessary under the tracking-progress adjustment approach for the SAF-related avoided emissions and removals.

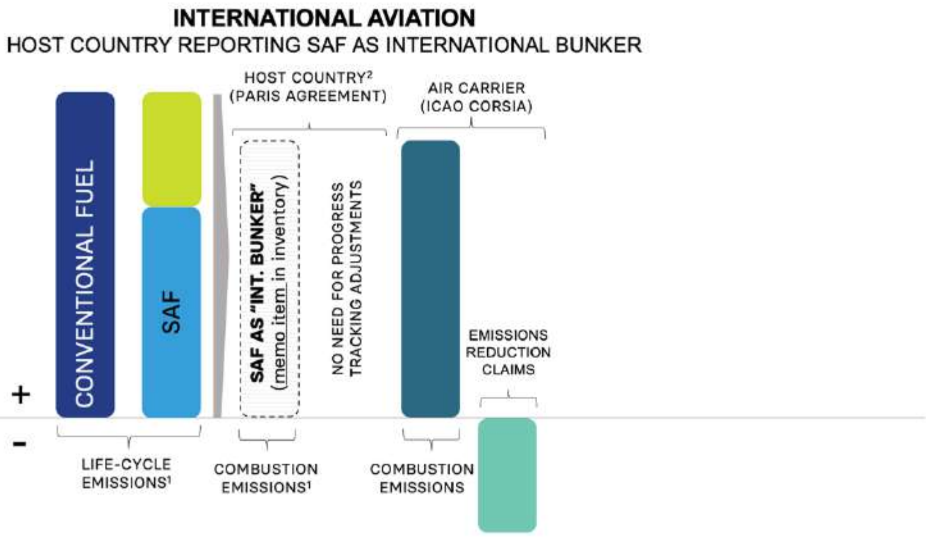
International-Bunker Approach

Finally, Figure 12 depicts the simple and straightforward case where the host country reports SAF use as international bunker (the international-bunker approach).

In this case, there is no need to perform any adjustments other than those applicable to emissions credits (LEC, REC and alike) and removals that would trigger a corresponding adjustment under Article 6. For simplicity, none of these adjustments are reflected in Figure 12.

FIGURE 12

International aviation case. No need for adjustments under the international-bunker approach other than the corresponding adjustments applicable to emissions reduction and removal credits (not reflected here).



[1] As captured in national GHG emissions inventories assuming combustion of biogenic SAF as "zero" CO_2 emissions

[2] Country where the SAF was uplifted for international aviation

SAF life-cycle emissions reductions (ER) as compared to conventional jet fuel

ER claimed for compliance purposes (same as)

SAF CO_2 combustion emissions

NOTE: For simplicity this case assumes that air carriers can claim all life-cycle emissions reductions rather than just around 82% of the total, as it is currently the case in ICAO.

C.3.3_Guidance for SAF-Related Avoided Emissions and Removals Transferred Internationally

The need for corresponding adjustments for avoided emissions (such as LEC, REC) and removals embedded in the life-cycle emissions of SAF that are internationally transferred is enshrined in the guidance on cooperative approaches referred to in Article 6, paragraph 2, of the Paris Agreement.[89] This UNFCCC guidance provides the rationale to inform how and when to perform corresponding adjustments for emissions reductions and removal credits. It was adopted in November 2021 by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement. It applies to mitigation outcomes authorized by a participating Party for use towards the achievement of either another Party's NDC or for use for other international mitigation purposes, including ICAO CORSIA.

In accordance with that guidance, all the avoided emissions and removals that are claimed by a country different than the country where these reductions take place or by an air carrier for CORSIA purposes, need a corresponding adjustment – regardless of whether or not the sector where the reductions take place is covered by the NDC of the host country.

[89] An advance unedited version can be found here.

As noted in Section C.3.2, countries with a single-year NDC who decide not to provide an indicative multi-year emissions trajectory, trajectories or budget for their NDC should not use the tracking-progress adjustment approach but the international-bunker approach instead. But that is not enough in the case of emissions reductions and removals embedded in SAF. As a result, air carriers, corporations and other end-users should only claim them when these take place in countries with multi-year GHG emissions annual trajectory, or equivalent.

This integrity safeguard only works for host countries that have properly communicated the highest possible ambition in line with Article 4.3 of the Paris Agreement. Unfortunately, not all current NDC pledges are fully in line with this requirement. As a result, an adjustment against, e.g., an inflated NDC crediting baseline defeats the purpose of the adjustment, resulting in "double counting" driven by the lack of ambition. Hence, air carriers and end-customers should only claim reductions and removals towards a voluntary target as an increase in global ambition without the assurance of their integrity.

Finally, as noted in Section D.2, to increase the awareness and accountability in line with UNFCCC guidance, host countries should provide SAF producers with a letter of assurance and authorization. This letter should (1) authorize the use of mitigation outcomes from SAF for international aviation purposes, and (2) declare that the host country will account for SAF emissions reductions claims by air carriers by applying the necessary adjustments to ensure accurate reporting towards an NDC in accordance with the guidance provided in this handbook.

Part D_SAF Premium and the Corresponding Emissions Reduction Cost

Once the environmental integrity of SAF claims is properly addressed, air carriers, corporations and other end-customers also need to assess an equally relevant matter: the SAF premium or abatement cost. Appendix B provides a big picture overview of the SAF premium and the corresponding abatement cost for key production pathways.

While the results captured in Appendix B are representative of the estimated current and future economic costs, the actual size of the premium changes depending on existing policy and regulatory incentives, which vary by jurisdiction. Subtracting the economic incentives from the SAF premium reveals the premium gap that air carriers, corporations and other end-customers will need to cover.

Important to note is that the SAF premium can be reduced both by measures that specifically incentivize SAF uptake, as well as measures that incentivize the use of alternative fuels in other sectors, e.g., renewable diesel for road transport, but allow SAF to opt-in as a compliance option. But not all incentives are compatible. To ensure environmental integrity, the compatibility with existing policy support should always be evaluated from the perspective of the atmosphere using the guiding principles described in Section B.2.4.

Table 6 outlines the general relationship between policy/regulatory incentives and the SAF premium an air carrier or a corporation would have to cover. A key assumption is that SAF meets the standard for environmental sustainability (referred to as high-integrity SAF) outlined in the previous sections.

TABLE 6
Overview of the potential SAF premiums air carrier and corporations need to cover to procure SAF.

Policy/Regulatory Incentive	Premium
NONE_No incentives exist to support SAF deployment.	LARGE_It covers the price difference between conventional jet fuel and high-integrity SAF.

Table 6 Cont.

Policy/Regulatory Incentive	Premium
MODERATE_Incentive(s) cover(s) the price difference between diesel for road transport and renewable diesel fuel.	MEDIUM_It covers the price difference between renewable diesel for road transport and conventional jet fuel and additional production costs for high-integrity SAF.
STRONG_Incentive(s) cover(s) the price difference between conventional jet fuel and SAF.	SMALL_It is reflective of the value of claiming SAF and the carbon price opportunity cost, if any, that ensures that their contribution goes beyond the policy/regulatory emissions reduction obligations.

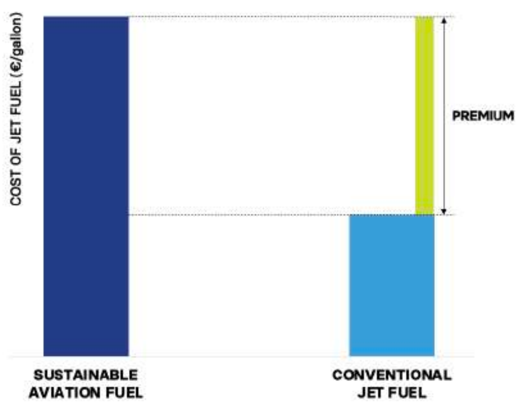
D.1_Case Study of SAF Premiums

D.1.1_The European Union

Evaluating the EU policy incentives that cover the SAF premium requires accounting for both measures that specifically target the uptake of SAF and those that cover the premium between conventional diesel (or gasoline) and alternative jet fuel. Where no such incentives are considered, the SAF premium is significant (see Figure 13).

This case study explores the effect the EU RED II in combination with either the EU ETS or ICAO's CORSIA have on the premium for SAF. It assumes an air carrier or corporation is looking to purchase high-integrity SAF, which might require an additional premium beyond the alternative fuel production cost. In the case of EU RED II opt-in incentives for SAF, the environmental integrity should be guaranteed by the multiyear GHG emissions reduction trajectory applicable to sectors such as ground transport. In this context, if alternative fuels currently used for ground transport are diverted to aviation, the ground transportation sector would need to implement alternative measures to reduce its emissions accordingly to meet its emissions reduction obligations.

FIGURE 13
Illustration of the premium for sustainable aviation fuel as compared to conventional jet fuel where no alternative fuel policy incentives are considered.



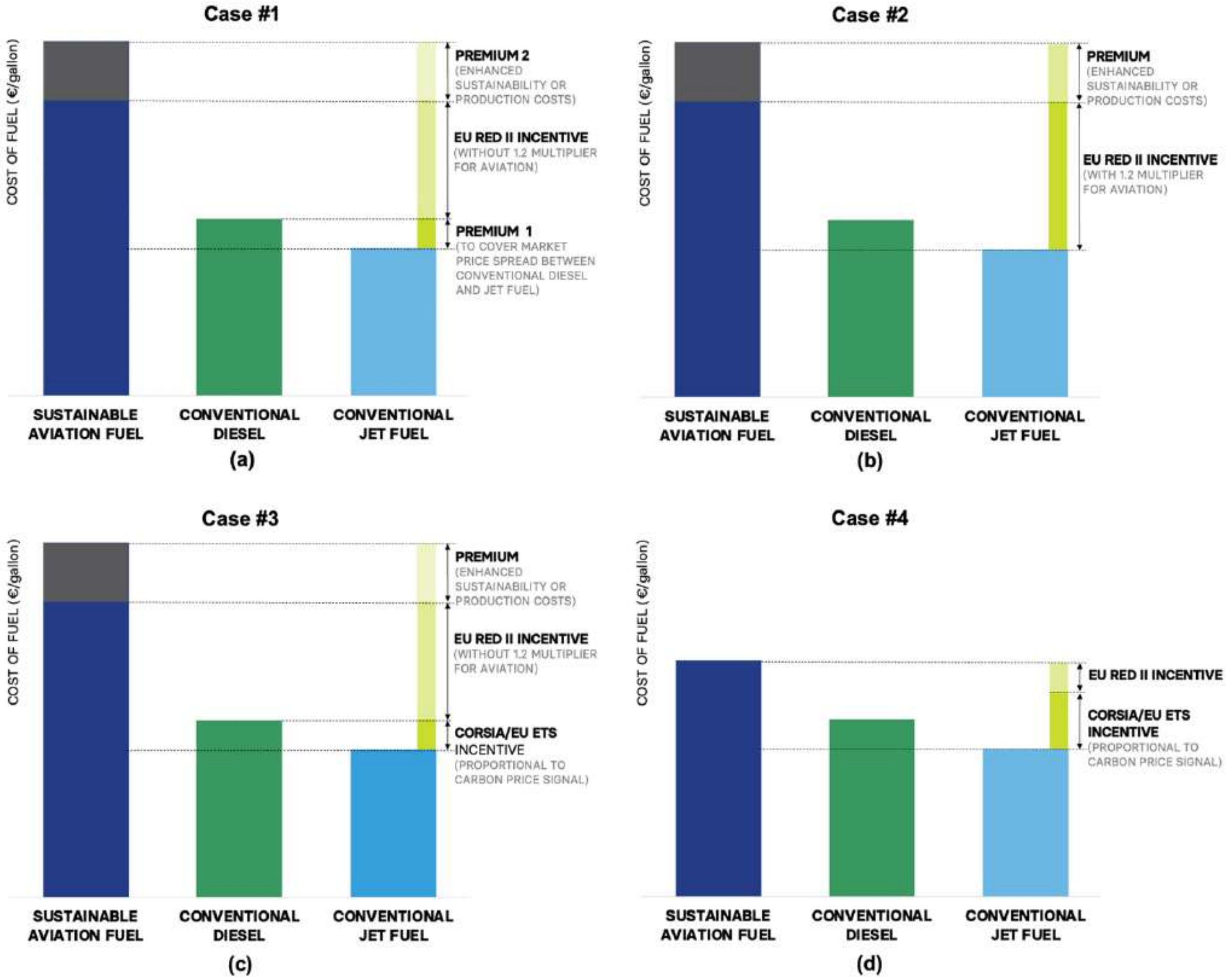
Four cases are presented in Figure 14 showing a set of different incentives based on diverging implementation of EU RED II by EU Member States, as well as future developments. The conclusions from this model can be extended to other jurisdictions with similar incentives for alternative fuels.

