

Sustainable Aviation Fuel Tutorial

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Abstract:

This tutorial comprehensively explores Sustainable Aviation Fuel's role, highlighting its utility in substantially decreasing greenhouse gas emissions and its adaptability with existing aviation infrastructure. The tutorial not only lists the major benefits of SAF but also addresses significant challenges such as high production costs. The tutorial also looks into global initiatives such as ICAO and its policies from regions like Europe, the USA, and Taiwan that promote the adoption and development of SAF through regulatory frameworks and incentives. The images used in this article are solely for commentary or research purposes and fall within the scope of Fair Use. The copyright of the original work belongs to the original author, and there is no intention to infringe upon their legal rights. For any questions, please contact the Republic of China Airline Pilots Association.

1. Introduction of Sustainable Aviation Fuel

Sustainable Aviation Fuel (SAF) is a type of fuel derived from renewable resources, including waste oils, agricultural residues, and other biomass. It is designed to be a "drop-in" replacement for conventional jet fuel, meaning it can be used in existing aircraft engines and fueling infrastructure without necessitating modifications. Technical analysis done at ICAO highlights that SAF could drastically cut greenhouse gas emissions—by up to 80% over the fuel's lifecycle—compared to standard jet fuels.

The production of SAF involves a conversion process that includes the pre-treatment of feedstocks and chemical reactions under specific conditions. This process typically involves recycling waste and biomass, which not only reduces environmental impact but also adds value through waste utilization. Despite the current challenges of higher production costs and limited availability compared to conventional fuels, ongoing technological advancements and supportive policies are expected to address these issues, making SAF more viable and widely available in the future.

Around the world, several initiatives are exploring the integration of SAF into operational use, illustrating a commitment to sustainable aviation. This tutorial aims to detail the various aspects of SAF, from its production processes to its future prospects, aiming to keep our pilots well-informed and engaged in sustainability efforts.

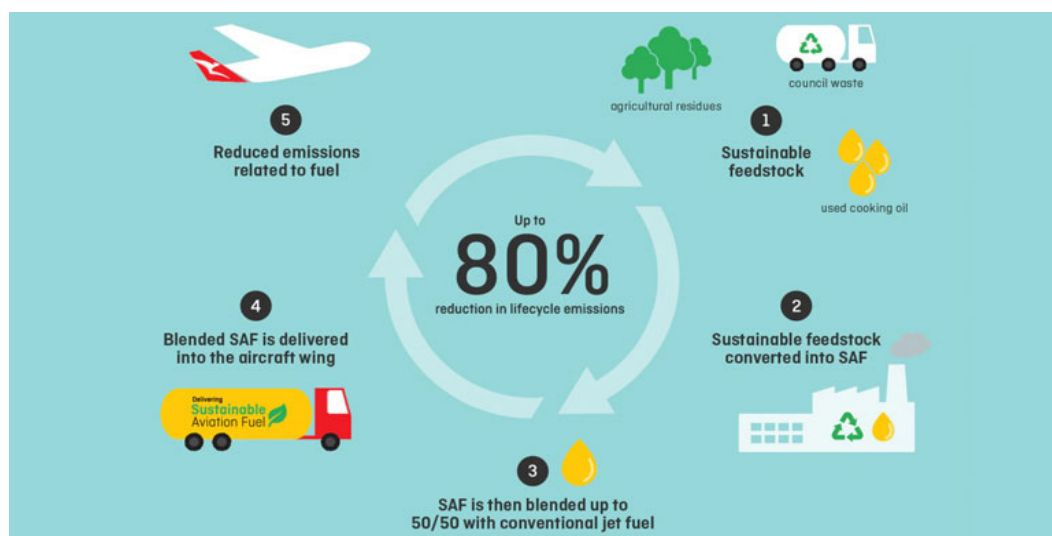


Fig. 1 Reduction in lifecycle emissions of Sustainable Aviation Fuel
(Source: Action Renewables Energy Trading Ltd, 2022)

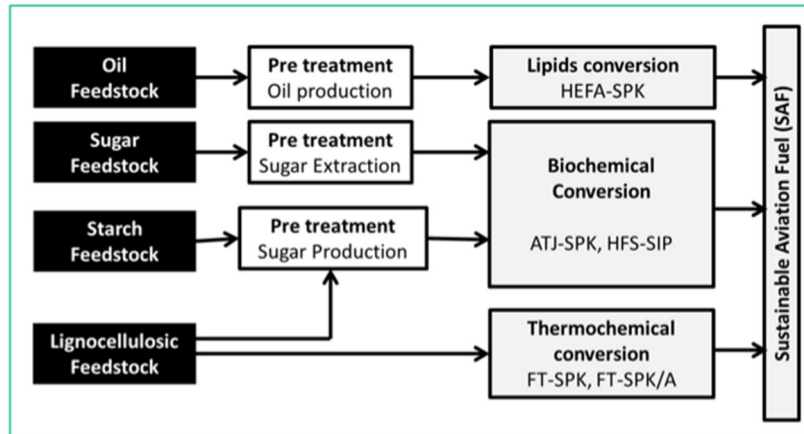


Fig. 2 General scope of conversion process
(Source: ICAO Sustainable Aviation Fuel Guide, 2017)

2. Background

In the late 1900s, international meetings began to focus on global warming and climate change. With increasing regulation and oversight, the first International Civil Aviation Organization (ICAO) Conference on Aviation and Alternative Fuels (CAAF/1) was held in 2009. Since then, numerous meetings on carbon reduction have taken place, and sustainable aviation fuel (SAF) first emerged as a prominent topic in 2010. Although SAF was recognized as a potential solution to combat climate change, it initially did not receive as much focus compared to other strategies.

