Net Zero Aviation in Latin America and the Caribbean: Pathways and Trade-offs

Final report

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Acknowledgements

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Executive Summary

Introduction and context

Aviation is essential to connectivity and economic development in the Latin America and Caribbean (LAC) region, contributing 3.6% of regional gross domestic product (GDP) and supporting 2.9% of employment in 2023[1]. The region spans nearly 22 million square kilometers, with a geography characterized by mountain ranges, rainforests, and deserts. This makes air transport critical for connecting communities, businesses, and tourism markets. However, the aviation market in Latin America and the Caribbean remains significantly smaller than in more mature markets. One clear indicator is air travel propensity: while passengers in North America take on average around 2.5 air trips per capita per year, the average in Latin America and the Caribbean is just 0.67 trips per capita[2]. This large gap reflects lower market maturity and the wealth disparities between countries. It highlights the importance of ensuring air travel affordability in a region where connectivity is still developing and plays a fundamental role in economic and social development[3].

Airlines in the region have made significant progress and investments to reduce emissions. Airlines across LAC operate one of the youngest and most fuel-efficient fleets globally, allowing the benefits of aviation to be realized with the lowest possible emissions. For example, the proportion of available seat-kilometers (ASKs) flown by new generation aircraft in the LAC region (38%) is higher compared to more developed economies, such as Europe (34%), the United States and Canada (34%), and Asia (26%). Airlines have also made significant achievements implementing operational efficiencies (corresponding to procedures under their control).

However, achieving net-zero emissions for aviation in LAC requires further action and support. There are many obstacles, including economic and developmental disparities, limited infrastructure, and varying regulatory capacities. The region's GDP per capita remains significantly lower than in Europe or North America, which may limit its ability to absorb the higher costs associated with sustainable aviation measures[4]. This could lead to reduced air travel demand and unfairly restrict social and economic development in the region.

A regionally tailored approach is needed for LAC. The region has many unique advantages, resources, and challenges to reduce aviation emissions. Acknowledging the UNFCCC principle of common but differentiated responsibilities and respective capabilities, this study assesses the circumstances and strategy for the LAC region to reduce aviation emissions and aims to provide a common framework for discussions[5].

As economies and populations grow, the regional aviation industry will continue to expand, ensuring a greater number of people have access to the benefits the sector brings. Per capita travel rates in LAC are projected to grow steadily, increasing by a compound annual growth rate (CAGR) of 2.7% between 2019 and 2050[6]. While this growth is crucial for developing economies, it also heightens environmental challenges that must be mitigated.

Latin America and the Caribbean (LAC) are entering a pivotal phase in the journey to reduce aviation emissions. This study, commissioned by ALTA and its members and developed in collaboration with ICF, provides a regional framework to support the transition to net-zero emissions by 2050. It considers the methodology from the International Civil Aviation Organization's (ICAO) Long-Term Aspirational Goal (LTAG), which sets a global benchmark for aviation climate action, while acknowledging the region's diverse circumstances[7].

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[1] ATAG - Aviation benefits beyond borders
[2] North America including the US and Canada. Calculated by ALTA analysis, using data from IATA economics
[3] ALTA - https://alta.aero/en/news/trafico-aereo-en-america-latina-y-el-caribe-crecio-38-interanual-en-2025/, IATA - https://www.iata.org/en/pressroom/2025-releases/2025-08-04-01/
[4] World bank GDP database
[5] UNFCCC: https://unfccc.int/resource/docs/convkp/conveng.pdf
[6] ALTA - Route to sustainability in Latin America and the Caribbean
[7] LTAG report

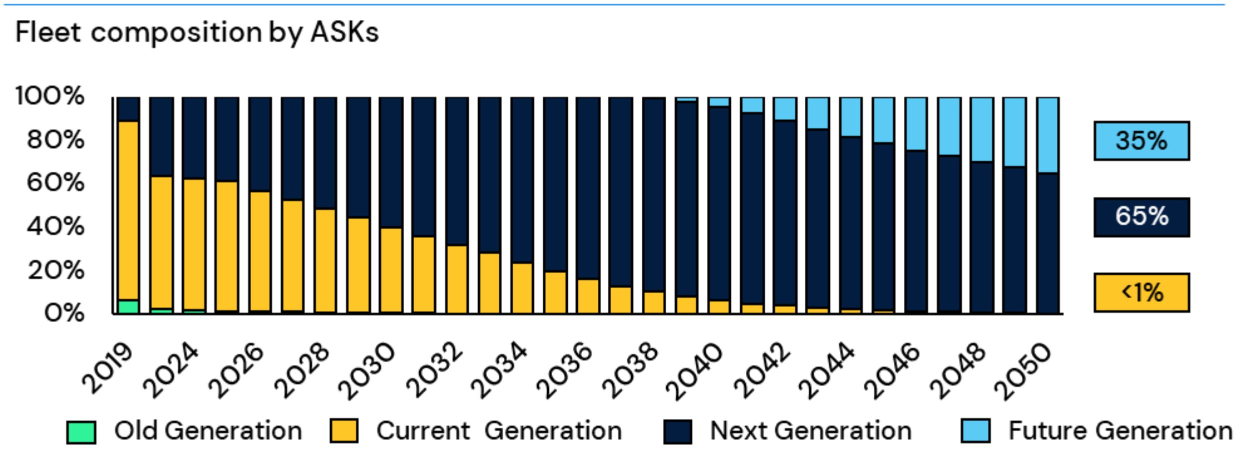
This study investigates the four key mechanisms that are widely considered to enable aviation to achieve net-zero emissions: (1) Technology (fleet modernization), (2) operational efficiency improvements, (3) fuel fossil carbon emissions reduction, and (4) carbon mechanisms. The first three of these mechanisms are the same as those considered by the LTAG, ensuring consistency with international standards. While not included in the LTAG, this study also goes further by exploring the opportunity for out-of-sector measures, such as carbon credits, to address aviation emissions, due to the positive impact airlines could have on the fragile and globally relevant ecosystems located in the region.

Airlines in LAC operate an efficient fleet, with increasing benefits as more fuel-efficient aircraft continue to enter operations.

Fleet renewal has accelerated post-COVID in the region, with new generation aircraft accounting for 19% of flights, up from 2% in 2019. As these newer aircraft also tend to operate longer routes, this represents 38% of ASKs. Airlines have actively retired older aircraft post-COVID and replaced them with more efficient models such as the A320neos and B737MAXs, which offer fuel savings of 15-20% over previous generations.

The region's airlines have over 700 aircraft on order, with nearly 80% being narrowbodies[8]. These orders will support both growth and replacement needs, with future generation aircraft[9] expected to enter service from the mid-2030s led by turboprop aircraft followed by regional jets and narrowbodies towards the second half of the decade. By 2050, new and future generation aircraft will dominate the fleet, driving further reductions in fuel burn per passenger kilometer. However, this will only be possible if current order books are achieved, and aircraft are delivered and introduced in service on time. Delays in the supply chain could result in slower adoption of these new aircraft even if airlines have invested and have committed to fleet renewal. The chart below shows the projected fleet transition profile in the LAC region, based on the 2024 baseline fleet, current and retirement age assumptions, order book and delivery assumptions, and inputs from key stakeholders in the LAC region.

Airlines in the LAC region have already started transitioning to more fuel-efficient aircraft. Future generation aircraft are expected to enter the fleet in the late 2030s



Source: ICF analysis. ASKs = Available Seats Kilometres; Future Generation will follow NEOs and MAXs

These trends highlight the substantial investment airlines have already made in fleet modernization and the critical role of continued technological advancement in achieving long-term emission reduction targets.

[8] CAPA fleet database

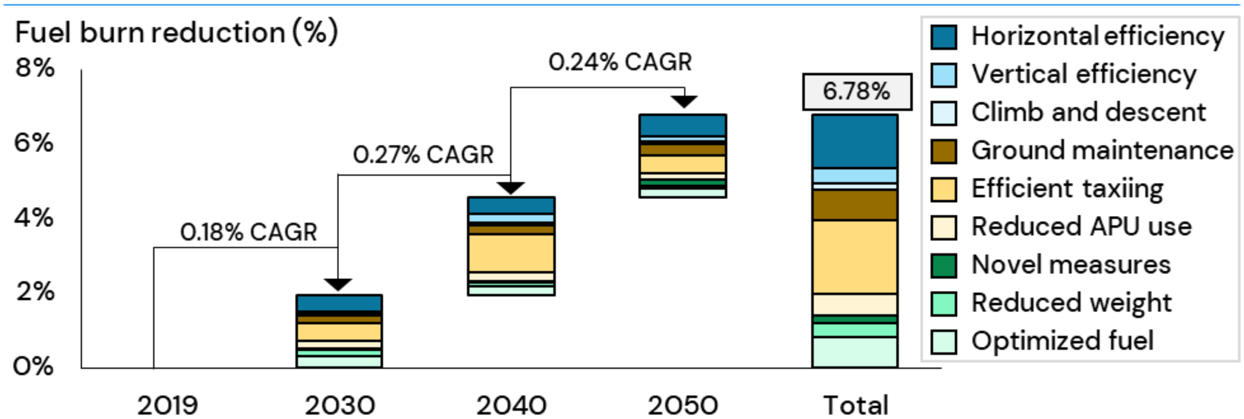
[9] Generation coming to the market after the NEOs and MAXs and E-jets E2 family

Operational efficiencies are an essential and immediate opportunity

Supporting greater operational efficiencies is an immediate and cost-efficient measure. Improvements across aircraft, airport, ground operations, and flight profile optimization offer a significant opportunity to reduce fuel consumption and emissions in the LAC region, with potential savings of 3.3% to 11.3% by 2050. These measures represent a win-win as they reduce emissions and operating costs, enhance resilience, and improve system-wide performance.

Airlines in the LAC region have already made significant progress in reducing their emissions through operational efficiency improvements. However, achieving even greater efficiencies depends on broader government and stakeholder involvement, investment by airports and air navigation service providers, and coordinated action across the aviation ecosystem.

Operational improvements in the LAC region could reduce aircraft fuel burn by 3.3-11.3% in 2050, but require the support of additional stakeholders

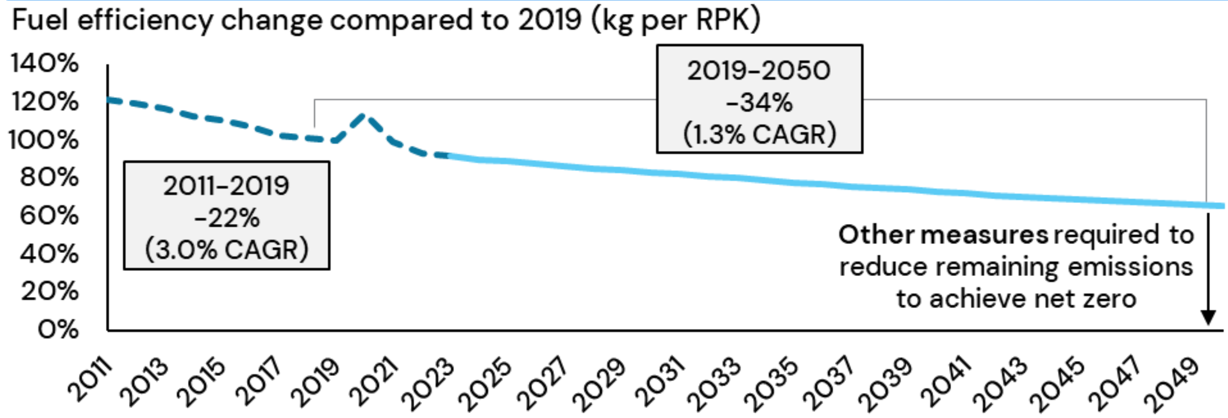


Source: ICF analysis
Note: Central scenario; Novel measures includes formation flight

Additional measures could reduce 2050 emissions by 6.8% under the central scenario, though most savings rely on action from stakeholders beyond airlines. Ground-based measures represent the largest opportunity, with potential for 3.4% emissions savings through increased use of fixed ground power, pre-conditioned air, greater single-engine taxi, and gradual adoption of electric tugs. Efficiency and planning measures could deliver 1.4% savings by 2050 relative to 2019 through wider use of advanced fuel planning tools, performance monitoring, and fully integrated digital fuel optimization. Flight profile optimization could yield 2.0% savings through more direct routing, improved flow management, and incremental technology adoption. Success across all measures relies on collaboration among governments, regulators, air navigation providers, airlines, and airports, supported by modernization, training, and transparent data sharing.

Fleet and operational efficiencies are crucial to reduce the emissions intensity, delivering meaningful and immediate reductions in fuel consumption and associated costs, but additional measures are required to address the residual emissions.

The combined impact from fleet and operational efficiencies can reduce emissions intensity by 34% between 2019-2050



Source: Historical from ALTA - Route to sustainability in Latin America and the Caribbean, ICF analysis

Deploying sustainable aviation fuel (SAF) to achieve net zero emissions by 2050

SAF is one of the key long-term emission reduction solutions available to the sector. In the baseline (activity growth with no emission reduction measures), total jet fuel consumption in LAC will increase from 21.2 million tonnes (Mt) in 2019 to 44.5 Mt by 2050, around 10% of projected global uplift[10]. More efficient aircraft and operational efficiencies significantly reduce jet fuel consumption, by 13.4 Mt and 1.1 Mt respectively, resulting in lower costs and emissions. However, even with these measures, 29 Mt of jet fuel would still be consumed in the LAC region, producing emissions of around 111 Mt (WTW[11]) of CO_{2e}. SAF, as well as carbon credits, are crucial to address these remaining emissions.

SAF offers a practical pathway to reduce aviation's lifecycle greenhouse gas emissions, as it can be used as a drop-in fuel[12] with existing aircraft and infrastructure. This compatibility makes SAF a key option to reduce aviation emissions without requiring major changes to aircraft or fuel systems. As a result, many aviation emission reduction strategies have focused on SAF adoption as a key measure to reduce aviation emissions.

The LAC region faces unique challenges that must be addressed to unlock the full potential for SAF. While each of these factors can be surmounted or mitigated, they suggest a need for greater support or slower deployment compared to the global average. Challenges include:

- **Limited government capacity for financial support.** There is less government finance available to subsidize the development of a regional SAF industry. Support on the scale of the IRA in the US, or the STIP in the EU would be challenging to achieve in the LAC region.
- **Higher fuel cost due to supply chain inefficiencies.** The cost of jet fuel in the region is higher than in comparison to other parts of the world due to inefficient supply chains, monopolistic and price-controlled supply in some countries, multiplicity of overlapping taxation regimes and inefficient and underinvested infrastructure, reaching 30 to 40%[13] of the operational cost for regional airlines. This can limit resources available to adopt costlier fuels.
- **Biofuels industry focuses on domestic land transport**. Due to the production chemistry of biofuels, SAF facilities typically co-produce other biofuels, such as naphtha and renewable diesel, whereas renewable

[10] Based on jet fuel demand modelling used in this study
[11] WTW = Well-to-wake
[12] Alternative fuel, which can be used in existing engines and infrastructure without any modifications, up to the ASTM blend limits.
[13] In 2022 jet fuel represented 43% of operating costs, while over the 2022-2025 period it has generally ranged between 42% and 30%

diesel facilities may not produce any SAF. In addition, renewable diesel production is typically cheaper than SAF as isomerization equipment is not required, less low-value naphtha is produced, and the industry has had several decades to mature the technologies. These factors result in a typical deployment schedule which is led by renewable diesel and ethanol, with SAF scaling later on these foundations. While Brazil stands out with a large-scale biofuels industry, use across the rest of the LAC region is much lower; the percentage of oil consumption met with biofuels is 4.4% in the US and 2.5% in Europe, compared to just 1.6% across LAC (excluding Brazil)[14]. Moreover, sustainability and certification requirements remain a key consideration for biofuel deployment. **This suggests a biofuel strategy may focus on on-road fuels initially, with SAF building on this foundation later.**

- **Constrained energy availability for green hydrogen production.** Green hydrogen is a key input for power-to-liquid production but is energy intensive to produce. While countries such as Chile and Brazil have strong potential for green hydrogen development, there is competition with other domestic energy uses. Moreover, the price airlines pay for power-to-liquid SAF is expected to remain significantly higher than that of other pathways, even as technologies mature.
- **High passenger price sensitivity amplifies the impact of SAF adoption.** SAF could have an important effect on airlines' cost structures and ticket prices. SAF is currently 3–12 times more expensive than conventional jet fuel and is projected to remain more expensive in the forecast horizon. Passengers in the developing LAC region are highly price sensitive, increasing the impact of any costs passed through to customers. As a result, any increase in ticket prices due to SAF adoption could reduce demand, potentially affecting air connectivity in a region where aviation plays a critical role in linking communities and supporting economic growth.
- **Challenging investment environment.** Lack of bankable demand from domestic airlines to support the development of SAF projects coupled with regional uncertainty in terms of geopolitics, domestic political uncertainty, interference from other governments, higher cost of capital for projects and lack of mature SAF technologies or financing mechanisms beyond production incentives, and high elasticity of demand, all of which lead to higher resulting prices for passengers and threatens potential impact on connectivity more than in other regions.

To assess the challenges, the impact of aligning to the high ICAO LTAG SAF blend was modelled. This assumes 96% replacement of fossil fuels with SAF, with carbon mechanisms only used for residual emissions. The high cost of SAF would add ~43 U.S. Dollars (USD) per departing seat by 2050 (30.6 Bn USD across the industry annually) and passenger sensitivity means that the increased ticket costs would result in a ~30% reduction in air traffic and connectivity in the region[15]. The projected demand reduction could result in a total aviation economic loss of ~156 Bn USD[16], significantly affecting regional passengers, the air transport sector, tourism, and broader regional economic and social welfare.

These factors mean a structured and collaborative approach is required to scale SAF in the region. None of these factors are insurmountable but mean that ambitions must be supported with a strategy that reflects the circumstances for each country. Importantly, these challenges also present opportunities for innovation and regional leadership. The LAC region benefits from abundant second-generation feedstock potential, positioning it as a future exporter if investments and partnerships are mobilized. Early action to expand biofuel production for road transport can establish the technical and economic foundation for SAF, enabling a gradual and regionally-appropriate transition.

[14] On an oil energy equivalence basis, source from EI Statistical review of world energy
[15] Elasticity source used – Estimating Price and Income Air Travel Demand Elasticities in Latin America (study performed by The University of San Andrés to support this study)
[16] Calculated by pro-rating the value of LAC aviation calculated by ATAG: https://aviationbenefits.org/

Over 1.9 billion gallons of SAF production capacity intentions have been announced in the LAC region[17], although none of the announced projects have yet passed the final investment decision (FID) stage, and very few have any material investment at feasibility stage. This indicates strong interest and the regional industry has meaningful opportunities to produce and export SAF if the challenges are addressed with coordinated efforts to address economic, technical, and sustainability difficulties. Careful planning and an understanding of the potential associated impacts on connectivity must be front and center in the design and implementation of policies in individual countries and the region as a whole.

The role for carbon credits to reduce aviation emissions in Latin America and the Caribbean

Market-based measures, including carbon offsetting and removals, offer a crucial pathway to reach aviation net zero emissions in the LAC region. These mechanisms enable airlines to compensate for residual emissions by purchasing verified carbon credits from projects that reduce, avoid, or remove greenhouse gases outside the aviation sector.

The LAC region plays a key role in the carbon market. Over the last four years, the region issued 23% of all global carbon credits, demonstrating an outsized role when compared to regional emissions (6.7% of global carbon emissions[18]). With expansive and globally-critical natural ecosystems, tropical forests, and rich biodiversity, the region is uniquely well positioned to lead in the generation of high-integrity carbon credits, although most of the abundant nature-based solution (NBS) methodologies present in the region are currently excluded from CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation). To date, key projects include developments through REDD+ (Reducing Emissions from Deforestation and Forest Degradation Plus) and other forestry-related projects. Guyana was the first country to have CORSIA-authorized credits issued (including the letter of authorization (LoA)), setting a global benchmark for jurisdictional REDD+ programs.

The global voluntary carbon market has expanded significantly, growing from 56 Mt in 2016 to 251 Mt in 2024, representing a CAGR[19] of roughly 20%. By 2050, analysts project the carbon market could reach between 1.8 and 8.2 billion tonnes (Bt) of CO_2 traded annually, including removals from direct air capture (DAC)[20]. This study estimates the global market at around 4.0 Bt by 2050, growing at about 11% per year, with the LAC region potentially accounting for around 1 Bt of that total. For aviation, the number of high-quality credits expected to be available in LAC is around 0.1 Bt by mid-century.

Market robustness and co-benefits are essential. The global market has come under intense scrutiny over recent years, driving a renewed focus on quality, accuracy, and co-benefits for local populations. This should drive further improvements in the maturity and impact from the market. Many airlines across LAC further benefit from their proximity and understanding of the ecosystems, communities, and projects developing carbon credits within the region, allowing an additional level of rigor and alignment of the benefits.

Realizing the potential for carbon markets in the region will require streamlined LoA processes for international schemes, strengthened monitoring, reporting, and verification (MRV) systems, and regional collaboration to harmonize standards and reduce fragmentation. Financial incentives such as tax credits and green bonds can help mobilize investment in high-quality projects. **As demand for aviation-eligible credits rises, the LAC region is well-positioned to meet regional and global needs if key regulatory and institutional barriers are addressed.**

Balancing the use of SAF and carbon credits by considering price and availability

The mix of SAF and carbon credits should be appropriate to the resources of each country. Both approaches can be environmentally robust with appropriate safeguards, and some combination of both mechanisms will always be necessary to achieve global aviation goals. Multiple factors determine the ideal

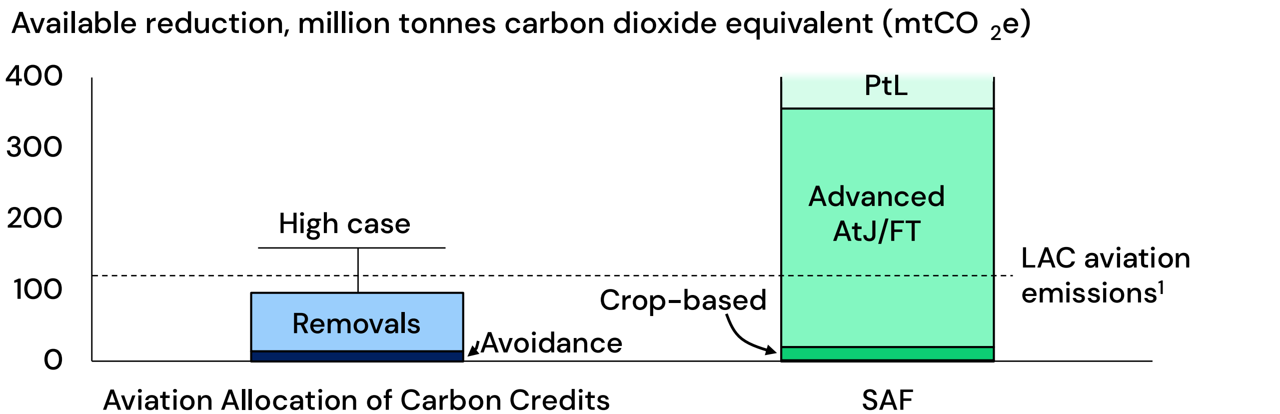
[17] ICF analysis of public sources
[18] OECD, 2023
[19] CAGR= ((Ending Value/Beginning Value) ^(1/Number of Years)) -1
[20] BloombergNEF, 2025, Green Earth, 2025

strategy to reduce aviation emissions, including the availability of infrastructure, expertise, SAF feedstock availability and investment potential, offsetting and removal opportunities and the strength of their co-benefits, the capacity and willingness of passengers to pay, and resources of governments to incentivize the development of new industries such as SAF.

Availability of mechanisms is a key consideration. SAF in 2024 represented less than 1% of global jet fuel use[21]. Multiple studies have highlighted the global availability of feedstock, and this evaluation identified feedstock potential in the LAC region. However, almost all these feedstock volumes require advanced technologies (such as production of cellulosic ethanol, alcohol to jet, Fischer-Tropsch) which are still to be deployed at commercial scale. The availability of feedstocks for the proven HEFA process and co-processing is constrained, and in strong competition for use as non-aviation biofuel and in other sectors. The carbon market is also relatively small today when compared to global emissions. In 2025, 251 Mt of credits were generated across all sectors, equivalent to less than a quarter of global aviation emissions, and just 0.7% of total global emissions. Increasing development and use of carbon credits allows significantly increased scale, but the market must be supported to give investors the confidence to invest, and to ensure the robustness and durability of the underlying reductions. The following chart illustrates the forecast 2050 availability in the LAC region, with comparison against the aviation emissions.

This shows two conclusions: a mix of mechanisms is required, and the LAC region may have an opportunity as a SAF exporter to countries where demand outstrips their feedstock availability.

LAC projected 2050 availability of carbon credits and SAF, in terms of CO_2e abatement



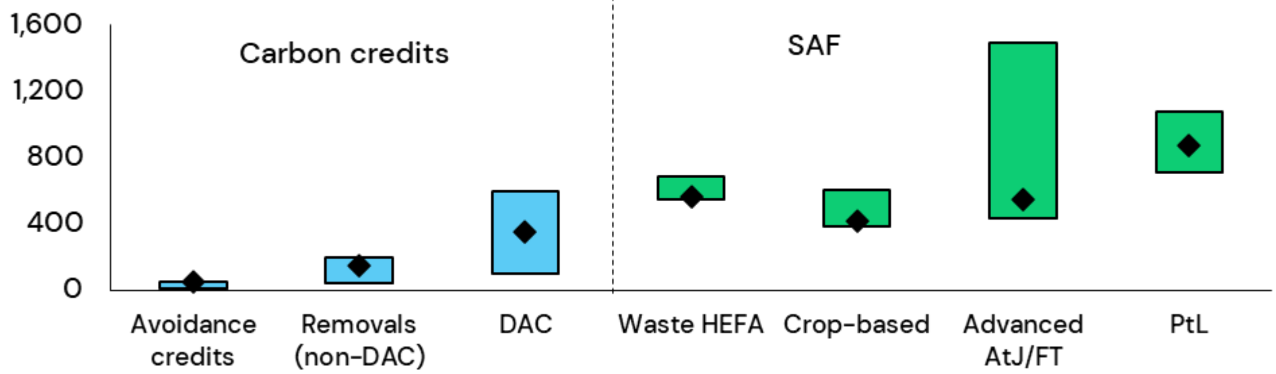
Source: ICF analysis
Notes: (1) After fleet and operational improvements

Comparing the 2050 cost of abatement for SAF and carbon credits. The price forecast for carbon credits is predominately driven by supply and demand, while the SAF price is driven by technological factors. As a result, the analysis assumes a gradual increase in the price for robust carbon credits as demand outstrips supply, but a gradual decrease in the price of SAF as technologies mature and the market scales. However, consideration to the fact that SAF feedstocks are commodities with their own markets is needed and as such have a price floor. There are some exceptions for individual pathways, for example, with technology progress decreasing the abatement cost for DAC from ~1,300 USD/tCO_2e today to between 100 and 600 USD/tCO_2e by 2050[22], and the constrained supply of waste oils (such as used cooking oil and tallow) increasing the cost of waste oil-based HEFA production over time.

[21] https://www.iata.org/en/pressroom/2024-releases/2024-12-10-03
[22] Elhardt, 2024; Young et al., 2023

LAC 2050 cost of abatement for selected carbon credit and SAF pathways

Abatement price, in USD per tCO_2e



Source: ICF analysis

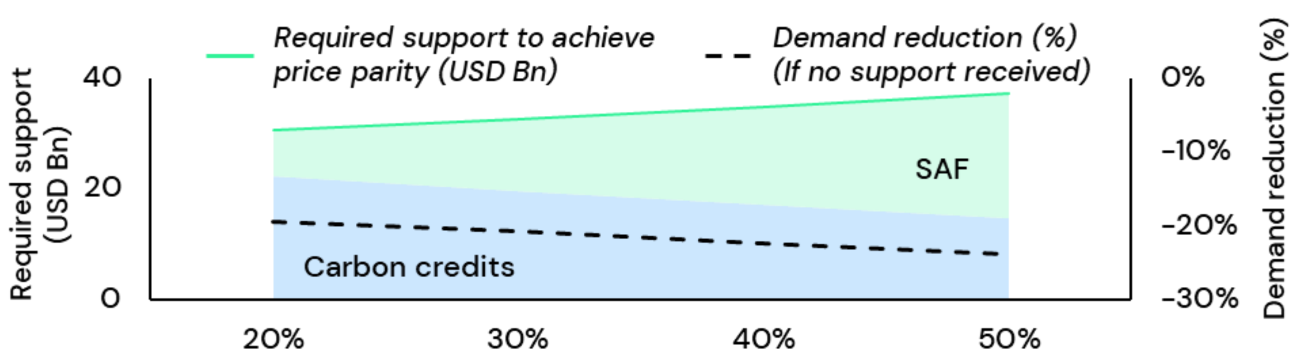
Note: The SAF abatement price is based on the SAF premium

The mix of carbon credits and SAF has a significant impact on the scale of support required

The cost impact varies significantly depending on the mix of carbon credits and SAF used. This study has evaluated the impact on demand and consequent lost economic value for a range of regional SAF blends, from 20% to 100%. The level of price support to mitigate the reduction in aviation demand has also been calculated. This shows that for a 20% blend by 2050, aviation demand would be reduced by 19.5%, equivalent to a 111 Bn USD reduction in potential economic value. 30.5 Bn USD in government support in 2050, and 224 Bn USD cumulatively, would mitigate this price and demand impact. By comparison, a 50% SAF blend would reduce demand by 24% with an economic impact of 131 Bn USD, requiring 37.3 Bn USD of support to mitigate the impact in 2050, and 284 Bn USD cumulatively.

2050 level of government support and investment required and demand reduction for mix of SAF and carbon mechanisms

Required support in USD bn (left) and demand reduction in % (right). Horizontal axis shows the 2050 regional SAF blend.



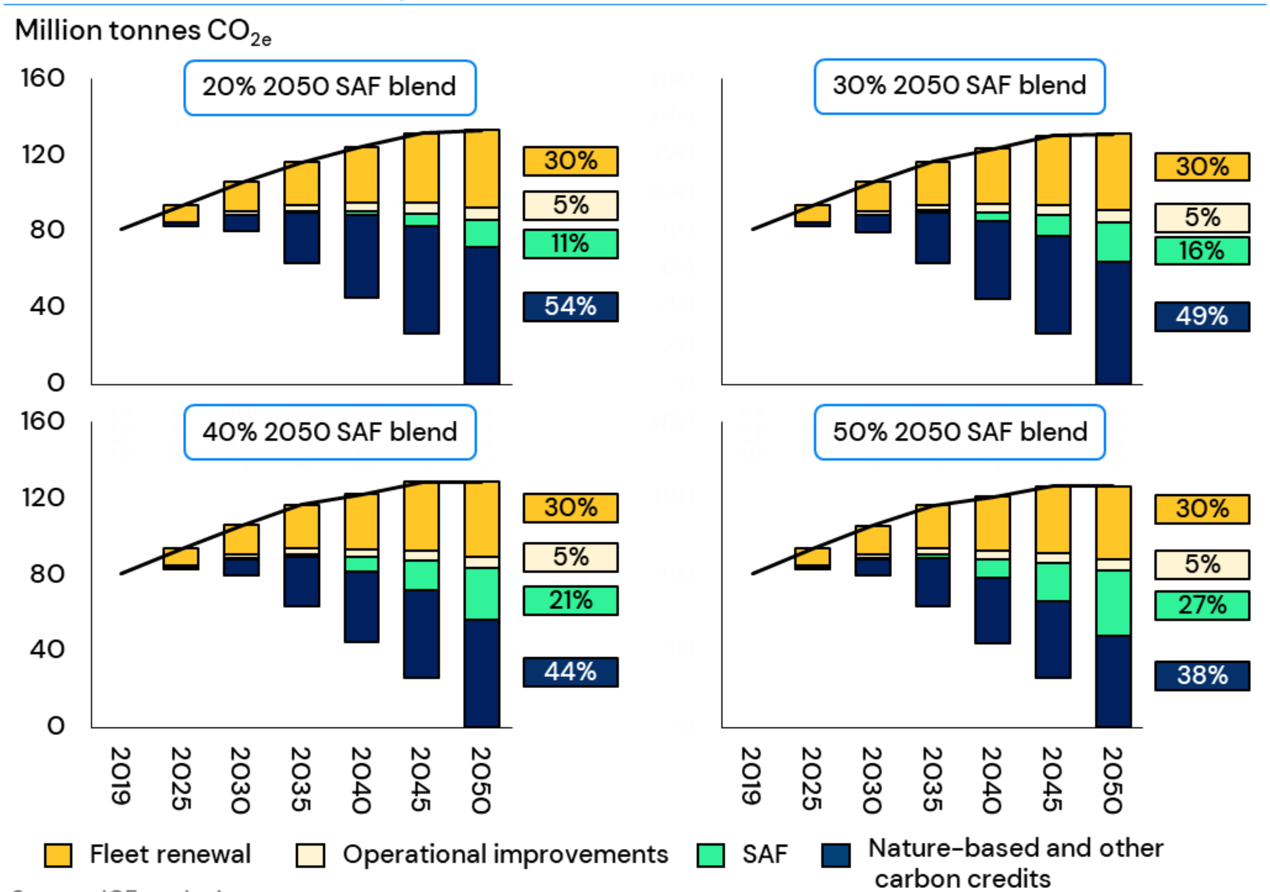
Source: ICF analysis

Table 1: Volume, cost, and impact on demand for carbon credits and SAF in 2050

SAF blend (2050)	20%	30%	40%	50%
Carbon credits required (Mt CO_2/year)	92.4	83.4	74.1	64.9
Cost of carbon credits (USD Bn/year)	22.2	19.7	17.2	14.6
Cost of SAF premium (USD Bn/year)	8.3	12.9	17.8	22.7
Total cost (USD Bn/year)	30.5	32.6	34.9	37.3
Demand reduction impact (%/year)[23]	-19.5	-20.7	-22.4	-24.0

Focusing on emission reduction pathways, with a SAF blend of 20–50% by 2050, the figure below illustrates how net-zero can be achieved through a combination of fleet renewal, operational efficiency improvements, SAF uptake, and carbon credits.

Illustrative decarbonization pathways for Latin America and the Caribbean's aviation sector to reach net-zero by 2050



Source: ICF analysis
Note: Baseline includes demand reduction

[23] Measured in reduction of departing seats. Note this shows an extreme case where full cost impact is passed-through to passengers.

Collaboration across industry stakeholders, jurisdictions and sectors, coupled with government support, is the only way to achieve net zero while allowing aviation to grow and continue to offer associated social and economic benefits.

This report assesses the implications of LAC airlines reaching net-zero by 2050, finding that immediate measures (fleet and operational efficiencies) can meaningfully reduce emissions, while addressing the residual emissions requires a careful strategy and targeted support due to the tradeoff between ensuring connectivity for the region vs adoption of costlier emission reduction strategies such as SAF. A rapid increase in the use of unsubsidized SAF and carbon credits would greatly increase the cost to passengers, resulting in demand reductions that would unjustly constrain aviation growth and connectivity compared to developed countries, having a direct impact on regional economic development. This would translate into tens of billions of USD of lost economic value by 2050 (including direct, indirect, induced and tourism)[24]. Aviation serves as a vital component of the LAC region, facilitating connections among regions and families, enabling the transportation of goods, and underpinning the tourism industry and economic development in general. This is particularly due to the vast distances, complex geographies and lack of alternative transport infrastructure in the region.

To tackle emission reduction costs, governments should deploy concrete economic and regulatory incentives that boost efficiency, innovation and competitiveness across the entire aviation value chain – from SAF producers to airlines. Policy packages can enable airlines to accelerate emissions reductions by combining targeted measures such as tax relief on SAF purchases, discounts or rebates on airport and air navigation charges tied to SAF use, and differentiated fiscal regimes that reward verified SAF uptake. Given the relative cost of jet fuel (~40% of operating costs) and SAF price (3 to 5 times of jet fuel), multiple combined measures which address the vast price gap will be required. Contributions from developed countries, multilateral organizations, implementation of technical solutions such as double auctions or revenue certainty mechanisms which have been proven to work to kickstart other renewable energy industries such as hydrogen will be required. A significant element of this support could come from foreign governments, either indirectly (e.g. governments in developed countries financing the R&D for new SAF production technologies) or directly (e.g. supporting the development of carbon credit projects and SAF production in LAC by providing export markets, or through direct investments and novel climate finance mechanisms). Within the region, government interventions should also include streamlined regulatory processes, and collaborative frameworks that encourage investment in cleaner technologies.

In addition, multi-stakeholder engagement can assist in balancing climate objectives with economic priorities, ensuring that the aviation industry remains resilient while progressing toward net-zero emissions goals. Regulatory alignment across the LAC region is a foundational requirement for reducing emissions in the aviation sector. Harmonized regulations will facilitate the effective implementation of various measures needed to support the industry's transition to lower emissions. Building on this foundation, the following strategic priorities outline the key areas where coordinated action and targeted support will be essential to enable the industry's transition to lower emissions.

- **Support fleet renewal:** Fleet modernization is the cornerstone to reaching net zero, given its significant impact on both fuel costs and emissions. Airlines have already invested billions in new aircraft, and this continued investment in next-generation aircraft and future propulsion technologies will drive ongoing reductions in fuel burn per passenger kilometer. Targeted support from governments and financial institutions, including accelerated depreciation and preferential financing help sustain airline investment.
- **Accelerate operational efficiency gains:** Operational efficiency improvements offer an immediate and cost-effective way to reduce emissions, often with co-benefits to the journey time and local air quality at airports. Many measures within airline control have already been implemented, including weight-reduction

[24] Based on the 2023 aviation value added across the region and normalized by the available seat kilometers (ASKs) projected: Aviation Benefits Beyond Borders

initiatives and training programs to encourage single-engine taxiing, with further gains depending on coordinated action with governments, airports and ANSPs.

- **Enable SAF scaling through a phased approach:** SAF is a necessary long-term emissions reduction measure, but high costs and infrastructure constraints mean regional targets must reflect local realities. A phased strategy should begin by understanding tradeoffs and aligning the needs of the economy as a whole, strengthening the renewable fuels industry for road transport, and understanding the potential of each country to find a suitable export market for SAF in order to achieve the necessary scale and long-term sustainability of the SAF market, and designing policies to support the creation of domestic bankable demand with a focus on passenger support for the adoption of SAF. This can create the foundation for SAF production. Governments, airlines and industry must work together to attract investment, streamline permits, and develop regional supply chains while ensuring connectivity and economic development at system level is protected. A unified and cooperative regulatory approach is necessary to promote SAF development, ensuring sufficient production volumes, competitive pricing, and CORSIA certification, including harmonized standards and streamlined cross-border processes for feedstock and fuel distribution. In parallel, enabling environmental attribute commercialization, such as book-and-claim systems, will be important to help offset costs and ensure a SAF export market for LAC SAF.
- **Strengthening and promoting interoperability of carbon credit market**: The LAC region has considerable potential to expand its carbon credit market while delivering significant co-benefits in terms of nature, water and biodiversity and supporting the reduction of emissions in other industries such as agriculture which represent a large proportion of emissions in the region. Governments and stakeholders must collaborate to establish transparent rules, standardized methodologies, and reliable MRV frameworks. This includes clarifying carbon ownership rights, facilitating the issuance and transfer of credits, and ensuring compatibility with international standards to attract both regional and global demand. In addition to reducing emissions, an effective carbon credit market can generate substantial co-benefits for conservation and biodiversity by incentivizing the preservation and restoration of forests, wetlands, and other critical ecosystems, protecting endangered species, and promoting sustainable land use practices that enhance ecosystem services and strengthen climate resilience across the region, while also delivering social benefits through rural job creation, improved livelihoods for local communities, and community development.
- **Facilitating continuous knowledge sharing:** It is crucial that all stakeholders including airlines, government agencies, industry partners, and regulatory bodies work collaboratively to address constraints, share technical expertise, and policy insights. By maintaining transparent and continuous communication channels, stakeholders can identify and address inefficiencies, implement proven solutions, and avoid duplicating efforts.

By prioritizing coordinated action and supportive policies, the LAC region can create an environment that promotes investment, drives innovation, and removes barriers to implementation. Achieving net-zero will require sustained commitment, shared responsibility, and a balanced approach that aligns climate objectives with economic and social priorities.

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1 Introduction

1.1 Introduction

This project explores the pathway and role of aviation in Latin America and the Caribbean to reduce emissions while maintaining connectivity. Aviation has committed to achieving net-zero emissions by 2050, and several global analyses, including the ICAO LTAG, provide an overarching framework to achieve this. However, the pathway, mechanism, and role for each region must be tailored to the resources and challenges in each country. The diverse nature of nations in Latin American and the Caribbean make it especially important to tailor the regional pathway. The goal of this project is to illuminate the challenges and opportunities of net-zero pathways and to provide a starting point for regionally appropriate aviation pathways.

1.2 The global context

The aviation industry is undergoing rapid transformation to reduce its carbon footprint. In 2022, the International Civil Aviation Organization (ICAO) set a long-term aspirational goal (LTAG) of achieving net-zero emissions by 2050.[25] The LTAG represents a collective commitment by ICAO member states to achieve net-zero emissions from international aviation, in-line with the broader UNFCCC Paris Agreement objective of limiting global average temperature rise. The LTAG is a non-legally binding target which does not impose specific targets on individual countries - instead recognizing that each state has individual capabilities and circumstances, such as different levels of development, market maturity and national priorities.

The LTAG was formed based on a scenario approach, to determine the potential trajectories based on high, middle and low readiness, attainability and aspiration. The LTAG analysis includes subset scenarios for technology, fuel and operations. Due to the challenges of abating emissions from aviation, despite the ambition, none of the scenarios meet net zero without out-of-sector measures, recognizing also the key role of carbon credits to achieve net zero. Each scenario also includes a defined level of such measures.

Recognizing the relevance and the high expert work backing the LTAG feasibility study, this study mirrors LTAG's scenario development methodology as it provides an industry-recognized standard for developing emission reduction pathways.

In this context, countries are increasingly establishing emission reduction plans for aviation to meet the LTAG, commonly as part of broader decarbonization strategies. By using this methodology and developing scenarios for the Latin America and Caribbean region, this study is contributing to the broader aviation emissions reduction discussion and providing a robust example on setting national/regional policies and industry strategies in line with the UNFCCC concept of common but differentiated responsibility.

1.3 Latin America and the Caribbean context

Aviation plays a vital role in LAC region, contributing 3.6% of regional GDP (equivalent to $240 billion) and generating 7-8 million jobs (2.9% of employment).[26] Given the region's expansive geography and limited ground infrastructure, air travel is essential for connectivity and remains irreplaceable due to the lack of

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[25] https://www.icao.int/environmental-protection/Pages/LTAG.aspx

[26] https://alta.aero/wp-content/uploads/2025/01/Route-to-Sustainability-in-LATAM-and-Caribbean.pdf

substitutes, especially to remote areas, supporting access to services like healthcare and education as well as acting as an agent of economic development.

Despite this, air travel remains underutilized in the region, with only 0.5 trips per capita per annum, compared to over two in the U.S. and Europe. Demand is growing quickly - passenger numbers have grown 18-fold since 1970, reaching 324 million in 2023, with 40% of that growth in the last decade. This traffic is projected to keep growing, with domestic passenger rates increasing 2.7-4.3% annually between 2027 and 2043.[26] International routes to and from these two regions are seeing the highest growth, with Africa, the Middle East, India, China, and other parts of Asia expected to see substantial growth. The Lima Declaration, issued in 2023 by Latin American Civil Aviation Commission (LACAC) Ministries and aviation authorities, aims to increase air traffic by 50% between 2023 and 2033.[27]

This growth, while overall positive from an economic and social perspective, also brings environmental challenges. The region accounted for 4.8% of global aviation CO_2 emissions from 2013 to 2023, with Mexico and Brazil the two highest emitters[28]. Aviation's emissions are expected to rise 0.9% annually to 2050 without any reduction efforts.[29] Therefore, in spite of the continuous energy and operational efficiency gains, and while recognizing that meaningful scope remains across the aviation ecosystem to further improve system-wide efficiency, reaching net-zero will require major investment at all levels of the aviation environment. These additional costs will raise ticket prices and limit access for lower-income or price-sensitive travelers, particularly given that SAF can be 3-12 times more expensive than conventional jet fuel, which already accounts for 35–40% of airline operating costs. Considering also the governmental capacity for support, and individuals and businesses' willingness to pay, economic disparities pose additional challenges for emission reduction initiatives. For example, in 2024 the region has a GDP per capita of $11,045, compared to $43,145 in Europe and $85,810 in the USA.[30]

Latin American, Central American and Caribbean countries (LAC) have endorsed the LTAG, alongside other agreements promoting the use of alternative fuels (e.g. the agreement achieved at the ICAO CAAF/3).[31] Evidencing this endorsement, LAC has actively engaged with LTAG through capacity building efforts, with examples from both the EU-Latin America Cooperation on Civil Aviation (EU-LAC) and ICAO's South American (SAM) and North American (NACC) regional offices. **It is key that countries in Latin America and the Caribbean adopt a regionally suitable and aligned approach to reduce emissions to ensure coherence and a seamless approach across the region but with reasonably differentiated approaches catering to the needs and realities of each country in the region. In particular, avoiding the implementation of mandated use of SAF due to its expected impact on connectivity. This would create a more unified market, streamlining infrastructure development, creating crucial research and innovation links, and pooling resources to potentially attract larger investments. Opportunities from a unified approach also include the potential to create a SAF hub in the region. Ensuring harmonization of regulations both between countries in the region and with global ones will enable easier trade of SAF and key feedstocks**

[27] Lima Declaration https://clac-lacac.org/wp-content/uploads/2023/12/RE-AsaExt7_NE02_engRev.pdf
[28] Aviation accounts for around 2% of global emissions; Source: https://atag.org/media/gw5cgzzh/fact-sheet_2_aviation-and-climate-change.pdf
[29] Waypoint2050 https://atag.org/resources/waypoint-2050-2nd-edition-september-2021/
[30] http://data.worldbank.org/indicator/NY.GDP.PCAP.CD
[31] https://atag.org/news/agreement-reached-on-aviation-clean-energy/

even across borders or, more prominently, would facilitate the uptake by the airlines irrespective of their routes or base. This will allow the region to take advantage of abundant feedstocks in some countries, in synergy with the required infrastructure, or even demand, in others.

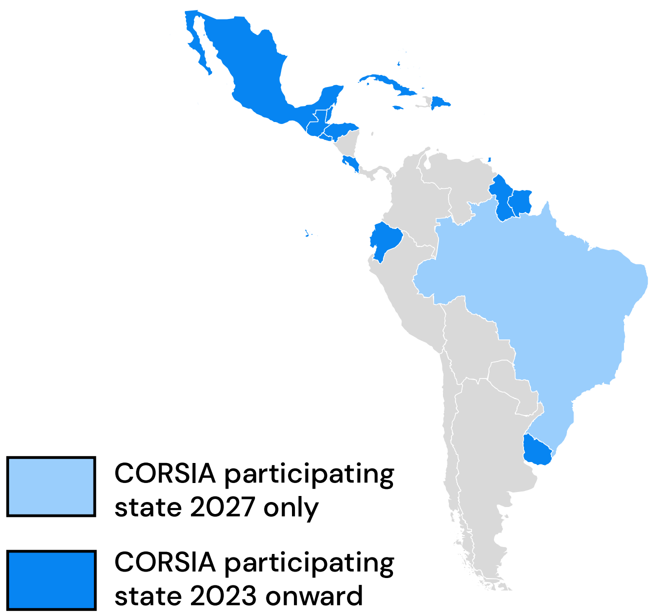
LAC nations also have a unique toolkit to reduce emissions. Nature-based solutions (NBS) like reforestation can sequester up to 2 gigatonnes of CO_2 annually by 2050, especially given the Amazon's role in absorbing nearly a quarter of global forest carbon and the fact that agriculture, forests, and land use represents the majority of the region's emissions[32]. Using NBS and carbon credits is a win-win scenario as it supports vital biodiversity protection, reducing environmental passives and enhancing the countries' natural capital. Including NBS and carbon credits in aviation emissions reduction shows strong sustainability intent and has material potential for the sector to contribute to protect and regenerate critical ecosystems in the region, but their exclusion from ICAO's LTAG core scenarios, due to a focus on internal emission reduction measures as opposed to out-of-sector measures, limits their current use. At the same time, prominent NBS methodologies in the region, such as standalone REDD+ amongst others, are also extremely limited or excluded from CORSIA, furthering hindering the region's ability to contribute to both protect its ecosystems and at the same time contribute to aviation's international schemes with its high potential solutions.

1.3.1 CORSIA

Flights between participating states count toward offsetting requirements in CORSIA. Flights involving non-participating countries are excluded from CORSIA obligations, except for monitoring and reporting, which covers all international flights. The regional situation is outlined on the map below. Only Brazil and Mexico are obligated under CORSIA due to their air traffic (international RTK in 2018[33]), with Mexico already participating under the voluntary phase. While not obligated, 16 other states in the region are participating in the voluntary phase and are assumed to continue beyond this[34]. Guyana has become a frontrunner by authorizing a total of 7.14 million credits as eligible for use by airlines in Phase 1 of CORSIA[35].

[32] https://www.science.org/doi/10.1126/science.aax0848 ; https://sigmaearth.com/how-reforestation-helps-reduce-carbon-emissions/ ; https://publications.iadb.org/en/benefits-and-costs-reaching-net-zero-emissions-latin-america-and-caribbean
[33] International-RTK-rankings_2018_SIDS_LDC_LLDC.pdf
[34] https://www.icao.int/sites/default/files/2025-06/CORSIA-States-for-Chapter-3-State-Pairs_5Ed_Rev_web.pdf
[35] https://lcds.gov.gy/guyana-announces-worlds-first-carbon-credits-for-use-in-un-airline-compliance-programme-corsia/

Countries participation in CORSIA in the LAC region



Participating States:
Bahamas
Barbados
Belize
Brazil (2027 onward)
Costa Rica
Cuba
Dominican Republic
Ecuador
El Salvador
Guatemala
Guyana
Honduras
Jamaica
Mexico
Saint Kitts and Nevis
Suriname
Trinidad and Tobago
Uruguay

Source: ICAO
Note: It assumes that countries that opted into the voluntary phase, from 2023, will remain in the mandatory phase from 2027

1.4 Assessment of existing work

As the region has been ramping up its emission reduction efforts in line with LTAG, nine of the eleven countries assessed in this study have published an aviation state action plan. The following sections explore the aviation context in each of the 11 countries in scope. The total GDP and number of jobs created through aviation are presented for each, based on the total benefit from aviation both directly and from the wider supply chain, employee spending, and tourism activities.

Table 2: Status of ICAO State Action Plans from countries in the region (11 focus countries only)

Measures proposed in action plan	ARG	BHS	BRA	CHL	COL	DOM	ECU	SLV	MEX*	PAN	PER*
State Action Plan submitted to ICAO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Date most recent published	2021	2022	2022	2022	2021	2021	2021	2020	2018	2018	2023
Airport infrastructure	✓	✓		✓	✓	✓					

Operational management *(Air traffic)*	✓	✓		✓	✓	✓	✓	✓		✓	
Research and Development				✓							
Out-of-sector measures			✓	✓	✓	✓		✓		✓	
SAF		✓	✓	✓	✓	✓		✓		✓	
Fleet efficiency	✓	✓	✓	✓	✓		✓	✓		✓	
Energy efficiency					✓						
Other market-based measures	✓					✓		✓			

** Mexico and Peru's Action Plans are not publicly available*

1.4.1 Argentina

Table 3: Aviation economic contribution in Argentina

GDP from aviation	Number of jobs from aviation
9.1 billion USD (1.4%)[36]	147,000[36]

In 2024, Argentina launched a reform of its aviation policy, seeking to liberalize the sector. The package of measures included fare deregulation, open market access, and an increase in rights for foreign carriers. Changes have also been seen in the aeronautical code, in airline partnerships and investment, and in infrastructure and ground services[37].

Alongside this reform, Argentina has been actively working to reduce emissions in its aviation sector. In 2021, the country updated its national strategy through its state action plan, coordinated by the National Civil Aviation Administration (ANAC)[38]. This plan builds on earlier efforts published in 2014, which primarily focused on improving energy efficiency of the country's national airline (Aerolíneas Argentinas), resulting in the development of an ongoing Fuel Efficiency Plan.

The central focus of Argentina's approach remains on improving operational efficiency. Aerolíneas Argentinas has already undertaken initiatives such as modernizing its fleet and reducing aircraft weight to cut fuel consumption[39]. At the same time, the country has invested in upgrading air navigation systems; installing automatic weather stations, modernizing instrument landing systems, and optimizing flight paths to reduce

[36] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-argentina/
[37] https://www.iata.org/contentassets/0b6d1c34ebb24fa390b6030be3327751/240712-arg-aviation-reforms-eng-final.pdf/
[38] https://www.argentina.gob.ar/sites/default/files/plan_de_accion_del_estado_argentino_para_la_reduccion_de_emisiones_de_co2_en_la_aviacion.pdf
[39] https://ria.utn.edu.ar/server/api/core/bitstreams/eed56cf2-dbc4-4e66-893a-6c150130fc8b/content/

unnecessary fuel burn[40]. Airports have also seen improvements, including the installation of energy-efficient LED lighting, runway renovations, and the implementation of emissions inventories and waste separation systems. Alongside this, Argentina is working to regionalize airport operations, to help distribute air traffic more efficiently and reduce congestion-related emissions.

Sustainable aviation fuel (SAF) is recognized as a key component of Argentina's emissions reduction strategy, though its development is still in the early stages. Argentina is in a strong position to explore the opportunity of SAF production due to readily available biomass, providing a strong feedstock for Fischer-Tropsch produced SAF, and existing biofuel production[41]. In these initial stages of development, partnerships are being leveraged to develop key insights, for example institutions such as the National Institute of Industrial Technology (INTI) are exploring SAF production opportunities. Meanwhile, Airbus and ICAO announced in early 2025 funding through the ACT-SAF (Assistance, Capacity Building and Training in SAF) program for a SAF feasibility study in the country[42]. Initial investments have been made with one notable collaboration between GreenSinnergy and Axens in Chubut, which aims to produce SAF using wind energy and the Fischer-Tropsch pathway[43]. This is aiming to produce 100,000 tonnes of SAF annually from 2030, with plans to scale to 500,000 tonnes.

Argentina is also committed to international carbon monitoring efforts. Since 2019, all Argentine-registered air operators have been required to report their CO_2 emissions annually to ANAC, in line with the global CORSIA framework. Additionally, the country has implemented a carbon tax on aviation fuel (domestic only) and launched training programs to raise awareness about climate change within the aviation sector.[44,45]

1.4.2 Bahamas

Table 4: Aviation economic contribution in the Bahamas

GDP from aviation	Number of jobs from aviation
N/A[46]	N/A

The aviation sector in The Bahamas plays a vital role in connecting the archipelago's islands and supporting its tourism-driven economy. In 2019, prior to the COVID-19 pandemic, the Bahamas saw annual passenger numbers upwards of 1.6 million and revenues of nearly $4 million.[47] The sector is governed primarily by the Civil Aviation Authority of The Bahamas (CAAB) and the Department of Aviation, which sits within the Ministry of Transport.[48] The CAAB is responsible for overseeing air traffic services, licensing and safety oversight, while the Bahamas Air Navigation Services Authority (BANSA) manages air navigation. The Civil Aviation Act and the

[40] https://www.aviacionline.com/airbus-and-icao-partner-to-study-sustainable-aviation-fuel-feasibility-in-argentina-panama-and-peru/
[41] https://www.aviacionline.com/airbus-and-icao-partner-to-study-sustainable-aviation-fuel-feasibility-in-argentina-panama-and-peru/
[42] https://www.aviacionline.com/airbus-and-icao-partner-to-study-sustainable-aviation-fuel-feasibility-in-argentina-panama-and-peru/
[43] https://www.axens.net/resources-events/news/greensinnergy-and-axens-sign-memorandum-understanding-advance-saf-project-argentina-latin-america/
[44] https://www.iea.org/policies/19277-law-27430-on-taxing-liquid-fuels-and-carbon-dioxide/
[45] https://www.argentina.gob.ar/anac/cipe/
[46] No public information for the Bahamas is available
[47] https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/ActionPlan/The-Bahamas-Action-Plan-for-Emissions-Reduction-APER-v1.pdf
[48] https://www.doabahamas.com/about

Air Navigation Services Authority Act provide the overarching legal framework for the aviation sector in the country.

The Bahamas launched its National Aviation Strategic Plan in 2023, designed to position the country as a regional leader in aviation. The eight-point plan outlined key pillars from infrastructure modernization to sustainable air transport services to be implemented from 2023-2026.[49] The plan set targets and actionable next steps for the sector to implement, such as the launch of the Annual Bahamas National Aviation Week, enhancing capacity and conducting environmental impact assessments to support airport expansions. As part of this, the Bahamas committed to forming a Sustainable Aviation Task Force to develop a Sustainable Aviation Plan.

This plan will likely build on the country's action plan for emissions reductions from civil aviation, published in 2022. The plan outlined initial actions for the sector, including fleet modernization, improved air traffic management and infrastructure use, and energy conservation measures. While SAF was not outlined in the country's action plan, some initial feasibility studies have been started by the Inter-American Development Bank (IDB), through a funded technical cooperation project.[50]

The government had also focused on modernizing its aviation sector through investment in airport infrastructure under the Family Islands Airport Renaissance Program, which was aiming to upgrade 14 airports to improve safety and efficiency. The scheme has since been cancelled.[51] Since this, the government has announced further aviation budget in the 2025/2026 financial year.[52] This includes budget for strengthening infrastructure, particularly for modernizing the Lynden Pindling International Airport and other plans for the Grand Bahama International Airport. This is accompanied by initial plans for sustainable aviation through feasibility studies for renewable energy at airports and incentives for airlines to improve fuel efficiency. There is also budget for enhancing connectivity and tourism, air safety and training, and job creation.

1.4.3 Brazil

Table 5: Aviation economic contribution in Brazil

GDP from aviation	Number of jobs from aviation
46.4 billion USD (2.1%)[53]	1.9 million[53]

The primary body responsible for aviation in Brazil is the National Civil Aviation Agency (ANAC), which oversees areas such as certification and inspection of aircraft, operators and maintenance organizations, airport regulations and enforcement of safety and operational standards. Earlier this year, Brazil announced the National Aviation Fund, offering 5 billion BRL (approximately 890 million USD) in loans and guarantees to support airline expansion, international route development and sustainability projects[54].

Brazil is the only country in Latin America and the Caribbean with a ratified sustainable aviation target, mandating CO_2 emissions reductions for airlines, rather than a fixed SAF blend percentage. Bill 528/20, known

[49] https://www.doabahamas.com/plans-and-projects
[50] https://www.iadb.org/en/project/BH-T1130
[51] https://www.doabahamas.com/plans-and-projects
[52] https://bahamasnational.com/bahamas-government-unveils-ambitious-aviation-plans-in-2025-2026-budget-communication/
[53] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-brazil/
[54] https://www.aviacionline.com/brazilian-congress-approves-usd-890-million-financing-for-airlines

as the "Fuel of the Future" law, establishes the National Program for Sustainable Aviation Fuel (ProBioQAV). The law requires air operators to reduce their domestic emissions starting with a 1% reduction in 2027, growing to 10% by 2037[55]. This approach should incentivize more carbon-efficient SAF production pathways but could induce in unintended consequences leading to additional financial burdens to operators, with, currently, uncertainty of the country's abilities to supply the expected amount of SAF in a competitive free market manner.

Brazil has significant SAF potential to become a leading producer of SAF for export to international markets due to its abundant feedstocks for a variety of SAF pathways. These provide an opportunity for Brazil to become a SAF feedstock hub in the region and globally, utilizing existing infrastructure and capabilities to build the SAF market. Brazil has an enabling environment for SAF supported by existing biofuels production. This is driven by the Brazilian National Biofuel Policy, RenovaBio, which supports biofuel producers to certify and trade their biofuels, alongside setting emissions reduction targets.[56] SAF producers are starting to tap into the Brazilian market, investing in novel feedstocks and technologies, reflecting the unique opportunities provided. Acelen is developing a palm-based SAF plant aiming to produce 20,000 barrels/day of SAF and renewable diesel by 2028[57].

In August 2024, the Brazilian government announced a US$1.09 billion funding package to support the development of SAF and marine biofuels[58]. This initiative, financed by the National Bank for Economic and Social Development (BNDES) and the Funding Authority for Studies and Projects (FNEP), is allocating funding through calls for proposals that target:

- Biorefinery construction
- Research and development
- Engineering and pilot projects
- Equipment acquisition and working capital

Brazil is also developing its own carbon market, where SAF and carbon credits are complementary measures but addressing different priorities. SAF is very relevant to the agricultural sector in Brazil, and it is strategic from an industrial point of view. Brazil is looking for coordination of these markets in the region, particularly with Colombia and Chile, to reinforce synergies and remove market barriers[59]. Brazil however has not yet been able to address the challenges posed by the additional cost of SAF on passengers and consequent impact on connectivity for remote regions in particular but with expected impact across the whole market.

[55] https://www.gov.br/planalto/en/latest-news/2024/10/lula-enacts-fuel-of-the-future-law-201cbrazil-will-drive-the-worlds-largest-energy-revolution201d
[56] https://www.gov.br/mme/pt-br/assuntos/secretarias/petroleo-gas-natural-e-biocombustiveis/renovabio-1/renovabio-ingles
[57] https://bioenergyinternational.com/acelen-renewables-discloses-brazilian-biorefinery-details/
[58] https://www.bndes.gov.br/wps/portal/site/home/imprensa/noticias/conteudo/bndes-e-finep-disponibilizam-6-bilhoes-de-reais-para-investimentos-em-combustivel-verde-para-aviacao-e-navegacao
[59] Personal communications during engagement meetings in Brazil (ANAC, CONAMA, Ministério da Fazenda)

1.4.4 Chile

Table 6: Aviation economic contribution in Chile

GDP from aviation	Number of jobs from aviation
7.9 billion USD (2.3%)[60]	212,000[60]

International flights accounted for only 25% of Chile's origin-destination departures, with eight of the country's top ten international destinations located within Latin America. Overall, Chile represents 5.1% of regional air traffic, and 65% of its international passenger departures are to other countries in Latin America.[61]. The aviation industry in Chile is overseen by the Directorate General of Civil Aviation (DGAC) and the Civil Aviation Board (JAC) of the Ministry of Transportation and Telecommunications.

In terms of aviation sustainability, Chile submitted its state action plan to ICAO in 2022[62]. Central to Chile's efforts is the Vuelo Limpio program, a public-private initiative that promotes energy efficiency, operational improvements, and the adoption of Sustainable Aviation Fuels (SAF). The program collaborates with major airlines, airports, and fuel distributors to monitor emissions, implement best practices, and develop a SAF 2050 Roadmap. This roadmap includes an ambition to meet at least 50% of civil aviation fuel demand with SAF by 2050. Chile is exploring SAF production and feedstock alternatives including oils, fats, and biological and municipal waste, as well as e-fuels[63].

Chile is also investing in advanced air navigation technologies, sustainable airport infrastructure, and fleet modernization to reduce emissions. The country is exploring green hydrogen as an emissions reduction tool, with projects led by CORFO (Production Development Agency) and international partnerships, particularly with the Netherlands. Chile has updated its State Action Plan in 2025, quantify CO_2 reductions, and plans to develop a regulatory framework to support SAF production and adoption[63].

1.4.5 Colombia

Table 7: Aviation economic contribution in Colombia

GDP from aviation	Number of jobs from aviation
15.5 billion USD (4.3%)[64]	921,000[64]

Regional operations are key for Colombia, with 60% of the top 10 destinations from Colombia within the Latin America and Caribbean region. Just 23% of the total departures in 2023 were represented by international air traffic.[65] In this context, Colombia has open skies policies with Argentina and the United States, and announced 110 new international routes between 2023 and 2024 to increase international connectivity and boost tourism.[66] As of 2023, 7.6 billion USD is brought to the country's economy by tourism supported by the aviation industry. The Civil Aviation Authority of Colombia (Aerocivil) is the national aviation regulator under the

[60] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-chile/
[61] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-chile/
[62] https://www.icao.int/environmental-protection/Lists/States_Action_Plans/Attachments/160/Plan%20de%20Acción%20de%20Chile%202022.pdf
[63] https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2025/Envreport2025_70.pdf
[64] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-colombia/
[65] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-colombia/
[66] https://aviacionaldia.com/en/2025/01/colombia-civil-aeronautics-authorized-110-international-air-routes-between-2023-and-2024.html

Ministry of Transport[67]. In this role it approved the creation of the new routes, as part of its role overseeing airspace management and airport operations, alongside licensing of airlines, pilots, and maintenance personnel, safety inspections and accident investigations, and ensuring international aviation compliance.

In January 2025, Colombia signed Resolution 00090, establishing a SAF roadmap. This sets goals for Colombia to become a regional leader in SAF production, producing 100 million gallons of SAF by 2035, expanding up to 450 million gallons by 2050.[68] The roadmap centers around three pillars: emissions reduction of the sector; development of a productive and sustainable industry; and social transformation and inclusion. These are supported by five cross-cutting pillars: legal and regulatory enablers; promotion of supply and demand; deployment of the supply chain; technological, educational and industrial development; and financing and investments. Ecopetrol, Colombia's state-owned oil company, is leading SAF innovation in the country. In 2024, it successfully conducted industrial tests at its Cartagena refinery, producing 32,000 barrels of jet fuel co-processed with vegetable

oils. Although not yet fully ICAO-certified SAF, this fuel marks a first step toward continuous SAF production, targeted for 2028.[69]

Aside from SAF, Colombia has also been looking to decarbonize its airports. The Dorado Max Project in Bogota is one of the largest airport modernization efforts in the region, seeking to integrate sustainable design and operations at El Dorado airport. The airport has achieved Level 4 in the ACI Airport Carbon Accreditation program, through methods such as installing 11,000 solar panels.[70]

The aviation sector in Colombia is operating in the context of a national carbon market. The country has had a carbon tax in place since 2016, which is currently at around $5.5 per tonne of CO_2e and applies to aviation fuels. Companies have been able to purchase domestic carbon credits since 2017 to offset. Additionally, Colombia is currently developing a national emissions trading scheme. The scheme is currently in its first phase which consists of testing and refining of operational rules, before being gradually expanded towards full implementation by 2030, as mandated by the Climate Action Law.[71]

1.4.6 Dominican Republic

Table 8: Aviation economic contribution in Dominican Republic

GDP from aviation	Number of jobs from aviation
12.9 billion USD (10.6%)[72]	550,000[72]

The majority of departures from the Dominican Republic in 2023 were to North America (66%), with intra-regional departures to other countries in Latin America accounting for 21% of the total. The Dominican Republic has seen a 62.7% increase in passenger departures over the last decade, now accounting for just over 10% of

[67] https://www.aerocivil.gov.co/
[68] https://aviacionaldia.com/en/2025/01/green-future-of-aviation-in-colombia-roadmap-to-sustainable-fuels.html
[69] https://www.icao.int/SAM/Documents/2025-RAAC18/RAAC18_WP34_Environment_SAF.pdf
[70] https://ala.aero/2023/09/el-dorado-international-airport-attains-milestone-as-the-first-airport-in-latin-america-and-the-caribbean-to-achieve-level-4-transformation-in-aca-program/
[71] https://icapcarbonaction.com/system/files/ets_pdfs/icap-etsmap-factsheet-92.pdf
[72] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-dominican-republic/

regional international passenger traffic. The country has seven airports with commercially scheduled flights and is connected to 45 countries by direct flights.[73] These are supported by an open skies policy with countries such as the US. The aviation sector in the Dominican Republic is governed by three main bodies[74]:

- Civil Aviation Board (JAC) – the governmental body responsible for regulating the economic aspects of civil aviation, including granting market access and negotiating air service agreements.

- Dominican Institute of Civil Aviation (IDAC) – oversees technical and operational aspects of aviation, such as air navigation services, safety oversight, and issuing Air Operator Certificates (AOC).

- Specialized Corps for Airport and Civil Aviation Security (CESAC) – responsible for implementing and enforcing aviation security measures, including the National Civil Aviation Security Program.

