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impact

ON SUSTAINABLE AVIATION

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INTRODUCTION

TAKING STOCK: AVIATION'S TRANSITION AT MID-YEAR 2026

By Ulrike Ziegler, President, impact on sustainable aviation e.V. (impact)

The first half of 2026 has reinforced a reality that many across the aviation ecosystem have long recognised: Aviation's transition is not a single technology challenge, nor a single policy challenge. It is a long-term, system-wide transformation requiring the alignment of finance, technology, infrastructure, regulation, markets, data, operational practices and, above all, collaboration.

Throughout the year, ***impact*** has continued to convene stakeholders from across the aviation value chain - from airlines, airports, fuel producers, manufacturers and investors to policymakers, academics and service providers - to explore the practical realities of decarbonising a sector that remains essential to global connectivity. The contributions collected in this mid-year publication reflect that diversity of perspectives. They examine issues ranging from SAF mandates, project bankability and sustainable finance to emerging propulsion technologies, carbon markets, non-CO_2 effects, air traffic management, infrastructure, regulation and market design.

Taken together, these contributions reveal a common theme: The transition is entering a more implementation-focused phase. Increasingly, the conversation is shifting from identifying potential solutions towards understanding how to mobilize funding and deploy solutions at scale. Questions of investment certainty, infrastructure readiness, risk allocation, commercial viability and delivery mechanisms are becoming as important as the technologies themselves.

This evolution was also reflected at the 2026 IMPACT Forum, where an invited group of industry leaders, decision-makers and subject-matter experts gathered under Chatham House Rules to discuss the opportunities and challenges shaping aviation's future. Held on an invitation-only basis, the Forum enabled a level of candour rarely possible in public settings, allowing participants to move beyond prepared remarks and openly discuss implementation barriers, emerging risks and opportunities for collaboration. A clear message emerged from those discussions: the industry's greatest challenge is not a lack of innovation, but the development of the ecosystem to turn innovation into deployment.

One topic that surfaced repeatedly throughout both the Forum and our expert discussions was **RISK**. As regulatory requirements evolve, carbon pricing mechanisms expand, technologies mature and market expectations continue to shift, aviation stakeholders are navigating an increasingly complex risk landscape. Transition risk is becoming a material consideration for airlines, airports, financiers and investors alike, influencing investment decisions, financing structures and long-term business planning. At the same time, participants highlighted the need to better understand other climate-related risks, particularly physical climate risks affecting infrastructure, operations, supply chains and asset resilience. The relationship between transition risks and physical climate risks is still evolving and represents an important area for further industry analysis and research.

This is where ***impact*** intends to continue playing a role. By convening stakeholders from across the aviation ecosystem, we aim to facilitate informed dialogue on the challenges

and opportunities shaping the sector's transition. Through our member calls, publications, interviews and the IMPACT Forum, we seek not only to share knowledge but also to help accelerate the conversations, collaboration and evidence-building that support effective decision-making. Insights emerging from these engagements will continue to inform future work on topics such as transition risk, climate resilience, project bankability, SAF market development, non-CO_2 impacts and the broader infrastructure requirements of aviation's transition.

As always, our objective is not simply to document developments in sustainable aviation, but to help foster the dialogue, evidence base and cross-sector collaboration needed to accelerate progress. We remain committed to bringing together diverse perspectives, challenging assumptions and periodically taking stock of where the industry stands on its transition journey.

The journey remains complex, and many uncertainties remain. Yet the conversations documented in this publication leave little doubt that momentum continues to build. The challenge ahead is not whether the transition will happen, but how effectively the aviation ecosystem can work together to make it happen at the scale and pace required.

PART 1: THE DECARBONISATION REALITY CHECK

impact MEMBERS' CALL EXCLUSIVE - A GENERAL NOTE

Throughout the first half of 2026, ***impact*** hosted a series of expert presentations featuring leading voices from across the aviation finance supply chain and beyond. Experts from the broader aviation decarbonization supply chain joined our bi-weekly members calls to share perspectives on the most pressing issues shaping aviation's path toward net zero.

The diversity of topics covered over the year reflects a fundamental reality: aviation's transition is not a single challenge with a single solution, but a complex, interconnected transformation. Progress depends not only on technological innovation, but equally on regulation, finance, data integrity, legal frameworks, market design, and risk management. Each session explored a different lever of change - and together, they illustrate how these elements must align to deliver credible, scalable decarbonization.

For ***impact*** members, these discussions provide early insight into emerging risks, opportunities, and decision points across the transition.

