WORLD ECONOMIC FORUM

Global Aviation Sustainability Outlook 2025

WHITE PAPER

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Images: Getty Images

Contents

Foreword

Gim Huay Neo
Managing Director and Head, Centre for Nature and Climate, World Economic Forum

This year marks an important moment for the aviation sector's journey to net zero. Updated national action plans on how countries intend to decarbonize aviation need to be submitted to the International Civil Aviation Organization (ICAO) by the next general assembly in September.

As part of those decarbonization plans, the first few sustainable aviation fuel (SAF) mandates in Europe came into force in January – with increasingly tough targets up to 2030. Over the coming months, more SAF plants will look to make their final investment decision and potentially progress to construction. Expectations for economy-wide decisions at COP30 in October are also high, with the aviation and clean fuels agenda playing an increasingly prominent role in multilateral events, including the G7 and G20.

The actions that industry and governments across the world take this year will be vital to ensure the aviation sector remains on the right flight path to meet internationally agreed targets, with no countries or regions left behind in the quest for sustainability. The global vision agreed through ICAO means that, within five years, the carbon intensity of jet fuel will have to reduce by 5%. Looking ahead 25 years, ICAO's long-term "aspirational goal" is net-zero international aviation by 2050.

However, the sector is also poised to grow significantly by that date. Aviation executives are increasingly facing trade-offs between sustainability and growth, and both these are affected by the constantly evolving geopolitical context, with increased conflicts, looming trade barriers and recent elections across the globe affecting air traffic, policy, investment and feedstock flows. These events are impacting the dynamics between countries and the opportunities for collaboration at a time when such cooperation is critical for the low-carbon transition. In this important year for aviation sustainability, the World Economic Forum aims to foster the international action and collaboration needed between governments, aviation stakeholders and the wider value chain to accelerate industry's transition to net-zero aviation and ensure sustainability remains paramount in the sector's quest for growth.

The aviation industry has demonstrated its ability to transform and adapt, by overcoming some of the challenges that have affected the sector in recent years, from safety issues to supply chain constraints and long-COVID impacts. How can this spirit of resilience be funnelled towards fuelling greater sustainability and how can momentum for sustainable aviation be maintained as the sector expands? Which priorities and actions can be taken forward? Which risks should public-private collaboration focus on this year to accelerate progress towards decarbonization?

These are some of the questions we posed to Chief Executive Officers from the World Economic Forum's aviation community in late 2024 and early 2025. Their views have informed this new flagship report that aims to set the scene for discussions over the year ahead. Our assessment, which we plan to publish regularly in this format, reviews key market developments and complements them with stakeholders' perspectives and priorities. Our aim is to capture the evolution of aviation executives' views over time and to inform ongoing opportunities for public-private collaboration.

Justin Erbacci
Director General, Airports
Council International World

In 2024, the aviation industry reached a significant milestone, with global passenger traffic not only recovering but also surpassing the pre-pandemic levels of 2019, marking a new era of growth. Airports play a key role in the aviation sector, directly employing 11.6 million people worldwide. As enablers of a sustainable aviation ecosystem, airports are focused on reducing energy demand, improving efficiency and supporting the deployment of SAF.

However, challenges remain. Governments, energy producers and the finance sector must accelerate SAF adoption through targeted policies and investments. Transparent traceability systems are crucial and governments must integrate aviation's clean energy needs into national policies, ensuring access to green energy. Infrastructure development for climate resilience, backed by financial mechanisms, is also vital.

We are committed to collaborating with industry partners in 2025 and beyond in building a sustainable aviation future.

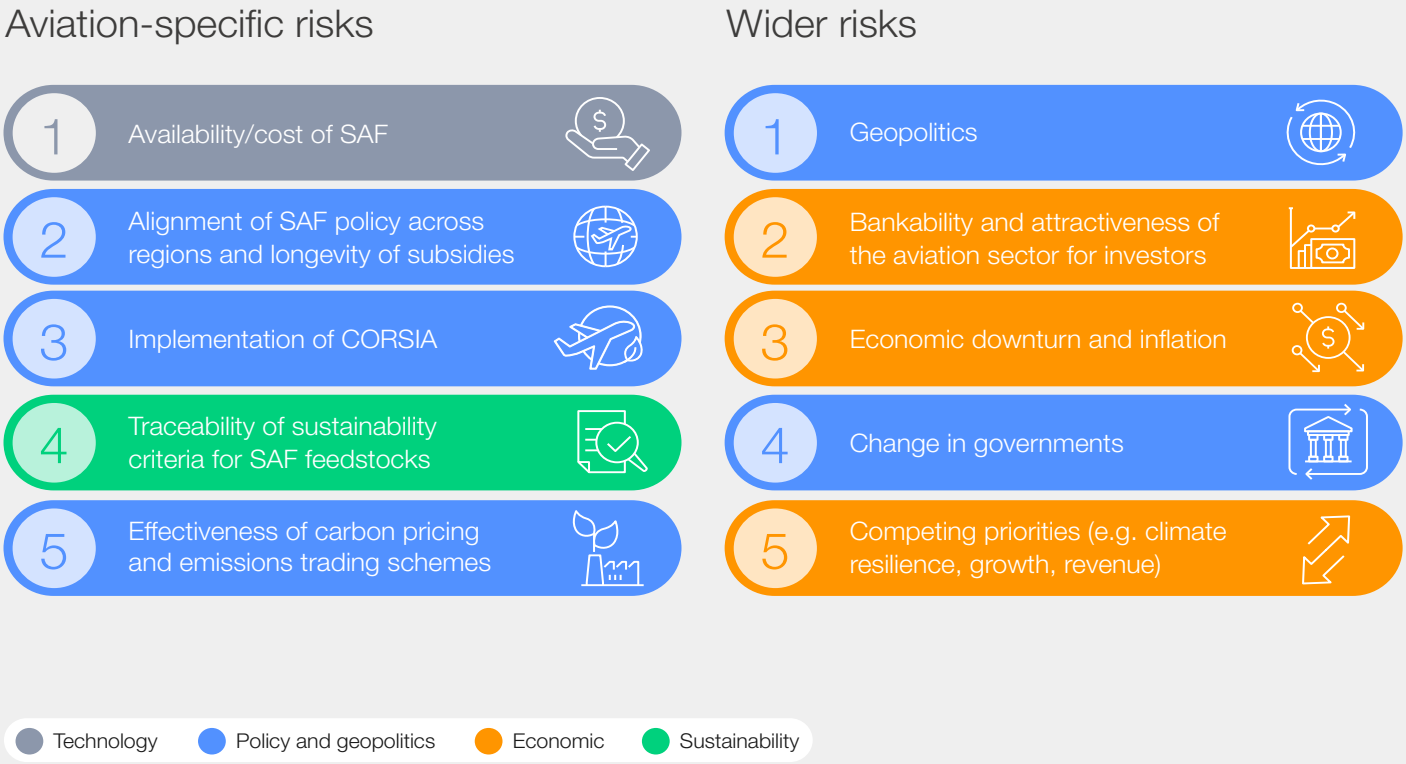
Executive summary

Aviation's journey towards net zero faces numerous economic, technological and geopolitical risks, but the main challenge for 2025 is the availability and cost of sustainable aviation fuel.

The aviation sector is at a critical juncture in 2025, as updated state action plans for decarbonization are due to be submitted to the International Civil Aviation Organization (ICAO). Industry stakeholders are increasingly looking to advance aviation decarbonization activity in tandem with boosting growth post COVID-19, but a number of challenges are affecting progress on sustainability. This year's actions by industry and governments are vital to meeting internationally agreed targets and ensuring no regions are left behind in the transition to net-zero aviation.

This report, produced by Airports of Tomorrow – a World Economic Forum initiative bringing together leaders from across the aviation industry – aims to provide an overview of the top risks and opportunities affecting aviation decarbonization progress in 2025, as perceived by industry members. The goal is to accelerate actions that the aviation industry can take forward on SAF, battery-electric and hydrogen aviation to achieve a net-zero aviation industry by 2050. Airports of Tomorrow C-suite stakeholders were surveyed and interviewed to capture perspectives, opportunities and risks concerning this year's progress on decarbonizing aviation.

FIGURE 1 **Top-10 risks affecting aviation decarbonization progress**



Note: SAF = sustainable aviation fuel, CORSIA = Carbon Offsetting and Reduction Scheme for International Aviation.

Source: World Economic Forum.

TABLE 1 | **Top-10 risks affecting aviation decarbonization progress**

Aviation-specific risks	Wider risks
1 **Availability and cost of SAF** are the biggest challenges for aviation decarbonization in 2025. Airlines need to commit to long-term SAF offtake agreements but de-risking mechanisms are vital as the risks of advanced SAF production technologies and varying regional policies pose significant hurdles. More corporate involvement and favourable policies are essential to attract capital and support SAF projects globally.	1 **Geopolitics** is the top non-sustainability challenge affecting progress on decarbonizing aviation. The withdrawal of the US from the Paris Agreement in early 2025 and the "America First" trade policy are being closely monitored by the aviation community, as increasing protectionism and tariffs pose significant risks. Geopolitical tensions are destabilizing feedstock exports and fuelling domestic energy security concerns. International scrutiny on fairness and competitiveness adds to the complex dynamics at play.
2 **Alignment of SAF policies across regions and longevity of subsidies** are crucial for encouraging investment and ensuring consistent SAF adoption across regions. In 2024, Asia Pacific emerged as a key market: several countries introduced supportive policies, while China is expected to unveil detailed SAF policies this year. Brazil and Chile have established national SAF programmes and partnerships. Oman and Saudi Arabia are formulating strategies for SAF development. Europe has strong SAF policies but faces competition from emerging markets with competitive feedstock advantages. In the US, the future of SAF incentives remains uncertain due to political changes. Patchy policy frameworks and varying sustainability standards pose challenges: consistent, aligned policies are needed to support global adoption of SAF and ensure progress towards decarbonization.	2 **Bankability and attractiveness of the aviation sector for investors:** aviation is not seen as a priority sector for investment by the financial community, despite needing significant capital to meet decarbonization goals. Multiple aviation technologies (e.g. SAF, hydrogen, eVTOLs) are looking to secure capital, with the first large investments in SAF in 2024 and increasing momentum for eVTOLs. Technology challenges and regulatory pressures persist, influencing whether and how investments in aviation decarbonization technologies are being made and perceived by the financial community.
3 **Implementation of CORSIA:** effective implementation of ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is essential for standardizing carbon reduction efforts and ensuring global compliance. Despite positive momentum, with more countries joining and new carbon credit programmes approved, challenges remain due to non-participation of major countries.	3 **Economic downturn and inflation:** despite easing inflationary pressures and encouraging profitability figures, the global economic outlook remains a concern for aviation executives, particularly in emerging markets. Rising costs in labour, supply chain bottlenecks and regulatory uncertainty are impacting profitability and affecting the sector's focus on the net-zero agenda.
4 **Traceability of sustainability criteria for SAF feedstocks:** as aviation's reliance on SAF increases, scrutiny on the sustainability credentials of feedstocks will intensify. Concerns around land-use change, deforestation, poor agricultural practices, food security and biodiversity impacts have led to regulatory restrictions and bans on certain biofuels. Improved transparency and research, along with consistent sustainability standards, are essential to address these risks and support the development of alternative SAF production pathways.	4 **Change in governments:** following a year of "super elections", stakeholders are concerned about changing government priorities, policy U-turns and the longevity of incentives that could impact aviation decarbonization. Some countries, like the United Kingdom, have accelerated towards sustainable aviation, but this is not the global trend. Elections this year in Australia, Canada, Germany, Singapore and Latin America could further influence aviation policies.
5 **Effectiveness of carbon pricing and emissions trading schemes:** airlines will need to navigate both CORSIA and local emission trading schemes, with varying regional policies and the inclusion of non-CO_2 emissions adding complexity and potential compliance costs.	5 **Competing priorities:** as the sector looks to grow further in terms of passenger numbers, connectivity and profitability, the decarbonization agenda faces challenges to ensure aviation's expansion can be sustainable and can attract the capital needed to scale-up new technology and meet decarbonization goals, in an increasingly competing environment. Profitability, growth, climate resilience and consumer experience improvements are critical areas of focus for Airports of Tomorrow stakeholders, affecting how aviation executives see and prioritize the decarbonization agenda across regions.

Note: These risks are based on responses to the survey of aviation executives conducted for this report.

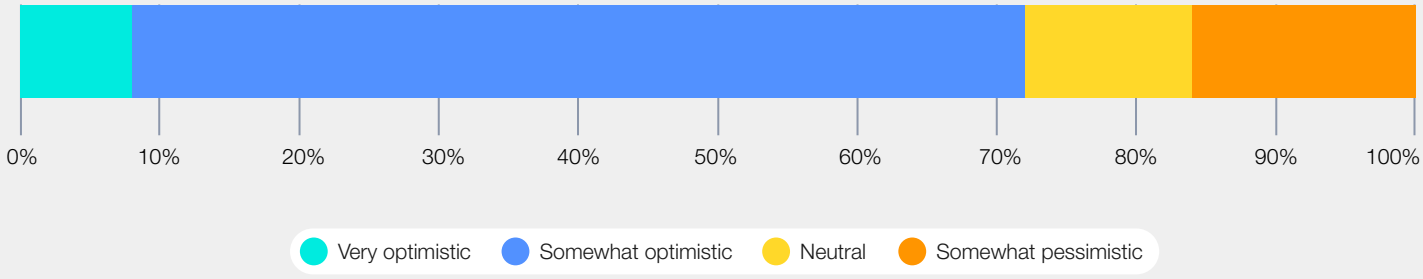
1 Cautious optimism

Expectations are high for a year of climate action in 2025 to ensure the decarbonization vision for 2030 of the International Civil Aviation Organization can be achieved.

During the last quarter of 2024, the World Economic Forum surveyed the views of around 30 C-suite executives from the aviation community. Despite headwinds last year – including SAF plant closures, scrapped projects and delays in policy guidance and incentives – executives were cautiously optimistic. More than two-thirds of respondents were confident that the momentum for aviation decarbonization will continue in 2025, with a minority voicing neutral or negative expectations for the year ahead (see Figure 2).

FIGURE 2 **Optimism about progress on decarbonization**

Looking ahead at 2025, how optimistic are you that the aviation sector will make meaningful progress towards decarbonization?



Source: World Economic Forum.

More than two-thirds of respondents to the Forum's C-suite survey were confident that the momentum for aviation decarbonization will continue in 2025.

Industry leaders flagged some developments as particularly promising:

- The second half of 2024 saw notable breakthroughs in technology development and investment, with significant capital raised by SAF start-ups.
- SAF production doubled from 2023 to 2024 and is expected to double again in 2025.[1]
- After several election cycles across the globe, more administrations are introducing new SAF policies or strengthening existing policies – the new government in the United Kingdom boosted support for SAF within weeks of taking office.

Respondents were also largely optimistic about the feasibility of the 2030 vision agreed at the third Conference on Aviation and Alternative Fuels (CAAF/3), convened by the International Civil Aviation Organization (ICAO) in Dubai in November 2023 (see Box 1 and Figure 3). However, a minority of respondents remain pessimistic about the sector's ability to reduce the carbon footprint of aviation fuels by 5% by the end of the decade.

BOX 1 **Decarbonization vision of the International Civil Aviation Organization (ICAO)**

Net zero by 2050:
At the 41st ICAO Assembly in October 2022, delegates from 184 member states of ICAO and 57 organizations adopted a collective long-term global aspirational goal (LTAG) of net-zero carbon emissions by 2050. This goal will be achieved through accelerated adoption of new and innovative aircraft technologies, streamlined flight operations and increased production and deployment of sustainable aviation fuels (SAF).