The Dominican Republic Action Plan for CO_2 Emissions Reduction (DRAPER) outlines a roadmap to reduce emissions from the aviation industry using a basket of measures[75]. The country is encouraging airlines to modernize their fleets and upgrade engines to meet ICAO's latest environmental standards. Meanwhile, airport sustainability initiatives are also being promoted, aligning with ICAO's Eco-Airport Toolkit. Airports are required to implement an Environmental Management System in-line with Dominican Aeronautical Regulation No.14[76]. Through this, airports are implementing waste management measures and developing clean energy electricity generation, particularly through the use of solar panels.

Additionally, the country has conducted a feasibility study under the ICAO-EU project to assess SAF production potential. The study considered the most promising feedstock to be sugarcane, given its abundance in the country and current level of abandonment of many of the suitable areas, which could be used to create SAF through Alcohol to Jet (AtJ) or Synthetic Iso-Paraffins (SIP).[75, 77] Currently, the Dominican Republic is already supporting a scale up of SAF, providing incentives for alternative fuels through Law 57-07, which provides tax exemptions for renewable energy projects.[78] These efforts are being underpinned by the Declaration of Santo Domingo, committing to the development and use of alternative aviation fuels, signed in 2023 by a variety of key stakeholders from ministries to institutions.[79]

1.4.7 Ecuador

Table 9: Aviation economic contribution in Ecuador

GDP from aviation	Number of jobs from aviation
4.6 billion USD (3.9%)[80]	330,000[80]

[73] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-dominican-republic/
[74] https://www.mesalex.com/blog-en/regulation-of-civil-aviation-in-the-dominican-republic
[75] https://www.icao.int/environmental-protection/Documents/FeasabilityStudy_DomRep_ENG_Web.pdf
[76] www.icao.int/environmental-protection/Documents/EnvironmentalReports/2025/Envreport2025_106.pdf
[77] Personal communications during engagement meetings in Dominican Republic (Second meeting on sustainable aviation fuel under the framework of the ASCENT93 project, 28/03/2025)
[78] https://www.iea.org/policies/5290-law-57-07-on-incentives-for-development-of-renewable-energy-sources-and-its-special-regimes
[79] https://dominicantoday.com/dr/local/2023/04/25/dominican-republic-launches-action-plan-to-reduce-co2-emissions-in-aviation/
[80] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-ecuador/

Most departures in Ecuador in 2023 were to domestic destinations, accounting for 60% of departures.[81] Internationally, North America was the primary destination for passengers departing Ecuador in 2023, with these routes accounting for 45% of the total travel. Other countries in Latin America accounted for 39% of destinations. Ecuador has seen an 11.4% growth in departures over the last ten years.

The Directorate General of Civil Aviation (DGAC) is the primary government body responsible for aviation policy in Ecuador. It operates under the legal framework established by Ecuador's Civil Aviation Law and is part of the broader governmental structure overseeing transportation and infrastructure. In recent years, Ecuador has pushed to enhance connectivity, reduce costs and attract more airlines as part of its State Agenda which recognizes aviation and tourism as crucial for the country's development. One key method to achieve this has been through tax reductions. Taxes such as the *EcoDelta* (for international departures) and *Potencia Turística* (for international arrivals) were reduced in 2023. Both taxes previously applied a flat fee per ticket, which has now been switched to a scaling system with a capped charge.[82] This has resulted in a decrease in prices for passengers. Ecuador has also started to recognize air operator certificates (AOCs) from other countries in the region to encourage new airlines to enter the country.[83]

DGAC is responsible for minimizing environmental impacts of aviation in Ecuador and oversees environmental compliance certification and approvals for the sector.[84] Ecuador is in the nascent stages of its aviation emissions reduction journey, without any specific legislation in place. SAF has been identified as an opportunity for the country, with potential feedstocks including sugarcane, palm and soybean oil, and MSW.[85]

1.4.8 El Salvador

Table 10: Aviation economic contribution in El Salvador

GDP from aviation	Number of jobs from aviation
1.5 billion USD (4.4%)[86]	118,000[86]

El Salvador's passenger numbers have grown by 98.9% in the last ten years. 100% of its departures are international, as the country has only one airport with commercially scheduled flights. The majority of passengers (74%) travelled to North America in 2023, with the top five destinations for passengers from El Salvador including Los Angeles, Washington, Houston, New York and Miami.[87] The Autoridad de Aviación Civil (AAC), Civil Aviation Authority, is responsible for regulating civil aviation in the country.[88] It oversees the implementation of the legal framework, *Ley Orgánica de Aviación Civil*. El Salvador also closely aligns with many ICAO policies, such as the Global Air Navigation Plan, which outlines goals for upgrading equipment, procedures, and infrastructure, with a focus on safety, efficiency, and sustainability.[89] The plan outlines

[81] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-ecuador/
[82] https://www.primicias.ec/noticias/economia/gobierno-tasas-aereas-ecodelta-potencia-turistica/
[83] https://aviationweek.com/air-transport/safety-ops-regulation/ecuador-accelerates-airline-entry-process-expand-market-access
[84] https://www.gob.ec/dgac
[85] https://news.mit.edu/2025/toward-sustainable-decarbonization-aviation-latin-america-0121
[86] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-el-salvador/
[87] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-el-salvador/
[88] https://www.aac.gob.sv/
[89] https://www.icao.int/NACC/Documents/Meetings/2018/ASBU18/ANP06-ElSalvador.pdf

equipment and procedure upgrades, performance-based navigation and monitoring and reporting systems to track improvements.

El Salvador is in the early stages of decarbonizing its aviation sector. In its State Action Plan, the country has outlined that steps to improve fleet efficiency and modernization have been in place for several years.[90] There are also efforts to improve air traffic management, taxiing processes and fuel usage. El Salvador notes in the Plan that while SAF is recognized as a key emissions reduction lever, the main challenge is gaining a multi-stakeholder commitment to developing such fuels.

In 2024, the Development Bank of Latin America and the Caribbean (CAF) agreed to provide USD320 million to El Salvador's aviation sector development program 'El Salvador Vuela'.[91] This will be delivered through three projects targeting airports in the country, including the one commercial airport which is also undergoing expansion. This money will support modernization of the sector, alongside enhancements to improve resilience to natural disasters, and efforts to improve cost efficiency and reduce air travel times.

As part of international emissions reduction efforts, El Salvador has signed up to the voluntary phase of the CORSIA scheme. El Salvador is also a member of the Climate & Clean Air Coalition (CCAC), committing to: Reducing greenhouse gases and short-lived climate pollutants, implementing the National Plan on Climate Change (2022–2026) and the National Environmental Policy (2022).

1.4.9 Mexico

Table 11: Aviation economic contribution in Mexico

GDP from aviation	Number of jobs from aviation
88.3 billion USD (4.9%)[92]	1,800,000[92]

The majority of departures from Mexican airports in 2023 were to domestic destinations (66%), with 57 airports in the country with commercially scheduled flights. The top 10 international destinations from Mexico in 2023 were all to airports in North America, with only 10% of passengers departing to airports outside of the Americas.[92] The civil aviation sector in Mexico is overseen by Agencia Federal de Aviación Civil (AFAC), operating under the Secretariat of Infrastructure, Communications, and Transport (SICT).[93]

Mexico was among the first countries to submit its State Action Plan for aviation emissions reduction to ICAO in 2012 and updated it in 2018; although the document is not public, the country is exploring opportunities to grow its SAF ecosystem, building on a long tradition of initiatives and research on the topic[94]. In June 2025, Airbus signed an agreement with Mexican airline Volaris to support ICAO's Voluntary Environment Fund, to finance a SAF feasibility study through ICAO's ACT-SAF program.[95] Alongside this, Mexico is seeking to commence domestic SAF production by 2030. Mexico's state-owned Airports and Auxiliary Services (ASA),

[90] https://www.icao.int/sites/default/files/environmental-protection/State_Action_Plans/PLAN-DE-ACCION-DE-REDUCCION-DE-CO2-DEL-ESTADO-ECUATORIANO-2021-2024-signed.pdf
[91] https://www.caf.com/en/currently/news/caf-supports-the-leap-in-air-and-digital-connectivity-in-el-salvador-with-usd-465-million-in-loans/
[92] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-mexico/
[93] https://centreforaviation.com/data/profiles/government-bodies/federal-civil-aviation-agency-afac-mexico/
[94] Personal communications during engagement meetings in Mexico (ASA, CONADESUCA)
[95] https://mexicobusiness.news/aerospace/news/airbus-volaris-sign-agreement-back-icao-saf-study-mexico

as the country's primary supplier of jet fuel, is working closely with AFAC in SAF technical working groups. ASA launched a pilot project blending SAF imported from the US with conventional fuel.[96]

Plan México (published January 2025) includes SAF as a national priority. The Biofuels Law, enacted in March 2025, along with its forthcoming regulations for implementation (in drafting at the time of writing this report), represents a key opportunity to set out clear, inclusive criteria aligned with international standards for the production and certification of SAF. Inter-institutional working groups (AFAC, ASA, SEMARNAT, SENER, CONADESUCA, SADER, SICT) have been established to harmonize policies, validate data and define sustainability and certification criteria[94]. Mexico was also re-elected as a member of the ICAO Council and reaffirmed its commitment to continue working toward ICAO's strategic objectives[97].

Mexico has been voluntarily participating in the CORSIA scheme and exploring airport emissions reduction through the Airport Carbon Accreditation (ACA) scheme. 45 airports in Mexico are currently signed up to ACA and are progressing in reducing their carbon emissions.[98] Grupo Aeroportuario de Sureste (ASUR) is a key airport operator in Mexico and has a Science-Based Targets initiative (SBTi) aligned climate action plan. Following this, over 50% of their airports in Mexico have installed solar panels, while some have installed batteries to improve energy storage. Two airports have also introduced electric vehicles for ground operations[99,100].

1.4.10 Panama

Table 12: Aviation economic contribution in Panama

GDP from aviation	Number of jobs from aviation
6.8 billion USD (8.2%)[101]	194,000[101]

90% of departures from Panama in 2023 were to international destinations, with the majority flying to another country in Latin America (57%)[102]. Panama's passenger departures have increased by 38.5% in the last decade, supported by 26 operating airlines, eight commercial airports and 23 new international routes in the last five years. Panama's main regulator for civil aviation, the Civil Aviation Authority, oversees the implementation of key aviation regulations in the country[103].

Panama has outlined 'Mission Panama' a government strategy to decarbonize the economy. This includes goals to use 70% renewable energy by 2050, with a focus on solar and wind energy. To support this, the government has introduced a 25% tax incentive for companies investing in new clean energy projects, based on carbon reduction levels[104]. Panama has launched a Carbon Negative Alliance with Bhutan and Suriname, and is collaborating with Costa Rica, Colombia and Ecuador to advance biodiversity protection.

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96 https://www.argusmedia.com/en/news-and-insights/latest-market-news/2697517-mexico-s-asa-to-play-key-role-in-saf-expansion
97 https://www.icao.int/news/all-incoming-icao-council-member-states-elected
98 https://www.airportcarbonaccreditation.org/accredited-airports/
99 https://www.airportcarbonaccreditation.org/nine-asur-airports-in-mexico-achieve-level-3-in-airport-carbon-accreditation/
100 https://www.asur.com.mx/responsabilidad-social-0
101 https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-panama/
102 https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-panama/
103 https://aeronautica.gob.pa/
104 https://missionpanama.gob.pa/boldly-sustainable/

In this context, Panama published a State Action Plan for aviation emissions reduction in 2018, outlining actions across a variety of measures to decarbonize the aviation sector. The country is looking to improve operational efficiency through updates to air traffic management, improving fleet efficiency, and introducing renewable energy sources for ground services[105]. The country's main airport, Tocumen International Airport, is currently exploring an expansion which would involve a third runway, with a primary focus of increasing cargo distribution from the airport.[106] The previous expansion of the airport was built into the country's action plan, including measures to improve accessibility of the airport, reducing congestion on the runway and improving ground support of refueling. No specific sustainability plan for this next expansion has been announced.

Panama's National Strategy for Green Hydrogen and Derivatives set targets for both renewable hydrogen derivatives and SAF, aiming for 30% of aviation energy supply to be from hydrogen, its derivatives or SAF by 2050[107]. The strategy maps out key overarching goals such as becoming a sustainable energy hub through facilitating the use of H2V in air and maritime, and creating a legal and regulatory framework to support investment and infrastructure development. Alongside increasing hydrogen, Panama is planning to start SAF production in 2027 from Biorefineria Ciudad Dorada[108]. The plant has a planned capacity of 2.6 billion gallons per year, which makes it one of the largest planned SAF production facilities globally. Converting purpose grown oils, waste fats and grease to SAF, the project is being led by SGP BioEnergy, in partnership with Topsoe and Fluor.

1.4.11 Peru

Table 13: Aviation economic contribution in Peru

GDP from aviation	Number of jobs from aviation
6.2 billion USD (2.3%)[109]	364,000[109]

Most departures in Peru in 2023 were to domestic destinations (78%), using the country's 23 airports with commercially scheduled flights[110]. Of the 22% of international departures, most passengers travelled to another Latin American country (46%), followed closely by North America (35%). Peru's civil aviation sector is governed by the General Directorate of Civil Aviation, under the Ministry of Transport and Communications. The Directorate has overseen the development of the National Civil Aviation Plan, which aligns with the ICAO NASP methodology. The plan involves strategic actions to address the doubling of air traffic anticipated in South America in the next 15 years[111]. In this context, Peru's passenger departures have grown by 8.7% in the last ten years[110].

Peru is in the nascent stages of its emissions reduction strategy and its State Action Plan for aviation decarbonization is not publicly available. Despite this, the country is exploring options for aviation emissions reduction. For example, Airbus is working with ICAO to conduct SAF feasibility studies in Peru as part of the

[105] https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/ActionPlan/SAP-PTY-(ES)-compressed.pdf
[106] https://en.tocumenpanama.aero/index.php/futuro
[107] https://www.gacetaoficial.gob.pa/pdfTemp/29771_B/98196.pdf
[108] https://www.safinvestor.com/project/142197/sgp-bioenergy-golden-city-biorefinery-panama/
[109] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-peru/
[110] https://www.iata.org/en/iata-repository/publications/economic-reports/the-value-of-air-transport-to-peru/
[111] https://www.icao.int/Newsroom/Pages/Heightening-cooperation-to-support-aviation-recovery-and-development-in-Peru.aspx

ACT-SAF program[112]. This is exploring the potential feedstock availability, infrastructure needs and economic viability for SAF in the country. In the meantime, Jorge Chávez Airport has completed a new aviation fuel storage facility[113]. The facility is fully automated and will over time introduce a new fleet of refueling vehicles, some of which are fully electric.

[112] https://www.icao.int/environmental-protection/Pages/act-saf.aspx
[113] https://exolum.com/en/noticia/exolum-begins-operations-at-limas-new-airport-following-completion-of-latin-americas-most-advanced-fuel-storage-facility/

2 Flight activity in Latin America and the Caribbean

The purpose of this section is to detail the activity forecast for the region including forecasting the future demand for passengers, cargo, flights and ATMs (air transport movements). This section will detail the methods followed before exploring the results at both a country-specific and an international level.

Key results Activity Forecast:

- The LAC region is forecast to have 815 million departing passenger by 2050, representing a 2.7% CAGR compared to 2019 in a baseline scenario, where no carbon reduction measures are implemented.
- Brazil, Mexico and Colombia remain the top three countries in terms of passenger volume.
- Dedicated freight volumes will grow at a 3.1% CAGR from 2019, reaching 3.3 Mt by 2050.
- Number of aircraft movement (ATM) will reach 5.9 million, translating to a 1.8% CAGR between 2019 and 2050

2.1 Latin America and the Caribbean region aviation activity

In 2024, airports in the LAC region served 385 million[114] departing passengers, accounting for 8% of the worldwide air passenger traffic. This is 9% above the 2019 figure, which indicates a robust recovery from COVID. The region has experienced relatively strong passenger traffic growth between 2009 and 2019 with a 6.4% CAGR (compound annual growth rate) observed, driven by increasing affluence and the entrance of LCCs which further stimulated demand.

In terms of aircraft movements, 2024 recorded 3.2 million[114] departing movements from the LAC region, accounting for 8% of the worldwide total. Nevertheless, this is just 98% of 2019's level, which implies that passengers per movement have increased compared to the pre-COVID period. Unlike passenger traffic, ATMs have only recorded a 1.0% CAGR between 2009 and 2019, implying a continuous improvement in load factor and aircraft size up-gauging.

On cargo, airports in the region are estimated to have processed close to 1.8 Mt of dedicated cargo in 2024 departing from the region. This is a 40% increase from 2019's level.

2.2 Methodology, data sources and assumptions

This section describes ICF's approach, the passenger and cargo flows considered in scope, and the main data sources and assumptions used to calculate the activity forecasts.

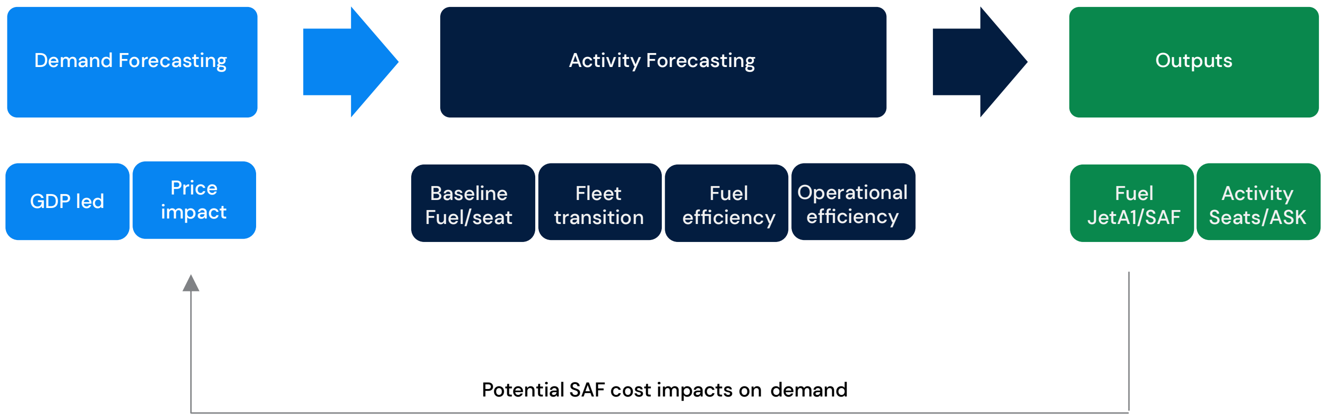
2.2.1 Methodology

Flying activity and fuel uplift depend on passenger and cargo volumes; therefore, fuel and CO_2 forecasts are based on passenger and cargo demand forecasts for the region. These forecasts were then converted into flying activity and a fuel consumption forecast.

The following figure provides a high-level summary of the forecasting approach. First, forecasts were prepared for passenger demand and dedicated freighter demand. These demand forecasts were then converted to activity forecasts considering fleet types, aircraft sizes, occupancy rates and sector distances. These activity metrics were also converted to fuel consumption based on current and expected fuel consumption rates for each segment and market under consideration. The outputs underpin the rest of the study, helping to size the SAF opportunity, estimate demand, and determine the level of offset required across all countries in this study.

[114] Departing from ALTA countries only, see section 2.2.2 for more details

Demand, activity and fuel requirement forecast methodology process



Source: ICF analysis

To forecast passenger demand, a bottom-up approach was used for the short-term forecast, and a top-down approach for the long-term forecast. Both used 2019 data as a baseline. The short-term bottom-up module focuses on 2025-2026 by taking market recovery trends, future seat capacity filed by airlines, and load factor performance into account.

The model then transitions to the long-term top-down macro-economic approach, covering the period between 2027-2050. As traffic demand has a strong correlation with economic activity, ALTA has commissioned an Argentina based university (Universidad de San Andrés - UdeSA) to determine this factor (income demand elasticity factor). The study adopted an econometric route-level panel model (log-log specification) to estimate the income demand elasticity factor.

The analysis started with collecting historical air travel related data between 2014 and 2024 provided by ALTA and supplemented by capacity figures from Cirium covering all the activities to/from the region. The comprehensive dataset setup includes key information such as passenger numbers, average fares, RPKs, ASKs, seats capacity, point of origin split and aircraft type, split by airlines, months and city-pairs. The study defines markets at the origin-destination-month level, hence the dataset is structured as a monthly route-level panel (O-D-month). Furthermore, to ensure the result reflects the typical market conditions, year 2020 data is excluded as air travel was largely impacted by COVID-19. On the macroeconomic data side, real GDP per capita and population were sourced from the International Monetary Fund's (IMF) World Economic Outlook (WEO) database to ensure comparability across different countries. In addition, jet fuel prices provided by S&P Global Energy through ALTA are incorporated as exogenous cost-shifters instrumental to address any fare endogeneity concerns. The study uses jet fuel prices as part of the instrumental variable strategy, but more specifically interacts fuel prices with route distance (with lags) and employs a network-based instrument.

To estimate elasticity, the price and income of origin and destination were considered separately, and an effective route-level income elasticity is calculated after estimation using point -of-origin (POO) passenger shares. The POO weights are not part of the estimation step itself and are applied post coefficient combination. External factors such as recessions were adjusted for routes with similar characteristics, but the report primarily accounts for macroeconomic shocks through time fixed effects and additional controls (e.g., seasonal indicators, COVID-related variables), rather than adjusting recession effects by route type directly. For instance, São Paulo to Miami was categorized as a long-haul international business market and adjusted for shocks common to this type of market. The model also went past robustness checks by introducing additional exogenous covariates, such as bilateral exchange rates, inflation indices, and measures of competitive structure (for example, Herfindahl–Hirschman Index, number of active carriers, and share of nonstop service).

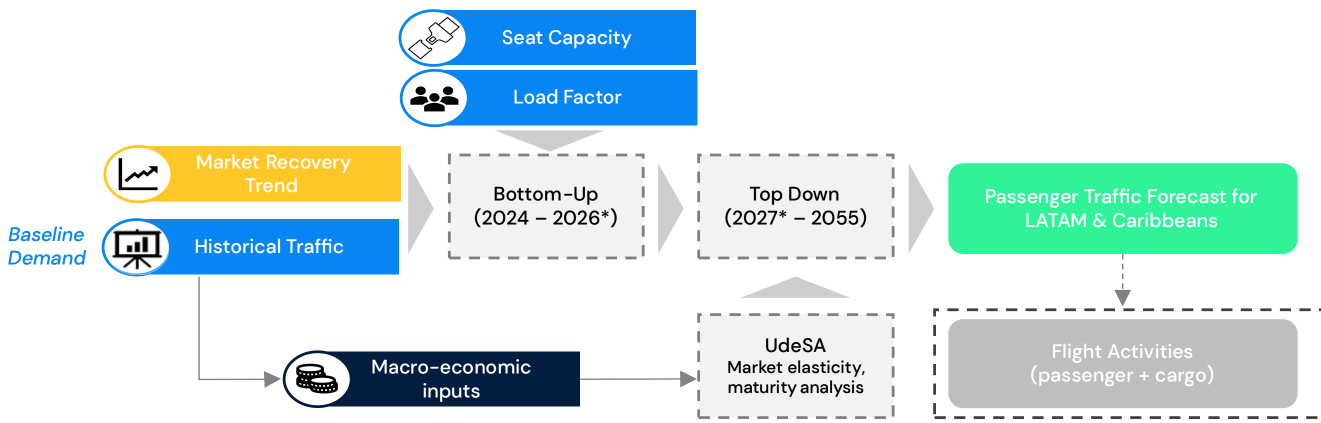
IATA also provides a high-level estimated income elasticity in a document published in 2008[115] by correlating air travel per capita against income per capita for a variety of nations. The analysis yielded a strong and positive relationship between the two parameters.

Table 14: Income elasticity by source and traffic flow

Market segments	UdeSA Income elasticity	Standard errors	IATA Income elasticity
Short haul	0.623	0.106	1.3 to 1.8
Medium haul	0.909	0.104	1.4 to 1.8
Long haul	0.939	0.168	1.5 to 2.0

This income elasticity multiplier provided by UdeSA was then applied to the GDP forecast to obtain a long-term passenger forecast for the region. The following figure illustrates the passenger forecast methodology.

Passenger demand forecast combines both bottom -up and top-down approaches



Source: ICF analysis

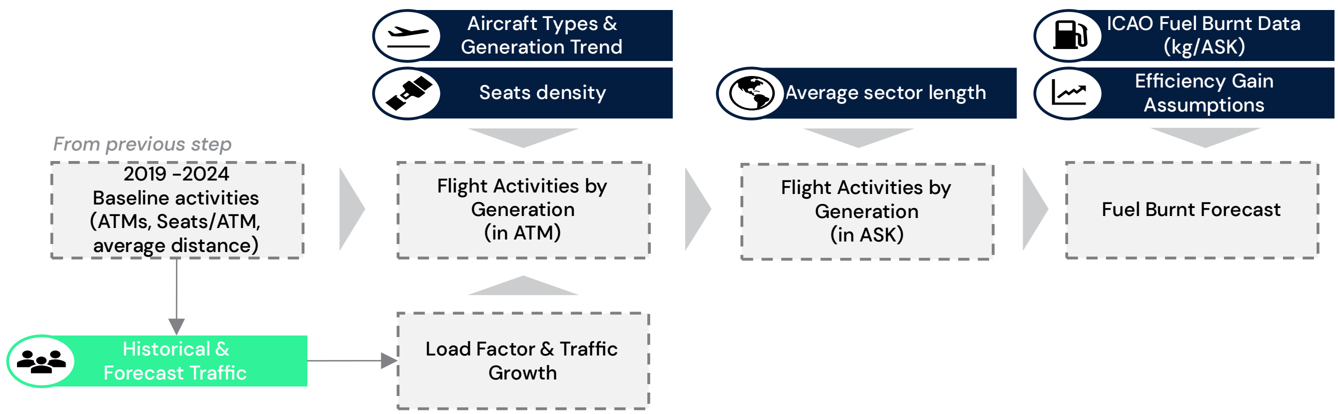
The passenger traffic forecast was then turned into an activity and a fuel consumption forecast by converting passenger numbers into available seat kilometers (ASKs) and then incorporating a fuel consumption per ASK value by aircraft type using the ICAO fuel burn database.

To convert the number of passengers into ASK, a country-pair level load factor is assumed based on historical trends, a small growth in load factor is assumed as airlines continue to optimize capacity for profitability. The number of seats is then allocated to different aircraft categories. This considered both current and future generation aircraft types, and the transition is allocated using an ICF propriety fleet dataset. The total seats by aircraft category were then coupled with an average sector length on a country pair level to obtain the ASK by aircraft category. This was then coupled with the ICAO fuel burn per ASK data to provide a fuel burn estimation.

115 Air Travel Demand, IATA April 2008

Efficiency improvements have also been considered, including fuel saving from intra-generation aircraft switches, inter-generation aircraft switches as well as operational efficiency enhancements. These are described in more detail in the following sections. The figure below outlines the activity and fuel burn forecast methodology.

Activity and fuel burn forecast methodology

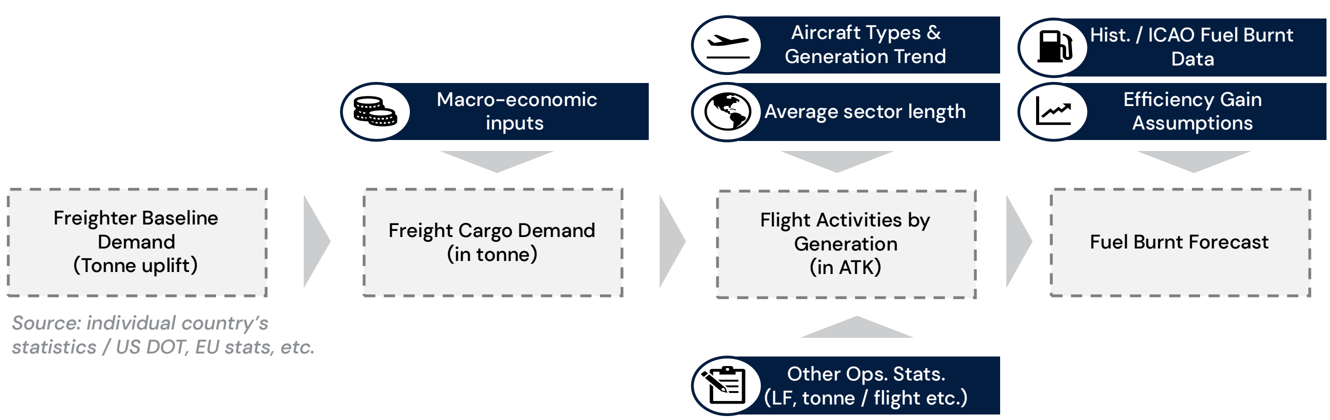


Source: ICF analysis

The cargo (dedicated freighter) forecast is prepared separately but in a similar way to the passenger demand. For this forecast it was imperative to segment cargo activity between belly aircraft activity (which is captured in the passenger forecast) and those aircraft only flying cargo operations.

The total freighter demand (tonnes uplift, excl. belly) is driven by econometric inputs, this is then converted into activities in terms of Available Tonne Kilometers (ATKs) before multiplying with the corresponding fuel burnt per ATK by aircraft type from the ICAO database. The exhibit below summarizes the cargo forecast approach.

Cargo activity forecast methodology



Source: ICF analysis

2.2.2 Scope

The forecast covers 49 countries in the LAC region (ALTA countries). All the modelling has been conducted on a return leg basis (i.e., considering both directions). Regarding fuel uplift, only the departing flights from these 49 countries will be considered and fuel uplifted for incoming flights from outside of the region are excluded. Moreover, this study only considers passenger and freighter activities (business jet, general aviation, military flights, and others are excluded). From experience in other markets, these categories typically represent under 2% of total fuel uplift, representing a small fraction of total carbon emissions. However, a mention must be made about Brazil's business jet market, which is the second largest in the world after the United States and may warrant special attention in more detailed future assessments. The following table provides a few examples to illustrate the regional scope of this study.

Table 15: Illustration of scope of study (example flows)

Example traffic flow	Market type	Traffic / activity forecast	Fuel uplift forecast
Brazil - Brazil	Domestic	Included	Included
Brazil - Mexico	Regional	Included	Included
Mexico - Brazil	Regional	Included	Included
Brazil - USA	International	Included	Included
USA – Brazil	International	Excluded	Excluded

In 2019 352 million passengers departed from the ALTA countries. In 2024 this figure grew to over 385 million passengers highlighting the region's strong performance post-COVID. These figures are built up on a country pair basis and remove the double counting from the higher-level regional activity ACI figures. For example, a passenger travelling from Brazil to Mexico is included at both Brazil (as a departing passenger) and Mexico (as an arriving passenger) airports for ACI data. The following table provides the summary for 2024 passengers and fuel burn.

Table 16: Baseline passenger and fuel for 2024

Segment	In Scope?	Passengers (million), 2024	Fuel uplift (million tonne), 2024
Domestic	Included	251	7.9
Regional	Included	56	3.1
International (departing)	Included	78.5	8.6
International (arriving)	Excluded	78.5	8.6
Total	**All**	**464**	**28.2**
Total (in scope)	**Included**	**385.5**	**19.6**

2.2.3 Data sources

To establish the baseline and future activity/emissions forecasts, a range of data sets were leveraged. These were selected to ensure robustness and compared to ensure accuracy and consistency. These data sources can be segmented into five main categories

1. **Historical** demand was considered for passengers, aircraft movements (ATMs) and cargo tonnages which are all key aviation metrics. These data sources underpinned the study by providing a robust baseline and overview of historical demand patterns in the LAC region.

2. **Current fleet** data was captured to further break down the underlying demand and supply patterns. A combination of published schedules and data from various aviation bodies was utilized.
3. **Future fleet** data and assumptions were informed by the latest schedule outlook published by airlines and ICF's internal fleet forecasting tool. The latter captures order books and production ratees for the aircraft OEMs (i.e. Boeing, Airbus, etc.) until the mid-2030s. Longer term assumptions regarding 1) future generation aircraft types were informed by research and current OEM plans, and 2) transition rates to future fleet types were informed by historical industry trends and production capabilities.
4. **Fuel consumption** was calculated by aircraft type using ICAO's latest available fuel consumption tables (v13.1). Future efficiency gains from new aircraft types and operational measures were informed by research, discussions with a major OEM, and ALTA's members.
5. **Econometric assumptions** were used to provide country level GDP, and GDP/Capita forecasts which underpin the long-term demand forecasts. IATA's AirportIS dataset provides a global database of industry fare levels used to influence cost of flying assumptions.

The following table provides a summary of the main data sources utilized.

Table 17: Data sources summary

Topic	Sources
Historical activity	▪ Airports Council International (ACI) Activity for Passengers, Air Transport movements (ATMs) and Cargo ▪ IATA AirportIS Passenger Demand ▪ OAG Schedules (Official Airline Guide) ▪ ALTA members provided country specific data ▪ Aviation Authority Data (e.g. US FAA T-100, other relevant nationals CAA)
Current fleets	▪ OAG Schedules ▪ Aviation Authority Data (e.g. US FAA T-100)
Future fleets	▪ OAG Schedules (for short-term) ▪ ICF's Fleet Forecast Tool (incorporates Airbus/Boeing inputs re production rates and retirement assumptions) ▪ Boeing CASCADE ▪ Industry Research (various)
Fuel burn/carbon	▪ ICAO Fuel Consumption Table (v13.1, Aug 2024) ▪ Boeing CASCADE ▪ Industry Research (various)
Economic inputs	▪ Blended sources (e.g. IMF, Oxford Economics) historical & future (1996-2050) real GDP growth forecasts ▪ IATA AirportIS provided fare curves for price paid ▪ IATA/ICF assumptions for price and income elasticities and market maturity rates ▪ ICF assumptions for airline operating costs

2.3 Latin America and the Caribbean economic outlook

This section summarizes the economic growth forecast for the LAC region. As outlined in Section 2.2.1, economic growth is one of the key drivers for increasing air travel. ICF has reviewed economic growth projections, particularly GDP forecasts, from multiple reputable sources and developed a consolidated consensus outlook

The LAC region averaged GDP is forecast to grow at a 2.2% CAGR between 2019 and 2050 led by major economies like Brazil, Mexico and Argentina. Higher growth rates are expected from smaller economies such as the Dominican Republic and Panama. Neighboring regions, such as North America, which is one of the major sources of inbound tourism for the LAC region, is expecting a GDP growth of 1.9% for the same period. The following table summarizes the GDP forecast for the key economies and individual focus countries.

Table 18: GDP forecast[116]

Region / country	2000-2019 CAGR	2019-2050 CAGR	2024-2050 CAGR
LAC region	2.3%	2.2%	2.3%
North America	2.1%	1.9%	1.9%
World	2.9%	2.4%	2.4%
Argentina	1.7%	1.8%	2.3%
Bahamas	0.7%	1.2%	1.3%
Brazil	2.3%	2.0%	2.0%
Chile	3.7%	2.2%	2.3%
Colombia	3.8%	2.8%	2.8%
Dominican Republic	5.1%	3.9%	3.9%
Ecuador	3.9%	1.8%	1.9%
El Salvador	2.0%	2.2%	2.1%
Mexico	1.6%	1.7%	1.9%
Panama	6.0%	3.1%	3.1%
Peru	4.9%	2.7%	3.0%

2.4 Total regional activity

This section provides the total regional activity forecasts for all 49 countries in the LAC region. In 2019, 352 million passengers flew on flights either within or departing the LAC region, with one-third flying domestic, and intra-regional and inter-regional accounting for 14% and 19% respectively. Brazil, Mexico, Colombia, Argentina and Chile were the top five aviation markets in terms of passenger volume, accounting for 75% of the region's departing traffic. Following COVID, total passengers recovered and surpassed 2019's levels by 9% in 2024, reaching 385 million annual passengers. In 2019 the region also handled a total of 3.3 million departing flights and 1.3 Mt on dedicated cargo flights.

The region has fully recovered from COVID in all three market segments (domestic, intra-regional and inter-regional) and is expected to resume its long-term growth trends supported by individual member countries' economic and tourism growth. Nevertheless, the region's economy is forecast to grow at a CAGR of 2.3% between 2025-2050. This will result in the region's economy being 95% larger than the 2019 baseline, which is equivalent to a 2.1% CAGR for the 2019-2050 period.

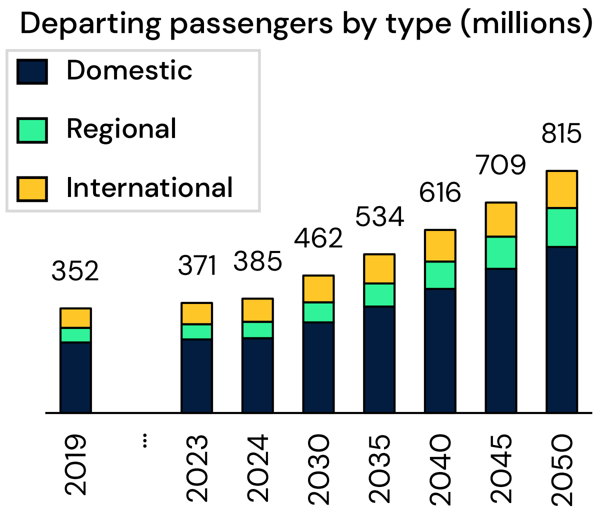
Over the long-term, the region's aviation market is forecast to grow, and total departing passengers are forecast to reach 815 million in 2050. This will represent an aviation market 130% bigger than 2019's baseline and a CAGR of 2.7%, supported by a growing economy and a bigger population (+0.5% CAGR 2019-2050). Trip per capita, an indicator to measure how many trips per population generates will increase from 0.53 in 2019 to 1.07 in 2050.

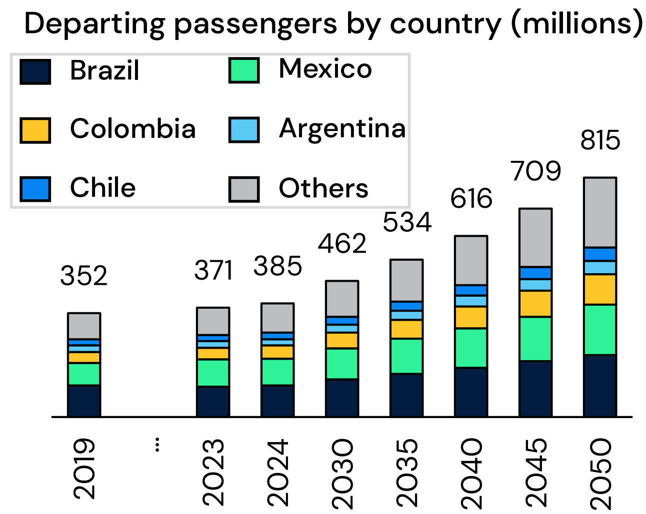
[116] IMF, Oxford Economics, ICF analysis

Domestic traffic is forecast to grow from 238 million departing passengers in 2019 to 559 million in 2050 equivalent to a 2.8% CAGR; intra-regional traffic is forecast to increase from 50 million departing passengers to 131 million translating to a 3.2% CAGR, while international will grow from 65 million departing passengers in 2019 to 125 million in 2050, equivalent to a 2.1% CAGR.

Brazil, Mexico, Colombia, Argentina and Chile are projected to remain as the top 5 aviation markets in the region by 2050. The following chart and table summarize the passenger forecast results for the region.

LAC passenger demand forecast by type (left) and market (right)





Source: PAXIS, OAG, national statistics, ICF analysis

Table 19: 2050 LAC region passenger traffic forecast summary

Focus country	2019 passengers (m)	2035 passengers (m)	2050 passengers (m)	2019 passenger share	2050 passenger share	2019-2050 CAGR
Brazil	106.4	146.8	210.3	30%	26%	2.2%
Mexico	77.3	118.9	170.9	22%	21%	2.6%
Colombia	37.2	63.6	104.5	11%	13%	3.4%
Argentina	22.8	32.2	44.8	6%	5%	2.2%
Chile	20.2	30.9	46.3	6%	6%	2.7%
Peru	19.6	30.8	52.5	6%	6%	3.2%
Panama	8.4	15.1	30.2	2%	4%	4.2%
Dominican Rep.	7.2	16.2	33.3	2%	4%	5.1%
Ecuador	5.0	7.8	10.5	1%	1%	2.4%
Bahamas	3.2	4.4	5.9	1%	1%	2.0%
El Salvador	2.6	4.5	7.1	1%	1%	3.3%
Others	42.3	63.0	98.3	12%	12%	2.8%
ALTA Total	**352.3**	**534.4**	**814.6**	**100%**	**100%**	**2.7%**

Table 20: Illustration of propensity to fly (example Brazil flows)

Example traffic flow	Market	2019 Passenger (dep+arr, m)	of which Brazil originating*	2019 Population (m)	2019 trip/capita
Brazil – Brazil	Domestic	94.9	94.9	207	0.46
Brazil – USA	International	4.6	3.3	207	0.02
Brazil – Argentina	Regional	3.8	1.6	207	0.01
…	…	…	…	…	…
Brazil Total		**118**	**108**	**207**	**0.52**

**First leg is departing from Brazil (a USA based passenger taking a return flight from Brazil to USA does not count)*

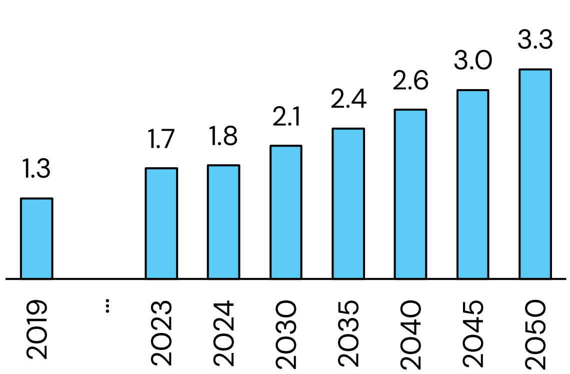
Table 21: 2019 (historical) and 2050 (forecasted) LAC region propensity to fly

Focus country	2019 Domestic trip/capita	2019 International trip/capita	2019 Total trip/capita	2050 Domestic trip/capita	2050 International trip/capita	2050 Total trip/capita
Brazil	0.46	0.06	0.52	0.89	0.09	0.98
Mexico	0.43	0.11	0.54	0.81	0.22	1.03
Colombia	0.60	0.15	0.75	1.51	0.26	1.77
Argentina	0.36	0.16	0.51	0.73	0.21	0.93
Chile	0.77	0.30	1.07	1.81	0.44	2.25
Peru	0.43	0.17	0.59	1.08	0.20	1.28
Panama	0.10	1.88	1.97	0.22	5.19	5.41
Dominican Rep.	0.01	0.46	0.46	0.02	2.12	2.14
Ecuador	0.16	0.13	0.29	0.34	0.15	0.49
Bahamas	2.97	3.01	5.97	4.09	6.11	10.21
El Salvador	n/a	0.36	0.36	n/a	0.94	0.94
Others	0.08	0.23	0.32	0.19	0.41	0.61
ALTA Average	**0.37**	**0.16**	**0.53**	**0.76**	**0.31**	**1.07**

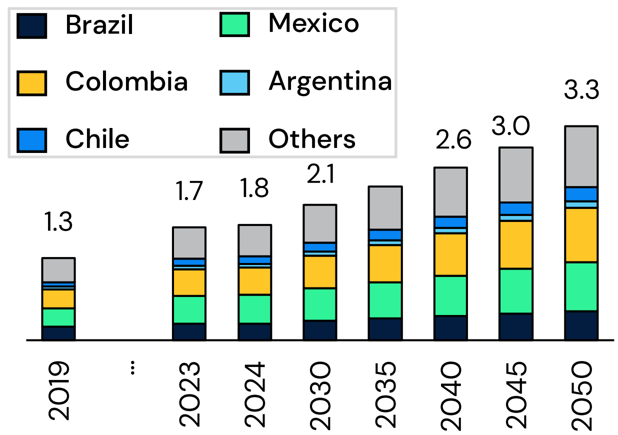
ATMs and cargo are forecast to increase to 5.9 million departing flights and 3.3 Mt of dedicated cargo, representing a CAGR of 1.9% and 3.1% respectively. The top five aviation markets will account for 64% of the departing ATMs in the region. The lower growth rate forecast for ATM relative to passenger demand highlights the continued upsizing of aircraft trends seen in the industry. The following charts summarize the cargo and ATM forecast results for the focus countries as well as the entire region.

LAC freight cargo demand forecast by total (left) and market (right)

Departing freight cargo, exc. belly (million tonnes)



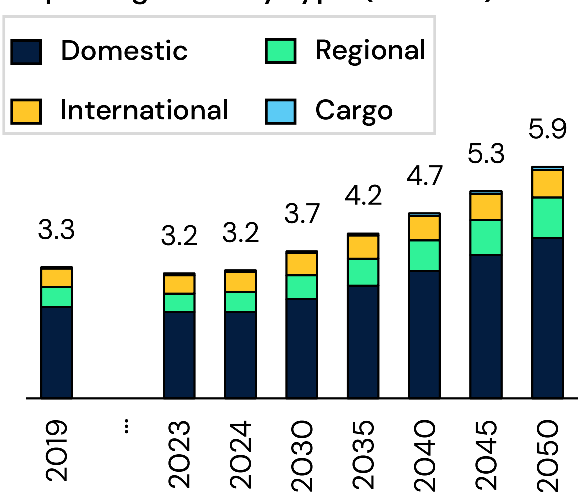
Departing freight cargo, exc. belly by country (million tonnes)



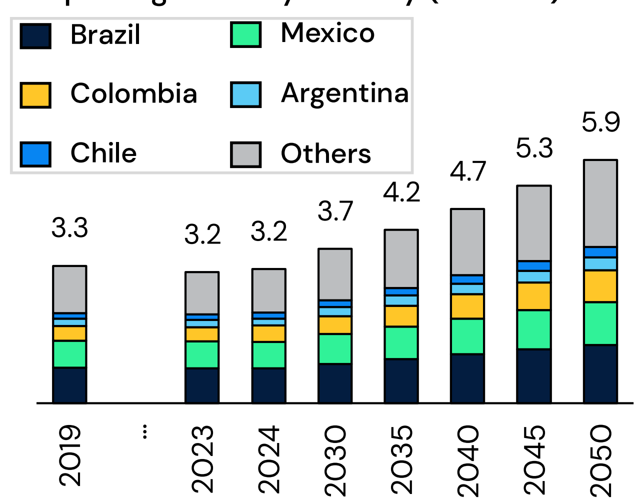
Source: PAXIS, OAG, national statistics, ICF analysis

Departing ATMs by type (left) and market (right)

Departing ATMs by type (millions)



Departing ATMs by country (millions)



Source: PAXIS, OAG, national statistics, ICF analysis
ATMs = Air Traffic Movements

Table 22: ALTA cargo and activity forecast summary

Focus country	2019 cargo ('000 tonnes)	2050 cargo ('000 tonnes)	2019-2050 cargo CAGR	2019 ATM ('000)	2050 ATM ('000)	2019-2050 ATM CAGR
Brazil	209	446	2.5%	868	1,411	1.6%
Mexico	281	755	3.2%	651	1,041	1.5%
Colombia	294	836	3.4%	348	769	2.6%
Argentina	40	93	2.8%	185	307	1.7%
Chile	68	217	3.8%	136	247	2.0%
Peru	52	122	2.8%	159	314	2.2%
Panama	41	126	3.7%	78	210	3.3%
Dominican Rep.	40	111	3.4%	50	200	4.5%
Ecuador	89	254	3.5%	53	76	1.2%
Bahamas	0.4	1.8	5.1%	70	64	-0.3%*
El Salvador	8	20	2.9%	23	45	2.2%
Others	142	303	2.5%	704	1,189	1.7%
ALTA Total	**1,264**	**3,283**	**3.1%**	**3,323**	**5,874**	**1.9%**

*Bahama negative growth due to a reduced number of ATM recorded in 2024 vs 2019 (-15%)

2.5 Country level forecasts

This sub-section provides a deep dive into the activity and fuel forecast for each of the focus countries assessed in the LAC region, which includes Argentina, Brazil, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Mexico, Panama, Peru, and the Bahamas.

2.5.1 Argentina

In 2019 Argentina handled 184 thousand departing flights and 40 thousand tonnes of dedicated cargo. 23 million passengers flew on flights either within or departing Argentina ranking the country as the 4th largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for 16 million passengers, equivalent to 70% of demand with intra-regional and international passengers accounting for 4.8 million and 2.1 million passengers, respectively. Following COVID, total passengers recovered to 97% of 2019's levels in 2024.

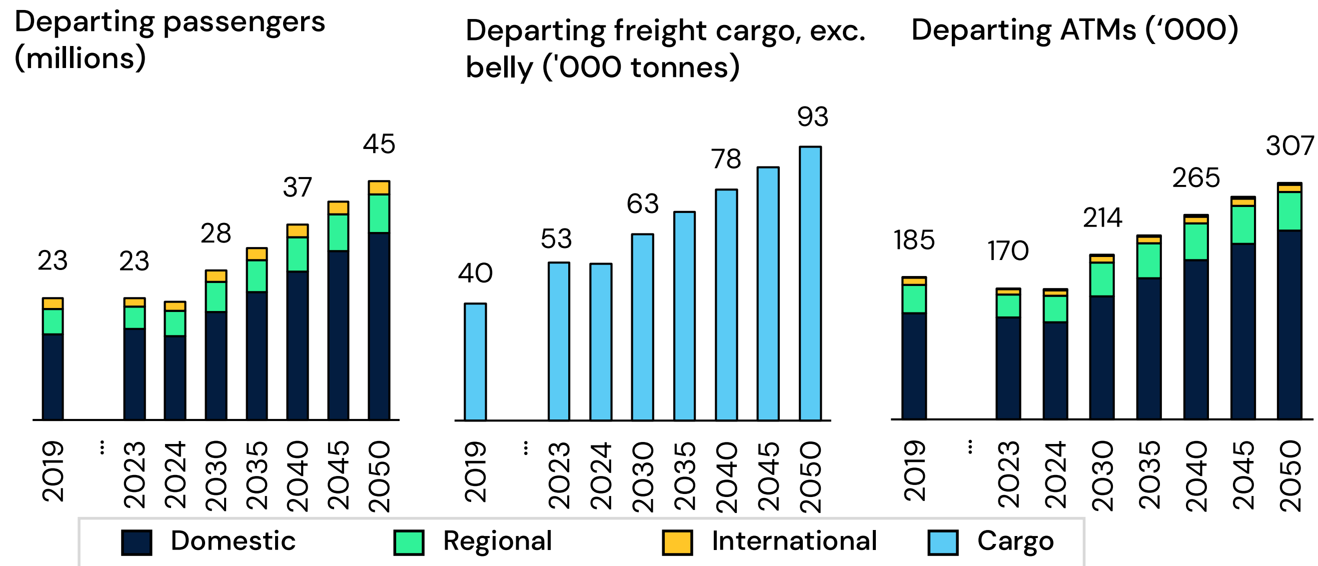
Argentina's aviation market is forecast to complete its recovery from COVID and resume long-term growth trends supported by ongoing economic growth in the country and growing inbound tourism. In the 2025-2050 period Argentina's economy is forecast to grow at a CAGR of 2.3%. This will result in an economy 74% larger than 2019's baseline which is equivalent to a 1.8% CAGR for the 2019-2050 period.

Over the long-term Argentina's aviation market is forecasted to gradually mature and that total passenger demand will grow to 45 million in 2050. This will represent an aviation market 96% bigger than 2019's baseline and a CAGR of 2.2%.

ATMs and cargo are forecast to increase to 307 thousand departing flights and 93 thousand tonnes of dedicated cargo, representing a CAGR of 1.7% and 2.7% respectively. The following chart summarizes the forecast results for Argentina.

[117] Departing passenger volumes considered

Argentina demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.2 Bahamas

In 2019, the Bahamas handled 70 thousand departing flights and 0.4 thousand tonnes of dedicated cargo. 3.2 million passengers flew on flights either within or departing Bahamas, ranking the country as the 14th largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for 1.2 million passengers, equivalent to 37% of demand with intra-regional and international passengers accounting for 119 thousand and 1.9 million passengers, respectively. Following COVID, total passengers have recovered and surpassed 2019's levels by 11% in 2024.

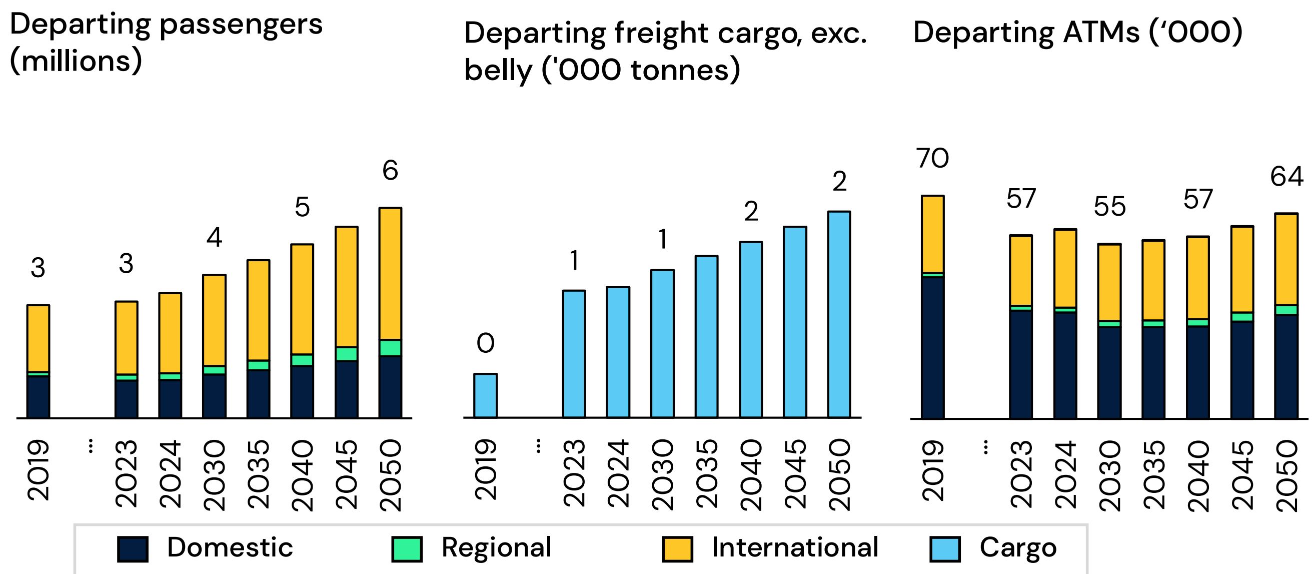
Bahamas's aviation market has fully recovered and resumed its long-term growth trends supported by ongoing economic growth in the country which leads to a higher inter-island demand and continuous growth in inbound tourism from North America and Europe. In the 2025-2050 period Bahamas's economy is forecast to grow at a CAGR of 1.3%. This will result in an economy 44% larger than 2019's baseline which is equivalent to a 1.2% CAGR for the 2019-2050 period.

Over the long-term Bahamas's aviation market is forecast to reach a total passenger demand of 5.9 million in 2050. This will represent an aviation market 86% bigger than 2019's baseline and a CAGR of 2.0%.

ATMs are forecasted to reach 64 thousand departing flights, representing a -0.3% CAGR decline compared to 2019 level. This is driven by a combination of lower 2025 activity level (only 55 thousand departing flights reported through OAG), together with a slow demand growth and the continuous aircraft up-gauging trend seen across the industry.

Cargo is forecasted to increase to 2 thousand tonnes of dedicated cargo, representing a CAGR of 5.1%. The following chart summarizes the forecast results for Bahamas.

The Bahamas demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.3 Brazil

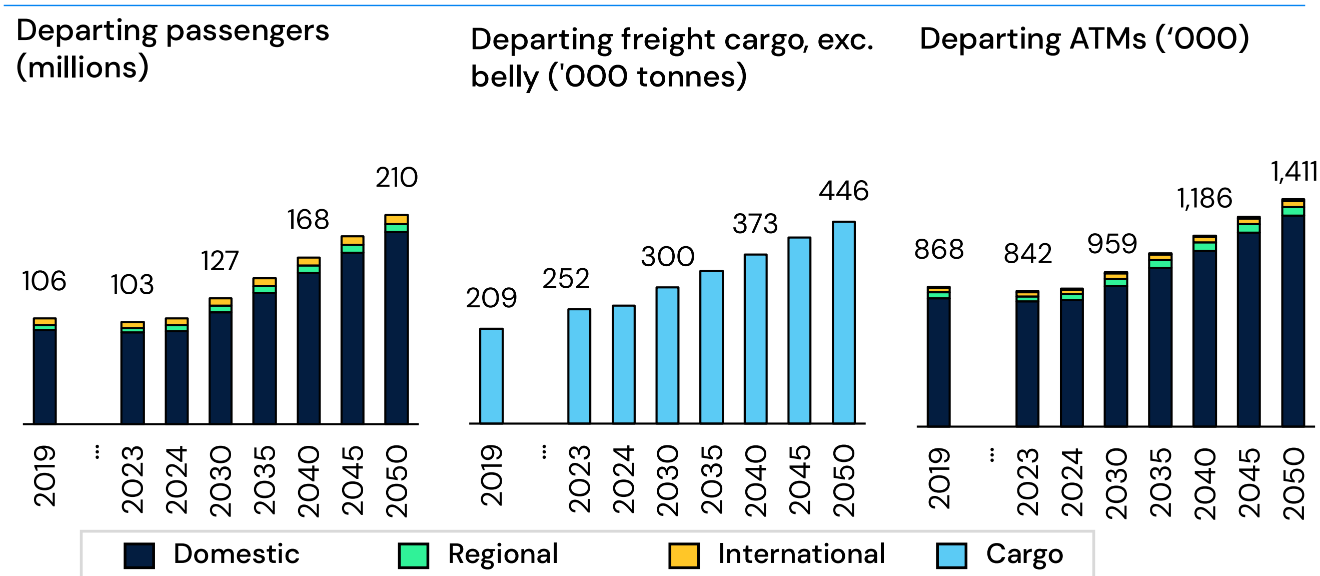
In 2019, Brazil handled 868 thousand departing flights and 209 thousand tonnes of dedicated cargo. 106 million passengers flew on flights either within or departing Brazil ranking the country as the largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for 95 million passengers, equivalent to 89% of demand with intra-regional and international passengers accounting for 4.9 million and 6.6 million passengers, respectively. Following COVID, total passengers recovered to 100% of 2019's levels in 2024.

Brazil's aviation market has resumed its long-term growth trends supported by ongoing economic growth in the country and closer ties with other countries in the region. As the biggest economy in the region, Brazil's economy is forecast to grow at a CAGR of 2.0% between the 2025-2050 period. This will result in an economy 87% larger than 2019's baseline which is equivalent to a 2.0% CAGR for the 2019-2050 period.

Over the long-term, Brazil's aviation market is forecasted to further mature and that total passenger demand will grow to 210 million in 2050. This will represent an aviation market 98% bigger than 2019's baseline and a CAGR of 2.2%.

ATMs and cargo are forecast to increase to 1.4 million departing flights and 446 thousand tonnes of dedicated cargo, representing a CAGR of 1.6% and 2.5% respectively. The following chart summarizes the forecast results for Brazil.

Brazil demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.4 Chile

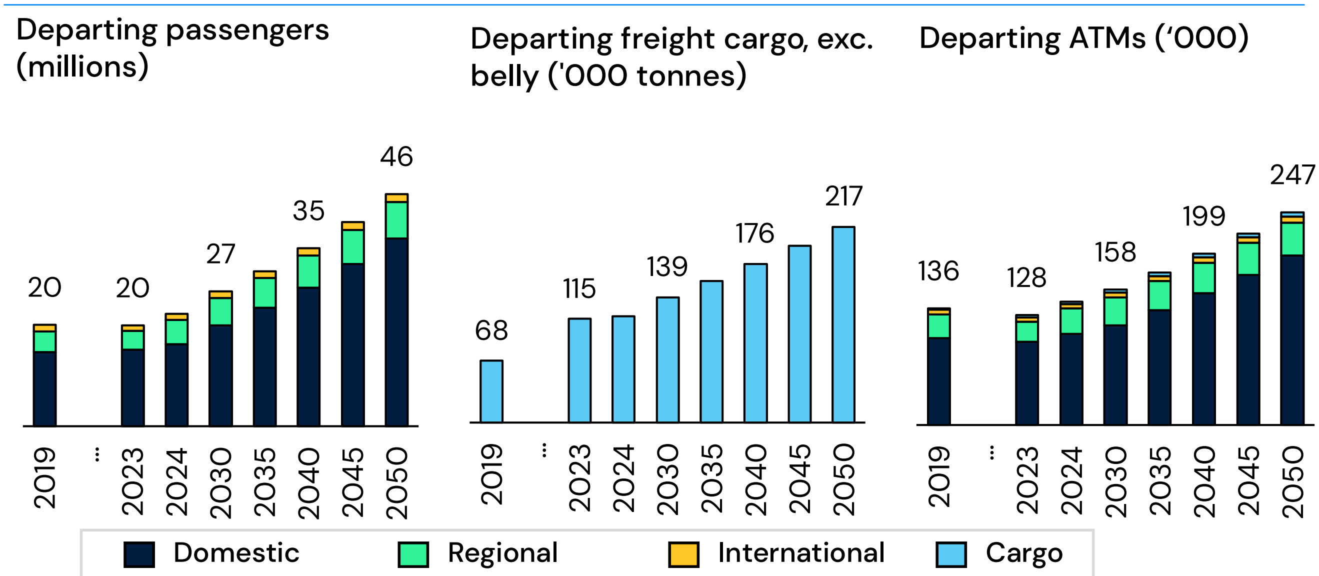
In 2019, Chile handled 136 thousand departing flights and 68 thousand tonnes of dedicated cargo. 20 million passengers flew on flights either within or departing Chile ranking the country as the 5th largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for 15 million passengers, equivalent to 73% of demand with intra-regional and international passengers accounting for 4.1 million and 1.3 million passengers, respectively. Following COVID, total passengers recovered to 111% of 2019's levels in 2024.

Chile's aviation market has fully recovered and resumed its long-term growth trends supported by ongoing economic growth in the country and across the region. In the 2025-2050 period Chile's economy is forecast to grow at a CAGR of 2.3%. This will result in an economy 96% larger than 2019's baseline which is equivalent to a 2.2% CAGR for the 2019-2050 period.

Over the long-term Chile's aviation market is forecasted to grow and mature and that total passenger demand will reach 46 million by 2050. This will represent an aviation market 129% bigger than 2019's baseline and a CAGR of 2.7%.

ATMs and cargo are forecast to increase to 247 thousand departing flights and 217 thousand tonnes of dedicated cargo, representing a CAGR of 2.0% and 3.8% respectively. The following chart summarizes the forecast results for Chile.

Chile demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.5 Colombia

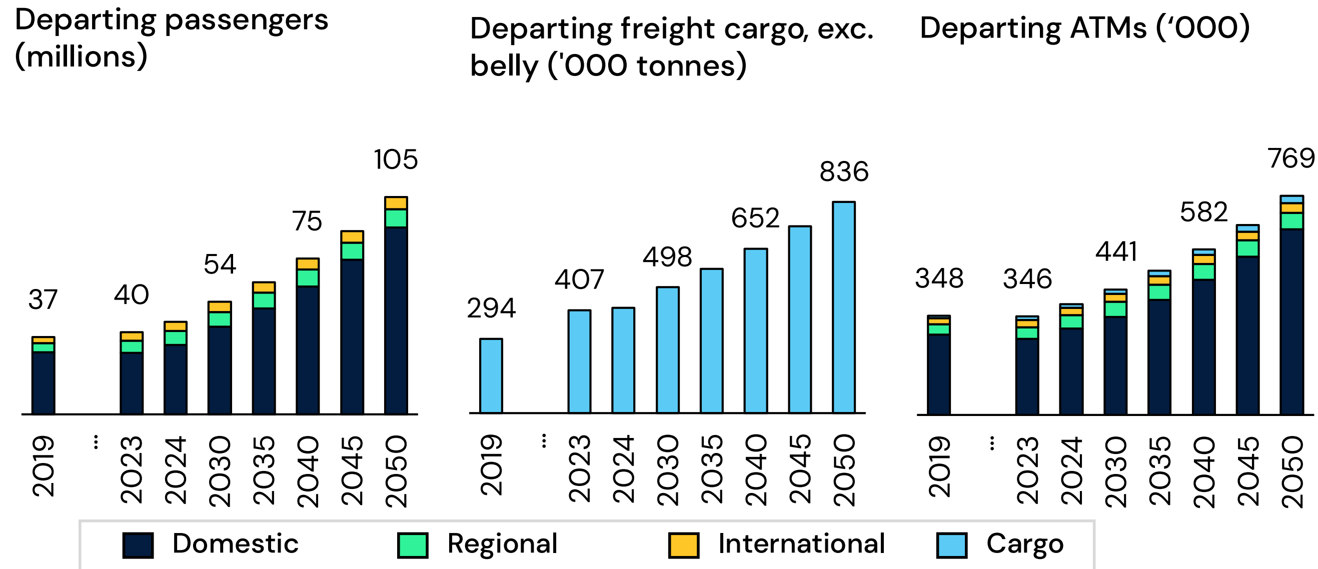
In 2019, Colombia handled 348 thousand departing flights and 294 thousand tonnes of dedicated cargo. 37 million passengers flew on flights either within or departing Colombia ranking the country as the 3rd largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for 30 million passengers, equivalent to 80% of demand with intra-regional and international passengers accounting for 4.3 million and 3.0 million passengers, respectively. Following COVID, total passengers have recovered and surpassed 2019's levels by 20% in 2024.

Colombia's aviation market has fully recovered and resumed its long-term growth trends supported by ongoing economic growth in the country and across the region. In the 2025-2050 period Colombia's economy is forecast to grow at a CAGR of 2.8%. This will result in an economy being 132% larger than 2019's baseline which is equivalent to a 2.7% CAGR for the 2019-2050 period.

Over the long-term Colombia's aviation market is forecast to grow and gradually mature. Total passenger demand will grow to 105 million in 2050. This will represent an aviation market 181% bigger than 2019's baseline and a CAGR of 3.4%.

ATMs and cargo are forecast to increase to 769 thousand departing flights and 836 thousand tonnes of dedicated cargo, representing a CAGR of 2.6% and 3.4% respectively. The following chart summarizes the forecast results for Colombia.

Colombia demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.6 Dominican Republic

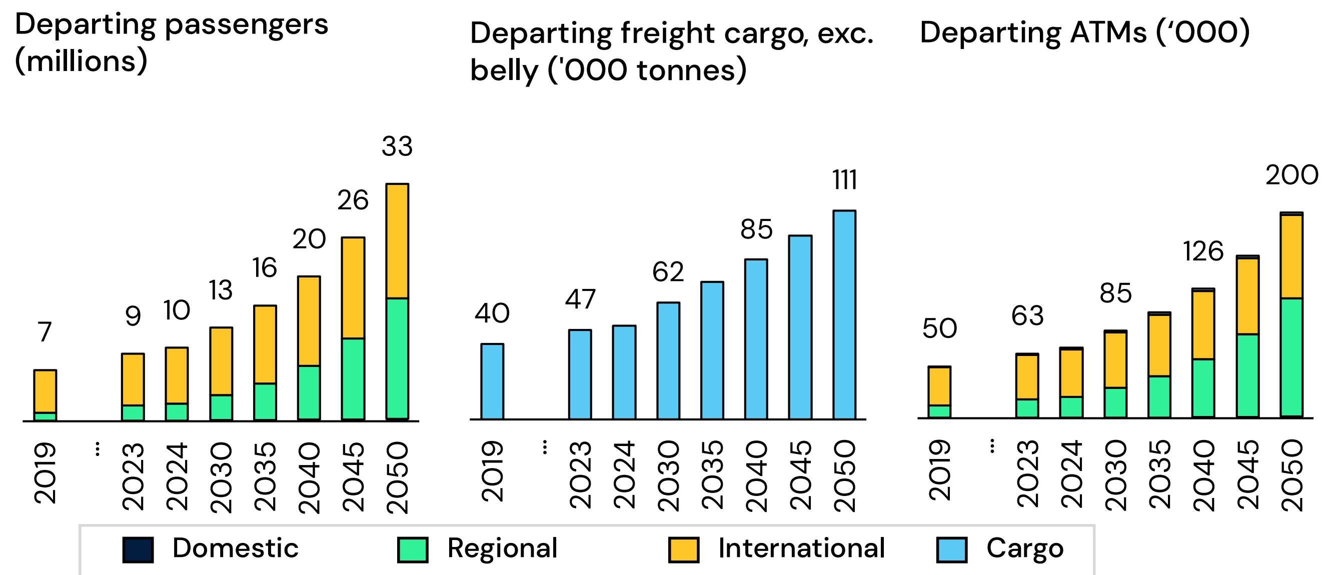
In 2019, the Dominican Republic handled 50 thousand departing flights and 40 thousand tonnes of dedicated cargo. 7 million passengers flew on flights either within or departing Dominican Republic ranking the country as the 8th largest aviation market in the LAC region by passenger volumes[117]. The domestic market is negligible, accounting for just 58 thousand passengers (equivalent to 1% of the demand), while intra-regional and international passengers accounting for 1.1 million and 6.0 million passengers, respectively. Following COVID, total passengers have recovered and surpassed 2019's levels by 43% in 2024.