As the urgency of climate change and global warming surpassed earlier scientific predictions, there was a greater push toward environmental sustainability. In 2015, the Paris Agreement set the goal of limiting global temperature increases to well below 2°C above pre-industrial levels, while pursuing efforts to limit the increase to 1.5°C. This agreement emphasized the need for immediate and concerted efforts to reduce carbon emissions across various sectors, including aviation.

Building on the momentum of the Paris Agreement, the growing body of SAF-related research provided international organizations with valuable insights and experience. This led to the development of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). CORSIA offers a clear understanding of sustainability and a methodological approach to analyzing lifecycle emissions. By 2021, advancements in technology and research enabled ICAO to aim for net zero carbon emissions by 2050. The following year, the Long-Term Aspirational Goal (LTAG) agreement highlighted SAF as the most promising candidate for reducing CO₂ emissions.

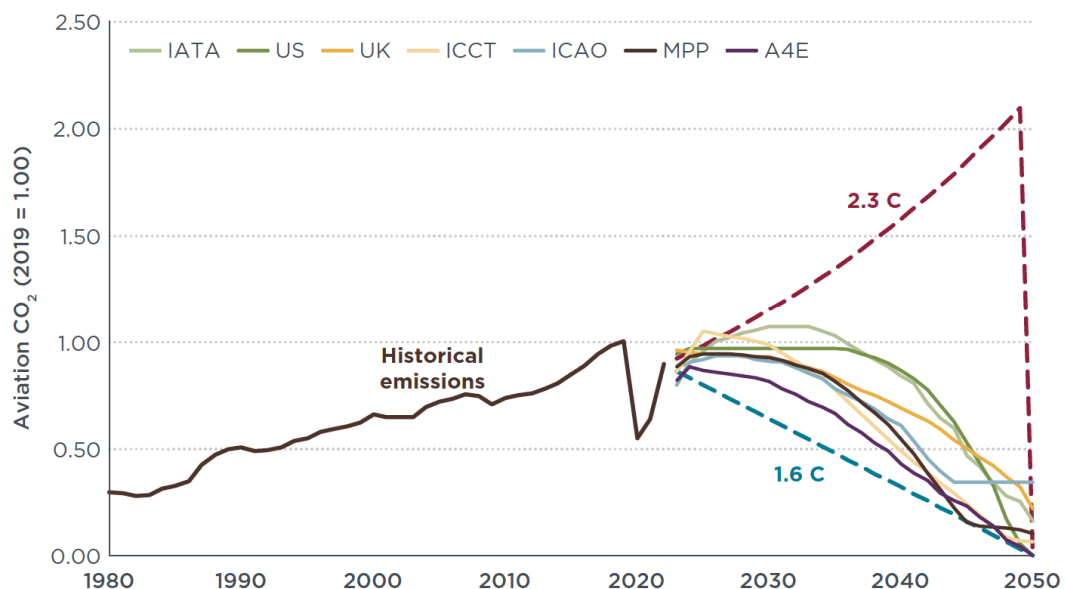


Fig. 3 Aviation CO₂ Emissions trajectories from different organizations and its effect on temperature
(Source: International Council on Clean Transportation Policy Update, 2023)

3. Pros and Cons of Sustainable Aviation Fuel (SAF)

3.1 Benefits of SAF

The consensus among scientists, governments, and international organizations on achieving net zero carbon emissions by 2050 has made SAF a crucial focal point in the aviation industry. SAF, developed over several years, offers distinct benefits compared to other sustainable fuels, particularly in the aviation industry. Here are some key benefits of SAF:

3.1.1. Reduced Greenhouse Gas Emissions

According to the IATA Sustainable Aviation Fuels Fact sheet, SAF can reduce lifecycle greenhouse gas emissions by at least 80% compared to conventional jet fuel. This significant reduction can help combat climate change and align with global efforts to reduce carbon footprints to reach net zero carbon emission.

3.1.2. Compatibility with Existing Engine and Fuel Tanks

One of the major advantages of SAF is its "drop-in" capability, which is well-documented in several publications, including the Sustainable Aviation Fuels Guide from ICAO. These sources demonstrate that SAF can be used in existing aircraft engines and fuel storage infrastructure without the need for modifications. This compatibility makes SAF easier and more cost-effective to implement compared to other alternative fuels that may require significant changes to existing systems.

3.1.3. Diverse Feedstock Availability

SAF can be produced through various conversion processes from a wide range of sustainable resources, including waste oils, agricultural residues, industrial solid waste, and even captured CO₂ from the atmosphere. This diversity in feedstocks helps repurpose waste materials and ensures a stable, sustainable supply of fuel which reduces reliance on any single resource. This versatile approach enhances the resilience and scalability of SAF production.