Case #1_EU RED II incentive

EU RED II incentivizes the uptake of alternative fuels by requiring a minimum share of the energy consumed in the road and rail transport sectors comes from renewable sources, and allows SAF to opt-in. The incentives for the deployment of alternative fuel in the road transport sector could help cover part of the SAF premium. This means the remaining SAF premium is equivalent to the difference in price between road diesel and conventional jet fuel (premium 1) as well as additional costs for enhanced sustainability and/or production processing costs (premium 2), as depicted in Figure 14.a.[90]

FIGURE 14

Illustration of the premium for sustainable aviation fuel. Case #1: SAF premium where the EU RED II incentive is accounted for (figure 14.a). Case #2: SAF premium where the EU RED II multiplier for aviation is accounted for (figure 14.b). Case #3: SAF premium where an EU ETS/CORSIA price signal is accounted for (figure 14.c). Case #4: Future SAF premium where EU ETS/CORSIA and EU RED II incentives are sufficient to cover the SAF premium (figure 14.d).



[90] If Renewable Diesel is ASTM certified as SAF with a blending wall of 10% (and assuming negligible additional processing costs), premium 2 will be mostly limited to cover enhanced sustainability features.

This case is compatible with how the United Kingdom operationalized the opt-in for aviation (i.e., aviation can generate compliance credits but has no obligations) under the Renewable Transport Fuel Obligation, the transposition of the original EU RED (see Appendix F for a detailed description). This financial support would be compatible with claims by air carriers and corporations in accordance with the atmospheric benefit test for as long as (1) the fuel producer does not also apply for the issuance of GHG credits under the GHG Regulations, which ensures compliance with the EU Fuel Quality Directive by establishing a 6% reduction in life-cycle GHG emissions of fuels for use in road transport in 2020 and onwards, and (2) the United Kingdom as host country provides a letter of attestation declaring that it will ensure accurate reporting and avoid double counting. As a result of the United Kingdom leaving the EU in 2020, the United Kingdom Government decided to suspend the applicability of the EU Fuel Quality Directive after 2020, leaving the Renewable Transport Fuel Obligation as the only binding regulation to date. The environmental integrity of these claims is guaranteed by the absolute cap applicable to ground transport under the United Kingdom's Climate Change Acts (and the annually binding cap under the EU Effort Sharing Regulation[91], applicable until recently in the United Kingdom).

Similar to the United Kingdom, the Netherlands was an early adopter of the aviation opt-in for meeting EU RED derived obligations. However, contrary to how it was originally structured in the United Kingdom, fuel suppliers use the Dutch Renewable Energy Units (hernieuwbare brandstofeenheden or HBEs) for meeting both the volume mandates and the GHG reduction obligations.[92] Therefore, air carriers and corporations willing to benefit from the associated financial support would not be entitled to claim the SAF environmental benefits, as that would result in double counting, i.e., the HBEs do not pass the atmospheric benefit test.

Case #2._EU RED II "multiplier" for aviation

Article 27 of EU RED II introduces a 1.2 multiplier for SAF, which applies to feedstocks other than food or feed crops, except for intermediate crops (e.g., cover crops) that do not trigger additional demand for land. The 1.2 multiplier allows Member States to count the energy content of SAF as 1.2 times towards its EU RED II goals.

If all Member States transpose it literally so that it functions as an incentive to deploy SAF, and not only for reporting EU RED compliance purposes, it may mean the EU RED II multiplier incentive is sufficient to cover at least the premium between alternative fuel and conventional jet fuel (see Figure 14.b). Again, there might remain an additional premium to

[91] EU Member States have binding annual GHG emission targets for 2021-2030 for those sectors of the economy that fall outside the scope of the EU ETS. See Commission Implementing Decision 2020/2126 on setting out the annual emission allocations of the Member States for the period from 2021 to 2030 pursuant to EU Regulation 2018/842.

[92] See here.

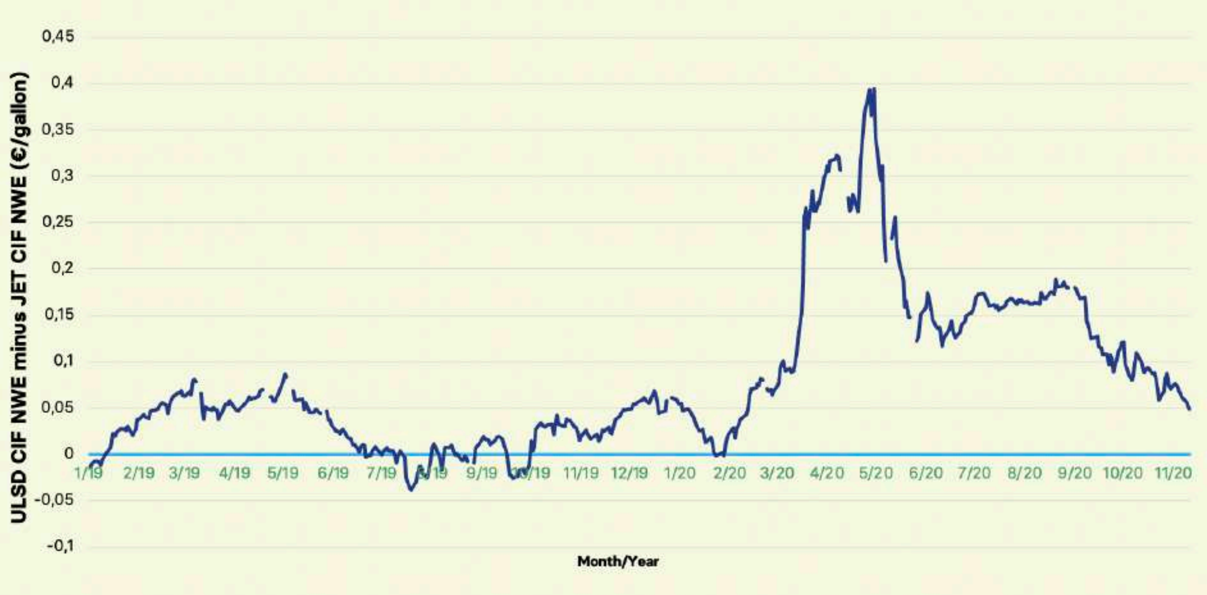
cover enhanced sustainability and/or production costs, in case the 1.2 incentive is not large enough.[93]

Case #3_EU RED II + EU ETS/CORSIA price signal

In addition to EU RED II incentives, the incentive for SAF generated by the EU ETS price signal for allowances may cover part of the premium. Therefore, a plausible scenario is that EU RED II covers the difference in cost between alternative fuel and conventional diesel and the EU ETS price signal covers at least the premium between conventional diesel and jet fuel (as depicted in Figure 14.c, but likely also the additional premium to cover enhanced sustainability and/or production costs. According to 2019 data, the delta between Ultra Low Sulphur Diesel and Jet fuel in Europe (Figure 15) could be covered with the EU ETS incentive for as long as the carbon price signal in this market is greater than around €5/tCO_2.

FIGURE 15

Petroleum products price delta: the difference in market price between (a) ultra-low sulfur diesel (ULSD) CIF NWE, and (b) JET CIF NWE expressed in € per U.S. gallon. (assuming 0.804 kg/l and 0.85 kg/l densities for jet and ULSD respectively). Raw data source: OPIS Europe Jet, Diesel & Gasoil Reports.



Case #4_Large EU ETS/CORSIA with EU RED II or ReFuelEU Aviation's envisioned incentives

As the EU ETS price signal increases, it will fill more of the price gap between SAF and fossil jet fuel, eventually covering more of the premium than EU RED II (see Figure 14.d). As the carbon price signal increases, it becomes the main driver for allocating resources proportionally to the size of the environmental attribute, assuming the EU ETS zero CO_2 combustion rating for biofuels is corrected and aligned with CORSIA's life-cycle approach.

[93] According to the OPIS Europe Jet, Diesel & Gasoil Report (last retrieved November 2020) the delta between jet fuel and road diesel in Europe would only require a small fraction of the incentive coming from the 1.2 multiplier.

At some point in the future, the EU ETS price signal combined with the 1.2 multiplier for SAF under EU RED II – or similar incentive including SAF uptake mandates — will offer air carriers with obligations under the EU ETS will have a sufficient incentive to deploy SAF to meet those compliance obligations. Even in that case, corporations will still need to cover a fraction of the premium to be able to claim emissions reductions, reflective of the fact that their contribution goes beyond existing compliance obligations.

In this scenario, the effective SAF premium gap for corporations would be equivalent to the EU ETS allowance (EUA) price, which ranged €30-80/tCO_2 in 2021.[94] However this assumes EU ETS zero CO_2 combustion rating for biofuels applies. If it is corrected and aligned with CORSIA's life-cycle approach, the effective. The effective SAF premium gap would rise from, e.g., €50/tCO_2 to around €64/tCO_2.[95] For reference, end-customers who want to use high-integrity SAF to fully compensate their carbon emissions for a Madrid-Paris round trip flight in economy class would be subject to an extra air ticket cost of €16 at least.[96]

Finally, some European countries have opted to transpose EU RED II implementing mandates for aviation instead of an opt-in. For instance, France has adopted a 1% volume mandate for SAF beginning in 2022.[97] Similarly to the case of EU RED II, the policy vehicle in France is an alternative fuel consumption incentive tax that can be waived when demonstrating alternative fuel use. There are two main differences between the traditional SAF opt-in and this mandate. First, in this case the regulated entity (fuel supplier) should pass-through the compliance cost to all air carriers purchasing jet fuel in France instead of passing it through to the ground transport sector. Meanwhile all air carriers uplifting jet fuel should be concerned by the increase in jet fuel cost, that should not entitle them to make any SAF use claims. Second, air carriers willing to claim SAF purchases for EU ETS or CORSIA compliance purposes would have to cover a fraction of the SAF premium equivalent to the SAF market value under the EU ETS (or the carbon market with the highest carbon price signal). The rest of the SAF premium should be supported by the sector through higher jet fuel cost. In this scenario, both the air carrier and the corporate customers would be subject to the same price reference, the EUA price. The case of France also sheds light on how the EC's EU-wide mandates under ReFuelEU Aviation (a key component of the "fit for 55"

[94] EUA price signal for May 2021-December 2021 Future contract (EUAA Futures) as reported by The ICE.

[95] If EU ETS zero CO_2 combustion rating error prevails, to estimate the actual abatement cost for the corporation, the EUA price reference would need to be adjusted with the SAF emissions reduction factor defined as ($1-LS_f/LC$), where LS_f is the life-cycle emissions value for SAF and LC the baseline life-cycle emissions values for conventional jet fuel as per CORSIA SARPs (op. cit.), i.e., 89 gCO_2e/MJ. For instance, for SAF with a LS_f of 20 gCO_2e/MJ, i.e., a 78% reduction as compared to the baseline, the corporation's price reference would increase to €64/tCO_2 instead of the EUA price reference of €50/tCO_2.

[96] Based on "ICAO Carbon Emissions Calculator" fuel burn estimates per passenger, which amount for approx. 82% of the life-cycle emissions of the fuel used, and assuming a EUA price of €50/tCO_2 and a 78% reduction in life-cycle emissions.

[97] "Loi de finances pour 2021" nº 2020-1721, December 29, 2020, Article 58 amending Article 266 quindecies of Code de Douanes, later modified by Ordonnance nº 2021-1843, December 22, 2021, Article 7.

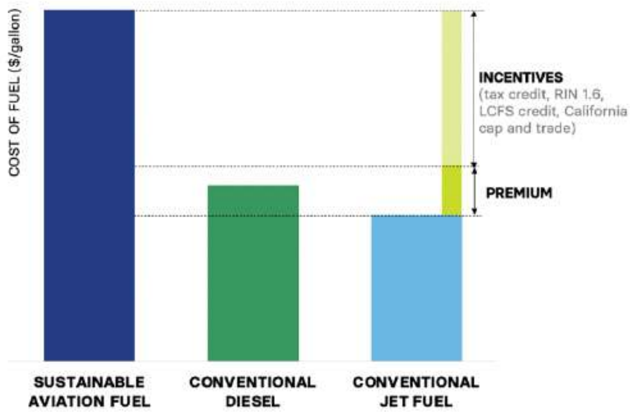
legislation package proposal) could be operationalized through at least 2030.