The Dominican Republic's aviation market has rebounded strongly and resumed its long-term growth trends, supported by growing leisure demand especially from the USA and Canada. In the 2025-2050 period Dominican Republic's economy is forecast to grow at a CAGR of 3.9%. This will result in an economy 223% larger than 2019's baseline which is equivalent to a 3.7% CAGR for the 2019-2050 period. Major inbound markets from regions like the USA is also forecasted to see a GDP growth of 1.9% for the same period.

Over the long-term Dominica Republic's aviation market is forecast to continue to grow and ICF forecasts that total passenger demand will grow to 33 million in 2050. This will represent an aviation market 364% bigger than 2019's baseline and a CAGR of 5.1%.

ATMs and cargo are forecast to increase to 200 thousand departing flights and 111 thousand tonnes of dedicated cargo, representing a CAGR of 4.5% and 3.4% respectively. The following chart summarizes the forecast results for Dominican Republic.

Dominican Republic demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.7 Ecuador

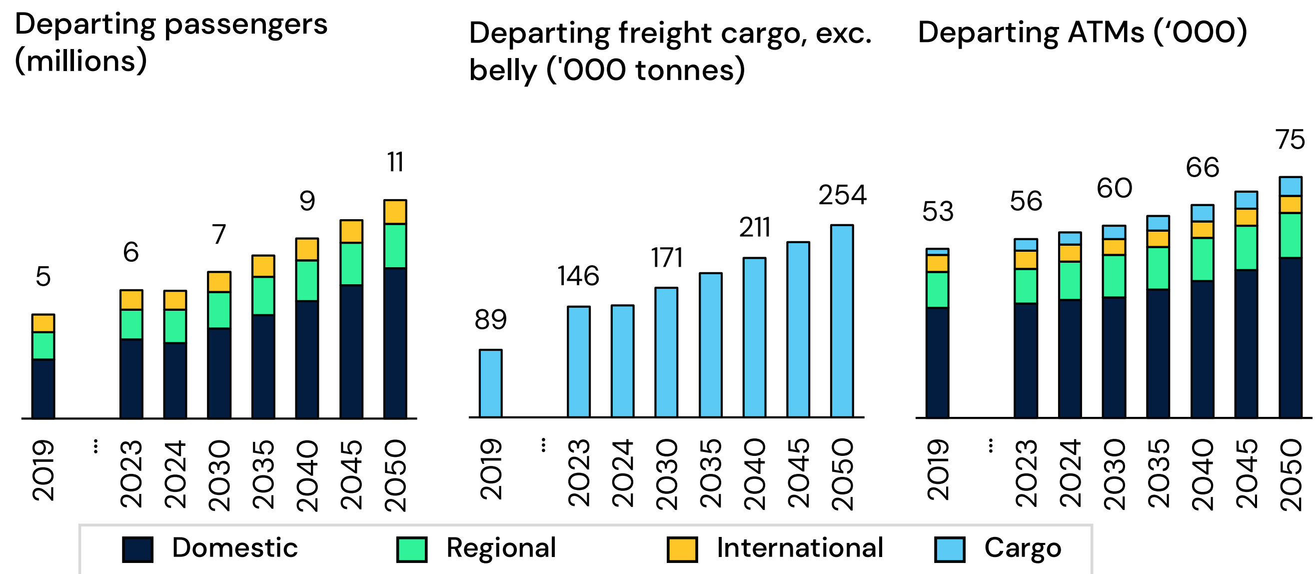
In 2019, Ecuador handled 53 thousand departing flights and 89 thousand tonnes of dedicated cargo. 5 million passengers flew on flights either within or departing Ecuador ranking the country as the 10th largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for 2.8 million passengers, equivalent to 56% of demand with intra-regional and international passengers accounting for 1.3 million and 868 thousand passengers, respectively. Following COVID, total passengers have recovered and surpassed 2019's levels by 22% in 2024.

Ecuador's aviation market has fully recovered and resumed its long-term growth trends supported by ongoing economic growth in the country and across the region. In the 2025-2050 period Ecuador's economy is forecast to grow at a CAGR of 1.9%. This will result in an economy 75% larger than 2019's baseline which is equivalent to a 1.8% CAGR for the 2019-2050 period.

Over the long-term Ecuador's aviation market is forecast to grow and total passenger demand is expected to reach 11 million in 2050. This will represent an aviation market 110% bigger than 2019's baseline and a CAGR of 2.4%.

ATMs and cargo are forecast to increase to 76 thousand departing flights and 254 thousand tonnes of dedicated cargo, representing a CAGR of 1.2% and 3.5% respectively. The following chart summarizes the forecast results for Ecuador.

Ecuador demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.8 El Salvador

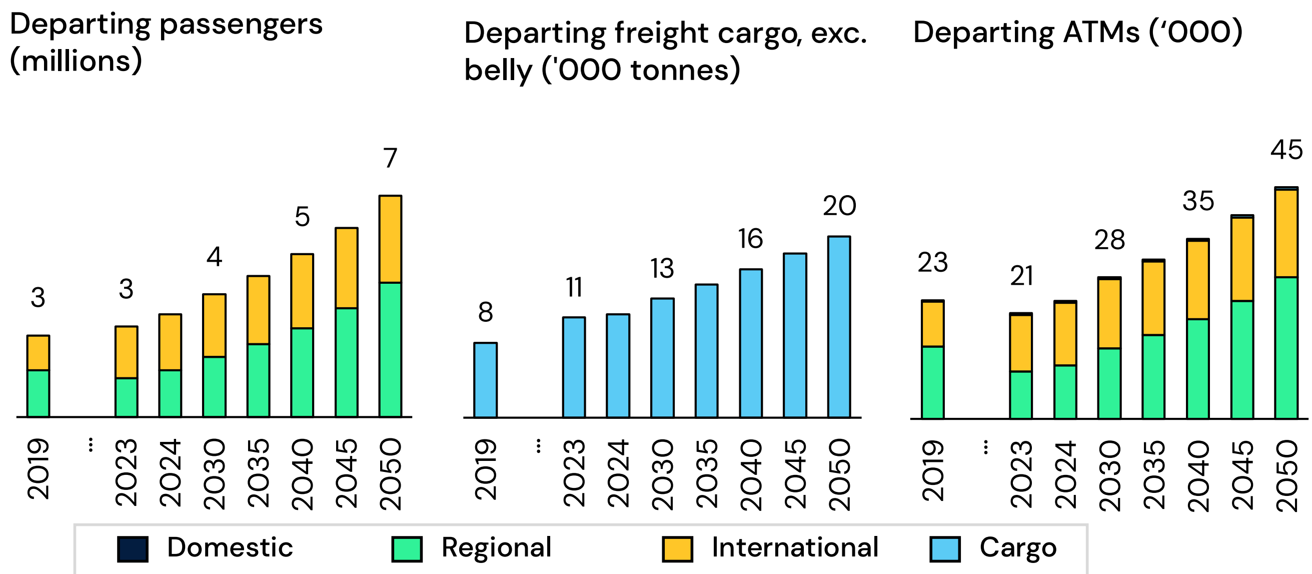
In 2019, El Salvador handled 23 thousand departing flights and 8 thousand tonnes of dedicated cargo. 2.6 million passengers flew on flights departing El Salvador ranking the country as the 16th largest aviation market in the LAC region by passenger volumes[117]. There is currently no domestic market, while intra-regional and international passengers accounted for 1.5 million and 1.1 million passengers, respectively. Following COVID, total passengers have recovered and surpassed 2019's levels by 26% in 2024.

El Salvador's aviation market has fully recovered and resumed its long-term growth trends supported by ongoing economic growth in the country and across the region. In the 2025-2050 period El Salvador's economy is forecast to grow at a CAGR of 2.1%. This will result in an economy 95% larger than 2019's baseline which is equivalent to a 2.2% CAGR for the 2019-2050 period.

Over the long-term El Salvador's aviation market is forecast to grow and total passenger demand is expected to reach 7.1 million in 2050. This will represent an aviation market 171% bigger than 2019's baseline and a CAGR of 3.3%.

ATMs and cargo are forecast to increase to 45 thousand departing flights and 20 thousand tonnes of dedicated cargo, representing a CAGR of 2.2% and 2.9% respectively. The following chart summarizes the forecast results for El Salvador.

El Salvador demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.9 Mexico

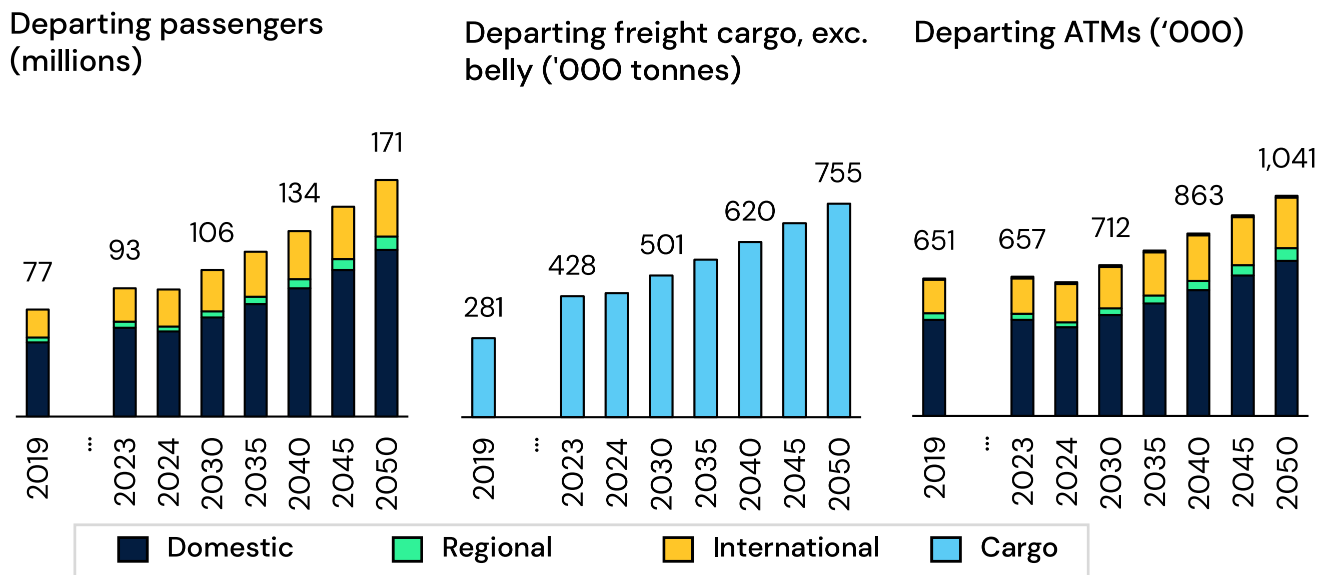
In 2019, Mexico handled 651 thousand departing flights and 281 thousand tonnes of dedicated cargo. 77 million passengers flew on flights either within or departing Mexico ranking the country as the 2nd largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for 54 million passengers, equivalent to 70% of demand with intra-regional and international passengers accounting for 3.7 million and 20 million passengers, respectively. Following COVID, total passengers have recovered and surpassed 2019's levels by 19% in 2024.

Mexico's aviation market has fully recovered and resumed its long-term growth trends supported by ongoing economic growth in the country and inbound tourism from North America and Europe. In the 2025-2050 period Mexico's economy is forecast to grow at a CAGR of 1.9%. This will result in an economy 68% larger than 2019's baseline which is equivalent to a 1.7% CAGR for the 2019-2050 period.

Over the long-term Mexico's aviation market is forecast to grow and further mature and ICF forecasts that total passenger demand will reach 171 million in 2050. This will represent an aviation market 121% bigger than 2019's baseline and a CAGR of 2.6%.

ATMs and cargo are forecast to increase to 1.0 million departing flights and 755 thousand tonnes of dedicated cargo, representing a CAGR of 1.5% and 3.2% respectively. The following chart summarizes the forecast results for Mexico.

Mexico demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.10 Panama

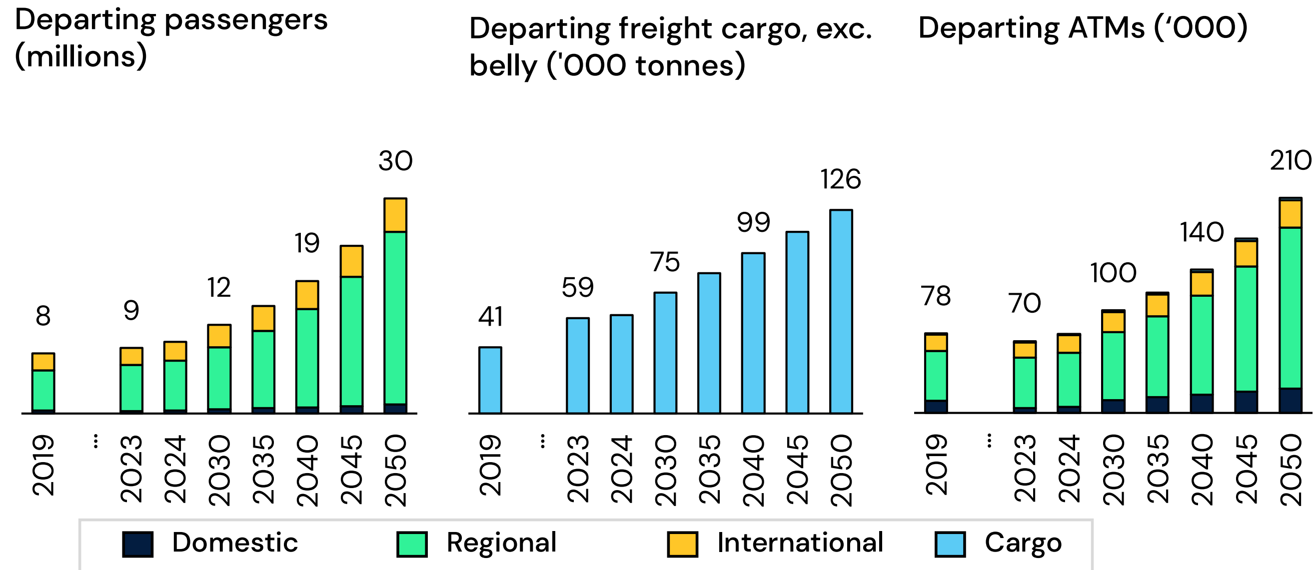
In 2019, Panama handled 78 thousand departing flights and 41 thousand tonnes of dedicated cargo. 8.4 million passengers flew on flights departing Panama ranking the country as the 7th largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for just 405 thousand passengers, equivalent to 5% of demand with intra-regional and international passengers accounting for 5.7 million and 2.4 million passengers, respectively. Following COVID, total passengers have recovered and surpassed 2019's levels by 19% in 2024.

Panama's aviation market has fully recovered and resumed its long-term growth trends supported by ongoing economic growth in the country and the home-based carrier's hub strategy. In the 2025-2050 period Panama's economy is forecast to grow at a CAGR of 3.1%. This will result in an economy 156% larger than 2019's baseline which is equivalent to a 3.1% CAGR for the 2019-2050 period.

Over the long-term Panama's aviation market is forecast to grow and the total passenger demand will reach 30 million in 2050. This will represent an aviation market 259% bigger than 2019's baseline and a CAGR of 4.2%.

ATMs and cargo are forecast to increase to 210 thousand departing flights and 126 thousand tonnes of dedicated cargo, representing a CAGR of 3.3% and 3.7% respectively. The following chart summarizes the forecast results for Panama.

Panama demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

2.5.11 Peru

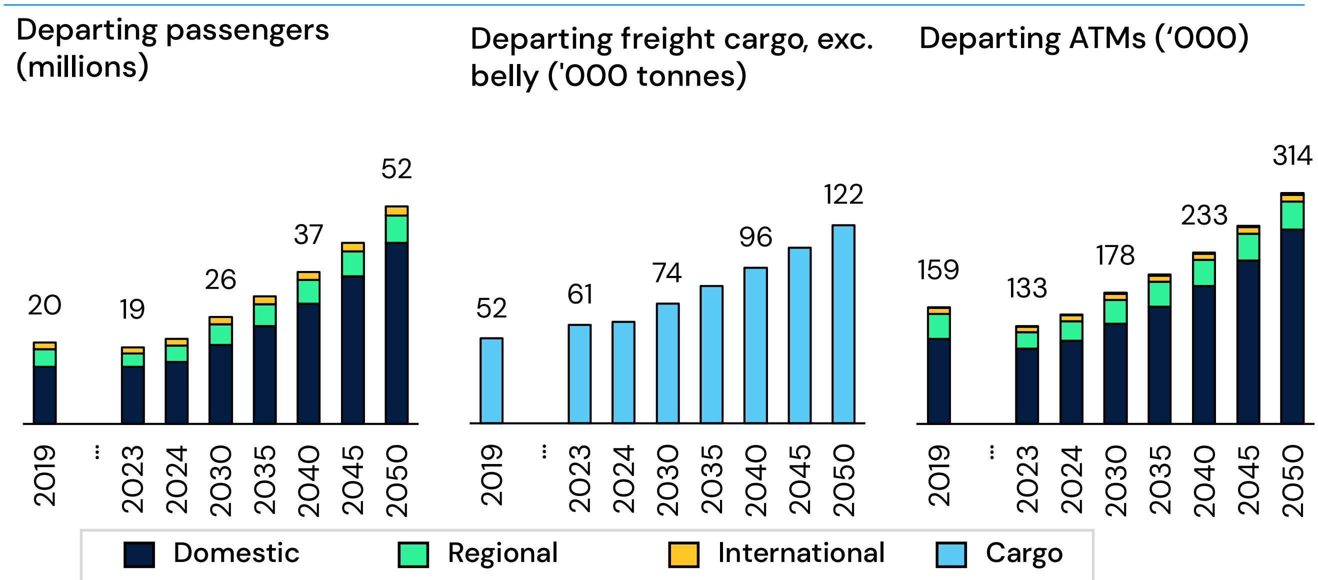
In 2019, Peru handled 159 thousand departing flights and 52 thousand tonnes of dedicated cargo. 20 million passengers flew on flights either within or departing Peru ranking the country as the 6th largest aviation market in the LAC region by passenger volumes[117]. The domestic market accounted for 14 million passengers, equivalent to 70% of demand with intra-regional and international passengers accounting for 4.3 million and 1.5 million passengers, respectively. Following COVID, total passengers have recovered and surpassed 2019's levels by 5% in 2024.

Peru's aviation market has fully recovered and resumed its long-term growth trends supported by ongoing economic growth in the country and growing tourism demand. In the 2025-2050 period Peru's economy is forecast to grow at a CAGR of 3.0%. This will result in an economy 130% larger than 2019's baseline which is equivalent to a 2.7% CAGR for the 2019-2050 period.

Over the long-term Peru's aviation market is forecast to grow and mature and ICF forecasts that total passenger demand will reach 52 million in 2050. This will represent an aviation market 167% bigger than 2019's baseline and a CAGR of 3.2%.

ATMs and cargo are forecast to increase to 314 thousand departing flights and 122 thousand tonnes of dedicated cargo, representing a CAGR of 2.2% and 2.8% respectively. The following chart summarizes the forecast results for Peru.

Peru demand and activity forecast



Source: PAXIS, OAG, national statistics, ICF analysis

3 The role of fleet renewal

3.1 Fleet retrofitting and replacement

This section discusses the nature of the fleet of aircraft operating in the Latin America and Caribbean region. It forecasts how the fleet will change with time to achieve growth, economic, and environmental ambitions, and how this influences the total jet fuel uplifted in the region.

Key result: Contribution of Fleet Renewal

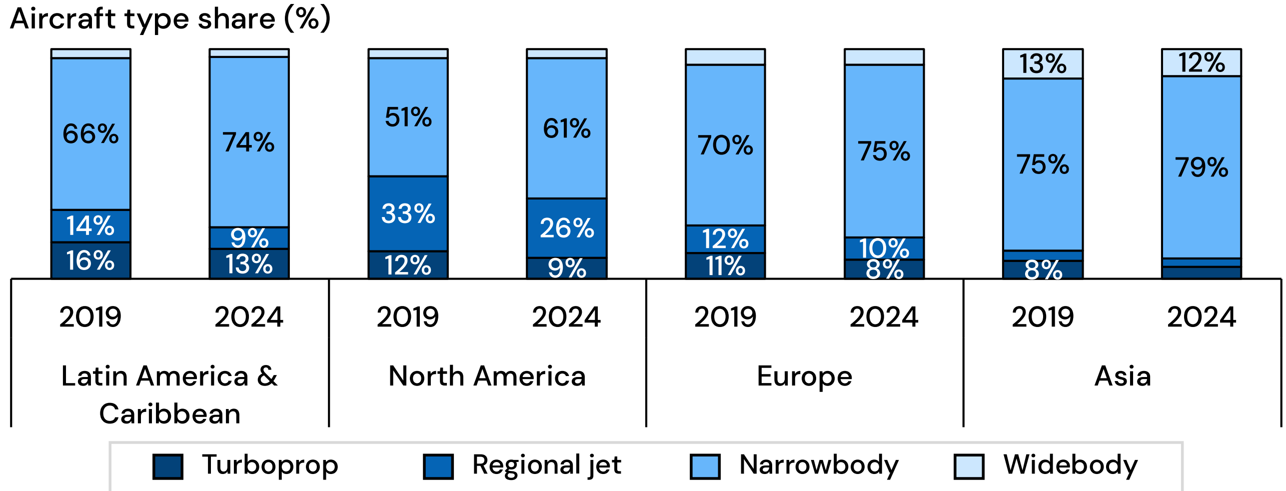
- In 2024, 38% of ASK departing from the LAC region were flown by new generation aircraft, up from 11% in 2019, making it one of the top regions by share of ASKs operated by new generation aircraft.
- The accelerated deployment of next-generation aircraft represents a critical pathway to improving fuel efficiency and reducing sector-wide emissions. However, realizing these environmental gains requires substantial capital investment from airlines - commitments that carriers across Latin America and the Caribbean have already undertaken through significant fleet-renewal programs and commitments.
- Future generation aircraft (conventional fueled) are forecasted to enter the regional fleet from the second half of 2030s, starting with turboprops and followed by regional jets and narrowbodies towards the end of the decade.
- By 2050, c.35% of the departing ASK from the LAC region is forecasted to be operated by future generation aircraft (conventional fueled), with the remaining 65% operated by new generation aircraft.
- Fleet renewal and the corresponding fuel efficiency improvements are projected to contribute ~30% reduction in total fuel burn per year by 2050, subsequently reducing emissions.

3.1.1 Current environment

In 2019, 66% of the flights departing the LAC region were flown by narrowbody jets, increasing to 74% in 2024. This reflected three key trends seen across the region and industry: the dominance of domestic activities, airlines focusing on the larger markets, and the continuous up-gauging of aircraft size (e.g. less E190 / E195 frequencies and more A320 / B737 family type flying) to pursue better economics and route profitability, especially post-COVID.

Nevertheless, given the market nature, the need to connect smaller and remote markets like inter-Caribbean islands remains an essential part of the aviation ecosystem in the region, consequently 13% of total flights were still operated in the region by turboprop aircraft in 2024. This is a higher share compared to other regions in the world which typically average under 10%. The chart below details the aircraft category comparison between the LAC region and other major regions of the world.

Flight activities comparison by region and aircraft category



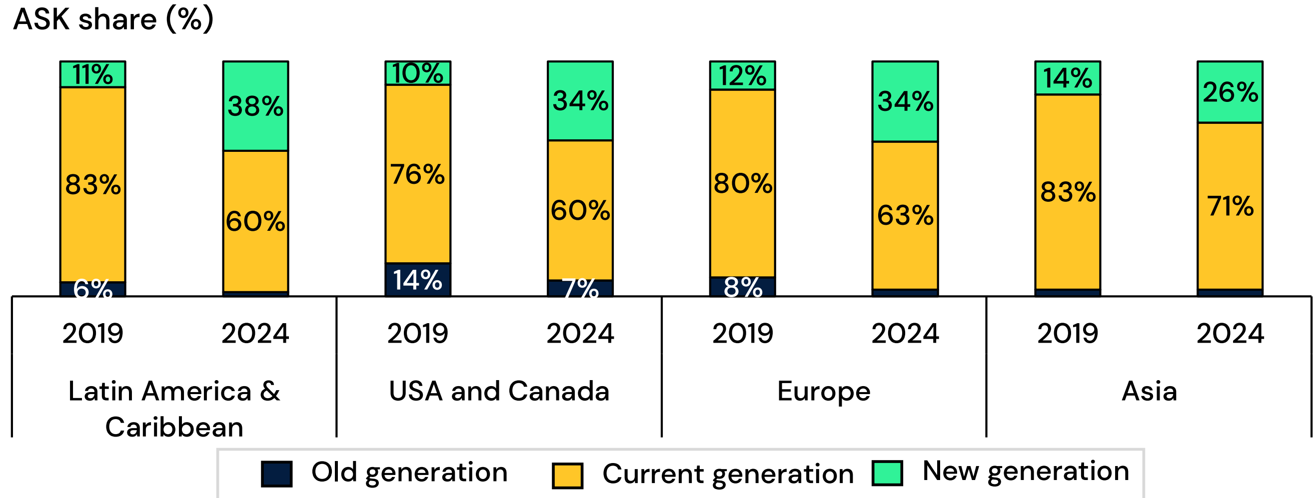
Source: OAG, ICF analysis

Aircraft are long-lived assets with a lifespan of 20-30 years, and major technological changes typically happen with a generational change. This analysis groups aircraft into several generations based on when they first entered service. This allows for comparison across generations and fuel-consumption improvements observed. The "old generation" includes older models like the Boeing 737 Classic and Boeing 767. The "current generation" refers to more recent models such as the Boeing 737NG, Airbus A320ceo, and Boeing 777. The "new generation" includes the latest, most advanced aircraft like the Boeing 737MAX, Airbus A320neo, Boeing 787, and Airbus A350. The forecast also considers a "future generation," which covers new aircraft models that are expected to enter service in the coming decades. These are aircraft, which are not yet in production, but are anticipated to offer an improvement compared to the most advanced active fleet represented by the “new generation” category.

In 2019, 83% of the departing ASKs from the LAC region were flown by a current generation aircraft type, with another 6% flown by an old generation aircraft. By 2024, several airlines had restructured (or grew) their fleets post-COVID, driving up the ASK share of new generation aircraft in the region to 38%. This made it the region with the highest share of ASKs operated by new generation aircraft. The current generation share had dropped to 60% as these newer aircraft entered the fleet, leaving just 2% operated by old generation aircraft.

The shift is mainly seen on some key domestic markets like Brazil, Mexico, Chile etc. ASKs between the region and North America also recorded some significant shifts towards the next generation aircraft types. The chart below provides the aircraft generation comparison between the LAC and other major regions of the world.

Flight activities comparison by region and aircraft generation

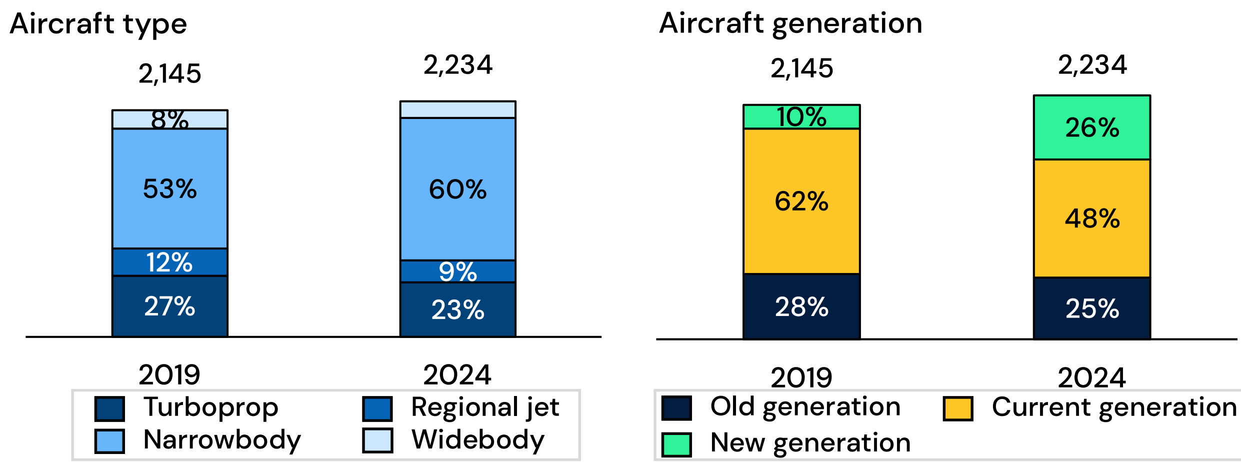


Source: OAG, ICF analysis
ASK = Available Seat Kilometre

3.1.2 In-service fleet and order book

In 2019, LAC airlines collectively operated a fleet of 2,145 aircraft. This number increased slightly to just over 2,230 aircraft in 2024 with narrowbody jets gaining a further 7% points in share, accounting for 57% of the total in-service fleet in 2024, while turboprop and regional jet share dropped by 4% points and 3% points respectively. Airlines have replaced their current generation aircraft with newer more fuel-efficient next generation aircraft during lease renegotiation cycle, and as a result the share of current generation aircraft has dropped to 48% in 2024, while new generation aircraft share increased to 26%. As current generation aircraft consist mostly of narrowbodies and regional jets, these aircraft usually generate a higher ATM per aircraft and thus accounting for most of the departing ATMs in the region. Old generation aircraft are mostly small turboprops or older jet aircraft, and thus airlines are keeping them for specific market needs or for their relatively lower ownership costs. The exhibit below shows the fleet size operated by LAC airlines and their split.

In-service fleet operated by LAC based airlines (pax & cargo fleet only, end of year snapshot)



Source: CAPA, ICF analysis

In terms of order book, the airlines based in the LAC region collectively registered 702 aircraft on order, with close to 80% being narrowbody jet aircraft. Volaris, based in Mexico, has the largest order book with 131 aircraft on order, followed by LATAM Group with over 110 aircraft. While some of these new aircraft are expected to support individual airlines' growth ambitions, part of the order is likely to be used for replacing older, in-service aircraft as they reach their retirement age.

Table 23: In-service and on order fleet for major airlines in the Latin America & Caribbean region (pax & cargo as of end 2024, firm order only)[118]

Airline	In-service fleet	On order turboprop	On order regional jet	On order narrowbody	On order widebody	On order total
LATAM Airlines Group	334	0	0	96	15	111
Abra Group[119]	307	0	0	221	14	235
Azul	182	4	56	20	7	87
Aeromexico Group	150	0	0	21	1	22
Volaris Group	113	0	0	131	0	131
Copa Airlines	112	0	0	35	0	35
Viva Aerobus	93	0	0	16	0	16
Aerolíneas Argentinas	80	0	0	6	0	6
JetSMART Group	40	0	0	76	0	76
Sky Airline	36	0	0	10	0	10
Caribbean Airlines Limited	20	0	0	1	0	1
Others	797	22	20	23	0	65
Total	**2,234**	**26**	**76**	**577**	**23**	**702**

[118] CAPA, ICF analysis
[119] Represents the total for ABRA, including Avianca Group and Gol Linhas Aereas. In November 2025 Abra Group signed a preliminary agreement with Sky Airlines - https://abragroup.net/wp-content/uploads/2025/11/ENG-Comunicado-Abra-Sky-Airline.pdf

3.1.3 Efficiency improvement

3.1.3.1 Inter-generational performance

Airlines accelerated their fleet renewal cycle during COVID, aiming to retire older less fuel-efficient aircraft with more efficient modern equivalents. Despite the higher acquisition cost, new generation aircraft are more fuel efficient and therefore help airlines to reduce fuel expenses as part of their operating costs. While fuel savings will vary from aircraft type to aircraft type, and the actual mission flown, it is generally accepted to be in the range of 15%-20% lower than current generation aircraft for the same category of aircraft.

For example, the Boeing 737MAX is advertised to be up to 20% more fuel efficient (on a per seat basis) than the Boeing 737NG; similar benefits are realized for Airbus A320neo versus A320ceo[121]. On the widebody side, the Airbus A330neo is advertised to be up to 25% more fuel efficient (on a per seat basis) than their current A330ceo through a mix of new engine technologies and a densified cabin[122]. The Boeing 787s are also marketed with a similar level of fuel savings compared to previous generation aircraft that they are replacing like B767s and B777-200s.

ICF expects future generation aircraft are likely to deliver a similar efficient improvement through a mix of more advanced engine technology, lighter materials and improved aircraft design. For example, engine OEMs are developing new engines with higher by-pass ratio which will improve propulsion efficiency; meanwhile airframe OEMs are investigating in bended wing or canard wing technology which will improve aerodynamic performance. The table below summarizes the assumptions ICF has taken when modelling fuel consumption for future generation (conventional fuel) aircraft type, which is in-line with other industrial publications[123].

Table 24: Future generation aircraft (conventional fuel) efficient gain assumptions[124]

Aircraft category	Efficient gain% (current > new generation)	Efficient gain% (new > next generation)
Turboprop	15%	15%
Regional jet	15%	15%
Narrowbodies jet	17%	22%
Widebodies jet	17%	18%

3.1.3.2 Intra-generational performance

While fleet renewal will drive savings on fuel, efficiency gains are also achieved through intra-generation upgrades. For example, a narrowbody aircraft produced in 2018 is more efficient than the same model produced 10-20 years earlier. These efficiency gains have typically been delivered through:

- Weight savings: Aircraft OEMs are able to reduce weight as aircraft program matures
- Aerodynamics: Aircraft OEMs have improved aerodynamic efficiency of existing models. Common examples include winglets / wing tips as well as drag reduction surfaces. This provided a 2%-4% fuel saving historically[125].
- Engines: Engine OEMs have improved models with various improvement packages implemented over the lifetime of an engine program. This provided 2%-5% fuel saving historically[126].

[121] https://www.airbus.com/sites/g/files/jlcbta136/files/2021-12/EN-Airbus-A320-Facts-and-Figures-December-2021.pdf
[122] https://www.airbus.com/en/products-services/commercial-aircraft/passenger-aircraft/a330-family
[123] IATA Aircraft Technology Roadmap to 2050 and Net zero 2050: new aircraft (December 2024)
[124] ICF analysis, Boeing Cascade
[125] Airbus and Boeing website
[126] GE Aerospace CFM56-5B upgrade

Combined these intra-generational benefits typically amount to low-mid single digit performance improvements in fuel efficiency throughout the life span of an aircraft type[127]. The table below summarizes the assumptions ICF has taken when modelling the efficiency improvement within the same aircraft generation.

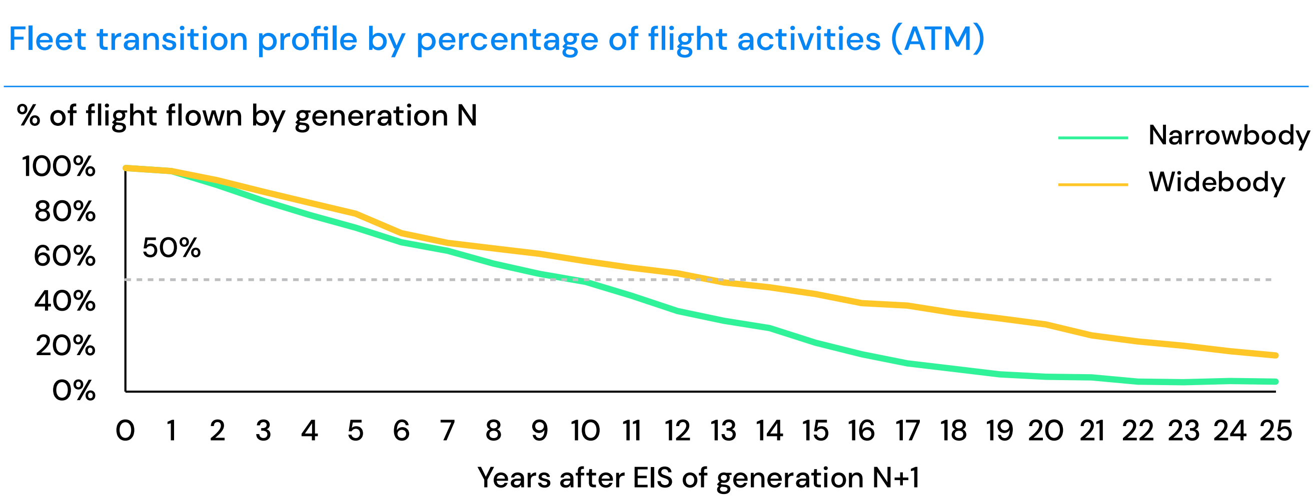
Table 25: Intra-generation aircraft efficiency gain assumptions[128]

Aircraft category	Efficient gain over lifetime
Turboprop	up to 2.0%
Regional jet	up to 2.0%
Narrowbodies jet	up to 2.0%
Widebodies jet	up to 2.0%

3.1.4 Fleet transition profile

3.1.4.1 Historical transition trend

To analyze the fleet transition trend, ICF has looked at the historical number of flights performed by previous generation aircraft (generation N, for example Boeing 737 classics, Airbus A340s, and Boeing 767s) versus next generation aircraft (generation N+1, for example, Boeing 737NGs, A330s, and Boeing 777s) and looked at their relationships. It is found that for narrowbodies, around 50% of the flight activity transitioned from older models to newer models after approximately 10 years from entry into service (EIS), and at 20 years and beyond only around 10% of the older models stay in operations. The trend is also applicable to LAC with roughly 10% of older models staying in operation after 20 years. For widebodies, generational replacement trends were found to take slightly longer. This is expected as airlines often operate widebodies to an older age compared to narrowbodies. The widebodies transition curve starts slightly later for the LAC region but the replacement rate catches up over time and reaches a similar level in year 20. The figure below summarizes the result of the fleet transition analysis.



Source: ICF analysis
EIS = Entry into service

[127] ATAG Waypoint 2050
[128] ICF analysis, Boeing Cascade

3.1.4.2 Latest transition trends

Looking at global narrowbody activities, new generation aircraft gained an average of 2%-point share each year between 2015-2024. The number is similar for LAC region, while North America and Europe were roughly 1% ahead of the average. Nevertheless, this is below the historical trend as new generation narrowbodies went through a series of production and certification issues, such as the grounding of B737MAX, A320neo engine issue, and the post-COVID supply chain issues which have shifted the replacement schedule to the right. On the widebodies activities side, the new generation gained an average of 4%-point share per annum between 2015-2024, which is in-line with the historical trend.

3.1.4.3 Fleet transition trend for Latin America and Caribbean

The final piece of information required to project the fleet transition plan is the potential entry into service (EIS) date for future types of aircraft. ICF has made the following EIS assumptions based on various literature reviews and desktop research:

Table 26: Entry into service (EIS) assumptions for future generation aircraft[129]

Aircraft category	Technology	Estimated EIS
Turboprop	Conventional fuel	Mid 2030
	Hydrogen / electrical	Beyond 2050
Regional jet	Conventional fuel	Mid / Late 2030
	Hydrogen / electrical	Beyond 2050
Narrowbodies jet	Conventional fuel	Late 2030
	Hydrogen / electrical	Beyond 2050
Widebodies jet	Conventional fuel	Early 2040
	Hydrogen / electrical	Beyond 2050

The inclusion of hydrogen and electric-powered aircraft within commercial fleets is projected to be beyond the forecast horizon of this study. This is based on several critical factors: the current technological maturity of these propulsion systems, significant uncertainties regarding their viability for large-scale commercial aviation, and the absence of supporting infrastructure and regulatory frameworks necessary for their widespread adoption. For instance, Airbus initially set a target for the introduction of hydrogen-powered aircraft by 2035, but in 2025, the company announced a delay, pushing the expected entry into service to the late 2040s[130]. Such delays underscore the challenges faced by manufacturers, including the need for significant advancements in fuel cell technology, hydrogen storage, and distribution, as well as the development of airport infrastructure capable of supporting these new aircraft types. Even if rapid technological progress occurs and hydrogen or electric aircraft are certified and begin commercial operations, their integration into airline fleets by 2050 is anticipated to be limited. Adoption will likely be restricted to short-range missions, primarily due to range constraints, infrastructure readiness, and operational complexities associated with these new propulsion systems. As a result, their contribution to reducing overall jet fuel consumption and emissions during the forecast period will be negligible if existent.

In 2024, there were 2% departing ASKs from the Latin America and Caribbean region operated by old generation aircraft, and this number is expected to further reduce as most of these aircraft have reached over 20 years old. There were another 60% of departing ASKs operated by current generation aircraft (e.g. A320ceo family, B737NGs, E190/5 etc.), the proportion is expected to reduce gradually through to the next decade as airlines continue to take delivery of new generation aircraft (e.g. A320neo family, B737MAX, E190/5-E2 etc.)

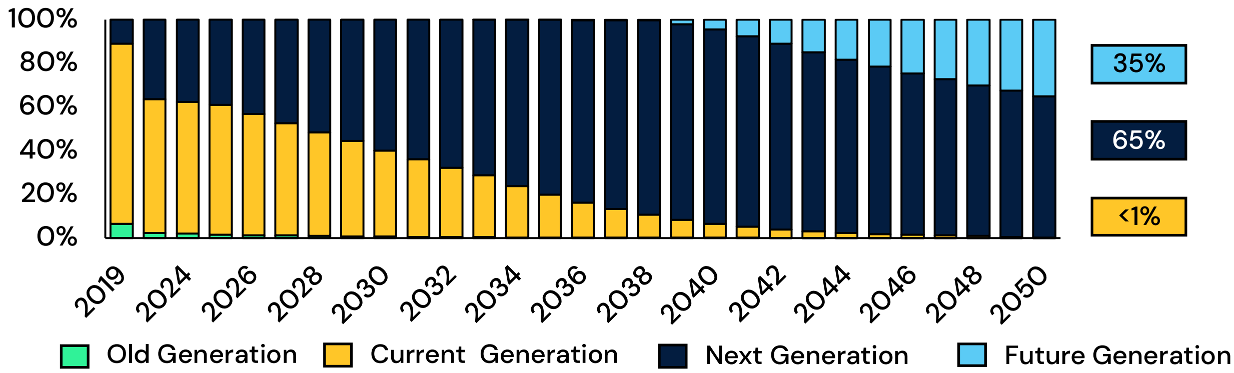
[129] ICF analysis, Boeing Cascade

[130] https://sustainabilitymag.com/articles/airbus-delays-plans-for-commercial-hydrogen-aircraft

which drives the new generation share increase. A small proportion of ASKs is anticipated to be operated by future generation conventional fueled aircraft starting from 2034/5 though they will be mostly turboprop aircraft based on the latest development trends seen in the industry before future generation (conventional fueled) regional jets and narrowbodies entering into service towards the end of 2030s. The exhibit below shows the fleet generation transition by ASKs.

Airlines in the LAC region have already started transitioning to more fuel -efficient aircraft. Future generation is expected to penetrate the fleet in late 2030s

Fleet composition by ASKs



Source: ICF analysis
ASKs = Available Seats Kilometres; Future Generation – the generation after NEOs and MAXs

4 Operational improvements & emission forecast

4.1 Introduction

Key results:

- Operational improvements across aircraft efficiency, airport and ground operations, and flight profile optimization can reduce fuel consumption by **3.3–11.3% by 2050**, equivalent to a jet fuel reduction of 1.0-3.5 Mt in 2050.
- Early savings come primarily from airline and ground measures such as efficient taxiing and optimized fuel planning, while long-term reductions depend on airspace modernization, advanced technologies, and harmonized cross-border procedures.
- Unlocking full benefits requires coordinated investment and regulatory alignment, supported by robust performance monitoring, digital tools, and strong collaboration among airlines, airports, air navigation service providers, and policymakers.

In 2023, Virgin Atlantic flight 100 took off from London to New York[131]. In collaboration with airports, air traffic control, and other stakeholders, operational efficiency improvements reduced the Boeing 787's jet fuel consumption, and hence CO_2 emissions, by 4.4% relative to a plane typically flying the route. En-route efficiency played a key role, accounting for 47% of the reduction, followed by pre-flight initiatives at 27%, and departure and arrival phases at 13% each.

Operational improvements offer a dual benefit by reducing both CO_2 emissions and jet fuel consumption for airlines. This is particularly true in the LAC region, where jet fuel prices are typically above the global average. Virgin flight 100 demonstrated that significant savings are possible with existing technology, but weather, operational, congestion, and investment challenges still hinder scaling this achievement across the industry. This analysis shows that many operational elements in the LAC region are already more efficient than the global average, yet further improvements could be achieved through targeted investments and regulatory changes.

This study aims to estimate the potential for operational improvements in the LAC region between 2019 and 2050, considering both current methods and future technologies. It draws on global case studies to highlight the drivers of these changes and the requirements for achieving further gains.

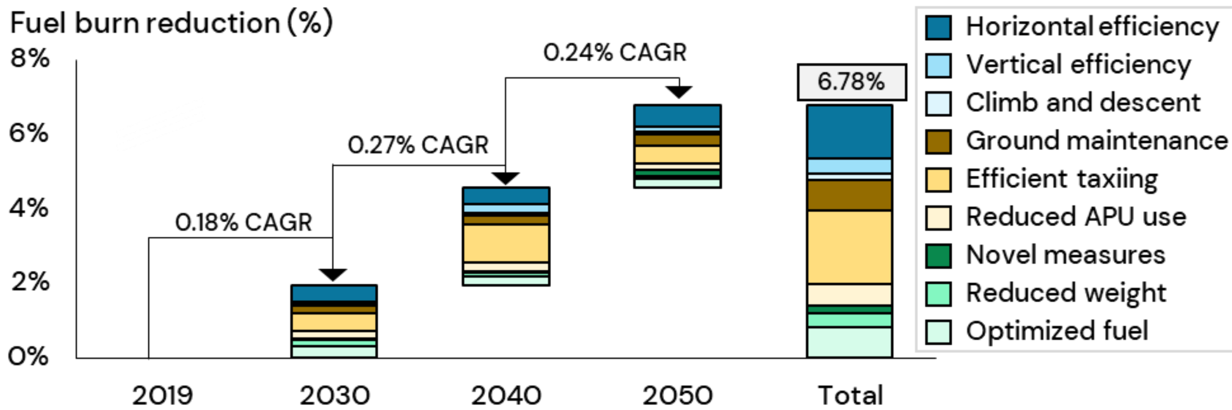
4.1.1 Summary of results

Operational improvements in the LAC region across aircraft efficiency, airport and ground operations, and flight profile optimization can reduce fuel consumption by 3.3–11.3% by 2050 compared to a 2019 baseline under the modeled scenarios. As illustrated on the figure below, these savings build progressively over time, with early gains driven by airline and ground measures, and larger long-term reductions resulting from airspace modernization, advanced technologies, and strong cross-stakeholder collaboration. Together, these initiatives

[131] https://flywith.virginatlantic.com/content/dam/sustainability/Flight100-Executive-Summary.pdf

represent one of the most cost-effective pathways to reduce aviation emissions while improving operational resilience and efficiency.

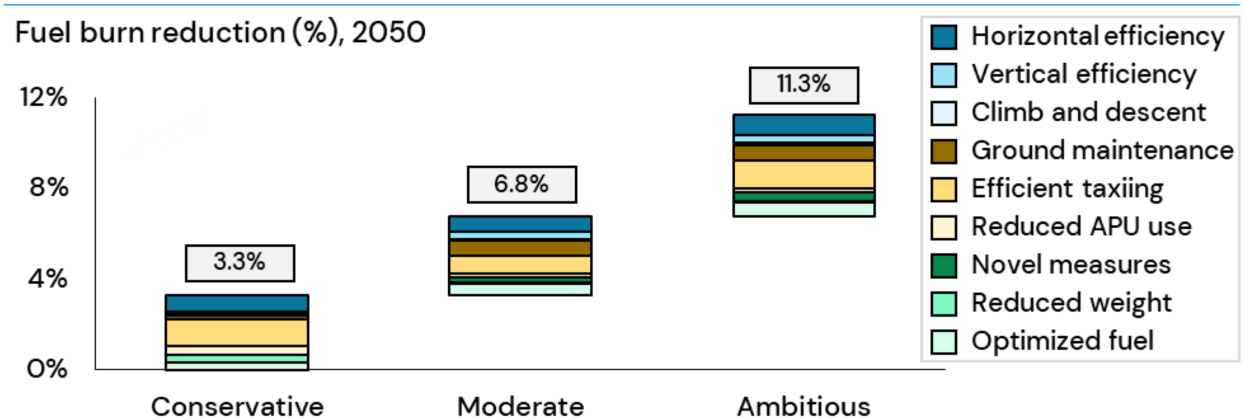
Operational improvements in the LAC region could reduce aircraft fuel burn by 3.3-11.3% in 2050, but require the support of additional stakeholders



Source: ICF analysis
Note: Central scenario; Novel measures includes formation flight

The difference between the conservative and ambitious scenarios, ranging from 3.3% to 11.3% in operational efficiency improvements, is substantial. This could translate to nearly 2.5 Mt of jet fuel savings annually by 2050. Achieving this full potential will largely depend on the level of support provided by other sectors, which this chapter explores in detail. The differences between scenarios in 2050, broken down by initiative group, are shown in the figure below.

Differences in operational efficiency gains depend on stakeholder support and technological maturity



Source: ICF analysis
Note: Novel measures includes formation flight

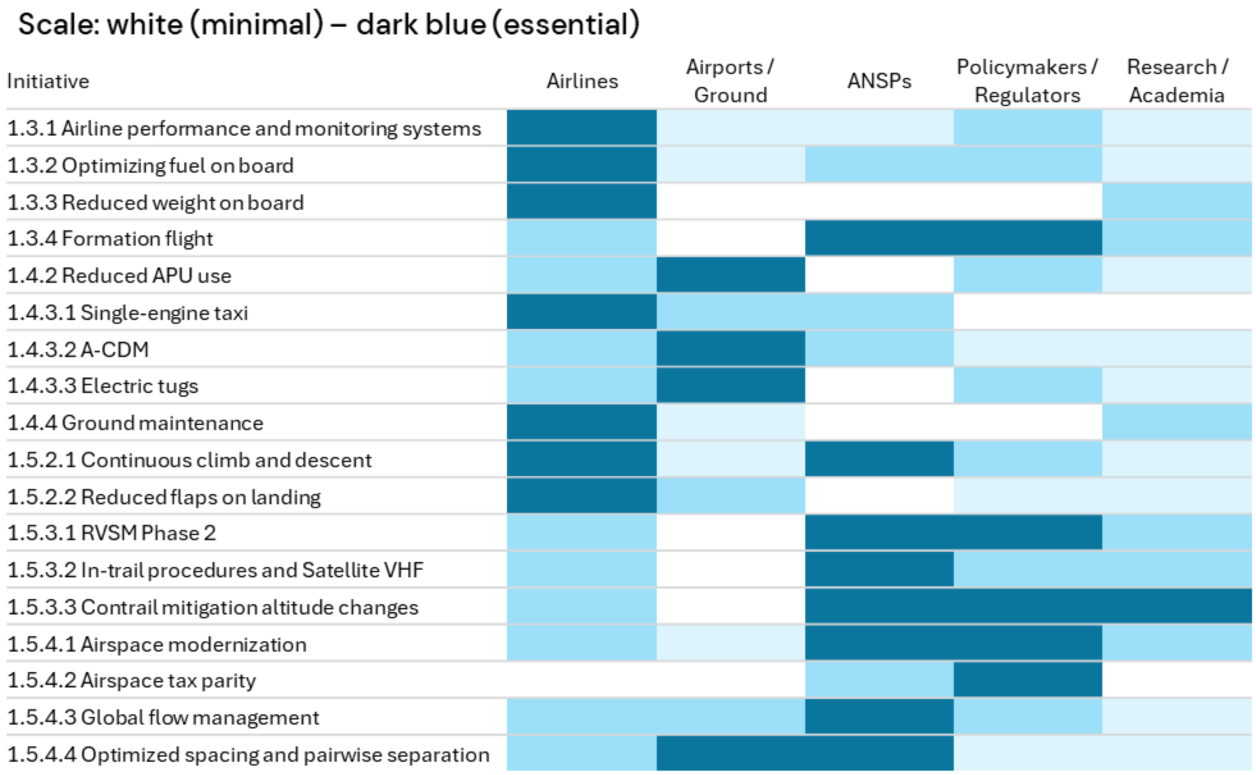
Aircraft efficiency and planning measures can reduce fuel burn by 0.2-1.0% by 2030 and 0.6-2.4% by 2050. Optimizing fuel on board offers the largest potential impact, but its success largely depends on the adoption and advancement of behavioral and efficiency monitoring programs. Reduced weight on board through lighter cabin equipment and materials can play a role, as well as novel measures such as formation flight, albeit largely dependent on technological advancements.

Airport and ground measures provide the largest near-term impact, with combined savings of 0.3-1.6% by 2030, increasing to 1.7-5.5% by 2050, of which 1.2-3.3% comes from more efficient taxi procedures. To realize maximum gains, airport collaborative decision making will roll out aggressively, shortening taxi times through improved predictability and sequencing, while single-engine taxi (SET) adoption will continue to increase as procedures mature. Electric ground tugs are expected to become a key fuel-saving measure by mid-century, offering greater reductions than SET, especially at major hubs with long taxi distances. Meanwhile, auxiliary power units (APU) reduction remains a foundational measure, supported by expanded electric ground power and pre-conditioned air (PCA) infrastructure, delivering up to 0.77% fuel savings by 2050. While these measures provide immediate and scalable emissions reductions, achieving their full potential requires significant infrastructure investment and close cross-stakeholder collaboration, with much of the opportunity dependent on airport-side upgrades and enabling government actions rather than airline initiatives.

Flight profile optimization, including climb and descent, vertical efficiency, and horizontal efficiency, offers savings of 0.2–0.9% by 2030, increasing to 0.9–3.4% by 2050, making it a critical component of long-term improvements. The LAC region is performing well on flight efficiency, with horizontal efficiency among the highest globally and climb and descent inefficiencies below the global average, reflecting strong operational practices. However, there is still room to unlock gains, largely from airspace modernization initiatives such as free route airspace (FRA), dynamic route availability, and optimized takeoff and departure separation through tools like optimized runway delivery (ORD) and optimized separation delivery (OSD). Achieving these improvements will require coordinated investment in air traffic management modernization, harmonized cross-border procedures, and strong collaboration among air navigation service providers (ANSPs), regulators, and airlines, supported by robust performance monitoring and behavioral programs to ensure consistent adoption.

Stakeholder coordination is critical to achieving these savings. Operational improvements require close collaboration between airlines, airports, air navigation service providers (ANSPs), regulators, and research organizations. While some measures depend on infrastructure upgrades or airspace modernization, airlines can continue to act through operational procedures, training, performance monitoring programs, and by participating in trials. These early actions not only deliver near-term gains but also build readiness for advanced technologies and regulatory frameworks. The figure below illustrates the level of involvement for each stakeholder across all initiatives, using a scale from minimal (white) to essential (dark blue) responsibility.

Stakeholder involvement by initiative



4.2 Scope and methodology

This study evaluates the potential for operational efficiency improvements in the LAC region, focusing on three categories of initiatives:

1. Aircraft efficiency and planning measures
2. Airport and ground operations
3. Flight profile optimization

The initiatives were selected based on consultations with industry stakeholders and a review of key reference reports, including ICAO's Long-Term Aspirational Goal (LTAG) analysis and the Destination 2050 roadmap[132].

Step 1 – Estimating fuel savings per initiative: For each initiative, the average fuel savings per flight were estimated, drawing on case studies, technical assessments, and other industry reports. Where available, a range of low and high savings values were applied to capture uncertainty. If savings were not already reported as percentages, they were expressed as a percentage reduction by normalizing the absolute fuel savings against the average fuel burn per air traffic movement in the region.

Step 2 – Establishing current implementation levels: Implementation baselines were derived from direct stakeholder input. Three ALTA member airlines, with a combined fleet size of around 300 aircraft, responded to a survey on current and planned adoption of ICAO LTAG measures, and four airlines participated in interviews on operational efficiency practices. This feedback was supplemented with international case studies and published adoption data to refine regional estimates.

[132] https://www.icao.int/sites/default/files/sp-files/environmental-protection/LTAG/Documents/ICAO_LTAG_Report_AppendixM4.pdf; https://www.destination2050.eu/roadmap/

Step 3 – Projecting implementation to 2050: Conservative, mid-range, and ambitious implementation scenarios were developed through 2050. These trajectories were informed by the survey and interview feedback, global implementation benchmarks, and evidence from comparable international contexts. For each measure, the projected implementation rate in a given year was calculated as the difference between baseline adoption and the forecast adoption rate.

Step 4 – Aggregating fuel savings: Annual fleet-wide savings were estimated by multiplying the incremental implementation rate of each initiative by its per-flight savings. In cases where performance varied significantly by aircraft type, both savings and implementation rates were calculated at the aircraft level and then aggregated to the regional fleet.

4.3 Aircraft efficiency and planning measures

4.3.1 Airline performance monitoring systems

Airline performance monitoring systems combine operational planning, real-time monitoring, and post-flight analysis to improve fuel efficiency throughout all flight phases. They use large-scale data and artificial intelligence to detect inefficiencies, recommend best practices, and engage crews in fuel-saving actions. Core functions include optimized fuel planning, in-flight trajectory monitoring, and post-flight feedback. By enabling data-driven decision-making, these systems reduce fuel burn, CO_2 emissions, and operational costs.

A large-scale Virgin Atlantic study highlights the behavioral dimension, testing how feedback and target setting influence pilot behavior[133]. The study introduced three interventions: providing information on fuel-saving opportunities, offering personalized targets, and giving monthly performance feedback. These interventions were grouped into four operational areas: *Flight Plan Savings*, which encouraged pilots to adhere to optimal routing and speed profiles; *Fuel Load*, which focused on reducing discretionary fuel carriage; *Efficient Flight*, which promoted practices such as continuous descent approaches; and *Efficient Taxi*, which encouraged single-engine taxi operations. The results demonstrated that even the announcement of monitoring improved compliance, a phenomenon known as the Hawthorne effect. When combined with feedback and targets, these measures resulted in 7,769 tonnes of saved fuel and 24,472 tonnes of CO_2 avoided during the eight-month trial. This evidence shows the power of combining technology with behavioral strategies to deliver significant efficiency gains.

To avoid double-counting, this study does not model these savings as a standalone measure; instead, benefits are distributed across related initiatives such as reduced APU use, optimized climb and descent, and reduced discretionary fuel.

Implementation responsibility: **Airlines** lead deployment and pilot feedback programs; **Regulators** support data governance.

4.3.2 Optimizing fuel on board

Reduced fuel on board means optimizing fuel loads to carry only what is necessary for planned operations, including contingencies and reserves. This approach minimizes excess carriage and, in turn, reduces in-flight fuel consumption. According to IATA, every additional tonne of fuel carried burns about 30 kg more fuel per hour[134]. In practice, however, additional fuel is often added for safety reasons, including uncertainty related to weather, congestion, or other potential needs to hold or divert.

Airlines that adopt advanced fuel planning practices and performance monitoring systems can achieve meaningful efficiency gains. Airlines have reported up to a 2% saving by improving discretionary fuel management through advanced performance programs[135]. The Virgin Atlantic study reinforces this point: pilots who received feedback and personalized targets achieved an average fuel saving of about 191 kg per flight

[133] https://www.lse.ac.uk/granthaminstitute/publication/impact-management-practices-employee-productivity-field-experiment-airline-captains/

[134] https://www.iata.org/en/publications/newsletters/iata-knowledge-hub/fuel-efficiency-in-aviation-why-it-matters-more-than-ever/

[135] https://blog.openairlines.com/engaging-pilots-in-fuel-efficiency-at-azul-airlines; https://www.aviationbusinessnews.com/low-cost/azul-to-use-skybreathe-360-eco-flying-platform/

through more accurate fuel planning[136]. As external factors such as weather forecasting technology, sequencing tools, and other congestion management measures evolve, the required discretionary fuel may be reduced.

Regulatory flexibility can further enhance efficiency. One airline in the LAC region reported being the only carrier to obtain approval from its civil aviation authority to reduce its discretionary fuel margin on narrowbody aircraft from the standard 5% to 3%. Such approvals typically require robust safety management systems, advanced flight planning tools, and strong operational oversight.

Under an ambitious scenario, airlines adopt advanced fuel management tools that continue to evolve technologically over time, alongside behavioral programs to reduce discretionary fuel carriage. Adoption is projected to reach 50% by 2030, 75% by 2040, and full implementation by 2050, resulting in net savings of 1.5% per flight. In contrast, a conservative scenario assumes adoption lags, based on the least ambitious feedback, and technology remains stagnant, yielding more modest savings of 0.5% per flight.

Dependencies: **Airlines** own fuel policy, analytics, and training; **Regulators** enable reserve policy flexibility; **ANSPs** support procedures that reduce contingency fuel requirements.

4.3.3 Reduced weight on board

Reducing cabin and onboard equipment weight is a proven way to improve fuel efficiency and cut emissions. The Aerospace Technology Institute's FlyZero program analyzed the potential for cabin weight reduction on the A320neo between 2020 and 2030[137]. The study estimated that cabin weight could be reduced by 16% through measures such as installing lightweight seats, optimizing galleys, and removing non-essential items, with seat replacement delivering the largest weight savings. These changes were estimated to cut CO_2 emissions by 0.85% per flight, consistent with ICAO's LTAG range for operational measures (0.65–0.85%).

Two of the three ALTA airlines interviewed expect implementation rates to align with LTAG projections, while one anticipates a slightly lower uptake. These form the ambitious and conservative scenarios in this study. Achieving the ambitious scenario depends on airlines accelerating cabin retrofits, supported by incentives for lightweight materials and supplier partnerships. Regulators can support this by setting weight-reduction targets and publishing best practices, while OEMs and seat manufacturers advance ultra-light designs.

Execution: **Airlines** specify and procure weight saving measures; **Suppliers/Research** advance lightweight designs.

4.3.4 Formation flight

Formation flight is a tactical technique where two or more aircraft fly in close proximity, allowing trailing aircraft to reduce aerodynamic drag and save fuel. In 2021, Airbus demonstrated formation flight under its fello'fly program, flying two A350s from Toulouse to Montreal at about 1.2 nm separation[138]. The trial showed that trailing aircraft could save 5–10% fuel on long-haul flights. Building on these results, Airbus leads the Gain Environmental Efficiency by Saving Energy (GEESE) project under Single European Sky Joint Research (SESAR) through 2026, focusing on operational concepts, safety assessments, and feasibility within European airspace.

Formation flights are most promising on high-density routes with structured tracks, such as the North Atlantic corridor, where predictable traffic flows and long cruise segments create favorable conditions for pairing aircraft[139]. However, operational complexity remains a significant barrier to formation flight and its commercial deployability remains largely unproven. Coordination of departures, flight plans, and precise positioning requires advanced automation, robust aircraft communication, and real-time data sharing. These operations must also be integrated into existing ATC systems while ensuring compliance with safety standards, including

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[136] https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2017/01/working-paper-262-Gosnell-et-al-March-2019.pdf
[137] https://www.ati.org.uk/wp-content/uploads/2022/03/FZO-AIR-POS-0039-Sustainable-Cabin-Design.pdf
[138] https://www.airbus.com/en/newsroom/stories/2024-09-airbus-and-sesar-partners-are-taking-wake-energy-retrieval-to-the-next
[139] https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/EnvironmentReport-2010/ICAO-ENV-Report-2022-F4.pdf

wake turbulence separation. Benefits are asymmetric: trailing aircraft gain most, while lead aircraft see little or none, requiring commercial agreements or incentives between airlines.

Stakeholders expressed optimism about formation flight adoption, though expectations vary. Two airlines projected a 3% adoption rate by 2030, and the third estimated 3% by 2040. Two forecast 15% by 2050, while one projected 10%. These figures form the basis of the ambitious scenario in this study. However, given the significant technological, regulatory, and operational challenges, these projections are considered highly optimistic. The conservative scenario assumes 0% adoption through 2050, reflecting the likelihood that formation flight will remain largely experimental, with only limited operational use by mid-century. This study assumes that formation flight will only be applicable to international flights.

Governance: **ANSPs and Regulators** co-lead procedures and safety cases; **Research organizations** support modeling and testing; **Airlines** participate in research trials and handle commercial agreements.

4.3.5 Aircraft efficiency and planning measures results

Table 27: Aircraft efficiency and planning measures implementation and savings

Measure	Fuel savings (%) *(Low, High)*	Baseline Implementation (%)	Metric	2030 (%) *(Low, High)*	2040 (%) *(Low, High)*	2050 (%) *(Low, High)*
Reduced fuel on board	1 *(0.5, 1.5)*	5	Additional implementation	32.5 *(20, 45)*	57.5 *(45, 70)*	82.5 *(70, 95)*
			Fleet-wide fuel reduction	0.33 *(0.10, 0.68)*	0.58 *(0.23, 1.05)*	0.83 *(0.35, 1.43)*
Reduced weight on board	0.75 *(0.65, 0.85)*	45	Additional implementation	21.7 *(21.7, 21.7)*	36.7 *(36.7, 36.7)*	47.5 *(45, 50)*
			Fleet-wide fuel reduction	0.16 *(0.14, 0.18)*	0.28 *(0.24, 0.31)*	0.36 *(0.29, 0.43)*
Formation flight	7.5 *(5, 10)*	0	Additional implementation	0.5 *(0, 1.0)*	0.7 *(0, 1.3)*	2.9 *(0, 5.8)*
			Fleet-wide fuel reduction	0.04 *(0, 0.10)*	0.05 *(0, 0.13)*	0.22 *(0, 0.58)*
Total fleet-wide fuel reduction				**0.5** ***(0.2, 1.0)***	**0.9** ***(0.5, 1.5)***	**1.4** ***(0.6, 2.4)***

Ambitious scenario: The LAC region accelerates progress through policy incentives, technology adoption, and industry collaboration. Airlines deploy advanced fuel management systems, behavioral programs, and accelerate cabin retrofits during maintenance cycles. OEMs and suppliers deliver ultra-light materials, while digital ATC integration and automation enable formation flight on select long-haul corridors. This scenario assumes strong regulatory support and investment, achieving full realization of savings potential by 2050.

Mid scenario: Progress is steady but incremental. Airlines lead on fuel optimization and weight reduction, driven by cost savings and sustainability commitments. Cabin weight reduction occurs mainly through fleet renewal, and fuel management software becomes standard by 2040. Formation flight adoption remains limited to trials and a few operational routes by 2050. This scenario reflects industry-driven improvements without transformative policy action.

Conservative scenario: Airlines implement only basic operational measures, and cabin weight reduction occurs mainly through natural fleet replacement. Formation flight remains experimental, with no operational deployment by mid-century. Fuel savings are marginal, and the region risks falling behind global best practices.

4.4 Airport and ground operations

4.4.1 Introduction

Ground operations account for about 8% of global aircraft emissions and offer some of the most immediately actionable opportunities to cut fuel burn and CO_2 emissions[140]. However, effective implementation requires coordinated efforts among airport operators, airlines, ground handling providers, and regulatory authorities.

4.4.2 Reduced APU use

Auxiliary power units (APUs) provide power and air conditioning when main engines are off, but they burn jet fuel and emit CO_2 and local pollutants. Their use can be minimized by substituting ground-based systems (aircraft ground energy systems (AGES)), such as fixed ground power units (GPU) and pre-conditioned air (PCA). Expanding AGES use reduces fuel burn, emissions, and noise during ground operations.

A 2016 Zurich Airport study assessed AGES and PCA impacts across 269,160 aircraft movements[141]. Emission intensity was found to vary significantly: APUs emit 337 kg CO_2/h for short-haul aircraft versus 0.7 kg CO_2/h for electric AGES, and 758 kg CO_2/h versus 1.2 kg CO_2/h for long-haul. Emissions, which totaled 50,066 tonnes of CO_2 when relying solely on APUs, fell to 8,945 tonnes with partial AGES deployment, and dropped to 2,131 tonnes under full deployment. This equates to a per-flight saving of about 178 kg of CO_2 between minimum and maximum scenarios.