The executive summaries - featured throughout this publication - capture the key takeaways from each session. Read individually, they offer focused expertise. Read collectively, they underline a central message: managing aviation's decarbonization is a system challenge - and understanding that system and the building of a broad aviation transition stakeholder network is becoming a strategic necessity.

impact MEMBERS' CALL EXCLUSIVE: "AVIATION VISION 2050: THE POTENTIAL FOR CLIMATE-NEUTRAL GROWTH"

By Sola Zheng – Senior Researcher at ICCT

Sola explored aviation's pathway to climate-neutral growth by 2050. It highlighted the gap between current progress and net-zero targets, while emphasizing the growing importance of non-CO_2 impacts-especially contrails-as key drivers of aviation's climate footprint. The discussion covered mitigation options such as SAF, contrail avoidance, and hydrotreating, along with their cost, scalability, and implementation challenges. Overall, the session underlined that only a combined approach addressing both CO_2 and non-CO_2 emissions can deliver meaningful progress.

impact MEMBERS' CALL EXCLUSIVE: "RISING AVIATION EMISSIONS: BRIDGING THE GAP BETWEEN TRAFFIC GROWTH AND DECARBONISATION"

By Andrew Doyle & Richard Evans - Senior Consultants at Cirium Ascend Consultancy

Andrew and Richard examined the widening gap between aviation traffic growth and decarbonization efforts. It showed that while efficiency improvements from fleet renewal, higher load factors, and operational gains are real, they are being outpaced by rising demand - leading to

increasing absolute emissions above pre-pandemic levels. The discussion also highlighted structural challenges, including the growing role of less efficient freighters and limited further gains in load factors. Overall, the session underscored that efficiency measures alone are insufficient, pointing to the need for scalable solutions such as SAF, improved data transparency, and broader systemic change to achieve net-zero target

FROM ASYMPTOTE TO HONESTY – WHAT AIR TRAFFIC MANAGEMENT CAN CONTRIBUTE TO AVIATION'S DECARBONIZATION

By Jörg Buxbaum - Doctoral Researcher at Technische Universität Braunschweig; Head of ATM Research and Foresight, DFS Deutsche Flugsicherung GmbH

Air navigation services are often portrayed in the sustainable aviation debate as a fast, simple, cost-efficient lever for cutting emissions. The argument is appealing: more direct routes, optimized flight profiles, less holding – all reduce emissions quickly, and buy the time disruptive innovation needs. None of this is fundamentally wrong. But it falls short.

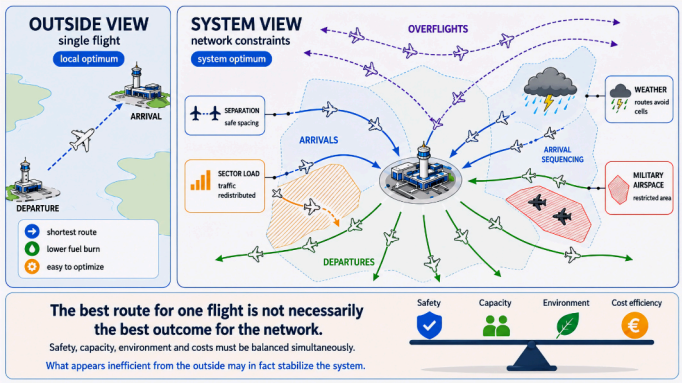
A problem does not become simple just because you describe a simple solution

For decades, the debate about the efficiency of European airspace has followed a simple logic: too many detours, too much fragmentation, too little coordination. From this, the expectation is derived that structural unification - the Single European Sky - must yield large, system-wide improvements. This view is appealing, and therefore widespread. But it captures the actual core of the problem only incompletely.

Yes: air traffic management (ATM) has a tangible influence on CO_2 reduction. Because of the system characteristics of air traffic, however, that influence is considerably smaller than is often claimed. And it competes with a factor that receives surprisingly little attention in many optimization calculations: the so far unchecked growth of air traffic.

Air traffic management obeys no classical optimization concept. It is a highly dynamic, net-worked, complex system with heterogeneous stakeholders, the highest safety objectives and constant exposure to weather. It mirrors its success across four dimensions simultaneously: safety, capacity, environment and cost. These do not sit side by side additively but stand in permanent tension – every change in one dimension affects the others.

Air navigation services therefore do not maximize any single target value; they balance a highly complex system. What looks like inefficiency from the outside, and is marketed politically as such, on the inside often is stabilization.



What actually is possible – and why we are not starting from zero

Within this system there are genuinely effective levers. More direct routes shorten flight paths; the gradual introduction of Free Route Airspace has already delivered measurable reductions. The average route extension relative to the shortest path in Europe is now down to just over 2.5 per cent – almost exactly the US figure, where there is no call for a “unified airspace” in the first place. Continuous Descent Operations (CDO) avoid the energy-intensive step profiles of conventional approaches and save, depending on traffic, 50 to 150 kilograms of fuel per approach of an A320 or a 737. As traffic increases, however, the success rate falls: an airport such as Frankfurt handles around 700 landings a day and having them all fly maximally fuel-efficient and safely separated approaches at the same time is physically impossible.

Optimized airspace and procedures bring local as well as system-wide improvements – but within an inherent conflict: not every local improvement benefits the overall system, and vice versa. Every solution is ultimately a compromise, leaving residual “efficiency potential” visible to observers. AI-assisted planning, too - a much-discussed promise at present - does not change physical boundary conditions. It cannot create airspace that is not there, nor remove separation minima that exist for good reason. A high-energy wake vortex behind an A380 obeys the laws of physics alone, and those we cannot change.