3.1.4. Energy Density and Performance

SAF possesses a high energy density similar to that of conventional jet fuel, which is crucial for aviation as it provides the necessary performance characteristics required for long-haul flights. This high energy density makes SAF a suitable option for long-range aviation applications. In contrast, other sustainable fuels, such as battery-electric or hydrogen, currently face significant challenges in achieving comparable energy density. These challenges make them less suitable for long-haul flights, and it is unlikely that these issues will be resolved by 2040.

3.1.5. Reduction of Non-CO₂ Emissions

In addition to reducing CO₂ emissions, recent research sponsored by the U.S. National Academies of Sciences found that a 50% SAF blend with conventional jet fuel reduces particulate matter (PM) by up to 65% and sulfur oxides (SO_x) by nearly 40%. This characteristic of SAF is shown to be highly efficient in addressing aviation climate impacts. According to the European Union Aviation Safety Agency's (EASA) recent

report, non-CO₂ emissions, such as those from particulates and sulfur oxides, can have climate impacts up to three times greater than those of carbon dioxide alone.

3.2 Drawbacks and Challenges of SAF

While SAF offers numerous benefits, it also faces several drawbacks and challenges that need to be addressed to ensure its wider adoption and effectiveness. Here are some of the main cons of SAF:

3.2.1. High Production Costs

- **Cost of Feedstocks:** The raw materials used to produce SAF, such as waste oils, agricultural residues, and other biomass, can be expensive. Additionally, the cost of transporting these feedstocks to production facilities can add on to the overall expense.
- **Production Processes:** The advanced technologies required to convert feedstocks into SAF, including demanding reaction environments and specific catalysts, are costly and not yet fully optimized for large-scale production. This lack of large-scale optimization contributes to higher production costs.
- **Market Price:** Currently, SAF is two to five times more expensive than conventional jet fuel. This significant price difference can deter widespread adoption by airlines, which operate on thin profit margins and are sensitive to fuel cost fluctuations.

3.2.2. Lifecycle Emissions

- **Life Cycle Emission:** While SAF reduces direct CO₂ emissions, the entire lifecycle of SAF, from feedstock cultivation to production, can still produce significant emissions, especially if not managed sustainably. ICAO has documented a CORSIA Default Life Cycle Emission Value that can be used as a reference for assessing these emissions.
- **Land Use Changes:** Some SAF production processes require additional facilities to be built, which can lead to direct land use change (LUC) emission. On the other hand, some feedstocks may cause indirect land use changes (ILUC), which can lead to deforestation, habitat loss, and also increase the carbon emissions.

3.2.3. Limited Availability and Scalability

- **Feedstock Supply:** To meet sustainability requirements, feedstocks that compete with food production or cause deforestation cannot be used for SAF production. This limitation leads to a constrained supply of truly sustainable feedstocks, which is insufficient to meet the growing demand for SAF production.
- **Production Capacity:** Current production infrastructures for SAF are limited, and scaling up to meet the rapidly increasing global aviation demand will require significant investment and time.
- **Infrastructure:** Expanding the infrastructure for SAF production, distribution, and storage is a complex and resource-intensive process. This includes building new facilities and upgrading existing ones to handle SAF conversion process. Additionally, compliance with regulations like the CORSIA requires careful planning to avoid ILUC, further complicating the expansion efforts.

3.2.4. Technological and Regulatory Challenges

- **Technological Development:** Many SAF technologies are still in the research and development phase and not yet ready for widespread commercial or large-scale deployment.
- **Policy and Incentives:** Insufficient and immature government policies to promote SAF production and adoption can slow down progress.

3.3 Comparison with Other Sustainable Fuels

SAF stands out due to its compatibility with existing aircraft designs and aviation infrastructure, significant carbon emission reductions, diverse feedstock options, and strong regulatory support. These factors make it a viable and effective solution for reducing the aviation industry's environmental impact in the short to mid term while other sustainable fuel technologies continue to develop. Despite existing challenges, ongoing research by scientists around the globe promises to develop practical large-scale methods that will lower the cost of SAF. As costs decrease, the profitability of SAF will attract more investments, further accelerating its adoption and production.

Aspect	Details
Benefits of SAF	1. Reduced Emissions: Up to 80% lifecycle GHG reduction. 2. Compatibility: Works with existing engines and tanks. 3. Diverse Feedstocks: Produced from waste oils, agricultural residues, and CO₂. 4. High Energy Density: Suitable for long-range flights. 5. Non-CO₂ Emissions: Reduces particulate matter and sulfur oxides.
Drawbacks and Challenges of SAF	1. High Costs: Expensive feedstocks and production. 2. Lifecycle Emissions: Significant emissions from production. 3. Limited Availability: Constrained feedstock supply and production capacity. 4. Technological Challenges: Many technologies still in development.
Comparison with Other Sustainable Fuels	1. Battery-Electric: Zero emissions, low energy density, short-haul only. 2. Hydrogen Fuel: High energy density, infrastructure challenges. 3. Biofuels for Ground Transport: Reduces emissions, competes with food. 4. Renewable Diesel: Reduces emissions, not optimized for aviation.