D.1.2_California

Evaluating the California policy incentives that cover the SAF premium requires considering the Federal and State-level incentives and comparing them to the incentives Renewable Diesel receives, including those that SAF is not eligible for, such as the California cap-and-trade incentive.

As noted in the introduction, in the United States of America, two federal policies incentivize SAF deployment: The Biodiesel Tax Credit and the Renewable Fuel Standard RINs. At the regional level, the CARB allows SAF suppliers or importers to opt in and generate California's LCFS credits. These credits stacked up to the Federal tax credit and the RINs, providing an economic incentive that reduces the premium for SAF, as compared to conventional jet fuel. Figure 16 illustrates the premium in California for SAF as compared to conventional jet fuel after accounting for existing policy incentives.

FIGURE 16
Illustration of the premium in California for sustainable alternative as compared to conventional jet fuel after accounting for existing incentives in the US.



In the case of California LCFS opt-in incentives for SAF, the environmental integrity is guaranteed by the absolute cap applicable to ground transport under California's cap-and-trade system, i.e., it passes the atmospheric benefit test described in Section B.2.4. If alternative fuels currently used for ground transport are diverted to aviation, the ground transportation sector would need to implement complementary measures or purchase allowances to reduce its emissions accordingly to meet its emissions reduction obligations.

Table 7 provides an overview of the difference in incentives between Renewable Diesel (RD) for road transport and SAF across the different applicable policy measures, assuming HEFA-RD qualifies as SAF, i.e., assuming negligible additional processing and certification costs for SAF as compared to RD.

Before August 2022, the difference in incentive between RD and SAF were projected to decline from $0.48/gallon to $0.40/gallon in the coming years. This is due to a decline in the LCFS conventional diesel carbon intensity value, which will reach parity with the conventional jet fuel value in 2023. For international aviation, CORSIA will generate a further incentive for SAF that may likely only partially offset the incentive for RD generated by the cap-and-trade system in California and bring down the difference in incentive.

The SAF premium gap did not change when CORSIA's pilot phase began in 2021 as originally expected. Indeed, CORSIA is not expected to generate demand or reveal a carbon price signal until around 2023 or 2024.[98] As a result, the emissions reduction price for high-integrity SAF would have remained around $56/t$CO_2$, increasing in parallel with the price of California's cap-and-trade system allowances. This price reference is valid for as long as California's Cap and Trade zero CO_2 combustion emissions rating error for biofuels prevails. When this accounting error is corrected the price reference will drop to around $48/t$CO_2$.

For reference, before August 2022, an end-customer who wanted to use high-integrity SAF to compensate 100% of the carbon emissions for a San Francisco-New York round trip flight in economy class would have been subject to a minimum extra air ticket cost of $33.[99]

TABLE 7

Difference in incentives between RD for road and SAF in California as of December 2021.

Policy Measure	Additional Incentive for RD ($/gallon)
Tax Credits_ Until August 2022, the Biodiesel Tax Credit used to provide an equal incentive for both RD and SAF of $1/gallon to both RD and SAF.[100]	$0.00 (-$0.25 to -$0.75[100])
RINs_ Under Renewable Fuel Standard, RD generates 1.7 RINs/gallon and SAF 1.6 RINs/gallon.[101]	$0.06
LCFS credit_ Although RD and SAF production pathways typically have equivalent carbon intensity values under the LCFS, conventional diesel will be assigned a higher carbon intensity for another two years (91.66 gCO_2e/MJ in 2021 and 90.41 in 2022) than conventional jet fuel (89.37 gCO_2e/MJ), after which they will have equal carbon intensity values.[102]	$0.08 in 2021 ($0.04 in 2022) (none 2023 onwards)

Table 7 Cont.

98 See supra note 18.

99 Based on "ICAO Carbon Emissions Calculator" fuel burn estimates per passenger, which amount for approx. 82% of the life-cycle emissions of the fuel used, and assuming a 78% reduction in life-cycle emissions, and a conservative difference in incentive between RD and SAF of $56/t$CO_2$ applicable before August 2022.

100 For an overview of tax credits before 2022 see here. In August 2022, the tax credits changed fundamentally with the enactment into law of the Inflation Reduction Act, which effectively addresses the difference in incentives between RD and SAF in jurisdictions like California. The tax credits applicable as of August 2022 amount to $1.25-$1.75 per gallon depending on the life-cycle emissions below 50% compared to fossil jet fuel.

101 See here.

102 See CI values for 2020 in the LCFS credit value calculator.

Policy Measure	Additional Incentive for RD ($/gallon)
California's cap-and-trade system_ It covers road transport but not aviation. RD is eligible to claim zero CO_2 combustion emissions under the cap-and-trade system, which creates savings equivalent to the value of the allowances avoided.[103]	$0.28
CORSIA carbon price signal_ Incentive for SAF only.	-$0.00[104]
Petroleum products price delta_ The final incentive to account for is the difference in market price between (a) ultra-low sulfur diesel (ULSD), which would be replaced by RD, and (b) conventional jet fuel, which would be replaced by SAF.	$0.06[105]
TOTAL	**$0.48[106]** **(-$0.05 with new SAF credits)[100, 107]** **($0.48/gallon is equivalent to $56/tCO2)[107]**

103 See here for cap-and-trade allowance prices. The qualified bid for the November 2021 auction resulted in a current price of $28.26 for 2018, 2020 and 2021 vintage allowances and an advance settlement price of $34.01 for 2024 vintage allowances.

104 Air carriers using SAF for international purposes will be entitled to claim emissions reductions on life-cycle basis from the use of SAF under CORSIA. As soon as CORSIA's offsetting obligations kick in air carriers will have an additional incentive, equivalent to CORSIA's carbon price signal, which could reduce the size of the additional incentive RD gets through the California cap-and-trade incentive.

105 Based on quotes for Los Angeles OPIS West Coast Market Report (November 4, 2020).

106 Assuming LCFS credit differences for 2021. Estimates including the newly adopted SAF credits of 2022 consider LCFS credit differences for 2022.

107 Assuming a SAF with a carbon intensity (or LS_f) of 20 gCO_2e/MJ.

CONCLUSIONS

The adoption of ICAO CORSIA means that at the international level, a strong framework for SAF is fully operational as of January 1, 2021. This framework holds enormous potential to enable the production of truly climate beneficial SAF (either biofuels or e-fuels). However, policies at the national level are still key to generate the needed economic incentives. Air carriers and corporations can then build on these existing policy frameworks to support the deployment of SAF and claim its environmental benefits.

This handbook recommends countries, air carriers, fuel producers, corporations and other end-customers to only incentivize/deploy/invest/purchase SAF that (i) achieves significant emissions reductions on life-cycle basis as compared to conventional jet fuel; (ii) meets a robust set of sustainability criteria; and (iii) avoids double counting. In this context, particular attention is needed to prevent ILUC because it can not only cancel out SAF emissions reductions, but also cause the destruction of ecosystems and livelihoods. Accounting for ILUC emissions but ignoring the associated broader environmental and social impacts is not appropriate. Therefore, where a feedstock is land-based, producers should implement measures sufficient for the feedstocks to be deemed as having low ILUC risk.

Air carriers and corporations that want to claim SAF emissions reductions towards a climate objective need to avoid double counting to ensure an atmospheric benefit. This handbook proposes a comprehensive framework to prevent double claiming and demonstrates its application for the most complex cases involving corporations. But this framework is also applicable to other aviation end-customers. Indeed, it provides the foundation for air carriers and other travel service providers to establish robust SAF programs to empower all their end-customers to contribute to the decarbonization of aviation.

In particular, this handbook provides the guiding principles to design and integrate a key element that has not been fully developed yet but is critical to trace SAF transactions and claims: A transparent accounting system and registry, which can be operationalized by means of a book-and-claim system for SAF. A book-and-claim system has the capability to track SAF that is directly connected to the air carrier or end-customer value chain but also SAF that has been traded with geographical and temporal flexibilities. A book-and-claim system can also be enhanced to have the capability to issue and track certified SAF emissions reduction credits, i.e., SAF that has already been used and therefore retired by an air carrier from the core book-and-claim system and is only pending end-customer designation. These carbon credits can be traded with geographical, physical and/or temporal flexibilities, a feature that could boost demand and drastically accelerate the uptake of SAF globally.

Air carriers, corporations and other end-customers who want to use SAF emissions reductions that take place in their value chains towards their voluntary targets should account for the full value-chain emissions of transport fuels instead of just combustion emissions. Only then will air carriers, corporations and other end-customers be able to claim SAF emissions reductions as a reduction in life-cycle emissions against the appropriate baseline, rather than a compensation of combustion emissions with upstream reductions. This is not common practice to-date. Traditionally, corporate aviation emissions from, e.g., business travel have focused on the associated combustion emissions. Since average jet fuel's combustion emissions amount to around 82% of total life-cycle emissions of jet fuel, the reported aviation related emissions would need to increase by about 22%, to account for the missing 18% upstream emissions.

This handbook also provides governments with an approach to consistently account for SAF claims by air carriers to avoid double counting. As commercially significant SAF volumes will be deployed in the near-term and SAF will play a key role decarbonizing aviation, governments need to get ready to properly account for the use of SAF and prevent double claiming. Building on this innovative approach, this handbook also provides governments with an approach to fix the well-documented and far-reaching accounting error that has severely undermined the integrity of biofuel claims for ground transportation for more than a decade. This represents a necessary departure from IPCC guidelines for national GHG emissions inventories, which up until now have also been wrongly applied to GHG emissions regulations.

Finally, in addition to addressing the integrity of SAF claims, air carriers, corporations and other end-customers should assess the SAF premium or abatement cost as well as the SAF premium gap after considering existing incentives and subsidies and the resulting abatement price reference. The size of the premium gap changes depending on existing policy and regulatory incentives, which vary by jurisdiction. In Europe, while the implementation of related policies varies by Member State, the latest developments are poised to generate incentives through mandates for the deployment of SAF volumes (something that happened as early as 2022 in some cases like France) or SAF emissions reductions (as is the case in Sweden). In this context, corporations and other end-customers seeking SAF emissions reductions would still need to cover a fraction of the total SAF premium, equivalent to the EU ETS price signal. This approach could become applicable across the entire EU beginning in 2025. The premium gap can be easily translated into airfare surcharges, which are easier to contextualize for end-customers. For instance, with that premium gap, end-customers who want to use high-integrity SAF to fully compensate their carbon emissions for a Madrid-Paris round trip flight in economy class would be subject to an extra air ticket cost of €16 at least.

In California, air carriers and end-customers who want to claim SAF emissions reductions need to cover the premium gap between RD and SAF after considering the available incentives at the Federal and State levels. This premium gap was around $0.48/gallon in December 2021 but is projected to shrink to $0.40/gallon assuming constant allowance prices in California. This is equivalent to an abatement cost of $48-$56/tCO_2. For reference, with this abatement price before August 2022, an end-customer who wanted to use high-integrity SAF to compensate 100% of the carbon emissions for a San Francisco-New York round trip flight in economy class with an abatement cost of $56/t$CO_2$ would have been subject to an extra air ticket cost of $33. However, this is about to change as a result of the enactment into law of the Inflation Reduction Act of 2022, which is poised to close the premium gap between RD and SAF in jurisdictions such as California.

In sum, this handbook provides key stakeholders with a framework to deploy SAF with environmental integrity, no double claiming and transparent abatement prices. As more stakeholders adhere to the guidelines in this handbook, the faster we can reach our destination of net zero aviation. This is a pivotal moment to jump-start the journey to net zero aviation and the aviation sector, as it recovers from the impact of a global pandemic and plans to navigate a changing climate, has a blue-sky opportunity that cannot be missed.

Appendix A_ Emissions reductions from the use of SAF in CORSIA

In adopting the CORSIA Resolution in 2016, ICAO's Assembly directed that ICAO's Council, with input from CAEP, developed a methodology for quantifying the emission reduction benefits of SAF so that air carrier's CORSIA offsetting requirements can be reduced through the use of these fuels (Paragraph 6 of the Assembly Resolution A39-3).