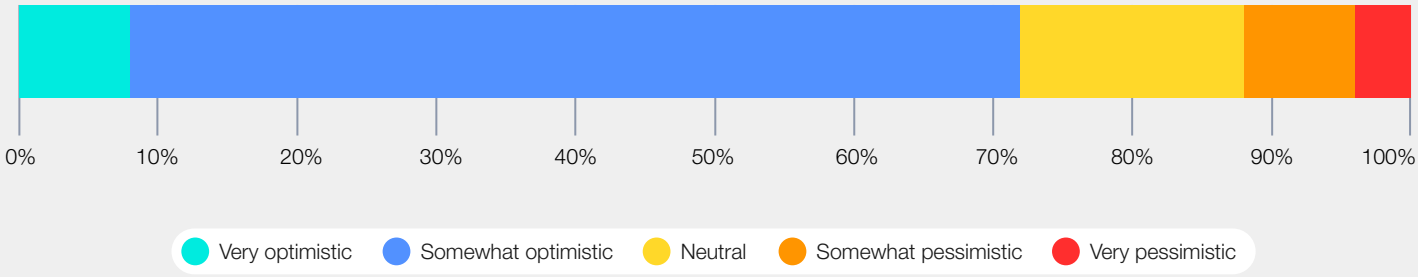
5% reduction in carbon emissions from aviation fuel by 2030:
At the third ICAO Conference on Aviation and Alternative Fuels (CAAF/3), in Dubai in November 2023, over 100 member states adopted a new *ICAO Global Framework for Sustainable Aviation Fuels (SAF), Lower Carbon Aviation Fuels (LCAF) and other Aviation Cleaner Energies*, which aims to reduce CO_2 emissions in international aviation by 5% by 2030, compared to zero cleaner energy use.

CORSIA:
The Carbon Offsetting and Reduction Scheme for International Aviation was adopted by ICAO in 2016 to achieve carbon neutral growth from 2020. The global market-based scheme requires airlines to offset any increase in CO_2 emissions above 2019 levels. CORSIA's pilot phase began on 1 January 2021 and it will become mandatory for all countries in 2027.

Source: ICAO.[2]

FIGURE 3 **Optimism that ICAO's 2030 vision will be achieved**

How optimistic are you that the 2030 vision agreed at CAAF/3 last year will be achieved?



Note: CAAF/3 = Third Conference on Aviation and Alternative Fuels, convened by the International Civil Aviation Organization (ICAO) in Dubai in November 2023.
Source: World Economic Forum industry survey.

The next ICAO General Assembly in September 2025 will be an important moment to assess industry optimism around the long-term global aspirational goal for net-zero carbon emissions by 2050.

The next ICAO General Assembly in September 2025 will be an important moment to assess industry optimism around the 2030 vision and whether the long-term global aspirational goal (LTAG) for net-zero carbon emissions by 2050 will remain the north star guiding countries ahead. Several of the stakeholders interviewed would like to see renewed support for ICAO from all countries, with a particular focus on supporting the Global South to achieve a just and equitable transition.

ICAO's General Assembly will not be the only international event under scrutiny this year. November's COP30 in Brazil represents a major moment to advance climate negotiations on the back of developments during COP29 in Baku and the submission of updated nationally determined contributions (NDCs) during 2025. While aviation has traditionally taken up limited space during recent conferences of parties, COP29 saw a multitude of aviation-related events and conversations spurred by key developments in international negotiations.

In Baku, both the agreement of a new collective quantifiable goal – aiming to scale-up at least $1.3 trillion of public-private financing for developing countries by 2035 – and the adoption of final Article 6 rules have implications on aviation. The former led to multiple calls for implementing a global solidarity levy on aviation and shipping fuels (see Chapter 3.3),[3] while the latter paved the way for a smoother implementation of ICAO's CORSIA scheme by clarifying rules on corresponding adjustments for the use of carbon credits as mitigation measures in aviation, while avoiding double counting towards an NDC.

As aviation and climate negotiators convene in international forums during this pivotal year for climate action, several surveyed CEOs highlighted the need for governments to agree on a consistent aviation decarbonization approach across countries and to establish a clear path to carbon emissions reduction targets already set, potentially through the introduction of interim milestones on the journey to the 2030 ICAO vision and 2050 long-term aspirational goal, so as to better guide industry and investors.

However, not all respondents were supportive of additional milestones or targets, given the increasing fatigue around sustainability targets that emerged at the end of last year. Some executives warned about setting targets without supporting actions.

Chapter 2 explores some of the more significant enablers proposed by industry leaders, such as global standardization of SAF sustainability criteria, regulatory standards building on CORSIA and the adoption of global de-risking mechanisms for SAF.

> **The aviation industry's journey towards net zero is a testament to the power of innovation and collaboration. At EcoCeres, we are committed to scaling SAF production through cutting-edge technologies and strategic partnerships, ensuring that cost and availability no longer hinder progress. As updated state action plans are submitted to ICAO, it is imperative that governments, industry leaders and innovators work hand-in-hand to accelerate decarbonization efforts. Together, we can turn these challenges into stepping stones, ensuring a sustainable future for aviation and leaving no region behind in the transition to net zero.**
>
> Matti Lievonen, Chief Executive Officer, EcoCeres

2 Sustainability risks

SAF availability and incentives remain top priority, as momentum for other levers reduces.

The Forum's survey of aviation executives asked them to rank the immediate risks directly affecting progress on aviation decarbonization, according to their impact. Three main groups of challenges were identified around technology, policy and geopolitics and sustainability (see Figure 4).

FIGURE 4 **Top 10 aviation-specific risks affecting decarbonization progress**

Source: World Economic Forum industry survey.

2.1 Technology challenges

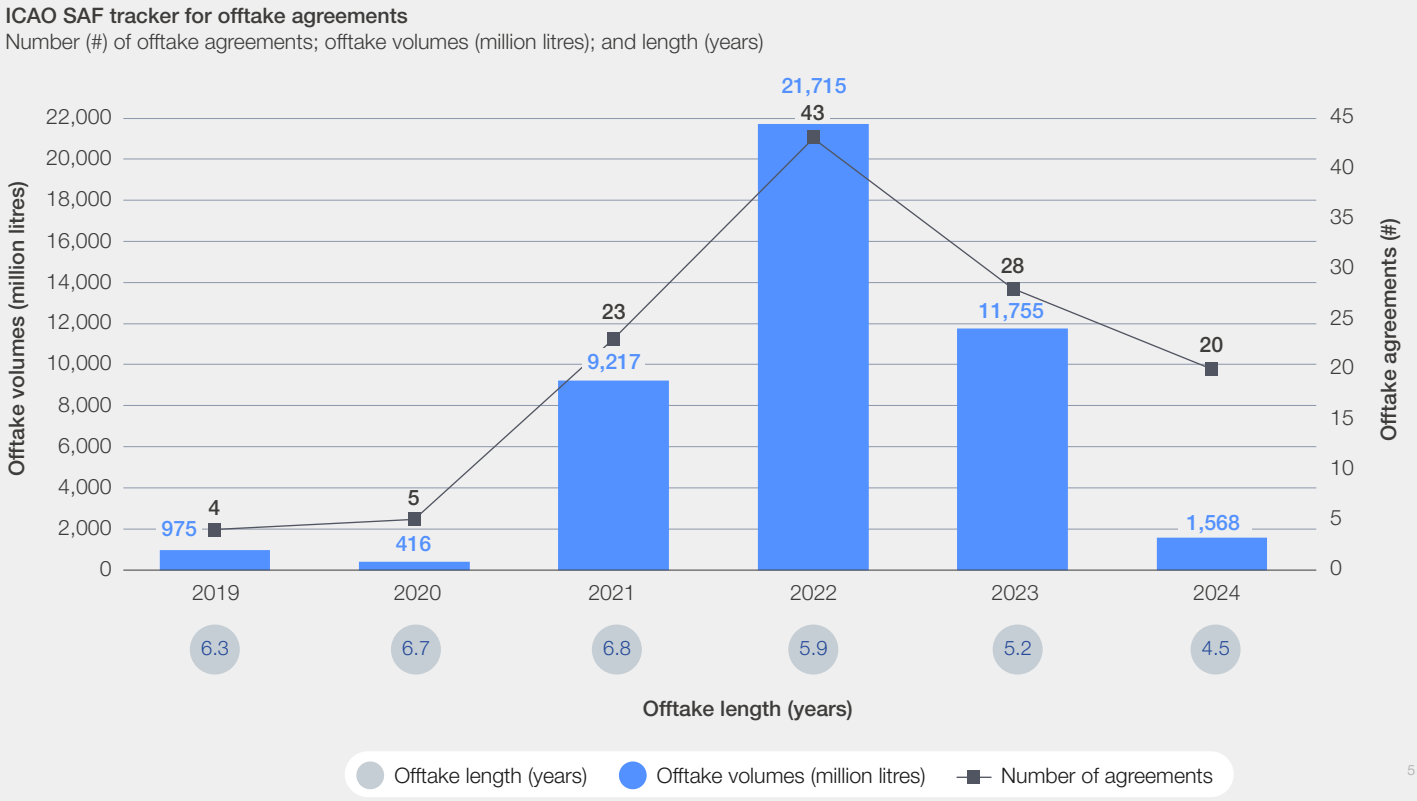
> ICAO's online tracker of SAF offtake agreements shows that the number of agreements, as well as their volume and average tenor, has been reducing since they peaked in 2022.

Availability and cost of SAF

Executives highlighted the availability and cost of SAF as the biggest challenge affecting progress on decarbonizing aviation during 2025. Many airlines typically highlight SAF's availability and price as the key obstacles preventing them from signing firm, long-term offtake agreements; equally, investors view such offtake agreements as a "must have" before providing SAF plants with the capital they need to develop. The challenge is that the airline business is known for its small margins – and the COVID-19 pandemic resulted in significant losses and bankruptcy risks that threatened the growth of the sector and exacerbated its traditionally low creditworthiness.

ICAO offers an online tracker of SAF offtake agreements, which shows that the number of agreements, as well as their volume and average tenor, has been reducing since they peaked in 2022 (see Figure 5).[4] While data should be interpreted cautiously, as offtake agreements are usually multi-year and thus may not need re-signing on a yearly basis, there is a clear downward trend in the willingness to enter long-term deals. This is particularly true in emerging aviation markets looking to grow, such as Asia Pacific, the Middle East and Latin America, where carriers fear the higher ticket prices could have a big impact on competitiveness at a key growth moment.

FIGURE 5 **Number, volumes and tenor of SAF offtake agreements, tracked by ICAO**



Source: ICAO.

Both SAF's availability and costs, however, are on a positive trajectory, at least for HEFA (hydrotreated esters and fatty acids), after substantial market developments in 2024. The Forum's 2025 white paper *Financing Sustainable Aviation Fuels: Case Studies and Implications for Investment* highlights that production capacity is expected to have reached 4.4 million tonnes per year (Mt/a) in 2024, doubling 2023's capacity.[5] Even so, demand is expected to outstrip supply by 2030. The price premium of SAF has also been reducing throughout 2024, at least in Europe, where the average cost differential between HEFA and conventional jet fuel has fallen from approximately 2x in September 2023 to 1.2x in November 2024.[6] Where balance sheets allow it, some airlines are signing long-term contracts for SAF offtakes or taking an equity stake in developing SAF projects, demonstrating a willingness to invest and pay the SAF premium.

A combined net profit of $30.5 billion and a record number of passengers are expected for 2024, while revenue is forecast to top $1 trillion for the first time in 2025.

The overall profitability of airlines is also increasing, according to the International Air Transport Association (IATA). A combined net profit of $30.5 billion and a record number of passengers are expected for 2024,[7] revenue is forecast to top $1 trillion for the first time in 2025, while growth forecasts up to 2050 are bullish, especially in emerging aviation markets such as China and India. Some stakeholders therefore challenge the view that SAF is either too scarce or too pricey to purchase – they claim that a weak demand signal from buyers is the reason why more SAF is not currently used. However, given the sector's low margins (IATA expects an average of $7 net profit per passenger in 2025), there is widespread acceptance that additional investment and de-risking mechanisms for SAF are needed before airlines can show more commitment.

Another challenge is that there is still a limited number of advanced SAF production technologies reaching financial investment decision worldwide, which in turn constrains the quantity of available suppliers. While investment in new HEFA capacity has continued throughout 2024, numerous projects in Europe and the US were paused or dropped during 2024 amid technical challenges. Similarly, some power-to-liquid projects were scrapped amid lack of demand or limited returns, even though the oil and gas sector distributed over $200 billion in dividends globally in 2024.[8,9] Meanwhile, a couple of advanced low-carbon fuels projects went bust and some energy players exited the SAF production market to focus on potentially more profitable activities such as supply and resale.

Role of corporate buyers and partnerships

With this chicken-and-egg situation persisting for a number of years, several stakeholders have highlighted the role corporate buyers (i.e. not airlines) can play in unlocking progress and stepping in to support both airlines and SAF suppliers. With the latest global election cycle generating policy uncertainty (see Chapter 3.1), private-sector initiatives and strong, voluntary commitments from scope 3 buyers could be powerful tools to attract capital towards SAF projects. An increasing number of corporates, including members of the Forum's First Movers Coalition, concluded their first procurements of SAF in 2024.

It is often where some of these private sector partnerships with investors and companies are in place that SAF projects are breaking ground: for example, developers like LanzaJet, Infinium and Twelve managed to secure a combined investment of up to $1.8 billion through such partnerships during 2024.

> **While airline and corporate investments in technology are valuable, committing to SAF through long-term offtake agreements is essential for financing projects and achieving scale. These offtake agreements not only provide the financial stability needed to accelerate production of SAF, but also play a key role in the trajectory of driving down cost over time by being a catalyst in moving projects forward.**
>
> Robert Schuetzle, Chief Executive Officer, Infinium