TABLE 1 Summary of Pros and Cons of SAF with Comparison of Sustainable Fuels

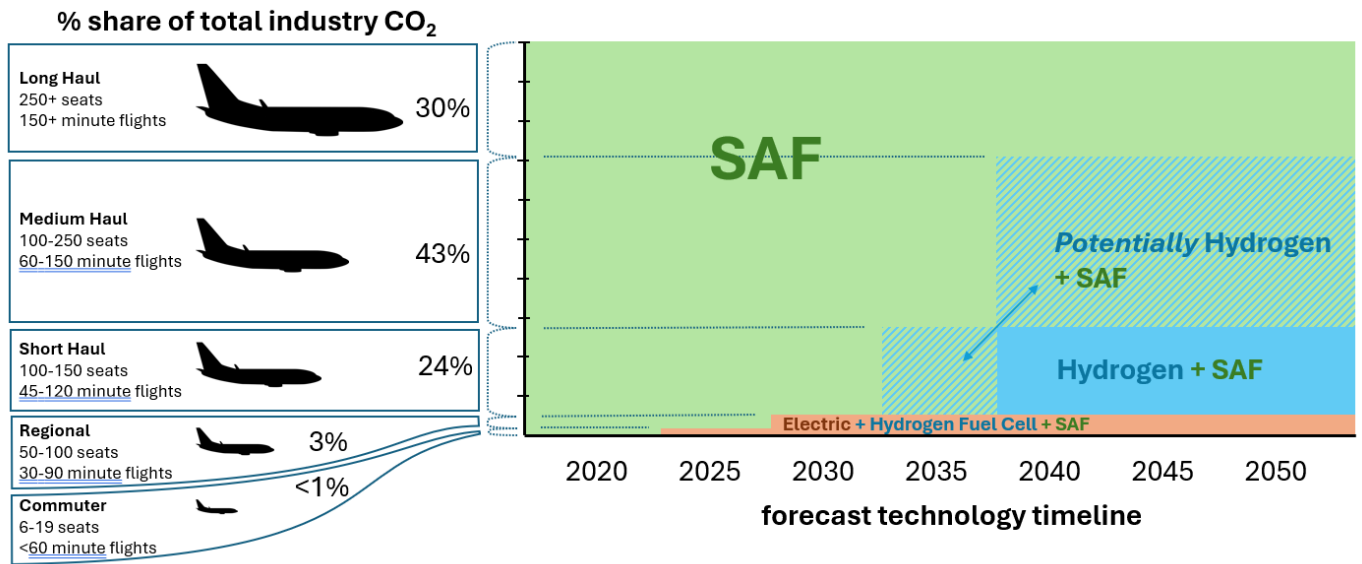


Fig. 4 Forecast percentage of alternatives power sources for Aviation.
(Source: Waypoint 2050 Report)

4. Policies and Prospects for Sustainable Aviation Fuel

The goals set in the early 2000s to limit global warming led to the development of practical approaches to achieve these targets, beyond merely setting objectives. Here, we discuss the policies and prospects in four key aspects: Worldwide, Europe, the USA, and Taiwan.

4.1 Policies

- Worldwide

ICAO first promoted the concept of Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) in International Accreditation Forum (IAF) 2018. By 2020, with sufficient data collected, ICAO published the “CORSIA Implementation Elements” to provide harmonized guidance for reducing emissions from international aviation and to establish standards to minimize market distortion while respecting the unique circumstances of respective ICAO member states.

CORSIA aims to cap net CO₂ emissions from international flights at 2020 levels through carbon offsetting.

Its implementation is divided into three phases:

- **Pilot Phase (2021-2023):** Voluntary participation by states;
- **First Phase (2024-2026):** Continued voluntary participation;
- **Second Phase (2027 onwards):** Mandatory participation for all ICAO member states, with certain exemptions, such as for least developed countries.

The implementation mechanism of CORSIA includes the following components:

- **Offsetting:** Airlines are required to purchase carbon offsets to cover emissions that exceed 2020 levels. These offsets fund projects that reduce or remove an equivalent amount of CO₂ from the atmosphere. The specific calculation method and requirements are outlined in the ICAO CORSIA Overview.
- **Monitoring, Reporting, and Verification (MRV):** Airlines must monitor their emissions, report them annually, and have their data verified by third-party entities. ICAO provides detailed guidelines for the MRV system.
- **Sustainable Aviation Fuel (SAF):** Airlines can use SAF to reduce their offsetting requirements, provided the fuel meets specific sustainability criteria set by ICAO. SAF must be certified by ICAO-approved Sustainability Certification Schemes (e.g., ISCC or RSB), guarantee lower lifecycle carbon emissions compared to conventional jet fuel, and meet other criteria related to land use, water, air, and biodiversity.

- Europe

Europe has implemented comprehensive policies to promote SAF as part of its broader climate goals:

- **European Green Deal:** This overarching policy aims to make Europe the first climate-neutral continent by 2050. It includes specific measures to promote the use of SAF in aviation. One of the key measures is the “ReFuelEU Aviation” initiative, which mandates increasing the share of SAF in aviation fuel. Fuel suppliers are required to blend 2% SAF by 2025, 5% by 2030, and at least 70% by 2050. This initiative supports the production and use of SAF, ensuring a gradual increase in SAF usage over time.
- **Renewable Energy Directive (RED II):** It sets targets for the European Union (EU) to achieve at least 32% of its total energy consumption from renewable sources, including SAF, by 2030. The directive establishes strict sustainability criteria, which encompass land use and biodiversity, ensuring that renewable energy production does not negatively impact high biodiversity areas or carbon-rich environments. RED II places a particular emphasis on SAF for transportation, offering additional incentive policies that encourage investment in SAF production facilities and the development of a robust supply chain, thereby supporting the aviation sector's transition to more sustainable energy sources.
- **Fit for 55 Package:** Introduced in 2021, this package aligns EU policies with the target of a 55% reduction in greenhouse gas emissions by 2030. It includes the revision of the Alternative Fuels Infrastructure Regulation (AFIR) to support the deployment of infrastructure necessary for SAF distribution and usage across EU airports.
- **EU Emissions Trading System (EU ETS):** The EU ETS is the world's largest carbon market and includes aviation within its scope. Airlines operating within the European Economic Area must monitor, report, and verify their emissions, and purchase allowances to cover them. This system incentivizes the use of SAF to reduce carbon footprints and comply with emission caps.

What will change



The ReFuelEU aviation regulation will oblige:

1. aircraft fuel suppliers at EU airports to gradually increase the share of sustainable fuels (notably synthetic fuels) that they distribute

Minimum share of supply of sustainable aviation fuels (in %)

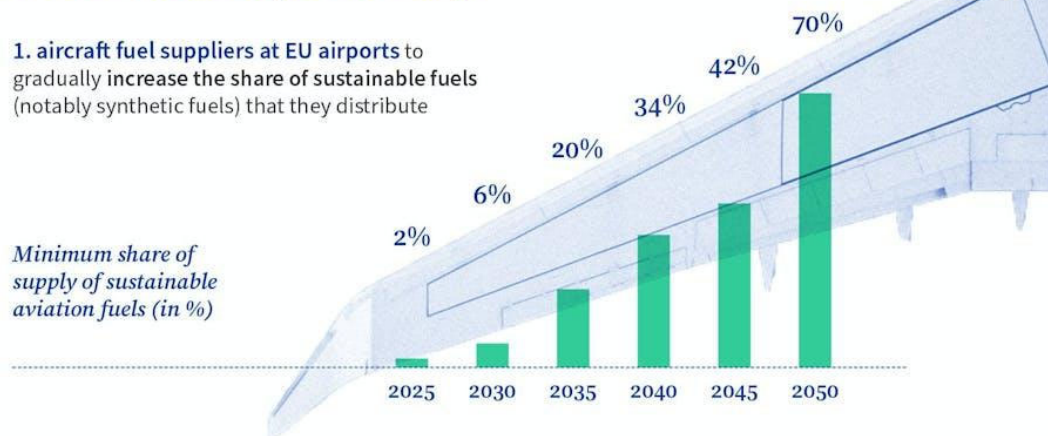


Fig. 5 ReFuelEU regulation from 2025 to 2050.
(Source: AviationPros, Ground Handling, 2023)

- USA

The United States has implemented several key policies and regulations to promote the production and use of SAF. These initiatives include:

- **Blender's Tax Credit:** This aims to increase the production of SAF by providing a tax credit of \$1.00 for each gallon of SAF blended with conventional jet fuel. This financial incentive lowers the price gap between SAF and conventional jet fuel.
- **Low Carbon Fuel Standard (LCFS):** In California, this standard seeks to reduce the carbon intensity of transportation fuels, including provisions for SAF by offering credits to fuel producers who supply low-carbon fuels. This encourages a shift toward cleaner energy sources.
- **Sustainable Aviation Fuel Grand Challenge (2021):** This initiative, launched in 2021, aims to increase SAF production to 3 billion gallons per year by 2030 and meet 100% of aviation fuel demand with SAF by 2050. It involves coordinated efforts across federal agencies as well as collaboration with the private sector. These efforts are focused on scaling up SAF production through the provision of technical and financial support for research and infrastructure development, fostering innovation, and ensuring a robust supply chain for sustainable fuels.
- **Bipartisan Infrastructure Law:** It, enacted in 2021, allocates \$500 million over five years to financially support the development of infrastructure necessary for SAF production and distribution. The DOE allocated \$64.7 million to scale up SAF-related projects.
- **Voluntary Carbon Offsetting Programs:** This is an ongoing program that encourages airlines to reduce their carbon emissions by purchasing SAF. Airlines voluntarily participate in these programs, supporting SAF production and using it to meet their carbon reduction goals, which in turn grants them tax credits. For instance, United Airlines, Delta Airlines, and Lufthansa has implemented similar a voluntary carbon offset program, allowing passengers to choose SAF contributions to reduce their travel emissions.