Under ICAO CORSIA SARPs[108], air carriers are requested to report all CO_2 combustion emissions from fuel use independently of its nature, i.e., conventional aviation fuel, and alternative fuels.[109] Air carriers can reduce their CORSIA emissions reduction obligations by claiming emissions reductions from the use of eligible SAF that meet an agreed standard.[110,111] Thus, instead of claiming "zero" CO_2 emissions from biogenic SAF combustion and implicitly consider that all SAF are carbon neutral, ICAO has developed a methodology to estimate the actual emissions reductions from the use of each SAF over its life cycle compared to the life-cycle emission of conventional jet fuel.

SARPs Volume IV, Chapter 3, para. 3.3 on "Emissions reductions from the use of sustainable aviation fuels" describes how to compute the SAF emissions reduction credit following a formula for batch-by-batch calculation of reductions associated with particular alternative fuels (equation 1).[112] To compute emissions reductions (ER) from the use of SAF the air carrier multiplies the total mass of SAF (MS) by the SAF emissions reduction factor (ERF) and the fuel conversion factor to CO_2 emissions (FCF).[113] The ERF, "1 - (LS_f / LC)", is inversely proportional to the life-cycle emissions benefit of the SAF as compared to the life

[108] ICAO, 2018, First edition of ICAO CORSIA SARPs Annex 16, Volume IV.

[109] ICAO, 2018, First edition of ICAO CORSIA SARPs Annex 16, Volume IV, Part II, Chapter 2.

[110] ICAO, 2018, First edition of ICAO CORSIA SARPs Annex 16, Volume IV, Part II, Chapter 3.

[111] According to the CORSIA SARPs the scope of the mechanism is Paragraph 6 was extended to cover fossil fuels with lower carbon intensities and now applies to "CORSIA eligible fuels", namely (1) SAF and (2) fossil "lower carbon aviation fuels".

[112] ICAO, 2018, First edition of ICAO CORSIA SARPs Volume IV, Part II, Chapter 3, Paragraph 3.

[113] The values assigned to the FCF consider CO_2 combustion emissions rather than the total life-cycle emissions. As a result, the ER, i.e., the size of the SAF credits, represent around 82% of the total emissions reductions for Jet-A fuel / Jet-A1 fuel. This makes sense in a context without clear guidance on how to avoid double claiming. Still, Equation 1 should have allowed all emissions reductions for as long as they were smaller or equal to the total combustion emissions, rather than applying a de facto discount. As soon as ICAO develops guidance to avoid double counting of SAF emissions reductions as per Part C in this Handbook, ICAO should amend the FCF to reward all the emissions reductions. For instance, assuming combustion emissions of 73 gCO_2e/MJ according to 2006 IPCC guidelines (note this figure might be different than the one considered by ICAO), the FCF should be 3.85 $kgCO_2$/kg fuel for Jet-A fuel / Jet-A1 fuel instead of 3.16 $kgCO_2$/kg fuel.

cycle (LC) representative of conventional fuel. The SAF life-cycle emissions value (LS_f) accounts for both core life-cycle emissions directly attributable to the production of the SAF and ILUC default values for pathways using land-based feedstocks.

$$ER_y = FCF * \left[\sum_f MS_{f,y} * \left(1 - \frac{LS_f}{LC}\right)\right] \quad \text{(Equation 1)}$$

Where:

ER_y =Emissions reductions from the use of CORSIA eligible fuels in the given year y (in tonnes);

FCF =Fuel conversion factor, equal to 3.16 $kgCO_2$/kg fuel for Jet-A fuel / Jet-A1 fuel and 3.10 kg *CO_2/kg fuel for AvGas or Jet-B fuel;*

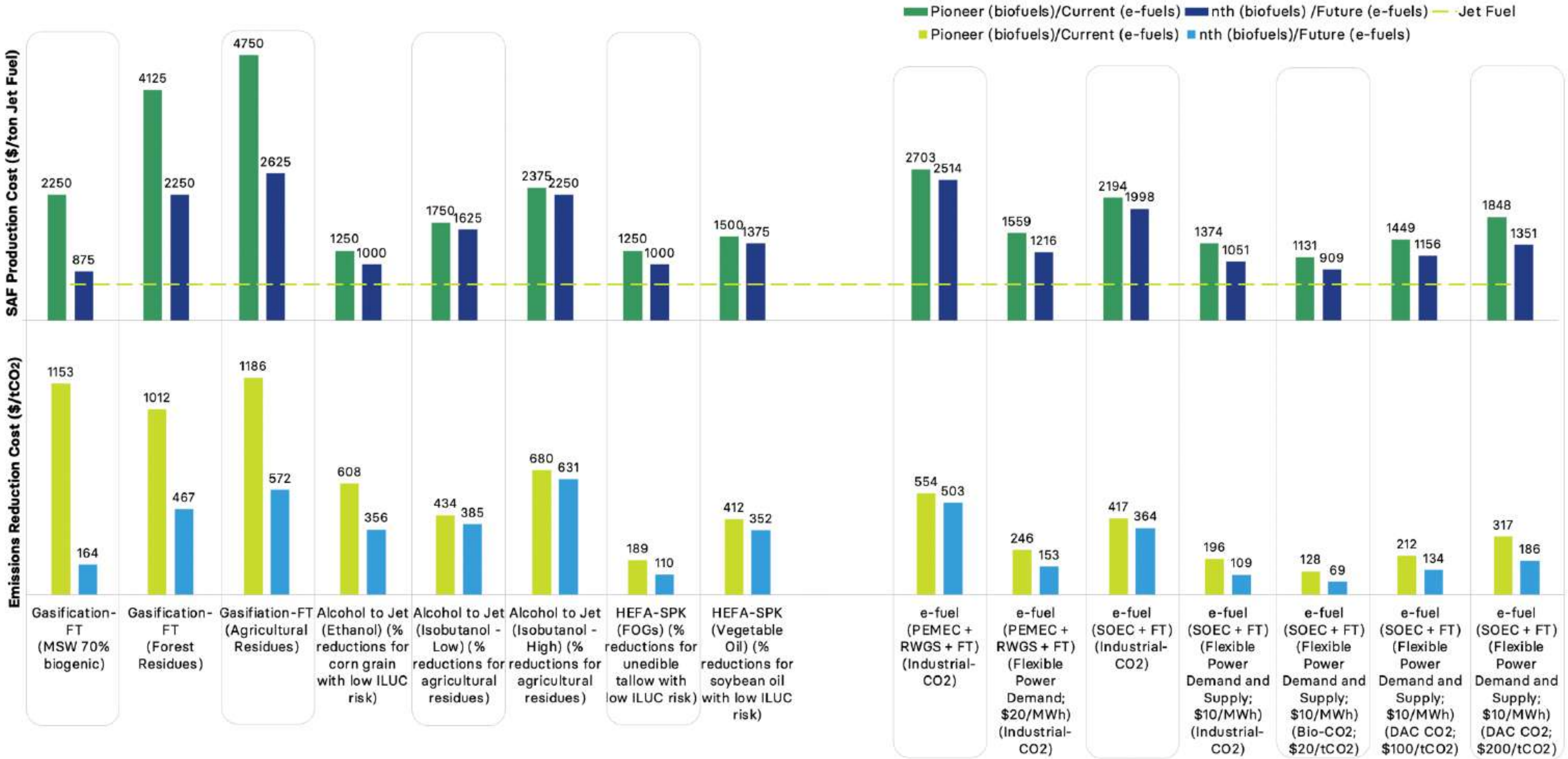
$MS_{f,y}$ *=Total mass of a neat CORSIA eligible fuel claimed in the given year y (in tonnes);*

LS_f *=Life-cycle emissions value for a CORSIA eligible fuel (in gCO_2e/MJ); and*

LC = Baseline life-cycle emissions values for aviation fuel, equal to 89 gCO_2e/MJ for jet fuel and equal to 95 gCO_2e/MJ for AvGas.

Appendix B_Big Picture SAF Production and Emissions Reduction Costs

FIGURE B.1 _Present and future SAF production and emissions reduction costs for biofuels (gasification Fischer Tropsch, alcohol-to-jet, HEFA) and e-fuels (PEMEC +RWGS + FT, SOEC+FT) pathways, with varying feedstocks and technology choices.



NOTE: The estimates are based on data from: (1) ICAO (2021) "SAF Rules of Thumb" for biofuel production costs, (2) ICAO document (2021) "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels" 3rd Edition, for default lifecycle emissions values for biofuels; (3) FT and RWGS reaction costs and fossil jet fuel price reference from World Economic Forum and McKinsey & Company, Clean Skies for Tomorrow (2021), "Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation" (op. cit.), and (4) Peterson D., J. Vickers, D. DeSantis (2020) "Hydrogen Production Cost From PEM Electrolysis – 2019. U.S. Department of Energy's Hydrogen and Fuel Cells Program Record 19009" and Peterson D., J. Vickers, D. DeSantis (2020) "Hydrogen Production Cost From High Temperature Electrolysis – 2020. U.S. Department of Energy's Hydrogen and Fuel Cells Program Record 20006", for current and future hydrogen production costs using central production facilities with PEMEC and SOEC (representative for High Temperature Electrolysis) pathways. Key assumptions for e-fuels described in Figure B.2.

FIGURE B.2

Breakdown of costs for e-fuels (current and future) for a 50,000 kg/day 119 MW and 80 MW installed 50,000 kg H_2/day capacity and 97% and 90% capacity factor for PEMEC.

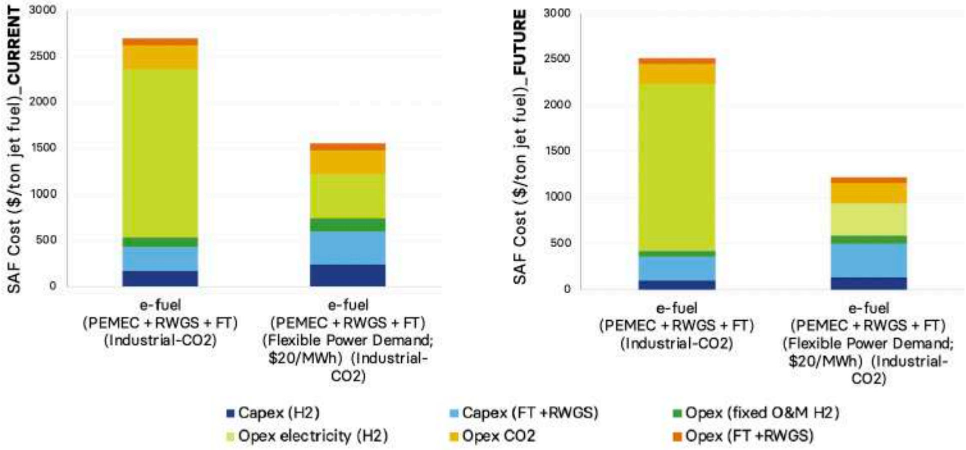
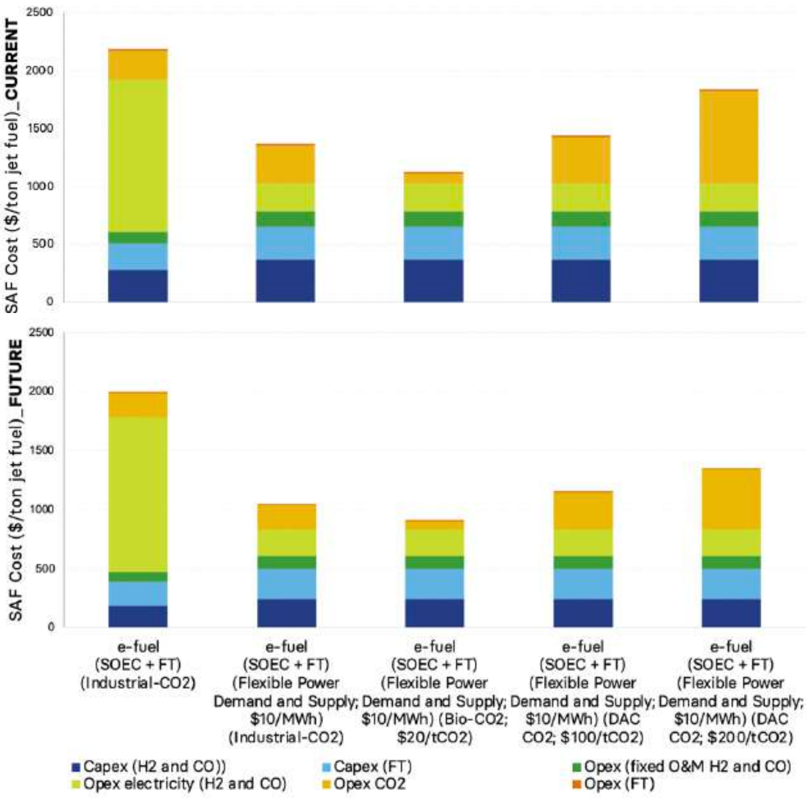


FIGURE B.3

Breakdown of costs for e-fuels (current and future) for a 50,000 kg/day 119 MW and 80 MW installed 50,000 kg H_2/day capacity and 97% and 90% capacity factor SOEC.