By 2018, 55% of European gates had ground power and 27% had PCA[142]. Airports have driven APU reduction through strict limits: Heathrow restricts narrowbody APU use to 15 minutes before departure and 10 minutes after arrival, while Schiphol plans a five-minute limit and full PCA coverage, alongside trials of hydrogen-powered GPUs[143]. Airlines and governments support these efforts. easyJet is deploying hybrid PCA units at Milan Malpensa under Project APU-ZERO, and Germany funded €1.9 million for 15 e-GPUs at Cologne Bonn[144]. Additionally, software solutions, such as Assaia's Turnaround Control Product, can optimize GPU use, and have achieved savings of 5 kg CO_2 per flight[145].

In Brazil, Engie and Inframerica installed solar-powered ground power and PCA systems at Brasília International Airport in 2019, saving an estimated 15 kt of CO_2 annually[146]. The project is expanding to 26 jet bridges and being implemented at Porto Alegre, Fortaleza, and São Paulo International Airports, collectively reducing CO_2 emissions by 76 kt per year and covering 28% of the Brazilian market. Airlines are also participating, through signing agreements with suppliers to reduce their APU use.

APU alternative adoption in the LAC region remains well below Europe, with deployment estimated at 20%, similar to ICAO LTAG global averages. Many airports lack fixed ground power and PCA, forcing reliance on APUs or costly self-provision. Renewable-powered AGES is often more expensive than diesel, and pricing structures

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[140] https://www.iata.org/contentassets/d1d4d535bf1c4ba695f43e9beff8294f/airport-environmental-sustainability-policy.pdf

[141] https://www.flughafen-zuerich.ch/-/jssmedia/airport/portal/dokumente/das-unternehmen/politics-and-responsibility/environmental-protection/technische-berichte/2018_zrh_aircraft-ground-energy-system.pdf?vs=1

[142] https://www.destination2050.eu/wp-content/uploads/2023/03/The-Price-of-Net-Zero-Report.pdf

[143] https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/team-heathrow/airside/operational-safety-insttructions/ASEnv_OSI_078%20Use%20of%20Aircraft%20Auxillary%20Power%20Units_v2.pdf; https://news.schiphol.com/action-plan-targets-reduced-auxiliary-power-unit-apu-use-by-stationary-aircraft-at-schiphol/; https://news.schiphol.com/world-first-at-schiphol-airport-tests-the-first-hydrogen-gpu/

[144] https://avitrader.com/2025/03/13/easyjet-rolls-out-project-apu-zero-at-milan-malpensa/; https://www.cologne-bonn-airport.com/en/company/newsroom/press-releases/detail/airport-invests-in-electric-gr

[145] https://worldaviationfestival.com/blog/airlines/apronai-case-study-reducing-kerosene-costs/

[146] https://www.engie.com.br/en/imprensa/press-releases/a-pioneer-in-the-decarbonization-of-airports-in-brazil-engie-supplies-aircraft-with-renewable-energy-and-reduces-emissions/

rarely incentivize low-emission options. Based on Zurich data and performance monitoring, reducing APU use could save about 183 kg of CO_2 (≈58 kg fuel) per turn, or 0.96% per flight.

Accelerating APU reduction in the LAC region requires coordinated action. Airports must expand AGES availability despite high costs, which average €150,000–170,000 for ground power and €240,000–270,000 for PCA units[147]. Regulators can drive adoption through APU time limits, emissions-based charges, and financial incentives. Airlines should commit via offtake-style agreements to guarantee demand, but such commitments will only be viable where pricing is cost-competitive. If current trends persist, adoption may reach 50% by 2050, a decade behind ICAO LTAG targets. With strong intervention through funding, clear operational mandates, and regional coordination, penetration could rise to 90% by 2050.

Roles: **Airports** deliver GPU/PCA availability alongside APU time limits; **Airlines** commit via offtake/usage and track compliance; **Policymakers** incentivize clean energy; **Suppliers** and **Research Institutions** develop more efficient technologies.

4.4.3 Efficient taxiing

4.4.3.1 Single engine taxi

Single engine taxi (SET) uses one engine instead of two for taxiing between the gate and runway (SET-out) or vice versa (SET-in), reducing fuel burn and emissions while maintaining safe ground operations[148]. In Europe, adoption remains limited: fewer than 10% of flights use SET-out, compared with about 50% for SET-in. This gap reflects safety and operational constraints[149]. SET-out adds workload for pilots and ATC, poses fire risks during engine warm-up, and requires time to start the second engine before take-off. SET-in also needs a cool-down period before shutdown. Both processes take about three minutes and require coordination, and minimum taxi time must be available for feasibility. Some airports prohibit SET entirely, while others restrict it in situations such as crossing active runways due to engine failure risk[150].

Despite these challenges, airlines in the LAC region have made significant progress in capturing fuel savings from SET. For instance, one ALTA airline achieved a 90% SET rate through strong procedures, culture, and training, showing that barriers can be overcome. Wider adoption is likely as Airbus now recommends SET as a default procedure, and improved ground-aircraft communication helps confirm minimum taxi time thresholds[151]. Technology also supports performance monitoring. For example, Volaris used Storkjet tools to find pilots at Cancún averaged 4:14 minutes of SET versus a possible 6:36 minutes, indicating room for improvement[152].

In 2019, average taxi-out and taxi-in times at 23 LAC airports were 20:36 and 8:48 minutes, similar to large US airports[153]. Using these figures, the regional fleet mix, and SESAR estimates, a flight using both SET-out and SET-in saved about 2.2% fuel compared to one using neither (see *Table 28*).

Table 28: Average SET benefits by aircraft type

Aircraft category	Fuel savings (kg/min)	Taxi-out saving (kg/aircraft)	Taxi-in saving (kg/aircraft)
Turboprop	2	41	18
Regional Jet	4	82	35
Narrowbody Jet	5	103	44

147 https://www.destination2050.eu/wp-content/uploads/2023/03/The-Price-of-Net-Zero-Report.pdf
148 https://www.sesarju.eu/sites/default/files/documents/webinars/Guiseppe.pdf
149 https://www.sesarju.eu/sites/default/files/documents/webinars/Guiseppe.pdf
150 https://www.eurocontrol.int/sites/default/files/2024-07/eurocontrol-sustainable-taxi-operations-conops.pdf
151 https://aircraft.airbus.com/en/services/enhance/system-upgrades/single-engine-taxi-without-auxiliary-power-unit-setwa
152 https://storkjet.com/wp-content/uploads/2024/06/Volaris-Case-Study-2024.pdf
153 https://ansperformance.eu/efficiency/; https://www.atlantis-press.com/proceedings/icmsem-23/125992457

Widebody Jet	10	206	88

Specific LAC data is limited, but rates are likely similar to Europe, about 10% for SET-out and 50% for SET-in, given comparable safety rules and fuel-saving goals. Increasing adoption will require more than technology improvements: airports need to provide clear operational guidance, regulators should standardize SET procedures, and airlines must embed SET into training and performance monitoring. Better ground-aircraft communication and integration of SET into flight planning tools will also be critical to achieving higher uptake.

Adoption levers: **Airlines** update standard operating procedures (SOPs), training, and monitoring; **Airports/ANSPs** provide clear local guidance and taxi-time predictability.

4.4.3.2 Airport collaborative decision making

Airport collaborative decision making (A-CDM) improves airport efficiency, predictability, and resource use by enabling real-time information sharing among airport operators, ATC, airlines, ground handlers, and network managers. By sharing key milestones such as target off-block time (TOBT), target start-up approval time (TSAT), and target take-off time (TTOT), A-CDM optimizes departure sequencing, reduces taxi delays, and supports fuel-saving measures such as SET.

A-CDM is in place at 34 European airports, while smaller airports use alternatives such as Advanced ATC Tower when full implementation is not justified[154]. EUROCONTROL's review of 17 airports found an average taxi time reduction of 7%[155]. Thirteen reported measurable taxi-out savings, with seven achieving reductions of one minute or more per flight. At Heathrow, improved A-CDM accuracy cut average deviation from planned take-off time from 8:40 minutes to 30 seconds. Implementing A-CDM requires strong stakeholder coordination, robust digital infrastructure, and accurate real-time data. EUROCONTROL estimates costs at €750,000 to €5,000,000 with annual operating costs of €50,000 to €500,000.

In 2025, El Dorado International Airport in Bogotá became the first in Latin America to implement A-CDM, enabling data sharing among airlines, ground handlers, and ATC[156]. Regional adoption can advance if airports and airlines establish clear CDM processes, commit to data sharing and joint training, and deploy airport operations centers focused on efficiency. A-CDM can also integrate with ATCO CDM (see Section 4.5.4.3), requiring regional coordination. Under an ambitious scenario, A-CDM could cover airports handling 25% of LAC flights by 2030 and 50% by 2040. This study estimates a 7% reduction in taxi-out times, noting that A-CDM also enables other operational improvements.

Accountability: **Airports** lead operations centers and data sharing; **ANSPs** integrate ATC milestones; **Airlines** provide accurate TOBT/TSAT inputs and comply with calculated time of take-off windows.

4.4.3.3 Electric tugs

Electric tugs are specialized towing tractors that allow aircraft to taxi without using their jet engines. A notable example is the TaxiBot, which was developed in 2009 by Israel Aerospace Industries (IAI) in partnership with TLD, a ground service equipment company, and entered service in 2014 with Lufthansa at Frankfurt Airport[157]. According to Lufthansa, using TaxiBot can save around 50–100 kg of fuel per Boeing 737 flight[158]. In India, TaxiBot has been in commercial use since 2018 and is now deployed at several airports. At Delhi, A320 and 737 operations save about 532 kg of CO_2 per aircraft for a 14-minute TaxiBot tow[159]. In Europe, TaxiBot is being trialed under SESAR's Highly Efficient Green Operations (HERON) initiative, with large-scale adoption projected

[154] https://www.eurocontrol.int/concept/airport-collaborative-decision-making
[155] https://www.eurocontrol.int/sites/default/files/2019-04/a-cdm-impact-assessment-2016.pdf
[156] https://www.sita.aero/pressroom/news-releases/el-dorado-becomes-first-airport-in-latin-america-to-implement-a-cdm-system/
[157] https://taxibot-international.com/
[158] https://taxibot-international.com/2017/10/09/iais-taxibot-obtained-faa-certification-for-the-boeing-737-family/
[159] https://www.tld-group.com/technologies/taxibot/

to cut fuel consumption by up to 50% and as much as 85% on longer taxi routes[160]. While TLD announced plans to introduce TaxiBots to Brazil in 2015, no further updates have been reported[161].

Currently, TaxiBot is certified for A320 and 737 families, with a widebody version planned and fully electric version expected by 2026. Destinations 2050 estimates that a narrowbody electric tug costs around €1.4 million, with widebody versions costing roughly double. Assuming three minutes to couple, two to decouple, and six hours of daily use, most airports would need five or fewer units, while major hubs could require over 80[162]. These figures highlight the scale of investment and infrastructure planning needed for widespread adoption in the LAC region, for which airports and ground handlers would likely be the primary cost bearers.

Widespread electric tug use in the LAC region will require coordinated investment and policy support. Airports and ground handling providers should fund the acquisition of electric tugs and supporting infrastructure such as charging stations and maintenance facilities, while governments can accelerate adoption through financial incentives and green financing programs. Airlines need to incorporate electric tug operations into their procedures and work with airports to optimize turnaround processes. Early adoption can begin with pilot programs at major hubs, allowing stakeholders to test operations, train crews, and collect performance data to build a strong business case for wider deployment.

Because electric tugs save more taxi fuel than SET, they are expected to be preferred. Under an ambitious scenario, adoption could reach 10% for narrowbodies by 2030 and 80% by 2050. For widebodies, adoption is unlikely before 2030 but could rise to 60% by 2050. The total implementation of the ambitious scenario is similar to ICAO's LTAG, whereas the baseline scenario aligns closely with stakeholder feedback.

Suggested roles: **Airports/Handlers** support tugs/charging; **Policymakers** offer green financing and incentives; **Airlines** adjust turnaround processes to integrate tug operations and participate in business-case pilots.

4.4.3.4 Efficient taxi sub-results

Table 29: Efficient taxi implementation and savings

Improvement	Fuel savings (%)[163]	Baseline implementation (%)	Metric	2030 (%) *(Low, High)*	2040 (%) *(Low, High)*	2050 (%) *(Low, High)*
SET	NB: 2.77 WB: 0.85	22	Additional implementation	13 *(8, 18)*	14.1 *(18, 10.2)*	8.6 *(28, -10.9)*
			Fleet-wide fuel reduction	0.28 *(0.17, 0.38)*	0.32 *(0.39, 0.26)*	0.18 *(0.59 -0.2)*
A-CDM	NB: 0.45 WB: 0.15	0	Additional implementation	15 *(5, 25)*	30 *(10, 50)*	45 *(20, 70)*
			Fleet-wide fuel reduction	0.05 *(0.02 0.09)*	0.11 *(0.04, 0.18)*	0.16 *(0.07, 0.25)*
Electric tugs	NB: 3.2-5.5 WB: 1.1-1.9	0	Additional implementation	4.7 *(0, 9.5)*	33.6 *(0.95, 57.8)*	49.7 *(20.5, 78.9)*
			Fleet-wide fuel reduction	0.15 *(0, 0.37)*	1.06 *(0.22, 2.3)*	1.65 *(0.54, 3.22)*

[160] https://www.airbus.com/en/newsroom/stories/2025-07-taxibots-spool-up-as-project-heron-winds-down
[161] https://airconnected.com.br/releases/novidade-do-tld-group-em-equipamentos-aeroportuarios-taxibot-chega-em-breve-ao-pais/
[162] https://www.destination2050.eu/wp-content/uploads/2023/03/The-Price-of-Net-Zero-Report.pdf
[163] NB: Narrowbody; WB: Widebody

Total fleet-wide fuel reduction			**0.5** ***(0.2, 0.8)***	**1.5** ***(0.6, 2.7)***	**2.0** ***(1.2, 3.3)***

4.4.4 Ground maintenance

Ground maintenance refers to routine actions that maintain engine and airframe performance to minimize fuel burn. These measures include, among others, on-wing engine washing, blade repair or replacement, and exterior cleaning to reduce drag. These measures prevent performance degradation that increases fuel consumption. Case studies show significant benefits. Pratt & Whitney's EcoPower engine wash program reports fuel savings of up to 1.2% per wash, and Southwest Airlines has saved over 9 million gallons of fuel and avoided about 90,000 tonnes of CO_2 since 2006[164].

The LTAG estimates the emission reductions from ground maintenance improvements to be between 0.2–1.9% a flight, and its implementation to be 30% in 2020, 50% in 2030, 70% in 2040, and 100% in 2050. Airlines in the LAC region estimate a slightly lagging implementation to these numbers until 2040, but it can be accelerated through airline investment in maintenance procedures.

Responsibility: **Airlines and MROs** schedule and execute programs; **Research** pinpoints effective mechanisms.

4.4.5 Airport and ground operations results

Table 30: Airport and ground operations implementation and savings

Improvement	Fuel savings (%) *(Low, High)*	Baseline Implementation (%)	Metric	2030 (%) *(Low, High)*	2040 (%) *(Low, High)*	2050 (%) *(Low, High)*
Reduced APU use	0.96	10	Additional implementation	20 *(10, 30)*	45 *(30, 60)*	60 *(40, 80)*
			Fleet-wide fuel reduction	0.19 *(0.1, 0.29)*	0.43 *(0.29, 0.58)*	0.58 *(0.38, 0.77)*
Efficient taxi	N/A	N/A	Fleet-wide fuel reduction	0.5 *(0.2, 0.8)*	1.5 *(0.6, 2.7)*	2.0 *(1.2, 3.3)*
Ground maintenance	1.05 *(0.2, 1.9)*	25	Additional implementation	20 *(15, 25)*	45 *(45, 45)*	75 *(75, 75)*
			Fleet-wide fuel reduction	0.21 *(0.03, 0.48)*	0.47 *(0.09, 0.86)*	0.79 *(0.15, 1.43)*
Total fleet-wide fuel reduction				**0.88** ***(0.32, 1.60)***	**2.40** ***(1.02, 4.17)***	**3.36** ***(1.74, 5.45)***

Ambitious scenario: The LAC region accelerates progress through strong policy support, coordinated investment, and digital integration. Airports expand AGES and PCA availability and invest in electric tug infrastructure, while airlines commit to using these systems through offtake agreements. SET adoption is optimized through technology, behavioral programs, and procedural improvements, and electric tug roll out at major hubs. A-CDM becomes standard at large airports, supported by airport operations centers and robust

[164] https://carbonoffsetsdaily.com/news-channels/usa/southwest-airlines-saves-millions-on-fuel-and-reduces-co2-emissions-with-pratt-whitney-ecopowerr-engine-wash-6787.htm

data sharing. Regulators enforce APU time limits, incentivize low-emission ground power, and provide green financing for electric tugs, while technology providers deliver cost-effective AGES, electric tugs, and digital platforms for turnaround optimization. This scenario reflects full industry collaboration and policy leadership to achieve maximum efficiency gains.

Mid scenario: Progress is steady but uneven. Airports gradually expand AGES and PCA, but investment in electric tugs remains limited. Airlines adopt SET widely but delay large-scale electric tug integration due to cost and infrastructure gaps, and A-CDM is implemented at some hubs only. Regulators introduce some APU restrictions and incentives, but measures lack consistency across the region. Airlines and airports collaborate on training and data sharing, but without strong policy or financing, adoption of advanced technologies remains slow. Efficiency gains are achieved, but significant potential remains untapped.

Conservative scenario: Adoption remains minimal due to weak regulatory action and limited investment. Some private operators continue to implement AGES and PCA, but high renewable energy costs make diesel GPUs more attractive, slowing the transition to low-emission ground power. Airlines implement SET inconsistently, and electric tugs remain largely absent. A-CDM is deployed at only a few airports. Regulators fail to enforce APU limits or provide meaningful incentives, and technology providers see little demand for advanced solutions. Fuel savings are marginal, and the region risks falling behind global best practices.

4.5 Flight profile optimization

4.5.1 Introduction

Flight profile optimization focuses on improving the efficiency of aircraft trajectories to reduce fuel burn and emissions. It involves stakeholders including air navigation service providers (ANSP), regulators, and airlines, working together to minimize inefficiencies in climb, cruise, and descent. A notable example is the UK's NATS 3Di metric, which measures airspace efficiency by comparing actual flight paths against an optimal trajectory based on great-circle routing and requested flight levels[165]. The UK Civil Aviation Authority (CAA) regulates this system and incentivizes performance by linking financial rewards or penalties to 3Di scores, with potential impacts equivalent to 1% of NATS' annual revenue. EUROCONTROL applies a similar approach through its performance review system, which tracks flight efficiency across European airspace to support continuous optimization and reduce aircraft-related CO_2 emissions.

4.5.2 Climb and descent optimization

Climb and descent phases offer significant opportunities to cut fuel burn through optimized profiles and procedures. Continuous climb operations (CCO), continuous descent operations (CDO), and reduced flap landings minimize level-offs, reduce drag, and improve efficiency. These measures depend on both technology and behavior, requiring advanced navigation capabilities, ATC coordination, and consistent pilot adherence supported by training and monitoring.

4.5.2.1 Optimized climb and descent operations

CCO and CDO allow aircraft to climb and descend without unnecessary level-offs, reducing thrust changes and time at inefficient altitudes. Optimized Top of Descent (ToD) ensures descent begins at the most efficient point based on performance and wind conditions.

CCO and CDO are widespread globally. A 2017 EUROCONTROL study found 94% of flights in Europe use CCO up to FL100 and 74% to top of climb, while 41% use CDO from FL75 and 24% from top of descent[166]. In ICAO's SAM region, rates were much lower at 34% for CDO and 26% for CCO, below the 40% target set by the Declaration of Bogota[167]. Performance-based navigation (PBN) is a key enabler of CCO and CDO because it

[165] https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/EnvironmentalReports/2016/ENVReport2016_pg138-140.pdf
[166] https://www.eurocontrol.int/concept/continuous-climb-and-descent-operations
[167] https://www2023.icao.int/SAM/Documents/2017-RAAC15/RAAC15_WP08.pdf

allows aircraft to follow precise lateral and vertical paths, reducing the need for level-offs[168]. In the SAM region, PBN coverage reached 71% for departures and 55.7% for arrivals in 2024, up from 66% and 50.7% in 2019[169].

Studies show CDO delivers greater benefits than CCO. EUROCONTROL estimated flights not using CDO could save 46 kg of fuel per flight, compared with 15 kg for CCO[170]. As part of its 2022 Environmental Report, ICAO conducted a climb and descent study by region, which quantified the fuel burn from inefficient climb and descents on an average basis of all flights in the respective regions (see *Table 31*)[171]. The results show that the potential savings (i.e., inefficiency) across the Caribbean and South America regions are significantly less than the global average.

Table 31: Average savings potential from CDO and CCO by ICAO region

ICAO region	CDO excess fuel (kg)	CCO excess fuel (kg)
Asia and Pacific (APAC)	47	13
Eastern and Southern Africa (ESAF)	23	2
European and North Atlantic (EUR/NAT)	37	4
Middle East (MID)	60	9
North America (NAM)	43	5
Caribbean / South America (CAR/SAM)	**24**	**3**
Western and Central Africa (WACAF)	20	1
Total	**41**	**7**

Performance monitoring has proven effective in improving compliance. For example, NATS in the UK reports that continuous descent approach (measured from around 6,000 ft.) performance improved from 56% to 76% between 2006 and 2016 through monitoring and feedback[172]. EUROCONTROL publishes CDO metrics by state, airline, and airport, showing significant variation: in 2024, Estonia achieved 71.5% CDO from top of descent compared to 13.1% in Germany, with an average of 33%[173]. Airlines can also benefit from monitoring. Wizz Air, working with Storkjet and the Silesian University of Technology, introduced a key performance indicator (KPI) for descent fuel consumption and provided monthly feedback to pilots[174]. This reduced total descent fuel consumption by 8% in the first year, driven by better speed compliance and more accurate top of descent estimates. However, a 2019 survey found that fewer than 30% of airlines measure their own CCO/CDO performance[175].

Further climb and descent efficiency gains can be achieved through advanced navigation procedures. Advanced required navigation performance (RNP) procedures, part of the PBN framework, enable aircraft to follow highly precise paths with onboard performance monitoring and alerting. This precision reduces track

[168] https://www.sciencedirect.com/science/article/pii/S0306261925001205
[169] https://www2023.icao.int/NACC/Documents/Meetings/2023/GREPECAS21/GRP21WP10.pdf
[170] https://www.eurocontrol.int/concept/continuous-climb-and-descent-operations
[171] https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/EnvironmentReport-2010/ICAO-ENV-Report-2022-F4.pdf
[172] https://skybrary.aero/sites/default/files/bookshelf/5881.pdf
[173] https://ansperformance.eu/efficiency/vfe/
[174] https://skybrary.aero/sites/default/files/bookshelf/5881.pdf
[175] https://www2023.icao.int/environmental-protection/Documents/EnvironmentalReports/2019/ENVReport2019_pg145-152.pdf

miles and supports CCO and CDO. At Santiago, advanced RNP departures were introduced to provide accurate lateral and vertical paths, and when combined with independent parallel approaches under visual conditions, these changes delivered an estimated annual saving of 380 tonnes of fuel[176]. Similarly, at Concepción and Atacama airports, advanced RNP approaches shortened arrival paths and improved top-of-descent consistency, resulting in an estimated annual saving of 192 tonnes of fuel for one airline.

For the LAC region, ICAO's potential improvements are used as a baseline for potential savings. Because the ICAO analysis already accounts for the current mix of optimized and non-optimized flights, this study sets a baseline implementation of 0% in 2019 for modeling purposes, even though airlines already apply climb and descent optimization practices. While CCO and CDO are unlikely to ever be fully optimized due to terrain, airspace constraints, and traffic complexity, significant improvements are possible. These depend on expanding PBN coverage, deploying advanced flight management and trajectory tools, and strengthening performance monitoring. Regular feedback to airlines and pilots, supported by clear KPIs and post-operations analysis, has proven effective in other regions and should be scaled in the LAC region. This study assumes that of the remaining potential savings, an additional 15% can be realized per decade. For CDO, the NAM region's average savings are used for flight landing outside of the LAC region.

Delivery model: **ANSPs** enable PBN and RNP procedures and provide clearances; **Airlines** integrate these into SOPs, expand pilot training, and implement performance monitoring and optimization programs; **Regulators** set performance targets and ensure transparency.

4.5.2.2 Reduced flaps

Reduced landing flaps is a procedure where aircraft land using a lower flap setting when conditions allow. This reduces aerodynamic drag on final approach, requiring less engine thrust and lowering fuel burn. The procedure is only used when runway length, weather, and aircraft weight permit, and it does not compromise safety.

Industry experience suggests that reduced flap landings save about 7 to 10 kg of fuel per landing for a narrowbody aircraft and up to 25 kg for a widebody[177]. An analysis involving Airbus found that Wizz Air saves around 15 kg of fuel per approach using reduced flap landing and leads the industry in terms of adoption[178]. While there is limited public information on reduced flap configuration in the LAC region, there are indications that it has been successfully implemented by some carriers.

Accelerating reduced flap adoption requires standardized procedures across eligible airports, supported by electronic flight bag prompts, pilot training, SOP integration, and performance monitoring with feedback. Under an ambitious scenario, these measures are implemented region-wide by 2040, while in a conservative scenario, adoption remains limited to a few carriers and airports. While the current use rate of reduced flap procedures is not known in the LAC region, it is assumed to be around 30%, around the maximum rate given current technology. In an ambitious scenario, this could rise by around 10% per decade.

Enablement: **Airlines** are responsible for developing and updating SOPs, delivering targeted pilot training, and implementing performance monitoring programs; **Airports** support by publishing local procedures and ensuring runway conditions allow reduced flap operations.

[176] IATA
[177] https://blog.openairlines.com/what-you-need-to-know-about-reduced-landing-flaps
[178] https://www.wizzair.com/en-gb/information-and-services/about-us/news/2020/10/29/wizz-air-develops-new-fuel-saving-initiatives-in-commitment-to-reducing-emissions

4.5.2.3 Climb and descent operations sub results

Table 32: Implementation and savings from climb and descent operations

Improvement	Fuel savings (%)	Baseline implementation (%)	Metric	2030 (%) *(Low, High)*	2040 (%) *(Low, High)*	2050 (%) *(Low, High)*
CCO	0.05	0	Additional implementation	10 *(5, 15)*	20 *(10, 30)*	30 *(15, 45)*
			Fleet-wide fuel reduction	0.00 *(0.00, 0.01)*	0.01 *(0, 0.01)*	0.01 *(0.01, 0.02)*
CDO	0.44	0	Additional implementation	10 *(5, 15)*	20 *(10, 30)*	30 *(15, 45)*
			Fleet-wide fuel reduction	0.04 *(0.02, 0.07)*	0.09 *(0.04, 0.13)*	0.13 *(0.07, 0.2)*
Reduced flaps	0.16 *(0.13, 0.18)*	30	Additional implementation	5 *(0, 10)*	12.5 *(5, 20)*	20 *(10, 30)*
			Fleet-wide fuel reduction	0.01 *(0, 0.02)*	0.02 *(0.01, 0.04)*	0.03 *(0.01, 0.05)*
Total fleet-wide fuel reduction				**0.06** ***(0.02, 0.09)***	**0.12** ***(0.06, 0.18)***	**0.18** ***(0.09, 0.27)***

4.5.3 En-route vertical efficiency

En-route vertical efficiency means reducing time spent cruising below the optimum flight level. When aircraft cannot reach or maintain efficient altitudes due to separation standards, traffic constraints, or communication delays, fuel burn and emissions rise. ICAO's 2025 analysis of vertical flight efficiency (VFE-ER) shows additional fuel burn increases with stage length, from 49.7 kg for flights under 500 nm to 267.6 kg for flights over 6,500 nm[179]. The global average inefficiency was 63.2 kg per flight, highlighting a major improvement opportunity.

4.5.3.1 Geometric Altimetry and RVSM Phase 2

Geometric altimetry uses GNSS-based measurements to determine true altitude, enabling more precise vertical separation than barometric systems. It underpins reduced vertical separation minima (RVSM) Phase 2, which proposes reducing minimum separation from 1,000 ft to 500 ft, allowing aircraft to fly closer to optimal profiles. The original RVSM, which cut separation from 2,000 ft to 1,000 ft, was implemented between 1997 and 2005 and reduced fuel burn over Europe by 1.6–2.3%[180]. It is expected that the savings from RVSM Phase 2 will be similar.

Currently, RVSM Phase 2 remains in the concept and validation phase under SESAR and ICAO programs, with trials focused on safety, wake turbulence, and avionics standards. Implementation will require global standardization, GNSS equipment, and regulatory alignment. Under an ambitious scenario, early adoption of geometric altimetry and RVSM Phase 2 procedures could begin in select corridors by the 2040s, supported

[179] https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/EnvironmentReport-2010/2025/Envreport2025_38.pdf

[180] Reduced Vertical Separation Minima (RVSM) | SKYbrary Aviation Safety; https://www.sesarju.eu/sites/default/files/documents/awards2021/R-WAKE%20and%20GEOMETRIC%20ALTIMETRY.pdf

by ANSP modernization and airline equipage programs. A conservative scenario assumes no RVSM Phase 2 adoption within the study horizon, limiting gains to procedural improvements.

Prerequisites: **ANSPs and regulators** lead standards development and safety validation; **Research** support system performance testing; **Airlines** prepare for future capability upgrades and procedural integration.

4.5.3.2 ITP and Satellite-Based VHF Communications

Oceanic vertical optimization is essential for long-haul flights crossing non-surveillance airspace, where procedural separation often forces aircraft to cruise below their optimum altitude for extended periods. Two key enablers, in-trail procedure (ITP) and satellite-based very-high frequency (VHF) communications, are designed to overcome these constraints and unlock more efficient altitude management.

ITP is an automatic dependent surveillance-broadcast (ADS-B) In application that lets an aircraft climb or descend through another aircraft's altitude on the same track using distance-based separation[181]. Federal Aviation Administration (FAA) trials in Oakland and Anchorage flight information regions (FIRs) reported average savings of 573 lb (≈260 kg) per flight for ITP-equipped aircraft, even without maneuvers, thanks to better situational awareness and earlier altitude changes.

Satellite-based VHF, demonstrated under SESAR's ECHOES program, provides voice and data connectivity over oceanic and remote regions[182]. The ECHOES project achieved the first-ever satellite-based VHF voice communication between a pilot and an ATC center over the Atlantic in 2025, confirming the feasibility[183]. These trials, involving Iberia, Air Europa, and TAP Air Portugal, demonstrated that satellite VHF can support reduced separation and dynamic altitude management in oceanic corridors. SESAR has announced that the next phase of testing will include the South Atlantic corridor in partnership with Brazil, a critical step for LAC region operations.

Based on airline feedback, this study assumes an initial ITP implementation rate of 25 % in 2020, increasing to between 80 and 90 % by 2050. These savings are applied only to widebody flights, used as a proxy for long-haul, where ITP procedures are relevant. The benefits of satellite-based VHF are not quantified separately in this analysis due to limited data, but the technology is recognized as a critical enabler for achieving these adoption levels. Achieving high adoption requires aircraft to be equipped with ADS-B In, as well as air traffic management system upgrades to process ITP requests. Investment requirements are significant. ICAO LTAG estimates that oceanic air traffic management system upgrades for ITP will cost approximately $3,000,000 per system and for airlines, ADS-B In equipage and activation are estimated at $15,000 per aircraft[184]. These figures highlight the need for coordinated investment by ANSPs, airlines, and technology providers to achieve high adoption.

Co-investment: **ANSPs** upgrade air traffic management systems; **Airlines** equip ADS-B In and participate in research and trials; **Regulators** coordinate cross-FIR procedures; **Research organizations** support technology validation, operational trials, and performance analysis.

4.5.3.3 Contrail mitigation altitude changes

Contrail mitigation involves adjusting cruise altitude to avoid cold, humid layers where persistent contrails form, which are a major contributor to aviation's non-CO_2 climate impact. Unlike other measures in this section, contrail mitigation does not save fuel; it increases fuel burn on adjusted flights. Studies and trials indicate that flights avoiding contrail-forming regions typically burn about 2% more fuel on those adjusted flights[185].

However, contrail formation is highly concentrated: research shows that around 5% of flights account for 80% of contrail-related warming[186]. This means that targeted strategies can deliver significant climate benefits with limited operational impact. Under such targeted programs, the estimated fleet-wide fuel increase is 0.01–

[181] https://www.faa.gov/air_traffic/technology/adsb/pilot/itp
[182] https://www.sesar.eu/news/testing-get-underway-2025-low-orbit-satellite-communication-technology
[183] https://www.enaire.es/en_GB/2025_06_24/ndp_gb_startical_successfully_launched_second_satellite_iod2
[184] https://www.icao.int/sites/default/files/sp-files/environmental-protection/LTAG/Documents/ICAO_LTAG_Report_AppendixM4.pdf
[185] https://blog.google/technology/ai/ai-airlines-contrails-climate-change/
[186] https://notebook.contrails.org/contrails-org-why-its-time-to-change-course-for-the-climate/

0.3%, even while mitigating a large share of contrail warming[187]. In this study, these averages are adjusted downward by 50% because flights departing from the LAC region are less likely to require large diversions, given that the most contrail-sensitive areas are concentrated in other regions such as the North Atlantic corridor. Despite the additional fuel burn, contrail mitigation remains a strong climate measure, and in this study, an ambitious implementation scenario is treated as the high case, reflecting its likely adoption alongside other major operational improvements.

Decision framework: **Research** provides contrail forecasts and impact metrics; **ANSPs/Regulators** enable tactical flexibility; **Airlines** apply targeted altitude adjustments.

4.5.3.4 En-route vertical efficiency sub results

Table 33: Implementation and savings from vertical en-route improvements

Improvement	Fuel savings (%)	Baseline implementation (%)	Metric	2030 (%) *(Low, High)*	2040 (%) *(Low, High)*	2050 (%) *(Low, High)*
RVSM	1.95 *(1.60, 2.30)*	0	Additional implementation	0	10 *(0, 20)*	15 *(0, 30)*
			Fleet-wide fuel reduction	0	0.20 *(0, 0.46)*	0.29 *(0, 0.69)*
ITP	0.76 *(0.65, 0.87)*	8	Additional implementation	6.33 *(0, 12.65)*	13.45 *(7.91, 18.98)*	20.56 *(17.4, 23.73)*
			Fleet-wide fuel reduction	0.05 *(0, 0.11)*	0.10 *(0.05, 0.17)*	0.16 *(0.11 0.21)*
Contrail mitigation	-0.08 *(-0.01, -0.15)*	0	Additional implementation	5 *(0, 10)*	20 *(10, 30)*	50 *(20, 80)*
			Fleet-wide fuel reduction	0.00 *(0, -0.02)*	-0.02 *(0, -0.05)*	-0.04 *(0, -0.12)*
Total fleet-wide fuel reduction				**0.04** ***(0, 0.10)***	**0.28** ***(0.05, 0.58)***	**0.41** ***(0.11, 0.78)***

4.5.4 Horizontal efficiency

An ICAO study on 2017 traffic estimated horizontal flight efficiency at 94–98% by region, with South America and ESAF near 98% and the Caribbean just over 97%[188]. This shows the LAC region already operates with high horizontal efficiency; however, targeted measures such as airspace modernization, harmonized charging structures, collaborative flow management, and dynamic separation tools can still deliver incremental gains. Even under ambitious scenarios, 100% efficiency is unrealistic due to persistent constraints such as weather deviations, temporary airspace reservations, terrain limits, and sequencing requirements near airports.

4.5.4.1 Airspace Modernization

Flights traditionally followed fixed airways, often causing inefficient routing and a higher fuel burn. Free route airspace (FRA) allows airlines to plan direct trajectories between defined entry and exit points when airspace is available. FRA has delivered major gains in Europe, reducing average route extension from 3.58% in 2007 to

[187] https://www.transportenvironment.org/articles/contrail-avoidance

[188] https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/EnvironmentReport-2010/ICAO-ENV-Report2019-F1-WEB-1.pdf

1.59% in 2024[189]. EUROCONTROL estimates that FRA now covers more than 75% of European airspace and that full implementation could save 6 Mt of fuel.

In the LAC region, under the CANSO ATFM Data Exchange Network for the Americas (CADENA) project, end-to-end optimization trials were run on four routes between the US and Latin America for 90 days[190]. The savings, when extrapolated to a year (one aircraft, five weekly flights), were substantial: Atlanta–Lima: 845,360 kg CO_2, Atlanta–Buenos Aires: 444,590 kg CO_2, Miami-Piarco: 271,934 kg CO_2, and Houston-Puerto Vallarta: 307,168 kg CO_2. On a single flight level, the CO_2 savings of direct routing for Atlanta to Lima was estimated to be 3,673.73 kg. Moreover, in Central America, the COCESNA "Single Sky" program is investing €24.6 million over six years to standardize and interconnect ATC systems across six states, improving route options and resilience[191].

Even with FRA, some restrictions remain in place for traffic management or military use, as published in the Route Availability Document (RAD), which defines which routes are open or closed at specific times. In the LAC region, several stakeholders have identified unused military airspace as a key inefficiency, though this issue is not limited to the LAC regional. A 2024 EUROCONTROL study found that 30–50% of booked military airspace is not actually used. While military planning is typically done in advance, allowing operators the opportunity to use optimal routes, airlines often file flight plans up to 10 hours ahead, creating a gap. In France, for example, flights have been observed to fly around reserved airspace even outside its booked hours, resulting in an additional route extension of 2–4%.

Dynamic RAD management temporarily relaxes restrictions when traffic and staffing allow, enabling more direct routings on the day of operations. SESAR and EUROCONTROL trials across 2,500 flights showed that lifting selected restrictions saved an average of 44 kg of fuel and 138 kg of CO_2 per flight, proving that dynamic RAD is an effective complement to FRA[192].

In Colombia, efforts are already underway to reduce inefficiencies caused by military airspace restrictions. Following advocacy from IATA, the Palanquero airspace is being made more flexible, which is expected to deliver average fuel savings of 117 kg per flight compared with the traditional routing[193].

An additional layer of airspace modernization involves dynamic sectorization, which optimizes the configuration of ATC sectors in real time based on traffic demand and controller workload. Automated systems continuously evaluate possible sector combinations, proposing configurations that balance capacity and complexity. This approach allows controllers to manage complex traffic flows more effectively, maximizing the benefits of FRA and dynamic RAD.

Not all modernization efforts, however, guarantee improved efficiency. A case study from an ALTA stakeholder highlighted Brazil's large and complex airspace as a particular challenge. Operators could submit preferred routing requests to optimize efficiency, but when combined, some integrations actually increased fuel burn in certain regions, even though improvements were achieved elsewhere. Stakeholders also noted that tactical flexibility in changing preferred routes remains critical to maximizing operational gains.

Given the high baseline, potential horizontal en-route efficiency gains from airspace modernization in the LAC region are estimated at 1.0–1.5%. Even with ambitious deployment, 100% efficiency is unattainable due to unavoidable factors such as weather, military airspace, terrain, and sequencing near airports.

Under a low implementation scenario, progress would be limited to partial FRA coverage, static route restrictions, minimal cross-border coordination, and infrequent sector reconfiguration, with civil-military coordination remaining ad hoc and few decision-support tools available. A high implementation scenario, by contrast, requires full FRA adoption across major FIRs, dynamic route availability management, and real-time

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[189] https://www.eurocontrol.int/concept/free-route-airspace#:~:text=Free%20route%20airspace%20(FRA)%20is,network%2C%20subject%20to%20airspace%20availability
[190] https://airspace.canso.org/canso-airspace-magazine-58-2023/planning-the-perfect-flight
[191] https://www.indracompany.com/sites/default/files/230510_pr_indra_cocesna.pdf
[192] https://www.sesar.eu/news/sesar-partners-offer-dynamic-solution-lowering-aviations-carbon-footprint
[193] IATA

sectorization supported by automated tools. Achieving this depends on strong institutional and financial support: investment in surveillance and communication infrastructure, harmonized policies between ANSPs, regulatory approvals, and comprehensive controller training. Additional enablers include structured civil-military agreements for flexible airspace use, performance-based incentives for ANSPs, and access to green financing or development bank funding to offset costs. Transparent post-operations analysis and regional governance frameworks such as CADENA or CIIFRA are essential to sustain improvements and ensure accountability.

Ownership: **ANSPs and regulators** deliver FRA, dynamic RAD, and sectorization through coordinated cross-border agreements; **Airlines** tactically use direct routings and participate in trials; **Regulators** facilitate civil-military coordination to unlock restricted airspace and ensure flexible use arrangements; **Research** supports system design, performance analysis, and validation of operational concepts.

4.5.4.2 Airspace tax parity

When planning a flight, airlines balance fuel burn, weather, and airspace charges to minimize operating costs. Large charge differences can influence route selection and lead to longer, less fuel-efficient paths. NASA's analysis of transatlantic flights found the extra fuel burn between cost-optimal and fuel-optimal routes was 0.4–1.0 tonnes eastbound and 0.5–0.9 tonnes westbound[194]. For example, on a Chicago–London flight, the fuel-minimizing route would burn 500 kg less fuel (55,100 kg versus 55,600 kg) but incur $400 higher charges ($1,800 versus $1,400), illustrating how fuel price and charges jointly shape routing decisions.

In the LAC region, charge disparities are stark. Airlines avoid FIRs such as Argentina, Brazil, and Venezuela, where international en-route charges are $1,163, $919, and $505 per 1,000 km, compared with $228 in Chile and $295 in Peru. Domestic fees are often far lower; in Argentina, domestic en-route charges are just $4 dollars per 1,000 km, compared to $1,163 for international. These imbalances drive detours that increase fuel burn and emissions. Under a low scenario, charges remain unchanged and no improvement occurs. Under an ambitious scenario, governments harmonize en-route charges or introduce parity mechanisms, enabling airlines to select fuel-optimal routes and fully realize these savings.

Key obstacles to harmonizing charges include regulatory fragmentation, reliance on overflight fees for revenue, and the absence of a regional cost-recovery framework. These can be addressed through regional agreements under ICAO or CANSO, building on initiatives like CADENA and CIIFRA. A phased approach could include publishing transparent benchmarks, introducing charge caps or parity corridors, and link fee reforms to environmental goals so states can access green financing or offset revenue impacts. Collaboration with airlines and financial institutions can help design cost-neutral mechanisms such as revenue pooling or traffic growth incentives to maintain state income while reducing distortive pricing. Aligning airspace chargers is not modelled independently in this study, rather, as part of airspace modernization.

Leadership: **Policymakers** harmonize en-route charges through regional agreements; **ANSPs** provide transparent cost structures.

4.5.4.3 Global flow management

While airport CDM improves efficiency, broader air traffic flow management (ATFM), including global ATFM, is crucial for balancing demand and capacity across the network, reducing airborne holding and improving predictability. Instead of absorbing delays in the air, ATFM shifts them to the ground or adjusts trajectories en-route, where fuel burn is minimal. This is supported by tools such as Calculated Take-Off Times (CTOTs), which aircraft must comply with within a small tolerance window, typically -5 to +10 minutes. By sequencing departures and arrivals more accurately, ATFM helps reduce congestion at busy airports and en-route choke points across multiple FIRs.

Globally, ATFM programs are expanding. India's Airports Authority reported 757 ATFM initiatives in 2024, saving an estimated 32,654 tonnes of fuel and 103,186 tonnes of CO_2 by reducing airborne delays and improving

[194] https://ntrs.nasa.gov/api/citations/20160008910/downloads/20160008910.pdf

CTOT compliance[195]. Compliance rates improved from 77% in 2023 to 85% in 2024, reaching 98% during later months of the year, demonstrating the value of coordinated stakeholder engagement.

In the LAC region, airlines already delay departures on the ground when arrival delays are anticipated and formalizing these procedures through regional or cross-FIR ATFM programs could deliver measurable efficiency gains. The LTAG estimates that the savings could range between 0.02% and 0.053% per flight. For successful implementation, a coordinated regional ATFM framework is needed, with shared demand-capacity balancing, harmonized procedures, and strict CTOT compliance. Lessons from India's ATFM program show that compliance improves when CTOT is integrated into start-up clearances, revised slots are coordinated proactively, and slots are delivered earlier in the turnaround. Achieving this requires investment in real-time data exchange, decision-support tools, and integration of airline operational data, supported by regulatory alignment and cross-border agreements. Based on stakeholder feedback, global ATFM implementation could reach between 50% and 100% by 2050.

Compliance: **ANSPs** run ATFM; **Airlines/Airports** integrate CTOTs into turnarounds; **Regulators** harmonize procedures across FIRs.

4.5.4.4 Optimized runway delivery support and reduced pairwise separation

Congestion at major airports often leads to long taxi queues for departures and airborne holding for arrivals, increasing fuel burn and emissions. These inefficiencies can stem from spacing rules based on fixed wake turbulence categories and static separation minima. Modern tools enable dynamic optimization of aircraft separations, maintaining safety while improving efficiency.

For departures, Optimized Separation Delivery (OSD) calculates aircraft spacing in real time, using advanced wake turbulence models such as RECAT-EU and the Pairwise Separation approach[196]. Instead of applying a uniform rule to all aircraft, OSD determines the minimum safe gap for each pair and adjusts for factors like crosswinds. SESAR trials at major European airports indicate that OSD can shorten departure queues, increase predictability, and reduce taxi-out fuel burn by around 6%.

On the arrivals side, Optimized Runway Delivery (ORD) tools allow controllers to manage spacing on final approach with greater precision. At London Heathrow airport, NATS compared average CO_2 emissions per aircraft for the periods January to May 2024 and January to May 2025, which are before and after the introduction of Pairwise Separation[197]. The data showed an approximate reduction of 240 kg of CO_2 per aircraft, suggesting a potential improvement in operational efficiency while maintaining safe and orderly arrivals.

In the LAC region, a number of separation improvements have been achieved through procedural changes. At São Paulo Guarulhos airport, dependency between arrivals and departures on closely spaced parallel runways required extended separations, causing delays and additional fuel burn[198]. In 2018, segregated operations under visual conditions were introduced, allowing independent arrivals on one runway and departures on the other. This reduced approach separation from 5 NM to 3 NM and departure spacing to about 1.5 minutes, increasing runway capacity from 52 to 60 operations per hour. Estimated annual savings are around 3,200 tonnes of fuel in flight and 1,250 tonnes during taxi for the airport's 270,000 yearly movements. Additional gains came from reducing unnecessary go-arounds through the introduction of reduced runway separation minima, which avoided about 34 go-arounds in 2024. Both measures improve predictability and reduce fuel waste and can be applied at other airports with appropriate runway layouts, safety oversight, and controller training.

ICAO's LTAG estimates global fuel savings of 0.038–0.189% per flight for OSD and 0.511–0.758% for ORD. Stakeholder feedback suggests implementation will lag behind these estimates. To accelerate implementation of optimized runway delivery and reduced pairwise separation in the LAC region, several steps are essential.

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[195] https://www.atfmaai.aero/portal/sites/default/files/CATFM%20Post%20ops%20Annual%20Report%202024.pdf
[196] https://www.sesarju.eu/sites/default/files/documents/solution/PJ02-01-02%20Contextual%20Note.pdf
[197] https://www.nats.aero/news/nats-delivers-on-time-boost-and-carbon-cuts-with-world-first-at-heathrow/
[198] IATA

First, regulators must approve separation standards and integrate them into national procedures. Air navigation service providers and airports need to invest in real-time optimization tools that link with arrival and departure management systems, supported by accurate wind and wake turbulence data. Controller training programs should be updated to embed these new concepts into daily operations, and infrastructure upgrades such as rapid-exit taxiways should be prioritized at high-density airports. Constraints like mixed-fleet complexity and local noise restrictions can be managed through phased rollouts and data-driven performance reviews.

Roll-out: **ANSPs and regulators** approve and operate dynamic separation; **Airports** integrate runway tools; **Airlines** adapt SOPs and scheduling.

4.5.4.5 Horizontal efficiency sub results

Table 34: Implementation and savings from horizontal efficiency improvements

Initiative	Fuel savings (%)	Baseline implementation (%)	Metric	2030 (%)	2040 (%)	2050 (%)
Airspace modernization	1.25 *(1, 1.5)*	0	Additional implementation	22.5 *(15, 30)*	45 *(30, 60)*	67.5 *(45, 90)*
			Fleet-wide fuel reduction	0.28 *(0.15, 0.45)*	0.56 *(0.30, 0.90)*	0.84 *(0.45, 1.35)*
Global flow management	0.04 *(0.02, 0.05)*	0	Additional implementation	12.5 *(0, 25)*	37.5 *(25, 50)*	75 *(50, 100)*
			Fleet-wide fuel reduction	0.00 *(0.00, 0.01)*	0.01 *(0.01, 0.03)*	0.03 *(0.01, 0.05)*
OSD	0.11 *(0.04, 0.19)*	0	Additional implementation	18.8 *(12.5, 25)*	37.5 *(25, 50)*	75 *(50, 100)*
			Fleet-wide fuel reduction	0.02 *(0.0, 0.05)*	0.04 *(0.01, 0.09)*	0.09 *(0.02, 0.19)*
ORD	0.63 *(0.51, 0.76)*	0	Additional implementation	18.8 *(12.5, 25)*	37.5 *(25, 50)*	75 *(50, 100)*
			Fleet-wide fuel reduction	0.12 *(0.06, 0.19)*	0.24 *(0.13, 0.38)*	0.48 *(0.26, 0.76)*
Total fleet-wide fuel reduction				**0.43** ***(0.22, 0.70)***	**0.86** ***(0.44, 1.40)***	**1.43** ***(0.73, 2.35)***

4.5.5 Flight profile optimization results

Table 35: Implementation and savings from horizontal efficiency improvements

Measure	Fleet-wide fuel reduction (%)		
	2030	2040	2050
Climb and descent optimization	0.06 *(0.02, 0.09)*	0.12 *(0.06, 0.18)*	0.18 *(0.09, 0.27)*
En-route vertical efficiency	0.04 *(0, 0.10)*	0.28 *(0.05, 0.58)*	0.41 *(0.11, 0.78)*
Horizontal efficiency	0.43 *(0.22, 0.70)*	0.86 *(0.44, 1.40)*	1.43 *(0.73, 2.35)*
Total	**0.53** ***(0.24, 0.89)***	**1.26** ***(0.55, 2.16)***	**2.02** ***(0.93, 3.40)***

Ambitious Scenario: The LAC region achieves significant progress through regulatory alignment, technology deployment, and strong stakeholder collaboration. Airlines build on existing adoption of CCO and CDO by improving consistency and optimizing procedures through advanced trajectory tools, real-time data integration, and performance monitoring. Governments and ANSPs modernize airspace structures, implement harmonized procedures, and enable dynamic separation standards. Reduced flap landings become standard practice where operationally feasible, supported by digital advisories and training. Regional agreements ensure cross-border coordination, and cultural alignment fosters transparency and shared accountability. These combined efforts deliver substantial reductions in fuel burn and emissions while improving predictability and resilience.

Moderate Scenario: Progress is steady but uneven. Airlines expand use of optimized climb and descent procedures and reduced flap landings, but adoption varies by airport and state. Airspace modernization advances gradually, with partial deployment of Free Route Airspace and limited adoption of dynamic separation tools. Collaborative decision-making and performance monitoring improve compliance, but data sharing remains inconsistent. Regulatory frameworks evolve slowly, and financial incentives are limited, leaving some efficiency gains unrealized.

Conservative Scenario: Adoption remains minimal due to weak regulatory action, limited investment, and fragmented governance. Airlines maintain current practices with only incremental improvements in CCO and CDO usage. Advanced air traffic management concepts such as dynamic separation and optimized runway delivery remain largely absent. Airspace modernization is slow, with persistent structural inefficiencies and limited cross-border coordination. Cultural and institutional barriers prevent meaningful collaboration, resulting in marginal fuel savings and a widening gap between the LAC region and global best practices.

4.6 Results and discussion

The results of this study, as displayed in the table below, demonstrate that operational efficiency measures can deliver substantial fuel and emissions reductions in the LAC region. By 2050, the combined impact of airline, ground, and flight profile measures could achieve up to 11.3% fuel savings. Ground operations represent the largest opportunity, followed by flight profile optimization, while airline-level measures provide smaller but still important gains. These potential savings do not imply that airlines can absorb the associated costs, as most measures require cross-stakeholder investment and supportive regulatory frameworks.

Table 36: Fleet-wide fuel reduction results, vs 2019 baseline

Measure	Fleet-wide fuel reduction (%)		
	2030	2040	2050
Aircraft efficiency and planning measures	0.5 *(0.2, 1.0)*	0.9 *(0.5, 1.5)*	1.4 *(0.6, 2.4)*
Airport and ground operations	0.9 *(0.3, 1.6)*	2.4 *(1.0, 4.2)*	3.4 *(1.7, 5.5)*
Flight profile optimization	0.5 *(0.2, 0.9)*	1.3 *(0.6, 2.2)*	2.0 *(0.9, 3.4)*
Total	**1.9** ***(0.8, 3.5)***	**4.6** ***(2.0, 7.8)***	**6.8** ***(3.3, 11.3)***

Realizing this potential requires more than technical solutions. It depends on coordinated action across governments, regulators, airlines, airports, and technology providers, supported by aligned incentives, targeted investment, and a culture of collaboration.

Regulatory alignment and incentives: Regulation must create an environment where efficiency measures are both feasible and attractive. This includes harmonizing procedures across borders, setting clear operational standards, and aligning financial incentives with environmental and performance goals. Incentive structures should reward compliance and innovation while ensuring that mandates are paired with enabling measures such as infrastructure upgrades and training. Governments can also build infrastructure requirements into contracts to ensure that new agreements include the capabilities needed to deliver efficiency gains.

Investment and infrastructure: These investments require shared responsibility across stakeholders. Governments can provide policy support and access to green financing, airports and ANSPs must prioritize infrastructure upgrades, and airlines should commit through long-term agreements that justify these investments. Development banks and financial institutions can play a role in reducing capital barriers and ensuring equitable cost distribution.

Airline and airport commitments: Airlines and airports must continue to operationalize these measures. Airlines need to continue integrating optimized climb and descent procedures, reduced flap landings, and efficient taxiing into their SOPs, supported by training and performance monitoring. Airports must complement these efforts by expanding infrastructure, implementing collaborative decision-making, and integrating real-time optimization tools for runway sequencing and departure management.

Technology and data integration: Digitalization is a critical enabler. Real-time data exchange between stakeholders supports collaborative decision-making, flow management, and optimized flight profiles. Performance monitoring and feedback loops, supported by clear KPIs, can drive continuous improvement. Technology providers must ensure interoperability and scalability to facilitate regional adoption.

Culture and behavioral change: Technology and regulation alone will not deliver results without a culture of collaboration. Airlines, airports, and ANSPs need to view efficiency as a shared responsibility rather than a competitive advantage. This requires transparent data sharing, joint performance reviews, and a willingness to adapt operational practices. Behavioral programs, such as pilot feedback and target-setting, have proven effective in other regions and should be scaled in the LAC region.

Regional coordination and governance: Fragmentation remains a major barrier. Regional platforms should be leveraged to harmonize procedures, share best practices, and coordinate investments. Structured agreements between civil and military authorities can unlock additional airspace capacity, while transparent benchmarking and reporting can sustain accountability. Linking efficiency improvements to environmental objectives can also unlock climate finance and strengthen the business case for reform.

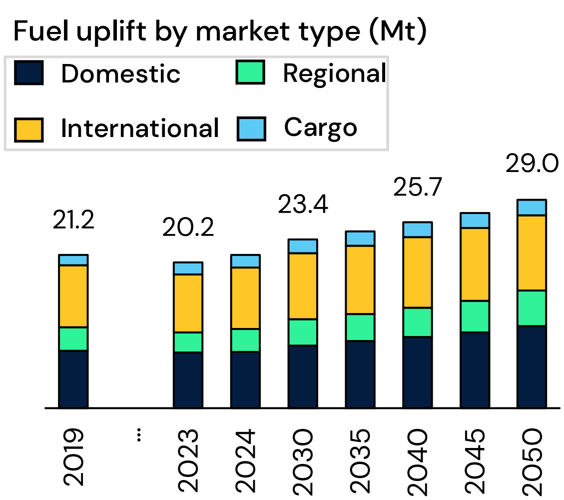
4.7 Baseline jet fuel forecast

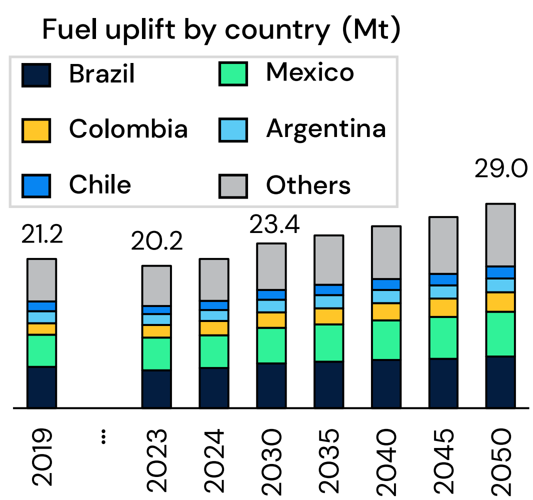
ICF estimated the baseline fuel uplift using historical activity levels combined with the ICAO fuel burn database. Future projections were then developed using the activity forecast discussed in Section 2 of this report, together with the fleet replacement and operational efficiency improvements forecast outlined in the previous sections.

In 2019, ICF estimated that a total of 21.2 Mt of jet fuel was uplifted by all departing flights from the LAC region, based on the ICAO fuel burn database. In 2023, fuel uplift saw a slight decline as the number of ATMs remained slightly below 2019 levels, and airlines retired or replaced older-generation aircraft with newer, more fuel-efficient models during COVID. 2050, ICF forecasts fuel uplift will reach 29.0 Mt, representing a 1.0% CAGR between 2019 and 2050. Compared to the forecasted 2.7% CAGR in traffic growth for the same period, this reflects continuous efficiency improvements driven by fleet renewal and operational measures, and without these measures, fuel uplift is projected to reach 44.5 Mt by 2050. Although domestic activities account for approximately 70% of ATMs, they represent only 39% of the forecasted fuel requirement due to shorter sector lengths. Regional and international activities account for roughly 17% and 36%, respectively, while cargo represents the remaining 8%.

By 2050, the top five countries are forecast to account for nearly 70% of the region's total fuel uplift: Brazil at 25%, Mexico at 22%, Colombia at 10%, Argentina at 7%, and Chile at 6%. This distribution remains largely consistent with 2019 levels. The following charts and table summarize the fuel uplift forecast results for these focus countries and the region overall.

LAC fuel uplift forecast by market type (left) and country split (right)





Source: ICF analysis

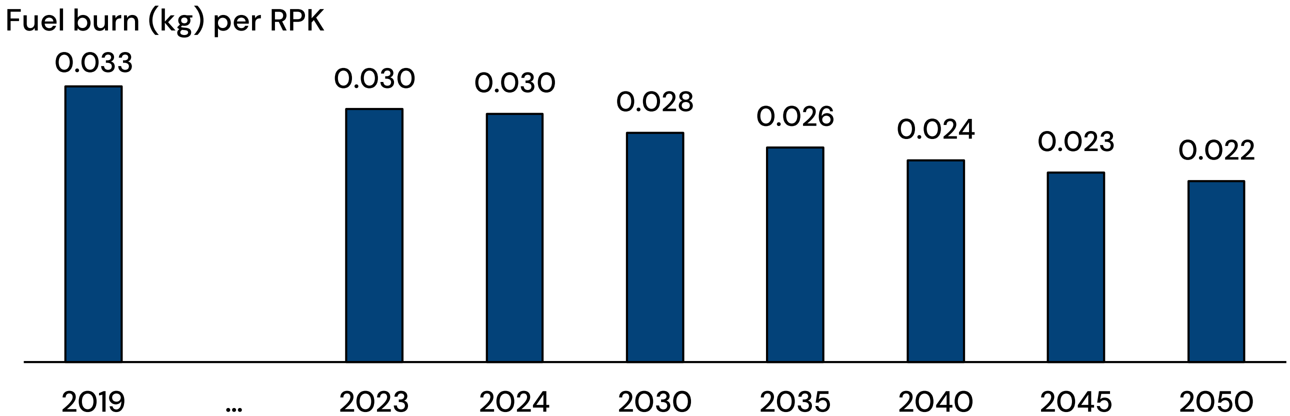
Table 37: Latin America and Caribbean region fuel uplift forecast summary by focus countries

Focus country	2019 fuel (Mt)	2035 fuel (Mt)	2050 fuel (Mt)	2019 fuel uplift share	2050 fuel uplift share	2019-2050 CAGR
Brazil	5.9	6.6	7.4	28%	25%	0.7%
Mexico	4.6	5.3	6.3	22%	22%	1.0%
Colombia	1.6	2.3	2.8	8%	10%	1.7%
Argentina	1.7	1.9	2.0	8%	7%	0.4%
Chile	1.4	1.5	1.7	6%	6%	0.7%

Focus country	2019 fuel (Mt)	2035 fuel (Mt)	2050 fuel (Mt)	2019 fuel uplift share	2050 fuel uplift share	2019-2050 CAGR
Peru	1.2	1.2	1.5	6%	5%	0.7%
Panama	0.7	0.9	1.3	3%	5%	2.2%
Dominican Rep.	0.6	1.0	1.5	3%	5%	3.0%
Ecuador	0.4	0.4	0.5	2%	2%	0.5%
Bahamas	0.1	0.1	0.1	1%	0%	0.4%
El Salvador	0.2	0.2	0.3	1%	1%	1.4%
Others	2.9	3.1	3.7	14%	13%	0.8%
ALTA Total	**21.2**	**24.5**	**29.0**	**100%**	**100%**	**1.0%**

In 2019, fuel burn per RPK was estimated at approximately 0.033 kg of jet fuel per RPK. This figure dropped to about 0.030 kg per RPK in 2023 as airlines deployed more fuel-efficient aircraft and improved operational practices following COVID. The metric continued to decline in 2024, reflecting further fleet transitions and recovery in long-haul operations. Fuel per RPK is expected to keep improving throughout the forecast period, reaching around 0.022 kg per RPK by 2050. This improvement is primarily driven by evolving aircraft technologies, with new-generation aircraft expected to account for nearly 80% of ASKs in the region by mid-2035. The figure below illustrates the forecasted evolution of fuel burn per RPK in selected years.

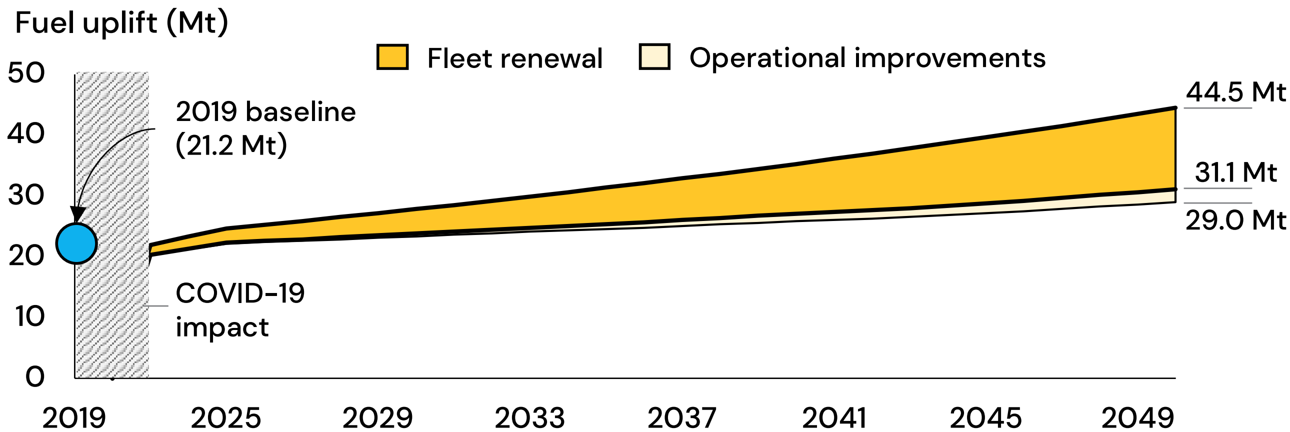
Fleet renewal and operational improvements are forecasted to result in annual fuel efficiency gain of 1.3% (CAGR) from 2019 to 2050 in the LAC region



Source: ICF analysis

Fuel uplift is forecast to grow at a 1.0% CAGR between 2019 and 2050. This growth is driven by a combination of cabin densification and evolving aircraft technology, which is expected to reduce fuel consumption by approximately 30% compared to today's levels. This aligns with current observations that each new aircraft generation delivers around 15–20% fuel savings. Additionally, operational improvements are projected to reduce fuel requirements by a further 6.8% by 2050. The following chart illustrates the fuel uplift forecast and the contribution of fleet renewal and operational improvements to fuel savings.

Fleet renewal and operational efficiencies are projected to reduce fuel burn by 35% in 2050. Additional measures are required to reach net-zero



Source: ICF analysis

5 Evaluating opportunities and obstacles for SAF in Latin America and the Caribbean

Key results:

- Over 1.9 billion gallons of SAF production capacity has been announced across the LAC region; however, no SAF has yet been produced in the region, and no projects have reached FID (as of November 2025). It is also important to note that announced capacity does not imply it will fully translate into operational as seen by numerous facility cancellations globally.
- HEFA remains the most commercially viable pathway today, but its scalability is constrained by feedstock availability. AtJ offers stronger long-term potential as feedstock availability expands.
- Sustainability concerns regarding feedstock origin and cultivation remain a key barrier and need to be addressed for SAF to have a real contribution. It is important that SAF production does not come at the expense of land-use change, food security, nature, and water, with over 2/3 of emissions in Brazil and Colombia originating in the AFOLU sector.
- SAF prices are expected to remain significantly above fossil jet fuel prices through 2050 (3 to 12 times higher), even with continued technology maturation and scaled production. Abatement costs vary by pathway but decline significantly over time. By 2050, AtJ pathways are projected to have the lowest abatement costs overall, with sugarcane ethanol-based AtJ representing the most cost-effective option, reaching approximately USD 417/tCO_2.

5.1 Opportunities and challenges for SAF in Latin America and the Caribbean

Sustainable aviation fuel (SAF) is the 'in-sector' measure with the greatest long-term theoretical potential to decarbonize aviation by reducing lifecycle greenhouse gas emissions compared with conventional aviation fuel (CAF). As a drop-in fuel, SAF can be used in existing fleets and infrastructure without modifications, which facilitates integration.

However, large-scale deployment in the LAC region and, globally, faces technical, economic and regulatory challenges, including:

- the availability of sufficient, sustainable feedstock;
- investments in supply chain, production and distribution infrastructure;
- limitation on export opportunities from LAC to other regions due to feedstock eligibility criteria under different regulatory frameworks;
- overcoming the substantial price differential with conventional fuels (3 to 12 times higher price for SAF), which could increase ticket prices and reduce connectivity.

Together, these challenges have hindered adoption of SAF, despite ongoing efforts of the global and regional aviation ecosystem.

In this report the current status of the SAF market in the LAC region is explored, the key challenges for the region are identified and opportunities for the development of the market are highlighted.

What is SAF?

SAF is a lower-carbon substitute for conventional jet fuel. It can be made using a variety of feedstocks, such as:

- Crops like sugarcane or oilseeds
- Wastes and residues from agriculture, forestry, or municipalities
- Captured CO_2 combined with renewable (or non-fossil low carbon) hydrogen

Lower Carbon Aviation Fuels (LCAF) are fossil-derived aviation fuels that achieve verified life-cycle emissions reductions by reducing emissions through the full supply chain. This can include improved

production processes, transportation, reduced flaring and methane emissions, and the addition of technologies such as carbon capture and storage (CCS/CCUS). LCAF is still developing as a solution, and more information is required to understand the potential as a decarbonisation mechanism.
Both SAF and LCAF are drop-in fuels, meaning they can be used in existing logistics infrastructure and aircraft without any modifications, once blended with conventional jet fuel.

Synthetic blending components
Synthetic Blending Components (SBCs) are fuel components produced in dedicated facilities and intended for blending with conventional jet fuel to form SAF. They must meet the ASTM D7566[199] specifications to ensure safe operation in aircraft. Currently, SBCs can be blended up to 50%[200] depending on the production pathway, with research underway to achieve 100% by 2030. Blending occurs at production or distribution terminals and should not be done at the airport fuel farm[201].