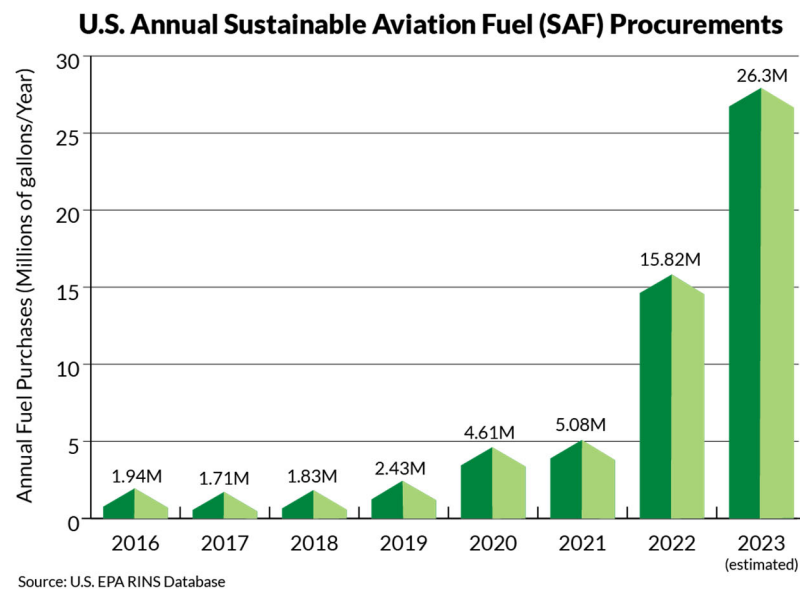


Fig. 6 U.S. SAF Procurements from 2016 to 2023
(Source: U.S. EPA RINS Database, 2022)

- Taiwan

- **Renewable Energy Development Act:** This Act provides incentives for researching projects related to renewable energy and its adoption, and promotes the development and use of renewable energy sources, including the production and use of SAF.
- **Greenhouse Gas Reduction and Management Act:** It establishes specific targets for reducing greenhouse gas emissions and implements carbon pricing mechanisms to promote sustainable fuels. The Act aims to reduce emissions to 2005 levels by 2025, achieve a 20% reduction compared to 2005 levels by 2030, and attain a 50% reduction by 2050. These measures are designed to encourage the transition to a low-carbon economy and enhance the use of sustainable energy sources.
- **2050 Net Zero Emissions Plan:** It aims to achieve net zero greenhouse gas emissions by 2050, highlighting the critical role of SAF.

4.2 Prospects

- Worldwide

CORSIA sets rigorous criteria for SAF, updating its framework annually to ensure genuine emissions reductions and minimal negative impacts. This continuous improvement process incorporates feedback to align with evolving best practices and scientific advancements.

To support the goal of net-zero carbon emissions by 2050 for international aviation, CORSIA requires eligible fuels to achieve at least a 10% reduction in net greenhouse gas emissions compared to traditional aviation

fuel. In June 2023, the first batches of SAF were certified under CORSIA, marking a significant milestone.

ICAO's "Assistance, Capacity-building, and Training for Sustainable Aviation Fuels (ACT-SAF) programme" provides technical and financial support, promoting international cooperation and enhancing SAF production and deployment capabilities.

As of January 1, 2024, 126 states are participating in CORSIA, demonstrating a strong commitment to aviation sustainability. Additionally, CORSIA is exploring a Book and Claim system, allowing airlines to purchase SAF even if it's not available at their departure airport, ensuring the environmental benefits are accounted for globally.

- Europe

Europe is rapidly advancing the SAF market through regulatory frameworks, financial incentives, and strategic infrastructure investments. Key measures include the EU ETS and ReFuelEU Aviation Initiative, mandating SAF inclusion in aviation fuel by 2025. Financial support from the Green Deal, Horizon Europe, tax exemptions, and subsidies boost SAF production and usage. Investments in production facilities and distribution networks ensure efficient delivery to airports. Collaboration with CORSIA and international partnerships standardize global SAF production. Research and development are supported by innovation hubs, pilot projects, and public-private partnerships like the Clean Sky Joint Undertaking. These efforts aim to establish a robust SAF market, reducing aviation emissions and helping Europe meet its climate targets.

- USA

The USA is investing heavily in R&D to optimize current SAF conversion processes and develop new SAF production technologies, including those utilizing waste feedstocks and advanced biofuels. The Clean Fuel Standard (CFS), a proposed federal regulation similar to California's Low Carbon Fuel Standard (LCFS), could further standardize efforts across the country, promoting the widespread adoption of SAF and other low-carbon fuels. With significant investments and supportive policies, along with being one of the world's most productive agricultural nations, the USA is poised to become a global leader in SAF production. This initiative will help reduce carbon emissions from aviation and create new economic opportunities.