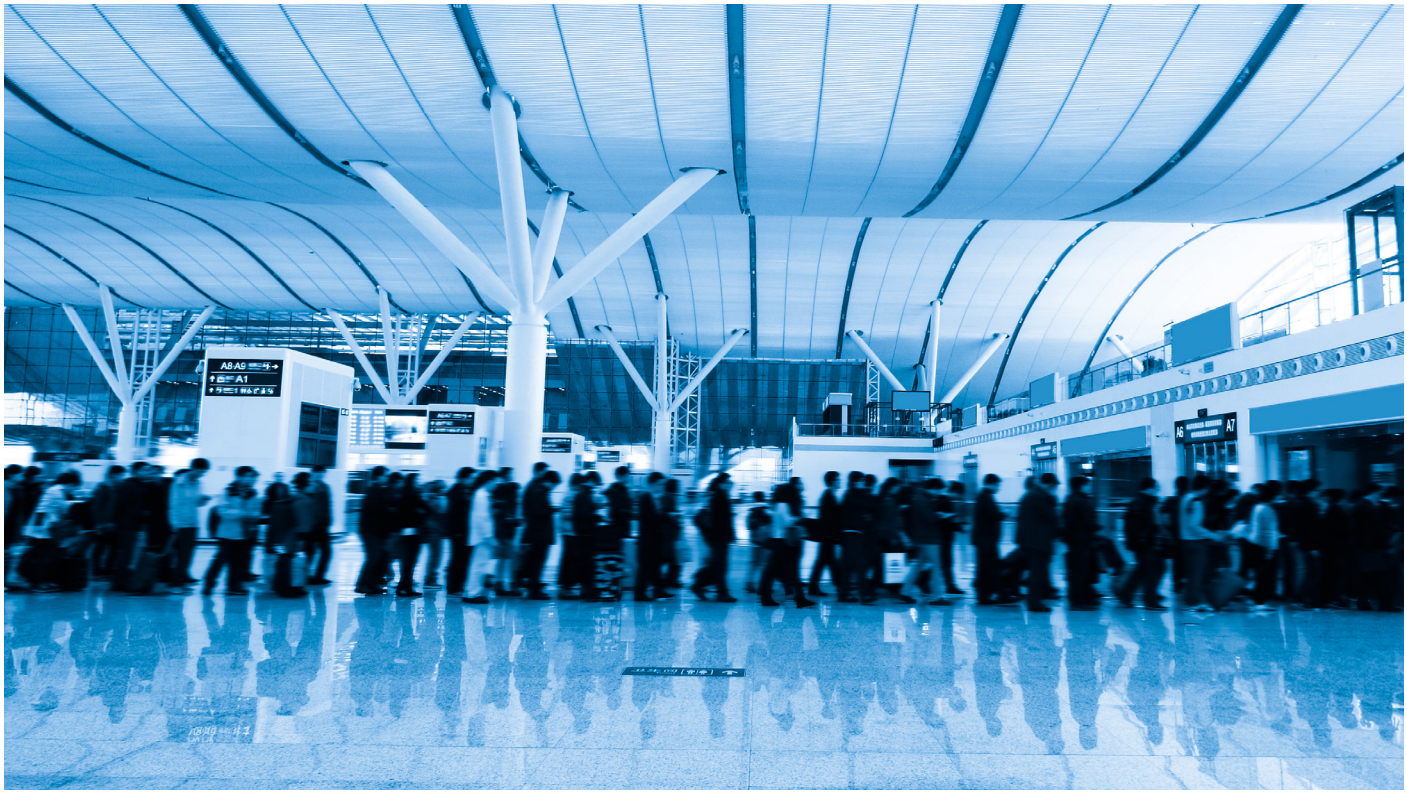
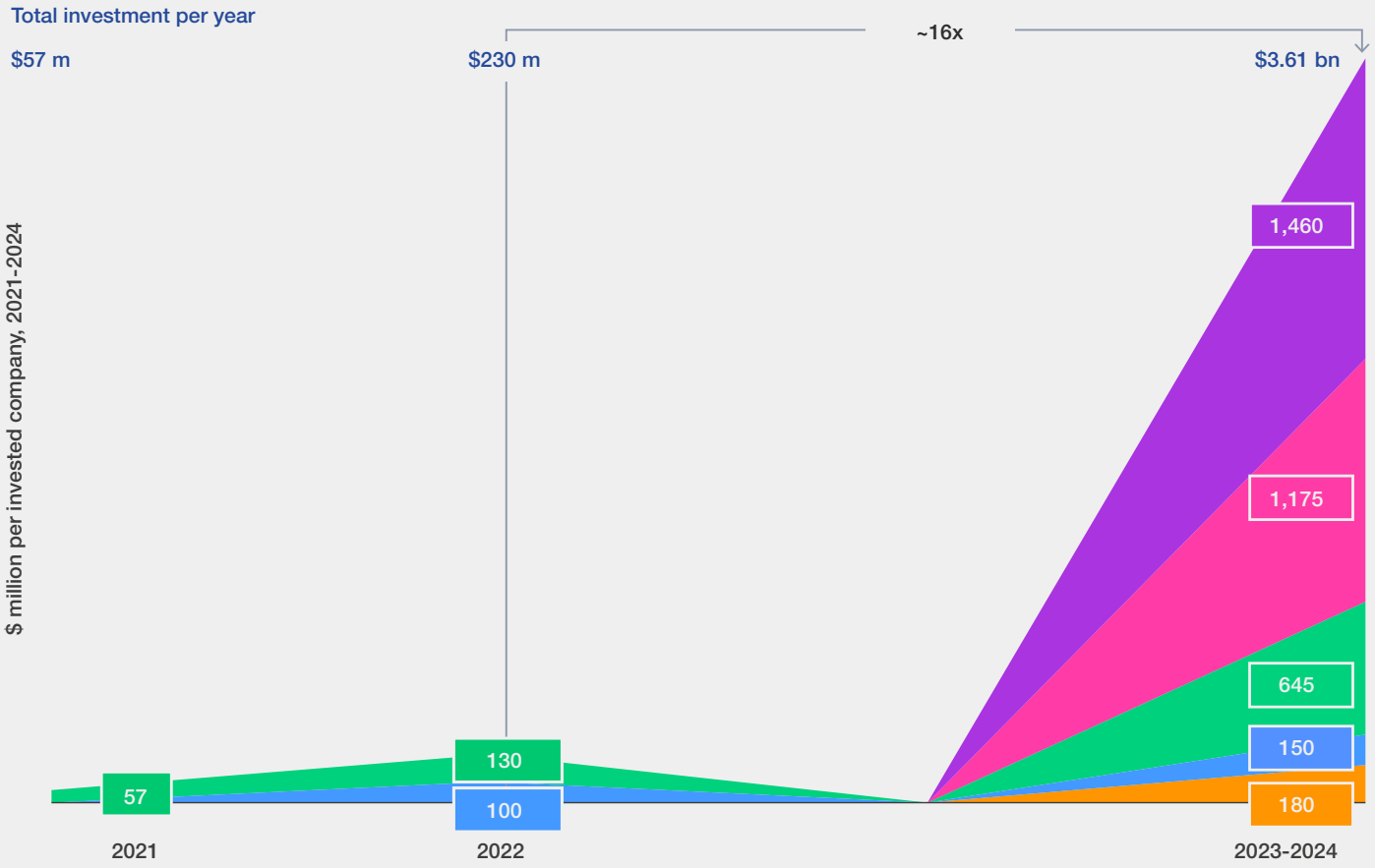


FIGURE 6 | **Recent investments made in SAF companies and projects, 2021-2024**



Company	Object	Value	Financier
Gevo $1.46 bn	Net-zero 1 project (South Dakota)	$1.46 bn loan guarantee	U.S. Department of Energy (2024)
Infinium *up to* $1.175 bn	Infinium's Project Roadrunner in West Texas	$75 m	Breakthrough Energy Catalyst (2023)
		More than $200 m	Brookfield Asset Management (2024)
	Other eFuels projects	*Up to* $850 m	Brookfield Asset Management (2024)
Twelve $832 m	Series A	$75 m	Capricorn Technology Impact Fund & others (2021)
	Series B	$130 m	DCVC & others (2022)
	Project equity: 'Airplants' to produce e-fuel	$400 m	TGP Rise Climate (2024)
	Series C	$200 m	TGP & others (2024)
	Credit facilities	$45 m	Fundamental Renewables & SMBC (2024)
LanzaJet $250 m	Freedom Pines Fuels	$50 m	Microsoft's Climate Fund (2022)
	Credit facilities	$50 m	Breakthrough Energy Catalyst (2022)
	SAF production in US	$30 m	Southwest Airlines (2024)
	SAF integration into airport operation	$20 m	Groupe ADP (2024)
	Growth equity funding	$100 m	MUFG (2024)
SkyNRG *up to* ~$180 m	Support facilities development	Up to €175 m	Macquarie Asset Management (2023)

Note: This is a non-comprehensive view of recent investment raised by SAF companies based on public information, focusing only on projects that received external capital contributions.

Source: Kearney analysis for Airports of Tomorrow, Infinium.[10]

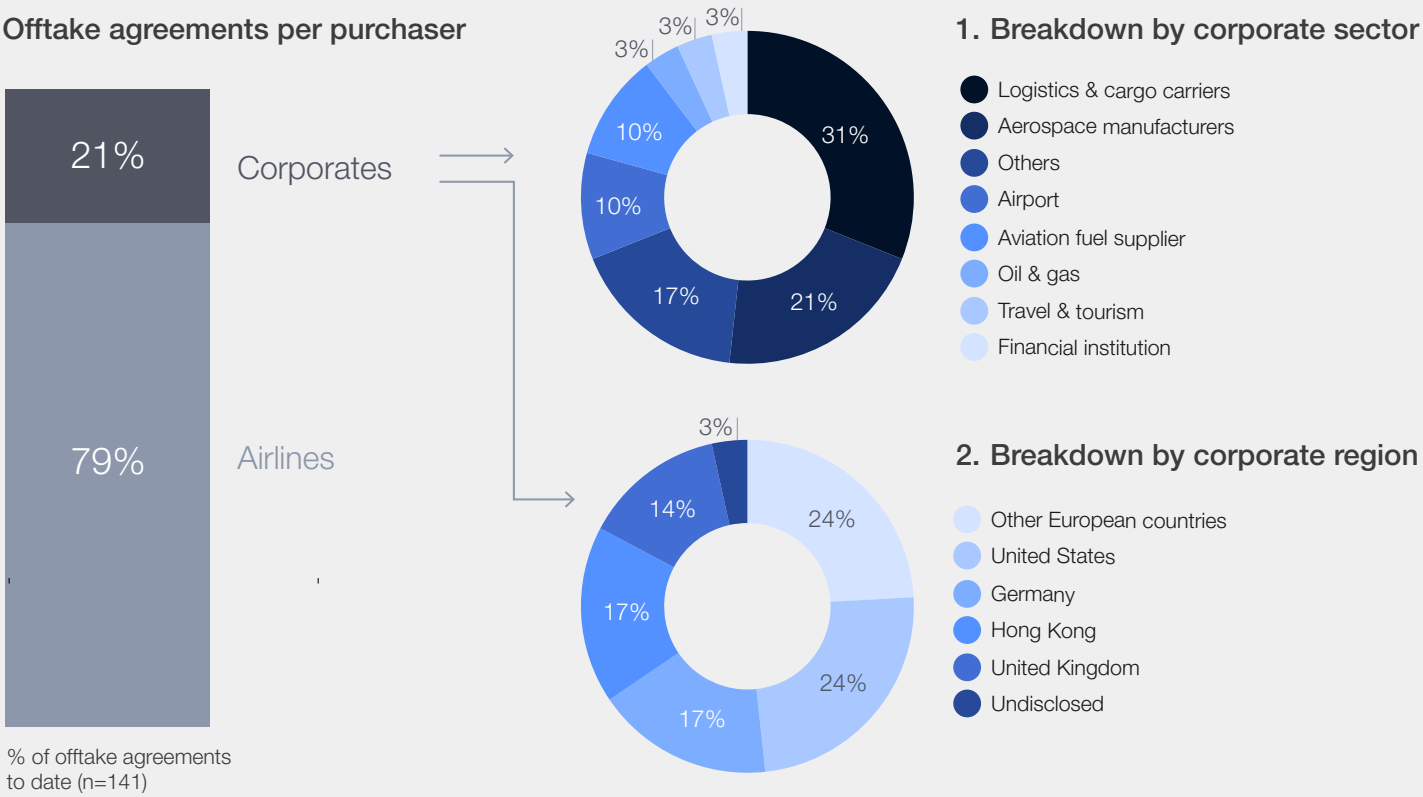
> **Collaboration among every member of the SAF ecosystem is critical to expanding SAF production and distribution. We know the important role airlines, policy-makers and investors play in scaling the industry, but corporations play a critical role as well. Companies looking to address their scope 3 emissions are uniquely positioned to help scale the availability of SAF through voluntary offtake agreements. By enabling scope 3 offtakers to share the responsibility, voluntary offtake agreements help relieve first-mover disadvantage and open up the broader marketplace. This helps drive demand for SAF and sets a strong example for other companies to follow.**
>
> Gene Gebolys, Chief Executive Officer, World Energy

> **We strongly believe in transformative partnerships across the full aviation value chain and beyond. Not only do we supply major airlines, we also offer SAF certificates to corporate customers like Microsoft. These alliances help us build a strong SAF industry and underscore our commitment to innovation, sustainability and excellence. We are proud to lead this change, driving progress and making a lasting impact on the aviation industry and our planet.**
>
> Alfred Stern, Chairman of the Executive Board and Chief Executive Officer, OMV

This investment boost has had a positive impact on the perception of technology risk as well. Some financiers, who believe non-HEFA pathways are maturing, are becoming more comfortable with the technology risks associated with SAF plants, resulting in more investment into SAF projects worldwide. Not all energy players have pulled out of SAF investment, with some doubling down on capacity expansion without significant issues in securing financing. Where there are favourable policy conditions or the involvement of other players, such as scope 3 buyers and multilateral development banks to reduce risks, energy majors have also invested in the sector.

Nearly four out of five SAF offtake agreements to date were signed by commercial airlines, while "corporates" signed the remaining 21%. Of these, about half were signed by logistics companies, cargo carriers and aerospace manufacturers (see Figure 7).

FIGURE 7 **Number of offtake agreements, by corporate type and region, up to 2024**



Sources: ICAO, Kearney analysis for Airports of Tomorrow.

The number of scope 3 buyers stepping into corporate offtakes is increasing, both where the policy direction is unclear and where policy is becoming supportive of SAF or mandates are kicking in, even if they may not yet recognize book-and-claim mechanisms as a way to meet targets.

Nevertheless, there is a risk in more established markets that some buyers may drop targets or reduce their involvement with SAF purchases in 2025, in light of the recent push-back against climate policies and commitments seen in other sectors (e.g. exit of members from the Net-Zero Banking Alliance). This may be counterbalanced by the potentially positive changes to carbon accounting guidance that many Airports of Tomorrow stakeholders expect from the Greenhouse Gas (GHG) Protocol's upcoming *Land Sector and Removals Guidance* in the first quarter of 2025, although a few stakeholders interviewed for this report expect this be delayed.[11] Uncertainty around the issue has left many corporate players in a wait-and-see position, holding off SAF investments.

> **2025 represents a convergence of technical, economic and regulatory possibilities. SAF represents a source of competitive advantage for countries and companies alike, with corporate travel playing a key role in helping encourage investment. We aggregate corporate demand for SAF from our clients and combine it with the purchasing power of airlines via Avelia in partnership with Shell Aviation. Both corporates and airlines invest in SAF and share the emissions reductions associated, spreading the green premium. We invite all companies to join us and share the costs and benefits of SAF across the travel and aviation sectors.**
>
> Paul Abbott, Chief Executive Officer, American Express Global Business Travel

Asia Pacific is among the key markets where SAF offtakes are expected to rise in 2025, with an increasing number of Southeast Asia carriers and corporates looking at SAF procurement, as demonstrated by the collaboration between HSBC, Cathay Pacific and EcoCeres launched in Hong Kong SAR at the end of 2024.[12] One market to follow closely will be mainland China: during 2024, local carriers began using SAF as part of a limited government trial; this may gradually encourage more airlines to commit to sustainable fuels in future.

As more SAF gets blended, more airports, fuel suppliers and fuel producers are examining the kinds of infrastructure investments they need to plan for the years ahead, as well as how to comply with mandates when there are specific traceability or chain of custody requirements. In Europe, the RefuelEU initiative sets minimum blending requirements, such as for airports handling at least 800,000 passengers annually or over 100,000 tonnes of freight. There are additional sub-targets specifically aimed at increasing the use of power-to-liquid (PtL) fuels. European fuel suppliers and airports, where fuel is managed directly rather than via consortia, are expected to be increasingly grappling with logistics assessments to understand the most efficient ways of delivering, storing and supplying fuels at the airport and to the wing.

> **Port infrastructure plays a crucial role in the aviation sector's energy transition. It is the hub for SAF. The quality control of the blending components, the right blending and the certification is essential. You cannot just blend SAF anywhere – the right, dedicated infrastructure is required and you need to be certified as a terminal operator. Vopak's global network with 32 ISCC-certified terminals is well positioned to accelerate the energy transition and support the aviation sector in their journey.**
>
> Dick Richelle, Chief Executive Officer, Royal Vopak

Availability and cost of clean hydrogen and electricity

Clean hydrogen

Clean hydrogen is an important enabler of aviation decarbonization, given its use as a process input or feedstock during SAF production, as well as its potential to power hydrogen-based aircraft and airport infrastructure.

Last year saw notable clean hydrogen developments, although the extent to which these advances may be leveraged by the aviation sector remains unclear. The availability of clean hydrogen is increasing globally, with over 1,500 large-scale projects announced and significant investments being made, particularly in Europe, North America and China.[13] During the first half of 2024, the pipeline had a net growth of 154 projects across different regions, with North America leading clean hydrogen capacity expansion, while Europe and Latin America focused specifically on renewable hydrogen. The United Kingdom, Germany

The availability of clean hydrogen is increasing globally, with over 1,500 large-scale projects announced and significant investments being made, particularly in Europe, North America and China.

and France have all set ambitious targets for "clean" hydrogen production by 2030, although it is unclear whether the 10 GW target set by the previous UK government for 2030 has been maintained by the new government.[14] Latin America continued to make gains due to its vast renewable energy resources.