Co-processing
Some renewable materials, such as lipids, can be co-processed in modified conventional refineries. In this approach, the renewable feedstock is introduced during refining. At present, lipids can be co-processed up to 5% of the final product, while HEFA-derived feedstocks can be co-processed up to 10%[202]. Co-processing allows incremental SAF production without the need for dedicated standalone facilities.

5.2 Global SAF policy framework: ICAO and CORSIA

In a global context, efforts to mitigate carbon emissions within the aviation sector have been driven by the International Civil Aviation Organization (ICAO), primarily through the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). CORSIA is a global framework with the purpose of carbon-neutral growth in international aviation from 2021 to 2035 (an extension may be possible), using 85% of 2019 emissions from flights between participating countries as its baseline.

CORSIA supports the Paris Agreement by requiring airlines to report emissions and to offset the sector's emission increase through the purchase and cancellation of emissions units. The use of CORSIA eligible fuels, (CEFs) that include both SAF and LCAF, reduces the offsetting requirements as much as the fuel reduces the carbon footprint compared with the fossil equivalent.

The net zero 2050 ICAO target (LTAG) is accompanied by a collective global aspirational Vision to strive for a 5% reduction in CO_2 emissions from international aviation by 2030 through the use of CEFs (CAAF/3). In pursuing this Vision, each State's special circumstances and capabilities will shape its contribution within its own national timeframe, without imposing specific obligations or commitments on individual States.

ICAO has also established the Assistance, Capacity Building and Training in SAF (ACT-SAF) and the Finvest platform to support SAF deployment at global level.

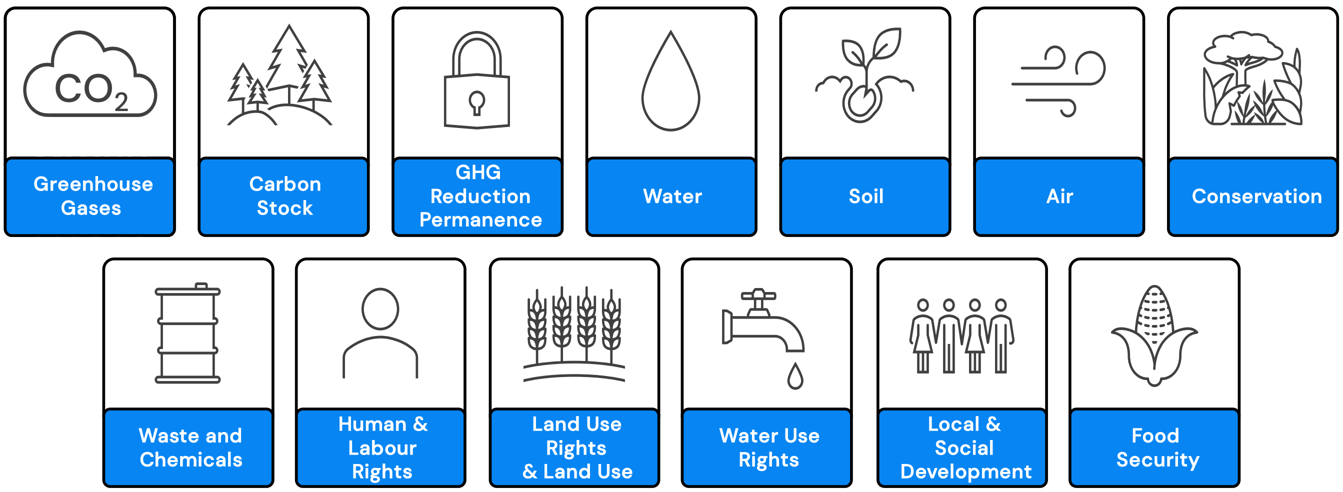
5.2.1 CORSIA

The sustainability criteria laid out in CORSIA are relevant to the LAC region. It is widely credited within the CAAF/3 context as a relevant foundation and is valued by regional countries as an appropriate basis for developing a SAF framework. Furthermore, it will guide the process for claiming potential emissions reductions from international flights operating on routes subject to CORSIA compliance.

[199] D7566 Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons
[200] https://www2023.icao.int/environmental-protection/GFAAF/Pages/Conversion-processes.aspx
[201] As recommended by JIG
[202] https://www.icao.int/environmental-protection/saf-conversion-processes

For SAF to be considered CORSIA eligible fuel (CEF), it must satisfy ICAO's CORSIA Sustainability Criteria[203], and fuel producers must be verified under a Sustainability Certification Scheme (SCS) approved by ICAO[204]. The sustainability criteria are structured around the environmental, social and economic "themes" shown in the figure below[205]. Generally, to comply, SAF must avoid or mitigate significant negative impacts on these themes and meet specified thresholds. These requirements are among the strictest applied to any biofuel today, which reflects the sector's intention to set a high bar for transparency.

Sustainability themes for CORSIA SAF



Source: ICAO, ICF analysis

Greenhouse gas (GHG) emissions, carbon stock and GHG reduction permanence

Compliance with the greenhouse gas and carbon stock sustainability themes is assessed using a quantitative methodology. According to the sustainability criteria, CEF must achieve a net GHG emissions reduction of at least 10% compared to the baseline emission value for conventional aviation fuel (89 gCO_{2e}/MJ) on a life cycle basis. In practice, this means that SAF should have a carbon intensity less than 80 gCO_{2e}/MJ to meet the CORSIA sustainability criteria.

The lifecycle emissions of CEF must be calculated according to the specified methodology and include a core life cycle assessment (LCA) component and, where applicable, an induced land use change (ILUC) component. The core LCA component reflects emissions directly associated with the fuel supply chain, including feedstock production, conditioning, transport and conversion into fuel as well as transport, distribution and, where applicable, combustion of the fuel.

The ILUC value reflects indirect emissions associated with land conversion (e.g., from forest, grassland, peatland, or soil carbon losses) driven by feedstock production. Considerations of direct land use change (DLUC) may also be required where land use changes occurred after 1 January 2008. This DLUC value replaces the ILUC value when calculating the full lifecycle emissions if DLUC emissions exceed ILUC emissions.

The total lifecycle emissions for a given SAF can be calculated using either:

[203] ICAO document "CORSIA sustainability criteria for CORSIA eligible fuels"
[204] ICAO document 04 - CORSIA approved Sustainability Certification Schemes
[205] CORSIA lower carbon aviation fuel has an additional criterion of seismic and vibrational impacts.

- Default lifecycle emissions values for SAFs published by ICAO as a function of the feedstock, conversion process, and production region of the SAF[206].
- Actual, calculated values, following the appropriate CORSIA methodology[207].

CEF producers may also utilize geological carbon capture and sequestration to reduce SAF carbon intensity. In accordance with the GHG reduction permanence theme, this is also subject to requirements defined by ICAO.

Compliance with GHG emissions, carbon stock and GHG reduction permanence must be assessed by an approved SCS.

Remaining sustainability themes

Unlike the GHG, carbon stock and GHG reduction permanence themes, the remaining sustainability themes in the figure above are less prescriptive. ICAO defines them broadly and allows flexibility in implementation at the State level, meaning that:

- Individual States can help define how compliance is assessed for these themes.
- SCS may adopt state-specific rules or guidance to demonstrate compliance.
- There are generally no quantitative thresholds equivalent to the 10% GHG reduction requirement; instead, compliance is based on avoiding or mitigating unacceptable negative impacts.

As a result, while these themes are essential for ensuring overall sustainability, they are more qualitative and context-dependent than the GHG-related themes, and the rigor of their application may vary by jurisdiction.

Feedstocks and CORSIA

ICAO maintains a positive list of feedstocks that are considered eligible under CORSIA[208]. These feedstocks can be broadly assigned to the categories described in Table 38 which also shows representative examples of feedstocks within each category. New feedstocks may be added to the list following the procedure defined by ICAO.

While in principle any feedstock that meets the CORSIA sustainability criteria could be used to produce CEF, the reality is more nuanced. Feedstocks that require an ILUC value and do not currently have an appropriate default value specified (i.e., are not on the positive list) cannot be used to produce CEF until both a core default value and an ILUC default value have been established and added to the ICAO list of CORSIA default values according to the CORSIA methodology for calculating actual lifecycle emission values. This has implications on the eligibility of feedstocks from the LAC region and is discussed in more detail further in the document.

Table 38: CORSIA feedstock categories, definitions and representative examples

Category	Definition	Representative example
Primary products and co-products	The main products of a production process. These products have significant economic value and elastic supply	• Sugarcane • Soybean oilseed • Camelina oilseed
By-product	Secondary products with inelastic supply and economic value.	• Tallow
Residue	Secondary materials with inelastic supply and little economic value.	• Bagasse, cobs, husks • Forestry residues

[206] ICAO document "CORSIA default life cycle emission values for CORSIA eligible fuels"
[207] ICAO document "CORSIA methodology for calculating actual life cycle emission values"
[208] SAF Feedstocks

Category	Definition	Representative example
Waste	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[209].	• Municipal soil waste • Used cooking oil

Primary products

The existing biofuels markets in the LAC region rely heavily on primary products (i.e., crops) as feedstocks – for example, sugarcane ethanol and soybean or palm biodiesel. Increased production of these established crop-based feedstocks for SAF is likely to generate concerns regarding many of the CORSIA sustainability themes discussed above, in particular land-use change and food security in addition to other expected impacts on nature and water.

Voluntary, feedstock-specific sustainability schemes, such as Bonsucro, exist in addition to CORSIA, which provides more detailed guidance and verification mechanisms for responsible feedstock production. These schemes focus on minimizing environmental impacts, improving social outcomes, and enhancing traceability throughout the supply chain. By certifying compliance with criteria such as responsible land management, water use efficiency, and labor standards, they can help mitigate risks associated with crop-based feedstocks, including deforestation, biodiversity loss, and competition with food production.

When aligned with CORSIA requirements, such certification schemes offer producers a pathway to demonstrate that their SAF meets both regional and international sustainability expectations, while also providing confidence to buyers and regulators regarding the environmental and social integrity of the fuels. Careful consideration must be taken when considering this type of local and national approaches, as there is a risk of limiting the export capabilities of SAF produced in LAC to international markets if domestic certification is mis-aligned with the certification used in overseas markets.

Wastes, residues, and by-products

Feedstocks derived from waste, residues, and by-products offer a lower-risk alternative to primary crops for SAF production. These materials, such as used cooking oil, sugarcane bagasse, forestry residues, or agricultural by-products typically have minimal associated land-use change impacts and do not compete directly with food production. However, compliance with CORSIA sustainability themes still depends on proper sourcing, processing, and lifecycle emissions accounting.

Sustainability certification schemes, including International Sustainability and Carbon Certification (ISCC) and Roundtable on Sustainable Biomaterials (RSB), provide guidance for their collection, processing, and traceability, helping to ensure environmental and social safeguards are maintained throughout the supply chain. Utilizing these feedstocks for SAF could allow producers in the LAC region to leverage existing waste streams, reduce greenhouse gas emissions, and deliver SAF that meets international sustainability requirements while navigating many of the risks linked to crop-based feedstocks, provided compliance with CORSIA criteria is demonstrated.

Summary

CORSIA's sustainability criteria provides currently the most relevant international framework for evaluating SAF. The CORSIA criteria establish both quantitative thresholds, such as lifecycle GHG reduction requirements, and broader qualitative themes related to land use, ecosystems, and social safeguards.

[209] Raw materials or substances that have been intentionally modified or contaminated to meet this definition are not covered by this definition.

5.3 SAF industry and policies in Latin America and the Caribbean

5.3.1 SAF policy and market development

Predictable, consistent, and robust policies are essential to support the development of the SAF industry and allow its use as part of achieving long-term sustainability goals. By providing clear guidance and incentives for producers and passengers, policymakers can stimulate investment, expand access to sustainable feedstocks, and drive cost reductions and offset price differential, facilitating broader adoption of SAF. While high production costs, limited feedstock availability for HEFA-based SAF, fuel supply chain inefficiencies and competition for resources pose challenges, well-designed policy frameworks can help limit the effect of these barriers and facilitate the progressive deployment of SAF.

Such policies are beginning to develop across the LAC region, although they are generally at a very early stage. The following sections summarize the SAF landscape across the LAC region.

5.3.1.1 Argentina

In Argentina's State Action Plan submitted to ICAO in 2021[210], migration towards SAF is noted as an expected impact of the CO_2 tax, which began to apply to aviation fuels in 2021. Apart from this measure, there are currently no dedicated national policies promoting or incentivizing SAF deployment, although several research and feasibility initiatives are under way. The National Institute of Industrial Technology (INTI) has undertaken research on bioenergy technologies that could support SAF production. In 2025, Airbus and ICAO announced a partnership to conduct feasibility studies on SAF in Argentina, as well as in Peru and Panama, under ICAO's ACT-SAF program[211].

5.3.1.2 Bahamas

SAF is included within the basket of measures expected to play a role in reducing CO_2 emissions from aviation in The Bahamas' State Action Plan, submitted to ICAO in 2022[212] however, there are currently no dedicated national policies or incentives in place to facilitate this. The Inter-American Development Bank (IDB) has initiated a technical cooperation project that aims to provide support for sustainable aviation in The Bahamas including the development of a sustainable aviation strategy, and studies to support the adoption of SAF[213].

5.3.1.3 Brazil

Brazil's 'Fuel of the Future' law establishes the National Program for Sustainable Aviation (ProBioQAV), which requires airlines to achieve CO_2 emissions reductions primarily through the use of SAF on domestic flights, rather than mandating a volumetric SAF blending percentage.

This law was established in 2024 and requires air operators to reduce their emissions from domestic flights starting with a 1% reduction in 2027 and growing to 10% reduction by 2037. However, the regulations that define the implementation details are still under discussion and the expected negative impact on connectivity has not yet been resolved.

Airlines are engaging and collaborating with the government in a set of roundtables to identify solutions that can make this target compatible with the significant cost impact foreseen for the airlines[214]. This could include price support mechanisms that could mitigate negative impacts to the essential connectivity airlines provide in the country.

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[210] Plan de Acción para la Reducción de Emisiones de CO_2 en el sistema de transporte aéreo argentino - Final

[211] https://www.aviacionline.com/airbus-and-icao-partner-to-study-sustainable-aviation-fuel-feasibility-in-argentina-panama-and-peru

[212] The Bahamas Action plan for Emissons reduction (APER)

[213] https://www.iadb.org/en/project/BH-T1130

[214] Noting the production cost of SAF is at least twice selling price of jet fuel and fuel means 30-40% of operating costs in the region, as provided by ALTA.

From a SAF sustainability perspective, the Fuel of the Future law requires at least 10% lower carbon intensity compared to conventional jet fuel. Additionally, this law encourages the use of the most carbon-efficient SAF production pathways[215, 216].

From 2027, Brazil will be included as one of the countries in the state pair list under CORSIA Phase 2 (mandatory). This will result in international emissions from Brazilian operators that exceed 85% of the levels observed in 2019 must be offset through the acquisition of carbon credits or the use of fuels eligible under CORSIA[217]. Brazil is also developing its own carbon market, where SAF and carbon credits are complementary measures.

In August 2024, the Brazilian government announced a US$1.09 billion funding package to support the development of SAF and marine biofuels[218]. This initiative, financed by the National Bank for Economic and Social Development (BNDES) and the Funding Authority for Studies and Projects (FNEP), is allocating funding through calls for proposals which target:

- Biorefinery construction
- Research and development
- Engineering and pilot projects
- Equipment acquisition and working capital

However, all incentives and funding currently are allocated to support production of SAF with no current support or incentives for the demand of SAF. Domestic Brazilian airlines are working with the government and stakeholders to ensure support for domestic passengers is implemented and the price gap addressed in order to prevent the expected reduction in air travel within Brazil due to the higher cost of SAF[219].

Beside a key aviation emissions reduction measure, SAF is considered important to the agricultural sector in Brazil, and it is also strategic from an agro-industrial point of view. It is important to note, however, that over 2/3 of emissions in Brazil originate in the AFOLU sector[220].

5.3.1.4 Chile

Central to Chile's efforts for aviation emissions reduction is the Vuelo Limpio program, a public-private initiative that promotes energy efficiency, operational improvements, and the adoption of SAF. The program collaborates with major airlines, airports, and fuel distributors to monitor emissions, implement best practices, and developed a SAF 2050 Roadmap. This roadmap aspires to meet at least 50% of civil aviation fuel demand with SAF by 2050 and is supported by a coalition of over 90 institutions. Chile is aiming to realize this ambition from large plants using oils, fats, and biological and municipal waste, as well as e-fuels[221].

On the research arena, the Technological Development Unit (UDT) at the University of Concepción produced the first liter of aviation fuel from residual plastics in Chile[222] and it is also performing research on the use of camelina as a sustainable crop for SAF.

A research and development project focused on producing SAF from camelina oil, using an experimental biorefinery has been explored by Universidad Católica de la Santísima Concepción through its Energy Center

[215] https://www2023.icao.int/environmental-protection/Documents/EnvironmentalReports/2025/Envreport2025_50.pdf
[216] https://www.argusmedia.com/en/news-and-insights/latest-market-news/2674362-brazil-saf-industry-set-to-take-off-in-2027
[217] https://www.gov.br/anac/pt-br/assuntos/meio-ambiente/corsia
[218] https://www.bndes.gov.br/wps/portal/site/home/imprensa/noticias/conteudo/bndes-e-finep-disponibilizam-6-bilhoes-de-reais-para-investimentos-em-combustivel-verde-para-aviacao-e-navegacao
[219] From stakeholder feedback in the project
[220] From stakeholder feedback in the project; AFOLU = Agriculture, Forestry, and Other Land Use
[221] https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2025/Envreport2025_70.pdf
[222] https://vuelolimpio.cl/2025/08/19/hito-udec/

(UCSC) and SKY. This initiative is at an early stage and marks the country's first science-industry agreement focused on producing locally sourced renewable SAF[223].

5.3.1.5 Colombia

In January 2025, Colombia signed Resolution 00090, establishing a SAF roadmap. This sets goals for Colombia to become a regional leader in SAF production, producing 100 million gallons of SAF by 2035, expanding up to 450 million gallons by 2050[224]. The roadmap centers around three pillars: emissions reduction in the sector, development of a productive and sustainable industry, and social transformation and inclusion. These are supported by five cross-cutting axes: legal and regulatory enablers, promotion of supply and demand, deployment of the supply chain, technological, educational, and industrial development and financing and investments. In particular, airlines have been participating in the discussions for the use of SAF, as well as in the development of legislation and regulatory frameworks for its implementation. Ecopetrol, Colombia's state-owned oil company has identified co-processing and dedicated SAF production as one of many targeted renewable initiatives for potential investment and has produced the first pilot batches of co-processed jet fuel in the country. It is also an active proponent of SAF projects, although none have been confirmed or funded to date.

In 2024, Ecopetrol conducted an industrial test at its Cartagena refinery, producing 32,000 barrels of jet fuel co-processed with vegetable oils. However, the produced fuel did not meet sustainability standards. Although not yet fully ICAO-certified, this fuel marks a first step towards potential future SAF production, targeted for 2028[225]. Despite this test phase being completed, a final investment decision as well as all necessary regulatory permitting for proposed upgrades to existing refinery installations are still pending to enable commercial-scale production[226].

5.3.1.6 Dominican Republic

On April 24, 2023, the Dominican Republic launched its "Santo Domingo Declaration," a national commitment to foster the development and use of SAF[227]. This initiative establishes a clear roadmap for decarbonizing the country's aviation sector, building upon previous milestones such as the 2016 "Punta Cana Declaration" and a 2018 feasibility study[228] on SAF. The declaration represents a unified governmental approach, involving key ministries and aviation authorities to spearhead this green transition.

The established roadmap outlines specific short and medium-term goals. For 2023, the focus was on creating collaborative frameworks and sharing information to identify and overcome initial barriers to SAF implementation. Looking ahead to the 2024-2026 period, the plan includes a comprehensive review of the legal and regulatory framework, specifically targeting the Renewable Energy Incentives Law, to create a favorable environment for the production, logistics, and adoption of sustainable fuels, positioning the nation as a regional leader in sustainable aviation.

Currently, the Dominican Republic is already supporting a scale up of SAF, providing incentives for alternative fuels through Law 57-07, which provides tax exemptions for renewable energy projects.[229]

[223] https://ucsc.cl/medios-ucsc/noticias/sky-y-ucsc-desarrollan-proyecto-para-producir-combustible-sostenible-de-aviacion-en-chile/

[224] Green future of aviation in Colombia: Roadmap to sustainable fuels

[225] https://www.icao.int/SAM/Documents/2025-RAAC18/RAAC18_WP34_Environment_SAF.pdf

[226] https://www.ogj.com/refining-processing/refining/optimization/article/55241583/ecopetrol-wraps-testing-for-saf-production-at-cartagena-refinery

[227] https://www.idac.gob.do/es/instituciones-suscriben-declaracion-de-santo-domingo-un-compromiso-para-promover-uso-de-energia-limpia-en-la-aviacion/

[228] https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/FeasabilityStudy_DomRep_ENG_Web.pdf

[229] https://www.iea.org/policies/5290-law-57-07-on-incentives-for-development-of-renewable-energy-sources-and-its-special-regimes

5.3.1.7 Ecuador

Ecuador has no SAF related polices nor legislation in place. However, it should be mentioned that SAF has been identified as a key opportunity, with potential feedstocks considered at this stage being sugarcane, palm oil, and MSW[230].

5.3.1.8 El Salvador

El Salvador acknowledges in its State Action Plan that, although SAF is recognized as a key instrument to reduce carbon emissions from aviation, the major challenge remains securing broad multi-stakeholder commitment to its development[231].

5.3.1.9 Mexico

Plan México (published January 2025) includes SAF as a national priority. The Biofuels Law (*Ley de Biocombustibles*), enacted in March 2025, along with its forthcoming regulations for implementation (in drafting at the time of writing this report), intends to set out clear, inclusive criteria aligned with international standards for the production and certification of SAF and aims to promote the use and commercialization of biofuels[232]. Inter-institutional working groups (AFAC, ASA, SEMARNAT, SENER, CONADESUCA, SADER, SICT) have been established to harmonize policies, validate data, and define sustainability and certification criteria. Mexican Federal Civil Aviation Agency (AFAC) is in addition leading the development of a national SAF roadmap, in a collaboration with the International Civil Aviation Organization (ICAO), airlines, and CANAERO. The release of this roadmap is expected during 2026, outlining key actions, including research and development, economic incentives, regulatory frameworks, infrastructure guidelines, and sustainability criteria for feedstocks to avoid negative impacts on food security and the environment[233].

The Biofuels law intends to promote waste (circular economy) and energy crops cultivated on marginal lands, ensuring there is no interference with food sovereignty and security. Collaboration with forestry authorities is being taken into consideration to define sustainability criteria and monitor land-use changes, while energy crops are restricted to marginal lands, surplus sorghum and sugarcane (excluding corn) may be used for biofuel production.

5.3.1.10 Panama

Panama's National Strategy for Green Hydrogen and Derivatives sets clear targets for the integration of renewable hydrogen and SAF into the aviation energy mix, aiming for these sources to supply 30% of the sector's energy demand by 2050[234]. The strategy maps out key overarching goals such as becoming a sustainable energy hub through facilitating the use of renewable hydrogen (H2V[235]) in air and maritime, and creating a legal and regulatory framework to support investment and infrastructure development.

5.3.1.11 Peru

Peru has not unveiled policy plans for SAF. Currently Airbus is working with ICAO to conduct SAF feasibility studies in Peru as part of the ACT-SAF program[236]. This is exploring the potential feedstock availability, infrastructure needs and economic viability for SAF in the country.

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[230] Toward sustainable decarbonization of aviation in Latin America | MIT News | Massachusetts Institute of Technology
[231] https://www.icao.int/sites/default/files/environmental-protection/State_Action_Plans/PLAN-DE-ACCION-DE-REDUCCION-DE-CO2-DEL-ESTADO-ECUATORIANO-2021-2024-signed.pdf
[232] https://www.diputados.gob.mx/LeyesBiblio/pdf/LBio.pdf
[233] https://mexicobusiness.news/aerospace/news/mexico-aims-sustainable-aviation-fuel-2030-says-canaero#:~:text=Mexico%20could%20begin%20producing%20sustainable,of%20Air%20Transport%20(CANAERO).
[234] Gaceta Oficial Digital
[235] H2V = Hidrogeno verde (Green hydrogen)
[236] https://www.icao.int/environmental-protection/Pages/act-saf.aspx

5.3.2 Announced SAF production capacity in Latin America and the Caribbean

Biomass and waste-derived feedstocks including agricultural and forestry residues, used cooking oil, and municipal organic waste, among others play a relevant role for developing SAF production through established and emerging conversion pathways. Harnessing these local resources could diversify the fuel mix, strengthen the domestic fuel industry, and make SAF deployment an integral part of the region's jet fuel security strategy. The table below shows the announced SAF facilities in the LAC region (as of October 2025) although **it is important to note there are no projects in the region which have passed a final investment decision (FID) stage yet**. Reaching FID marks an important stage for a project, increasing the chance that it will move forward to construction and production due to the established financial commitment. At present, all projects in the LAC region are undergoing pre-feasibility and feasibility phases, evaluating the potential, technological options, and commercial viability of each proposal. However, it is common for some project announcements not to proceed beyond the feasibility stage. This has been observed even in more developed markets such as Europe where large oil and gas majors such as Shell and BP have cancelled their plans to continue with the announced SAF projects[237][238]. Hence, announced capacity is just an indication of the potential production but **does not imply it will materialize into operational production**.

Table 39: SAF facilities in LAC region (Status: announcement and target) as of October 2025

Country	Producer	SAF (m gallons)	Feedstock	Year (estimated)[239]	Status	Technology
Argentina	Grupo Bahia Energia[240]	49.5	Ethanol (from corn)	2031	Announcement	AtJ
Argentina	GreenSinnergy and Axens[241]	*	Biogenic CO_2	2033	Announcement	PtL (FT)
Brazil	BP Bunge Bioenergia[242]	396.3	Ethanol (sugarcane)	2030	Target	AtJ
Brazil	Brasil BioFuels[243]	66.0	Palm Oil	2026	Announcement	HEFA
Brazil	Petrobras[244]	231.2	Soybean oil and tallow	2029	Announcement	HEFA
Brazil	Petrobras[245]	297.2	Soybean oil and tallow	2029	Announcement	HEFA
Brazil	Green Fuels[246]	*	-	2031	Announcement	AtJ

[237] https://www.shell.com/news-and-insights/newsroom/news-and-media-releases/2025/shell-not-restart-construction-rotterdam-biofuels-plant.html
[238] https://www.safinvestor.com/news/147414/castellon/
[239] If there is no announced
[240] https://www.safinvestor.com/news/146125/argentina/
[241] https://www.qcintel.com/biofuels/article/german-firm-partners-with-axens-for-argentina-saf-plant-42839.html, https://www.axens.net/resources-events/news/greensinnergy-and-axens-sign-memorandum-understanding-advance-saf-project-argentina-latin-america/
[242] https://www.bp.com/en/global/air-bp/news-and-views/air-bp-news/bp_plans_to_deliver_five_projects_to_increase_SAF_supply.html
[243] Biofuels: produced from palm oil | Grupo BBF
[244] Petrobras licenses Honeywell UOP technology for renewable diesel, SAF production in Brazil
[245] https://www.jota.info/energia/petrobras-anuncia-producao-de-saf-entenda-o-que-e-o-combustivel-sustentavel-de-aviacao
[246] https://greenfuels.co.uk/producing-fuel/

Country	Producer	SAF (m gallons)	Feedstock	Year (estimated)[239]	Status	Technology
Brazil	Energis 8 Group[247]	99.1	Ethanol	2031	Announcement	AtJ
Brazil	Raizen[248]	33.0	Ethanol (sugarcane)	2031	Target	AtJ
Brazil	Acelen[249]	132.1	Inedible seed and waste oils	2027	Announcement	HEFA
Brazil	Refinaria Riograndense[250]	99.1	Soybean oil and tallow	2028	Announcement	HEFA
Brazil	Satarem America[251]	*	Ethanol (sugarcane)	2028	Announcement	AtJ
Brazil	Sempen[252]	*	-	2033	Announcement	PtL
Chile	Copec & Ineratec[253]	0.8	Biogenic CO_2	2032	Announcement	PtL
Colombia	Quipu Bio[254]	*	-	2028	Target	HEFA
Colombia	Bio-D[255]	49.5	Agricultural and forest residue	2027	Announcement	AtJ
Colombia	Ecopetrol[256]	*	Palm oil, UCO	2028	Announcement	HEFA
Colombia	Ecopetrol[257]	92.5	Palm oil, UCO	2030	Announcement	HEFA
Panama	SGP BioEnergy- First phase[258]	366.5	-	2027	Announcement	HEFA

[247] https://www.cnnbrasil.com.br/economia/negocios/empresa-promete-investimento-de-r-2-bi-para-produzir-combustivel-sustentavel-de-aviacao-no-interior-de-sp/
[248] https://finance.yahoo.com/news/ceraweek-brazils-raizen-scouting-locations-175330828.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAABMF-Dd7LtG258fQqJRxuQ0x9ONNOEHaHAEsaZvv1JCN8mGyhpDwqzP2KAbnJW9oL_lFOgzOPpBikBafiklQXRxfJryOVvNxYUQCNVuMV762_puRfNaFKDlmZNtG5Hu3JyQtD4706Ky68lNxQUM-iqy_uWJn4AMv11Y-dUjUlvt-
[249] https://www.prnewswire.com/news-releases/acelen-renewables-selects-honeywell-for-saf-and-renewable-diesel-fuel-production-302042935.html
[250] https://www.topsoe.com/press-releases/topsoe-to-provide-technology-for-one-of-brazils-first-commercial-scale-sustainable-aviation-fuel-production-plants
[251] https://en.clickpetroleoegas.com.br/Brazilian-city-will-gain-new-factory-worth-R%2423-billion-and-this-will-generate-800-direct-jobs/
[252] https://www.sempen.com/#OurProjects
[253] https://www.ineratec.de/en/news/ineratec-and-copec-enter-strategic-partnership-spearhead-e-fuel-availability-chile ; https://www.safinvestor.com/opinion/145423/chile/
[254] https://www.linkedin.com/company/quipu-bio/about/
[255] https://www.aviacionline.com/2023/05/revolutionizing-aviation-in-colombia-latam-airlines-and-bio-d-partner-to-produce-sustainable-fuel/
[256] Ecopetrol wraps testing for SAF production at Cartagena refinery | Oil & Gas Journal
[257] https://www.safinvestor.com/news/147339/ecopetrol/
[258] https://www.argusmedia.com/en/news-and-insights/latest-market-news/2496643-sgp-plans-2024-fid-for-panama-biorefinery, https://www.safinvestor.com/project/142197/sgp-bioenergy-golden-city-biorefinery-panama/

** This information has not been announced*

Although the number of projects is notable, it is important to highlight that only a fraction of these projects have had any feasibility investment and none of them have reached FID. Moreover, a significant portion rely on the ATJ pathway, a technology that remains under development and not yet mature. Brazil has the largest number of SAF production projects announced in the region. Coupled with the statewide feedstock availability and already existing biodiesel and ethanol value chains, there exists the potential for Brazil to become a large regional SAF supply hub. Argentina, Chile, Panama, and Colombia have also announced facilities focused on HEFA, AtJ, and PtL pathways. The figure below illustrates the existing oil refineries, jet fuel ports and announced SAF facilities in the region.

Refineries, announced SAF facilities and major jet fuel ports in the LAC region

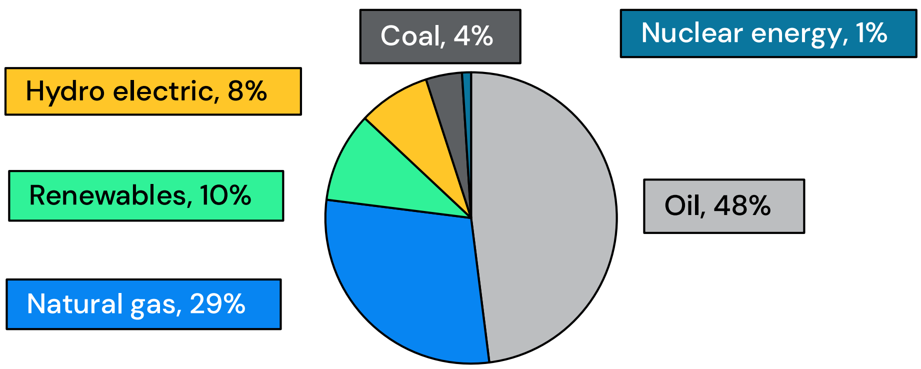
Source: Miskolc Enterprise, S.L., 2025 ICF analysis

5.4 Energy infrastructure and implications for SAF production

In the context of SAF production it is relevant to look at the overview energy landscape of the region. The energy balances, as well as the weight of renewable energy are relevant to the outlook for SAF potential production and possible demand by other sectors.

In the clean energy sector, the region is emerging as one of the key leaders globally. In 2024, renewables and hydroelectric power accounted for some of the major sources of energy, as shown in the figure below, underscoring the region's strong orientation toward cleaner energy. Leveraging its forest resources, as well as corn and sugarcane production, the region has also become the world's second-largest producer of biofuels[259]. This energy profile reflects the significant potential for further expansion of clean energy sources.

Close to half of the energy supply in the LAC region comes from oil, but renewables and hydro-electric relevance is growing



Source: Energy Institute Statistical Review of World Energy 2025, ICF analysis

5.4.1 Refining and jet fuel supply challenges

The reliability and adequacy of refining and jet fuel supply are critical to the future operations of airlines in the LAC region. Without a stable and sufficient supply of jet fuel at a competitive price, airlines face heightened risks of increased operational costs (already a significant contributor to overall operational costs for airlines in the region, between 30-40%) and operational challenges, which can undermine connectivity and economic growth across the region. As aviation continues to expand, ensuring modernized refining infrastructure and resilient fuel distribution will be essential not only for maintaining service reliability but also for supporting the region's competitiveness in the global air transport market.

In 2024, the region's refining capacity remained limited, contributing to 8% of the worldwide refining capacity of 4,731 Mt per year.

Over the next 25 years, OPEC projects a modest refining capacity increase of just 45.3 Mt in the region[260]. With overall growth expected to remain flat, supply security will depend on utilization rates, refinery modernization to meet cleaner-fuel standards, and stable policy signals to attract investment.

Historically, much of the crude industry was configured to serve U.S. market demand, prioritizing exports over the production of refined fuels for domestic consumption, including jet fuel. The refining infrastructure, such

[259] Energy Institute Statistical Review of World Energy, 2025
[260] https://publications.opec.org/woo/Download

as the one in the Caribbean region, was designed around residual fuel output to meet U.S. requirements rather than building capacity for transportation fuels within the region[261].

Further, the overall regional refining utilization has declined sharply, from 84% in 2000 to just 62% in 2024. This decline stems from a combination of structural and external challenges. Geopolitical sanctions, particularly on Venezuela due to the US sanctions on its oil supply, have severely constrained one of the region's largest refining systems. At the same time, limited reinvestment, deferred maintenance, and aging infrastructure, including in major refining hubs such as Mexico, have reduced efficiency and reliability. Many facilities also remain technologically outdated and are ill-suited to processing the heavier crude grades that dominate regional production, further restricting utilization, leading to import dependency, and affecting the region's energy security.

There have been instances where refinery infrastructure failures have disrupted jet fuel supply. In August 2024, a power failure at the Cartagena refinery led to a nationwide Jet A1 shortage in Colombia. Fuel supplies were exhausted at airports in Leticia, Montería, and Bucaramanga, while levels in Bogotá fell to critical lows, affecting all airlines in Colombia. The disruption created a 5% deficit in Jet A1 deliveries and required emergency imports of 12,700 tonnes. This highlighted the importance of ensuring a reliable jet fuel supply in the region. As a result, declining refining assets has eroded the region's ability to meet jet fuel demand, reinforcing dependence on imports despite substantial installed capacity. This is demonstrated in the figure below. Recent reports have highlighted significant challenges in the management of jet fuel supply across several countries in the region. These supply disruptions have led to increased uncertainty and instability within the aviation sector, with direct consequences including flight delays. Such issues underscore the urgent need for improved coordination and oversight of fuel distribution processes to mitigate operational risks and ensure the reliability of air transport services[262], [263], [264].

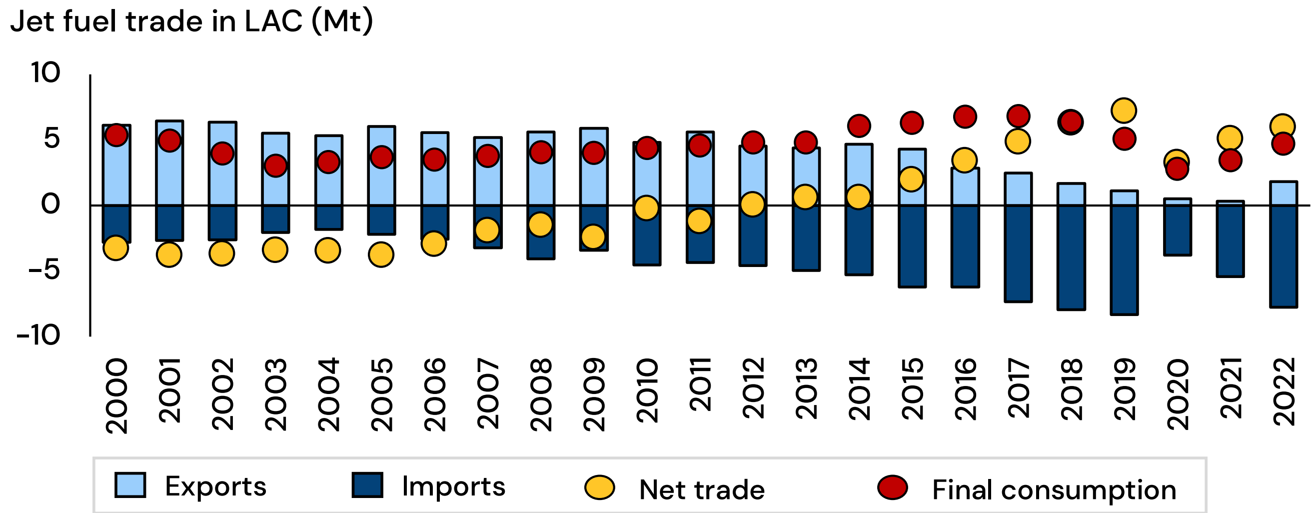
[261] https://digitalcommons.law.umaryland.edu/cgi/viewcontent.cgi?article=1103&context=mjil

[262] https://rpp.pe/lima/actualidad/pasajeros-de-vuelo-a-arequipa-se-encuentran-varados-en-avion-por-falta-de-combustible-en-nuevo-aeropuerto-jorge-chavez-noticia-1638386?ref=rpp#google_vignette

[263] https://www.infobae.com/peru/2025/06/03/mtc-senala-a-lap-como-responsable-del-desabastecimiento-de-combustible-en-el-nuevo-aeropuerto-jorge-chavez/

[264] https://rpp.pe/lima/actualidad/lap-reconoce-que-no-hay-correcta-distribucion-de-combustible-en-nuevo-aeropuerto-tras-reportes-de-vuelos-varados-noticia-1638394?ref=rpp

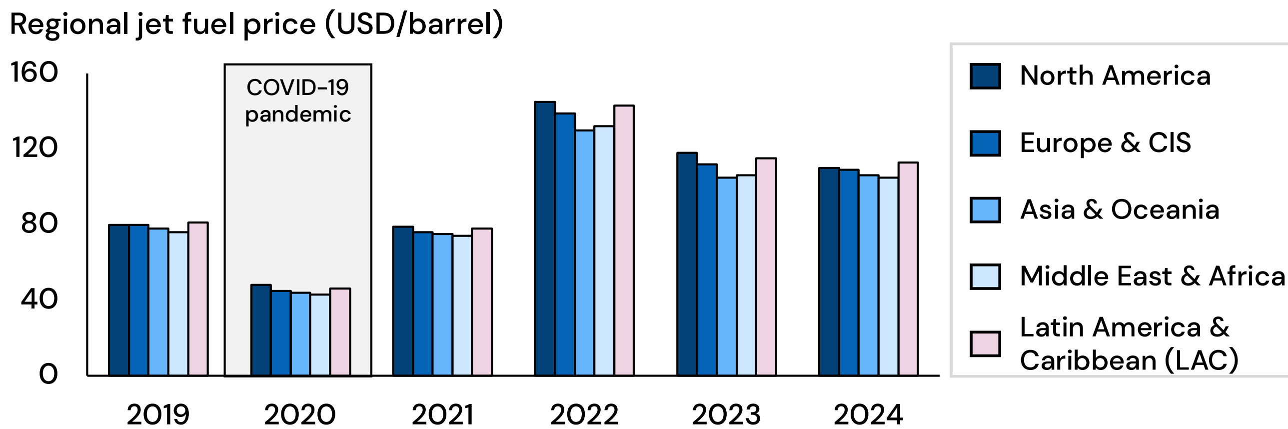
The LAC region has become a net importer of jet fuel in the past decade



Source: UN statistics, ICF analysis

In 2024, Latin America and the Caribbean recorded the highest jet fuel prices per barrel worldwide and has consistently been the highest or second highest region since 2019, as shown in the figure below. This is driven by the region's heavy reliance on imports, limited and uneven refining capacity, and a fragmented supply chain, challenges further compounded by currency depreciation and elevated logistical costs.

Jet fuel price in LAC has historically been at the high-end compared to other regions



Source: S&P Global Energy, ©2025 by S&P Global Inc. Platts World Jet Fuel Indexes. ICF analysis

5.5 Sustainability and the global SAF market

The LAC region is often cited as having significant potential for SAF production, owing to its vast agricultural landscape and consequent feedstock availability. However, assessment of this potential must be carefully balanced against associated risks, including competition with food production, land-use change, and pressures on local ecosystems, with a particular focus on biodiversity, water availability and social impact at scale. To address these risks, robust sustainability criteria is an essential component of renewable fuel policy, ensuring that the deployment of renewable fuels delivers genuine environmental and social benefits to each country and their population as a whole.

Further assessment is needed to fully understand SAF production's broader environmental, social, and economic impacts in the LAC region. Comprehensive, independent data collection and scientific analysis at the catchment, landscape, and regional levels are crucial for identifying potential trade-offs and unintended consequences. Government incentives or targeted support could play a pivotal role in accelerating the development of this robust evidence base, encouraging collaboration among stakeholders and ensuring transparency. Such initiatives would not only provide policymakers with critical information for responsible decision-making but also facilitate alignment with international sustainability standards, ultimately strengthening the region's position in the global SAF market.

5.5.1 Sustainability in Latin America and the Caribbean context

Several countries in the LAC region are beginning to explore sustainability frameworks for SAF, often drawing on international guidance such as CORSIA and the principles of the UNFCCC. In particular, the UNFCCC's principle of common but differentiated responsibilities is important in the region due to its wide socioeconomic diversity, offering a framework for balancing environmental performance with local development realities. These initiatives remain at an early stage, reflecting both the nascent state of SAF deployment in the region and the need to integrate broader development considerations into sustainability frameworks.

At the same time, the data needed to fully support CORSIA certification and other international sustainability assessments is still developing in the LAC region. Much of the information available today comes from production-unit studies, which provide useful insights but may not capture broader systemic impacts at the catchment, landscape, or regional level. Strengthening independent scientific data at these scales would give policymakers greater confidence in addressing potential trade-offs and avoiding unintended consequences. This also presents an opportunity for the region to build a robust evidence base that supports both domestic priorities and international alignment.

Current biofuel markets in LAC are dominated by primary crop-based feedstocks such as sugarcane, soy, and palm. These are well established but raise recurring concerns over land-use change, biodiversity, and food security - which could influence their role as feedstocks for SAF. At the same time, there is growing interest in wastes, residues, and by-products, such as bagasse, forestry residues, used cooking oil, and municipal solid waste. These materials generally create lower pressures on land use, but they still require lifecycle emissions accounting and traceability. Voluntary certification schemes such as Bonsucro, ISCC, and RSB play a complementary role alongside CORSIA, providing feedstock-specific sustainability standards that help frame how different SAF options are assessed in the region.

To date, most renewable fuel regulatory efforts in Latin America have focused on domestic biofuel markets rather than international trade. Several countries could look to build on these existing biofuel programs to support SAF sustainability.

Harmonization of sustainability criteria is an important enabler towards the international trade of SAF. This applies to both trade within the LAC region, and globally - where more stringent sustainability criteria may be enforced. With continued investment in data, scientific analysis, and independent monitoring, the region has a strong opportunity to shape a sustainable SAF industry that meets both local development priorities and global air transport needs.

While Latin America and the Caribbean are taking initial steps toward SAF sustainability, many frameworks remain in early development stages. The region's socioeconomic diversity underscores the relevance of UNFCCC guidance in crafting equitable and context-sensitive sustainability policies. Aligning with international sustainability criteria can enhance market access, particularly in the context of book and claim; however, the degree of significance may vary based on each country's strategic priorities and stage of development.

5.5.2 Global SAF sustainability standards

Around the world, different jurisdictions have established their own frameworks to govern the environmental and social performance of SAF. Alignment of the criteria across these frameworks is therefore central to ensuring that SAF can move freely across markets while maintaining credibility in terms of climate and sustainability outcomes. In the context of SAF, the European Union, United Kingdom and the United States are the most advanced in terms of progress towards implementing sustainability criteria, while other regions are still developing domestic frameworks or rely primarily on international standards such as CORSIA.

5.5.2.1 European Union

In the EU, sustainability criteria for SAF are defined by ReFuelEU[265] Aviation and the Renewable Energy Directive III (RED III). These frameworks specify minimum lifecycle GHG savings thresholds compared to fossil jet (94 gCO_{2e}/MJ) of 65%[266] for biofuels and at least 70% for recycled carbon fuels and renewable fuels of non-biological origin. SAF produced from crops is not eligible under ReFuelEU Aviation. RED III also contains environmental provisions regarding biodiversity, land-use change and soil health but does not contain guidelines on social or economic aspects of sustainability.

5.5.2.2 United Kingdom

In the United Kingdom, sustainability criteria for SAF are defined under the SAF Mandate, part of the Renewable Transport Fuel Obligation. Eligible fuels must achieve a minimum 40% reduction in lifecycle greenhouse gas emissions relative to fossil jet fuel (~89 gCO_2e/MJ). Only wastes and residues, recycled carbon fuels, and power-to-liquid fuels produced using low-carbon hydrogen and renewable electricity are eligible. Crop-based biofuels (including those produced from dedicated energy crops) are excluded.

The mandate includes environmental provisions for forest biomass, requiring legality of harvesting, sustainable forest management, and traceability of feedstocks. Like the EU framework, the UK SAF Mandate focuses primarily on environmental performance and does not provide detailed guidance on social or economic sustainability aspects.

5.5.2.3 United States

In the United States, sustainability criteria for SAF are primarily defined through the One Big Beautiful Bill Act (OBBBA), which extends the 45Z Clean Fuel Production Credit through 2029. Eligible fuels must have a lifecycle greenhouse gas emission less than 47.4 gCO_{2e}/MJ.

However, beginning in 2026, only feedstocks sourced from the United States, Canada, or Mexico qualify for this credit[267], effectively excluding imports from Latin America. While the OBBBA also removes indirect land-use change (ILUC) from emissions calculations, this has limited direct implications for the Latin American market (other than Mexico), given the restriction of the credit to North American feedstocks and production.

5.5.2.4 Summary

Like CORSIA, the sustainability frameworks for SAF in the EU, UK, and US all include clear GHG reduction criteria, although the specific thresholds and eligible feedstocks vary across regions. CORSIA sets a lower global baseline of 10% GHG reduction, meaning that SAF meeting CORSIA alone may not automatically satisfy the more stringent requirements of these regional markets. For example, in the EU, food and feed crops are not

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[265] It is worth noting that IATA analysis suggests that, under the ReFuelEU mandate, SAF fees paid by airlines have been more than double the SAF market prices, as fuel suppliers, as the obligated parties (fuel supplier), have opted to pass through compliance penalties: https://www.iata.org/en/iata-repository/publications/economic-reports/excessive-saf-fees-in-the-eu--a-lost-opportunity-to-abate-2.7-million-tonnes-of-co2

[266] Under RED II, transport biofuels must achieve 50% savings for installations operational before October 2015, 60% for those after October 2015, rising to 65% savings for new installations after 2021.

[267] https://rsmus.com/insights/services/business-tax/obbba-tax-clean-fuels.html#:~:text=Exclusion%20of%20foreign%20feedstocks:%20Effective,producers

considered eligible feedstocks, whereas they can be used in the US and under CORSIA, provided the required sustainability criteria are met. At the same time, CORSIA adopts a more holistic approach, addressing environmental, social, and economic sustainability themes, whereas the EU, UK, and US frameworks focus primarily on environmental performance. Differences in sustainability standards can affect market access for SAF, as producers must align with the specific requirements of each jurisdiction.

5.6 Biogenic feedstock availability for SAF production

This section outlines the approach to selecting the feedstocks analyzed in this study and the methodology used to quantify their availability for SAF. The discussion is presented by feedstock to facilitate a more efficient description of the methodology. The results are summarized at a country level in Section 5.6.5.

5.6.1 Feedstock selection

The feedstocks considered are summarized in the table below and were selected based on their:

1. Recognition by CORSIA – only feedstocks currently recognized by CORSIA were considered[268].
2. Compatibility with at least one of the ASTM approved SAF conversion processes[269].
3. Demonstrated commercial relevance in Latin America - only feedstocks with established or emerging supply chains in the region were included, ensuring near- to medium-term feasibility for SAF production.

Table 40: Summary of the feedstocks considered for SAF production in this study

Feedstock	ICAO Classification	Compatible Conversion Processes
Palm oil	Primary product	HEFA, co-processing
Soybean oil	Primary product	HEFA, co-processing
Sugarcane (as ethanol)	Primary product	AtJ
Corn (as ethanol)	Primary product	AtJ
Animal fats	By-product	HEFA, co-processing
Agricultural residues	Residue	FT, AtJ (as lignocellulosic ethanol)
Forestry residues	Residue	FT
Used cooking oil	Waste	HEFA, co-processing
Municipal solid waste	Waste	FT
Waste gases (as ethanol)	Waste	AtJ

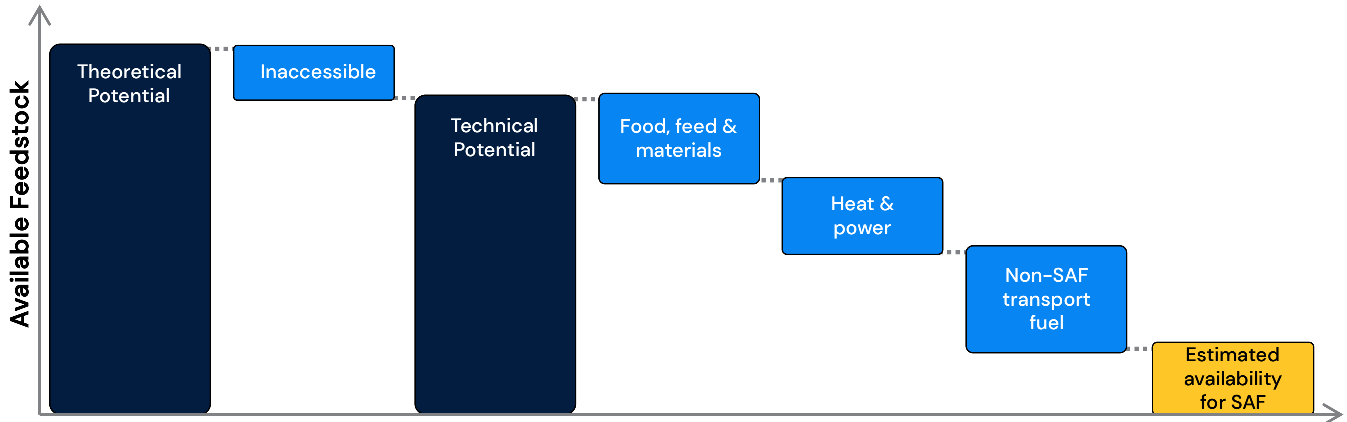
5.6.2 General methodology

The general methodology followed to assess the availability of feedstocks for SAF is illustrated in the figure below. The first step is to assess the theoretical potential of the feedstock, defined as the maximum quantity of the feedstock that is available. The second step is to estimate the technical potential, which represents the fraction of the theoretical potential that can actually be collected, accounting for technical and logistical limitations. After this, existing competing uses of the feedstock are considered, including applications in food, feed, materials, heat and power generation, and non-SAF transport fuels (e.g., road transport). The quantity remaining after these deductions is regarded as the feedstock available for SAF production.

In the following sections the theoretical potential, and estimated availability for SAF are evaluated for each of the feedstocks identified in the table above[270].

[268] ICAO SAF Feedstocks
[269] ICAO – Approved Conversion processes
[270] Feedstock volumes quantified as energy using the following conversions (GJ/t): UCO, Animal Fats, and Vegetable Oils: 37; Ethanol: 27; Agricultural and Forestry Residues: 18; MSW: 12.

3-step approach is followed to obtain the feedstock available in the LAC region to produce SAF



Source: ICF analysis

5.6.3 Feedstock deep-dive

5.6.3.1 Used cooking oil

Used cooking oil (UCO) is an oil-based feedstock suitable for SAF production via the HEFA and co-processing process. To assess the SAF potential from UCO, the analysis begins with the population data[271] for each country within the study's scope. Subsequently, vegetable oil consumption is explored as well as a collection rate to estimate recoverable UCO volumes. This methodology follows the approach developed by Teixeira et al. work[272] where 320 g of UCO are generated per kg of vegetable oil consumed, and 232 g per kg of UCO are subsequently valorized.

From the collected UCO, an analysis is conducted to estimate SAF availability excluding volumes allocated to other transport sectors. It is important to highlight that 0.1 Mt was subtracted as this quantity is allocated for biodiesel production biodiesel (FAME)[273]. The resulting SAF availability is presented in the following table.

Table 41: UCO theoretical availability and estimated availability for SAF production based on 2025 estimates[274]

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Argentina	8.37	1.66
Bahamas	0.02	-
Brazil	45.67	5.39
Chile	1.22	0.24
Colombia	7.99	1.59
Dominican Republic	2.42	0.48

[271] https://population.un.org/wpp/
[272] Teixeira, M. R., Nogueira, R., & Nunes, L. M. (2018). Quantitative assessment of the valorisation of used cooking oils in 23 countries. *Waste management*, *78*, 611-620.
[273] https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels%20Annual_Brasilia_Brazil_BR2024-0022.pdf
[274] ICF analysis

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Ecuador	3.52	0.70
El Salvador	0.20	0.02
Mexico	16.30	3.23
Panama	0.38	0.08
Peru	2.78	0.55
Total	**88.87**	**13.94**

The results show that Brazil, Argentina and Mexico present the highest SAF availability derived from UCO feedstock, while Bahamas, El Salvador and Panama SAF availability is negligible (less than 1 PJ).

Outlook

The collection of UCO is currently undergoing a growth phase in many Latin American countries, driven by environmental regulations, public awareness campaigns, and the increasing viability of UCO as a feedstock for biofuels. Considering the population growth, the expansion of collection networks and increased consumer participation, the theoretical availability of UCO is expected to continue its upward trend, making it a potential source for SAF.

5.6.3.2 Animal fats

Animal fats include beef tallow, pork lard and chicken fat which are by-products of industrial rendering. Thus, edible fats are used in food production, inedible fats present an opportunity to applications such as pet food, animal feed, energy generation and soap manufacturing. This feedstock is attractive since it possesses lower costs in comparison with vegetable oils, however, it presents sustainability concerns and regulatory restrictions limits in several countries[275]. As shown in the table below, this feedstock can be converted to SAF using HEFA and co-processing pathways. To evaluate the SAF availability derived from animal fats, the tallow production in each country is explored. To accomplish this, the tallow production and cattle values were extracted from FAO[276], [277].

Table 42: Animal fats theoretical availability and estimated availability for SAF production based on 2025 estimates[278]

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Argentina	10.34	1.34
Bahamas	-	-
Brazil	44.86	5.12
Chile	0.74	0.09
Colombia	7.86	1.02
Dominican Republic	-	-
Ecuador	-	-
El Salvador	0.22	0.03

[275] Blanshard, A., McCurdy, M., & Chokhani, S. (2021). *Fueling Net Zero How the aviation industry can deploy sufficient sustainable aviation fuel to meet climate ambitions An ICF Report for ATAG Waypoint 2050.*
[276] https://www.fao.org/faostat/en/#home
[277] https://www.fao.org/global-perspectives-studies/food-agriculture-projections-to-2050/en/
[278] ICF analysis

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Mexico	7.84	1.01
Panama	-	-
Peru	1.57	0.20
Total	**73.43**	**8.81**

Brazil accounts for approximately 72% of the tallow production among the countries included in this study, followed by Argentina (15%). Based on this analysis, tallow has been used in several applications such as feed formulations for pigs, poultry, pets, chemical, hygiene, and cleaning industries in the production of varnishes, lubricants, and glycerin for pharmaceutical use. In Brazil, the primary use of tallow is biodiesel production, due to this cost effectiveness and sustainability as a fat source[279].

In practice, approximately 30% of rendering process in Brazil is used for biodiesel production, 27% for personal care, 30% in pet food[280] and the remaining 13% for exports. In terms of exports, the United States accounted for approximately 97% of Brazil's tallow exports in 2025[281]. In addition, 0.64 Mt from tallow in Brazil was excluded as it is allocated for biodiesel production (FAME)[282]. Consequently, the potential to produce SAF from animal fats in the region depends primarily on redirecting export volumes toward domestic production. The analysis of SAF availability from animal fats was conducted using the same methodology applied to Brazil, resulting in an estimated potential of 5.12 PJ for Brazil, followed by 1.34 PJ for Argentina and 1.01 PJ for Mexico.

Outlook

Animal fat is a co-product of the meat processing industry. While the meat industry in Latin America is substantial, its growth is typically steady and tied to population and economic growth. The volume of animal fat generated is relatively consistent with the scale of livestock production and processing. While there is increasing interest in its use for biofuels, the overall supply is not expected to see dramatic increases beyond the steady growth of the primary industry.

5.6.3.3 Palm oil

Palm oil is a widely produced vegetable oil in Latin America, derived from the fruit of oil palm trees. In the context of SAF production, it can be used as a feedstock to produce HEFA-based SAF or as an input to co-processing pathways.

As shown in the table below, Colombia is the largest producer of palm oil in the LAC region, with production reaching 65 PJ (1.77 Mt) in 2022. Other significant producers include Brazil, Ecuador, Mexico and Peru, with annual production across the region, including Colombia, totaling 131 PJ (3.5 Mt).

Palm oil is widely used in the production of food and other industrial products such as soap and detergents. These uses take precedence over biofuel production according to the waste hierarchy. As such, palm oil that is currently used for these purposes, including exports, was considered unavailable for SAF production in this analysis.

279 https://brazilianrenderers.com/fats/
280 https://nara.org/wp-content/uploads/2024/10/Lucas-Cypriano-Brazil-update.pdf
281 https://www.fastmarkets.com/insights/us-saf-exporters-become-key-outlet-for-brazilian-tallow-in-august/
282 https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels%20Annual_Brasilia_Brazil_BR2024-0022.pdf

Table 43: Palm oil theoretical availability and estimated availability for SAF production based on 2025 estimates[283]

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Argentina	-	-
Bahamas	-	-
Brazil	21.70	0.0035
Chile	-	-
Colombia	65.40	-
Dominican Republic	1.70	-
Ecuador	16.20	-
El Salvador	-	-
Mexico	13.20	-
Panama	2.20	-
Peru	10.40	-
Total	**130.80**	**0.0035**

Palm oil is also established in the LAC region as a feedstock for biodiesel (i.e., fatty acid methyl ester, FAME) production, which may be consumed domestically or exported. For the purposes of this analysis, it was assumed that the volume of palm oil currently consumed domestically as biodiesel was unavailable for SAF production, in order to avoid displacing existing renewable energy use.

Conversely, palm oil that is currently exported as biodiesel is assumed to be potentially redirectable and could be retained domestically for SAF production. Using data from USDA, only Brazil[284] was identified as palm-based biodiesel exporter[285].

Although Colombia is the largest producer of palm oil in the LAC region, and has a developed domestic biodiesel industry, all domestic production is consumed within Colombia[286]. Similarly, domestic biodiesel production in Peru is entirely used domestically[287]. Biodiesel production in the remaining palm-producing countries is limited[288].

Based on the assumptions described above, none of the countries assessed have a current supply of palm oil that is likely to be available for SAF production. The volume of palm oil derived biodiesel exported from Brazil was found to be negligible (0.0035 PJ, ~0.09 kilotonnes). In the other palm oil-producing countries, current production is entirely consumed by domestic uses or exports already committed to other higher priority (i.e., food/feed) markets, making it unavailable for SAF production.

Outlook

The analysis described above highlights that at current levels of production there is likely to be limited opportunity for the use of palm oil as a feedstock for SAF production in the LAC region as the existing supply is committed to other uses in established markets. This indicates that an increased supply of palm oil would be required to facilitate its use in SAF production. This could be possible, for example, through improved agricultural practices delivering increased yields on existing plantations. However, it is essential that the use

[283] ICF analysis
[284] USDA – Brazil Biofuels Annual 2024
[285] This assumes that the feedstock composition of Brazilian biodiesel exports mirrors the proportions used in domestic production.
[286] USDA – Colombia Biofuels Annual 2025
[287] USDA – Peru Biofuels Annual 2025
[288] Technical Note No.5 An introduction to the biofuels sector in Latin America and the Caribbean

of palm oil as a SAF feedstock does not divert the feedstock from existing markets, particularly food, or induce land use change for palm production.

Sustainability is a critical consideration for the use of palm oil as a SAF feedstock. Under the current CORSIA framework, an ILUC value is only specified for palm oil produced in Indonesia and Malaysia. As a result, palm oil produced in the LAC region is not considered an eligible feedstock under CORSIA. In addition, palm oil that is processed without capturing methane from palm oil mill effluent (POME) is unlikely to meet CORSIA sustainability requirements. In Colombia, for instance, fewer than 12% of processing plants currently have methane capture systems in place[289]. Moreover, assurances around the potential systematic impact of any expansion of palm production into current non-planted territories on water and biodiversity, and in particular avoidance of wetlands, peatlands, or savannah.

5.6.3.4 Soybean oil

Soybean oil is a widely produced vegetable oil in Latin America, derived from soybeans and can be used as a feedstock to produce HEFA-based SAF or as an input to co-processing pathways.

As shown in the table below, soybean oil production in the LAC region is heavily concentrated in Brazil and Argentina, which produce around 323 PJ (8.7 Mt) and 276 PJ (7.5 Mt) per year, respectively. The volume of oil output is shaped by both the scale of soybean production and the extent of domestic crushing capacity[290].

For example, in Argentina, crushing capacity exceeds domestic soybean production, requiring imports of beans to fully utilize facilities. By contrast, in Brazil, crushing capacity is only about half of the annual soybean harvest, meaning a significant share of soybeans is exported rather than processed into oil domestically.

In this analysis, soybeans that are not crushed domestically were considered unavailable for SAF production, since exports of whole beans from Latin America are primarily destined for food and feed markets[291]. Soybeans that are traded within the region and subsequently crushed are reflected in the soybean oil production figures of the country where the crushing occurs, thereby avoiding double counting.

Soybean oil is used widely in Latin America as a feedstock for biodiesel production. In line with the methodology applied to palm oil (see Section 5.6.3.3) it was assumed that only the volume of soybean oil currently exported as biodiesel could be considered available for SAF production.

Table 44: Soybean oil theoretical availability and estimated availability for SAF production based on 2025 estimates[292]

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Argentina	276.00	31.30
Bahamas	-	-
Brazil	323.00	-
Chile	0.38	-
Colombia	6.80	-
Dominican Republic	0.21	-
Ecuador	0.18	-
El Salvador	-	-

[289] https://elpalmicultor.com/biogas-impulso-economia-descarbonizacion-sector/
[290] https://www.spglobal.com/commodity-insights/en/news-research/latest-news/agriculture/022725-brazilian-soybean-meal-pulls-ahead-as-argentina-faces-supply-challenges
[291] https://www.reuters.com/markets/commodities/chinas-reliance-soybean-imports-continues-despite-cutback-plans-braun-2025-04-30/
[292] ICF analysis

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Mexico	36.80	–
Panama	0.26	–
Peru	0.05	–
Total	**643.68**	**31.30**

This analysis showed that Argentina exports 31 PJ (0.85 Mt) of soybean oil as biodiesel, which is equivalent to around 50% of domestic production[293], and could be considered as being available for SAF. Available quantities in Brazil are much lower, where domestically produced biodiesel is almost all consumed in-country[294].

Outlook

The potential to increase soybean oil production in the LAC region for use as a feedstock for SAF is likely to be limited due to concerns around land use change, water and nature impact at scale. OECD-FAO forecasts suggest that global soybean production will continue to grow by about 1.3% annually until 2029[295], driven by yield Increases (66% of output growth) harvested area increase (33% of output growth). However, this growth is largely in response to increased demand from livestock feed[295]. Therefore, any new demand for soybean oil for SAF would most likely be layered on top of this strong, existing, and growing demand for animal feed. This inherently creates pressure for further land expansion, even considering productivity gains.

Historically, soybean production In the LAC region has been a driver of deforestation. While efforts to eliminate direct deforestation in the region have been somewhat successful[295], expansion of soy plantations have recently been shown to be indirectly driving deforestation in Brazil and Argentina[295].

Additionally, in Brazil, domestic supply of soybeans already exceeds crushing capacity, therefore this capacity would have to be increased before soybean oil could be produced as a SAF feedstock in the country[290].

5.6.3.5 Bioethanol from sugarcane and corn

Bioethanol is a key feedstock for SAF production via the alcohol-to-jet (AtJ) conversion process. It is typically produced through the fermentation of sugar- or starch-rich crops, most notably sugarcane and corn in Latin America. While its primary use remains as a road transport fuel, bioethanol is also employed in the pharmaceutical, food, chemical, bioplastics, and sanitizer industries[296].

Table 45: Bioethanol theoretical availability and estimated availability for SAF production based on 2025 estimates[297]

Countries	Theoretical Potential in 2025 (PJ)		Estimated availability for SAF in 2025 (PJ)	
	Sugarcane	Corn	Sugarcane	Corn
Argentina	–	16.00	–	0.85
Bahamas	–	–	–	–
Brazil	537.00	150.00	5.30	1.50
Chile	–	–	–	–
Colombia	8.30	–	–	–

[293] USDA – Argentina Biofuels Annual 2024
[294] USDA – Brazil Biofuels Annual 2024
[295] https://www.transportenvironment.org/uploads/files/2020_11_Study_Cerulogy_soy_and_deforestation.pdf
[296] Ethanol - UNICA
[297] ICF analysis

Countries	Theoretical Potential in 2025 (PJ)		Estimated availability for SAF in 2025 (PJ)	
	Sugarcane	Corn	Sugarcane	Corn
Dominican Republic	–	–	–	–
Ecuador	1.13	–	–	–
El Salvador	–	–	–	–
Mexico	–	–	–	–
Panama	–	–	–	–
Peru	3.40	–	–	–
Total	**549.83**	**166.00**	**5.30**	**2.35**

As shown in the table above, current bioethanol production in Latin America is dominated by Brazil, where 686 PJ (32.5 billion liters) is produced annually. Both sugarcane (325.7 Mt) and corn (15.5 Mt) are used as feedstocks for bioethanol production in Brazil, with sugarcane the dominant feedstock. The majority of the bioethanol produced, 609 PJ (28.8 billion liters), is used as road transport fuel within Brazil, with domestic fuel bioethanol consumption reaching 628 PJ (29.7 billion liters) in 2024.

Argentina[293] (16 PJ, 0.76 billion liters), Colombia[298] (8 PJ, 0.40 billion liters) Peru[299] (3 PJ, 0.16 billion liters) and Ecuador[300] (1 PJ, 0.05 billion liters) also have established bioethanol production industries but at a significantly smaller scale than Brazil.

In line with the approach used for palm and soybean oil, bioethanol currently consumed as transport fuel is assumed unavailable for SAF production, to preserve existing renewable energy uses. Accordingly, only exported bioethanol was considered available for SAF. Of the countries assessed, only Brazil and Argentina are net exporters of fuel bioethanol, exporting 6.76 PJ (320 million liters) and 0.85 PJ (40 million liters), respectively; these volumes were treated in this analysis as available for SAF production.