NOTE (Figure B2 and B3): All capital costs for PEMEC and SOEC assume manufacturing at volumes such that economies of scale have been achieved. Effective electricity cost over life of plant (40 years) of $7.35/MWh (current) and $7.91/MWh (future). No significant thermal energy feedstock cost for SOEC as integrated with exothermic FT process heat and potentially, if necessary, with additional heat from the combustion of gaseous FT co-products. For scenarios with Flexible Power Demand and Supply with a reduced capacity factor of 70% and scaled up capital costs: Hypothetical electricity prices for interruptible grid electricity contracts (100% renewable) of $20/MWh for PEMEC and $10/MWh for SOEC (a lower price is considered for SOEC for illustrative purposes assuming it can generate power operating as a Fuel Cell on demand). Industrial CO_2 cost $81-$66/tCO_2 for current and future scenarios respectively, as per World Economic Forum and McKinsey's report (op. cit.); Hypothetical DAC and biogenic CO_2 prices for reference.

Appendix C_The Case of HEFA Renewable Diesel Qualifying as SAF

To date, ASTM International has certified seven biofuel production pathways for blending with fossil jet kerosene. Of the six pathways, only the pathway for hydro-processed esters and fatty acids - synthetic paraffinic kerosene (HEFA-SPK) has been deployed, albeit with limited production. [114]

Given the existing HEFA installed capacity, larger volumes of SAF for aviation could be produced. Tapping on the already installed capacity originally deployed for fulfilling biofuel volume mandates for road transport could quickly multiply available SAF volumes in the near-term if hydro-processed esters and fatty acids renewable diesel (HEFA-RD, often referred to as HEFA+) is certified under the fast track procedure under the ASTM Fuel Evaluation Process .

HEFA-RD, has a similar production pathway to HEFA-SPK, but is designed so that hydrocarbon chains are longer, making them more similar to those found in renewable diesel for road.[115] Once approved and commercially available, it is expected HEFA-RD will cost less and be easier to deploy than HEFA-SPK because HEFA-RD can be produced at renewable diesel production facilities.[116]

Another key distinction between HEFA-SPK and HEFA-RD is that where HEFA-SPK has a blend rate as high as 50%, HEFA-RD has only been blended at a maximum of 15%.[117] The different blend rates stem from the longer hydrocarbon chains in HEFA-RD, designed to minimize the creation of low-value light compounds (e.g. naphtha, propane) which cannot be in the finished jet fuel. [118] The modification also means HEFA-RD has a higher freezing point than HEFA-SPK, so it does not perform as well at cold temperatures, an issue for

[114] OECD/IEA, 2018, Renewables. Analysis and Forecasts to 2023. Market Report Series.

[115] ICCT, 2018, Policy and Environmental Implications of Using HEFA+ for Aviation.

[116]OECD/IEA, 2018, Renewables. Analysis and Forecasts to 2023, Market Report Series, (op. cit.).

[117] Ibid.

[118]ICCT, 2018, Policy and Environmental Implications of Using HEFA+ for Aviation, (op. cit.).

aeroplanes.[119] In order to compensate for the higher freezing point, HEFA-RD must be blended at lower volumes with conventional jet fuel. [120]

Unlike HEFA-SPK, HEFA-RD is not currently ASTM certified, a process which took three years for HEFA-SPK to complete.[121] However, HEFA-RD could benefit from the fast track, ASTM Fuel Evaluation Process which targets fuels that have a conventional hydrocarbon composition. [122] The fast-track options allows for fuels that will only have a low blend level of 10% to be certified following a streamlined approval process.[123]

[119] Ibid.

[120] Ibid.

[121] James Hileman, 2019. ICAO Stocktaking Seminar Presentation: Fuel Approval Process and Status.

[122] IATA, 2019, IATA Sustainable Aviation Fuel Symposium Presentation.

[123] Ibid.

Appendix D_Requirements for Low ILUC Risk and Landfill Emissions Credits

D.1 Low ILUC Risk Designations

Biomass production for biofuels has a high risk of ILUC because it can result in the displacement of pasture and agricultural land, previously dedicated to the production of food and feed crops. The displaced demand is mainly satisfied through the following: (1) land management practices that intensify production, (2) reduced consumption of food and feed, or (3) by bringing non-agricultural land into production elsewhere. If non-agricultural lands are converted to satisfy displaced production, biofuel production incurs an indirect land use change. If the converted land has a high carbon stock, it can lead to significant land use change emissions that have the potential to negate all the emissions reductions achieved from the use of biofuels; in some cases, resulting in substantially greater emissions from the biofuel than the conventional fossil fuel it is intended to replace.

Under the ICAO framework, a risk-based approach is applied, assuming that food and feed biofuel stocks have an inherent indirect land-use change risk. Indirect land-use change emissions need to be estimated using theoretical models and the resulting ILUC values are included in the life-cycle value for pathways using food and feed crops as feedstock. The ICAO framework also sets specific sustainability criteria designed to safeguard against direct land use change, for example, biofuels cannot be produced from land with high carbon stocks.

In parallel, fuel producers have the option to implement measures covered under the low LUC risk practice module to prevent indirect land use change and, consequently, claim zero ILUC values. The low ILUC risk practice module is a key component to the risk-based approach to LUC in the SAF life-cycle emissions methodology. This module needs to be designed in conjunction with the ILUC approach. Indeed, ILUC values adopted by ICAO already incorporate the positive impact land management practices such as those envisioned in the low ILUC risk module would have. Therefore, ILUC waivers should only be rewarded under special circumstances and/or for a limited period of time to ensure that the benefit of implementing them is not counted for more than once in the context of CORSIA.

Alternatively, as proposed in Section B.1, all feedstocks with ILUC risk would need to receive low ILUC risk certification to be eligible under CORSIA, the only approach that is compatible with the principles guiding the sustainability criteria and that ensures that SAF emissions reduction claims have integrity.

The low ILUC risk module should only be envisioned as a policy tool aimed at catalyzing the adoption of best practices that generate real and measurable net improvements that would not have happened in its absence. Unfortunately, the provisional methodology adopted by ICAO (pending amendments under consideration by ICAO Council in 2022) is not consistent with this goal and needs to be enhanced. The following amendments are necessary:

(1) Baseline for yield increases.

To set up a baseline for yield increases, the ICAO methodology uses data from the preceding 5 years from similar producers within the same region. In this context, “similar producers” is only defined as producers growing the same or equivalent crop using similar management model. However, it should mean producers with similar site and location factors, a consideration that would have made the approach meaningful. Indeed, location and site factors are responsible for as much as 50% of the yield[124] — resulting in significant variation among crop producers within the same region. Furthermore, mathematically, 50% of farms would achieve yield increases above the proposed baseline in any particular region according to the ICAO baseline methodology, i.e., 50% of the farms around the world would be wrongly entitled to low ILUC risk designation for feedstock produced in farms with yields above regional average without the need to demonstrate, in most cases, the connection between such yield increases and the implemented measure. However, in the absence of biofuel demand, all of the crop produced at these farms above such an arbitrary baseline would have got a market in food, feed, or materials. Displacing some of this crop for biofuel production would thus reduce the amount available for other uses, raising commodity prices, and causing ILUC.

The low ILUC risk-eligible feedstock should only represent a real enhancement and be attributable to an implemented measure. It is necessary to identify the specific practice attributable to the SAF production that generates the additional yield, as well as the additional amount.

The baseline shall be calculated considering (a) the average actual yields in the land where the measure is implemented during the 5 years preceding the implementation, and (b) the average annual yield growth for similar producers in the region during the 10

[124] See for instance RSB, 2015, “RSB Low iLUC Risk Biomass Criteria and Compliance Indicators”, RSB reference code: [RSB-STD-04-001 (Version 0.3)] p. 5.

years preceding the implementation of the project activity, or equivalent. The baseline would be the result of projecting the average actual yields in the land with the estimated average annual yield growth for similar producers in the region. This solution is consistent with the baseline methodology pioneered by RSB.[125]

(2) Duration of designations.

In the case of Yield Increase Approach, designations should have a limited duration of 10 years without renewal. This accounts for the fact that innovative practices today will gradually become mainstream practices in the future. Meanwhile changes in land practices may occur rapidly and would advise shorter timeframes, 10 years appears as a reasonable compromise to reconcile the need to safeguard the environmental integrity with the need to ensure investments in innovative practices. Besides a 10-year timeframe is consistent with UNFCCC existing practices.[126]

For the Unused Land Approach there should be either a limited duration of 10 years without renewal or a periodical risk rating re-evaluations every 5 years to account for changing conditions in the business-as-usual scenario. In this context, the low ILUC risk designation should be subject to renewal for a maximum of 15 years. Fast changing conditions would advise shorter revision frequencies. However, 10 years and 15 years appear as a reasonable timeframe to reconcile business certainty and environmental integrity. Besides, it is consistent with UNFCCC existing practices where project developers can chose between a 10-year .[127] To make the evaluation and re-evaluation process meaningful, feedstock producers would need to show evidence that the land is located in a region in which no significant additional agricultural development is taking place or is foreseen in the near-term (except for biofuel production), or that the plot of land has certain characteristics that form a barrier to its development (e.g., contaminated land) into agriculture and thereby make its development in the near-term unlikely in the absence of biofuel production. After a maximum of 5 years, to be entitled to continue claiming low ILUC risk designation, feedstock producer would need to show evidence that the relevant criterion is still applicable to the plot of land in question.

(3) Improvements in post-harvest losses.

[125] Ibid.

[126] A 10-year timeframe is consistent with the timeframe adopted November 2021 under the UNFCCC Article 6.4 Mechanism under the Paris Agreement for projects without crediting period renewal.

[127] A 5-year timeframe is consistent with the timeframe adopted November 2021 under the UNFCCC Article 6.4 Mechanism under the Paris Agreement for projects that opt for reevaluation of the crediting baseline, which can be renewed twice.

Among the different measures noted in the ICAO methodology that could result in an increase in the harvested feedstock eligible there is one, namely, "improvements in post-harvest losses"[128] that would require further evaluation before including it as eligible. Therefore, this measure should be excluded until further analysis is carried out as its scope appears to go beyond the scope originally intended for low ILUC risk practices.

D.2. Default low risk of ILUC assumption for certain feedstocks

The ICAO methodology assigns zero ILUC values to SAF produced from 'wastes, residues and by-products' (see Box 2 for a definition). ICAO considers that wastes and residues have little or no commercial value, and therefore using them to produce SAF would not generate any indirect effects because it would not divert them from other economic uses and thus indirectly increase demand for their production.

A similar reasoning applies to by-products in spite of having economic value per definition, while at the same time, the ICAO methodology[129] provides that if the CAEP Fuels Task Group, based on a scientific literature review conducted every three years, finds there are significant indirect effects associated with particular by-products, then these will be reclassified as "co-products," meaning they will have to account for their indirect emissions.

BOX 2

ICAO's methodology[130] definition for wastes, residues and by-products.

Wastes are materials with inelastic supply and no economic value. A waste is any substance or object which the holder discards or intends or is required to discard. Raw materials or substances that have been intentionally modified or contaminated to meet this definition are not covered by this definition.

Residues are secondary materials with inelastic supply and little economic value. Residues include: a) Agricultural, aquaculture, fisheries and forestry residues: Residues directly deriving from or generated by agriculture, aquaculture, fisheries and forestry, b) Processing residues: A substance that is not the end product that a production process directly seeks to produce; the production of the residue or substance is not the primary aim of the production process, and the process has not been deliberately modified to produce it.