The International Energy Agency (IEA) reports that if all the clean hydrogen projects in the pipeline globally were to materialize, the sector would see an annual growth rate of 90% between 2024 and 2030, even faster than historical solar energy deployment.[15] However, many believe this rate is unrealistic given that, as for SAF projects, clean hydrogen deployment has recently seen delays and setbacks amid unclear demand and financing hurdles, as well as regulatory uncertainty and complexity, including on additionality rules.[16,17]

In the US, the delayed 45V incentives guidance released by the previous Biden administration in January 2025 received mixed reactions due to its perceived complexity, with further uncertainty around the future of these incentives under the second Trump administration.[18] Europe has seen similar regulatory challenges, with a proposed windfall tax in Spain (now discontinued) blamed for stalling electrolytic hydrogen projects.[19]

Such uncertainties can slow production, but experts believe supply will keep growing in 2025, alongside demand for the product. Hydrogen demand is likely to have reached almost 100 Mt in 2024, but most of this growth comes from the refining and chemicals sectors, rather than to fuel new aviation-related technologies.

The cost of clean hydrogen will impact both SAF adoption and its commercial feasibility for direct use in aircraft and ground-handling infrastructure. The latest BloombergNEF short- and long-term forecasts for clean hydrogen production costs, published in 2024, were revised upwards as a result of higher electrolyser costs, risk-free financing costs and power pricing agreement (PPA) prices.[20]

Despite these supply, demand and cost trends, the aviation executives interviewed for this report were not overly worried about the cost and availability of clean hydrogen at this stage. This may reflect the still limited uptake of this energy vector in aviation, both for airports use as well as for aircraft propulsion (see section below).

Other than as an input for SAF production, hydrogen use in aviation as of 2024 has predominantly been limited to a number of airport trials for storing and liquefying hydrogen, or testing hydrogen refuelling systems. Among the airports looking into this, Toronto Pearson, Dubai, Kansai, Christchurch and Dallas Fort Worth continue to explore hydrogen production, storage, distribution and use. Meanwhile, Bristol Airport saw the first airside hydrogen refuelling trial ever to take place at a UK airport, in partnership with EasyJet.[21] These airport efforts are connected to Airbus's plans to develop a global ecosystem with airports to ensure the necessary infrastructure is in place for future hydrogen aircraft.[22]

Other activities include the exploration of co-locating hydrogen production facilities within airport boundaries and partnerships across the value chain – one example is the collaboration between the Port of Rotterdam and Rotterdam The Hague Airport announced in 2024.[23]

Where preliminary assessments of hydrogen use at airports have been completed, stakeholders consulted for this report were more concerned with techno-economic feasibility, including the cost of conversion between ammonia, liquid and gaseous hydrogen, the potential safety hazards of operations and the energy lost in conversion processes. Many agreed that the business case for onsite hydrogen (or SAF) production would need to be supported by government policy to be profitable, as it will not benefit from process synergies typically found in traditional refineries. Respondents also suggested that co-location with renewable energy sources would improve electrolyser utilization, reduce electricity network costs and ultimately make hydrogen production more cost-effective.[24]

In 2025, it is uncertain whether airport trials looking to use hydrogen will expand further (see next section), but some of the stakeholders interviewed believe aviation will face growing challenges in securing hydrogen for both SAF production and refining, as well as for zero-emission propulsion and infrastructure. As countries grapple with higher-than-expected green hydrogen costs and increased competition across regions, many stakeholders expect that blue or even grey hydrogen will be seen as more acceptable, but this will have implications on the eligibility of fuels under government incentives. Some of the industry stakeholders interviewed mentioned geologic hydrogen as an upcoming area of interest for their business, alongside pink hydrogen from nuclear energy via small modular reactors (SMRs). As of 2024, 68 active SMR designs were being taken forward globally;[25] meanwhile the European Union may assess – as soon as early 2025 – whether to relax current regulations to allow nuclear energy to produce hydrogen and fuels.[26]

> **2025 marks a pivotal year as we transition from development to full commercialization of power-to-liquid SAF. With strong value chain partnerships—from CO_2 and hydrogen to drop-in fuel—we are ready to scale. Regulatory incentives at the EU level further accelerate this progress, driving sustainable aviation forward.**
>
> Tim Böltken, Chief Executive Officer, Ineratec

> **The availability of low-cost renewables is essential for the development of power-to-liquid (eSAF), providing the foundation for both affordability and scalability. While the market has experienced pricing pressure lately from growing demand across industry and tech, there remain significant opportunities to expand supply alongside eFuel projects. Partnering with renewable power developers to support the build-out of new projects dedicated to the fuel space, especially in regions with abundant renewable potential yet to be fully developed, will be crucial in supporting eSAF production.**
>
> Liz Myers, Senior Vice President, Strategy and Solutions, Infinium

Electricity

The aviation industry's decarbonization roadmaps are contingent on the availability and cost of electricity and the availability of related transmission infrastructure. This is particularly relevant for power-to-liquid production pathways and for the scalability of green hydrogen, as electricity is a major component of the cost for e-fuels.

The aviation sector's growing demand for electricity coincides with increasing competition for power from other sectors. In its 2024 mid-year assessment, the IEA noted how demand for electricity is rising at its fastest rate in years, driven by electric vehicles (EVs), cooling and heat pumps,[27] and artificial intelligence (AI). Increasing power consumption from data centres has already led countries such as Ireland to pause applications for grid connections.[28] Grid connection and investment both remain critical factors: BloombergNEF reports that over $800 billion will be needed annually by 2030 to accommodate greater electrification of end uses.[29]

Executives interviewed for this report highlighted that the availability of low-cost renewable electricity is crucial for the economic viability of e-SAF and green hydrogen production, alongside factors that affect energy consumption such as the efficiency of the conversion process and the load factor of the electrolyser when producing hydrogen. As they looked towards 2025, interviewees expected regions with cheaper electricity and shorter connection delays to attract increasing interest from power-to-liquid developers.

> In February 2025, Airbus slowed down work on its ZEROe programme, with a reported delay of up to 10 years despite progress in signing partnerships.

Availability of hydrogen-powered and battery-electric aircraft

Advanced air mobility, battery-electric and hydrogen propulsion developers are facing both headwinds and tailwinds.

Rolls-Royce's exit from the electrical propulsion business due to its inability to find a buyer,[30] Universal Hydrogen's failure to secure additional funding, Lilium's new restructuring after fundraising efforts towards the end of 2024[31] and Embraer's delay to the roll-out of hydrogen aircraft to 2040[32] all highlight the techno-economic complexity of new propulsion. The most notable development in the zero-carbon emission propulsion agenda, however, comes from Airbus, which in February 2025 slowed down work on its ZEROe programme, with a reported delay of up to 10 years despite progress in signing partnerships with airports and the wider value chain in 2024.[33]

Until this announcement, there was some optimism within industry on the back of positive developments in 2024. Cranfield University in the UK received a £69 million boost for its hydrogen development programme,[34] while American Airlines was one of the first major carriers to commit to purchasing ZeroAvia hydrogen engines.[35] After some earlier delays, the US Air Force, working with NASA, started tests of a subscale "blended-wing body" (BWB) aircraft demonstrator in January 2025. Having received the green light from the Federal Aviation Administration (FAA) last year, the project is on track to deliver its first flight by the end of 2027.[36] Meanwhile, Safran's first electric motor was certified by the EU's Aviation Safety Agency (EASA) in January 2025.[37]

However, these latest developments, changes in government, supply chain constraints and conventional aircraft roll-out delays, especially in the US but also in Europe, introduce uncertainty around the prioritization of zero-emission propulsion programmes and their timing, complicating airport master-planning and supply chain preparation. This is happening at a critical time, when SAF as well as other hard-to-abate sectors are all looking at hydrogen for offtakes, with nearly 70% of demand for green hydrogen in the US by 2050 coming from the chemicals, heavy industry, road transport and shipping sectors.[38] Even though zero-carbon emission propulsion may progress, questions around the sector's ability to secure timely supply of hydrogen and electricity remain.

BOX 2 **Expectations for zero-carbon aircraft development in 2025**

Confidence in the possibility of achieving major breakthroughs in zero-carbon aircraft development in 2025 was already low among interviewees for this report, before the announcement from Airbus in February 2025 that it was delaying work on its ZEROe programme for up to 10 years.

Nevertheless, this is not expected to deter pragmatic and ambitious action from both the private sector and governments looking to maintain the momentum for zero-emission flight. Despite a limited number of new aircraft designs entering airworthiness certification, airport trials are underway and may continue, aimed at gathering technical and economic feasibility data to assess the realistic prospect of scaling-up new refuelling technology and infrastructure.

Availability of carbon dioxide removals and out-of-sector carbon offsets

Most decarbonization scenarios agree that carbon dioxide removals (CDR) will be needed to get to net-zero aviation, so as to offset residual emissions not yet mitigated through in-sector measures such as SAF or zero-carbon emissions propulsion. Yet the extent to which the industry agrees that carbon capture should be used for residual emissions only is unclear. Several energy majors that participated in Airports of Tomorrow roundtables pointed out that the additional steps involved with in-sector measures (e.g. capturing carbon and converting it into power-to-liquid fuels) would cost more than continuing to use conventional fossil jet fuel and capturing and storing carbon through CDR.

Very few airlines publicly committed to CDR agreements in 2024, with British Airways spearheading investment in the technology,[39] followed by SWISS[40] and Japan Airlines.[41] Some of the stakeholders interviewed, however, expect the number of CDR offtake agreements to continue in 2025, as more airlines start to complement their SAF strategy and diversify investment, so as to potentially reduce the cost of the net-zero transition, assuming the carbon abatement cost of CDR proves to be lower than the cost of SAF.

On a similar note, interest in CDR from corporates already involved with scope 3 SAF procurement increased notably in 2024, with Microsoft, Salesforce and Google each signing several CDR agreements, including Google's largest biochar CDR order announced in January 2025.[42] While these agreements are often to mitigate the increasing environmental footprint of data centres and AI – rather than air travel emissions – they remain relevant to the aviation discussion, as corporates are increasingly taking a portfolio approach to investing in new technology – a trend expected to continue in 2025.

On the back of this increasing interest in carbon dioxide removals, some respondents expected competition between airlines and other sectors for CDR procurement to increase in 2025.

Nevertheless, trends from late-2024 show that despite a significant increase in CDR offtakes, the number of first-time buyers has stalled,[43] leaving an opportunity for more airlines to step in.

> **Carbon dioxide removals (CDR) can play a key role in mitigating operational emissions for aviation, diversifying existing decarbonization strategies, and complementing a SAF and CORSIA-eligible offset portfolio. The availability of CDR credits in the voluntary carbon market remains relatively limited, making up just 4% of total supply, yet demand is growing. Carbon Direct is focused on ensuring more of that supply meets high-quality standards so the industry can expand with confidence. In 2025, we must significantly scale both nature-based and high-durability CDR solutions by increasing investment, securing forward purchases, and broadening the buyer base.**
>
> Jonathan Goldberg, Founder and Chief Executive Officer, Carbon Direct

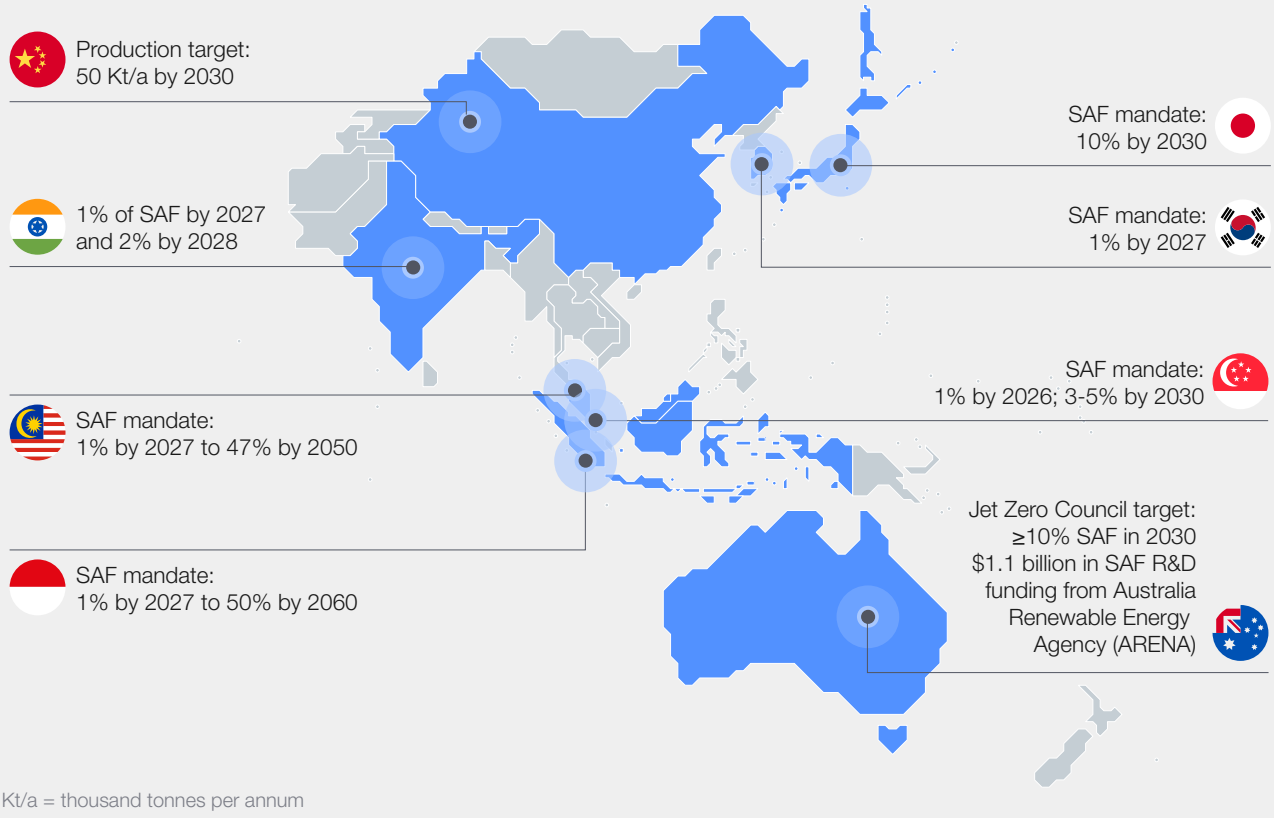
2.2 Policy and geopolitical challenges

Alignment of SAF policy across regions and the future of SAF subsidies

Asia Pacific

In 2024, Asia Pacific emerged as a hot SAF market, with an increasing number of governments introducing supporting policies (see Figure 8). Singapore introduced a new levy on air tickets to support SAF expansion; Malaysia, the Philippines, Indonesia and South Korea announced or explored plans to introduce SAF mandates; and Australia made funding available for low-carbon fuel projects as part of its $1.1 billion innovation fund.[44]

FIGURE 8 **Overview of introduced and pending SAF policies in Asia Pacific**



Note: Kt/a = thousand tonnes per annum

Source: Kearney analysis based on multiple sources.[45]

China is likely to unveil more detail on its rumoured SAF policy in 2025. The country gradually released the first components of its SAF policy in 2024, when it launched a new sustainability certification body in Chengdu and a consultation on domestic fuel standards, while piloting SAF usage with Air China, China Eastern and China Southern in September 2024. In Hong Kong SAR, a policy white paper released by the Hong Kong SAF Coalition recommended a SAF uplift blueprint and a feasibility study into a levy mechanism to encourage SAF uptake.[46]

Although Japan was one of the first countries to propose a SAF mandate, many of the executives consulted for this report believe the country's SAF sector is developing slowly. Respondents that attended one of the regional Airports of Tomorrow roundtables in Tokyo concurred that Japan's ability to produce SAF in the short term may be limited. However, they remained confident that with a level playing field among carriers domestically and internationally to spur demand, along with the right supply-side incentives, most SAF production pathways could be scaled-up in Japan.