Outlook

All countries in the LAC region have the potential to produce sugar and starch crops suitable for bioethanol. Output from the sector could increase due to improvements in crop yields, such as those forecast by FAOs Food and Agriculture Projections to 2050. However, increasing ethanol production by planting more crops raises concerns about food security and land-use change, water and nature which may limit the role crops can play in ethanol production for SAF applications.

Second-crop corn offers a promising pathway to increase ethanol supply sustainably. Grown between main crop harvests (typically soybeans), it carries a lower risk of land use change and was recently certified under CORSIA as having low land-use change risk[301]. However, the carbon intensity of second-cropping corn is higher, resulting in lower energy efficiency per hectare[302]. In Brazil, the production of corn ethanol has been forecast to double by 2032, driven in part by the increased use of second crop corn[303]. Currently, 12 additional corn ethanol plants are under construction in Brazil, while nine more have received regulatory approval[303].

In the long term, it is also likely that increased electrification of road transport could lead to bioethanol that is currently used in the sector becoming available for SAF. For example, the ICCT have developed a scenario for

[298] USDA – Colombia Biofuels Annual 2025
[299] USDA – Peru Biofuels Annual 2025
[300] USDA – Ecuador Sugar Annual 2025, IICA - El estado de los biocombustibles líquidos en las Américas 2024
[301] First ISCC Low Land Use Change Risk Certificate Issued - ISCC System
[302] From stakeholder feedback
[303] Brazil's corn ethanol output projected to nearly double by 2032 on industry expansion | S&P Global Energy

a high uptake of electric vehicles in Brazil, which suggests that EVs could account for 70% of new vehicle sales in the country by 2050[304].

Given the significance of Brazil as an ethanol producer, an assessment was carried out to determine the impact of improved sugarcane yields, increased corn ethanol production and an aggressive uptake of EVs in the country on the long-term availability of bioethanol for SAF production.

Under these circumstances, the analysis shows that overall bioethanol production could increase by 22% by 2050, predominantly driven by increased corn ethanol production[305]. At the same time, an aggressive uptake of electric vehicles (at ~40% of the passenger vehicle fleet[306]) could reduce demand from the road transport sector by around 30% by 2050. Combined, this unlocks 384 PJ of bioethanol by 2050, which could be utilized in SAF production.

Given that most of the other countries in the LAC region are net importers of bioethanol it is likely that any increase in domestic production will be consumed by existing markets.

5.6.3.6 Ethanol from waste gases

Steel mill off-gases are the gases produced as by-products during steelmaking processes. These gases contain combustible components that can be captured and utilized as energy or converted into biofuels. Specifically, in this analysis basic oxygen furnace (BOF) gas is considered for conversion to ethanol, which can then be converted to SAF through the AtJ process.

Table 46: Ethanol theoretical availability and estimated availability for SAF production based on 2025 estimates[307]

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Argentina	2.30	0.28
Bahamas	-	-
Brazil	19.90	2.50
Chile	0.60	0.08
Colombia	0.84	0.10
Dominican Republic	-	-
Ecuador	0.32	0.04
El Salvador	0.05	0.01
Mexico	8.60	1.10
Panama	-	-
Peru	0.97	0.12
Total	**33.58**	**4.23**

[304] The transition to electric vehicles in Brazil's automotive industry and its effects on jobs and income – ICCT 2025
[305] https://unica.com.br/en/the-sector/ethanol/, UNICA state that corn ethanol production could rise to 14 billion liters in 2033 from 8.2 billion liters in the 2024/2025 harvest season.
[306] Based on the ICCT electrification scenario, with electric passenger car sales reaching 6% of new vehicles in 2030, 40% in 2040, and 70% in 2050.
[307] ICF analysis

Statistics on Latin American crude steel production for 2024 were obtained from Instituto Aço Brasil[308]. During the steel making process, 100 Nm^3 of BOF gas is produced per tonne of crude steel[309]. In this analysis it was assumed that 70% of crude steel produced within the LAC region utilizes BOF technology and on that 75% of this is currently used for energy recovery at the steel mill, with the remaining 25% flared[309]. The off-gases that are currently flared were assumed to be available for SAF production, with a conservative capture efficiency of 50%. Based on available literature, it was assumed that 0.64 tonnes of ethanol is produced per 1000 Nm^3 of BOF gas. The results of this analysis are summarized in the table above.

This analysis shows that there is moderate potential for steel mill off-gases to produce ethanol in both Brazil and Mexico, based on the assumptions described above. However, it should be noted that this analysis reflects off-gas production across all steel mills within each country. Literature data suggests that in order to be viable, an ethanol plant should produce 58 million liters of ethanol per year[309], which would require approximately 72 million Nm^3 of off-gases to be generated at a single site. Therefore, while regional potential exists, the scale of off-gas generation at individual steel mills may be insufficient to support a single commercially viable ethanol plant.

Outlook

The availability of steel-mill off gases for SAF production is unlikely to increase from current levels as globally, the industry is likely to move towards lower carbon technologies to meet the demand for low-carbon products.

5.6.3.7 Agricultural residues

Agricultural residues are the by-products of crop cultivation and processing that remain after the primary product has been harvested or extracted. They can be converted to SAF using gasification and Fischer-Tropsch (FT) pathways, or via AtJ following conversion to cellulosic ethanol. Agricultural residues can be split into two categories; field residues and processing residues.

Field residues are generated in-field during harvesting, most typically from cereals and other grains such as rice. These include straw and stalks that remain after the primary product is collected. A portion of these residues are typically left in field for agronomic reasons. Similarly, when collected, these residues are often used in animal husbandry. The fraction of these residues that are not required for either of these purposes may be used for heat and power generation or biofuel production. However, collection of these residues poses an economic and logistical challenge, as their generation is dispersed over de-centralized farming systems.

Processing residues are generated at the site where the primary crop is processed. These include shells, husks, cobs, and bagasse. Processing residues can have uses in animal feed and are also often used on-site to generate heat and power for processing operations. Processing residues not required for these purposes are considered available as a feedstock for SAF.

Across the LAC region, agricultural residues that are surplus to these requirements are often openly burned, contributing to air pollution and CO_2 emissions. Redirecting this resource to SAF production would therefore not only supply a renewable feedstock but also deliver additional environmental benefits by replacing open burning with a higher-value use in the waste hierarchy.

To evaluate the SAF availability derived from agriculture residues, the methodology initially examined crop and livestock production data for each country within the scope of this project, utilizing FAOSTAT[310] as the primary data source. Major residue producing crops in each country were identified and carried forward in this analysis.

[308] Estatistica-da-Industria-do-Aco_2o_TRI_2025.pdf
[309] https://www.safmaps.com/dbms-app/#off_gases_reports
[310] FAOSTAT

Average production figures for the period 2019–2023 were used to account any annual climatic or environmental influences on production. Subsequently, the primary field and processing residues were identified, along with their respective residue-to-product ratios (RPRs)[311, 312, 313, 314]. The final result is derived by summing the field and processing residues, after accounting for allocations to non-transport bioenergy, other non-bioenergy applications, and the portion of residues left in the field. Field residues and processing residues were considered separately to ensure that their respective value chains were accurately reflected.

Table 47: Agriculture residues theoretical availability and estimated availability for SAF production based on 2025 estimates[315]

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Argentina	8,110.00	462.09
Bahamas	0.18	0.02
Brazil	19,818.00	1,215.00
Chile	133.00	7.30
Colombia	374.00	27.83
Dominican Republic	64.00	4.35
Ecuador	171.00	11.41
El Salvador	66.00	4.52
Mexico	2,043.00	120.72
Panama	32.00	2.09
Peru	279.00	69.33
Total	**31,090.18**	**1,924.66**

SAF availability derived from agriculture residues is presented in the table above. The results show that Brazil possess a potential availability of 1215 PJ followed by Argentina (462.09 PJ). Conversely, Ecuador, Chile, El Salvador, Dominican Republic, Panama and Bahamas present an availability less than 15 PJ.

Outlook

While already significant, the potential for increased collection and valorization of agricultural wastes remains largely untapped. Improvements in agricultural practices, coupled with growing awareness of circular economy principles and the development of decentralized processing technologies, suggest a future where a larger proportion of these residues can be economically collected and converted. Policies promoting sustainable agriculture and waste-to-energy solutions will further drive this growth.

5.6.3.8 Forestry residues

Forestry residues are organic materials produced by the existing forestry and timber industries. They can be gasified, to produce SAF via an FT pathway, or used as a feedstock for ATJ following conversion to lignocellulosic ethanol. Forestry residues can be split into two classes, harvesting residues and processing residues.

[311] Sustainable Production of Second-Generation Biofuels (EN)
[312] Microsoft Word - ldoc9385_ornl_feedstock_potential_final_feb18.doc
[313] Osei, I., Addo, A., & Kemausuor, F. (2021). Crop residues utilisation for renewable energy generation in Ghana: Review of feedstocks assessment approach, conversion technologies and challenges. *Ghana Journal of Technology*, *5*(2), 29-42.
[314] Martinez-Valencia, L., & Valderrama-Rios, C. Sustainable Aviation Fuel Production in Colombia: Opportunities and Challenges.
[315] ICF analysis

Harvesting residues include small-diameter stemwood with little or no commercial value, along with branches, brash, and other material typically left on the forest floor during forest management or felling operations. Retaining part of this material in the forest during is essential for maintaining biodiversity, soil fertility, and soil carbon. However, some of it can be recovered as part of existing forestry operations, though this usually requires additional investment in collection and transport infrastructure. In Latin America, particularly in rural areas, part of this resource is also utilized as fuelwood[316].

Processing residues are by-products generated during the conversion of harvested timber in sawmills and other wood-processing facilities. These include sawdust, bark, wood chips, slabs, and shavings. Unlike harvesting residues, processing residues are concentrated at centralized locations and are already widely utilized for applications such as bioenergy, pulp, and panel products. Due to these existing uses, processing residues were not included in this analysis as diverting them to SAF production could compete with established industries, many of which take precedence according to the waste hierarchy.

Forestry harvesting residues can be generated from both primary (natural) forests and commercially planted forests. This analysis focuses only on residues from planted forests, as these are generally produced in a more regulated and managed environment. As a result, there is a higher likelihood that their recovery can be carried out in a sustainable manner, with reduced risk of negative impacts on biodiversity and ecosystem functions. In contrast, residues from primary forests were excluded, since it is much more challenging to ensure that their removal would be sustainable or environmentally responsible.

In this analysis, the potential availability of forestry harvesting residues from eucalyptus and pine plantations was estimated as follows, according to the methodology reported by Agroicone[317]:

$$Harvesting\ Residues\ =\ Planted\ area\ \times\ Mean\ annual\ increment\ \times\ Residue\ ratio\ \times\ Recovery\ rate$$

Where:

- Planted area is the total area of planted forest in each country in hectares
- Mean annual increment (MAI) is the quantity of biomass produced per hectare per year, specific to each country and species
- Residue ratio represents the proportion of harvested biomass that becomes residues (e.g., branches, brash, small stemwood); and
- Recovery rate is the fraction of those residues that can feasibly be collected, after accounting for ecological and operational constraints.

Data on the area of planted forest was obtained from the FAO Land Use data set[318], except for Brazil where a dedicated study on eucalyptus plantations was used[319]. The distribution of planted forest between eucalyptus and pine, as well as country specific MAIs, and species-specific residue ratios were obtained from the literature. Finally, a recovery rate of 50% was assumed in all cases[317].

Ecuador, El Salvador, the Dominican Republic, and Panama were excluded from this analysis due to their relatively small areas of planted forest and the scarcity of reliable data. In these countries, available information does not clearly distinguish between commercial plantations intended for wood production and plantations established for conservation or restoration purposes.

According to a recent study by Agroicone, most harvesting residues are currently left in the field, primarily for economic, rather than agronomic reasons[317]. Therefore, the estimate of forestry harvesting residues reported in this study represents potential availability and assumes that the required logistics and infrastructure could

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[316] Astrid Schilmann et al 2021 Environ. Res. Lett. 16 105012. DOI: 10.1088/1748-9326/ac28b2
[317] https://www.safmaps.com/dbms-app/pdfs/SAF_WOOD_RESIDUES_Final.pdf
[318] https://www.fao.org/faostat/en/#data/RL
[319] https://www.safmaps.com/dbms-app/#eucalyptus_reports

be put in place to support their collection. Agroicone also notes that a small quantity of these resources is sometimes collected for use for heat/power generation by mills, although no quantitative data is provided. In this analysis, we conservatively assume that 30% of the collected harvesting residues are used for heat/power generation and are consequently unavailable for SAF.

Table 48: Forestry residues theoretical availability and estimated availability for SAF production based on 2025 estimates[320]

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Argentina	87.20	30.50
Bahamas	725.00	254.00
Brazil	215.00	75.00
Chile	27.60	9.70
Colombia	2.40	-
Dominican Republic	5.67	-
Ecuador	0.69	-
El Salvador	10.60	3.71
Mexico	0.54	-
Panama	23.30	8.20
Peru	-	-
Total	**1,098.00**	**381.11**

The results of this analysis are presented in the table above and show that there is significant potential for forestry residues as a feedstock, particularly in Brazil, where 254 PJ of forestry harvesting residues could be available each year. Overall, 94% of the forestry harvesting residues in the LAC region are concentrated in Brazil, Chile and Argentina. However, as discussed above, it is important to note that these values represent the potential availability; current limitations in logistics combined with the challenging economics of using forestry residues for SAF production mean that the accessible supply is considerably lower at present.

Outlook

The analysis presented in the table above highlights the strong potential for using forestry residues as a sustainable feedstock for SAF production in the LAC region, provided that the necessary collection, transport, and processing infrastructure is developed and ecological constraints, such as soil health and biodiversity, are maintained.

5.6.3.9 Municipal solid waste

Municipal solid waste (MSW) is a diverse feedstock which comprises several waste streams, such as food, greens, plastics, paper, card, among others. Waste collection, management, composition patterns, size and density of the population affect the MSW characteristics. Consequently, the composition of municipal solid waste varies significantly across countries and cities[321].

[320] ICF analysis

[321] Gueboudji, Z., Mahmoudi, M., Kadi, K., & Nagaz, K. (2024). Characteristics and impacts of municipal solid waste (MSW): A review. *Technical Landfills and Waste Management: Volume 1: Landfill Impacts, Characterization and Valorisation*, 115-134.

Currently, a significant portion of global municipal solid waste is mismanaged, with at least one-third either openly dumped or burned which possess a global opportunity to produce SAF from municipal waste, enhancing waste management practices while contributing to the reduction of aviation emissions[322]. The production of SAF from MSW via FT technology lies in avoiding the emissions that would result from the waste decomposing in landfills. By converting the biogenic fraction of MSW into drop-in fuels, the life-cycle carbon footprint of air travel can be reduced[323].

The MSW assessment was conducted based on a detailed ICF model. In practice, MSW model uses data from World Bank group[324] to build a country-level relationship between historical population and GDP to forecast volume, composition, and destination of waste from each country. This tool considers all waste, uncollected, recycling and composting, incineration, landfill, dumping and other specifications suitable for SAF production.

The following table shows the SAF availability considering municipal solid waste as a feedstock. As noted, this analysis was conducted based on waste generation and GPD per capita. Thus, SAF availability derived from municipal solid waste is highest in Brazil (558 PJ), followed by Mexico, Argentina and Colombia.

Table 49: MSW theoretical availability and estimated availability for SAF production based on 2025 estimates[325]

Country	Theoretical Potential in 2025 (PJ)	Estimated availability for SAF in 2025 (PJ)
Argentina	249.60	114.00
Bahamas	3.60	1.20
Brazil	1,092.00	558.00
Chile	98.40	57.60
Colombia	177.60	75.60
Dominican Republic	63.60	28.80
Ecuador	80.40	33.60
El Salvador	24.00	14.40
Mexico	732.00	237.60
Panama	24.00	13.20
Peru	127.20	55.20
Total	**2,672.40**	**1,189.20**

Despite the challenges associated with its use, MSW has demonstrated potential availability for SAF production. Enhancing waste management practices could result in an increase in municipal and industrial waste availability. Biofuels and bioenergy have emerged as viable solutions through waste valorization. Circular economy and bioeconomy frameworks are identified as key drivers shaping waste to alternative strategies in LAC region[326].

Outlook

[322] Kafle, S., Karki, B. K., Sakhakarmy, M., & Adhikari, S. (2025). A Review of Global Municipal Solid Waste Management and Valorization Pathways. *Recycling*, *10*(3), 113.
[323] How all sustainable aviation fuel (SAF) feedstocks and production technologies can play a role in decarbonising aviation | News and views | Air bp
[324] Population, total | Data
[325] ICF analysis
[326] Ulloa-Murillo, L. M., Villegas, L. M., Rodríguez-Ortiz, A. R., Duque-Acevedo, M., & Cortés-García, F. J. (2022). Management of the organic fraction of municipal solid waste in the context of a sustainable and circular model: Analysis of trends in Latin America and the Caribbean. *International Journal of Environmental Research and Public Health*, *19*(10), 6041.

The production of MSW is directly linked to population growth and urbanization, which are ongoing trends in Latin America. As cities expand and waste management practices improve (moving away from landfills towards more circular approaches), the availability of MSW as a feedstock for energy recovery and SAF production is expected to grow significantly. Policy shifts towards waste-to-energy and resource recovery will be key drivers.

5.6.4 Emerging feedstocks and future opportunities

This study has focused on the most reliable data for the region to ensure the best degree of accuracy. However, this includes the limitation that potential feedstocks and technologies may be developed in the future, offering additional potential. Four case studies have been highlighted in the following section.

5.6.4.1 Macauba

The macauba palm (*Acrocomia aculeata*) is an oil-producing palm native to tropical America that displays intense fruiting which results in high fruit and oil yield. Studies show its energy conversion efficiency per hectare surpasses traditional energy crops such as sugarcane, oil palm, sunflower, maize, and jatropha[327]. For example, it has been shown to be 7 to 10 times more productive per hectare planted than soybeans[328].

The Brazilian Development Bank (BNDES) has approved R$ 257.9 million in financing for the establishment of the Acelen Agripark, a technology innovation center dedicated to research and development of macauba. This initiative is part of Acelen's integrated project to produce renewable diesel and SAF, focusing on the domestication of macauba and its cultivation on degraded land[329].

These figures suggest the feasibility of integrating Macauba cultivation into broader sustainable land management strategies, utilizing minimal portions of underutilized land and allowing for coexistence with other rehabilitation initiatives without substantial competition. Currently, Macauba is not on the ICAO CORSIA eligible fuels list.

5.6.4.2 Sargazo

Sargazo, also known as *Sargassum*, is a type of brown seaweed that periodically washes ashore in massive quantities throughout the Caribbean region. Sargazo has now become an environmental concern due to its unprecedented blooms in recent years. These thick mats of seaweed accumulate along coastlines, smothering beaches, disrupting tourism, harming local fisheries, and releasing hydrogen sulfide gas as they decompose, which can affect air quality and human health. The management and disposal of sargazo have become a pressing issue for many Caribbean nations.

Despite these challenges, sargazo also presents an opportunity as a potential feedstock for SAF. Its rapid growth rate, abundance, and non-reliance on arable land make it an appealing renewable resource. However, the practicalities of large-scale sargazo collection are fraught with difficulties, including its high moisture content, which complicates processing and transportation and further processing, and the logistical hurdles of harvesting mixed, often sandy biomass from the shorelines. Furthermore, there is a lack of comprehensive data and research on the conversion pathways and economic feasibility for SAF production from sargazo. At present, while the potential is recognized, significant scientific and technical advancements are needed before sargazo can contribute meaningfully to the SAF supply chain.

Sargazo has emerged as a potential feedstock candidate for SAF production in Mexico, the Bahamas, and the Dominican Republic which aligns with broader sustainability goals in the region[330]. Currently Sargazo is not on the ICAO CORSIA eligible fuels list.

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[327] https://pure.iiasa.ac.at/id/eprint/20207/1/IIASA-WWF_Sustainable-Aviation-Fuels_South-America.pdf
[328] https://h2businessnews.com/brasil-acelen-anuncia-la-primera-extraccion-industrial-de-aceite-de-macauba-para-combustibles/
[329] https://agenciadenoticias.bndes.gov.br/socioambiental/BNDES-aprova-R$-258-mi-a-Acelen-para-inovacao-e-desenvolvimento-da-macauba-para-combustiveis/
[330] Personal communications during engagement meetings (SEMARNAT)

5.6.4.3 Intermediate crops – camelina

Cover and intermediate crops, such as camelina, offer a sustainable approach by making use of underutilized arable land without compromising soil health or existing agricultural production. Unlike multi-cropping systems, which grow two or more primary cash crops sequentially or simultaneously on the same land, cover crops are typically planted between main crops or during fallow periods and are primarily intended to provide environmental benefits, though they can also be harvested for value-added products such as SAF. When grown under robust environmental standards, camelina provides new opportunities for local farmers and increases energy feedstock availability, all while avoiding competition with food crops and preserving natural landscapes.

Based on data from local developers[331], the total addressable area for camelina cultivation is estimated at around 30 Mha across Argentina, Brazil, Uruguay, and Paraguay. However, this represents a maximum potential, and the feasible area will likely be lower once climate suitability and other agronomic constraints are considered, although specific data are not yet available. For example, in Argentina, the addressable area is estimated at 13.6 Mha, but the realistically feasible area is closer to 11 Mha.

Oil yields per hectare are highly variable, ranging from 400 to 800 kg/ha. Assuming a medium yield of 600 kg/ha, the maximum potential production could reach approximately 18 Mt of oil. This represents a significant additional energy resource, which could serve both aviation and other markets outside the region. It should be noted, however, that real-world deployment is unlikely to reach these maximum estimates. These figures are intended solely to provide an indication of potential areas for further exploration and development.

5.6.4.4 Perennial grasses

Perennial grasses such as miscanthus and switchgrass are CORSIA recognized feedstocks[332]. These can be particularly attractive for SAF production from an environmental perspective when compared to other crop-based feedstocks because they have high annual yields, minimal input requirements (e.g., water, fertilizer etc.) and can grow on marginal, degraded or underutilized land[333]. Elephant grass is also emerging as a promising perennial feedstock, particularly in tropical regions, to supply biomass for advanced biofuels. However, commercialization of perennial grasses for SAF production is at an early stage. Recently, Jord, a company that specializes in cultivating C4-grass biomass, grown on marginal or degraded lands in Senegal and the Dominican Republic announced a partnership with biorefining technology developer Votion Biorefineries aimed at developing SAF from C4-grass[334].

5.6.5 Summary of results

The results from the analysis of feedstock availability are presented in Table 50. This analysis shows that Brazil is the country with the most significant potential for SAF production, with 2,046 PJ of feedstock potentially available. Argentina (642 PJ) and Mexico (367 PJ) also have notable resources.

Crop-based feedstocks, UCO, and animal fats are currently constrained, as they are largely committed to existing markets such as biodiesel production or food applications. A notable exception is soybean oil in Argentina, where significant exports for biodiesel create potential opportunities for diversion to SAF under changing market conditions. In the mid- to long-term, the availability of these feedstocks may increase if road transport electrification reduces demand for conventional fuels.

Emerging feedstocks, particularly agricultural residues, represent a substantial untapped resource. Our analysis suggests that 1924 PJ of agricultural residues could be mobilized for SAF production across the region, even after accounting for current bioenergy and non-bioenergy uses. This highlights the importance of developing supply chains, including collection, storage, and transport infrastructure, to transform this potential

[331] Data provided to ICF by Camelina Company based on proprietary studies.
[332] https://www.icao.int/environmental-protection/saffeedstocks
[333] Role of Energy Grasses – Sustainable Biofuels in the UK and Europe - Haush
[334] Sweden's Jord, Votion team up to produce SAF from C4-grass | SAF Investor

into practical SAF production capacity, though these supply chains are often complex and can be costly. Realizing this potential will likely require targeted policies, investment incentives, and coordination with existing agricultural and bioenergy stakeholders.

Overall, the regional analysis reveals a dual strategy: short-term exploitation of underutilized crop oils in specific contexts, coupled with medium- to long-term scaling of residues through supply chain development and supportive policy frameworks.

Table 50: Summary of estimated feedstock availability for SAF based on 2025 production estimates, PJ

Feedstock	Argentina	Brazil	Chile	Colombia	Dom. Republic	Ecuador	El Salvador	Mexico	Panama	Peru	Bahamas
UCO	1.7	5.4	0.24	1.6	0.5	0.7	0.0	3.2	0.0	0.6	0.0
Animal fats	1.3	5.1	0.1	1.0	-	-	0.0	1.0	-	0.2	-
Palm oil	-	0.0	-	-	-	-	-	-	-	-	-
Soybean oil	31.3	-	-	-	-	-	-	-	-	-	-
Bioethanol from sugarcane and corn	0.9	6.8	-	-	-	-	-	-	-	-	-
Ethanol from waste gases	0.3	2.5	0.1	0.1	-	0.0	0.0	1.1	-	0.1	-
Agriculture residues	462.0	1,215.0	7.3	27.8	4.4	11.4	4.5	120.0	2.1	69.3	0.0
Forestry residues	30.5	254.0	75.2	9.7	-	-	-	3.7	-	8.2	-
Municipal solid waste	114.0	558.0	57.6	75.6	28.8	33.6	14.4	238.0	13.2	55.2	1.2
Total	**642**	**2,047**	**141**	**116**	**34**	**46**	**19**	**367**	**15**	**134**	**1.2**

Note: Values rounded to one decimal. Totals rounded to closest integer

5.7 SAF calculated price methodology and forecasts assumptions

Price of SAF overview

The SAF industry remains at an early stage of development compared to the established conventional jet fuel market, where transparent pricing mechanisms have been in place for many years. Global production of SAF is still limited, resulting in price volatility that reflects several influencing factors, such as fuel type, location, and purchasing arrangements (including spot versus long-term contracts).

This analysis adopts a **calculated price for SAF** that incorporates a range of components, including direct production cost, anticipated returns on investment, and logistical expenses associated with activities such as blending, transportation, and storage, as well as administrative costs.

At present, a market premium is often observed for SAF, reflecting its limited availability, the early stage of market development, and the complexities involved in scaling up supply chains compared to conventional jet fuel. Even though such market premium exists, it is challenging to project the market conditions and reflect accurately as large fluctuations have been observed. Nevertheless, this premium is expected to decrease over time as the market matures, production volumes increase, technological advancements are realized, and regulatory frameworks evolve. This is expected to result in market price converging towards the calculated price for SAF. The section aims to provide insight into these dynamics by focusing on the calculated SAF price, offering a foundation for assessing the economic feasibility and future potential of SAF pathways in the region.

5.7.1 Methodology

A comprehensive techno-economic discounted cash flow (DCF) model was developed to estimate the price of different types of SAF in Latin America and the Caribbean. The analysis establishes a baseline minimum fuel selling price (MFSP) that reflects production-related costs, logistics and distribution and certification.

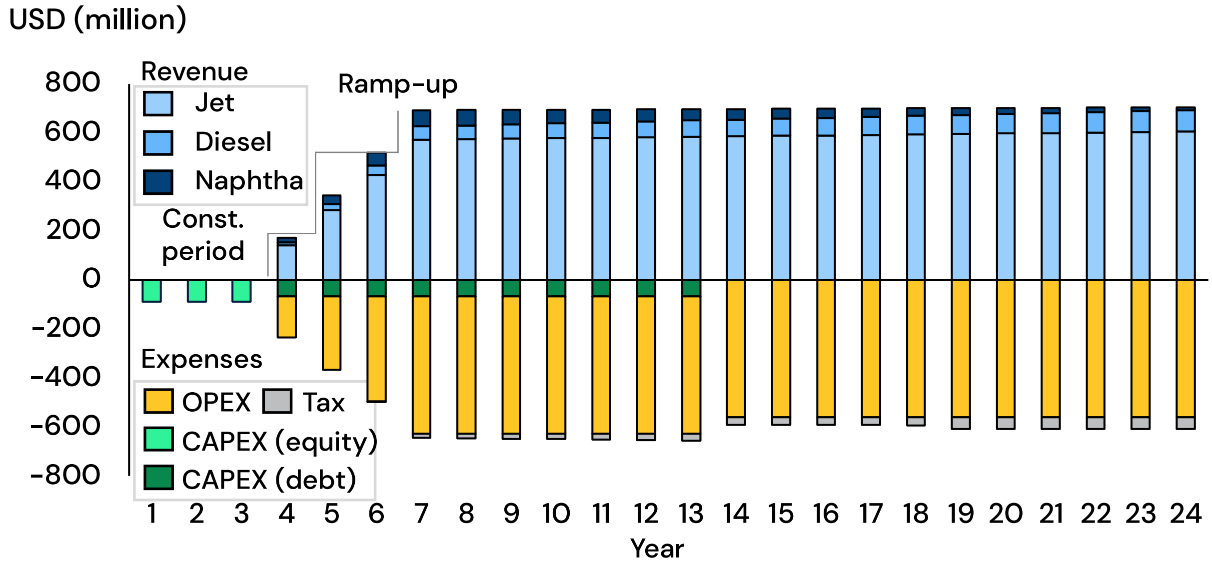
The model concentrates on key price drivers such the cost of production influenced by capital investment, feedstock choices, and technology configurations, as well as operating expenses, logistics and administrative costs. It reflects the challenges of developing SAF facilities, particularly for pathways that are still emerging or have limited commercial deployment. Cost estimates are based on consolidated assumptions intended to provide a representative view of price economics in the region. While some parameters are tailored to specific countries, individual project characteristics may lead to variations from these estimates.

ICF's model enables the calculation of MSP by technology and by country. The model assumes a three-year construction period for a facility followed by a production ramp-up phase. The main cost components include:

- Capital costs (split into equity and debt)
- Operating expenses (including utilities, feedstocks, and fixed costs)
- The corporate tax rate on earnings

Revenues are generated from SAF sales and co-products such as renewable diesel and naphtha. The figure below illustrates an example of the annual cash flow outlook for a potential facility commencing construction in 2025.

Example cash flow outlook for an AtJ sugarcane facility in Brazil

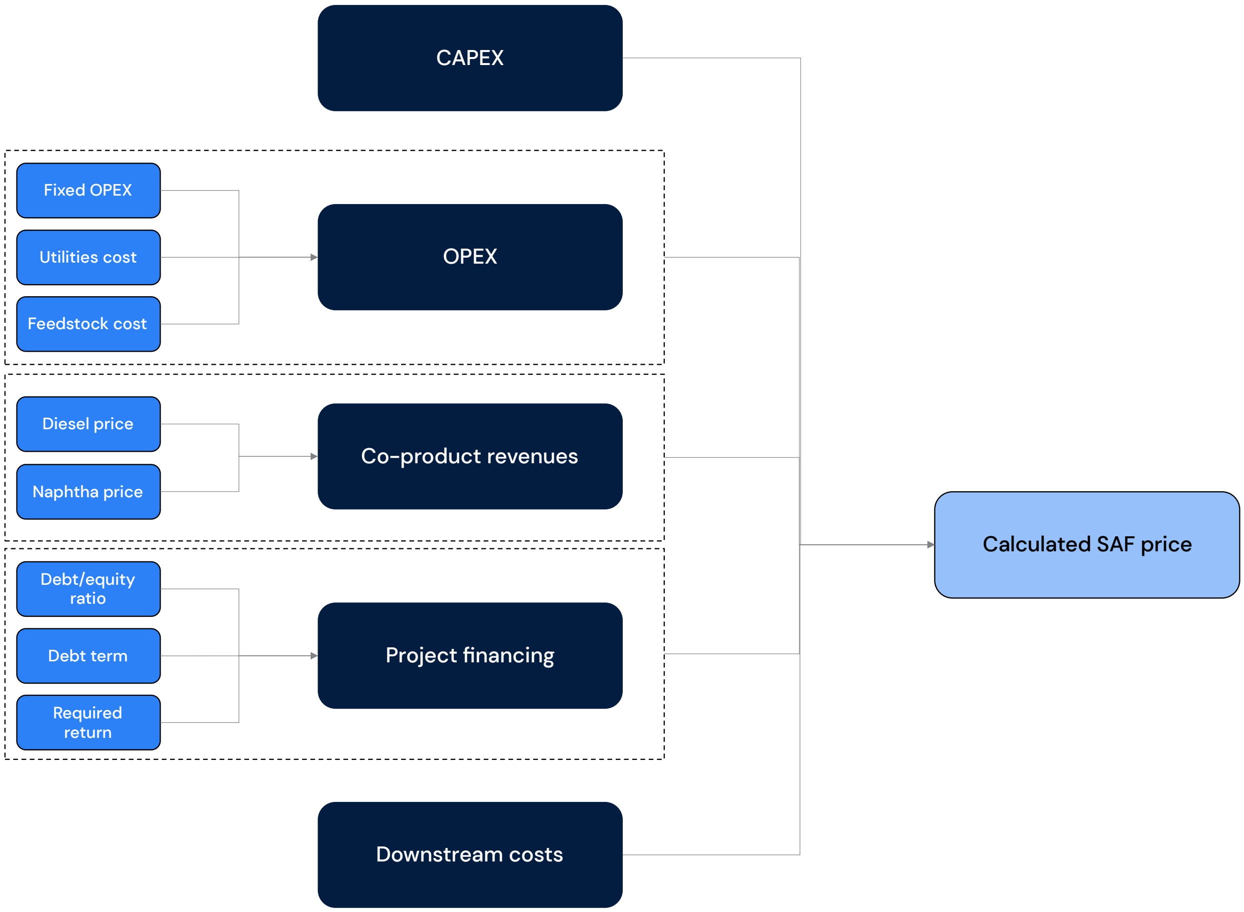


Source: Includes data from S&P Global Energy, ©2025 by S&P Global Inc., IEA. ICF analysis
Assumptions: 3-years construction period, 3-years ramp-up period until full production capacity is reached, 20 years operational life, corporate tax rate on earning in Brazil of 34%
AtJ = Alcohol-to-Jet

The model is adjusted for all combinations of country, feedstock, technology, and construction year within the assumed timeline (up to 2050), producing a dynamic cash flow outlook for each facility. It then calculates the MFSP required for SAF to achieve a net present value (NPV) of zero at the target internal rate of return (IRR). Determining the SAF estimated price for each feedstock, country, and technology, assuming construction timelines in five-year intervals, enables subsequent aggregate analysis. While financial assumptions vary by country, results are presented at an aggregate level for clarity. Logistic and administrative costs are added to reach the calculated SAF price.

The figure below presents the model architecture and input streams that feed into the final SAF calculated price. These inputs and assumptions are discussed in detail in the following sections. The model assumes a facility with an annual nameplate capacity of 132,132 mmgpy (0.4 Mt), a 3-year construction timeline, and a ramp-up period to full operational output. Adjustments are made for potential downtime, and a 20-year operational lifetime is assumed.

SAF price calculation model inputs/outputs flow diagram



5.7.2 CAPEX and fixed OPEX

5.7.2.1 CAPEX

Capital expenditure (CAPEX) represents a major share of the upfront investment for a SAF production facility. CAPEX includes all expenses needed to design, license, procure, build, and commission the physical plant before SAF production begins. These costs cover engineering studies, project management, land acquisition, civil works (such as foundations and buildings), purchase and installation of process equipment (reactors, columns, separators, compressors), electrical infrastructure, instrumentation, and safety systems. Indirect expenses - including permitting, legal fees, and contingencies for unexpected construction challenges are also part of CAPEX.

The amount and structure of these costs depend on the chosen SAF technology pathway. For example, HEFA-based plants, often adapted from existing biodiesel facilities, generally require less CAPEX compared with FT synthesis, PtL, and AtJ-based plants. Each technology has its own engineering requirements, supply-chain needs, and demands for specialized labor and equipment. FT synthesis, which converts biomass or waste into syngas before producing liquid hydrocarbons, needs high-temperature reactors and gas-treatment units. PtL requires electrolyzers and synthesis and upgrading units, while AtJ relies on fermentation and upgrading technologies. As a result, capital costs can range widely, from tens of millions to several hundred million USD for a commercial-scale facility.

CAPEX also varies by location due to local construction costs, workforce skills, and infrastructure availability. Economies of scale and established engineering and construction capabilities can lower costs, whereas projects in less industrialized settings may face higher costs due to imported equipment or specialized expertise.

Over time, CAPEX for SAF facilities is expected to decrease. This change is driven by wider deployment of SAF technologies, which leads to increased experience and efficiency during project execution. Standardizing equipment and plant designs can further reduce costs as suppliers offer ready-made solutions and project teams benefit from less custom engineering. Advances in process technology, such as improvements in catalysts, better integration of co-products, or enhanced process control can reduce the equipment and installation requirements. Growth in the pool of skilled workers and more developed local supply chains may also lower costs tied to specialized labor and imported components. The pace of CAPEX reductions will depend on factors like technology development, industry experience, and the broader economic situation. Overall, the outlook suggests that SAF facilities will gradually become more affordable and feasible for a wider range of markets and investors.

This analysis utilizes CAPEX cost projections developed by the International Air Transport Association (IATA), which include historical (2020) and forecasted capital costs by technology through 2045 as a baseline[335]. For consistency, the reported values for specific SAF outputs were converted to CAPEX per tonne of nameplate capacity, with adjustments based on yield. Interpolation was applied to estimate annual changes in capital costs, enabling the model to reflect these variations according to each plant's assumed construction date and to evaluate how evolving CAPEX may influence SAF production costs and subsequently prices. ICF further refined the projected capital costs per unit of output, reflecting market reality for a HEFA-based plant[336]. Besides, the cost provided in the IATA study for the FT technology is for a pilot facility, whereas the current study assumes a commercial scale plant, reflecting in a lower capital cost. Higher costs in the model compared to IATA's original figures are adopted, which reflect potential inefficiencies expected in the region compared with more developed markets.

Table 51: Evolution of CAPEX costs per technology (USD/gallon of nameplate capacity)

Technology	Unit	2020	2035	2045
HEFA	USD/gallon	2.54	2.47	2.43
AtJ	USD/gallon	6.43	5.79	3.86
FT	USD/gallon	44.10	26.46	26.46
PtL	USD/gallon	41.73	17.76	17.38

5.7.2.2 Fixed OPEX

Fixed operating costs – such as maintenance, labor, insurance, permitting, and selling, general and administrative (SG&A) expenses – typically expressed as a percentage of CAPEX because they scale with the size and complexity of the facility. These costs tend to be relatively stable year to year and do not vary

[335] https://www.iata.org/contentassets/8d19e716636a47c184e7221c77563c93/finance-net-zero-roadmap.pdf

[336] Actual cost reported by Neste for the development of a HEFA-based SAF Singapore refinery - https://www.neste.com/news/neste-oil-starts-up-its-new-renewable-diesel-plant-in-singapore

significantly with production volume. Maintenance and labor usually account for the largest shares, followed by insurance and property taxes. The table below summarizes the assumed fixed-cost shares by technology pathway.

Table 52: Fixed OPEX facility values per technology[337]

Component	% of CAPEX annually	HEFA	AtJ	FT	PtL
Maintenance	%	1.5	1.5	2	1.5
Labor	%	1	1.5	1.2	1
G&A	%	0.5	0.15	0.15	0.5
Insurance	%	0.75	0.75	0.75	0.75
Property tax	%	1	1	1	1
Major maintenance	%	1	1	1	1
Total	**%**	**5.75**	**5.9**	**6.4**	**5.0**

5.7.3 Variable OPEX (utilities and feedstock)

The variable operating costs of an SAF facility refer to expenses that fluctuate with production levels. Feedstock is the primary contributor, including UCO, animal fats, agricultural residues, MSW, and other inputs described in Section 5.6. Feedstock costs depend on type and availability and may be influenced by seasonal factors or competition from other industries. Energy consumption (utilities) is another significant component, as SAF production often involves processes such as hydroprocessing or Fischer-Tropsch synthesis that require electricity and heat. For PtL SAF, renewable electricity used to produce green hydrogen via electrolysis is a key cost driver. The energy source, whether grid-based or renewable, affects both cost and carbon intensity.

5.7.3.1 Utilities

For HEFA, AtJ, and FT technologies, four main utility inputs were assumed: electricity, natural gas, hydrogen, and oxygen. The energy requirement varies by process technology and therefore influences associated costs. The table below summarizes the assumed energy requirement per technology.

Table 53: Energy requirement per technology[338]

Utility	Unit/gallon of fuel output	HEFA	AtJ	FT
Electricity	kWh	0.09	1.42	0.38
Natural gas	MMBtu	0.01	0.02	-
Hydrogen	t of H_2	1.4×10^{-4}	3.0×10^{-5}	-
Oxygen	t of O_2	-	-	0.01

[337] https://www.easa.europa.eu/en/document-library/general-publications/state-eu-saf-market-2023
[338] Electricity, natural gas and hydrogen based on ICF internal modelling. Hydrogen based on https://cs3.mit.edu/publication/118414

Knowing the utilities required to produce a gallon of fuel output allows for the calculation of the annual cost associated with these utilities for the specific modelled facility size. Linking the utility requirement to the price of each and the annual facility output gives the annual utility cost. Various sources were used for obtaining regional energy prices.[339]

For PtL technology, four utility inputs were considered: renewable electricity, chemical inputs, water, and wastewater removal[340]. The levelized cost of electricity (LCOE) was assessed on a country-by-country basis where data was available[341]. This involved calculating a weighted average LCOE for solar PV, onshore wind, and renewable hydropower based on each country's current generation mix and applying projected cost reductions through technology learning curves. When country level LCOE data was unavailable, regional values were applied.

Other utilities are typically required for SAF operations; however, their contribution to overall utility cost is limited and they have not been modelled in this study.

5.7.3.2 Feedstocks

Feedstock costs typically represent a considerable share of total OPEX. Technological advancements in collection and processing, such as improved UCO recovery, MSW sorting, and agricultural residue logistics, can affect both availability and cost over time. Market dynamics also shape feedstock prices. Most feedstocks used for SAF production are traded as commodities, meaning their costs fluctuate with supply–demand balances, geopolitical developments, and trade policies. When availability is limited or competition from other industrial applications increases, prices may rise. Conversely, widespread access to certain feedstocks can exert downward pressure on costs.

There are also regional variations in feedstock prices due to local resource availability, infrastructure, and regulatory environments. For example, some regions have established supply chains and incentive programs that can impact costs, while others may experience logistical constraints that result in higher prices. Additionally, seasonality and weather patterns can influence the production and collection of certain types of biomass or waste-derived feedstocks. Over time, it is possible for the overall feedstock cost profile to shift as new technologies are adopted, recycling rates improve, and market conditions evolve. Monitoring these factors can provide insight into future trends in SAF production economics and inform facility planning and investment decisions.

Although prices vary across Latin America and the Caribbean, Brazil has been used as a benchmark in the analysis due to greater feedstock price data availability. Where country specific data has been found, it has been prioritized over, however this is in limited cases. S&P Global Energy feedstock cost data has been used as the main source for current market prices supplemented by independent research and assumptions for feedstocks where trading information is not available[342]. As this study projects to 2050, costs for some feedstocks are expected to change. ICF developed scenarios to capture these changes and analyze their impact. The following price profiles were assumed for the different groups of feedstocks:

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[339] Electricity costs per country (Dec 2024) - https://www.globalpetrolprices.com/electricity_prices/ ; Oxygen – ICF assumption; Hydrogen - https://cs3.mit.edu/publication/118414

[340] Renewable energy and water consumption, chemicals cost, and waste water generation based on ICF internal modelling; water and waste water treatment costs based on https://iwaponline.com/h2open/article/3/1/355/76768/Drivers-of-change-in-urban-water-and-wastewater.

[341] LCOE by country and region based on IRENA, 2024; renewable energy generation based on https://pxweb.irena.org/pxweb/en/IRENASTAT/; LCOE future trends based on NREL 2024 ATB.

[342] Historical and current (August 2025) prices were provided by S&P Global Energy for used cooking oil, animal fat, soybean oil, sugarcane ethanol traded in Brazil, as well as soybean oil in Argentina.

- Oil feedstocks converted to SAF through the HEFA pathway, such as UCO, animal fat and soybean are assumed to increase in price over the projected timeframe due to product scarcity globally and increased demand from other sectors
- Second generation ethanol produced from agricultural and forest residues, as well as waste gases, is projected to reduce in price driven by the learning rate associated with the production of this ethanol and the advancement in technology and processing
- Crop ethanol produced from sugarcane and corn is assumed to express relatively stable price profile, so current level price is kept

5.7.4 Physical fuel and co-products

5.7.4.1 Jet fuel

Currently SAF trades at a premium compared to conventional jet fuel[343]. Fossil jet is a commodity, with established, transparent market, whereas SAF market is still nascent, transactions are limited, and price volatility is high. Fossil jet fuel pricing is primarily dependent on crude oil market dynamics, refining costs, and distribution logistics. Another factor influencing the future economics of conventional jet fuel is the potential implementation of carbon taxes or similar environmental levies. Such measures are designed to internalize the environmental costs associated with fossil fuel combustion, effectively increasing the price of jet fuel for the air carriers. This could potentially impact regional air travel patterns, especially in high price sensitive regions such as LAC. The negative impacts on demand could include reduced flight frequency, pressure on airline profitability, and decreased regional connectivity as airlines are forced to cut routes or limit service in response to increased operational costs from carbon pricing (with jet fuel already representing 30-40% of operational costs for airlines in the region).

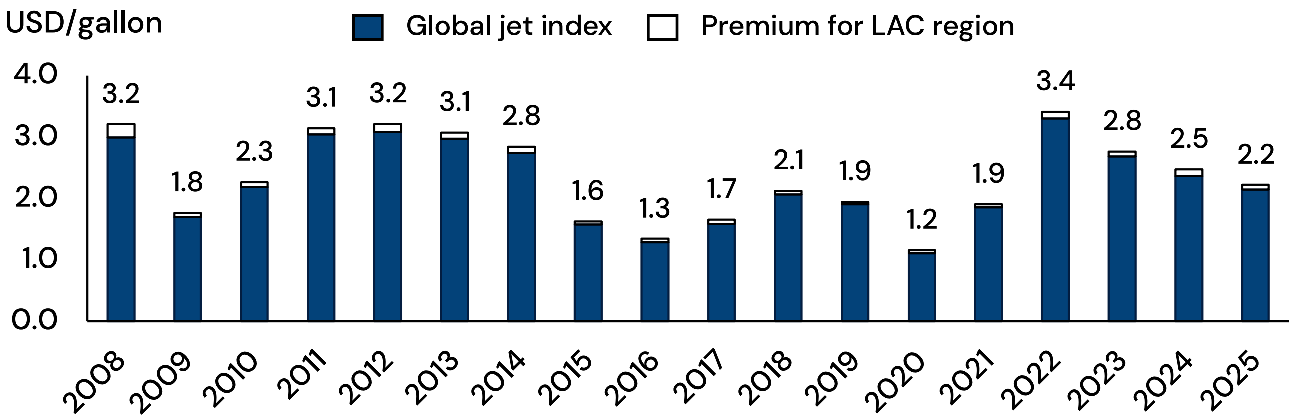
In contrast, SAF price reflects not only the production cost driven by price of feedstocks, often derived from renewable sources, the technological pathway and efficiency of the conversion processes (and associated production facility financing), but also value of co-products, blending and logistics costs, administrative costs and a market premium in some cases. To understand the “green” premium of SAF and further compute abatement cost linking the carbon saving when using SAF instead of conventional jet fuel to the underlying price, it is important to have an estimation of current and future fossil jet prices.

Conventional jet fuel in Latin America and the Caribbean has historically traded at a premium to the average global kerosene price[344], likely driven by limited domestic production and reliance on imports as explored in more detail in Section 5.4.

[343] https://www.airlines.org/dataset/saf-vs-jet-fuel-comparison/

[344] Based on analysis of S&P Global Energy global jet index and Latin America and the Caribbean jet index

Jet fuel has historically traded at a premium in the LAC region compared to a global average



Source: S&P Global Energy, ©2025 by S&P Global Inc. ICF analysis

The jet fuel forecast uses as a baseline the relationship between crude oil and kerosene observed historically. A correlation analysis was performed on the historical average annual prices (2002-2024) of Brent oil compared to S&P Global Energy Platts Jet Index Latin America and the Caribbean[345,346]. The figure above shows the historical Latin America jet fuel index prices. An R^2 value of 0.96 was found, highlighting a strong linkage between the two. This was then extended further utilizing the forecasted IEA crude oil prices summarized in the table below[347]. Values were interpolated to obtain the annual average price assumed each year. Linking these prices to the S&P Global Energy Latin American jet fuel index utilizing the underlying correlation equation provides two scenarios for the future kerosene cost in the region (using the STEPS and APS crude oil scenarios). The NZE scenario, however, is considered relatively extreme case for oil price so the corresponding jet fuel price was not modelled in this study.

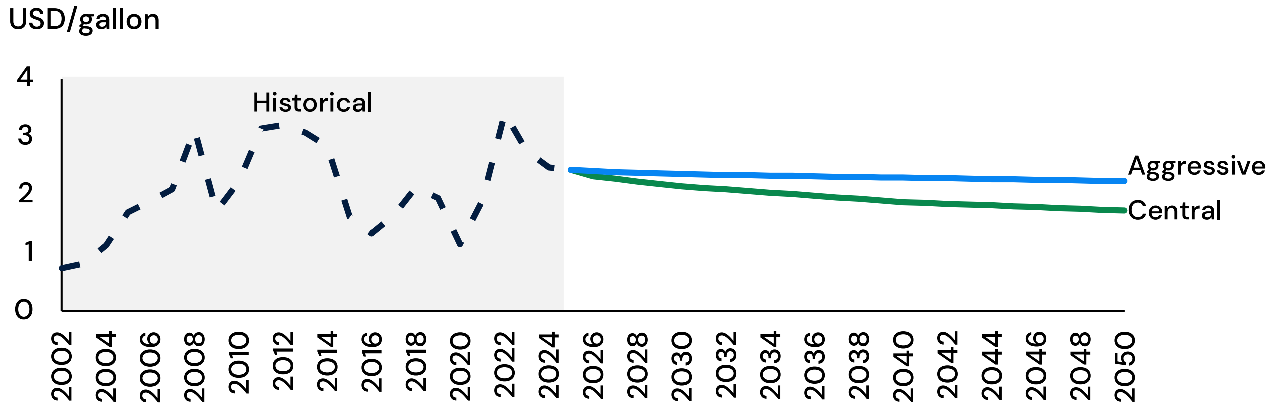
Table 54: IEA crude oil price forecast per scenario

IEA scenario	Unit	2023	2030	2040	2050
STEPS[348]	USD/bbl (USD/gallon)	82 (1.91)	79 (1.88)	77 (1.83)	75 (1.78)
APS[349]	USD/bbl (USD/gallon)	82 (1.91)	72 (1.71)	63 (1.50)	58 (1.38)

345 Brent oil historical prices - https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=M
346 Provided by S&P Global Energy for the purpose of this analysis
347 https://www.iea.org/reports/world-energy-outlook-2024
348 STEPS = Stated Policies Scenario; designed to provide a sense of the prevailing direction of energy system progression and current policy landscape. The STEPS provides a more conservative benchmark for the future than the Announced Pledges Scenario (APS), by not taking for granted that governments will reach all announced goals - https://www.iea.org/reports/global-energy-and-climate-model/stated-policies-scenario-steps
349 APS = Announced Pledges Scenario; illustrates the extent to which announced ambitions and targets can deliver the emissions reductions needed to achieve net zero emissions by 2050 - https://www.iea.org/reports/global-energy-and-climate-model/announced-pledges-scenario-aps

IEA scenario	Unit	2023	2030	2040	2050
NZE[350]	USD/bbl (USD/gallon)	82 (1.91)	42 (1.00)	30 (0.71)	25 (0.67)

Two scenarios were constructed for the jet fuel price outlook in the LAC region



Source: Includes data from S&P Global Energy, ©2025 by S&P Global Inc., IEA. ICF analysis
Assumptions: 1. Historical relationship (2002 to 2024) between Brent oil price and S&P Global Platts Jet Index Latin America & Caribbean used (R2 value of 0.97, i.e. high correlation); 2. IEA crude oil price scenarios assumed to represent Brent price forecast; 3. 2025 value used is an average observed up to July 2025 based on S&P Global Energy data

5.7.4.2 Co-products

Revenues from the production of other fuels, such as renewable diesel and naphtha, can have a meaningful impact on the price of SAF. When these by-products are generated alongside SAF, they can be sold in the market, providing additional revenue streams. This supplementary income helps to lower the overall cost of SAF production, making it more economically viable. Renewable diesel (RD), for instance, is in high demand due to its lower carbon footprint compared to traditional diesel, and naphtha is a valuable feedstock in the petrochemical industry. By capitalizing on these by-products, producers can reduce the financial burden associated with SAF production, thereby promoting its adoption and usage. The revenues generated from such co-products are dependent on their market price, as well as the volumes produced. These volumes subsequently are dependent on the technological pathway and the facility specification. Different product slates could result in a different share of co-products generated annually. For the purposes of this analysis, an increasing SAF yield is assumed, reflecting the assumption of economic conditions benefiting SAF prioritization over other fuels and technology developments allowing for higher SAF yields. The table below indicates the assumed product slates in the model over the analyzed timeline.

[350] NZE = Net Zero Emissions by 2050 Scenario; The Net Zero Emissions by 2050 Scenario (NZE Scenario) is a normative scenario that shows a pathway for the global energy sector to achieve net zero CO_2 emissions by 2050, with advanced economies reaching net zero emissions in advance of others - https://www.iea.org/reports/global-energy-and-climate-model/net-zero-emissions-by-2050-scenario-nze

Table 55: Assumed product slates [351]

Technology	Unit	2025			2035			2050		
		Jet	Diesel	Naphtha	Jet	Diesel	Naphtha	Jet	Diesel	Naphtha
HEFA	%	53	40	7	60	32	8	70	20	10
AtJ	%	78	7	15	81	10	9	85	14	1
FT	%	61	36	3	63	34	4	65	30	5
PtL	%	72	14	14	75	13	13	80	10	10

The analysis uses market prices of *5.45 USD* per gallon for RD and *4.69 USD* per gallon for renewable naphtha[352] to estimate the revenues generated from such co-products. While these figures reflect current market conditions, the renewable fuels market is volatile, and prices may change over time. ICF's projections are based on the assumption that these prices remain constant throughout the forecast period, though shifts in co-product markets could affect the "green" premium for SAF. These prices are based on the European market, as comparable data for Latin America and the Caribbean is not readily available. To account for regional cost differences, the analysis includes a transportation cost adjustment of 0.25 USD per gallon[353].

5.7.5 Project financing assumptions

Project financing represents a foundational element for the advancement of SAF facilities. Given the significant capital requirements and early-stage industry dynamics, a clear understanding of these mechanisms is crucial. As the industry matures, factors such as technological development, operational efficiencies, and economies of scale are expected to influence risks and costs, potentially improving access to finance and reducing manufacturing expenses. The following sections explore how these financing structures and market conditions shape the investment landscape for SAF projects and outline the assumptions taken in the analysis for Latin America and the Caribbean region.

5.7.5.1 Capital structure

Due to the capital-intensive nature of these projects, as well as evolving technologies and market conditions, securing an appropriate financing structure is a key part of project development. A standard approach is a debt/equity mix. In most cases, debt financing constitutes about 60% to 80% of total capital requirements, supplied by lenders such as commercial banks, development finance institutions, or specialized infrastructure investors. The remaining 20% to 40% is typically covered by equity contributions from project sponsors, private equity funds, or strategic partners. The exact proportions may shift depending on project specifics, investor confidence, and negotiations with financial institutions.

In this study, debt-to-equity ratios of 70%/30%, 60%/40%, 55%/45%, and 55%/45% have been used for the HEFA, AtJ, FT, and PtL processes, respectively. These ratios are representative of 2025 levels and a gradual increase in the debt share is modelled over the forecast to reflect expected de-risking of SAF technologies and the attraction of more debt finance for facilities built later in the period.

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[351] ICF assumption
[352] RD price is the average cost in the period (May 2024 to July 2025) –raw data provided by S&P Global Energy for the purposes of this analysis. Renewable naphtha price (August 2025) from Quantum intelligence
[353] ICF assumption

5.7.5.2 Cost of debt and terms

Debt providers require regular interest payments and principal repayments according to an agreed schedule. The interest rates applied to project debt are strongly influenced by the project's location, and this is closely tied to the perceived risk of debt default. In regions such as North America and Western Europe, where financial markets are stable and policy frameworks for renewable fuels are mature, the risk of default is generally low, leading lenders to offer lower interest rates. In emerging markets with less predictable regulatory environments or higher country risk, lenders perceive a greater chance of default due to factors such as currency instability, shifting legal frameworks, or limited experience with large-scale SAF projects. To compensate, they require higher interest rates.

Latin America and the Caribbean currently have no operating SAF facility (2025), some economies are unstable, and markets are volatile. A higher interest rate is therefore expected for SAF financing in the region. Credit rating agencies such as S&P Global Ratings analyze the credit stability situation in countries globally and indicate which regions are showing higher debt default percentage, indicating higher risk in these regions. Summary of the latest credit ratings per country in Latin America and the Caribbean are shown in Table 56 below. For countries with lower ratings, a higher interest rate on the debt is assumed.

To construct the interest rate assumptions, ICF have assumed a baseline central bank rate representing a proxy of a long-term bank target to decouple the current economic situation, current rates and inflation[354]. Typically, the debt rate for a renewable project such as solar or SAF is higher than the central bank rate due to the risks associated with such projects in the still nascent industries. A premium of 2.5% to 5% over the baseline rate in each country has been assumed in the analysis depending on the S&P Global Ratings country's credit rating provided. The study assumes a constant rate throughout the timeline since the analysis decouples interest rates and inflation. While monetary policy changes could cause fluctuations in baseline interest over a 25-year period depending on whether an expansionary or contractionary policy is implemented, separating these effects on inflation streamlines the analysis. The link between central bank rates and the cost of debt for a project have recently been demonstrated by the increase of solar projects cost increase due to rising interest rates[355]. The model assumes a debt term of 10 years.

5.7.5.3 Cost of equity

In addition to debt, equity financing plays an equally critical role in the overall capital stack of a SAF project. The cost of equity represents the return that investors expect in exchange for their capital investment, reflecting both the opportunity cost of investing elsewhere and the unique risks associated with the project. Unlike debt providers, equity investors do not receive fixed payments; instead, their returns are contingent on the project's performance and profitability. As a result, they face a greater risk of losing their capital if the project underperforms or fails.

This risk-return dynamic is particularly relevant for facilities that rely on emerging or less-proven pathways such as AtJ, FT, and PtL. While these offer feedstock flexibility and potential scale, they carry higher technical and operational risks than more mature routes such as HEFA. The commercial track record for AtJ, FT, and PtL is relatively limited, and challenges in process optimization and regulatory compliance can affect timelines and returns. To compensate, equity holders demand higher returns, which raises the cost of equity.

To reflect these differences, the analysis assumes initial Internal Rates of Return (IRR) of 18% for HEFA, 20% for AtJ, and 22% for FT and PtL. While higher IRR are required today, this analysis assumes limited volumes of SAF until after 2035, so these values are chosen to represent values at a point where the industry has started to de-risk to match this timeline. This is amplified as the methodology staggers the deployment of SAF, starting

[355] https://sustainablefinance.ox.ac.uk/wp-content/uploads/2025/03/Executive-Summary-renewable-poser-Dec-2024.pdf

with more affordable pathways before transitioning to more expensive but more sustainable approaches; this results in a further delay to the deployment of higher risk technologies such as FT and PtL. As technologies mature and more facilities are deployed in the region, these pathways are expected to be de-risked and slightly reduce the cost of equity below these starting points. A more aggressive near-term reduction is modelled for AtJ due to industrial-scale facilities starting to commercialize, while the reduction for FT is assumed to be more gradual[356]. The baseline required cost of equity is further adjusted by country to reflect economic conditions and attractiveness, relying on S&P Global Ratings credit ratings to model higher required returns for riskier locations.

Careful analysis and transparent structuring of these project financing assumptions help ensure that both investors and lenders have a shared understanding of the risks and potential returns. By doing so, projects are better positioned to achieve financial close and operate successfully over their intended lifetimes.

Table 56: Country specific financial inputs (as of September 2025)

Country	S&P Global Ratings country rating[357]	Assumed risk premium over baseline debt rate[358]	Corporate tax rate[359]
Argentina	CCC	5%	35%
Bahamas	B+	4%	–
Brazil	BB	3%	34%
Chile	A	2%	27%
Colombia	BB	3%	35%
Dominican Republic	BB	3%	27%
Ecuador	B-	4%	25%
El Salvador	B-	4%	30%
Mexico	BBB	2.5%	30%
Panama	BBB-	2.5%	25%
Peru	BBB-	2.5%	30%

356 https://www.lanzajet.com/freedom-pines
357 https://tradingeconomics.com/country-list/rating ; https://www.spglobal.com/ratings/sri/
358 ICF assumption
359 https://tradingeconomics.com/countries

5.7.6 Downstream costs

While the price of SAF is based on production costs and required returns, it is essential to recognize that the final price paid by airlines includes a range of downstream expenses, as well as margins associated with the market dynamics. Downstream costs encompass blending, transportation, storage, and administrative expenses, all of which influence the delivered price of SAF. These downstream costs are significant, particularly considering that fuel expenses typically represent between 30% and 40% of an airline's total operating costs. With SAF often commanding a higher base cost, these supplementary expenses become increasingly relevant to the final purchase price.

While the cost of blending has been estimated at $0.01–0.02 per gallon of biofuel in the UK, costs are expected to be higher in the LAC region given current infrastructure[360]. Transportation represents a more significant share of downstream expenses and varies widely based on airport size, distance from production sites, and supply chain sophistication. For airports that are smaller, urban, or less well-connected such transportation costs are even higher. However, these facilities are unlikely to receive substantial quantities of SAF in the foreseeable future. The cost of SAF transport is expected to be comparable to that of conventional jet fuel, since both rely on the same infrastructure. A 2021 study on Brazil found the cost of transporting jet fuel 400 km by road and ship to be $0.33 and $0.17 per gallon, respectively[361]. Over time, however, targeted investments in infrastructure such as centralized blending hubs and improved storage capacity could reduce these costs and enhance SAF's economic viability across the region. Such improvements would contribute to a more efficient supply chain and could enhance the accessibility and economic viability of SAF adoption across diverse airports.

Beyond production and downstream costs, SAF pricing varies according to the procurement approach and the chosen pricing methodology. Near-term supply or spot purchases typically involve higher premiums due to short-term market dynamics[362]. Long-term offtake agreements enable producers to plan operations over an extended period and secure guaranteed future supply, hence the margins are typically narrower under such agreements. Across all procurement types, the final price is shaped by the structure of the agreement, prevailing market conditions, and the allocation of operational and financial risks.

[360] https://assets.publishing.service.gov.uk/media/66601969dc15efdddf1a872d/uk-saf-mandate-final-stage-cost-benefit-analysis.pdf
[361] https://ptx-hub.org/wp-content/uploads/2021/07/Cost-Analysis-of-Aviation-Fuels-in-Brazil.pdf
[362] https://www.iata.org/contentassets/d13875e9ed784f75bac90f000760e998/saf-procurement_12052024.pdf

In this study, the downstream cost of SAF in 2030 is estimated at $0.95 per gallon. These costs are projected to decline steadily until 2045, stabilizing at approximately $0.50 per gallon. The cost breakdown includes transportation, which is relatively high given the region's dependency on road transport, as well as blending and administrative expenses. The premium is going down with projected logistics networks developing.

The role of Book and Claim in SAF supply

In SAF landscape, book-and-claim has emerged as a chain-of-custody system designed to reconcile the geographic mismatch between where SAF can be most efficiently produced and where it is actually demanded. By allowing physical SAF supply to be concentrated in optimal production hubs - regions with abundant feedstocks, low-carbon electricity, or favorable infrastructure while enabling "virtual" environmental attribute transfers to buyers anywhere in the world, book-and-claim expands market reach and accelerates emissions reductions, even in locations poorly suited for SAF production or distribution.

Today, credible certification and registry systems exist that can minimize the risk of double claiming. However, regulatory concerns remain. Governance and operational oversight of registries are still evolving, and policymakers are grappling with the implications of separating physical fuel uplift from the associated environmental benefits. This separation raises questions about how to treat co-benefits such as local air-quality improvements, tax incentives, or other policy-linked advantages that may or may not be stackable for suppliers or end users. It also highlights the potentially uneven distribution of employment, technological development, and economic value creation, which tend to concentrate around production hubs rather than the locations where the environmental attributes are ultimately claimed and therefore, where the extra cost is borne.

Economically, book-and-claim undeniably enhances competition by enlarging the effective market size and lowering supply costs. Yet this very dynamic can create barriers for new entrants, especially those developing early-stage or higher-risk SAF technologies. For instance, a country with abundant clean water, frequent renewable-energy curtailment, and a low-carbon electricity grid could produce highly competitive e-SAF under a book-and-claim model. While this is beneficial for buyers and efficient from an open-commerce perspective, it may disadvantage regions still transitioning to cleaner grids, potentially affecting energy security and slowing diversification of supply pathways. The risk of market "dumping" also becomes more relevant in a system where physical transport constraints no longer limit competition.

From a logistics standpoint, book-and-claim is often compatible with existing conventional fuel supply chains, which helps keep costs relatively low. However, the administrative and technical costs of establishing and maintaining robust registries can offset these logistical savings. Moreover, when regulatory frameworks such as CORSIA do not link the environmental claim to the physical uplift location, the added value of book-and-claim diminishes. Only in cases where uplift location is highly relevant does book-and-claim become particularly advantageous, yet those are precisely the scenarios where implementation becomes more complex.

Overall, book-and-claim is a powerful enabler of SAF market growth and cost reduction, but its design and governance require careful attention to ensure fairness, integrity, and long-term sustainability across the global aviation sector.

5.7.7 Abatement cost

To calculate the abatement cost for each feedstock, the first step was to determine the life cycle emissions values. 2025 CORSIA Default Life Cycle Emissions Values, including induced land use change (ILUC) were used as the primary source wherever available[363]. For feedstocks with separate values reported for standalone and integrated facilities, the integrated value was assumed based on regional realities. Where Brazil-specific values were available, these were prioritized over global averages. For FT-MSW, the life cycle emissions factor was

[363] https://www.icao.int/sites/default/files/environmental-protection/CORSIA/Documents/CORSIA%20Eligible%20Fuels/ICAO-document-06-Default-Life-Cycle-Emissions-June-2025.pdf

applied as a function of non-biogenic content using ICAO values[364]. As CORSIA does not include values for PtL, data from the World Economic Forum were used instead[365].

Between 2025 and 2050, the carbon intensity of SAF is expected to decline for several reasons. Across all production pathways, a 50% reduction in emissions from fuel production is assumed, due to reduced carbon intensity of energy inputs. ILUC values are projected to decrease by 25–50% due to improvements in agricultural practices. The biogenic content of MSW is expected to increase as sorting technologies advance. Additionally, PtL processes are anticipated to become less energy-intensive as efficiency improves. The values used for 2025 and 2050, including ILUC assumptions, are presented in the table below.

The reduction in carbon intensity relative to fossil jet fuel was then calculated by comparing each feedstock's life cycle emissions value against the CORSIA baseline of 89 gCO_2e/MJ. This reduction was converted into avoided emissions per tonne of fuel using a well-to-wake factor of 3.81. For each year and feedstock–technology combination, the difference between the calculated price of SAF and the price of fossil jet fuel, expressed per tonne of fuel, was divided by the associated amount of avoided emissions. The resulting abatement cost is expressed in US dollars per tonne of CO_2 avoided.