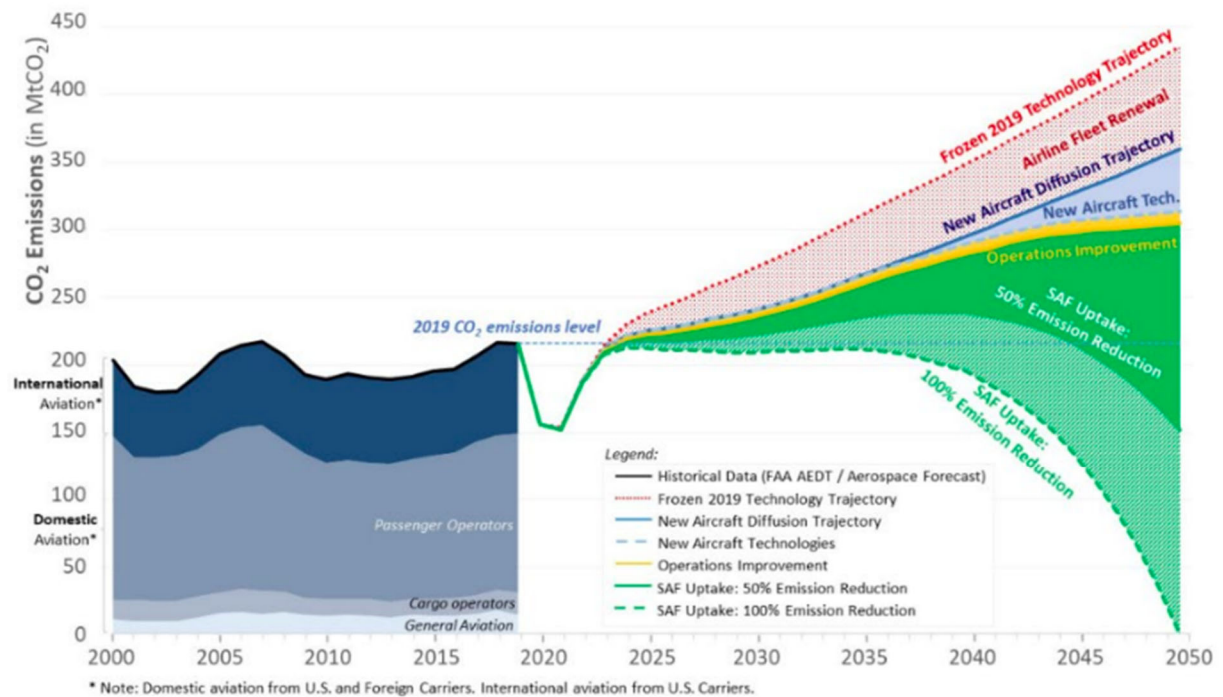


Fig. 7 Analysis of future U.S. domestic and international aviation CO₂ emissions.
(Source: FAA. United States Climate Action Plan, 2021)

- Taiwan

Taiwan is actively advancing its sustainable aviation fuel (SAF) initiatives. In 2023, China Airlines completed its first passenger flight using a 10% SAF blend, highlighting its commitment to reducing carbon emissions. In the first half of 2025, Taiwan will begin supplying SAF to airlines as part of a pilot project led by CPC, targeting major airports. The Civil Aviation Administration (CAA) aims for Taiwanese airlines to achieve 5% SAF use by 2030, aligning with ICAO's emissions reduction goals. Taiwan's participation in international partnerships, such as CORSIA, further enhances its capabilities in SAF production and deployment, ensuring alignment with global best practices.

Net Zero Carbon Emissions by 2050								Reduce carbon emissions by 30% by 2030
SAF Targets:								
	23 billion liters of SAF by 2030	90% of fuel to be SAF by 2050	3 billion gallons of SAF by 2030, 35 billion by 2050	10% SAF in the UK by 2030	3 billion gallons of SAF by 2030	10% of flights with SAF by 2030, 70% by 2050	secured 3.8 billion gallons of SAF	10% of flights with SAF by 2030

Fig. 8 Pathways to Net Zero Carbon Emissions by 2050 by different organizations.
(Source: Climate Drift, SAF Solution and Framework, 2024)

5. Conclusion

Sustainable Aviation Fuel (SAF) is a critical element in the global strategy to reduce aviation carbon emissions. The commitment to net-zero emissions by 2050, supported by the Paris Agreement and CORSIA, underscores SAF's importance.

Global initiatives like ICAO's ACT-SAF and the U.S. Sustainable Aviation Fuel Grand Challenge show robust efforts to enhance SAF production and infrastructure. Europe leads with policies like the European Green Deal and ReFuelEU Aviation initiative, ensuring increased SAF usage and supporting research and infrastructure.

Taiwan, with its advanced waste management and technological expertise, has significant potential to enhance its SAF capabilities. Ongoing pilot projects and planned SAF integration into major airports demonstrate Taiwan's commitment. However, further policy development, infrastructure expansion, and international collaboration are essential.

To advance, Taiwan should focus on enhancing policies, increasing SAF investments, and fostering international collaborations. Establishing a robust distribution network at major airports is vital. By leveraging its waste management practices and joining global initiatives, Taiwan can significantly contribute to reducing aviation emissions and lead in SAF innovation.

Strategic actions and global best practices will enable Taiwan to achieve its net-zero emissions goal by 2050, creating economic benefits and driving innovation in the SAF market.