While domestically produced fuel is unlikely to meet all the demand for SAF in Japan, there is particular interest in scaling-up HEFA in the short term and e-fuels in the long term. However, large quantities of used cooking oil are currently exported to other countries, with limited options for new offtakes with restaurants – although trials for improved collection in Hokkaido are showing promising results. For Japan to remain competitive, argue executives from its domestic aviation industry, the government needs to roll out additional incentives.

Latin America

Latin America also saw some key market developments. Brazil signed its Fuels of the Future bill into law in October 2024:[47] this established its national SAF programme and introduced a mandate on carriers to reduce GHG emissions by 1% in 2027, gradually ramping up to 10% in 2037 – although this abatement does not necessarily need to come from SAF. The Brazil government also announced an investment of around $1 billion to stimulate SAF production through biorefineries development as well as research and development. As of November 2024, the government has been evaluating the 76 proposals received, which totalled a value of around $28 billion (of which 43 proposals worth $20 billion have fuel production as the main goal).

In April 2024, Chile announced its SAF Roadmap 2030, focused on starting local production by 2030 and setting a target of 50% SAF by 2050, with a promising role for power-to-liquid. Chile and Brazil established a partnership creating a joint working group on SAF, which aims to share best practices, regulatory and market experience, and technical and scientific knowledge on SAF development.

> **The 'Future Fuel Law' in Brazil has created the regulatory framework that allows the development of SAF projects. Our company is already developing biorefineries in Brazil and Paraguay. We believe it is very important to define global mandates and certification systems considering local aspects. This will boost the market with offtakes and facilitate financing for SAF projects worldwide.**
>
> Erasmo Carlos Battistella, Chief Executive Officer, Be8

Middle East

In the Middle East, following the introduction of the United Arab Emirates' SAF policy in 2023, Oman announced the development of local SAF policies and standards during 2024. Other countries in the region have not yet implemented comprehensive national SAF policies, but are formulating strategies or leveraging partnerships for SAF development. This includes Saudi Arabia, where the General Authority of Civil Aviation convened the inaugural Civil Aviation Environmental Sustainability Program Implementation Committee in November 2024, designed to achieve net-zero emissions by 2060 by tracking progress and providing guidelines to the aviation sector.

Europe

Europe has strong SAF policy foundations in place: its mandate under the ReFuelEU initiative requires a 2% share of SAF in EU airports from January 2025 and the bloc features complementary policies such as the EU Emissions Trading System (EU ETS). Yet there are very few SAF production facilities that are non-HEFA, few co-processing plants[48] and only a handful of SAF projects going through FID. Not all European countries have committed funding for SAF programmes, although, notably, the United Kingdom has confirmed an additional revenue support mechanism for the industry. The report by Mario Draghi on the future of European competitiveness estimates that €61 billion a year will be needed for aviation decarbonization in the continent, which is seen as a priority for the sector to remain competitive.[49]

United States

In the US, the Clean Fuels Production Credit (section 45Z) was set to provide a tax credit from 1 January 2025 for the production of transportation fuels with lifecycle GHG emissions below certain levels. Days before the incoming Trump administration took over, the US Treasury

released guidance on section 45Z, clarifying eligibility for credits of up to $1.75 per gallon, as well as detailing an updated methodology to calculate the carbon intensity of the fuel. To reduce the import of foreign feedstocks the US government restricted the applicability of 45Z to refineries that use domestic feedstocks. While such "carrots" have long been advocated by the industry, biofuel producers raised public concerns about whether the new guidance release would provide enough certainty to negotiate feedstocks and offtake agreements going forward.

At the time of writing, however, the long-term impact of the 45Z guidance remains unclear after President Trump signed an executive order to freeze and review all new federal rules, including a 90-day postponement of the 45Z tax credit.[50] Meanwhile the "Farm to Fly Act" was reintroduced in the Congress. It does not involve tax credits but focuses on clarifying SAF eligibility and taxonomy and fostering collaboration. Promisingly, a Montana Renewables project looking to deploy SAF got a loan guarantee approved by the new administration in February 2025.

Policy patchwork

There are two important consequences arising from the proliferation of SAF policy across regions. First, a patchy policy framework is developing, with different sustainability standards and targets, as well as different obligated parties and reporting requirements.

Second, most emerging markets benefit from competitive-priced feedstocks, electricity or labour costs compared to Europe and, to some extent, the US. Meanwhile, China benefits from the world's largest renewable energy pipeline as well as used cooking oil and raw materials for electrolysers. As a result, many of the stakeholders interviewed for this report agreed that the market for SAF and wider aviation decarbonization technology in the US and Europe could face challenges from Asia and South America.

For example, there is a likelihood that producers in emerging markets will prioritize domestic supply rather than exports, due to their own mandates as well as logistics and carbon-related issues. Consequently, there are concerns that regions like Europe may not be able to develop a competitive domestic market for the sustainable fuels that represent a critical cost for their airlines, nor even be able to import these fuels if more countries move to mandate SAF usage.

Expectations on aviation decarbonization policies for 2025

Building on this context, the Forum's survey asked executives for their views on how regional and global policies on aviation decarbonization might evolve in 2025 (see Figure 9).

- **Oceania:** the regulatory advances Australia achieved in 2024 bring optimism to 2025, although advancing domestic SAF production and feedstock availability continue to remain pragmatic challenges. For New Zealand, expectations were more pessimistic.

- **North America:** stakeholders' views were split on whether SAF would remain a priority for the new Trump administration in 2025. Early announcements and the reintroduction of the bi-partisan Fly to Farm Act suggest the topic still remains relevant across the political spectrum, but the temporary freeze of grants and incentives, including for clean hydrogen, pose practical challenges to progress on decarbonizing aviation.

- **China:** while many of the C-suite stakeholders interviewed for this survey expected no substantial policy development, there was general consensus within industry that China could soon introduce substantial production incentives and targets for its domestic SAF industry. During regional Airports of Tomorrow roundtables, attendees said that Hong Kong SAR and mainland China are unlikely to introduce mandates unless there is certainty they can be met.

- **Europe:** the extent to which policy can strengthen Europe's competitiveness is expected to dominate the debate during 2025. In January, the UK government introduced a guaranteed strike price for SAF;[51] meanwhile in February, the European Commission published its new Clean Industrial Deal. By mid-2025, an EU Sustainable Transport Investment Plan is expected, which could include SAF investment provisions among other transport decarbonization solutions.[52] Alongside these developments, some executives expected a relaxation of feedstock criteria (e.g. on cover crops) to potentially increase the pool of fuels and regions from which Europe may import SAF in the future, while boosting competitiveness. Discussions will also continue on whether the EU's Carbon Border Adjustment Mechanism (CBAM) should expand to include aviation as it currently excludes the sector.

- **Sub-Saharan Africa:** stakeholders did not expect any significant changes in the SAF policy landscape in the region, although a number of feasibility studies currently being undertaken by ICAO's Assistance, Capacity-building and Training for Sustainable Aviation Fuels (ICAO ACT-SAF) initiative may prompt some early policy development. With South Africa taking over the presidency of the G20 in 2025, the topic may continue to feature in international discussions. A sustainable fuels roadmap has been proposed as one of the G20's deliverables, although, at the time of writing, the themes of SAF and aviation seem to be playing a less prominent role than during the previous G20 presidency of Brazil.[53]

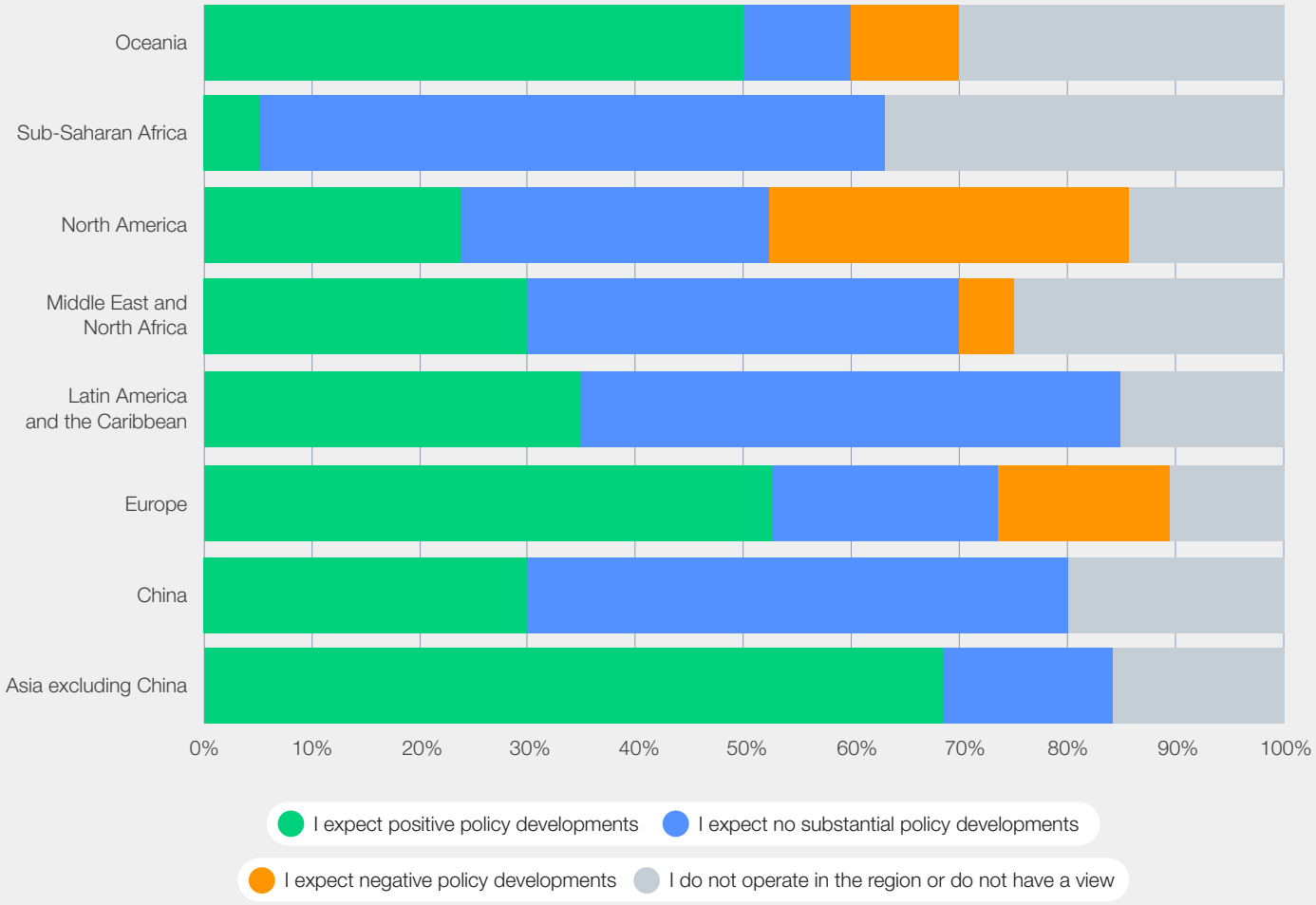
– **Middle East and North Africa:** respondents were split on whether the region would move forward with its SAF ambition and, for example, whether the targeted development of early-stage facilities to produce SAF at commercial scale by 2025 would remain on track. Several stakeholders however believed the Gulf Cooperation Council (GCC) could prove to be a receptive venue for coordinated policy discussions on aviation decarbonization.

> **Success in reaching the required SAF levels demands bold first moves, including more FIDs, especially for transformative technologies like eSAF (power-to-liquid). But private innovation alone won't suffice. Governments worldwide must step up with more robust policy frameworks, especially beyond North America and the EU. Within technology, companies like Topsoe need to be ready with de-risked solutions and the catalysts needed for current and future feedstocks and pathways. Flexibility, reliability and adaptability will be key as third-gen feedstocks, eSAF and advanced pathways scale and come online. Collaboration, regulation and extended financing will turn promise into progress.**
>
> Elena Scaltritti, Chief Commercial Officer, Topsoe

> **Taking advantage of the joint production of renewable fuels for all transport sectors, including road, aviation and maritime, would allow cost efficiency and faster technology development of SAF. Hence, SAF production business cases must include the acceptance of renewable fuels for road transport, otherwise Europe will need to import them from other regions, jeopardizing the EU's competitiveness and industrial growth.**
>
> Josu Jon Imaz, Chief Executive Officer, Repsol

> **Now is not the time to become distracted. The SAF industry has continued momentum with an industry that is taking hold. Adjusting to new political norms are a factor that any sector with long-term aspirations must confront. Encouragingly, we are seeing consistent and increasing policy support for SAF from governments all around the world.**
>
> Jimmy Samartzis, Chief Executive Officer, LanzaJet

FIGURE 9 | **Expectations for the evolution of aviation decarbonization policy, by region**



Source: World Economic Forum industry survey.

CORSIA and emissions trading schemes

Last year saw positive momentum for ICAO's CORSIA initiative. Saint Lucia, Gabon and Uzbekistan joined the voluntary phase 1, bringing the total number of countries participating in the scheme from 2025 to 129.[54] Four new carbon credit programmes were approved by ICAO as CORSIA-eligible,[55] expanding the pool of credits available and potentially easing the crunch that market commentators expect in the coming years.[56]

Developments on Article 6 of the Paris Agreement, approved at COP29, were welcomed by the industry as a positive step towards a smoother implementation of CORSIA. In future, for a carbon credit to be compliant with CORSIA, the host country in which the project is located must authorize the transaction (via a "letter of authorization") and adjust its carbon inventory to ensure the carbon savings are not double-counted in its nationally determined contributions.

Despite these advances, several respondents to the Forum's survey flagged the implementation of CORSIA as a key risk for 2025. Many pointed out that China, Brazil, Russia and India have yet to join the first phase and see a potential risk that the US may reduce its participation or compliance, given the country has the largest demand for CORSIA units.[57] Many of the airlines interviewed, however, reiterated their support for CORSIA and their willingness to participate, even on a voluntary basis. This demonstrates widespread support for the scheme and the importance of multilateral collaboration to tackle international aviation emissions. Nevertheless, participants' ability to purchase credits may still be limited and market-dependent, with experts expecting potential volatility.

In some markets, airlines will increasingly need to comply with not only CORSIA but also local emission trading schemes. In the EU, this year will see the continuation of the gradual phase-out of free allowances for airlines and reduction of the aviation emission caps, alongside a price-bridging mechanism to support SAF uptake. However, there were diverging views among respondents on the effectiveness of the ETS, as the price-bridging support is applied

The EU Emission Trading System is evolving to address non-CO_2 emissions, including those from the aviation sector: from 2025, it aims to incorporate emissions such as nitrogen oxides (NOx), particulate matter and water vapour.

retrospectively and flights departing from the EU to destinations outside the European Economic Area (EEA) are not covered by the scheme – apart from the United Kingdom and Switzerland.

The EU ETS is evolving to address non-CO_2 emissions, including those from the aviation sector: from 2025, it aims to incorporate emissions such as nitrogen oxides (NOx), particulate matter and water vapour into its framework.[58] The inclusion of non-CO_2 emissions will require airlines to monitor and report these emissions for each flight. Many airlines claim this adds regulatory pressure and leads to compliance costs and operational adjustments, although European carriers flying predominantly short-haul and other industry stakeholders welcomed this development.[59]

An increased focus on non-CO_2 emissions and contrails has been a theme of 2024, which saw a flurry of activities and trials in this area. Several airlines have been testing and optimizing flight planning and airspace management to reduce the formation of contrails, using AI and optimization software to help select more fuel-efficient routes and altitudes.[60] Many respondents expect trials to continue in 2025, while expressing cautious optimism around the impacts, given the scientific uncertainty surrounding these issues. Research into this area is continuing: one of the latest studies from the Whittle Laboratory at the University of Cambridge highlights how the implementation of a global contrail avoidance system could reduce the warming effect of aviation by 50-85% by 2050.[61]

Geographic concentration of feedstock resources

As of 2024, the vast majority of SAF being produced or developed is HEFA, with increasing interest in alcohol-to-jet following the inauguration of the first commercial-scale refinery by LanzaJet in 2024. SAF production is therefore highly dependent on bio-feedstock and trades. This report has already discussed how markets in Asia and South America benefit from access to higher volumes of feedstocks and lower costs, while other markets, including the US and Europe, have developed greater dependency on imported low-cost feedstocks (see section above).