Table 57: Life cycle emissions by technology-feedstock combination

Technology	Feedstock	2025 LCA Value (gCO_2e/MJ)	2025 Abatement Cost (USD/CO_2e)	2050 LCA Value (gCO_2e/MJ)	2050 Abatement Cost (USD/CO_2e)
HEFA	UCO	13.9	480	9.3	565
HEFA	Animal fat	29.7	630	19.8	661
HEFA	Soybean oil	61.1	1,175	44.4	941
HEFA	Palm oil	76.5[366]	2,075	55.6	949
AtJ	Agricultural residues	24.6	1,122	15.0	560
AtJ	Forestry residues	24.9	1,020	15.2	500
AtJ	Waste gases	29.4	835	23.8	469
AtJ	Sugarcane ethanol	32.8	704	17.2	417
AtJ	Corn ethanol	63.4	1,567	33.2	546
FT	MSW	39.3	2,694	25.7	955
PtL	CO_2	10.0	1,947	5.7	874

[364] https://www.icao.int/environmental-protection/saf-rule-of-thumb
[365] https://www3.weforum.org/docs/WEF_FMC_SAF85_Technical_Brief_2024.pdf
[366] Assumes biogas is captured and oxidized

5.7.8 Calculated SAF prices and abatement cost results

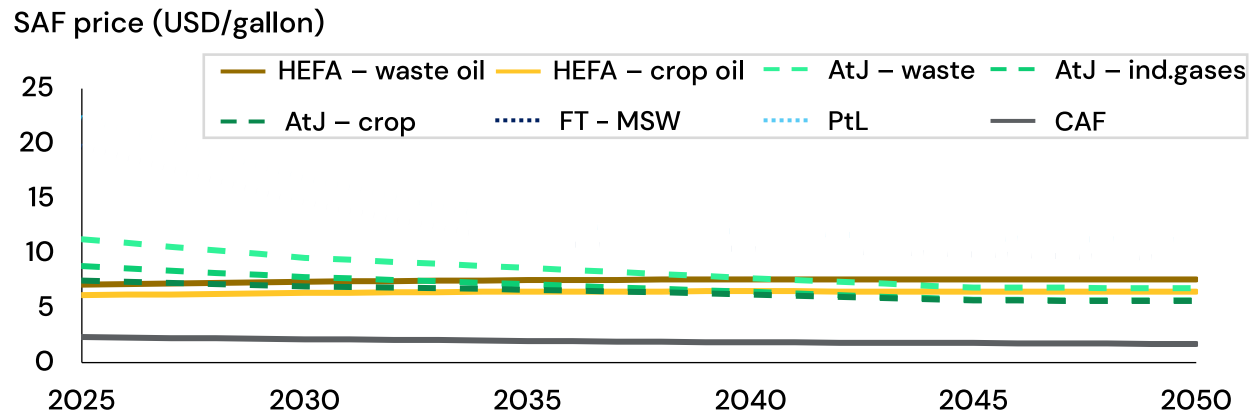
This section presents the results for the calculated price of SAF, forecasted through 2050. As a nascent sector, prices will evolve with technology scaling, supply-chain maturation, shifting market conditions, as well as growing demand, and will differ by pathway. Future price trajectories will be driven by technology maturity and learning, feedstock availability and price, capital expenditure, operational efficiency, and market factors, which together will shape the feasibility and competitiveness of each route.

These SAF price estimates are then coupled with a carbon intensity analysis to reach the abatement cost of different feedstock - technology combinations. Linking the availability and SAF potential analysis with the abatement costs will allow for a projection of potential CO_2 saving from SAF in the different countries in the Latin American and the Caribbean region and the associated costs in the next steps of the study. Discussion on what this means for the price of SAF, as well as sensitivity are also presented in this section.

5.7.8.1 Results overview

The projected evolution of SAF price and abatement costs across pathways in the LAC region are presented in the following two figures[367]. Results are presented as aggregated averages, with detailed country- and feedstock-level analysis conducted in the background, and are intended to provide an indicative view of regional conditions and potential. An overview of the current status and outlook for each of the four technologies is provided in the following sub-sections.

SAF price is projected to decrease for most pathways due to technology maturing, while HEFA price is increasing due to feedstock trade dynamics



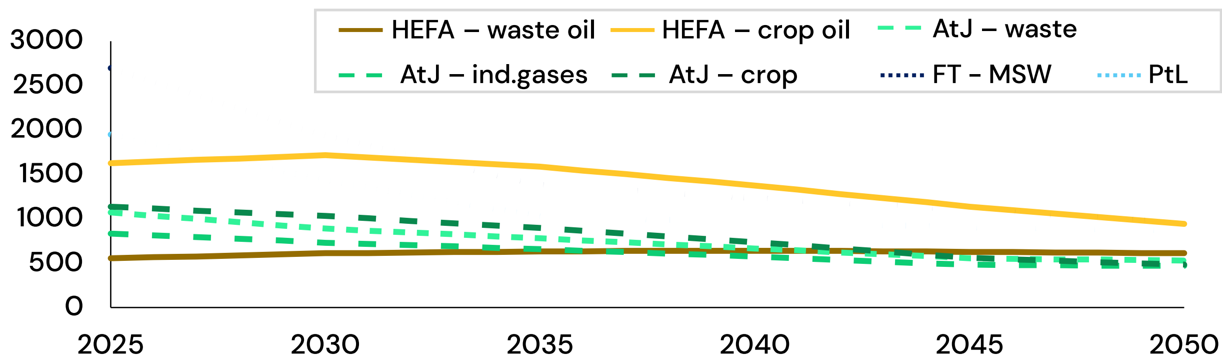
Source: ICF analysis

Note: HEFA crop oil = soybean oil and palm oil, HEFA waste oil = Used cooking oil and animal fat, AtJ crop = sugarcane and corn ethanol, AtJ waste = agricultural and forest residues, CAF = conventional aviation fuel

[367] Price includes cost of production and downstream costs; Lifecycle emissions values based on https://www.icao.int/sites/default/files/environmental-protection/CORSIA/Documents/CORSIA%20Eligible%20Fuels/ICAO-document-06-Default-Life-Cycle-Emissions-June-2025.pdf, https://www.icao.int/environmental-protection/saf-rule-of-thumb, and https://www3.weforum.org/docs/WEF_FMC_SAF85_Technical_Brief_2024.pdf

Abatement cost is projected to reduce for most pathways due to carbon intensity improvements and technology maturing

Abatement cost per technology (USD/tCO_{2e})



Source: ICF analysis
Note: HEFA crop oil = soybean oil and palm oil, HEFA waste oil = Used cooking oil and animal fat, AtJ crop = sugarcane and corn ethanol, AtJ waste = agricultural and forest residues

5.7.8.2 HEFA

Current status: HEFA is currently the most economically viable pathway in terms of MSP, primarily due to its advanced technological maturity. This maturity translates into lower capital investment requirements and reduced risk premiums, as the technology has demonstrated reliable performance on a commercial scale. However, feedstock availability in LAC is relatively constrained, particularly after adjusting theoretical supply to reflect what the aviation sector can realistically access (see Section 5.6). These constraints highlight the importance of considering both technological readiness and feedstock accessibility when assessing SAF options in the region.

Outlook: Capital expenditure for HEFA facilities is expected to decline by only about 4% between 2025 and 2050, as the technology's maturity limits further reductions. This modest improvement is likely to be offset by rising feedstock costs due to limited supply. Consequently, overall calculated prices are projected to trend slightly upward, by approximately 5% for crop oil feedstocks and 7% for waste oil feedstocks over the same period. Given the large share of feedstock costs in total production cost, HEFA economics are highly sensitive to market conditions.

Sustainability: The cost of abatement varies significantly by feedstock. In 2025, UCO based HEFA SAF has the lowest abatement cost among all technology-feedstock combinations assessed, at approximately \$480/tCO_2, followed by animal fats at \$630/tCO_2. This reflects both lower prices compared to other SAF types and high lifecycle emissions reductions relative to fossil jet fuel. In contrast, HEFA SAF from soybean and palm oil has more than double the abatement cost of UCO and animal fats, partly due to indirect land use change (ILUC) emissions associated with such feedstocks. Over time, abatement costs for HEFA SAF are expected to rise as feedstock prices increase and fossil jet prices decline.

5.7.8.3 AtJ

Current status: AtJ-based SAF currently has the second lowest calculated price among the technologies assessed. Its capital intensity is higher than HEFA, with upfront investment per gallon of fuel approximately double that of HEFA. However, this gap is expected to narrow as facilities benefit from economies of scale, technological improvements, and operational efficiencies. Feedstock availability analysis indicates that agricultural and forestry residues offer considerable potential for SAF production in LAC, while industrial gases represent another promising source (Section 5.6). Nevertheless, in 2025, crop-based AtJ SAF has estimated price about 50% lower than waste-based AtJ SAF.

Outlook: AtJ is expected to experience more pronounced capital cost reductions than HEFA, with CAPEX requirements projected to decline by about 40% between 2025 and 2050. This is driven by technological improvements and global deployment assumed, which reduce investment risk and associated costs. Over time, the estimated price of SAF from waste-based ethanol is projected to converge toward that of crop-based ethanol, largely due to improvements in processing technologies, supply chain efficiencies, and feedstock availability.

Sustainability: Abatement costs for AtJ SAF depend strongly on feedstock choice. In 2025, sugarcane ethanol offers the lowest abatement cost among AtJ feedstocks at around \$704/tCO_2, improving to approximately \$417/tCO_2 by 2050, the lowest among all feedstock-technology combinations assessed. Agricultural and forestry residues are likely to play a key role, with abatement costs declining by about 51% between 2025 and 2050, reaching \$530/tCO_2.

5.7.8.4 Gasification FT

Current status: SAF production via FT from MSW is currently the most capital-intensive pathway, with CAPEX per gallon of fuel about 17 times higher than HEFA. This reflects the complexity and scale of the required infrastructure, including advanced reactor systems, gas treatment units, and integration processes. Current deployments are largely limited to pilot scale, with high technological uncertainties and operational risks. Despite these challenges, FT from MSW is promising for LAC because MSW has few competing uses and is widely available.

Outlook: FT from MSW is projected to achieve the largest production cost and subsequently price decrease among the pathways. In the near term, prices are expected to fall from \$19.71/gallon in 2025 to \$14.60/gallon in 2030 and \$10.90/gallon by 2035. These reductions are driven by advances in reactor design, gas treatment systems, and process integration, as well as economies of scale, broader market adoption, and technology de-risking.

Sustainability: Lifecycle emissions for FT from MSW depend on the biogenic content of the waste. At 100% biogenic content, lifecycle emissions are reduced by about 94% compared to fossil jet fuel, whereas at 0% biogenic content, emissions increase by about 92%. For this analysis, an initial CI value of 39.3 gCO_2/MJ was applied, resulting in an abatement cost of approximately \$2694 per tCO_2 in 2025. While this is high relative to other pathways, FT abatement costs are expected to decline more than any other pathway over time, although they remain higher than those of waste-based AtJ and PtL.

5.7.8.5 PtL

Current status: PtL currently exhibits the highest estimated theoretical price among the pathways assessed at about \$22.30/gallon in 2025. Costs are driven primarily by both CAPEX and variable operating expenses, particularly the cost of renewable electricity for hydrogen production. However, PtL facilities have lower CAPEX and fixed OPEX than FT plants because they avoid gasification and syngas cleanup, enabling more modular deployment. The availability of abundant renewable resources in LAC supports PtL’s long-term potential.

Outlook: PtL-based SAF prices are highly sensitive to renewable electricity prices, which are expected to decline significantly as wind and solar PV continue to scale. Electrolyzer costs are also projected to fall and combined with improvements in plant design and process efficiency, these changes are expected to strengthen PtL’s competitiveness. Calculated prices are projected to decline from \$22.30 per gallon in 2025 to $16.87 in 2030 and $11.16 in 2035. Despite these improvements, the price of PtL SAF is not expected to fall below any of the other feedstock-technology combinations assessed in this study between 2025 and 2050.

Sustainability: PtL offers the highest emissions reduction potential among the pathways assessed when powered by additional renewable electricity and paired with DAC or sustainable biogenic CO_2 sources. In 2025, the abatement cost is approximately $1947/t$CO_2$, which is lower than FT from MSW but higher than HEFA and AtJ. By 2035, PtL's abatement cost is modeled to fall to $1027/t$CO_2$, and $874/t$CO_2$ in 2050.

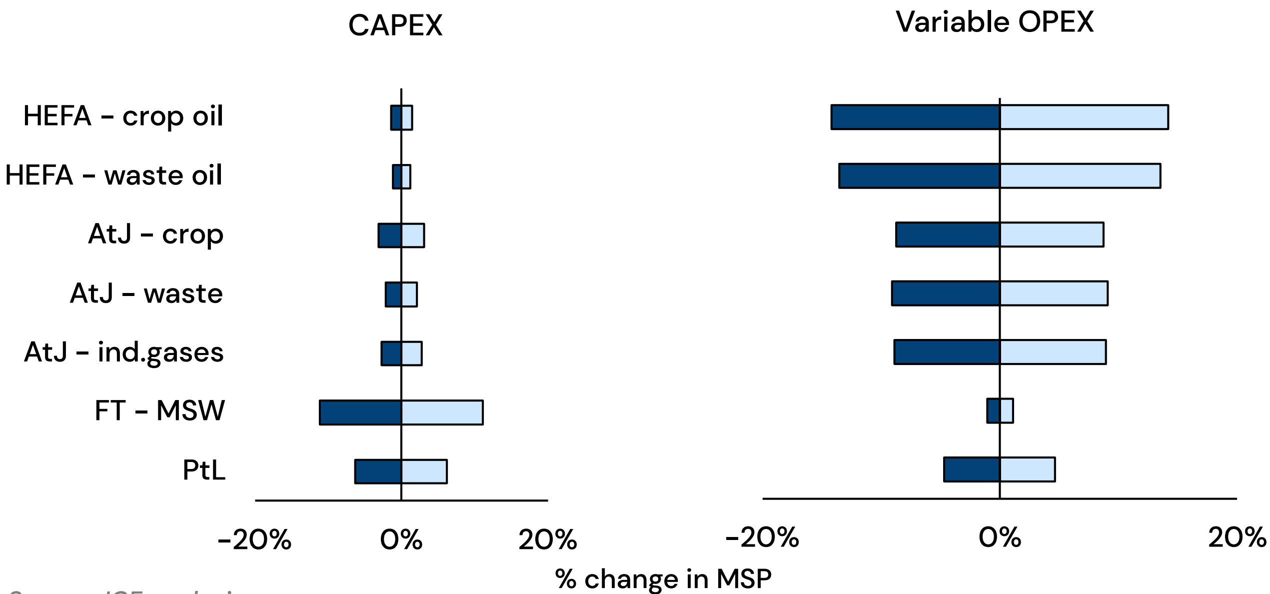
5.7.8.6 Price sensitivities and uncertainties

A ±10% sensitivity analysis was conducted for each SAF production pathway to evaluate how changes in key cost drivers influence estimated prices in 2030 and 2050. The analysis considered five variables: CAPEX, variable OPEX, debt interest rates, IRR, and corporate tax rate. These sensitivities highlight which pathways are most exposed to cost volatility and where uncertainties could significantly affect future SAF prices.

The results show that CAPEX uncertainty has the greatest impact on capital-intensive pathways such as FT and PtL. A 10% increase in CAPEX raises FT calculated MSP by approximately 11.1% in 2030 and 11.4% in 2050, while PtL estimated price increase by 6.2% and 4.9% over the same periods. In contrast, HEFA is far less sensitive, with changes of only 1.2–1.3% in 2030 and 0.9–1.0% in 2050, as its economics are dominated by feedstock rather than capital investment. These findings indicate that FT and PtL are highly exposed to uncertainties in construction costs, supply chain constraints, and technology learning rates. Accelerated learning through rapid deployment and policy support could reduce CAPEX faster than expected, significantly lowering costs and market prices by 2050. Conversely, slower deployment or persistent bottlenecks could keep prices elevated.

As shown in the figure below, pathways that are less sensitive to CAPEX tend to be more sensitive to variable OPEX uncertainty. For HEFA, a 10% increase in variable OPEX leads to a 13.5–13.8% rise in MSP in 2030 and 12.1–12.2% in 2050, reflecting its strong dependence on feedstock prices. AtJ shows similar exposure, with variations of 8.7–9.1% in 2030 and 9.9% in 2050. PtL is moderately sensitive, with changes of 4.7% and 6.3% in 2030 and 2050, respectively, due to renewable electricity costs for hydrogen production. FT shows less than 2% variation, reinforcing that its economics are dominated by capital rather than operating inputs.

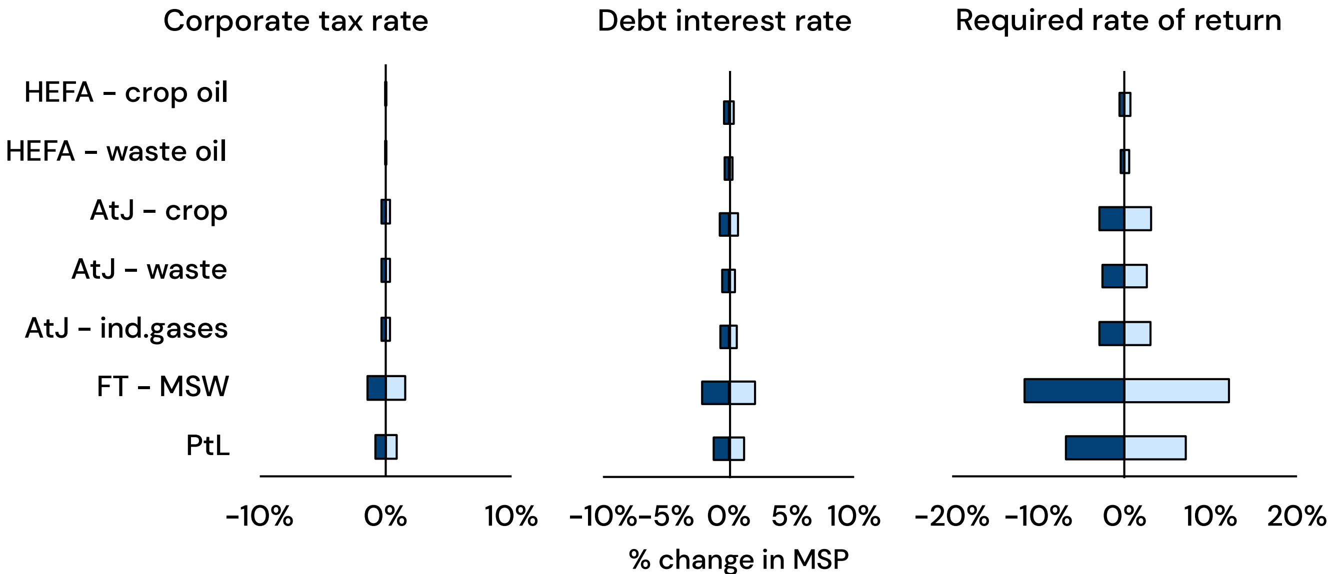
Sensitivity to a 10% change in CAPEX/ variable OPEX for a facility commencing construction in 2030



Source: ICF analysis
Note: CAPEX = capital expenditure, OPEX = operating expenditure, MSP = minimum selling price
HEFA crop oil = soybean oil and palm oil, HEFA waste oil = Used cooking oil and animal fat, AtJ crop = sugarcane and corn ethanol, AtJ waste = agricultural and forest residues

Financial assumptions introduce another layer of uncertainty. As seen in the figure below, FT and PtL are most sensitive to changes in tax rates, debt interest rates, and required return on equity because their cost structures are dominated by financing. Higher tax rates reduce after-tax cash flows, while increases in debt interest rates directly raise borrowing costs. The most significant financial driver is the required return on equity by investors. For FT and PtL, where both capital intensity and perceived risk are high, equity makes up a substantial portion of total costs and is subject to higher baseline return expectations. As a result, even a small change in the required return over the project's lifetime produces a disproportionate increase in calculated price compared with tax or interest rate changes, which only influence specific parts of the cash flow.

Sensitivity to a 10% change in financial variables for a facility commencing construction in 2030



Source: ICF analysis

Note: CAPEX = capital expenditure, OPEX = operating expenditure, MSP = minimum selling price

HEFA crop oil = soybean oil and palm oil, HEFA waste oil = Used cooking oil and animal fat, AtJ crop = sugarcane and corn ethanol, AtJ waste = agricultural and forest residues

5.7.9 Conclusions

This section has assessed the current status and future potential of SAF in the LAC region, highlighting both opportunities and constraints across policy, feedstock availability, technology pathways, and economic feasibility.

The analysis highlights that SAF represents a key in-sector measure for decarbonizing aviation, with drop-in compatibility and long-term emissions reduction potential. **However, deployment in the LAC region faces several challenges, including limited sustainable feedstock availability for currently mature technologies (e.g. HEFA relying on UCO), high production costs and subsequent prices, infrastructure gaps, as well as sustainability concerns.** These barriers are compounded by the early-stage nature of policy frameworks and the absence of commercial-scale SAF production facilities in the region.

Feedstock analysis indicates that residues and wastes, including agricultural residues, municipal solid waste and forestry residues constitute the most abundant resources across the region, with Brazil, Argentina and Mexico with the highest potential. Crop-based oils such as soybeans and palm are currently constrained due to competing uses and sustainability concerns.

Technology assessments show that HEFA is currently the most cost-effective pathway, though its scalability is limited by feedstock constraints. AtJ and PtL pathways offer longer-term promise, particularly as renewable electricity capacity expands and second-generation ethanol technologies mature. Co-processing may provide a transitional solution, but its contribution to deep decarbonization is limited by blend ratios and lifecycle emissions accounting complexities.

Techno-economic modelling suggests that SAF calculated prices will remain above conventional jet fuel prices through 2050 (3 to 12 times higher depending on the feedstock and technology used), with abatement costs varying significantly by feedstock and technology. Waste-based pathways such as AtJ from industrial gases and FT from MSW show potential for cost reductions over time, though they currently face high capital intensity and operational risks.

Investments enhancing infrastructure and developing more robust supply chains could help address regional inefficiencies and reduce the logistical costs associated with transporting fuel to airports.

SAF development across the region is progressing, with several countries initiating SAF roadmaps, feasibility studies, and funding mechanisms. However, most frameworks remain in early stages, and harmonization with international standards such as CORSIA will be essential to support market access and sustainability verification.

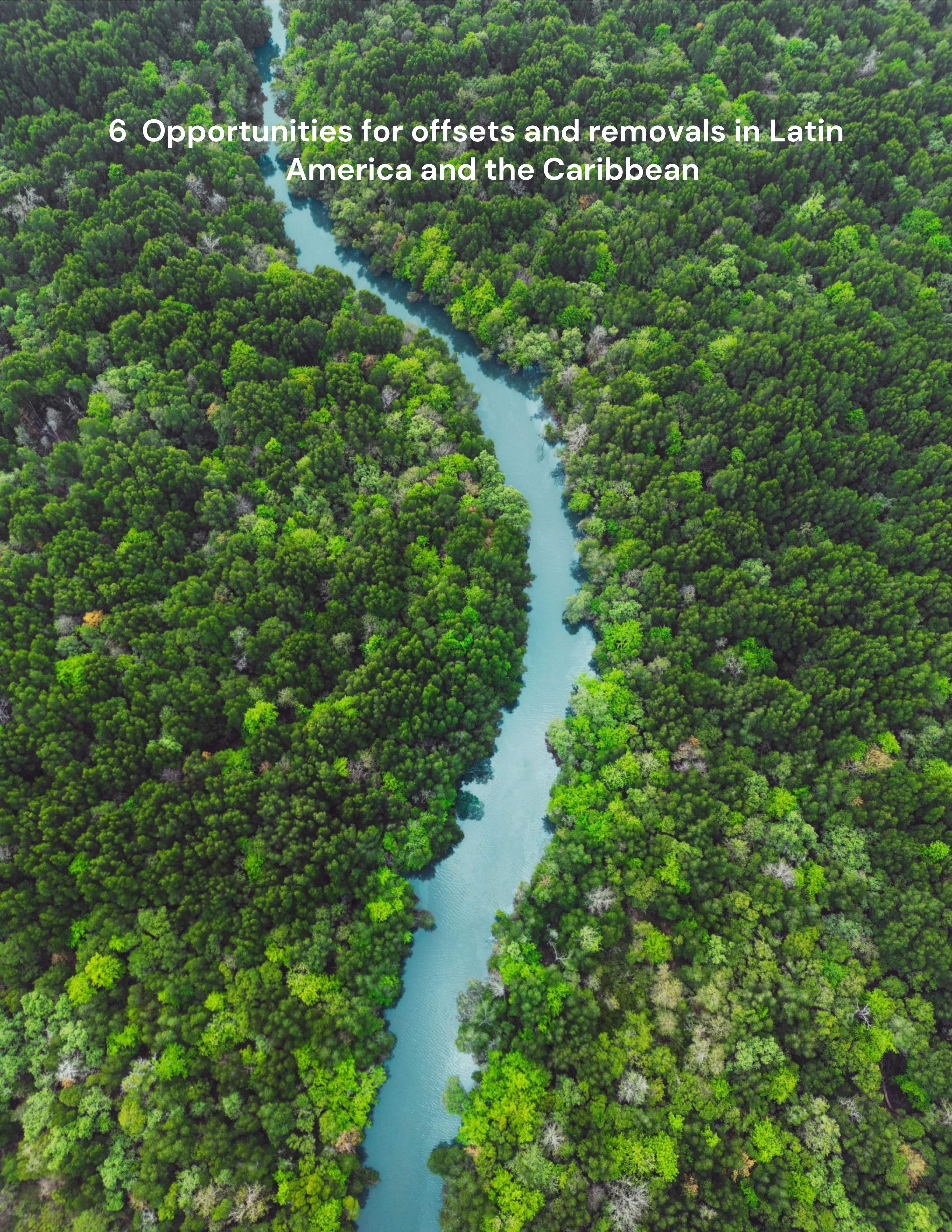
In summary, the LAC region has the foundational elements to support SAF development, but realizing this potential will require:

- **Strengthened data and sustainability frameworks** are essential for ensuring consistent monitoring, verification, and reporting standards across the region. Government involvement is required to establish robust policies, allocate resources, and facilitate collaboration among stakeholders, making it possible to implement and maintain effective data and sustainability systems.
- **Mobilizing targeted investment and economic incentives across the entire aviation value chain** is essential to unlock the emissions reduction potential of SAF in LAC. By strategically deploying financial resources and creating robust economic incentives, governments can facilitate infrastructure development, support the expansion of supply chains from feedstock production to fuel distribution and limit the price gap to conventional fuel.
- **Continued policy evolution and alignment with international standards**. Harmonization of policies to international standards is required to avoid fragmentation of regulatory approaches, and sustainability criteria across LAC. By aligning national frameworks with international benchmarks like CORSIA, countries can facilitate cross-border SAF trade, streamline certification processes, and ensure consistent sustainability verification.

- **Strategic prioritization of feedstocks with low sustainability risk and high availability.** By targeting these feedstocks, countries can minimize environmental and social risks while maximizing the potential for reliable SAF production. This approach also facilitates compliance with international sustainability standards and supports long-term scalability, as these types of feedstocks are less likely to face future regulatory or market constraints.

The findings of this report provide a basis for informed decision-making and highlight areas for further exploration, including the role of emerging feedstocks, the integration of SAF into broader energy and climate strategies, and the potential for SAF exports and environmental attributes.

6 Opportunities for offsets and removals in Latin America and the Caribbean



6.1 Opportunity for market-based measures

Key results:

- The LAC region's rich biodiversity positions the region as a global leader in developing high-integrity carbon credits, and it also holds the potential to generate a significant amount non-nature-based solutions.
- The global carbon market is shifting toward high-integrity nature-based solutions. This is essential to improve the environmental benefits, but will drive price increases.
- Engineered removals remain costly today but are expected to decline significantly by 2050, complementing nature-based solutions and diversifying the region's carbon credit portfolio.

6.1.1 Introduction

This section highlights the scope and relevance of carbon credits for aviation in Latin America and the Caribbean, given the positive role aviation can play in the conservation and restoration of critical global ecosystems as well as the reduction in emissions from agriculture, the region's highest-emitting sector[368]. It reviews the historical volumes and average prices of carbon credits alongside various future forecasts. Market-based measures, which include mechanisms like carbon offsetting, are policy tools designed to provide economic incentives for reducing greenhouse gas emissions by putting a price on carbon; specifically, carbon credits represent verified emission reductions or removals that can be purchased to compensate for emissions elsewhere. The analysis encompasses both CORSIA and Voluntary Carbon Market (VCM) carbon credits from global and regional projects, providing a thorough overview of the market and its main drivers. Supply and demand dynamics are examined through an evaluation of current prices, projects, and regulatory frameworks to reveal key trends and developments. The section concludes with an assessment of strategic recommendations to leverage Latin America's potential as a leader in carbon offset development, identifying recommendations for opportunities within the regional context.

6.1.2 Carbon credits background

Carbon credits complement a broader portfolio of measures to address aviation's climate impact, allowing aviation stakeholders to mitigate part of their emissions by purchasing verified carbon credits generated by projects that reduce, avoid, or remove greenhouse gas emissions outside of the aviation sector. Each credit corresponds to one metric tonne of CO_2-equivalent emissions reduced or removed, certified under recognized standards to ensure environmental integrity and permanence. Carbon credit projects can also generate economic value for host States by attracting investment, creating jobs, and supporting local development.

Several airlines are already engaged in voluntary carbon offsetting programs by supporting certified projects that avoid, reduce, or remove greenhouse gas emissions. The global framework is rapidly developing, particularly through ICAO CORSIA, which aims to provide a harmonized framework for offsetting emissions from international flights, helping bridge the gap between actual emissions and the sector's agreed baseline levels. CORSIA can be understood as a subset of the VCM, in that it draws from the same pool of carbon credits and utilizes many of the same registries and standards used in voluntary offsetting. However, while the VCM allows companies across all sectors to purchase credits on a purely voluntary basis to claim emission reductions, CORSIA introduces a layer of regulatory oversight specifically for international aviation. Under CORSIA, only credits meeting ICAO's stringent eligibility criteria are allowed for compliance purposes. This means that while not all VCM credits are CORSIA-eligible, all credits used within CORSIA originate from the broader VCM.

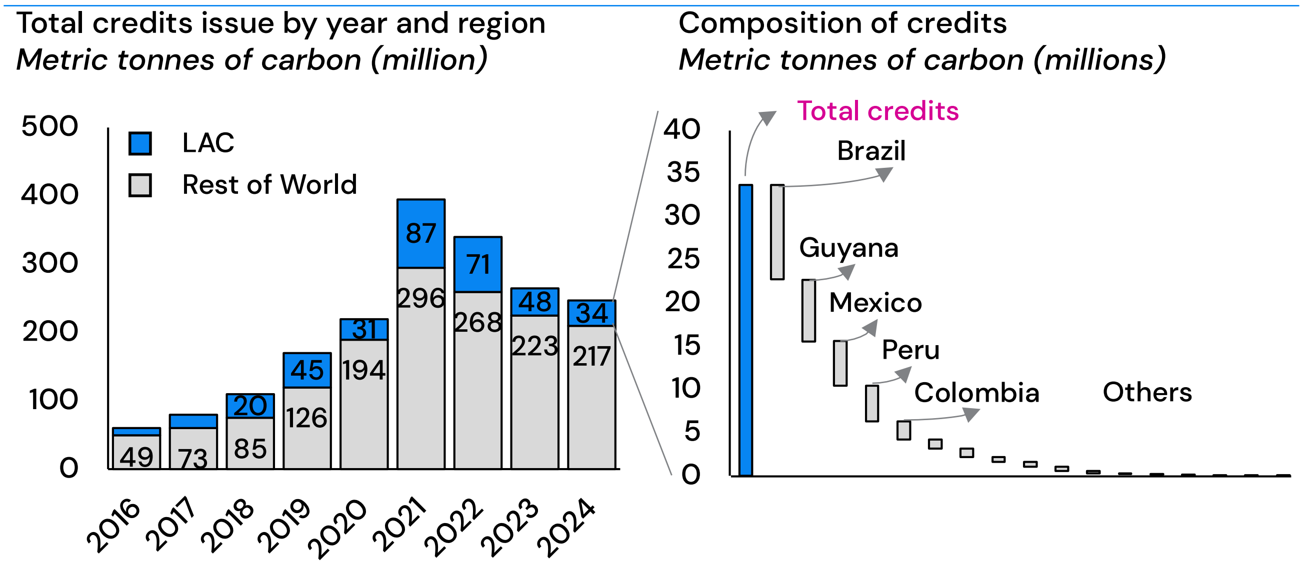
[368] https://publications.iadb.org/en/benefits-and-costs-reaching-net-zero-emissions-latin-america-and-caribbean

6.2 Carbon offsets global market

6.2.1 VCM Overview

Year-over-year data reveal a shrinking voluntary carbon market, understood to be largely driven by a heightened focus on credit integrity. The introduction of more rigorous methodologies, validation procedures, and integrity standards has resulted in fewer projects qualifying for credit issuance, leading to a significant decline in new credits entering the market. This trend reflects a deliberate market evolution away from older, lower-quality credits toward a more credible, high-integrity system. As reflected in the figure below, issuance volumes have fallen notably since their peak, with a 20-25% decline from 2021 reported in 2024 and continuing lower issuance into 2025. As issuances fall, carbon credit retirements have increased over time, signaling increased demand from buyers to align with climate goals369. Latin America and the Caribbean remain leading sources of credit issuance, historically hovering between 12% and 23% of the global total, with Brazil and Guyana prominent in representing over 80% of credits in the region.

Regional share in total credits issued was 13% in 2024. Top 4 countries have issued ~80% of credits in the region, with 32% from Brazil and 21% from Guyana

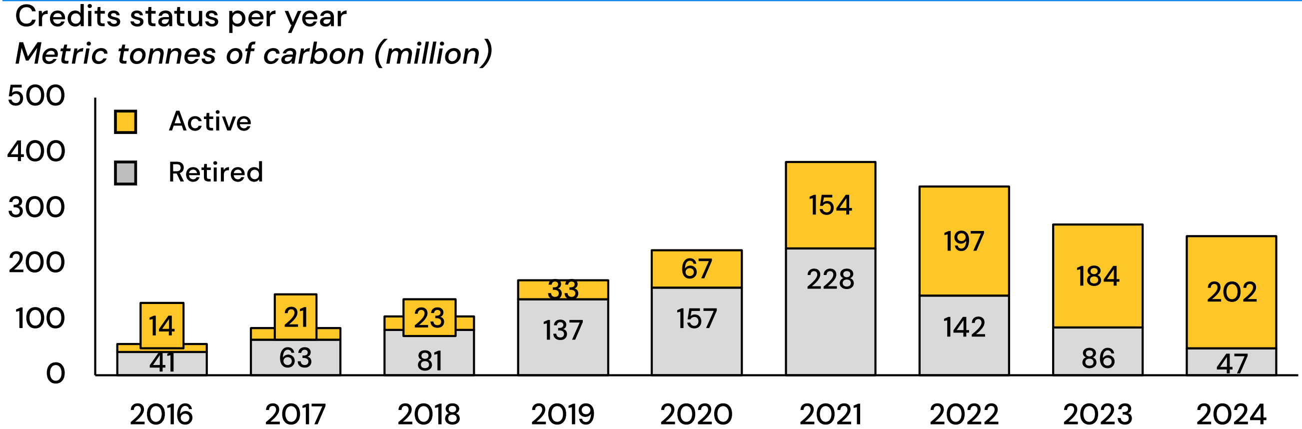


Source: Data from top five voluntary carbon credit registries (American Carbon Registry (ACR), Architecture for REDD+ Transactions (ART), Climate Action Reserve (CAR), The Gold Standard (GS), Verified Carbon Standard (VCS), ICF analysis

The figure above illustrates the ratio of retired credits to active credits and appears to suggest a decline in retirement, since the retired portion shrinks with each year. However, since credits can be retired across multiple years, and more recently issued credits have had limited time to be sold and retired, the apparent drop over time is an artificial deflation, reflecting an artifact of timing rather than a trend in retirements.

[369] https://www.nature.com/articles/s41467-024-51151-w

Artificial deflation in credit retirement due to more recent credits having less time to be sold and retired



Source: Data from top five voluntary carbon credit registries (American Carbon Registry (ACR), Architecture for REDD+ Transactions (ART), Climate Action Reserve (CAR), The Gold Standard (GS), Verified Carbon Standard (VCS), ICF analysis
Note: Includes only active and retired credits

6.2.2 CORSIA overview

Meaningful year-over-year comparisons of CORSIA-eligible credits within the voluntary carbon market begin in 2024, when emissions subject to CORSIA offsetting requirements exceeded the scheme's baseline levels. Although offsetting requirements have been in place since 2021 for routes between voluntarily participating states, the sector's emissions during the 2021–2023 pilot phase remained below the baseline, resulting in a zero-sector growth factor (SGF)[370]. As a consequence, airlines operating on CORSIA routes were not required to purchase offsets for compliance, and demand for CORSIA-eligible credits remained minimal. This changed in 2024, as emissions surpassed the baseline and offsetting obligations become operationally relevant.

In 2024, the supply of CORSIA-eligible credits was very low, as CORSIA is one of the most stringent schemes in the VCM, meaning that qualifying credits are generally recognized to as being of the highest quality. Of the remaining high-quality credits, only 17 million met CORSIA standards globally. Furthermore, only about 8 million of these credits had a corresponding Letter of Authorization (LoA) from host governments, which is the formal approval required to authorize the use of credits toward CORSIA compliance, all of which originated from a single project in Guyana (REDD+ ART TREES). Credits that would otherwise be CORSIA-eligible but lack LoA can be described as CORSIA pending, of which there were 7 million in 2024. Of the CORSIA-eligible with LoA, 30% were already committed through multi-year agreements, leaving only roughly 5 million credits available on the open market.

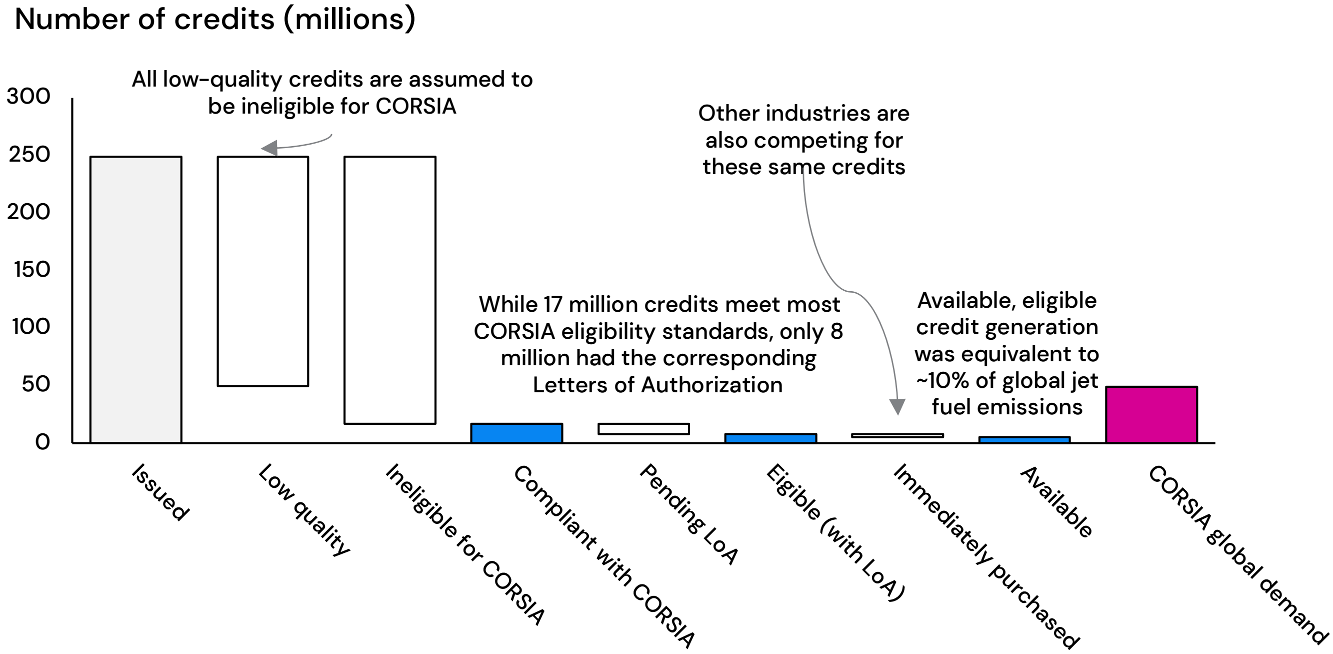
Global aviation emissions annually (domestic and international) reached 950 Mt in 2024; however, emissions on State pairs subject to CORSIA offsetting requirements totalled 363 Mt[371]. Relative to a baseline equal to 85% of 2019 emissions for those State pairs, this resulted in a 2024 SGF of 15.9%, which States must apply when calculating 2024 offsetting requirements, prior to consideration of CORSIA Eligible Fuels. Beyond the snapshot of 2024 (figure below), cumulative offsetting requirements for CORSIA's first phase (2024-2026) have been estimated by ICAO in the range of 106 to 149 Mt, roughly 15% of which is estimated to be addressed

[370] The SGF measures how much sector-wide emissions exceed the 2019 baseline and determines the share of emissions airlines must offset
[371] https://www.iea.org/energy-system/transport/aviation; https://www.icao.int/sites/default/files/environmental-protection/CORSIA/Documents/CORSIA%20Central%20Registry/CORSIA-Annual-SGF-4ed-2025-web.pdf

through CORSIA Eligible Fuels (CEF)[372]. That leaves approximately 90 to 127 Mt (cumulative) unaddressed and in need of additional offsets through Phase 1.

Given this demand, the current supply of eligible carbon credits available on the open market is less than required for CORSIA, and total carbon credit issuance is less than total aviation emissions. While credit issuance is expected to grow, there may also be increased competition from other sectors, highlighting the importance for aviation to use a portfolio of approaches to reduce emissions.

Nested subset of carbon credits vs CORSIA demand, 2024



Source: Data from top five voluntary carbon credit registries (American Carbon Registry (ACR), Architecture for REDD+ Transactions (ART), Climate Action Reserve (CAR), The Gold Standard (GS), Verified Carbon Standard (VCS)
Note: CORSIA global demand estimated based on 2023 data reported to ICAO
LoA = Letter of Authorization

6.3 Pricing and volume projections

6.3.1 Summary of results

The results from this analysis illustrate a clear price escalation driven by supply-demand imbalances. ICF estimates that, in the base case, prices for CORSIA-eligible credits are projected to rise from around $21.50 per tonne in 2025 to over $50 by the end of CORSIA Phase 2 (see figure below). This price increase closely tracks with tightening eligibility standards and constrained issuance capacity, including delays in LoAs and regulatory reforms.

Simultaneously, voluntary market prices have fallen below $5 for many abundant avoidance credits but are expected to rise steadily as market preference shifts toward high-integrity removals including biochar and Carbon Capture and Storage (CCS). While rising demand is expected to increase the price of traditional avoidance and nature-based removal credits, it may have a different effect on engineered removals. These

[372] https://www.icao.int/sites/default/files/environmental-protection/CORSIA/Documents/CAEP_Inputs-to-2025-CORSIA-periodic-review-C235.pdf

technologies, such as direct air capture (DAC), are likely to scale up as conventional options become constrained. Their costs will be primarily influenced by technological progress rather than market scarcity. Currently, DAC has an abatement cost estimated between $1,000 and $1,300 per tonne of CO_2e. However, with lower capital expenditures and risk reduction through rapid deployment, costs could fall below $600 per tonne by 2050.

Key qualitative and quantitative findings are detailed in the following sections with reference to the breakdown of credits issued versus retired, drivers of price escalation, projected supply expansion via regulatory reform (especially LoAs), and the role of nature-based solutions.

6.3.2 Methodology and assumptions

This analysis required a repository of all credits issued, including information about their location and their CORSIA eligibility. To that end, ICF built a credit volume database drawing from the top five voluntary carbon credit registries (American Carbon Registry (ACR), Architecture for REDD+ Transactions (ART), Climate Action Reserve (CAR), The Gold Standard (GS), Verified Carbon Standard (VCS)), together comprising >98% of global VCM issuance[373] since 2016, with detailed tracking of project origin, retirements, and type. As it is limited to the top 5 major registries, this database does not include smaller registries, niche projects, or private bilateral offtake contracts (unless those contracts result in a credit transaction (issuance, transfer, or retirement) within the registry itself). This repository was used to understand historic volumes of credits, which also served as a datapoint for volume projections and pricing. The assessment of credit eligibility for inclusion in the database accounted for project vintage (2016+), quality screening, host government LoAs, and regulatory status updates.

Historic credit prices were sourced from global and regional spot market prices from S&P Global Energy, validated by communications with brokers referencing individual project prices. The projections of pricing and volume into the future use the 2025 credit pricing, established as above, as a starting point, then model the rise and fall of prices according to a suite of different future policy and market scenarios, informed by a suite of credentialed institutions and stakeholder feedback, to create projection scenarios. Assumptions considered in this analysis for both VCM and CORSIA included those developed by Abatable, BloombergNEF, Statista, CarbonCredits.com, and MSCI, alongside historical data from S&P Global Energy. A key factor in these projections is the learning rate of engineered carbon removal technologies, such as DAC. Recent research suggests that the cost reductions for these methods are likely to occur more slowly than previously anticipated. Comprehensive studies examining scaled DAC deployment scenarios estimate 2050 abatement costs ranging from $230–$540 per tonne, and in some cases $100–$600 per tonne[374]. Achieving the lower end of these cost ranges will require high learning rates, which depend on accelerated deployment supported by policy frameworks that ensure demand certainty.

All assumptions are reflected in the table below. Assumptions like these anchor the price forecasts and help clarify which credits are likely to meet demand under each scenario. The range in prices projected by ICF for both VCM and CORSIA are dictated by the assumptions summarized in the following table.

This methodology combines and averages quantified forecasts from leading market researchers (such as Abatable, BloombergNEF, and others) into unified low, mid, and high scenarios with a similar suite of assumptions, aligning their projections on a common timeline so they can be directly compared and assessed side by side. Grouping and comparing projections from multiple leading market researchers allows for the consideration of a wider range of assumptions and reduces the bias inherent in relying on any single forecast. For example, the assumptions across the Low, Mid, and High cases embed the impacts of various LoA rollout timelines and increased investment in carbon crediting technologies. In the Mid and High cases, constrained supply in the 2020s directly reflects bottlenecks from limited Letters of Authorization, with their gradual expansion factored into projected price recovery in the 2030s and beyond, whereas LoA is less constraining in the Low scenario. Similarly, all scenarios reflect the impact of technological progress, showing how supply

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[373] https://perspectives.cc/wp-content/uploads/2024/07/PCG_CCPs-AF-analysis_07_2024.pdf

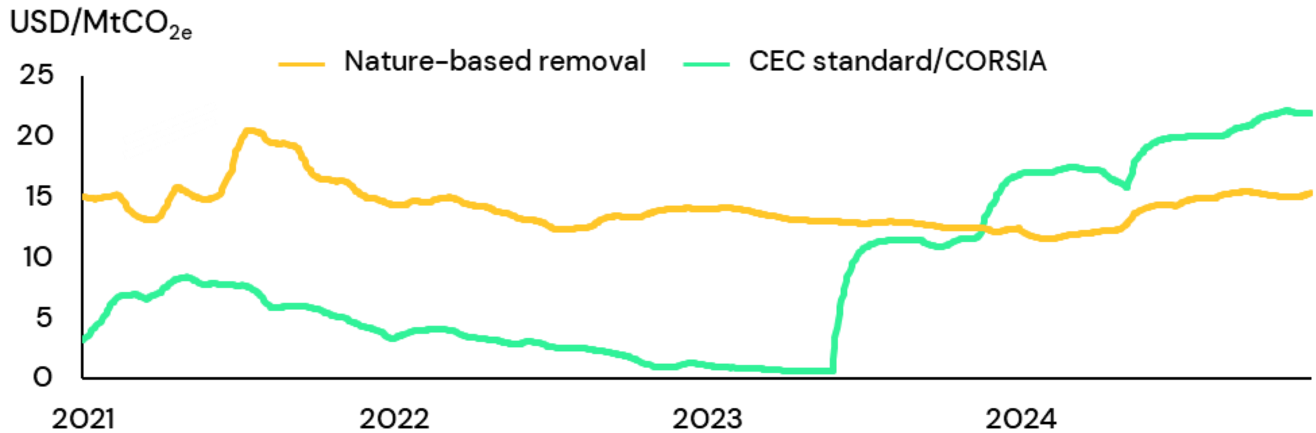
[374] https://ethz.ch/en/news-and-events/eth-news/news/2024/03/cost-of-direct-air-carbon-capture-to-remain-higher-than-hoped.html; https://www.sciencedirect.com/science/article/pii/S2590332223003007

evolves over time. Initially, there is an oversupply of lower-quality avoidance credits, which slows market development. However, as new (often technology-driven) removal methods become available in the 2030s and beyond, the supply shifts toward higher-integrity removals. These assumptions account for the gradual rollout of new technologies and delays in capital investment, which influence both pricing and market dynamics. While overall, this methodology provides a structured approach to integrating multiple forecasts, uncertainty remains due to sensitivity around the timing and scale of LoA issuance and technological advancements. These factors introduce variability that has been directionally captured by this methodology, but the full extent of their impact is difficult to quantify precisely, so the resulting projections should be viewed as indicative ranges rather than exact forecasts.

Table 58: Assumptions for ICF VCM and CORSIA Pricing Projections

Low (Oversupply)	Mid (Base Case)	High (Aggressive Demand)
VCM: Avoidance credits dominate through 2050, integrity standards remain weak, and oversupply keeps prices anchored close to project costs. CORSIA: Supply of CORSIA credits is expected to outpace offset demand through Phase 1, leading to a dip in prices. In Phase 2, a more relaxed approach by governments or ICAO to legislate credit integrity or require credits results in lowered demand and a persistently oversupplied market. *Technology: Does not advance or scale significantly due to limited demand and deployment, given the oversupply of inexpensive, low-integrity credits.*	VCM: Supply tightens in the mid/late-2020s due to limited authorizations and stronger oversight, causing upward pressure for prices in the 2030s. Demand for higher-quality issuances progressively expands the availability of engineered removals. CORSIA: Prices of CORSIA credits are expected to rise sharply in the near term, driven by a constrained credit supply due to a lack of LoAs. Prices continue to increase through Phase 2 and beyond, but at a slower pace as the market adjusts and new projects come online. *Technology: Moderate deployment causes some cost decline and increases availability of high-integrity removals.*	VCM: Constrained supply through 2030, driven by expanding compliance and removals-only rules, fuels strong competition and high prices for high-integrity credits, while earlier oversupply and focus on low-quality avoidance credits delay removals technology investment, making conventional, legacy removals scarce and costly. CORSIA: Rising demand for CORSIA credits drives prices upwards, initially driven by strong aviation growth and the slow adoption of SAF in Phase 1 of CORSIA. Demand continues to increase in Phase 2 when CORSIA expands to include additional countries. *Technology: Matures slowly at first then diffuses rapidly once demand increases, lowering costs of high-integrity removals.*

Historically nature-based voluntary carbon market credits were trading at a premium to CORSIA credits but more recently the trend has shifted



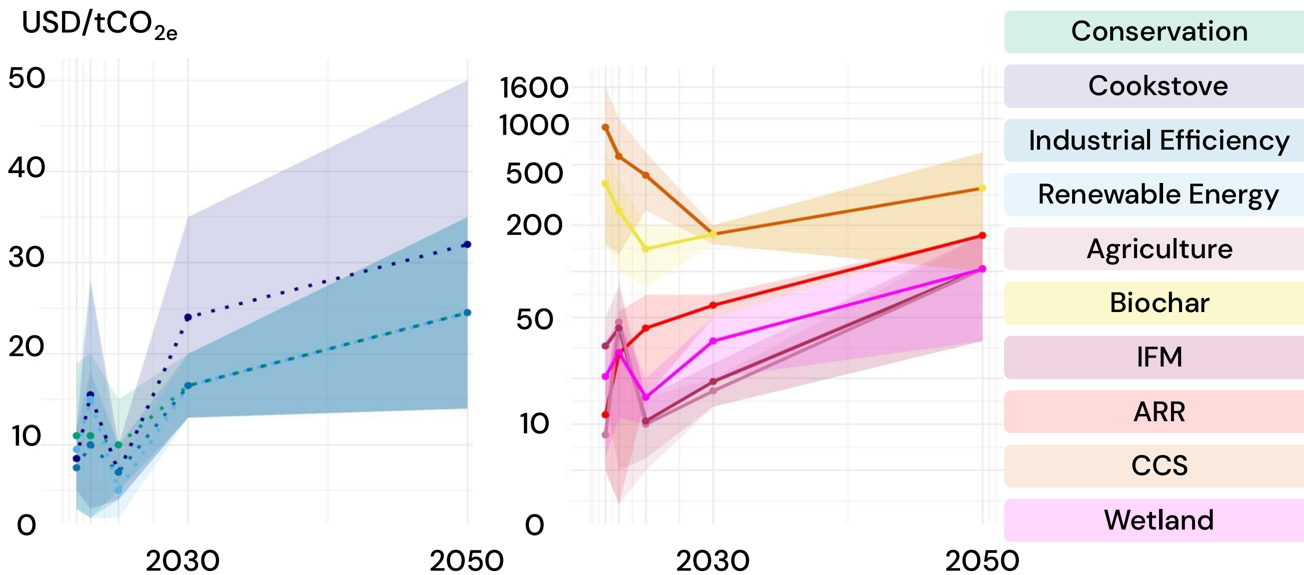
Source: S&P Global Energy, ©2025 by S&P Global Inc. ICF analysis
Notes: Modified for the purposes of this analysis with an exponential smoothing damping factor of 0.9 to protect data confidentiality; limited to 2021 onwards due to data availability constraints; CEC: CORSIA Eligible Credit.

6.3.3 VCM

The main predictor for credit pricing in the VCM, historically and into the future, is the type of credit issued. Avoidance credits are produced by projects that prevent future emissions; for the purposes of this analysis broken into the following categories: cookstoves (replacing inefficient cookstoves with more efficient ones), conservation/REDD+, renewable energy, and industrial efficiency. These types of projects tend to have lower prices because they face persistent oversupply as a result of lower project development costs, limited additionality constraints, and ongoing integrity concerns, suppressing buyer confidence. On the other hand, removal credits involve actively extracting carbon from the atmosphere and sequestering it; for the purposes of this analysis broken into the following categories: CCS (Carbon Capture & Storage), biochar, ARR (Afforestation, Reforestation, Revegetation), IFM (Improved Forest Management), and removal through implementing carbon accumulation practices or restoration in Agricultural or Wetland environments. These credits come with higher development costs due to technology, infrastructure, monitoring, and verification requirements. Consequently, they command premium prices driven by constrained supply, rising demand for high integrity, and market preferences for long-term carbon sequestration. This pricing divergence is reinforced by factors such as project size, location risk, co-benefits (e.g., biodiversity, social impact), vintage, and developer reputation, but none supersedes project type as the overriding determinant. Under all forecasted projection scenarios, removals' scarcity and rigor will differentiate them from avoidance credits, solidifying their role as the highest-value credits in a maturing voluntary carbon market.

Generally, VCM credit prices have fallen between 2022 and 2025, to less than $5 per tonne CO_{2e} for many avoidance projects and some removals projects. This is due to the persistent oversupply of avoidance credits; legacy oversupply keeps VCM volumes high and prices suppressed, as many available credits are perceived as lower quality or less additional, limiting price growth in the near term. From 2025 onwards, VCM prices are predicted to rise steadily as the market undergoes a shift toward higher-integrity credits. Tightening qualification criteria, regulatory shifts, and growing corporate and sectoral commitments, especially for removals, drive prices upward in the long term. One countertrend to this general statement is observed in biochar, CCS, and ARR credits, which start at high prices and decrease as the technologies develop, stabilizing between $100 and $600 per credit by 2050. These credits require substantial upfront investment in technology and infrastructure, including novel monitoring methods and rigorous verification to ensure carbon permanence and adherence to strict quality and integrity standards. The figure below illustrates the rise and fall of VCM credit prices.

VCM Forecast, Avoidance (Left) and Removal (Right)



Sources: S&P Global Energy, ©2025 by S&P Global Inc., Abatable, BloombergNEF, Statista, CarbonCredits.com, Young et al., 2023, ETH Zurich
Note: Removals Price is a log scale

6.3.4 CORSIA

The price of CORSIA-eligible offsets is largely driven by whether a project has secured a Corresponding Adjustment (CA). A CA is the formal accounting adjustment required under CORSIA to ensure that an emission reduction transferred internationally is not counted twice (i.e., once by the host country and again by the airline using the offset for compliance). Offsets that have a CA (or are expected to receive one) are more expensive because supply is still limited and airlines must use these for CORSIA compliance. With only a few corresponding adjustments currently in place, scarcity is one of the strongest upward pressures on CORSIA offset prices.

Insurance mechanisms also affect pricing. These products protect the environmental integrity and regulatory validity of CORSIA-eligible offsets. For example, Gold Standard has approved Oka's insurance. If a corresponding adjustment fails and offsets become invalid for CORSIA compliance, the insurance compensates the developer and, as understood, ensures replacement with other eligible offsets. This risk coverage, in turn, increases overall costs.

Modelling CORSIA-specific scenarios based on a number of sources[375] suggest that the market price for eligible credits will increase substantially from approximately $21.5 per credit in 2025 to around $50 by the end of CORSIA Phase 2 in 2035. Price variability depends on the balance between supply constraints and demand growth, with potential scenarios ranging from oversupply (leading to lower price surges) to high demand-driven price escalation.

The trajectory highlights how the balance between supply and demand will be central to CORSIA's price formation over the next decade. In an oversupply scenario, generous eligibility and limited scrutiny by ICAO allow a broad flow of credits into the system, moderating costs for airlines, while tighter authorization processes and stronger integrity enforcement could constrain project issuance, amplifying scarcity and

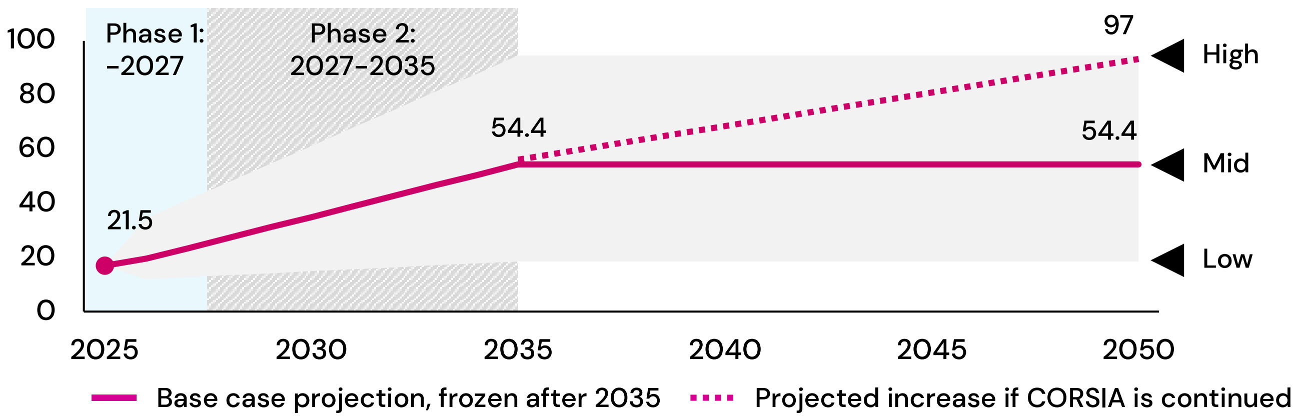
[375] Including: S&P Global Energy, ©2025 by S&P Global Inc., Abatable, BloombergNEF, and MSCI.

pushing prices higher as offset requirements expand in Phase 2 when coverage broadens to additional major aviation markets. Overall, CORSIA's path through 2035 is shaped by three key forces: the pace of aviation growth between participating countries, the degree of oversight around credit quality, and how quickly new supply pipelines come online. If supply maintains an edge over demand, prices are likely to remain relatively low; if constraints bite just as demand accelerates, prices could reach or exceed the upper end of projected ranges.

Given ICAO's current uncertainty around post-2035 phases, the scheme's influence stops short of shaping long-term trajectories, leaving future dynamics to be determined by pending policy decisions. The CORSIA price projections below reflect today's credit landscape and technological maturity, while the VCM price modeling draws from different data sources and assumptions, so the figures are not directly comparable and may diverge as markets evolve.

It is estimated that the CORSIA credit price will more than double in a decade. High uncertainty surrounds the long-term CORSIA carbon credit prices

CORSIA credit price over time, current and projected (USD)



Source: S&P Global Energy, ©2025 by S&P Global Inc., Abatable, BloombergNEF, MSCI. ICF analysis

6.4 Carbon credits in Latin America and the Caribbean

6.4.1 Regional market overview

Latin America and the Caribbean have historically played a substantial role in voluntary carbon markets (VCMs); accounting for between 13% and 23% of global credit issuance over the past 5 years. While early projects constituted a mix of renewable energy and forestry activities, the region has recently shifted towards prioritizing higher-quality, CORSIA-eligible, and nature-based credits; the bulk of which touch the fields of forestry or biodiversity. As of 2025, credits in South America are mainly generated through REDD+ projects, which call for reducing emissions from deforestation and forest degradation, and conservation, sustainable forest management and enhancement of carbon stocks. The Amazon basin and surrounding ecosystems position Latin America as one of the most critical growth areas for nature-based and avoided deforestation offsets through REDD+ and related projects. However, only a fraction of this potential currently counts for CORSIA, since eligibility filters and host-country authorization processes limit how quickly nature-based solutions can translate into compliant supply.

The region's importance is further reinforced by a dynamic policy environment. Several countries are advancing carbon-related innovations, including the introduction of carbon taxes and emission trading systems (with Mexico, Colombia, Chile, Brazil, and Argentina leading in this regard), legal reforms designed to address carbon rights and benefit-sharing, and evolution of LoAs which determine the use of credits under Article 6 of the Paris Agreement. These developments are expanding market opportunities and helping to attract investment into high-quality project pipelines.

At the same time, scaling the supply of aviation-eligible credits will require significant technical and institutional advances. Meeting international aviation standards for measurement, reporting, verification (MRV), and baselines necessitates stronger technical capabilities, as well as streamlined regulatory approvals that can reduce delays in bringing projects to market. Some countries in the region have made progress through advanced MRV systems, such as Guyana's 1-hectare resolution framework. However, broader regional adoption of such robust MRV infrastructures is needed to meet evolving compliance needs[376]. How effectively the region addresses these challenges will play a decisive role in shaping Latin America and the Caribbean's future as a global hub for carbon credits.

Guyana has emerged as a global leader by being the first country to issue CORSIA-authorized LoAs for carbon credits. Through a collaborative process involving the Architecture for REDD+ Transactions (ART) over 18 million ha of forest in the country (approximately 85% of Guyana's territory), Guyana issued jurisdictional TREES credits with corresponding adjustments, explicitly meeting CORSIA's stringent eligibility requirements, which would allow international airlines to purchase and retire these credits for regulatory compliance.

Looking ahead, the supply of credits from the region will be shaped by stronger validation protocols and enhanced quality requirements. These measures, while essential for credibility, are expected to constrain overall credit availability. Moreover, demand for these credits is expected to be strong, as they align with both compliance requirements and buyer interest in high-impact nature-based solutions. As a result, market competition is set to intensify, and price increases are projected to continue through at least 2035. This dynamic is especially relevant for the aviation sector, which faces growing compliance obligations under the CORSIA framework and will compete with other industries for a limited pool of eligible credits.

6.4.2 Carbon markets cases studies

6.4.2.1 Argentina

Current credit supply in Argentina remains limited, as most market activity is provincial in scope and nascent in scale. Some isolated pilot projects have emerged, like REDD+ efforts in provinces such as Córdoba, Neuquén, and Misiones[377], but there is not yet a consolidated federal framework to coordinate efforts. This fragmentation reflects Argentina's federal governance structure, where provinces retain significant authority over natural resource management. That dynamic creates both opportunities for local experimentation and risks of regulatory inconsistency for investors. That said, the natural resource base in Argentina is vast and offers high future potential in forestry, agriculture, and energy sectors. Realization of that potential depends on scaling up project pipelines and establishing streamlined federal oversight.

6.4.2.2 Brazil

Brazil has produced the largest number of carbon credits from Latin America and the Caribbean currently in circulation, accounting for nearly a third of all LAC credits in 2024[378]. As of 2024, the Brazilian market reached approximately USD 2.11 billion and is forecasted to grow to nearly USD 25 billion by 2033[379]. This rapid growth in the Brazilian carbon market is driven in part by regulatory advances including the Brazilian Greenhouse Gas Emissions Trading System (SBCE), which establishes market rules, emphasizes conservation and restoration standards, and enables interoperability between voluntary and regulated markets[380]. While Brazil's current credit marketplace is already extensive, Brazil holds the largest by-country share of the Amazon rainforest, representing significant opportunity to increase credit offerings and scale existing pipelines to high-quality, aviation-eligible credits.

[376] https://escholarship.org/content/qt9mf72304/qt9mf72304.pdf
[377] https://carbon-pulse.com/421906/
[378] https://scioteca.caf.com/bitstream/handle/123456789/2397/ENG_Bolet%C3%ADn%20N%C2%B05%20%E2%80%93%20ILACC.pdf?sequence=4&isAllowed=y
[379] https://www.imarcgroup.com/brazil-carbon-credits-market
[380] https://www.gov.br/planalto/en/latest-news/2024/12/president-lula-signs-law-creating-regulated-carbon-market-in-brazil

6.4.2.3 Chile

Chile's voluntary carbon market is in a period of rapid development, supported by a robust regulatory framework. Chile's Green Tax Emissions Compensation System (SCE) allows large emitters (over 25,000 tCO_2/year) to meet carbon tax requirements by purchasing domestic carbon credits[381]. In 2024, the SCE drove the retirement of over 4.4 million carbon credits (up from only 260,000 in 2023, when the policy was first introduced)[382] highlighting both rising demand and the critical role of market instruments in meeting NDC targets. Chile is well-positioned to continue developing carbon credit projects; the Chilean government has recognized key international standards (Verra's VCS, Gold Standard, BioCarbon Registry, and Cercarbono), ensuring supply integrity and alignment with global markets, and recent legal resolutions have clarified eligibility of both domestic and internationally certified credits. A growing number of local projects, especially in agriculture, forestry, and land use (AFOLU), are entering the pipeline.

6.4.2.4 Colombia

Colombia has one of Latin America's most advanced domestic carbon markets. Its carbon tax law since 2017 has allowed companies to offset tax liabilities by purchasing credits from domestic projects, spurring rapid project development across forestry, agriculture, and renewable energy sectors. Thanks in part to that policy, over 230 Colombian projects have been certified since 2002 (resulting in the mitigation of over 231 Mt CO_{2e}). However, the Colombian carbon market faced a significant downturn in 2023 when the government imposed a cap limiting the use of domestic credits to offset only 50% of carbon tax liabilities. This policy change sharply reduced demand and depressed prices, leading to oversupply with approximately 63.7 million carbon credits unsold as of late 2024. The market price dropped from a previous peak of COP 22,000 (≈ USD 5.94) per credit to a range between COP 12,000-16,000 (≈ USD 3.24-4.32)[383]. The shift created uncertainty, but also provided an opportunity for buyers, who now control pricing.

The current oversupply and suppressed prices are limiting near-term growth, not due to a lack of project development or issuance, but because demand is constrained by domestic policy design. Colombia's abundant forest reserves and biodiversity provide strong potential, particularly for REDD+, ARR, land-use, and renewable energy projects, with ARR already scaling and carbon credits being sold in international markets. Expansion is expected as more high integrity projects are certified by various standards and carbon market matures and grows. Cercarbono, a domestic Colombian registry, has received conditional Phase 1 approval for multiple novel nature-based removal methodologies and is anticipating full CORSIA eligibility[384]. This regulatory maturity and project diversity make Colombia a regional leader in carbon crediting.

6.4.2.5 Guyana

Guyana stands out in the Latin American and Caribbean region through its leadership in jurisdictional REDD+ carbon markets with the ART TREES project, the only program globally to have issued TREES carbon credits. Covering approximately 18 million hectares (87% of the country's forested land) the project issued 33.47 million credits for the 2016–2020 period and an additional 7.14 million credits for 2021, positioning Guyana as the sole provider of CORSIA-eligible credits with valid Letters of Authorization in 2024. This jurisdictional REDD+ initiative protects around 21.8 billion tonnes of CO_{2e} by avoiding deforestation and promoting reforestation, showcasing the potential for tropical forest countries to lead high-integrity carbon credit supply.