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

By contrast, the ICAO methodology assigns ILUC values to SAF produced from crops that are generally fed to animals or consumed as food by humans, because the methodology assumes that if these feed and food crops are diverted to SAF production, farmers will need to produce more of the feed and food crops to satisfy demand for those – and the farmers may need to deforest more land, increase their use of fertilizer or other inputs, and increase the amount of

[128] "Improvement is post-harvest losses" is defined as "losses that occur at cultivation and transport up to but not including the first conversion unit in the supply chain"

[129] See section "4. Feedstock Categories" in ICAO document "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values", (op. cit.).

[130] ICAO document "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values", 2019, (op. cit.).

transport in order to produce those crops and get them to market, resulting in increased indirect emissions. While this differentiation between food and feed crops, on the one hand, and wastes, resides, and by-products, on the other hand, is understandable, it inadvertently creates incentives for feedstock producers to seek ICAO designation as a "waste, residue or by-product" even though the materials involved have economic uses and therefore have risks of indirect emissions, including as a result of indirect land use change.

However, under some circumstances these wastes, residues and by-products might have displacement effects. Rather than assuming a feedstock has no displacement effects, fuel producers should show evidence that these feedstocks do not result in displacement emissions from ILUC. Importantly, not all displacements result in indirect emissions, e.g., when the displacement occurs in a sector that is capped under a cap-and-trade system. This can be demonstrated by achieving certification under RSB's low ILUC Risk Biomass Criteria and compliance indicators or by means of RSB's Standard for Advanced Biofuels and the Methodology for Displacement Emissions to demonstrate no displacement emissions from ILUC.

In case wastes, residues and by-products have displacement effects other than ILUC, the fuel producer should estimate and add displacement emissions to their life-cycle emissions using RSB Methodology for Displacement Emissions (RSB-STD-04-002).[131,132]

Under that methodology, where a feedstock is shown to have ILUC risk, it should be automatically ineligible for financial support.

D.3 Avoided Emissions from "Landfill Emissions Credits"

According to "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values"[133], the production of SAF from wastes and residues may generate "emission credits" that can be subtracted from the actual life-cycle values. And in particular, SAF produced from MSW feedstocks may generate an avoided Landfill Emissions Credit (LEC) and a Recycling Emissions Credit (REC).

A substantial share of the environmental benefits claimed with MSW-based SAF will probably come from changes in waste management entitled to generate LEC and REC. For instance, an MSW-based SAF that is only 50% biogenic would have a life-cycle emissions value as large as conventional fuel and would not even qualify as SAF. This is mostly the case

[131] "RSB Methodology for Displacement Emissions", 2018, (op. cit.)

[132] Not all displacements result in indirect emissions, e.g., when the activity displaced occurs in a sector that is capped under a cap-and-trade system.

[133] See here.

because of CO_2 combustion emissions from the non-biogenic content are fully accounted for. This turns the MSW SAF pathways into a parallel channel to get similar LEC and REC equivalent offsets generated with UNFCCC CDM and voluntary market methodologies, which could also potentially be used to meet CORSIA obligations without the need of producing a SAF. Meanwhile the methodology for REC adopted by for CORSIA purposes is consistent with UNFCCC accounting, the same cannot be said about the LEC methodology. This advises caution and calls for rightfully aligning the CORSIA's LEC methodology with the standard LEC methodologies that will be entitled to generate units for CORSIA and align it with UNFCCC accounting.

The ICAO CORSIA LEC methodology assumes emissions as a function of 100-year life-cycle business as usual scenario that is not re-evaluated to match real world evolving conditions, granting emissions reductions that would only have happened – if at all — over the 100 years after MSW-based SAF use. This is an unprecedented approach in the context of a market-based measure such as CORSIA. This approach implies borrowing emissions reductions from the future, which is inconsistent with UNFCCC accounting and crediting rules applying elsewhere, including the emissions reduction units eligible under CORSIA for the very same mitigation activities. This is not appropriate.

Granting –upfront— emissions credits that would have happened over the following 100 years, generates another inconsistency with UNFCCC accounting rules when it comes to making the necessary corresponding adjustments to avoid double claiming. Absent any change to the methodology, the host country would need to make an adjustment for landfill methane emissions that would have only gradually showed up in its inventory –if ever— over decades to come in line with the "first order decay approach" used to account for methane emissions from landfills in national GHG emissions inventories worldwide.

Furthermore, the ICAO CORSIA methodology fails to capture changing conditions in the business-as-usual scenario, overestimating so the associated emissions reductions. For instance, if a few years after SAF production begins the host country adopts legislation to ban landfills and mandate MSW incineration or gasification for energy purposes, the fuel producer would still be entitled to claim "indefinitely" LECs corresponding to all the MSW it diverts from inexistent landfills according to ICAO CORSIA methodology. This would be the case in spite of the fact that because of MSW incineration or gasification all methane emissions would have been avoided anyway. Similarly, if a landfill without any methane control measures is capped a few years after SAF production takes off, or if the landfill is reclaimed and the old MSW combusted together with fresh sources to generate energy, the air carrier will still be entitled to claim LECs indefinitely in spite of the fact that most of the emissions would have been avoided anyway.

The overestimation in emissions reductions from unrealistic business-as-usual scenarios would be compounded on top of the potential overestimation for not considering on-field uncertainties. This advises the adoption of a “model correction factor”. Fuel producers should adopt a 10% correction factor, consistent with the correction factor used in the CDM for the same kind of methodology.

Meanwhile the methodology correctly includes the avoided electricity credit that needs to be subtracted from the LEC in case the landfill gas was collected and used for generating electricity in the business-as-usual scenario, which is fine, the methodology can only consider a sketchy estimate for the avoided electricity credit because the carbon intensity of the grid electricity over 100 years is obviously unknown. Absent a better estimate, the methodology assumes that all future displaced electricity over the following 100 years would have got the same average carbon intensity of otherwise displaced grid electricity of the year the MSW was displaced from the landfill. This approach penalizes air carriers sourcing MSW-based SAF from countries that have already embarked on the decarbonization of the power generation sector. The displaced electricity credit should be updated periodically to reflect grid electricity emissions.

D.3.1_Amendments to the MSW Landfill Emissions Credit Methodology

ICAO Council should adjust the LEC methodology in accordance to IPCC guidance and UNFCCC accounting rules and establish clear rules for setting business as usual counterfactual scenarios. This requires:

(1) incorporating a temporal dimension to the equations in Section 6 of “ICAO document - CORSIA Methodology for Calculating Actual Life Cycle Emissions Values”, by adding a temporal index and using IPCC’s readily available default decay rates for the same wastes categories as those already considered in the methodology, and

(2) a set of additional requirements to demonstrate that the landfill emissions credits represent a net enhancement of what would have happened in the absence of the MSW diversion from the landfill, namely, (a) the landfill emissions credits represent GHG emissions reductions or carbon sequestration or removals that exceed any GHG reduction or removals required by law, regulation, or legally binding mandate, and that (b) the landfill emissions credits exceed any GHG reductions or removals that would otherwise occur in a conservative, business-as-usual scenario. To ensure the counterfactual scenarios stay valid over time, fuel producers shall undergo a re-evaluation of the business-as-usual scenario through a review mechanism that captures changing conditions (including legal requirements, LFGCE and MCF) every 5 years.

Adding a temporal index as the one proposed here would not add significant complexity in the accounting of SAF to reduce offsetting obligations under CORSIA. Rather than allocating gradually all future associated emissions reduction over 100 years to specific SAF batches, which does not make any sense, the methodology hereby recommended proposes a conceptually different LEC approach. In this case the actual LEC claimed in a given year is generated from all MSW displaced from the landfill since the very beginning of SAF production, i.e., it accounts for all methane avoided in a given year as a result of SAF production. Then, the total LEC generated in a given year is proportionally allocated to all the MSW-based SAF produced in the same year. Any other alternative involving the generation of LEC bit by bit over 100 years would obviously add a tremendous amount of unnecessary complexity. It would also result in MSW with large non-biogenic content not being eligible under CORSIA because it will not meet the 10% threshold.

Finally, to limit unintended incentives for poor landfill management, the proposed way forward involves gradually constraining the capacity to claim LEC emissions reductions as follows. After the first re-evaluation of the business-as-usual scenario, fuel producers shall assume that landfill gas collection efficiency (LFGCE) in Step 5 of LEC methodology is either “active” or “moderate” – but not “minimal” or unmanaged — whichever is closer to landfill-specific conditions in accordance with definitions in footnotes to Table 3. After the second re-evaluation of the business-as-usual scenario, the landfill gas collection efficiency (LFGCE) shall be assumed to be active. This way poor landfill management is not rewarded beyond what is reasonably acceptable as it only rewards for LEC beyond landfill management practices that the host country is meant to adopt in the context of climate change policy.

ICAO should adopt the following amendments to *ICAO document - CORSIA Methodology For Calculating Actual Life Cycle Emissions Values* in ***italics and bold***:

6.1 Methodology for calculation of landfill emissions credits

1. SAF produced from Municipal Solid Waste (MSW) feedstocks may generate an avoided Landfill Emissions Credit (LEC).

2. ***Fuel producers need to demonstrate that the LEC emissions reduction credits are a net enhancement of what would have happened in the absence of the MSW diversion from the landfill. The emission reduction credits represent GHG emissions reductions or carbon sequestration or removals that exceed any GHG reduction or removals required by law, regulation, or legally binding mandate, and that exceed any GHG reductions or removals that would otherwise occur in a conservative, business-as-usual scenario. Fuel producers shall undergo a re-evaluation of the business-as-usual***

scenario through a review mechanism that captures changing conditions (including legal requirements, LFGCE and MCF) every 5 years.

3. ***To prevent unintended incentives for poor landfill management, after the first re-evaluation of the business-as-usual scenario, fuel producers shall assume that landfill gas collection efficiency (LFGCE) in Steps 5 is either "active" or "moderate" –but not "minimal" or unmanaged— whichever is closer to landfill-specific conditions. After the second re-evaluation of the business-as-usual scenario, the landfill gas collection efficiency (LFGCE) shall be assumed to be "active".***

4. The value of the LEC shall be calculated as follows:

Step 1 – Estimate the proportional shares of each of the following four waste categories (*j*) that make up the MSW diverted from landfilling: paper/textiles; wood/straw; other (non-food) organic putrescible/garden and park waste; and food waste/sewage sludge. These shares should be expressed in terms of the dry mass of each waste category (*j*) per dry mass of MSW diverted from landfilling (before additional sorting and recycling, if applicable) (eg. $W_{paper/textiles}$ = 0.4 dry tonne per dry tonne of MSW).

Step 2 – Select the degradable organic carbon content (DOC) and the fraction of carbon dissimilated (DOC_F) values from Table 2 that best represent each waste category (*j*) in the MSW. Use weighted averages to generate DOC and DOC_F values that accurately represent each of the four waste categories of the MSW feedstock of interest.

Table 2: DOC and DOC_F

Material	DOC[134] (% of dry matter)	DOC_F[1] (%)
Corrugated containers	47%	45%
Newspaper	49%	16%
Office paper	32%	88%
Coated paper	34%	26%
Food waste	50%	84%
Grass	45%	46%
Leaves	46%	15%
Branches	49%	23%
Gypsum board	5%	45%
Dimensional lumber	49%	12%
Medium-density fiberboard	44%	16%
Wood flooring	46%	5%

[134] EPA, "Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM). Management Practices Chapters." 2016. EPA Office of Resource Conservation and Recovery (ORCR).

Step 3 – Select the methane correction factor (MCF) from Table 3 that most accurately represents the conditions of the landfill in question.

Table 3: Methane correction factor (MCF)[135]

Landfill conditions	MCF
Anaerobic managed solid waste disposal site	1.0
Unmanaged solid waste disposal site – deep	0.8
Semi-aerobic managed solid waste disposal site	0.5
Unmanaged solid waste disposal site - shallow	0.4

Step 4 – Use Equation 1 to calculate total CH_4 generation, *Q*, from each waste category, *j*, per dry tonne of diverted MSW.