China has been the world's largest supplier of used cooking oil, with peak exports in November 2024, due to a sharp increase in shipments to Europe and the US. Following updated 45Z guidance, market experts consulted for this report expect trade flows to be diverted from the US to Europe, although the Chinese government's removal of the 13% tax rebate on exports is expected to create volatility. On a similar note, in 2024, Indonesia restricted exports of palm oil mill effluent and used cooking oil, to favour domestic use ahead of an increased B40 biodiesel blending mandate and a tighter approval process for exports announced in 2025.[62]

Executives interviewed believe recent feedstock trades and policies are opening up an opportunity for alternative feedstocks or other countries to step in. Latin America is a natural candidate, with Brazil holding notable volumes of soybean (HEFA feedstock) and sugarcane (AtJ feedstock). According to market experts consulted for this report, trades of tallow, which could potentially lead to fuels with a lower carbon intensity than used cooking oil, may also face an increase in 2025, although much of this is likely to be used for renewable road transport fuel rather than aviation. Meanwhile, China has been increasing its global share of ethanol production for use in road transport, reaching approximately 4.9 billion litres in 2024. Renewable diesel refinery capacity in China is currently limited, but it could be temporarily boosted and subsequently repurposed for SAF if and when demand for road transport fuels decreases. However, new SAF facilities will most likely be needed to achieve scale, further exacerbating changes in feedstock value chains.

Amid an increasingly complex trade and geopolitical context, experts interviewed are confident that, during 2025, regions such as Europe may have to explore loosening feedstock eligibility criteria to accommodate a wider pool of imports, or look at greater domestic production of feedstocks, such as cover crops. These decisions will come with sustainability trade-offs (discussed in the following section) and will need to be assessed alongside anti-dumping concerns, already the focus of a European investigation in 2024.[63]

As SAF scales, ensuring its integrity is paramount – without robust safeguards, sustainability risks could undermine its potential. RSB's recent work in Southeast Asia highlights how strong sustainability standards, particularly around feedstock traceability and land-use protections, provide a clear path forward for responsible SAF expansion. In 2025, we will continue driving solutions that protect ecosystems, foster transparency and build confidence in truly sustainable SAF, while also ensuring it supports economic resilience, strengthens rural livelihoods and secures long-term decarbonization.

Elena Schmidt, Executive Director, Roundtable on Sustainable Biomaterials (RSB)

2.3 Sustainability challenges

> The establishment of a new SAF research centre in Chengdu will have as its first task the definition of new standards and a Chinese certification system for sustainable fuel.

Traceability and sustainability criteria for SAF feedstocks

As global trades of feedstocks and fuels flourish and aviation's reliance on SAF as a means to get to net zero increases, scrutiny of the sustainability credentials of these commodities is expected to intensify. Land-use changes, deforestation, poor agricultural practices, food security and biodiversity impacts are some of the potential concerns that have, in Europe at least, prompted investigations into the integrity of biofuel imports. This in turn has led to regulatory restrictions or bans on first-generation fuels derived from food crops, as well as caps on biofuels made from used cooking oil and animal fats.

The risk of a supply-constrained scenario could exert positive pressure on the development of power-to-liquid or alternative SAF production pathways (e.g. gasification and Fischer-Tropsch). Equally, amid these concerns, some countries are moving towards improving transparency and research in this area. In 2024, the Roundtable for Sustainable Biomaterials published a comprehensive assessment of the SAF potential in Southeast Asia, identifying deforestation as the most significant risk in the region and recommending sustainable cultivation practices for food and feed crops to limit the risks of land-use change.[64]

Standards are helpful to assess these risks, although there are currently multiple methodologies employed globally. The EU's Renewable Energy Directive (RED) II, ICAO's CORSIA model and the US GREET (Greenhouse gases, Regulated Emissions, and Energy use in Technologies) model all calculate the lifecycle assessment as well as direct and indirect land-use changes in different ways. These methodologies may be updated periodically to reflect the latest evidence. For example, in April 2024 the US amended the GREET model to allow corn-to-ethanol to remain eligible for a lower carbon intensity value than in Europe, by introducing reductions for sustainable land management practices such as cover-cropping and no-till farming.

Much of the debate in 2024 has revolved around accuracy and interactions between these standards and this is expected to increase further as China develops its own methodology. The establishment of a new SAF research centre in Chengdu will have as its first task the definition of new standards and a Chinese certification system for sustainable fuel. In September 2024, as methodologies multiplied, the IEA set out options for defining more consistent sustainability criteria for fuels across sectors and regions. The IEA's report recognizes the need for a minimum emission threshold across fuels and stresses the benefit of a risk-based approach on indirect land-use change over quantitative modelling.[65]

Greenwashing and consumer scepticism

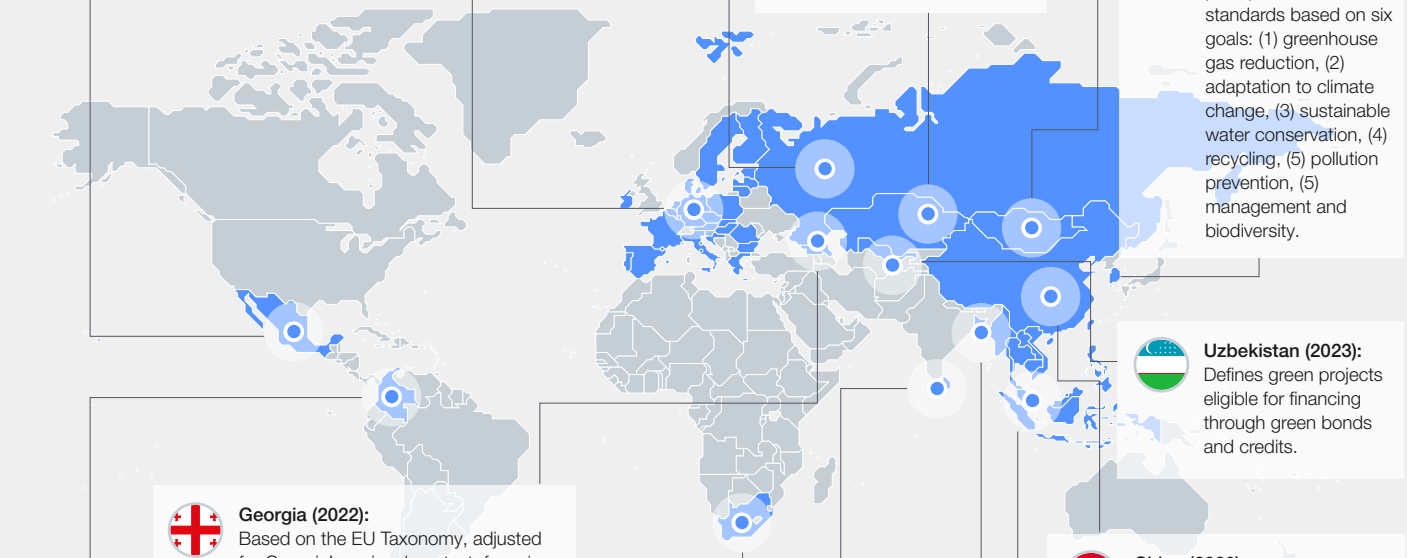
Despite traceability of feedstocks featuring high on the list of priorities for 2025, especially as new markets look to move into SAF production, stakeholders interviewed for this report were not generally worried about the risk of greenwashing and how this could affect passengers' perspectives on sustainability. However, this finding should be caveated, as the relative importance of the risk of greenwashing varies by stakeholder category and by region (e.g. acceptance of certain feedstocks or practices can be more stringent in certain regions).

In emerging economies in particular, investors attending Airports of Tomorrow roundtables during 2024 repeatedly flagged concerns with investment in SAF production pathways or feedstocks that may not be universally recognized as sustainable. This heightens the need for more consistent sustainability criteria across countries, as well as alignment of national taxonomies, which can employ varying criteria to determine whether a certain aviation decarbonization investment or activity can be deemed sustainable or transitional.

In 2024, the European Commission provided further guidance on the implementation of the EU Taxonomy,[66] while Brazil started work on a new aviation taxonomy and the ASEAN Secretariat also launched a consultation process on the aviation sector.

Feedstock risk, however, is only one of the factors used to determine how "sustainable" a fuel is – and how this information is communicated publicly can also affect the perception of greenwashing. In April 2024, concerns in Europe around greenwashing hit the news when the European Commission wrote to 20 airlines to investigate whether the climate projects those companies were undertaking and advertising as "green" or "carbon neutral" – as well as their wider claims of progress towards net-zero emissions – could be validated as such.[67] Meanwhile, a Virgin Atlantic advertisement to celebrate "the first transatlantic flight powered by 100% sustainable aviation fuel" was banned, after the UK's advertising watchdog deemed it "misleading".[68] A Dutch court made a similar ruling on previous KLM advertising campaigns.[69] By contrast, a district court in the US dismissed a similar greenwashing lawsuit against United Airways in August 2024.[70]

FIGURE 10 | **Official environmental taxonomies, by country and region, 2019-2023**



EU (2020):
Defines six environmental objectives on: (1) climate change mitigation, (2) adaptation, (3) water resources, (4) circular economy, (5) pollution prevention, (6) biodiversity. Activities must "do no significant harm" to any objective while complying with minimum social safeguards.

Norway has also adopted the EU Taxonomy.

Russia (2021):
Covers waste management, energy, construction, industry, transport, water supply, biodiversity, agriculture.

Mongolia (2019):
Stipulates a list of activities considered environmentally sustainable for investment purposes, e.g. green loans, green bonds. Seven overall categories are identified and supported with quantitative policy targets.

Mexico (2023):
Follows the structure and methodology of the EU Taxonomy; defines criteria for 124 activities in six sectors responsible for ~90% of Mexico's GHG emissions.

Kazakhstan (2021):
Defines green projects eligible for financing through green bonds and credits with a focus on energy, green buildings, water, waste, agriculture, clean transport.

South Korea (2022):
Guideline is not legally binding but provides principles and standards based on six goals: (1) greenhouse gas reduction, (2) adaptation to climate change, (3) sustainable water conservation, (4) recycling, (5) pollution prevention, (5) management and biodiversity.

Uzbekistan (2023):
Defines green projects eligible for financing through green bonds and credits.

Georgia (2022):
Based on the EU Taxonomy, adjusted for Georgia's regional context, focusing on improving energy efficiency in its emerging economy and reducing reliance on fossil fuels.

China (2020):
Focuses on defining eligible projects for green bonds in areas like renewable energy, pollution control, ecological conservation. Excludes "clean coal", aligning more closely with international standards after recent updates.

South Africa (2021):
Adapted from the EU Taxonomy to suit local conditions and development needs; covers renewable energy, green buildings, sustainable agriculture.

Colombia (2022):
Framework includes: (1) climate change mitigation and adaptation, (2) sustainable water management, (3) promotion of a circular economy, (4) pollution prevention and control, (5) conservation of terrestrial and marine ecosystems and biodiversity, as well as soil management.

Sri Lanka (2022):
focuses on sectors such as renewable energy, sustainable agriculture, waste management, climate resilience.

Bangladesh (2020):
Includes tech-screening criteria, six environmental objectives and principle of substantial contribution to one[1] – plus DNSH and minimum social and governance safeguards.

ASEAN (2021):
A multi-tiered system catering to member countries at varying stages of development. Classifies activities under a "Foundation Framework" (basic principles) and a "Plus Standard" (more advanced criteria).
Note: Singapore, Malaysia, Thailand also have their own taxonomies.

1. The principle of substantial contribution requires that, for an activity/project to be considered compliant, it must make a significant positive impact on at least one of the environmental objectives specified by the tech-screening criteria, while ensuring it does no significant harm (DNSH) and adheres to minimum social and governance safeguards.

Source: Kearney analysis for World Economic Forum.

BOX 3 | **Expectations around greenwashing for 2025**

Looking ahead into 2025, stakeholders interviewed expect concerns around greenwashing to evolve differently across different regions. Europe is likely to see closer scrutiny of environmental claims by aviation stakeholders. Meanwhile, in the US, an expected decrease in communication and advertisement campaigns on ESG-related activities (including SAF) may lead to less emphasis on this issue.

Nevertheless, striving for more consistent and aligned approaches to sustainability across regions will most likely remain a priority for many stakeholders. Aligning sustainability criteria and taxonomies is predicted to feature in many international discussions, including at the G20 as well as in ICAO, where work to develop the Finvest Hub proposition continues, following progress announced at the Global Implementation Support Symposium in February 2025.[71]

Airlines may choose to voluntarily improve transparency and simplify information provided to passengers – especially in Europe, where a new labelling scheme is being introduced in summer 2025.[72] This could potentially improve consumers' willingness to pay for decarbonization, given that voluntary "pay-for-SAF" options embedded into airlines' booking platforms were reported to have gained some limited traction with passengers in 2024.

3 Non-sustainability risks and trends

Geopolitical and economic factors continue to affect whether and how aviation executives prioritize decarbonization, with a number of active geopolitical and trade challenges as of 2025.

The World Economic Forum's survey of aviation executives also asked respondents to rank wider risks, beyond immediate aviation-specific sustainability concerns, that are affecting progress on decarbonizing the sector. Challenges identified include risks arising from policy and geopolitics, economics, technology and social issues (see Figure 11).

FIGURE 11 **Top-10 wider risks affecting aviation decarbonization progress**

Source: World Economic Forum industry survey.

3.1 Policy and geopolitical risks

Geopolitical tensions are driving insecurity on feedstock exports, while increasing the prioritization of domestic energy security agendas at a time of global uncertainty.

Geopolitics, tariffs and sanctions

According to the executives consulted, geopolitics tops the list of non-sustainability challenges affecting aviation decarbonization progress. The Forum's *Global Risks Report 2025*[73] also highlights geopolitics as one of the key concerns for the international community. The previous chapter highlights risks and challenges specific to the aviation sector and SAF feedstocks. This chapter addresses wider dynamics that can affect relationships and negotiations between countries, including at COP30 and the ICAO General Assembly later this year, as well as trade flows and thus aviation and cargo movements.

At the time of writing in early 2025, the impacts of the US withdrawal from the Paris Agreement and its "America First" trade policy are being closely monitored by the aviation community. The risk of increased protectionism and escalating tariffs across the economy continues a trend already seen in 2024, when both the US (under the Biden administration) and the EU introduced a number of measures in relation to Chinese solar panels, electric vehicles and electric vehicle batteries.

Experts interviewed believe that geopolitical tensions are driving insecurity on feedstock exports, while increasing the prioritization of domestic energy security agendas at a time of global uncertainty. Meanwhile, the use of incentives to accelerate domestic industrial development has led to increased scrutiny by the international community around fairness and competitiveness. For example, the EU investigated Chinese biodiesel, which imposed anti-dumping duty rates for biofuels, but left out SAF.[74]

Change in governments

Following a "super-year for elections" across the world – including in the US, India, United Kingdom and South Africa – respondents expressed concern about changing government priorities, leading to potential U-turns on policy and regulation, as well as doubt around the longevity of incentives. While in some cases changes in government have resulted in a greater prioritization of the aviation decarbonization agenda (e.g. in the UK, according to executives interviewed), this has not necessarily been the case across all regions.

This year sees the continuation of the election cycle in Australia (where the government has been increasingly supportive of sustainable aviation and fuels policy, and is hoping to host COP31), Canada, Chile, Germany and Singapore – as well as mid-term elections in Argentina.