6.4.2.6 Mexico

In 2023, Mexico was the first country in Latin America to launch an Emissions Trading System (ETS), setting limits on carbon emissions from the energy and industrial sectors[385]. The compliance carbon market segment is currently the largest in the country, and the carbon tax has led to a reduction of 1.8 Mt CO_2e each year,

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[381] https://documents1.worldbank.org/curated/en/099060225142533399/pdf/P179222-5f48ad48-c833-4da1-8a5c-607779bd9f30.pdf
[382] https://www.green.earth/news/corporate-demand-grows-for-chiles-carbon-credits
[383] https://www.argusmedia.com/en/news-and-insights/latest-market-news/2687085-colombia-s-offset-cap-drops-carbon-market-demand
[384] https://www.clearbluemarkets.com/knowledge-base/cercarbono-methodology-and-procedure-updates
[385] https://icapcarbonaction.com/system/files/ets_pdfs/icap-etsmap-factsheet-59.pdf

although the voluntary market segment is growing quickly[386]. Mexico has ambitious GHG reduction targets and aims to reduce net greenhouse gas emissions 35% by 2030[387]. Mexico's established ETS and emphasis on carbon reduction cements its position as a key region for future carbon offsetting project development. More specifically, as a top market for U.S. food and agricultural exports, Mexico is poised to become a leader in carbon offsets through agricultural and land-use change projects.

6.4.2.7 Peru

After its 2025 approval of Verra VCS, Peru is likely to continue growing its carbon project development offerings[388]. Peru has the world's fourth largest forest cover and significant potential to drive extensive reforestation projects[389]. Peru's carbon market is currently valued at USD 0.65 billion and is one of the smallest in Latin America, however, it is projected to grow 40% by 2033[390]. The federal and private sectors have embraced early adoption of mitigation protocols, and Peru aims to have net-zero emissions by 2050. To implement its compliance market, Peru held a thorough public consultation period to create substantive rules and increase compliance. Despite these positives, there have been legal roadblocks with emissions reductions failing to register with RENAMI (El Registro Nacional de Medidas de Mitigación GEI) and Peru's National Environmental Fund effectively managing REDD+ results-based payments. Fragmented national and regional governments and unclear ownership of carbon rights further complicate the market[389].

6.4.3 Pricing by country

In Latin America and the Caribbean, the average Nature-Based Avoidance credit ranges between $2-$8 USD; and the average Nature-Based Removal credit ranges between $8-$24 USD[391]. According to S&P Global Energy data, in countries where both credit types have been developed, namely Brazil and Colombia, the Nature-Based removals are far higher than the avoidance credits. This aligns with global projections.

The data displayed in the figure below is limited to carbon credit heards from S&P Global Energy, which refers to a reported bid, offer, or transaction price for a specific carbon credit collected from market participants. These heards are not comprehensive of every carbon credit issued worldwide, which is why there are notable gaps (e.g., Mexico missing Nature-Based Avoidance credits), and the number of heards per country and credit type ranges from 4 to 155. The graph is shown here to be directionally informative of comparative pricing.

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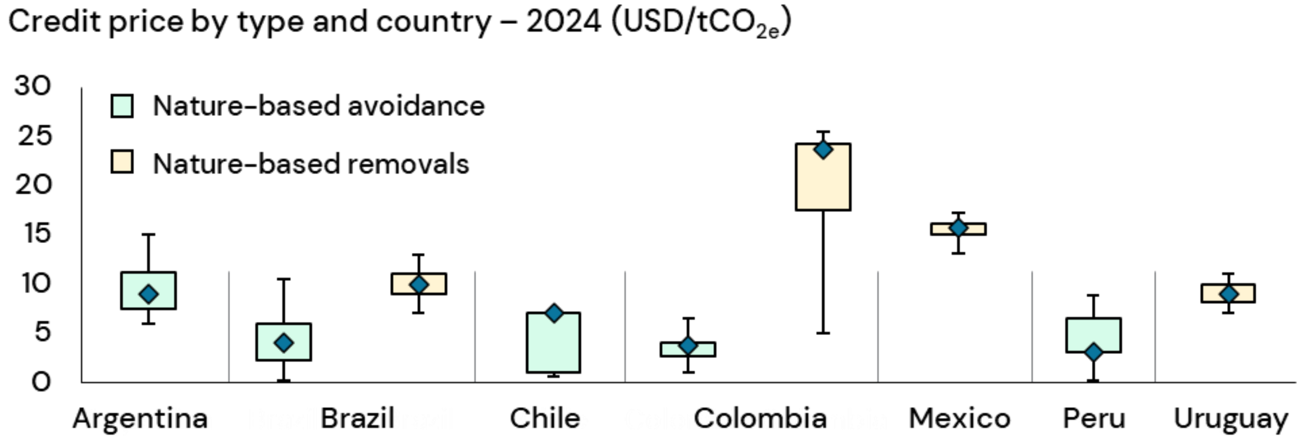
[386] https://icapcarbonaction.com/system/files/document/201025_idb_compliancevoluntary_paper-rz.pdf#:~:text=REDD+%20credits%20certified%20by%20Verra%20currently%20represent,in%20the%20region%20in%202020%20and%202021.
[387] https://climatepromise.undp.org/what-we-do/where-we-work/mexico
[388] https://verra.org/peru-approves-verras-vcs-program-and-two-methodologies-advancing-climate-action-and-carbon-market-integrity/
[389] https://www.cifor-icraf.org/publications/pdf_files/infobrief/8750-Infobrief.pdf
[390] https://www.cognitivemarketresearch.com/regional-analysis/south-america-carbon-credits-market-report
[391] S&P Global Energy, ©2025 by S&P Global Inc.

Carbon credit prices vary by country and type



Source: S&P Global Energy, ©2025 by S&P Global Inc. ICF analysis
Note: Lines indicate the full range, while bars represent the interquartile range

6.5 Strategy and recommendations

6.5.1 Governments in Latin America and the Caribbean

Latin America and the Caribbean are entering a decisive phase in the development of national and regional carbon markets with direct implications for the aviation sector. Rising demand for high-quality credits has created increasing pressure on the limited supply of CORSIA-eligible credits; driven by country-level NDC commitments, emerging compliance regimes such as carbon taxes and trading systems, and competition from other sectors like the maritime industry. At the same time, VCM is shifting toward higher-integrity standards and a growing share of carbon dioxide removal (CDR) credits, which carry higher costs but are essential to meeting long-term climate goals. Against this backdrop, regional governments must strengthen their market and regulatory frameworks to ensure the continued development of carbon credit projects, while ALTA and its member airlines play an active role in securing access to scarce credits and additionally developing robust carbon mitigation strategies.

1. **Unlock credits by streamlining LoA processes and clarifying carbon rights.** Several regulatory bottlenecks currently constrain the region's ability to scale credit supply. Of primary importance, delays in the process of individual countries issuing LoAs prevent project approvals and limit otherwise eligible credits from full compliance under CORSIA. Prioritization and streamlining of this process would immediately increase credit supply and ensure greater consistency with Paris Agreement commitments. Importantly, transparent national carbon inventories can enable countries to quantify and monetize mitigation outcomes, attract investment, and retain revenue. Additionally, government legislation clarifying land tenure, carbon rights, and benefit-sharing rules is vital to reduce investor risk and safeguard community participation. Stronger legal frameworks that recognize carbon property rights expand project pipelines and ensure equitable distribution of benefits by providing clear, enforceable ownership and usage rights over forest carbon resources. This clarity reduces uncertainties and risks for investors and project developers, thereby incentivizing the initiation and scaling up of forest carbon projects.
2. **Support high-quality carbon markets to scale.** High-quality carbon credits generally require higher upfront costs due to rigorous standards and additional requirements. Regional governments can help remove financial barriers and scale carbon markets by adopting financial incentives such as tax credits, green bonds, and earmarking revenues from carbon taxes. These measures improve project

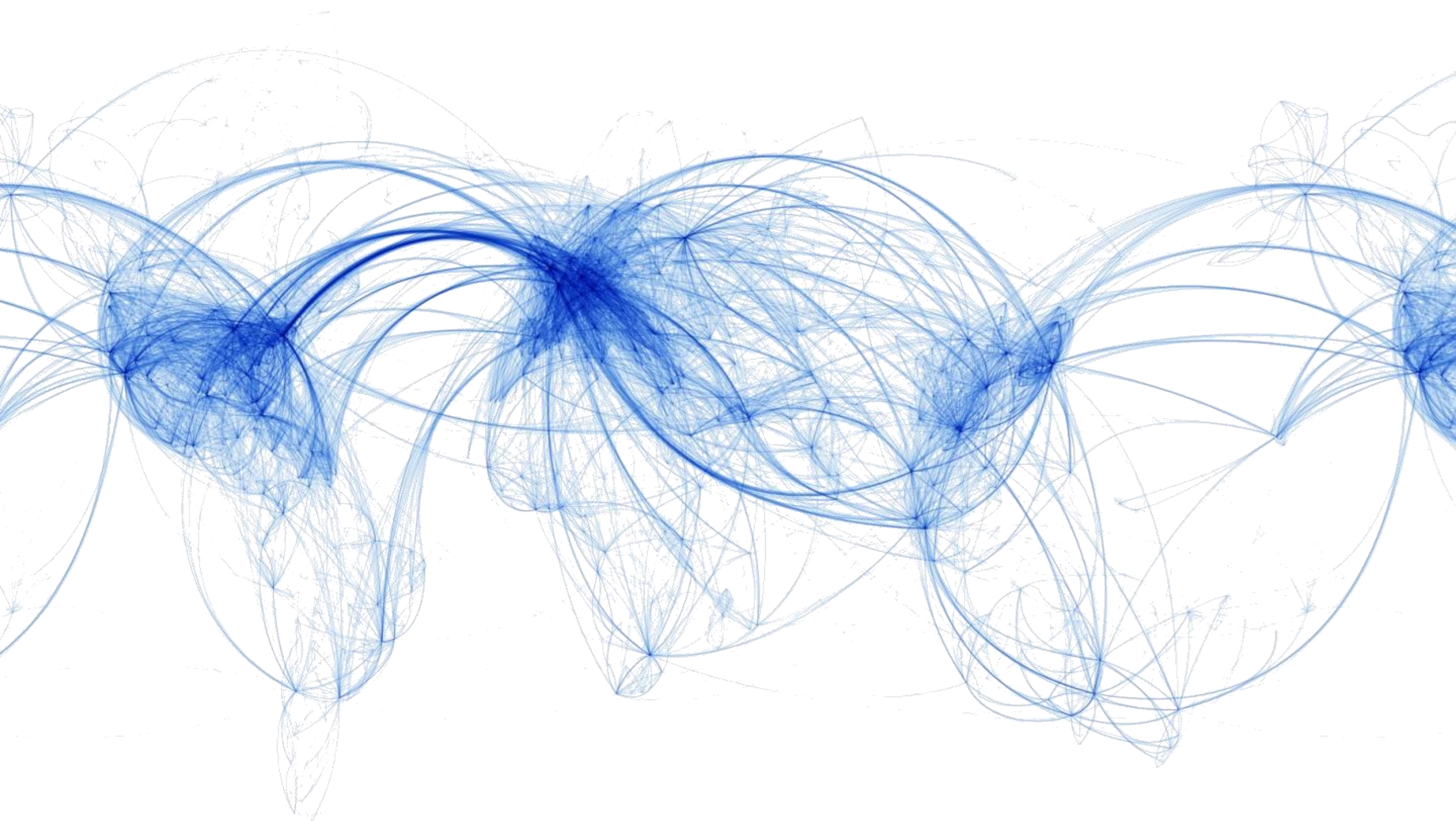
viability by offsetting taxes owed, mobilizing large-scale private capital for investment under favorable terms for high-quality carbon credit projects, and explicitly support carbon market initiatives, including capacity building, technical assistance, MRV, infrastructure development, and co-benefit programs for local communities. Together, these mechanisms create a stable economic environment that stimulates participation from both public and private sectors and advances carbon market development.

3. **Strengthen MRV frameworks and innovation.** The expansion of national MRV frameworks is another critical area for development in Latin American governments, as robust tracking of emissions reductions and carbon removals underpins both environmental integrity and the international credibility of carbon credits. Without transparent and standardized MRV protocols, concerns around greenwashing, exaggerated baselines, and faulty additionality may undermine the market. To remedy this, governments can scale up digital MRV (D-MRV) technologies, using Guyana as a model. The Guyanese government, in partnership with international academic and technical experts, has developed one of the most advanced D-MRV systems in the region, integrating multiple forms of remote-sensed imagery to track forest change at 1-hectare resolution.

4. **Harmonize standards through regional collaboration.** Another high-potential path towards developing carbon markets is regional government collaboration, since fragmentation across Latin America weakens efficiency and market confidence, while increasing transaction costs. Multi-country initiatives such as Carbon Pricing in the Americas, the Pacific Alliance, and the Latin American and Caribbean Carbon Forum have already laid this groundwork. Moving beyond fragmented project-by-project schemes toward shared standards can improve environmental integrity, limit leakage between borders, and create more liquid, investable markets through policy coherence. Such alignment can also support interoperability across national systems, enhance transparency and comparability of credits, and reduce administrative and transaction costs for governments, project developers, and buyers. Aligning methodologies, MRV standards, and benefit-sharing safeguards can help countries pool resources, avoid duplication, and scale access to international demand (particularly under Article 6 of the Paris Agreement). Regional knowledge exchanges and joint platforms could also accelerate capacity building in countries that are newcomers to compliance trading or voluntary market regulation

5. Empower national authorities to further facilitate CORSIA eligibility of regional mitigation solutions. Governments should strengthen and empower designated national authorities to engage more proactively with ICAO processes and technical bodies to facilitate that the region’s abundant mitigation solutions, including REDD+, AFOLU, and broader nature-based solutions, can be recognized under CORSIA with appropriate environmental and social safeguards. Enhanced technical capacity, and coordinated regional engagement can help align methodologies, safeguard frameworks, and authorization processes with CORSIA requirements, unlocking access to international aviation demand while preserving environmental integrity and national interests.

7 Why is a regional approach required for Latin America and the Caribbean?



Key results:

- Global net-zero frameworks are inappropriate to apply in LAC because the region faces unique conditions.
- Establishing a unified regional trajectory is complex due to substantial differences across countries. A range of possible trajectories provides governments and stakeholders with options that better reflect national circumstances.
- All net-zero pathways are associated with substantial economic implications, highlighting the need for coordinated support from national governments to mitigate costs and safeguard connectivity.

7.1 Scope and methodology

7.1.1 Scope

The analysis presented in this section combines all elements described in the report, including traffic activity, fleet improvements, operational efficiency enhancements, and the availability and pricing of SAF and carbon credits. These elements are combined to model country-specific net-zero roadmaps based on different scenario levers, which are then aggregated to the regional level. Each option achieves net-zero by 2050, reflecting the ambition of ALTA and its members. All inputs follow the rigorous methodologies outlined throughout this report, and the options and impacts described in this chapter incorporate extensive stakeholder engagement to ensure alignment with the LAC region realities.

7.1.2 Methodology

The scenario model built for this study allocates abatement measures for each country across all years from 2025 to 2050 to meet emissions reduction targets and SAF blend percentages, in order to illustrate the impacts of different pathways for the region. Measures are assigned based on the lowest cost of abatement, subject to availability, as established in previous chapters. The model accounts for real-world constraints and operates through four sequential allocation phases, followed by a feedback loop that adjusts for changes in aviation demand caused by emissions reduction measures.

1. *Traffic, technology, and operations:* The first phase calculates annual aviation emissions for each country and applies technology and operational improvements to estimate remaining emissions and updated jet fuel demand.

2. *Domestic SAF allocation*: Each country receives sufficient SAF to meet half of its annual blend objective[392]. SAF is allocated based on the lowest abatement cost of locally available feedstock and technology combinations. Allocations in this first run of the model use domestic feedstock and maintain or increase usage annually, reflecting continuity of production once facilities are operational.

3. *Regional SAF allocation:* The remaining SAF needed to meet the desired blend is aggregated across all countries and allocated from a regional pool of feedstock left after domestic allocation. SAF is allocated based on lowest abatement cost, with shares distributed proportionally to each country's unmet SAF requirements. Production growth must remain steady or constant for each feedstock-technology pathway.

4. *Residual emissions abatement:* After SAF allocations, remaining emissions are addressed using the lowest-cost options available, typically carbon credits. All are drawn from a regional pool and subject to availability.

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[392] A 50% threshold balances domestic energy security with regional integration, allowing countries to maintain control over SAF supply while benefiting from regional optimization

5. *Demand impact and re-run:* Once all phases are complete, the model evaluates how additional price due to SAF and carbon credits affects aviation demand. This is done on route-level, including domestic, regional and international traffic flows with varying levels of price sensitivity. Average SAF price per country in the LAC region is used, together with the SAF uptake scenario and a regional average price of carbon credits. SAF demand in other regions is based on implemented and announced mandates and targets to reflect SAF uplift requirements on international flights. These changes update fuel demand and emissions estimates, and the model re-runs all allocation phases to refine SAF and abatement distributions, ensuring the final outcome reflects the economic realities of achieving net-zero.

7.2 Global benchmarks

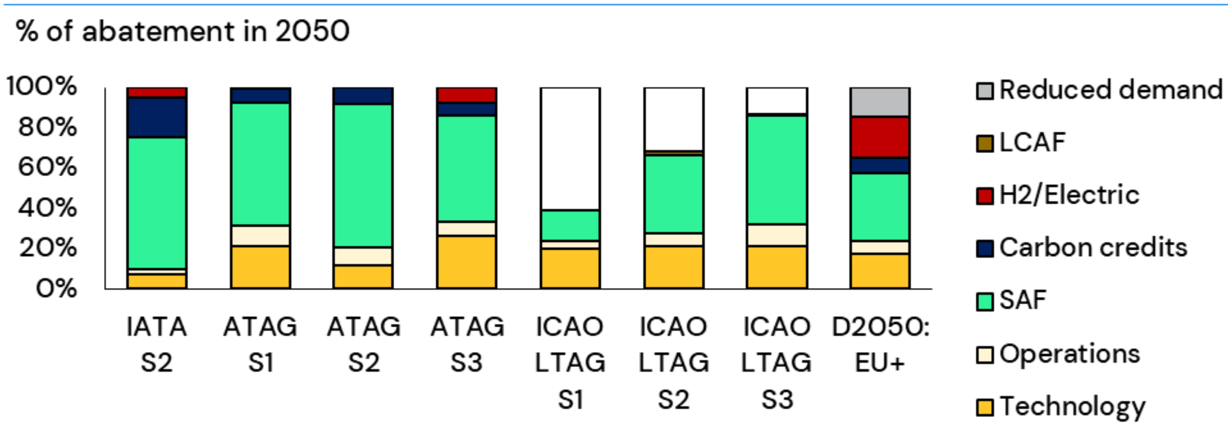
Aviation emission reduction initiatives are advancing worldwide, but strategies must reflect regional circumstances. While the global objective of net-zero emissions is shared, pathways differ due to variations in resources, infrastructure, and economic conditions.

The LAC region offers unique opportunities and challenges. It benefits from abundant natural resources, enabling nature-based offsets, and has significant feedstock availability and access to relatively inexpensive renewable energy. However, as an emerging economy, regional connectivity is vital for growth, and many areas in the region depend on aviation for basic connectivity in the absence of reliable substitutes. Aviation also contributes substantially to employment and economic value. Any increase in air travel costs will have a stronger impact on demand compared to developed regions. Further regional constraints include limited access to private capital, less mature regulatory frameworks, and gaps in technical expertise.

In contrast, Europe and North America have established aviation markets, greater investment capacity, and stronger government support for climate policies. These advantages enable advanced technologies, progressive emission reduction strategies, and robust regulatory structures that facilitate SAF integration and carbon market development.

Industry roadmaps differ in expectations for technology development, including hydrogen and electric aircraft, operational techniques such as formation flights, and SAF advancements that influence cost relative to conventional fuel. Some roadmaps exclude the impact of abatement measures on demand, and others do not reach net-zero. The figure below illustrates differences among a number of industry-wide roadmaps.

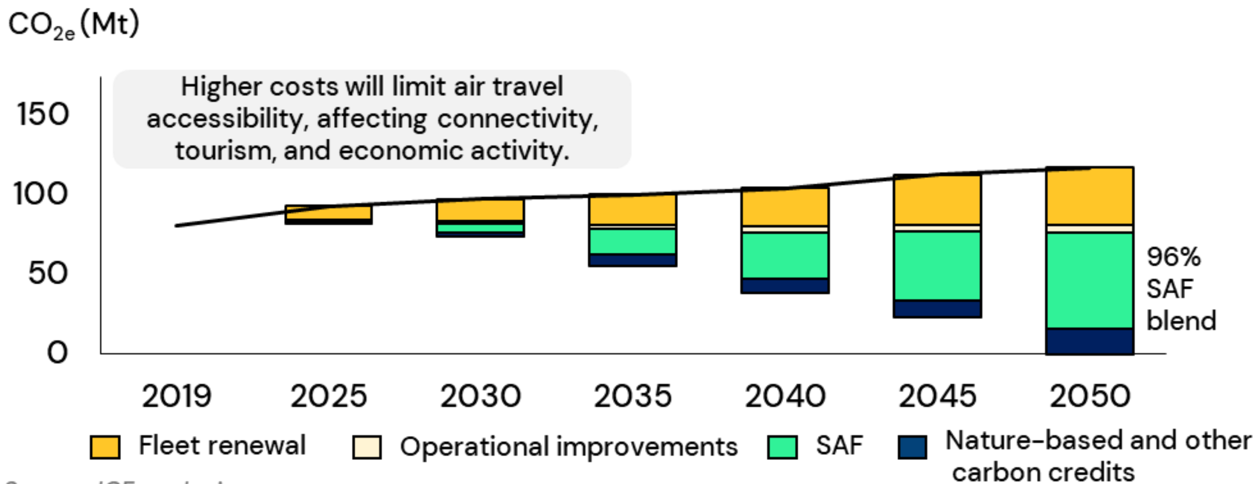
Industry roadmaps vary in abatement strategies



Source: IATA

Among the most SAF-intensive global scenarios is ICAO's LTAG S3, which targets a 96% SAF blend by 2050 as part of its emphasis on in-sector mitigation and minimizing residual emissions. Achieving this globally requires rapid technology scaling, significant capital investment, robust supply chains, and open trade flows. A 96% SAF blend case applied to the LAC region is illustrated in the figure below, which would have implications for connectivity, tourism and economic activity, especially in areas where aviation is the only viable transport option.

Hypothetical scenario (aligned to ICAO LTAG S3 SAF % blend) and why this means a different approach is required for the region



Source: ICF analysis

However, reaching a 96% SAF blend in LAC presents many challenges, including substantial capital investment, the construction and rapid scaling of SAF production facilities across the region, and the development of efficient intraregional supply chains to support consistent fuel availability. Costs would rise significantly. Without material economic support, airlines would need to pass these expenses to consumers, increasing ticket prices and reducing demand by around 30% in 2050. The potential loss in aviation economic value is estimated to be approximately 156 Bn USD under this scenario[393]. Policymakers and industry stakeholders must weigh these impacts when designing emission reduction strategies to preserve connectivity and economic resilience while advancing net-zero goals. **Global targets such as a 96% SAF blend are unrealistic for the region's economic and social context. Rather, approaches must be tailored to preserve regional connectivity and bolster economic development, while still supporting progress toward net-zero goals.**

7.3 Scenarios for Latin America and the Caribbean

7.3.1 Results

Achieving net-zero in LAC will involve significant costs regardless of the pathway. Multiple options exist for progress, and each requires careful consideration of economic and operational realities. Fleet renewal and operational improvements have historically reduced emissions and remain promising, particularly with government support. Fleet renewal could reduce fuel burn and CO_2 emissions by 30% annually by 2050, while operational improvements could add a further 3.3-11.3%, depending on the level of support (6.8% under the mid-ambition scenario). While these measures lower fuel costs, they do require substantial investment and collaboration across stakeholders.

However, these strategies alone cannot deliver net-zero. SAF and carbon credits are essential to address residual emissions, and both entail costs that cannot be recovered through fuel savings. The region encompasses countries with varying levels of economic activity, government focus, and technological development, making a uniform approach challenging. This analysis therefore presents a range of options,

[393] Including direct, indirect, induced, and tourism-related contributions

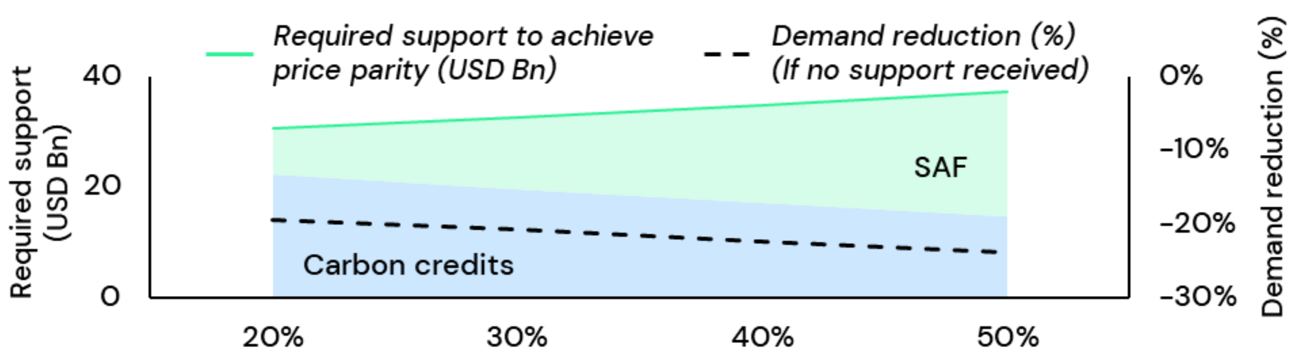
allowing governments and stakeholders to set specific goals. All scenarios require financial support for airlines to offset the costs of SAF and carbon credits, or the sector will face severe economic impacts if sustainable targets are to be met.

The figure below presents the annual impact on demand resulting from achieving net-zero in 2050 across SAF blend levels ranging from 20% to 100%, alongside the corresponding level of support needed to mitigate these impacts. In a 20% SAF blend scenario, residual emissions will have to be offset through the procurement of carbon credits, including engineered carbon removals. Under this scenario, total costs to airlines are estimated at 30.5 Bn USD, or cumulatively 224 Bn USD, and demand reduction is projected at approximately 19.5% in the absence of financial support. While this approach reduces immediate capital requirements for SAF production infrastructure, it places pressure on carbon credit markets and assumes the availability of large-scale carbon removal technologies.

A 100% SAF blend scenario entails complete substitution of conventional jet fuel with SAF. This requires extensive investment in SAF production capacity, feedstock supply chains, and supporting infrastructure. The cost to airlines is substantial, with total expenditure estimated at 50.4 Bn USD in 2050, and 518 Bn USD cumulatively, and demand reduction projected at 31.4% without support. Even at full SAF adoption, carbon credits remain necessary because the average GHG reduction from SAF in 2050 is estimated to be 82%, leaving residual emissions that must be addressed to achieve net-zero. The impacts of each SAF blend scenario, including demand implications and economic impacts, are summarized in the figure and table below. A 50% SAF blend, for example, still requires large investment and may result in an average air travel demand reduction of 24%.

2050 level of government support and investment required and demand reduction for mix of SAF and carbon mechanisms

Required support in USD bn (left) and demand reduction in % (right). Horizontal axis shows the 2050 regional SAF blend.



Source: ICF analysis

Table 59: Demand impact and emission reduction measures cost (2050 annual)

SAF blend (2050)	20%	30%	40%	50%
Carbon credits required (Mt CO_2/year)	92.4	83.4	74.1	64.9
Cost of carbon credits (USD Bn/year)	22.2	19.7	17.2	14.6
Cost of SAF premium (USD Bn/year)	8.3	12.9	17.8	22.7
Total cost (USD Bn/year)	30.5	32.6	34.9	37.3
Demand reduction impact (%/year)[394]	-19.5	-20.7	-22.4	-24.0

394 Measured in reduction of departing seats

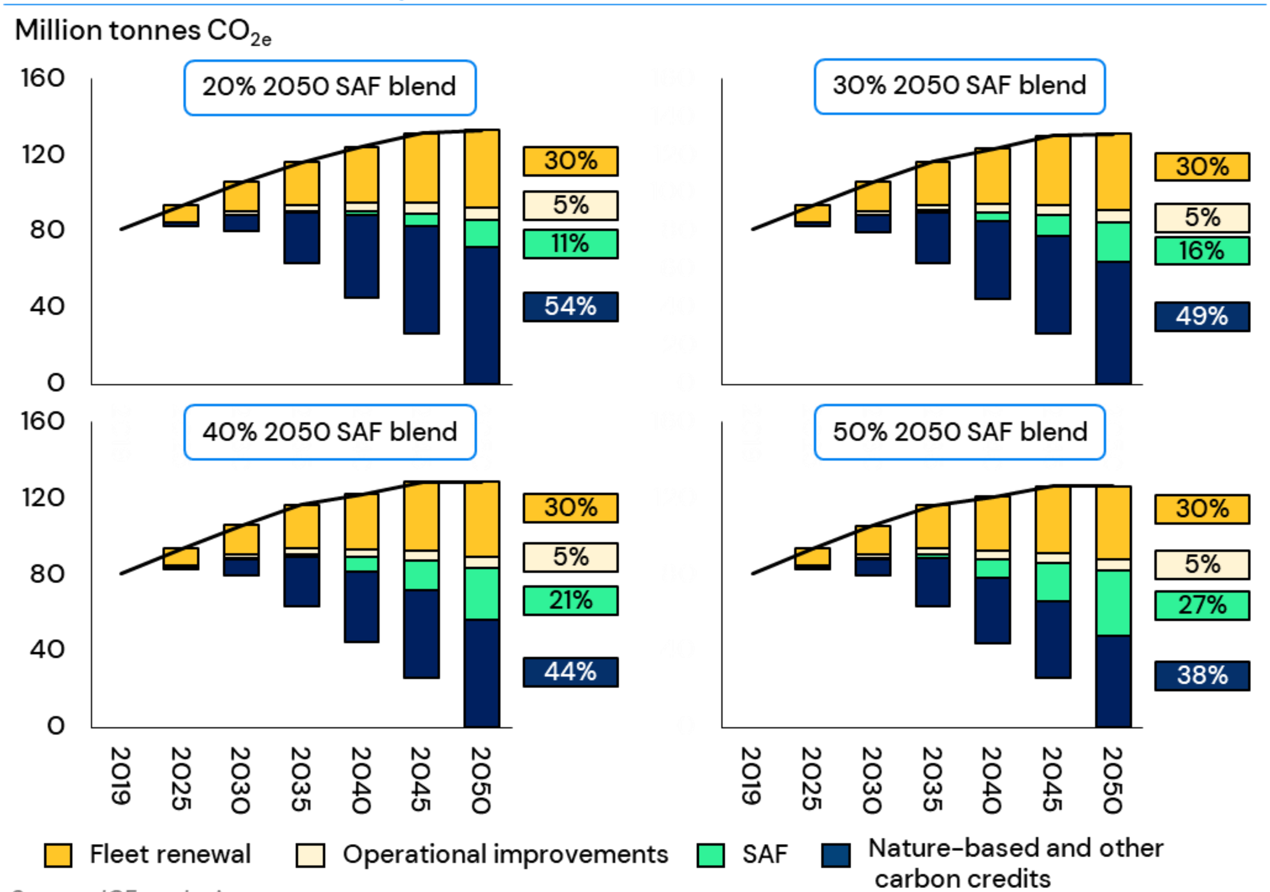
The table below presents the cumulative number of passengers not flown between 2030 and 2050 under these scenarios, along with the level of support required to mitigate this impact.

Table 60: Demand impact and emission reduction measures cost (2030-2050 cumulative)

SAF blend (2050)	20%	30%	40%	50%
Passengers not flown (million)[395]	1,287	1,385	1,526	1,681
Support required (USD Bn)	224	242	262	284

SAF blend range of 20% to 50% by 2050, supplemented by carbon credits could represent a viable pathway for the LAC region. With support, this range balances economic feasibility, infrastructure requirements, and demand impacts while supporting progress toward net-zero. The figure below illustrates the contribution of each measure in achieving net-zero within this 20–50% blend range.

Illustrative decarbonization pathways for Latin America and the Caribbean's aviation sector to reach net-zero by 2050



Source: ICF analysis
Note: Baseline includes demand reduction

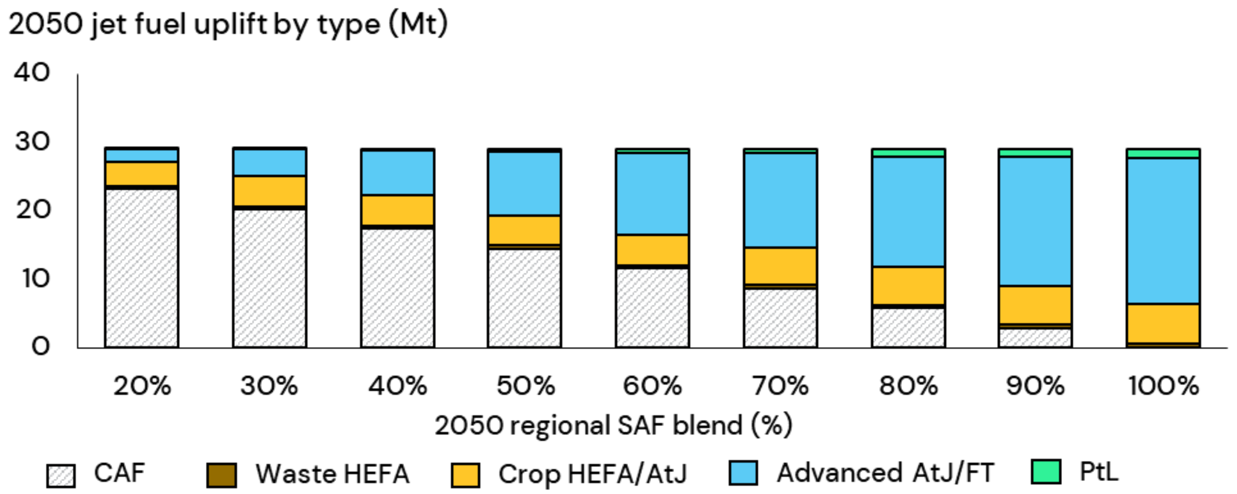
[395] Measured in number of departing seats

7.3.2 Discussion

7.3.2.1 Regional jet fuel mix and abatement cost by SAF blend

The mix of SAF feedstock-technology pathways used to meet each blend requirement depends on both abatement cost and feedstock availability. At lower blend levels, crop-based SAF dominates, primarily derived from sugarcane ethanol due to its relatively low abatement cost and projected increasing availability. As supply tightens or when countries must meet part of the blend target using domestically sourced feedstocks, more advanced options become necessary. Under these conditions, significant volumes of AtJ SAF produced from forestry and agricultural residues enter the mix. Although PtL remains costlier than waste-based AtJ throughout this study, small quantities emerge in countries with limited waste-based options. The figure below highlights the region's 2050 jet fuel mix by SAF blend scenario.

Increases in SAF uptake are predominantly met by advanced AtJ SAF

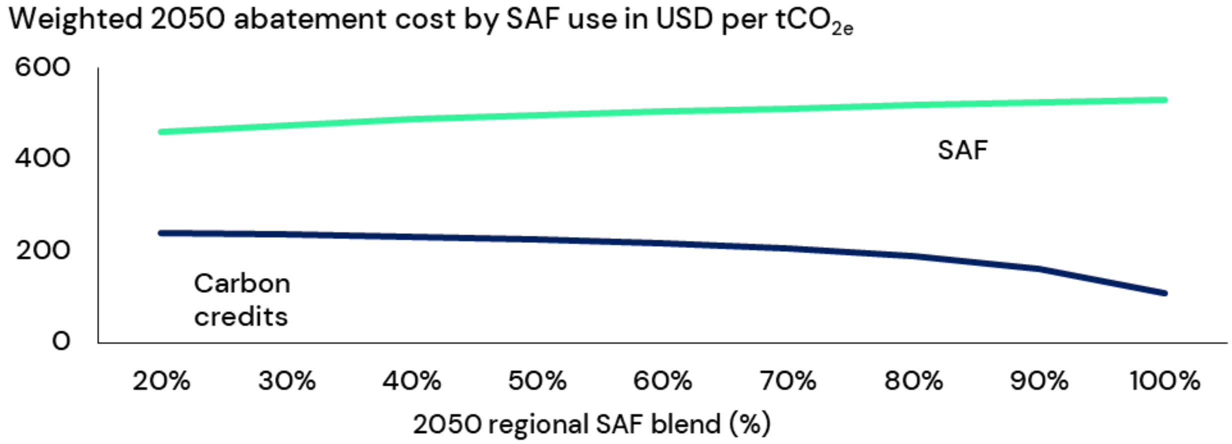


Source: ICF analysis

As reliance on higher-cost SAF increases, the weighted average abatement cost rises with the blend requirement. From an airline perspective, the price per gallon of SAF is projected to reach USD 6.08 in 2050 under a 20% blend, USD 6.47 under a 50% blend, and USD 6.77 under a 100% blend. These averages mask substantial variation across countries driven by feedstock availability and economic conditions. For example, under a 50% blend requirement, SAF prices in The Bahamas are expected to exceed those in Brazil by more than 20% in 2050, primarily as a result of feedstock constraints.

Carbon credits costs follow an opposite. As SAF blend requirements decrease, the volume of carbon credits required rises, and their price escalates. This is due to tightening supply of credits and nature-based removals, which forces greater reliance on the more immature and expensive engineered removals. The weighted average abatement costs for SAF and carbon credits across SAF blend levels from 20% to 100% in 2050 are presented in the figure below.

The abatement cost of both SAF and carbon credits rises with their use, as cheaper options are exhausted and more expensive ones are needed

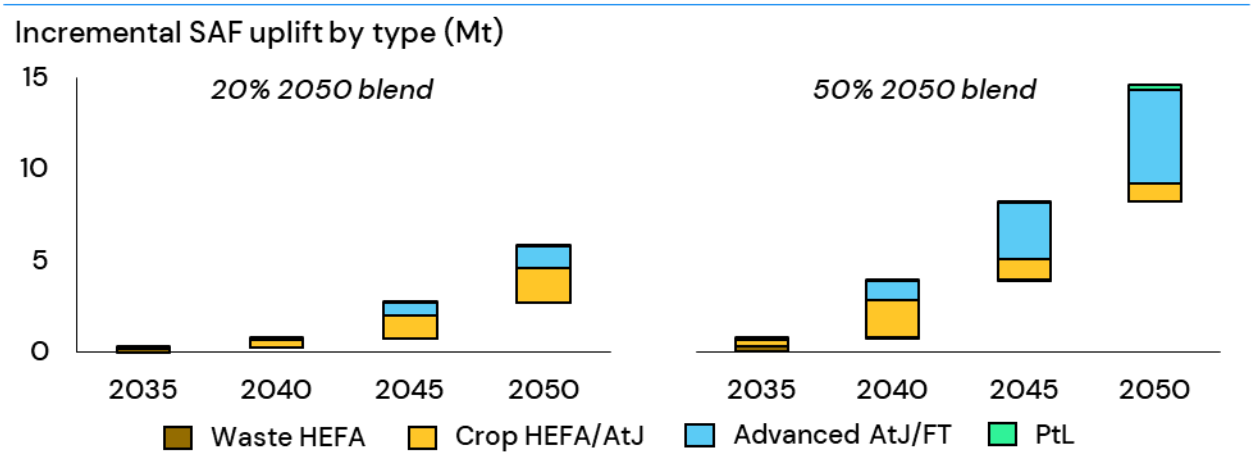


Source: ICF analysis
Note: The SAF abatement price is based on the SAF premium

7.3.2.2 The evolution of SAF mix and abatement cost over time

The SAF mix also evolves significantly over time. Under all highlighted scenarios, initial volumes are dominated by waste HEFA, primarily derived from UCO, due to its low abatement cost and immediate availability. However, UCO supply is limited in the LAC region, and growth beyond initial volumes is constrained. As SAF demand surpasses UCO-based supply, sugarcane ethanol-derived AtJ SAF begins to enter the mix, representing the next lowest abatement cost option with substantial scalability. Unlike waste-based HEFA SAF, crop-based AtJ continues to grow steadily over time. This growth is supported by increasing sugarcane ethanol production and the ability of countries with limited domestic supply to import from those with surplus capacity. In later years, waste-based AtJ SAF becomes a critical contributor, filling residual requirements as more advanced technology-feedstock pathways mature and scale. This progression reflects global realities, where advanced SAF technologies are unlikely to achieve immediate large-scale deployment.

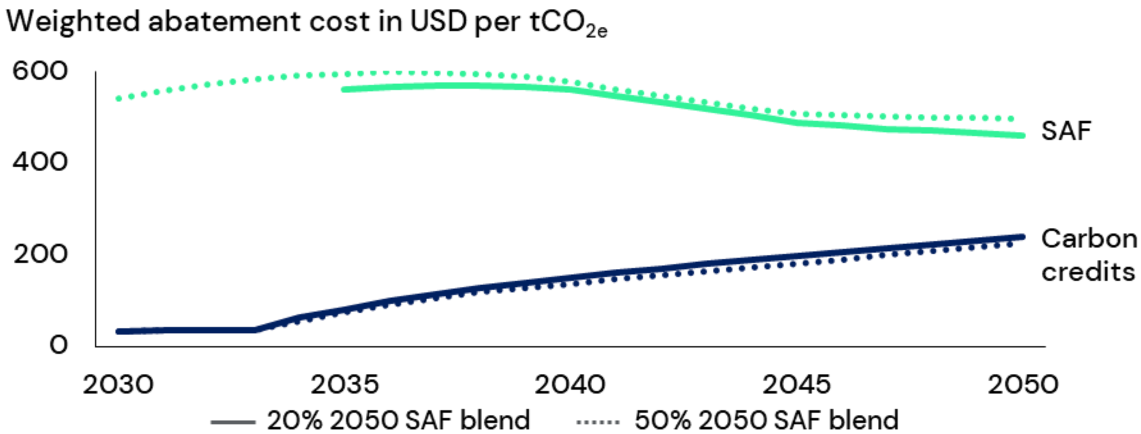
Waste HEFA and crop-based AtJ/FT are likely to remain the dominant pathways through the 2040s under the examined range of blend targets



Source: ICF analysis

The trajectory of average abatement cost for SAF initially rises as low-cost feedstock-technology options are exhausted and reliance shifts to more expensive technologies. However, as these technologies mature, production efficiencies improve, logistics become more streamlined, and the carbon intensity of SAF decreases, the abatement cost of advanced pathways declines in later years. In contrast, the abatement cost of carbon credits is expected to increase steadily over time. This trend is driven by tightening supply and growing demand, which necessitate the use of higher-cost engineered removals to meet residual emissions targets.

Although SAF abatement costs remain higher than that of carbon credits, the gap narrows over time



Source: ICF analysis. The solid line represents a scenario with a 20% 2050 SAF blend, and the dotted line represents 50%.

7.3.2.3 The impact of operational efficiency improvements

By 2050, operational efficiency improvements could reduce annual aviation emissions in the LAC region by 3.3% to 11.3%. While this chapter applies a mid-case estimate of 6.8%, actual outcomes could be considerably lower or higher depending on stakeholder ambition, regulatory alignment, and the pace of technological development. The difference between the low and high improvement trajectories corresponds to 9.4 Mt CO_2e annually by 2050. Without these improvements, airlines would need to rely more heavily on measures that do not generate fuel savings, specifically greater SAF consumption and higher carbon credit purchases, to compensate for the shortfall each year.

Under a 50% SAF blend scenario, the gap in required SAF and carbon credits between achieving 11.3% rather than 3.3% operational improvements would result in annual cost savings of 3.6 Bn USD by 2050, highlighting that operational efficiency is a critical element of any net-zero pathway and cannot be considered optional. Realizing this potential requires governments, regulators, airlines, airports, ANSPs, and technology providers to work together under clear regulations, aligned incentives, targeted investment, and a shared commitment to collaboration and data transparency. To make this happen in practice, the region needs to harmonize procedures, upgrade physical and digital infrastructure, adopt effective technologies, and build a culture where operational efficiency is treated as a shared responsibility. Without these foundations, progress will remain uneven and the region will face higher reliance on SAF and carbon credits. When these elements come together, operational efficiency can lower airline fuel costs, strengthen day-to-day operations, and reduce the overall impact of reaching net-zero.

7.3.2.4 The impact of de-risking SAF

Global technology development will be one of the most decisive factors in shaping the cost, feasibility, and impacts of reaching net-zero in the LAC region. While the SAF blend scenarios presented earlier assume a mid-case pricing trajectory with moderate abatement cost declines over time, actual outcomes will depend on how quickly advanced technologies mature and how effectively global learning curves are leveraged.

If SAF adoption reaches 50% of total jet fuel use by 2050, economies of scale and accelerated technology deployment could deliver far greater cost reductions than those assumed in the baseline scenarios. As production facilities expand and supply chains become more efficient, capital expenditure requirements will fall, financing conditions will improve, and operational costs will decline. Conversely, if SAF development lags, costs for airlines could rise. To illustrate this, a scenario assuming faster technology and cost improvements was developed, in which capital expenditure decreases by 20%, debt and equity interest rates by 15%, and corporate tax rates, feedstock, and utilities by 10% relative to the baseline. A scenario assuming slower technology and cost improvements applies the opposite changes, highlighting the sensitivity of costs to global technological and financial conditions. Under the scenario used in this study, the average SAF abatement cost in 2050 falls to approximately USD 498 per tonne of CO_2e. Based on the faster and slower improvement scenarios, this could range from 450 USD to 550 USD, with a corresponding annual cost difference for airlines of 4.7 Bn USD under a 50% blend. These ranges reinforce the critical role of global technological development in mitigating economic pressures on the sector.

Achieving these reductions will require coordinated action across multiple fronts. Governments must create enabling environments that attract investment and accelerate innovation. Public-private partnerships will be essential to share risk and mobilize capital for demonstration facilities that validate new technologies and accelerate commercialization. International collaboration is also critical to harmonize standards, facilitate open trade flows for feedstock and SAF, and ensure that emerging economies benefit from global progress rather than being left behind.

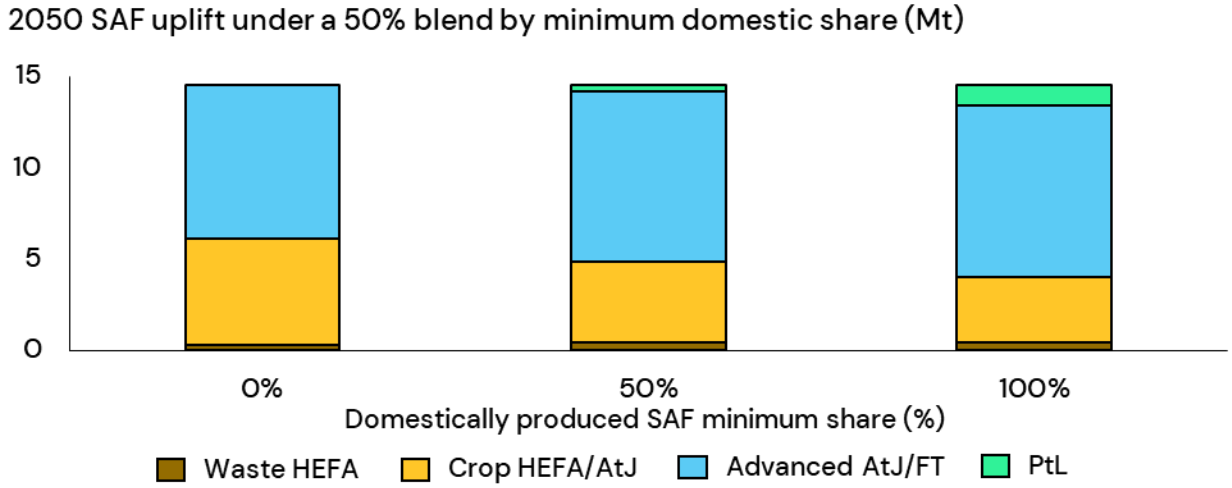
The impact of global technology development extends beyond cost reduction. It strengthens the resilience of emission reduction strategies by enabling flexibility in feedstock sourcing, improving production efficiency, and reducing reliance on carbon credits. It also drives operational improvements that can deliver billions in savings and lower demand impacts. For the LAC region, leveraging these advancements through proactive policy, investment in demonstration facilities, and regional cooperation will be essential to achieve net-zero targets while safeguarding connectivity and economic growth. Without these measures, the region risks higher costs, reduced accessibility, and slower progress toward sustainability.

7.3.2.5 The balance of regional integration and realizing the domestic benefits of SAF

Given the wide variation in SAF production costs and feedstock availability across LAC countries, it is important to balance the potential benefits for individual countries with the opportunities that regional integration offers to lower costs and improve overall supply resilience. An important consideration is energy security, which in this context refers to ensuring that each country has reliable access to SAF without becoming overly dependent on imports or vulnerable to supply disruptions. Domestic production can provide economic value by creating jobs, stimulating investment, and reducing exposure to global price volatility, while regional approaches can enhance efficiency, distribute risk, and support a more stable market. Together, a balanced approach can help countries strengthen resilience against geopolitical risks and maintain long-term competitiveness in the aviation sector.

The figure below illustrates the differences between scenarios where the domestic SAF minimum, the share of SAF that must be sourced locally to meet a 50% blend target in 2050, is set at 0% versus 100%. In the scenario with no domestic minimum, SAF derived from sugarcane ethanol, industrial waste gas, and forestry residue through AtJ pathways is fully utilized across the region because these feedstocks offer the lowest abatement costs by 2050. However, industrial waste gas has limited availability, so sugarcane ethanol and forestry residue, alongside corn ethanol AtJ, dominate regional SAF use in this scenario. PtL SAF is not used in this case because its abatement cost remains higher than all other options.

Full regional integration results in crop-based SAF replacing all PtL and some advanced pathways, but may compromise energy security



Source: ICF analysis

When the domestic minimum is set at 100%, the picture changes significantly. Forestry residue and corn ethanol AtJ usage declines sharply because these resources are concentrated in specific countries. Agricultural residue AtJ, which is more evenly distributed across the region, becomes the dominant feedstock by 2050. Countries which lack sufficient HEFA or AtJ-compatible feedstock, rely heavily on PtL to meet their SAF demand.

The cost implications of these two scenarios are substantial. Achieving net-zero with a 50% SAF blend sourced entirely domestically would cost significantly more, 3.8 Bn USD higher in 2050, than a scenario with full regional integration. Moreover, disparities between countries become pronounced under a domestic minimum requirement. For example, Brazil's average SAF abatement cost in 2050 is about 33% lower than the regional average because of its abundant sugarcane ethanol supply, which offers the lowest abatement cost.

To balance these considerations, this analysis uses a 50% domestic minimum that allows countries to avoid excessive reliance on high-cost SAF while still distributing economic benefits and supporting energy security. Under this approach, SAF use across the region in 2050 is primarily driven by forestry residue, sugarcane ethanol, and agricultural residue AtJ, with smaller contributions from UCO, animal fats, industrial waste gases, MSW, and PtL scattered across different countries.

8 Closing statement

Air transport is a foundation of connectivity and economic growth in the LAC region. The region's expansive geography and dispersed communities make aviation indispensable for connectivity among families and friends, trade, tourism, and access to essential services. In 2023, the sector contributed 3.6% of GDP and supported nearly 3% of employment. Passenger demand is expected to grow steadily through 2050.

The aviation sector in the LAC region is committed to reducing emissions. Airlines in the LAC region have made significant investments and progress to reducing their emissions through levers such as fleet renewal and operational efficiencies. However, emission reduction goals must be balanced with safeguarding affordability and connectivity. Climate action cannot come at the expense of accessibility, as air transport remains vital for inclusive growth and competitiveness in a region where alternatives are limited and distances are significant.

Fleet is one of most effective measures to reduce emissions while growing the economy. Newer aircraft deliver notable improvements in fuel efficiency, operating costs, and environmental performance, producing benefits for both airlines and passengers. Maintaining momentum in fleet renewal will allow the region to continue reducing emissions intensity while supporting traffic growth. LAC air carriers have already committed substantial investments into fleet replacement strategies.

Operations efficiencies represent an immediate and cost-effective measure to reduce emissions but require collaboration across stakeholders and support from governments. Enhancing operations through aircraft efficiency and planning measures, airport and ground initiatives, and flight profile optimization offer meaningful savings in fuel and emissions. Achieving these improvements requires coordinated action from governments, ANSPs and airports, as well as investments in modernized systems and streamlined processes.

The most ambitious global pathways are unrealistic for the region. A regionally tailored approach is required to reach sustainability targets while preserving connectivity, reflecting the UNFCCC principle of common but differentiated responsibility. Out of sector measures and SAF strategies must reflect national realities, price sensitivity, and market maturity. High reliance on expensive abatement options could suppress connectivity in a region where passengers are highly price-sensitive and alternatives to air transport are limited. Pragmatic pathways are needed that balance in-sector measures with credible and well-regulated carbon credit mechanisms while maintaining connectivity and competitiveness.

SAF is one of the key in-sector measures with long-term potential for decarbonizing aviation, but several economic, technological, political and regulatory barriers must be solved. LAC has the potential to become an important part of the global SAF industry, leveraging local feedstocks, creating jobs, and improving fuel security. However, there is very little production in the region at the time of writing, with only a small volume of co-processing capacity and no stand-alone facilities. Reflecting the early development stage of the SAF industry in LAC, indicative price points have also been higher than comparisons in other regions. Scaling production will require supportive policies, investment in supporting infrastructure, and mechanisms to minimize the price impact on passengers. Regional focus and alignment with the requirements of export markets can provide the bankable demand needed to achieve the desired objectives. Regional integration of policy frameworks and sustainability standards could further improve market efficiency.

Several critical ecosystems are located in the LAC region, and preserving and restoring them is essential. The region hosts some of the world's most extensive and critical ecosystems, offering opportunities for high-quality offsetting and nature-based solutions that deliver environmental and social benefits. Well-designed and regionally integrated carbon markets can channel investment into conservation, biodiversity, and community development, while supporting the broader transition to sustainable aviation.

Delivering aviation emission reduction in the LAC region will require coordinated action across all stakeholders and must reflect regional realities. Operational improvements represent one of the most immediate and cost-effective opportunities, but unlocking these gains depends on closer collaboration between governments, ANSPs, airports and airlines. Over the longer term, emissions reductions will need to be supported by a balance between the gradual scale-up of SAF and the use of high-quality carbon credits. Given cost sensitivities and uneven market maturity, these pathways must be carefully calibrated to reduce emissions while preserving affordability, connectivity and competitiveness.

Appendix

Appendix

Appendix A: The role of co-processing

Co-processing is a technique within refinery operations that brings together renewable feedstocks such as waste oils, fats, and certain types of biomass with conventional fossil-based inputs to produce fuels exhibiting lower carbon intensity than standard jet fuel. The approach leverages existing refinery infrastructure and technology, thus allowing the energy sector to begin decarbonizing aviation fuel with comparatively modest modifications to their facilities. This method allows for incremental integration of renewable material into the fuel mix, which can be adjusted depending on feedstock supply, demand, and regulatory requirements. Co-processing offers several advantages compared to standalone SAF facilities:

1. By using current assets, refineries can avoid the substantial capital expenditures typically associated with building dedicated SAF facilities, facilitating more rapid adoption and scaling of production.
2. The flexibility of co-processing is further enhanced by its ability to accommodate a variety of renewable feedstocks, enabling facilities to respond to local resource availability and market fluctuations. Feedstocks for co-processing can include used cooking oils, animal fats, and agricultural residues, although their suitability depends on their chemical composition and processing requirements. The process contributes to a reduction in overall lifecycle greenhouse gas emissions.
3. Blending renewable and fossil-derived inputs enables refineries to optimize fuel production without disrupting established supply chains, making co-processing a pragmatic way to transition toward lower-carbon aviation fuels.

Despite these advantages, co-processing faces several limitations:

1. One primary constraint is the technical limitation on the proportion of renewable feedstock that can be incorporated into refinery streams. Excessive renewable content may affect catalyst performance, equipment integrity, and product quality, thereby restricting how much fossil fuel can be displaced. Currently co-processing is limited to 5% blend ratio of renewable feedstocks in a conventional petroleum refinery. There is undergoing work on evaluating the increase of this blend share from 5% to 30%, increasing the potential co-processing volume further[1]. However, even with this potential increase (still under evaluation), the SAF quantities produced through co-processing will be limited.
2. Despite the lower capital requirements and production cost, co-processed SAF is still affected by market dynamics and **its price to airlines remains high compared to fossil jet fuel** (at least 3 to 4 times higher currently).
3. Certification and traceability requirements introduce additional complexity, as robust systems must be in place to document the origin, blending ratio, and processing details of renewable inputs to meet sustainability standards and regulatory frameworks. These tracking needs are especially important for ensuring that co-processed SAF meets international specifications required for aviation use.
4. Lifecycle emission accounting is another challenge for co-processing. The mixing of various carbon sources introduces uncertainty in quantifying net emissions reductions and can complicate compliance with environmental reporting obligations. The overall sustainability impact of co-processing is closely linked to the characteristics and sourcing of renewable feedstocks. **Some feedstocks, such as certain types of vegetable oils or biomass, may present indirect sustainability risks, including land-use change, biodiversity impacts, and resource competition with other industries.**
5. Technical integration of renewable materials may require modifications to refinery operations, such as changes to catalyst selection, adjustments in process conditions, and enhanced maintenance practices. These operational complexities can result in additional costs and necessitate ongoing staff training and expertise development.

6. Because co-processing produces a fuel containing both renewable and fossil components, and can currently only be blended at 5%, the potential emissions reductions are inherently limited relative to 100% renewable SAF pathways. This positions co-processing as a transitional solution, suitable for near-term carbon intensity reductions but unlikely to deliver the deep emissions reduction needed to meet long-term aviation climate goals.

Overall, co-processing provides a pathway for refineries to begin producing SAF at scale and to make incremental progress toward sustainability objectives. Its main strengths are the ability to utilize existing assets, respond flexibly to feedstock markets, and facilitate a smoother transition from fossil-based fuels to renewable alternatives. The approach also supports early market penetration of SAF and enables refineries to meet emerging regulatory and market pressures for lower-carbon aviation fuels. However, as industry standards evolve, and as the supply and viability of renewable feedstocks improve, dedicated production platforms capable of generating SAF from 100% renewable inputs are expected to become increasingly important in achieving widespread, long-term reductions in aviation emissions.

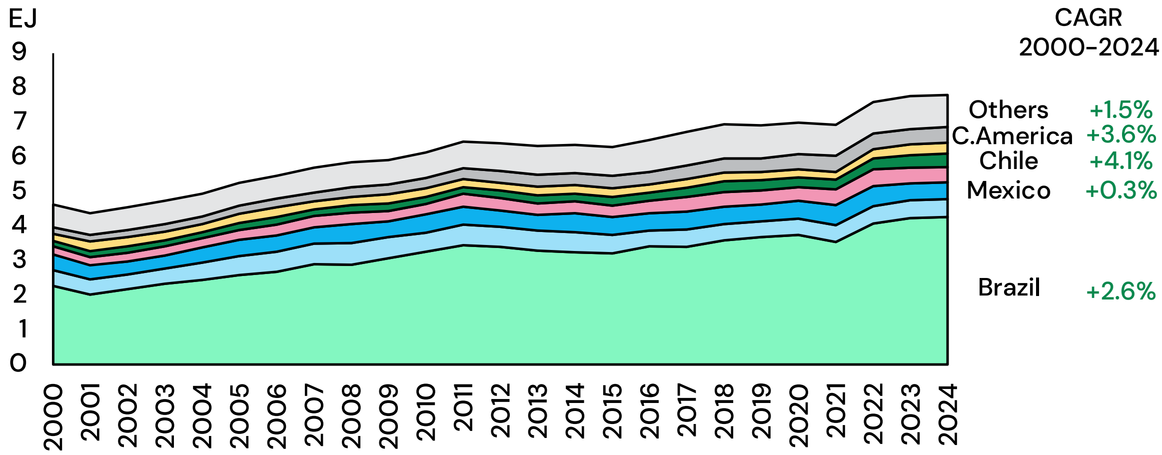
Appendix B: Renewable electricity landscape and potential for PtL in the region

The LAC region has established itself as a renewable energy leader, with renewable and hydroelectric sources accounting for 62% of total electricity generation in 2024[396]. This substantial renewable penetration in electricity generation significantly exceeds the global average of 32%, positioning the region as a model for clean energy transition and suggesting strong potential for scaling SAF that depends on renewable electricity.

Since 2000, the region's renewable capacity has expanded at an average annual rate of 2.9% dominated by Brazil. Brazil has been contributing more than half of the region's renewable power supply over the past two decades.

In 2024, renewables accounted for 87% of Brazil's electricity generation - nearly three times the global average of 32%. This high share of renewable power indicates that Brazil, and potentially other countries in the region, could play a role in enabling PtL SAF pathways in the longer term, given their requirement for large volumes renewable electricity.

Renewable power supply in the LAC region has been growing steadily historically (2000-2024)



Source: Energy Institute, ICF analysis

Brazil's success in reaching such a high share of renewables is primarily due to its robust hydroelectric base and the rapid expansion of solar and wind power in recent years. The share of hydro has fluctuated from year to year over the past decade amid varying weather conditions, standing at 55% of Brazil's electricity in 2024 compared to 63% on average in 2013[397]. Meanwhile, the share of wind, solar and other renewables has been growing rapidly in recent years, reaching 32% in 2024. Countries such as Chile and Colombia have also reported major growth since 2000. These trends highlight the potential for several LAC countries to leverage their growing renewable capacity for SAF production in the future, both for domestic use and export-oriented projects.

Despite improvements in electricity infrastructure and the growing integration of renewable power, access to electricity remains a challenge in the region. In 2023, the overall electricity access stood at 97%, with a few countries reaching close to 100%[398]. However, some areas still face challenges with the coverage and quality of the service, with rural areas and underprivileged neighborhoods often experiencing unreliable access to electricity. Central America and the Caribbean, for example, have below-average electricity access rates of about 92% and 83% respectively, while the access rate growth across the region has not improved for the past decade.

[396] Energy Institute Statistical Review of World Energy, 2025
[397] https://ember-energy.org/latest-insights/brazil-rises-as-g20-renewables-powerhouse/
[398] https://www.iea.org/commentaries/bottom-up-energy-transitions-managing-the-rise-of-energy-communities-in-latin-america

Electricity network losses for the region average 16%, as opposed to 6% for OECD countries. In 2019, power outages were estimated to last 16 times longer than in the European Union and occur 10 times more frequently, while widespread illegal grid connections in urban areas continue to drive non-technical losses. Overcoming these constraints will be essential if renewable electricity is to move beyond meeting basic needs and support transformative technologies such as PtL SAF.

The LAC region's high share of renewable electricity provides a strong foundation for the energy transition and indicates potential to support future SAF production, particularly through PtL pathways that depend on renewable electricity. This is further emphasized by some countries already establishing PtL SAF ambition, for example Chile, indicating the region's desire to leverage the renewable electricity potential[399]. **Realizing this potential will require ongoing improvements in grid reliability, diversification of renewable sources, and careful alignment between energy sector developments and emerging fuel production needs.**

[399] https://vuelolimpio.cl/wp-content/uploads/2024/10/Chile_SAF_Roadmap_2050_.pdf

Appendix C: Elasticity analysis

To project long-term traffic growth and assess potential demand changes resulting from ticket price increases associated with carbon reduction measures, this study relies on elasticity estimates produced by the Universidad de San Andrés (UdeSA). The study provides region-specific estimates of how air travel demand responds to changes in ticket prices and income levels.

In the context of aviation demand modelling, two types of elasticities are particularly relevant. Price elasticity of demand measures how passenger volumes respond to changes in airfares, while income elasticity of demand captures how air travel demand evolves as economic activity grows. These parameters allow traffic projections to incorporate both macroeconomic growth and potential demand reductions resulting from higher ticket prices.

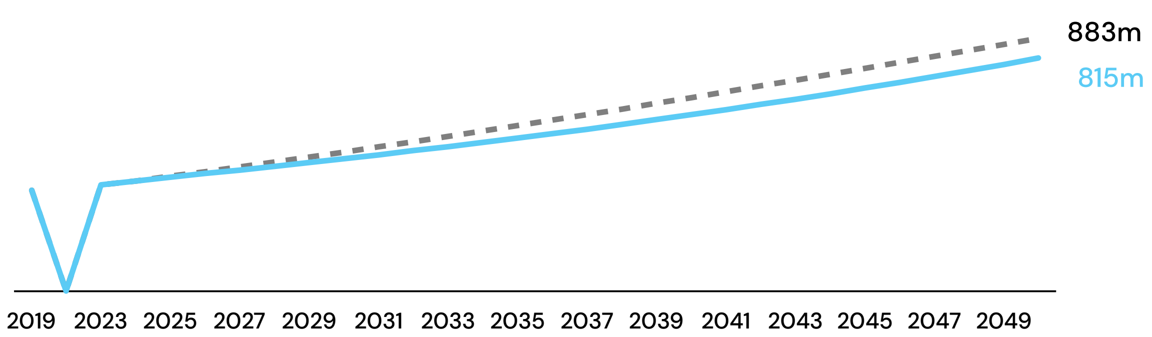
The UdeSA study estimates these elasticities using a route-level econometric model based on a log-log specification, which allows the estimated coefficients to be interpreted directly as elasticities. The analysis is conducted using a panel dataset covering the period 2014–2024 (excluding 2020) at a monthly origin-destination route level. Markets are defined as airport-pair and month combinations, allowing the model to capture both route-specific characteristics and seasonal variations in demand. The dataset combines detailed air transport data provided by ALTA with additional information from Cirium and international macroeconomic sources. Key aviation variables include passenger volumes, average fares, RPKs, ASKs, seat capacity, aircraft type, and point-of-origin passenger shares, aggregated by airline, route, and month. Macroeconomic variables such as GDP per capita and population are sourced from the IMF World Economic Outlook database to ensure comparability across countries.

Because airline pricing decisions may respond to demand conditions, the study addresses potential endogeneity between fares and passenger volumes using an instrumental variable approach. In particular, jet fuel prices sourced from S&P Global Energy (interacted with route distance) are used as cost-based instruments to isolate exogenous variations in fares that are unrelated to short-term demand fluctuations. Additional controls, including seasonal indicators, macroeconomic variables, and measures of market competition, are incorporated to ensure robust estimation.

The estimation produces both price elasticities and income elasticities for the region. For comparison purposes, this analysis also references earlier elasticity estimates published by IATA in a global study conducted in 2008. However, these values are used only as an indicative benchmark, as the IATA estimates were derived using a different methodology and dataset.

Regionally tailored income elasticity analysis results in 7.7% lower yearly departing passengers by 2050

Departing air passenger traffic forecast (million per year)

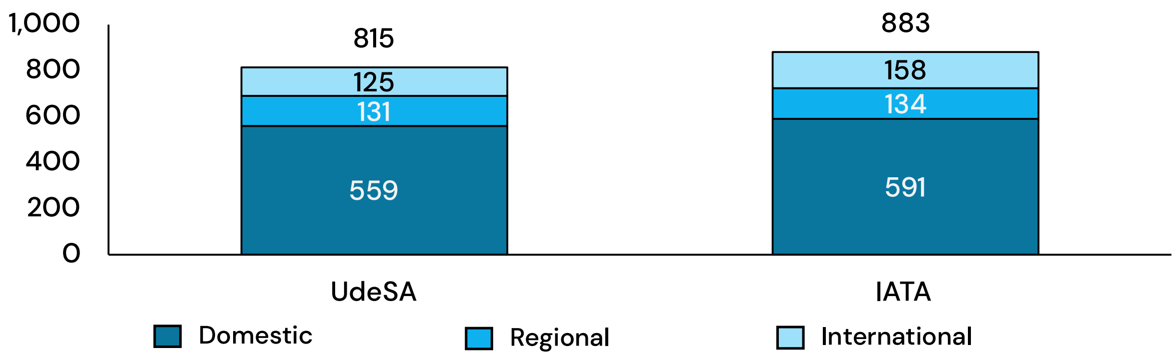


Source: IATA, UdeSA, ICF analysis

Applying the IATA elasticity parameters results in a projected traffic level of approximately 883 million departing passengers from the LAC region by 2050. Using the region-specific elasticities estimated by UdeSA yields a slightly lower projection of around 815 million departing passengers, reflecting the higher price sensitivity identified in the regional econometric analysis.

International traffic is impacted the most by applying regionally tailored income elasticity, with a decrease of 21% compared to using IATA global elasticity values

Departing air passenger by destination category (million per year - 2050)



Source: UdeSA, IATA. ICF analysis

Because the UdeSA estimates are derived from a dataset specifically covering Latin America and the Caribbean and incorporate more recent market conditions, they are used as the primary elasticity inputs for this study.

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