6. Reference

- AVIATION'S GREEN FLIGHT-PATH IN FOCUS on <https://eurac.tv/9S0I>
- California Low Carbon Fuel Standard (LCFS) regulations on <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/lcfs-regulation>
- China Airlines Sustainability Flight Leads the Way with Low Carbon Meals and Net Zero Carbon Emissions on <https://www.china-airlines.com/sea/id/discover/news/press-release/20230522>
- CPC to import Taiwan's first SAF for 2025 trial on <https://www.argusmedia.com/en/news-and-insights/latest-market-news/2580818-cpc-to-import-taiwan-s-first-saf-for-2025-trial>
- Delta Airlines SAF commitment “How Delta is fueling a more sustainable future during Earth Month and beyond” on <https://news.delta.com/how-delta-fueling-more-sustainable-future-during-earth-month-and-beyond>
- Electric Vehicle (EV) and Fuel Cell Electric Vehicle (FCEV) Tax Credit (Blender's Tax Credit) on <https://afdc.energy.gov/laws/409>
- E-SAF: Techno-Economics of PtL and PtH2 Focus North America and Europe on https://lbst.de/wp-content/uploads/2023/12/DA_E-SAF_Report_final_2023_12_04.pdf
- ESTIMATING SUSTAINABLE AVIATION FUEL FEEDSTOCK AVAILABILITY TO MEET GROWING EUROPEAN UNION DEMAND from International Council on Clean Transportation on <https://theicct.org/publication/estimating-sustainable-aviation-fuel-feedstock-availability-to-meet-growing-european-union-demand/>
- EUROPEAN AVIATION ENVIRONMENTAL REPORT 2022 Executive Summary and Recommendations on https://www.easa.europa.eu/eco/sites/default/files/2023-02/EnvironmentalReport_EASA_summary_12-online.pdf
- European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions from EU ETS on https://malta.representation.ec.europa.eu/news/european-green-deal-commission-proposes-transformation-eu-economy-and-society-meet-climate-ambitions-2021-07-14_en
- European Union Aviation Safety Agency (EASA) SAF on <https://www.easa.europa.eu/en/domains/environment/sustainable-aviation-fuels-saf>
- European Union Green Deal on https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_19_6691/I_P_19_6691_EN.pdf
- Fit for 55 package on [https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733513/EPRS_BRI\(2022\)_733513_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733513/EPRS_BRI(2022)_733513_EN.pdf)
- How Aviation Stakeholders are Taking Steps to Comply with ReFuelEU Regulations from AviationPros on <https://www.aviationpros.com/ground-handling/article/53080532/how-aviation-stakeholders-are-taking-steps-to-comply-with-refueleu-regulations>
- IATA Developing Sustainable Aviation Fuel on <https://www.iata.org/en/programs/environment/sustainable-aviation-fuels/>
- ICAO Conversion Processes on <https://www.icao.int/environmental-protection/SAF/Pages/Conversion-processes.aspx>

- ICAO document “CORSIA Sustainability Criteria for CORSIA Eligible Fuels” on https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_Eligible_Fuels/ICAO%20document%2005%20-%20Sustainability%20Criteria%20-%20November%202022.pdf
- ICAO Sustainable Aviation Fuel Guide on https://www.icao.int/environmental-protection/Documents/Sustainable%20Aviation%20Fuels%20Guide_100519.pdf
- ICAO Sustainable Aviation Fuel on <https://www.icao.int/environmental-protection/Pages/SAF.aspx>
- ICAO’s ACT-SAF initiative on <https://www.icao.int/environmental-protection/Pages/ACT-SAF.aspx>
- ICAO’s CORSIA on <https://www.icao.int/environmental-protection/CORSIA/Pages/SARPs-Annex-16-Volume-IV.aspx>
- Innovation Fund: grant agreements signed with further 16 innovative large-scale projects from EU Emissions Trading System (EU ETS) https://climate.ec.europa.eu/news-your-voice/news/innovation-fund-grant-agreements-signed-further-16-innovative-large-scale-projects-2023-01-19_en
- Lufthansa voluntary carbon offset program “Carbon-neutral flying” on <https://www.lufthansa.com/content/lh/gc/en/carbon-offsetting>
- News from ActionRenewables about Sustainable Aviation Fuel (SAF) on <https://actionrenewables.co.uk/news/sustainable-aviation-fuel-saf/>
- Paris Agreement on https://unfccc.int/sites/default/files/english_paris_agreement.pdf
- ReFuelEU Aviation initiative on https://commission.europa.eu/document/download/b94c33cd-7249-4b4e-9c0d-5a0f8aed6b1d_en
- Renewable Energy – Recast to 2030 (RED II) on https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en
- Renewable Energy Directive (RED II) on <http://data.europa.eu/eli/dir/2018/2001/oj>
- Sustainable Aviation Fuel ‘Facilitation Initiative’ Grant Agreement EASA.2015.FC21 on <https://www.easa.europa.eu/en/document-library/research-reports/grant-agreement-easa2015fc21-0>
- Sustainable transport from EU ETS on https://transport.ec.europa.eu/transport-themes/sustainable-transport_en?prefLang=ro
- The benefits of Sustainable Aviation Fuel go beyond CO₂ on <https://aviationacrossamerica.org/news/2020/12/15/the-benefits-of-sustainable-aviation-fuel-go-beyond-co%e2%82%82/>
- The Challenge Ahead: A Critical Perspective on Meeting U.S. Growth Targets for Sustainable Aviation Fuel from National Renewable Energy Laboratory <https://www.nrel.gov/docs/fy24osti/89327.pdf>
- U.S. Bipartisan Infrastructure Law on <https://www.whitehouse.gov/wp-content/uploads/2022/05/BUILDING-A-BETTER-AMERICA-V2.pdf>
- U.S. Sustainable Aviation Fuel Grand Challenge from DOE on <https://www.energy.gov/sites/default/files/2022-09/beto-saf-gc-roadmap-report-sept-2022.pdf>
- United Airlines' Eco-Skies Alliance program on <https://www.united.com/en/us/fly/company/responsibility/eco-skies-alliance.html>

- United States National Academies of Sciences on
<https://www.nationalacademies.org/topics/environment-and-environmental-studies>
- Updated analysis of the non-CO₂ effects of aviation from EU ETS on
https://climate.ec.europa.eu/news-your-voice/news/updated-analysis-non-co2-effects-aviation-2020-11-24_en?prefLang=sk