Equation 1: Total CH_4 generation from waste category *j*, ***per year,*** per dry tonne of diverted MSW [g CH_4 / t dry diverted MSW]

~~$Q_j = W_j \times DOC_j \times DOC_{F\_j} \times F \times MCF \times (16/12) \times 10^6$~~

$$Q_{j,y} = \sum_{x=1}^{y} \sum_{j} \left[W_{j,x} \cdot DOC_j \cdot DOC_{F,j} \cdot F \cdot MCF \cdot \frac{16}{12} \cdot 10^6 \cdot e^{-k_j \cdot (y-x)} \cdot \left(1 - e^{-k_j}\right) \right]$$

where:

$Q_{j,y}$	= *total CH_4 generation* ~~***over a 100-year period***~~ ***in year y*** *from waste category j*
$W_{j,x}$	= *dry mass of waste category j per dry mass of MSW diverted from landfilling [%]* ***in year x (t)***
DOC_j	= *degradable organic carbon content from Table 1 [%]*
DOC_{F_j}	= *fraction of degradable organic carbon dissimilated from Table 1 [%]*
F	= *CH_4 concentration in LFG, 50%*
MCF	= *Methane correction factor from Table 2*
16/12	= *CH_4 to carbon ratio*
10^6	= *grams per tonne conversion [g / t]*
k_j	= ***decay rate for the waste type j (1/yr) from Table 4.***
x	= ***years in the time period in which waste is disposed at the landfill, extending from the first year in the time period (x=1) to year y (x=y)***
y	= ***year of the emissions reduction crediting period for which methane emissions are calculated***

[135] Intergovernmental Panel on Climate Change (IPCC). 2006 IPCC guidelines for national greenhouse gas inventories.

Table 4: Default values for the decay rate (k_j) per year.[136]

Waste category, j		*Boreal and temperate (MAT ≤ 20°C)*		*Tropical (MAT > 20°C)*	
		Dry (MAP/PET < 1)	*Wet (MAP/PET >1)*	*Dry (MAP < 1000 mm)*	*Wet (MAP >1000 mm)*
Slowly degrading waste	*Paper/textiles waste*	*0.04*	*0.06*	*0.045*	*0.07*
	Wood/straw waste	*0.02*	*0.03*	*0.025*	*0.035*
Moderately degrading waste	*Other (non-food) organic putrescible/garden and park waste*	*0.05*	*0.10*	*0.065*	*0.17*
Rapidly degrading waste	*Food waste/Sewage sludge*	*0.06*	*0.185*	*0.085*	*0.4*

MAT – Mean annual temperature; MAP – Mean annual precipitation; PET – Potential evapotranspiration.

If a waste type disposed in a SWDS can not clearly be attributed to one of the waste types in the table above, project participants should choose, among the waste types that have similar characteristics, the waste type where the values of DOCj and kj result in a conservative estimate (lowest emissions), or request a revision of/deviation from this methodology.

Step 5 - Select the ~~***lifetime***~~ LFG collection efficiency (*LFGCE*) that most accurately represents the landfill-specific conditions in Table **5**, for each waste category of the organic MSW diverted from the landfill. If the landfill in question is not managed, and LFG is not collected, use a value of 0%. Note that in this case, it would be inappropriate to also select a MCF value of 1.0 which corresponds to an anaerobic managed solid waste disposal site.

[136] Source: CDM EB 66 Report Annex 46, page 12, quoting IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 5, Table 3.3.

Table 5: Landfill gas collection efficiency (LFGCE)[137]

Climate zone		Boreal and temperate (MAT ≤ 20°C)						Tropical (MAT > 20°C)					
		Dry (MAP/PET < 1)			Wet (MAP/PET >1)			Dry (MAP < 1000 mm)			Moist and wet (MAP >1000 mm)		
LFG collection / Waste category, *j*		Active[a]	Moderate[b]	Minimal[c]	Active[a]	Moderate[b]	Minimal[c]	Active[a]	Moderate[b]	Minimal[c]	Active[a]	Moderate[b]	Minimal[c]
Slowly degrading waste	Paper/ textiles waste	78%	70%	56%	82%	71%	56%	79%	70%	56%	83%	71%	56%
	Wood/ straw waste	68%	63%	51%	74%	67%	54%	71%	65%	53%	76%	68%	55%
Moderately degrading waste	Other (non-food) organic putrescible/ garden and park waste	80%	71%	56%	83%	69%	54%	83%	71%	56%	80%	61%	55%
Rapidly degrading waste	Food waste/ Sewage sludge	82%	71%	56%	79%	59%	49%	84%	70%	55%	72%	46%	43%

MAT – Mean annual temperature; MAP – Mean annual precipitation; PET – Potential evapotranspiration.

[a] Active: Typically, the landfill operator is using horizontal LFG collectors from the early stage of cell development while still accepting MSW (less than a year after cells' first waste disposal), and vertical collectors once cells are capped.

[b] Moderate: Horizontal collectors are installed to capture LFG 1-3 years after cells' first waste disposal, and vertical collectors are used once cells are capped.

[c] Minimal: LFG is not collected during waste acceptance, but vertical collectors are used once cells are capped.

Step 6 – Select the oxidation rate that best represents the landfill conditions: 10% should be used for modern, sanitary, and well-managed landfills; 0% should be used in all other cases.[2]

Step 7 – Calculate non-captured CH_4 emissions, CH_4^n, per dry tonne of diverted MSW using Equation 2. Note that Q_j and $LFGCE_j$ are defined for each waste category, *j*.

Equation 2: Non-captured CH_4 emissions (CH_4^n) [g CH_4 / t dry MSW]

$$CH_4^n = \sum_j \left[Q_j \times (1 - LFGCE_j) \times (1 - oxidation\ rate)\right]$$

[137] Nine landfills were interviewed, and three landfills that represent active, moderate, and minimal LFG collection were selected and simulated based on the method provided in Lee et al. (2018) with phased collection efficiency specified in Barlaz et al. (2009).

Lee, U., Han, J. and Wang, M., 2017. Evaluation of landfill gas emissions from municipal solid waste landfills for the life-cycle analysis of waste-to-energy pathways. Journal of Cleaner Production, 166, pp.335-34

Barlaz, M.A., Chanton, J.P., Green, R.B., 2009. Controls on landfill gas collection efficiency: instantaneous and lifetime performance. J. Air Waste Manag. Assoc. 59, 1399–1404.

$$CH^{n}_{4}{}_{y} = \sum_{j}[Q_{j,y} \cdot (1 - LFGCE_j) \cdot (1 - oxidation\ rate)]$$

Step 8 – Calculate biogenic CO_2 in non-captured CH_4 emissions, $CO_2{}^n$, and biogenic CO_2 that remains as carbon in the landfill, $CO_2{}^s$, using Equation 3.

Equation 3: $CO_2{}^n$ and $CO_2{}^s$ [g CO_2e / t dry MSW]

~~$CO_2{}^n = CH_4{}^n \times 44/16$~~

$$CO^{n}_{2_y} = CH^{n}_{4_y} \cdot \frac{44}{16}$$

$$CO^{s}_{2} = \sum_{j}[W_j \times DOC \times (1 - DOC_F) \times (44/12) \times 10^6]$$

Step 9 – In the case that the project of interest diverts MSW from a landfill where collected CH_4 is used for electricity generation instead of flaring, calculate the avoided electricity credit using Equation 4 ***(applicable only when displacement results in indirect emissions).***

NOTE: Not all displacements result in indirect emissions. For instance, there would be no indirect emissions when the activity displaced occurs in a sector that is capped under a cap-and-trade system.

Equation 4: Avoided electricity credit [g CO_2e / t dry MSW]

~~$Avoided\ electricity\ credit = LHV_{CH4} \times \eta \times CF \times [\Sigma_j(Q_j \times LFGCE_j)] \times CI_{elec} \times 10^{-3}$~~

$$Avoided\ electricity\ credit_{\ y} = LHV_{CH_4} \cdot \eta \cdot CF \cdot \left[\sum_{j}(Q_{j,y} \cdot LFGCE_j)\right] \cdot CI_{elect_y} \cdot 10^{-3}$$

where:

LHV_{CH4}	= *lower heating value of CH_4, 0.0139 MWh / kg*
η	= *net electricity generation efficiency (eg. 30%, dependent on landfill of interest)*
CF	= *capacity factor including downtime (eg. 85%, dependent on landfill of interest)*
$Q_{j,y}$	= *total CH_4 generation from waste category j* ***in year y*** *from Equation 1[g CO2e / t dry MSW]*
$LFGCE_n$	= *landfill gas collection efficiency selected from Table 3 [%]*
CI_{elec}	= *average carbon intensity of grid electricity in the region where the landfill generating electricity is located (use the highest spatial resolution regional-level CI published by a relevant national entity)* ***for year y*** *[gCO_2e / MWh]*
10^{-3}	= *kilogram per gram conversion [kg / g]*

Step 10 - Calculate the final LEC of the SAF production process, as shown in Equation 5. This landfill- and waste-specific LEC value is to be subtracted from the default core LCA value (g CO_2e/MJ) of MSW-derived SAF.

Equation 5: Final LEC calculation [g CO_2e/MJ]

$$\sout{LEC = \frac{CH_4^n \times (GWP_{CH_4}) - CO_2^n - CO_2^s - [avoided\ electricity\ credit]}{Y}}$$

$$LEC_y = MoCF \cdot \frac{CH_{4_y}^n \cdot (GWP_{CH_4}) - CO_{2_y}^n - CO_{2_y}^s - [avoided\ electricity\ credit_y]}{Y_y}$$

where:

$CH_4{}^n{}_{\boldsymbol{y}}$	= *non-captured* CH_4 *emission* ***in year y*** *[g* CH_4 */ t dry MSW]*
GWP_{CH4}	= *100-year global warming potential of* CH_4*, 28 g* CO_2*e / g* CH_4
$CO_2{}^n{}_{\boldsymbol{y}}$	= *Biogenic* CO_2 *in non-captured* CH_4 *emissions* ***in year y*** *[g* CO_2*e / t dry MSW]*
$CO_2{}^s{}_{\boldsymbol{y}}$	= *Biogenic* CO_2 *that remains as carbon in the landfill* ***in year y*** *[g* CO_2*e / t dry MSW]*
[avoided electricity credit $_{\boldsymbol{y}}$*]*	= *Emissions offset by replacing grid electricity with electricity from captured* CH_4 ***in year y*** *[g* CO_2*e / t dry MSW]*
$Y_{\boldsymbol{y}}$	= *Total energy yield* ***in year y*** *(liquid fuels, other fuel and energy co-products and non-energy co-products) from MSW [MJ/ t dry MSW]. Note that this is calculated on the basis of MSW diverted from the landfill, before any additional sorting or recycling takes place.*
MoCF	= ***model correction factor of 0.9***

-END-

D.3.2_Amendments to the MSW Recycling Emissions Credit Methodology

ICAO Council should adjust the REC methodology to establish clear rules for setting business as usual counterfactual scenarios to demonstrate that the REC is a net enhancement of what would have happened in the absence of the MSW diversion from the landfill. Similarly to the LEC methodology, this requires a set of additional requirements. First, the recycling emissions credits shall represent GHG emissions reductions that exceed any GHG reduction or removals required by law, regulation, or legally binding mandate. Second, the recycling emissions credits shall exceed any GHG reductions or removals that would otherwise occur in a conservative, business-as-usual scenario. Finally, to ensure the counterfactual scenarios stay valid over time, fuel producers shall undergo a re-evaluation of the business-as-usual scenario through a review mechanism that captures changing conditions every 5 years.

Proposed amendments to *ICAO document - CORSIA Methodology for Calculating Actual Life Cycle Emissions Values* in ***italics and bold***:

6.2 Methodology for calculation of recycling emissions credits

SAF produced from Municipal Solid Waste (MSW) feedstocks may generate a Recycling Emissions Credit (REC), due to additional recyclable material being recovered and sorted during feedstock preparation. The emissions avoided for additional recycling of plastics and metals, calculated separately, are summed to generate a total RED value.

"Fuel producers need to demonstrate that the REC are a net enhancement of what would have happened in the absence of the MSW diversion from the landfill. The REC must represent GHG emissions reductions that exceed any GHG reduction or removals required by law, regulation, or legally binding mandate, and that exceed any GHG reductions that would otherwise occur in a conservative, business-as-usual scenario. Fuel producers shall undergo a re-evaluation of the business-as-usual scenario through a review mechanism that captures changing conditions every 5 years."