Interstate armed conflict

Ongoing conflicts across the world, in particular following Russia's invasion of Ukraine, continue to have an impact on airspace closures and climate change, as well as on aviation safety.

Longer routes arising from the closure of Russian airspace have led a number of carriers to pull out of Asian markets, citing longer and less attractive journeys for passengers, as well as increased fuel costs and revenue losses. The climate impact of diverting civil aircraft traffic around Russia has been quantified at 24 million tonnes of CO_2-equivalent, around 14% of the total climate impact of the war in its first two years.[75]

At the same time, Chinese carriers that can continue to use Russian airspace have increased their presence across Europe-Asia routes. In 2024, several European carriers complained about increased competition from Chinese carriers and their growing market share – for example, Chinese carriers are now running nearly three-quarters of all flights between China and France and Germany, as well as nearly all flights between China and the United Kingdom and Italy.[76] This increasing activity has prompted Western airlines to push for caps to flights to and from China, although as of February 2025 no additional restrictions have been implemented, at least in Europe.[77]

Air traffic restrictions and diversions have also affected the Middle East, with a number of carriers avoiding Iranian airspace and cancelling flights to Tel Aviv throughout 2024.[78] Conflict developments, both in Ukraine and across other active war zones, will continue to generate a volatile and disrupted environment, with many executives not expecting airlines to resume routes until after such situations stabilize.

On top of the implications of re-routing and increased competition on carriers' offer and profitability, from a sustainability standpoint it remains to be seen whether greater penetration of extra-EU carriers in Europe may bring about other impacts in 2025: many of these long-haul routes are currently excluded from mandates and emissions trading schemes, leaving SAF use on such journeys up to the voluntary action of airlines.

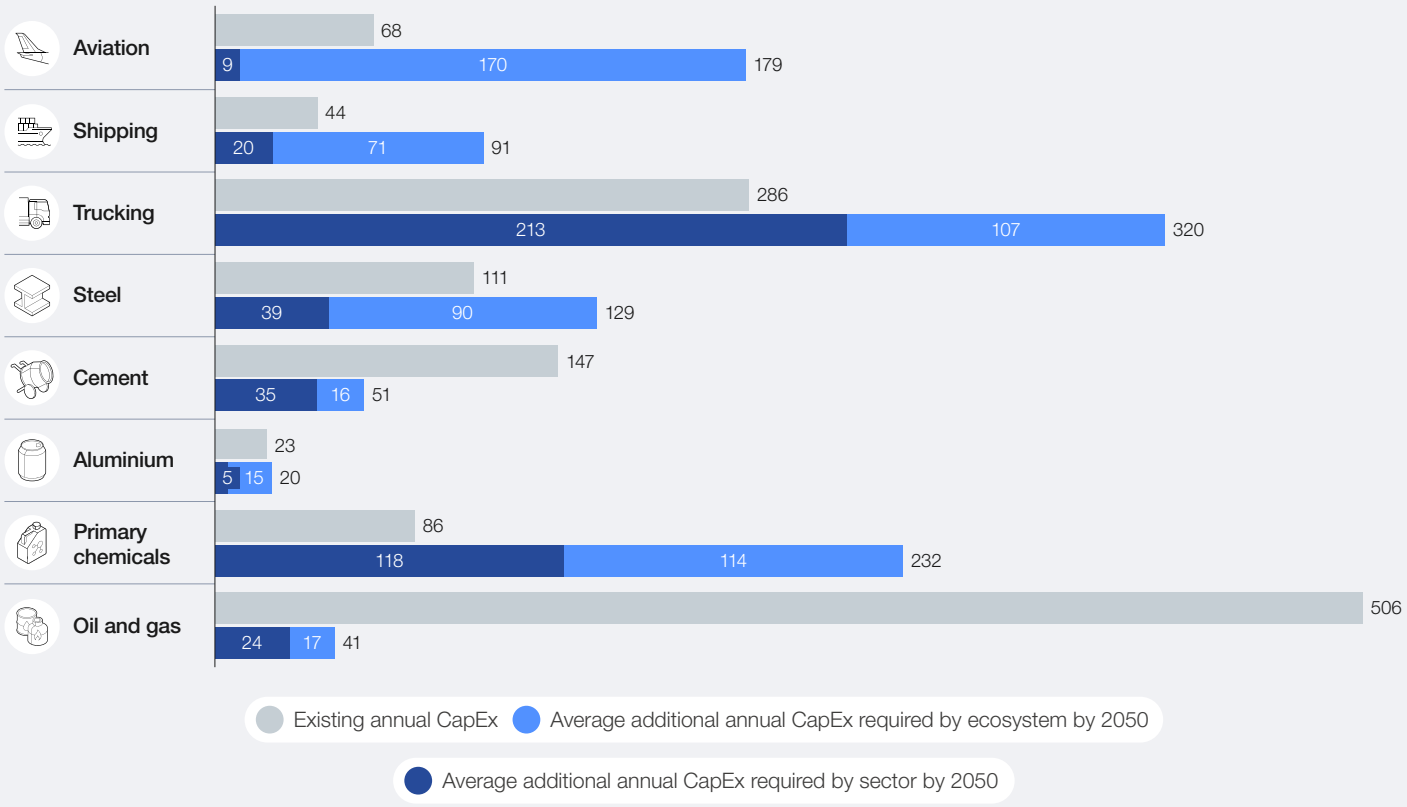
3.2 Economic risks

Bankability and attractiveness for investors

One of the key concerns voiced by respondents to the Forum's survey was that the aviation sector is not viewed by the financial community as an investment priority, despite needing at least $20 billion of capital investment to meet ICAO's 2030 vision and over $5 trillion to get to net zero. While capital for decarbonization projects is increasing overall, aviation is having to compete with many other transition technologies for investment.

The Forum's *Net-Zero Industry Tracker 2024* highlights how annual investment in decarbonizing aviation is ahead of shipping, but behind the CapEx secured by the trucking, steel, cement and chemicals sectors (see Figure 12).[79]

FIGURE 12 **Existing annual CapEx vs. additional annual CapEx required by 2050, by sector and ecosystem ($ billion)**



Source: Accenture analysis, based on MPP, S&P, DNV, Center for Global Commons and IEA data. Previously published in the World Economic Forum's *Net-Zero Industry Tracker: 2024 Edition*.

> The aviation sector is not viewed by the financial community as an investment priority, despite needing at least $20 billion of capital investment to meet ICAO's 2030 vision and over $5 trillion to get to net zero.

Within the aviation sector, there are also multiple technologies looking to secure funding, including SAF, hydrogen and, increasingly, eVTOLs (electric vertical take-off and landing aircraft). While potentially attracting a different pool of investors and risk appetite, eVTOL companies gained significant momentum in 2024, with $2.3 billion raised in 2024 and over $13 billion raised since 2019,[80] as well as a number of orders from airlines. The latest eVTOL transactions include: $894 million of investment in Joby Aviation from Toyota Motor Corporation in 2024;[81] a $430 million investment in Archer Aviation from a group of investors including United Airlines and Stellantis;[82] a $50 million boost to Vertical Aerospace;[83] and a $114 million investment in Lilium in early 2024. However, Lilium did not secure a loan guarantee from the German government in November 2024 and declared insolvency, but eventually received a capital investment of $200 million in December 2024 to resume work.[84]

> **Investor appetite for electric aviation has never been stronger. The capital flowing into eVTOL companies like Archer reflects a clear belief in the future of sustainable urban air mobility and a shift to greener transportation. To maintain this momentum in 2025, we need regulatory certainty, infrastructure investment and continued public-private collaboration across the world. The opportunity is massive and with the right policy and capital alignment, electric air taxis will redefine how people move in cities – sooner than most expect.**
>
> Nikhil Goel, Chief Commercial Officer, Archer Aviation

Despite significant investment, there are still technology challenges, risks and regulatory pressures affecting the progress of eVTOLs. Alongside the profile of the investor, these challenges will ultimately determine whether eVTOL start-ups could scale-up alongside other SAF, CDR or zero-emission propulsion technologies, at a time where investment in all these pathways is critically needed to remain on track to deliver net-zero aviation by 2050.

Economic downturn, inflation and competing priorities

While sustainability remains a key priority for the aviation industry, 2024 saw an increasing number of economic challenges affecting the sector's focus on its net-zero agenda. The degree to which these affect decarbonization varies, but many of the executives surveyed and interviewed flagged a range of priorities they are grappling with that may limit their bandwidth or capital for decarbonization projects.

Inflation, revenue and growth

The International Monetary Fund expects global headline inflation to decrease to 4.2% in 2025, with global growth forecast to be at 3.3% for both 2025 and 2026.[85] While inflationary pressures have been easing and overall concerns across the global economy are decreasing, according to the Forum's *Global Risks Report 2025*, the global economic outlook remains a key worry for many of the aviation executives consulted.[86]

Facing adverse market conditions and some COVID-19 leftovers, several of the executives interviewed, in particular airport CEOs, mentioned economic profitability as a greater priority than sustainability. This point was particularly highlighted by executives from aviation hubs in emerging markets in Latin America, the Middle East and Southeast Asia.

Passenger numbers, however, remain encouraging. Airports Council International (ACI) World estimates that 2019's traffic levels were finally surpassed in 2024, with 9.5 billion passengers (104% of 2019).[87] Asia Pacific and European carriers were the primary contributors to the net increase in traffic, while North American carriers experienced a significant rise in demand and other regions continued to see steady market expansion.

The overall profitability of airlines is increasing according to IATA, with an expected combined net profit of $30.5 billion in 2024 and bullish growth forecasts to 2050, especially in emerging aviation markets such as China and India. While profit is going up, several stakeholders mentioned that costs are also increasing. On average, despite some volatility, jet fuel costs have remained fairly stable throughout 2024, but rising labour costs and workforce and supply chain bottlenecks, alongside regulatory uncertainty, have been mentioned as key areas of concern for executives.

Some of these factors, together with demand, are combining to push airfares up, with an average year-on-year increase in US airfares of 8% in 2024.[88] Despite this short-term increase, IATA reported that domestic airfares in the US, China and India were still close to or below 2015 levels, following an overall long-term downward trend, with more volatile ticket prices for international trips.[89] Market commentators are expecting airfares to continue rising in 2025, potentially climbing by as much as 20% in the first half of the year.[90] As a result, airlines' revenues in 2025 are expected to surpass the $1 trillion milestone for the first time, with a forecast net profit of $36.6 billion – a record high for the industry.

With airfares increasing, some of the airlines surveyed by Airports of Tomorrow were concerned about the prospect of passing on the additional cost of SAF to passengers, on top of any non-fuel-related price hikes. However, there was also greater acceptance that a SAF premium could work, if it were applied consistently and equally across carriers.

In terms of market consolidation, last year saw a number of acquisitions and new partnerships aimed at growing and strengthening the financial position of the carriers involved. Alaska Airlines completed the purchase of Hawaiian Airlines, following a regulatory green light,[91] while the sale of ITA Airways to Lufthansa Group was also finalized. This trend is expected to continue in 2025, with the Gol-Azul merger plan approved by the Brazil government.[92]

Some of the executives surveyed for this report consider consolidation and partnerships to be key strategies to boost financial profitability, in turn enabling future investment in new technology. However, they also highlighted how such discussions could temporarily pause carriers' prioritization of the decarbonization agenda until the financial implications of mergers, consolidations, restructurings and acquisitions are completed.

Aviation expansion and growth

As passenger numbers grow, some airports are looking to expand and new airlines are launching to capture a share of this increasing demand. The expansion of Dubai World was announced in April 2024, with the aim to operate five runways and become the largest hub in the world.[93] Meanwhile, Saudi Arabia announced the construction of a new airport in Riyadh with six runways, a new $50 billion investment in the country's airports[94] and the launch of a new carrier, Riyadh Air.

Asia Pacific is also looking to grow. Hong Kong International Airport (HKIA) inaugurated its third runway in November 2024.[95] With cargo movements increasing as well as passenger numbers, DHL Express inaugurated new facilities at HKIA in April, with its HK$1.5 billion fully automated sorting system.[96] In North America, Toronto Pearson Airport unveiled a renovation plan to increase capacity.[97]

In early 2025, the UK government announced its backing for a major expansion at London Heathrow,[98] as well as the start of restructuring work at London Stansted, backed by a £1.1 billion investment from the government.[99] The construction of a new terminal at Singapore Changi Airport is also expected to start later this year,[100] while Melbourne Airport announced plans for a major expansion, as airlines launch new routes and connectivity to Australia is expected to increase in the year ahead.[101,102]

On the back of positive growth forecasts and air travel expansion announcements, 2024 also saw greater debate on how the growth of the sector can be compatible with its climate commitments. This was the focus of a paper commissioned by the European Union Joint Research Centre, published in December 2024, which predicted that aviation's continuing growth has set it on course to triple CO_2 emissions by 2050. The paper concluded that technological improvements will need to be complemented by a place-based approach to aviation decarbonization as well as communication strategies to encourage less energy-intensive travel habits.[103]

Some of the aviation and transport sector stakeholders interviewed for the World Economic Forum's January 2025 white paper *Intelligent Transport, Greener Future: AI as a Catalyst to Decarbonize Global Logistics*, identified solutions powered by artificial intelligence (AI) as a potential avenue to make the transport sector both greener and more efficient, while supporting business growth.[104] As aviation looks to expand, the applications of AI across the sector are wide-ranging, from more seamless management of passenger flows within the airport to greater efficiency and potentially additional carbon savings during operations.

> **As passenger traffic in aviation grows, so are airports expanding to capture this demand. As a result, airports are increasingly using AI to improve passenger experience and operational efficiency. At Industry.AI we connect hundreds of cameras across the airport and use advanced deep-tech vision AI to improve passenger flows. In addition, AI is being used to improve sustainability and emissions by optimizing the entire power and air-conditioning plant at airports.**
>
> Tejpreet S. Chopra, President & Chief Executive Officer, Industry.AI (BLP Group)

Some of the Airports of Tomorrow executives interviewed for this report were enthusiastic about AI as a topic of growing interest for 2025, both as a means to achieve decarbonization and to improve operations and revenue. While AI may have not yet achieved the same level of popularity as in other sectors, many stakeholders consulted were confident this will change throughout the year, with increased focus at the upcoming Dubai Airshow in November 2025.

Climate resilience

As aviation grows and airports expand, increasing scrutiny is being focused on the environmental footprint of materials and construction processes, as well as on the overall compatibility of growth and sustainability. This is happening at a time when severe climate-driven events are increasingly impacting aviation, highlighting the rise of climate adaptation and resilience as a priority topic for some of the executives interviewed, in particular for airports.

Following the heaviest rainfall on record in April 2024, flooding in Dubai and its impact on airport operations hit the headlines,[105] but there have been several other airports and airlines impacted by climate change, such as Porto Alegre in Brazil in August 2024.[106] A study published by ACI Latin America and Caribbean in 2024 found that over 90% of airports interviewed had experienced higher temperatures and rainfall, although only half of them have carried out or expect to complete a climate change risk assessment.[107] This highlights the limited visibility of climate resilience in airport planning, despite its immediate consequences on operations, as well as the need for greater guidance. In this context, ACI Europe and EUROCONTROL published a short briefing in November 2024 highlighting steps aviation stakeholders can take to prepare for climate disruptions.[108]

Some Airports of Tomorrow stakeholders have started to undertake action to bolster climate resilience. These include Ferrovial, which is raising the floor of its new JFK Terminal 1 buildings to mitigate flooding and Sofia Airport's use of heat-resistant materials for resurfacing.[109] As severe weather events intensify, airlines are also having to adapt their operations, in particular

due to increased turbulence – a recurring theme picked up by the news in 2024. Following a number of heavy turbulence episodes that entailed hospitalizations and casualties in the last year, several airlines are introducing changes to operations and onboard services.[110]

As the likelihood and frequency of severe weather events is expected to increase, some of the stakeholders interviewed expect the topic of climate resilience in aviation to assume a higher priority in executives' agendas going forward. This is not expected to compete with or deter climate mitigation action – rather, it is seen as an opportunity for the industry to engage on the topic of aviation sustainability with a wider pool of stakeholders that may be affected by climate disruptions at airports, such as insurance companies, public transport operators and hospitality providers.