[...]

-END-

Appendix E_High-Integrity Electrofuels

Electrofuels or e-fuels, also known as e-kerosene or power-to-liquids, are anticipated to be a key enabling technology for the eventual decarbonization of aviation. This pathway involves the production of an electricity intensive syngas –a mixture of hydrogen and carbon monoxide— that is then converted into SAF and other hydrocarbon liquids by a Fischer-Tropsch (FT) reaction. The carbon used in e-fuels could ideally come from two main sources: (1) pre-combustion waste CO_2 from, e.g., MSW-based biogas production or cellulosic ethanol fermentation, and eventually (2) DAC. The latter is expected to take a growing role over time in the production of e-fuels as production costs decrease and waste CO_2 becomes scarce in a carbon constrained world.

There are two relatively new promising routes for producing e-fuels that are commercial or on the verge of commercialization: (1) Proton-Exchange Membrane Electrolysis Cells (PEMEC), combined with the reverse water-gas shift (RWGS) reaction to activate CO_2 to produce the syngas (mixture of hydrogen and carbon monoxide) for synthesizing e-fuels with the conventional FT process, and (2) Solid Oxide Electrolysis Cells (SOEC) that can either electrolyse steam to produce hydrogen, or CO_2 to produce carbon monoxide, [138] or co-electrolyse the right mixture of steam and CO_2 to produce the syngas for the FT process. While the SOEC pathway is less mature than PEMEC, it has greater thermodynamic efficiencies and can be thermically integrated with the FT process to tap of the highly exothermic FT reaction to fulfill the system thermal needs, bringing down the operational costs of the electrolyser. Besides, SOEC is today by far the most mature technology for direct electrochemical conversion of CO_2 into CO.[139] Alkaline Electrolysis Cells, a mature water electrolysis technology, is less suitable for e-fuel production (lower current density results in higher operational costs). Promising research and development as well as demonstration projects are underway on alternative e-fuel production pathways that could improve efficiency and significantly reduce costs.

The production of e-fuels is energy intensive. One unit of e-fuel energy requires an input of around two units of energy for the integrated SOEC co-processing route, and more than two

[138] Hauch A. et al., 2020, Recent advances in solid oxide cell technology for electrolysis, Science, 370, (6513), eaba6118.

[139] Ibid.

units for the PEMEC combined with RWGS reaction route.[140, 141, 142] It is therefore necessary to ensure that the origin of the electricity is renewable and that it does not result in displacements that could generate large indirect emissions. Otherwise, e-fuels could end up with higher life-cycle emissions than conventional jet fuel.

In the absence of an agreed methodology to estimate potential indirect emissions – still to be agreed upon for CORSIA purposes and in other fora — the best practice would be to implement measures that minimize the risk of such indirect emissions from occurring.

One way to ensure the environmental integrity of e-fuels on a life-cycle basis is to rely only on **surplus renewable electricity**. This concept goes beyond the concept of curtailment in demand-driven electric power systems. Unlike such demand-driven systems, **renewables-based power generation systems** are supply driven and can operate without significant energy storage while still providing a high level of reliability.[143] Once large wind or solar capacity is in place power production becomes intermittent and the ability to manage the load becomes a critical feature for balancing the grid.

In this context, a significant fraction of demand would need to be flexible, and interruptible technologies such as electrolysers used for e-fuel production could play a key role, resulting in a comprehensive energy transition. E-fuel production facilities can be designed to take dynamic loads or have the flexibility to operate the electrolyser in reverse as a fuel cell[144] to generate electricity when necessary, further enhancing its grid balancing services.

However, this does not necessarily mean that the e-fuel facility would be operating with a very low load factor. Renewable-based power systems can be described as having a broad range of flexible demand types depending on their load factors, including one that is interruptible but with relatively large annual load requirements of at least 70%.

Interestingly, high-integrity e-fuels could be achieved using cost-effective surplus renewable

[140] Malins, C. 2017, “What role is there for electrofuel technologies in European transport’s low carbon future?”, Cerulogy.

[141] Yu Luo, Yixiang Shi, Ningsheng Cai, 2021, Chapter 5 - Stabilization of intermittent renewable energy using power-to-X,Hybrid Systems and Multi-energy Networks for the Future Energy Internet, Academic Press, 2021, Pages 113-140.

[142] Adelung, S., Maier, S., Dietrich, R. U., 2021, Impact of the reverse water-gas shift operating conditions on the Power-to-Liquid process efficiency, Sustainable Energy Technologies and Assessments, 43, 100897.

[143] Lugovoy, O., Gao S., Gao J., Jiang K., 2021, "Feasibility study of China's electric power sector transition to zero emissions by 2050", Energy Economics, Elsevier, vol. 96(C).

[144] According to Schmidt et al. (2017), a comparative advantage of SOEC electrolysis technology is that it could operate in reverse mode as a fuel cell. See Schmidt O., A. Gambhir, I. Staffell, A. Hawkes, J. Nelson, S. Few, 2017, “Future cost and performance of water electrolysis: An expert elicitation study”, Volume 42, Issue 52, Pages 30470-30492.

power from the grid even when fossil-based electricity is part of the energy mix. Of course, this only works in a scenario where the country is transitioning to a renewables-based power generation system and has attained a critical level of renewable electricity deployment. According to a feasibility study of China's power sector transformation into a renewable-based system,[145] the amount of surplus electricity available for interruptible demand could in theory be sufficient to cover around 10% of global aviation jet fuel demand with e-fuels in 2030 and 100% by 2050. This illustrates the tremendous potential for producing e-fuels with the highest environmental integrity and the importance for the aviation sector to explore synergies with the power sector, as well as with other hard-to-decarbonize sectors that could be interested in, e.g., the renewable diesel fraction of e-fuels production.

While operating with lower capacity factors increases the capital and fixed operational and maintenance costs, it can bring down significantly the electricity cost, which has been reported as the major contributor to the operational costs as compensation for the interruptible demand. Hence, this opens the door for e-fuel producers to secure a lower cost of electricity through power purchase agreements with interruptible demand provisions, making it possible for the e-fuel pathways to become cost competitive – sooner than anticipated — with other SAF pathways.[146]

Additional e-fuel production cost savings emerge from e-fuel production system integration, which allows to exploit thermodynamic efficiencies – as well as other potential synergies – between, e.g., high-temperature co-electrolysis (SOEC), liquid solvent-based DAC technologies, water desalination on one side, and the exothermic Fischer-Tropsch reaction, which generates waste heat and lower-value e-fuels, on the other side.

Finally, according to the International Energy Agency (IEA)'s Net Zero by 2050 pathway,[147] electricity generation will need to reach net-zero emissions globally by 2040, which will require greater power system flexibility to ensure reliable supplies. IEA estimates that the system flexibility must quadruple globally in tandem with a more than two-and-a-half-fold increase in electricity supply, and notes that a key source of demand flexibility would come from hydrogen-based fuels such as e-fuels. This illustrates the relevance of e-fuel production at the global scale – provided countries seriously embark on the imperative transformation of their power generation systems to fight climate change.

145 Lugovoy et al., 2021 (op. cit.).

146 See World Economic Forum and McKinsey & Company, 2020, (op. cit.), for a useful projection of e-fuel production costs, and Appendix B for an illustration of projected current and future e-fuels production and emissions reduction costs that accounts for the synergies described in this appendix.

147 See here.

Appendix F_SAF Incentive Analysis: The United Kingdom

This Section assesses the compatibility of the opt-in for aviation under the Renewable Transport Fuel Obligation[148] (RTFO) with air carriers and corporate customers claiming SAF environmental attributes. Generally, the kind of financial support provided by the RTFO would be compatible with claims by air carriers and corporations for as long as: (1) the fuel producer does not also apply for the issuance of and emission reduction credits, and (2) the United Kingdom provides a letter of attestation declaring that it will ensure accurate reporting and avoid double counting.

F.1_Background on United Kingdom Regulations for Alternative Fuels

The RTFO was originally introduced in the United Kingdom in 2008 and was first amended in 2011 to adapt it to the EU Renewable Energy Directive of 2009. It sets annual obligations on transport fuel suppliers, which can be met by supplying renewable fuel or purchasing renewable transport fuel certificates (RTFC) from other suppliers. Renewable fuels must meet specified sustainability criteria to be entitled to receive RTFC, otherwise it is counted as fossil fuel.

Obligated fuel suppliers are required to redeem RTFC in proportion to the volume of fossil fuel and unsustainable renewable fuels they supply. RTFC may be earned by any company supplying sustainable renewable fuels. They may also be bought or sold on an open market. Obligated suppliers have the option to 'buy out' of their obligation, paying a fixed fee per liter of renewable fuel that they would otherwise have had to supply.

Since 2018, renewable fuel used in aviation in the United Kingdom is also eligible for reward under the RTFO (“opt-in” provision) as long as it meets the sustainability criteria. The United Kingdom is currently discussing a separate SAF mandate, which would be expressed in a GHG emissions reduction target, not a volume mandate.

In parallel to the RTFO, the Motor Fuel (Road Vehicle and Non-Road Mobile Machinery)

[148] See here.

Greenhouse Gas Emissions Regulations[149] (GHG Regulations) were introduced in 2012 to implement the EU Fuel Quality Directive 98/70/EC and require suppliers to report annually on the amount, energy content and GHG emissions of relevant fuels supplied. The GHG Regulations set life-cycle GHG reduction targets for transport fuel suppliers (4% in 2019 and 6% in 2020 compared to the 2010 fossil fuel baseline). Sustainable renewable fuel supplied under the GHG Regulations is awarded 'GHG credits' which have a cash value and can be traded with other suppliers (in the same way as RTFC). Fuel suppliers can also buy-out of their GHG reduction obligations.

Critically, in October 2021 the United Kingdom Government suspended the Motor Fuel GHG Regulation meaning the RTFO currently provides the only incentive for SAF in the United Kingdom. [150] The suspension is a departure from the approach Europe took to maintain the Fuel Quality Directive post-2020, maintaining the same goal than originally adopted for 2020. The United Kingdom decision to suspend this regulation means that there is no need to require SAF suppliers not to apply for the GHG credits issued under that regulation.

F.2_Double Counting

The risk of double claiming remains as the United Kingdom might still claim the emissions reductions associated with the RTFC to meet its transport domestic goals, capturing these reductions in its National Inventory Report. To avoid double counting, corporate customers would need to (1) get assurance through the SAF supplier that the United Kingdom agrees to accurately report SAF use for aviation and avoid double counting (see next section), and then (2) request contractually that:

i. the air carrier reports the use of SAF in accordance with existing regulations but do not claim SAF use towards compliance, and that

ii. the United Kingdom gets notice of the SAF use claim for aviation purposes through the SCS. The SCS will make available the information required for the United Kingdom to accurately account for SAF use and avoid double counting (note this information could be anonymized but ideally should be fully transparent and publicly available).

Corporations and air carriers that purchase SAF for which RTFCs have been rewarded can be confident they are creating a new emission reduction because the absolute cap under the

[149] See here.

[150] See here.

United Kingdom's Climate Change Act[151] is applicable to, inter alia, ground transport. In other words, although the RTFC generated by SAF will help meet RTFO obligations, other action to reduce emissions is still required to comply with the absolute cap.

F.3_Letter of Attestation

As the regulated entity under the RTFO, the SAF supplier should request guidance from the United Kingdom government on emission reduction claims as part of the process to opt-in to the RTFO.

If the United Kingdom Government authorizes air carriers to claim the emissions reductions from RTFO-incentivized SAF, it should provide a letter of attestation confirming emissions reductions will not be claimed towards the United Kingdom emissions reduction target where the SAF is:

(a) claimed for international aviation, or

(b) claimed for domestic aviation towards a voluntary goal. This letter of attestation is critical to prevent double counting.

Sustainability Certification Schemes will be responsible for providing the United Kingdom Government with the necessary information on SAF use, making a book-and-claim registry critical to increase transparency.

[151] Note this is also consistent with the annually binding cap under the EU Effort Sharing Regulation, applicable until recently in the United Kingdom. EU Member States have binding annual GHG emission targets for 2021-2030 for those sectors of the economy that fall outside the scope of the EU ETS. See Commission Implementing Decision 2020/2126 on setting out the annual emission allocations of the Member States for the period from 2021 to 2030 pursuant to EU Regulation 2018/842.

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