> **Today's airports, many of them now decades old, are not equipped to handle the extreme weather increasingly affecting their operations. The heightened risk posed by these events will require airports to clearly articulate, plan and adequately fund measures to improve weather resilience, ensuring climate change adaptation features prominently in asset renewal and new facility design. This presents an unmissable opportunity for collaboration and design innovation, further enhancing safety and protecting the vital economic role of airports.**
>
> Justin Jones, Global Aviation Market Director, AtkinsRéalis

> **Airport resilience is rooted in embracing technological advancements, committing to sustainable practices, and fostering an adaptive, forward-thinking operational culture. Our comprehensive strategy focusing on digitalization and sustainability aims to transform Sofia Airport into an efficient, eco-friendly and resilient hub, capable of meeting the evolving needs of the aviation industry. As we look at the coming years, this holistic approach ensures that the airport is not only prepared for unforeseen events but is also positioned to lead in innovation and passenger satisfaction.**
>
> Jesus Caballero, Chief Executive Officer, Sofia Airport

Consumer experience

Among the other priorities competing for aviation executives' attention, both airlines and airports have flagged passenger experience as an area of focus, including before flying, with enhancements on booking systems and apps, and while travelling both on the ground and in the air.

The focus of recent improvements has increasingly revolved around improving the size, comfort and offer of premium classes due to the surging demand for premium products (+43% growth in premium passengers in mid-2024 compared to a year before) and the higher proportional contribution of the segment to revenue.[111] However, it is worth noting that this trend differs by region: North America is seeing a gradual phase-out of first class seats[112] and affordability remains a key priority in emerging markets.

Within this context, the sector has started to explore how to capitalize on the potentially higher willingness of premium or frequent flyers to pay a premium for their air travel, including for more sustainable travel choices. This has resulted in a growing trend to embed sustainability into passenger retention programmes, including through the award of bonus miles for SAF purchases as part of frequent flyer schemes for some airlines, starting from 2025.[113]

3.3 Social issues

Labour shortages and skills gaps

In 2024, the aviation industry continued to face significant challenges related to labour shortages and skills gaps that are having an impact on both airports and airlines across regions (from India to Australia).[114,115] Alongside pilots and cabin crew, vacancies were high for aircraft maintainers – an issue that has affected both the military and civilian sectors for several years.[116,117]

As passenger numbers increase, new airlines launch and new routes open, some of the stakeholders interviewed for this report were concerned that staffing shortages could get worse in the coming years –aligning with forecasts by ICAO that the sector will need 480,000 new technicians and over 350,000 pilots by 2026.[118] Existing and new airlines have ongoing recruitment campaigns. One example is Saudi Arabia's new carrier, Riyadh Air, which is expected to begin operations in 2025 and is actively recruiting 700 new pilots.[119]

Workforce shortages can pose a threat to operational readiness and safety, as the recruitment of new maintainers may not keep pace with the needs of the industry.[120] In its *Next generation of aviation professionals (NGAP) strategy* released in 2024, ICAO identified the lack of qualified personnel as one of the key causes of low compliance with aviation safety requirements.[121]

There are also important implications on sustainability, as the turnover and number of vacancies has an impact on the retention of talent and skills at a time when new technology and sustainability practices are being embedded into airport and airline operations. The integration of AI, robotics and automation in aviation operations is creating demand for new skills,[122] alongside changes in refuelling and safety practices as multi-fuel technology is brought into the airport environment.

Looking ahead to 2025, stakeholders interviewed for this report highlighted how the aviation industry must take decisive action to address the labour shortage and skills gap to ensure future operational readiness and safety, through recruitment campaigns, streamlined certification and enhanced retention strategies, as well as through reskilling activities to ensure that future sustainability requirements can be met and opportunities leveraged by the existing workforce. As part of this, AI and automation are expected to play a key role, creating significant demand for technology-related skills, as well as uniquely human abilities such as creativity, critical thinking and adaptability.[123]

Beyond airlines and airports, stakeholders also highlighted labour shortages across other parts of the aviation and fuel value chains that can have an impact on the sector's ability to meet its internationally agreed targets. Among the concerns flagged were shortages of engineering, procurement and construction (EPC) contractors for SAF plants – a common trend affecting many other sectors, including wind energy.[124]

Just transition, involvement of the Global South and inequality

As part of the increasing need to channel more capital towards developing countries for decarbonization, support for a just transition in aviation has become a recurrent theme for governments and international organizations, including for some Airports of Tomorrow stakeholders. The just transition has been a key area of debate during international negotiations and discussions in 2024, both within ICAO and at COP29, which focused on raising climate finance for this topic.

The just transition across the economy is expected to remain a key priority for the sector in 2025, in particular during the ICAO General Assembly. A key priority of the Finvest Hub proposition unveiled by ICAO in February 2025 is the prioritization of financial support to scale-up alternative fuels in developing countries.[125]

A number of recent proposals to advance the just transition across the economy will have an impact on aviation. In October 2024, the International Monetary Fund (IMF) proposed the idea of pricing the emissions of international aviation and shipping, an approach they said could raise up to $200 billion a year in revenues by 2035, which could be allocated to climate finance.[126] Meanwhile, the Global Solidarity Levies Task Force – launched at COP28 and co-chaired by Barbados, France and Kenya – is planning to publish climate-related levy proposals across several sectors by April 2025. For aviation, the task force proposes a levy of €0.33 per litre of jet fuel for international flights, as well as a frequent flyer levy of $9 for a person's second flight, rising to $177 for their 20th flight within the same year. These two measures would generate an estimated $140 billion per year of funding, according to the task force.[127]

Airlines expressed their reservations with these proposals during COP29;[128] similarly, some of the executives interviewed for this report were not supportive of the measures, but expected this topic would continue to feature heavily in upcoming international discussions.

Meanwhile, programmes of foreign aid to support the decarbonization of the aviation sector continued, with over 20 feasibility studies in emerging countries being taken forward by the ICAO ACT-SAF programme in 2024, with support from the United Kingdom,[129] the Netherlands,[130] France, the European Union and Airbus.[131]

> The IMF has proposed the idea of pricing the emissions of international aviation and shipping, an approach they said could raise up to $200 billion a year in revenues by 2035, which could be allocated to climate finance.

3.4 Technology risks

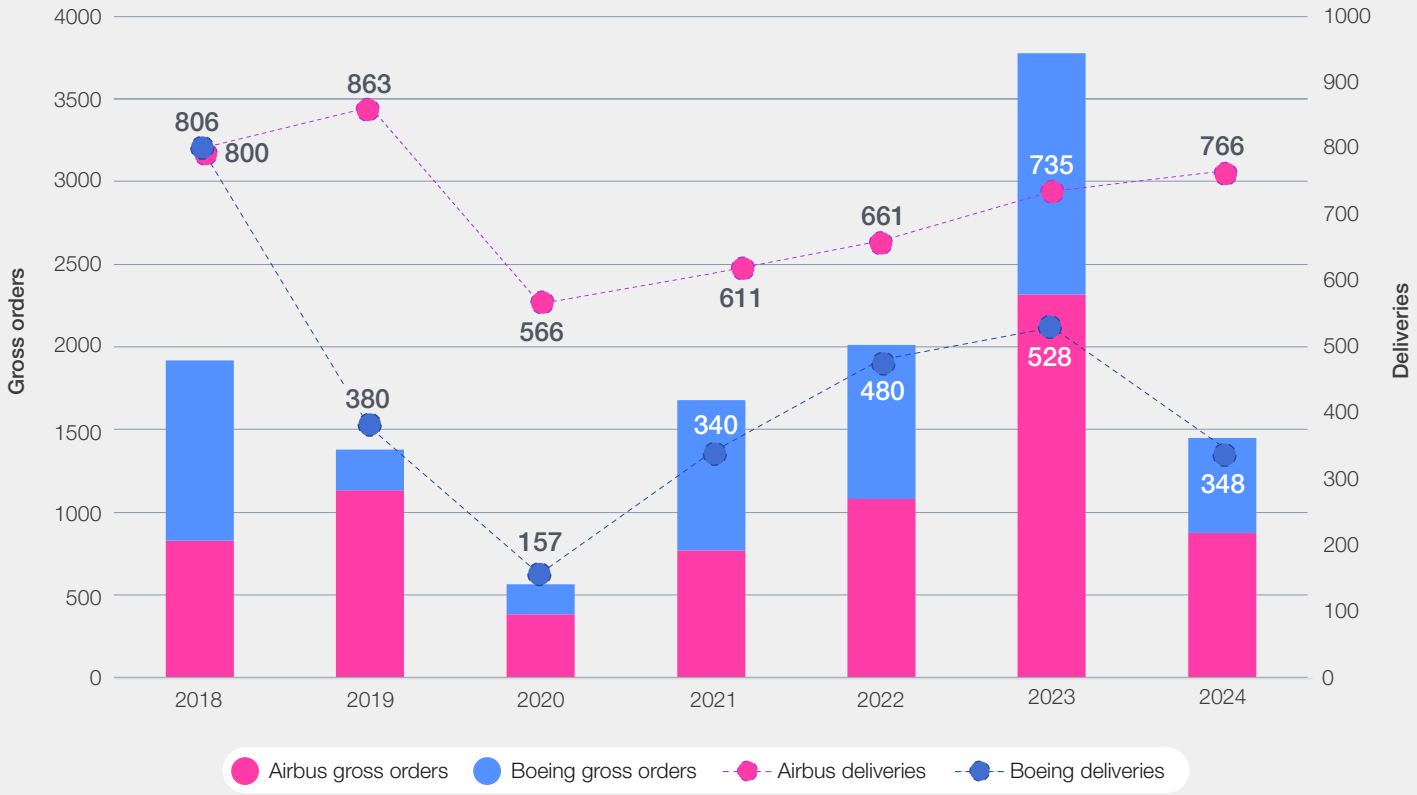
Conventional aircraft manufacturing and production slowdown

Delivery delays and other supply chain issues in 2024 have led airlines to keep flying older airplane models, negatively affecting fuel efficiency and increasing maintenance costs. With greater fuel efficiency being a key pillar of most, if not all, airlines' plans for net zero, this has impacted progress on decarbonization and even affected strategic goals around sustainability, as exemplified by Air New Zealand's decision to backtrack on its 2030 carbon emissions reduction commitment.[132]

OEMs have seen increased scrutiny on safety and production quality as well as some workforce disputes – these have had an impact both on the orders of new aircraft (down for Airbus and Boeing in 2024 compared to the previous year, as shown in Figure 13) and on the development of zero-carbon propulsion projects (discussed in Chapter 2).

Looking at 2025, Airbus and Boeing have outlined their strategies to address these challenges, with a positive outlook for production. Additionally, Honeywell's forecast indicates an increased demand for new business jets and stable growth for the next decade, which could positively impact both companies, as well as Comac (Commercial Aircraft Corporation of China), as they adapt to market demands and enhance their production capabilities.[133] Comac in particular is ramping up efforts to expand its production capacity and improve its supply chain to meet increasing demand,[134] especially from Southeast Asian countries.

FIGURE 13 **Airbus and Boeing – historic gross orders and deliveries (2018-2024)**



Source: Airbus and Boeing.

Delay in the rollout of new aircraft is pushing airlines to fly older and less efficient planes, often with additional costs needed to refurbish existing fleets, as demand for premium classes increases. For example, in 2024 British Airways[135] announced plans to retain and upgrade its A380 fleet with new cabins to improve the passenger experience, while increasing the number of premium seats; meanwhile, Emirates completed the refurbishment of its A380s and started to deploy these on a greater number of routes.[136]

Conclusion

More action is needed across the value chain to convert stakeholders' cautious optimism into greater confidence in aviation's ability to meet its decarbonization targets.

The research behind this report shows that industry stakeholders and governments are continuing to make significant progress towards decarbonization. Sentiment around the ability of the sector to meet its 2030 vision remains positive, while a huge amount of resources have been mobilized towards the transition.

However, market developments and the evolving views of aviation executives interviewed for this report highlight a number of challenges that have an impact on climate action. Some of these risks are specific to the aviation sector, while others are broader economic and geopolitical constraints. For aviation professionals involved in decarbonizing the sector, tackling some of these challenges while looking to grow sustainably can lead to trade-offs, while paving the way to innovation and new opportunities. These include artificial intelligence – a topic that has not featured heavily in this white paper but which is expected to attract further interest throughout the year and in future iterations of this exercise.

To reflect the priorities identified by Airports of Tomorrow and by executives engaged in the initiative throughout the year, the World Economic Forum's sustainable aviation work for 2025 will:

- Continue fostering discussions on SAF policy and geopolitics, identifying where possible synergies exist across regions as well as enablers of greater investment in SAF production and avenues to boost the demand signal, including in emerging markets.
- Keep interest in zero-carbon emissions propulsion and infrastructure alive, with an upcoming report on the steps airports can take to become energy hubs; including a greater focus on quantitative analysis that can help enhance an understanding of the techno-economic feasibility of multi-fuel applications within airports in the future.
- Explore how innovation can boost both the climate mitigation and adaptation agendas for aviation stakeholders, looking at best practice and enablers that airports and airlines are implementing to disseminate findings and lessons learned.

Appendix: Methodology

The analysis presented in this report is based on a comprehensive and multi-faceted approach, incorporating various data collection methods to ensure a realistic perspective from the Airports of Tomorrow community.

The insights presented in this report are based on the following inputs:

1. In-person regional Airports of Tomorrow roundtables held throughout 2024 in different locations, including Switzerland, Singapore, Saudi Arabia, China, Japan, Brazil and the US, as well as the Airports of Tomorrow Chief Executive Officers meeting hosted during the Annual Meeting in Davos in January 2025. These roundtables gathered nearly 300 executives and experts across regions and from different parts of the aviation value chain.

2. An anonymous survey conducted among C-suite executives at the end of 2024, which included responses from 25 stakeholders in the Airports of Tomorrow community and beyond. Those who indicated their stakeholder category included eight fuel producers or suppliers, three airports, two investors and one OEM. Others to respond included executives from airlines, non-governmental associations and trade bodies. Most were active predominantly in Europe, North America, the Middle East and Asia (excluding China). Survey questions included:

– How optimistic are you that the aviation sector will make meaningful progress towards decarbonization in 2025?

– How optimistic are you that the 2030 vision agreed at CAAF/3 last year will be achieved?

– Which are the top risks that most likely pose the biggest threat to aviation decarbonization progress in 2025, in your view?

– What is your top priority as a CEO when it comes to aviation sustainability for next year?

– What would you like the sector to achieve by the next ICAO General Assembly in September 2025?

– How do you expect aviation decarbonization policy to evolve next year across regions?

3. An anonymous survey of approximately 30 CEOs from the airports community, who were attending the Airports Council International World Annual General Assembly in Atlanta in September 2024. This was an earlier version of the survey rolled out at the end of 2024 with the Airports of Tomorrow community and was used to capture airport-specific priorities.

4. Over 20 bilateral interviews in the last quarter of 2024. These interviews allowed us to delve deeper into specific issues and gather detailed insights from key individuals. During these interactions, we explored various critical topics with CEOs and executives, focusing on specific issues and opportunities faced by each organization.

The insights collected from these various sources were meticulously analysed to provide a neutral and objective assessment of the industry's challenges and risks. By integrating these diverse data collection methods with additional desktop-based research and a review of the latest market developments, our methodology aims to depict the factual status of progress on decarbonization and to capture the overall sentiment of the aviation industry looking at 2025. This is not intended to be a forecast or prediction of how the sustainability discussion will evolve over time, but the approach can provide a solid foundation for additional debate within industry to maintain the momentum for aviation decarbonization.

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