How realistic is further potential?

In the strategic documents of European aviation, the fuel-saving potential from ATM optimization is put at 6 to 11 per cent - from the EUROCONTROL Fuel Inefficiency Study (8.6 to 11.2 per cent) and the European Commission (10 per cent) to the Destination 2050 roadmap (6 per cent). ATM contribution and airline operations are often reported together, which tends to overstate the actual room for maneuver that air navigation services have on their own.

Break these figures down and a more differentiated picture emerges. A substantial share - an estimated 3 to 5 per cent - consists of immutable system characteristics: the price paid for separation minima, capacity buffers, military use and weather. A further 2 to 3 per cent has already been captured by the measures of the past two decades - Free Route Airspace, A-CDM, cross-border airspace optimization. What remains realistically achievable

is in the order of 1 to 3 per cent. Taken together, these three components span the same 6 to 11 per cent cited above.

Efficiency gains follow a law familiar from economics and engineering alike: costs rise disproportionately the closer you get to the theoretical optimum. The first improvements are cheap; every further per cent becomes more demanding, more expensive and more conflict-laden. And efficiency gains have, by their nature, an asymptote – at some point the curve flattens. In ATM we have already reached that region in many places. There is no "low-hanging fruit" left, even if the term is still heard, including at scientific conferences.

On top of this comes a measurement problem: if the remaining potential is only a few per cent, the measurement must be at least as precise as the expected improvement - in validation, in simulation and in operations. But against what should one measure in an operation that runs differently every day because of weather, payload, cost index and traffic? Air navigation services do not even know the actual fuel burn of a flight - that information is available only to the cockpit crew and, post-ops, to the airline.

None of this means that further optimization is pointless. It means we have to speak honestly about the proportionality of effort and return. And above all: efficiency improvement is no substitute for disruptive innovation. The history of the diesel engine is a case study – optimized for decades, per centage point by per centage point. Structural change did not come from the next injection tweak, but from new players with a different agenda, and the laws of physics on their side.

Aviation's efficiency trap

Even if every operational potential were fully exhausted, a fundamental problem would remain: efficiency works in relative terms, emissions in absolute ones.

The figures are unambiguous. According to Cirium EmeraldSky, the global CO_2 emissions of commercial aviation in 2024 were already one per cent above the CORSIA baseline year of 2019. The share of modern aircraft types – A320neo, 737 MAX, A350 – rose over the same period from 14 to 34 per cent of the passenger fleet, and CO_2 intensity per passenger kilometer dropped by around seven per cent. And yet absolute emissions rose, because passenger traffic grew four per cent beyond the pre-crisis level. We are becoming more efficient in certain terms and still emitting ever more. That is aviation's efficiency trap.

A simple calculation makes it tangible. Germany handles around three million flights a year; at an average of ten tonnes of CO_2 per flight, that gives a baseline of roughly 30 million tonnes per year. If air navigation services save two per cent of fuel through every available measure, that figure falls by 600,000 tonnes - a substantial amount. But traffic growth acts cumulatively: at two per cent annual growth, it takes just one year for the additional traffic to offset the entire ATM saving. After ten years, the growth-driven additional emissions exceed the annual ATM saving many times over. This dynamic cannot be resolved by optimizing individual system elements.

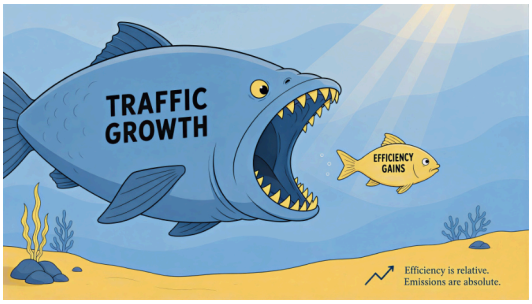
The elephant in the room

The fact that traffic growth consumes nearly all non-disruptive efficiency gains is like the elephant in the room. This is discussed openly neither within the aviation community nor in wider society. Yet here lies the real stress test of any decarbonization strategy. Aviation is

possibly the only industrial sector that, in its official pathways, promises massive growth and net zero at the same time. In hardly any other sector would this be accepted un-questioned.

Even Sustainable Aviation Fuel – the most promising lever available today – is not climate-neutral. Across its full life cycle, SAF reduces the climate impact by roughly 50 to 70 per cent compared with fossil kerosene, depending on the production pathway. An enormous step forward, but not zero.

Perhaps an analogy helps. Anyone wanting to lose weight will not get there through more exercise alone; they also have to adjust their calorie intake. Aviation is currently promising to lose ten kilos while simultaneously stocking the buffet, enlarging the plates – and whetting the appetite. More efficiency is the exercise. But without an honest discussion about quantity – about growth – the equation stays incomplete.



Where the levers lie

If air navigation services can realistically contribute only a few more per cent, where do the levers lie? The next generation of ATM improvements differs fundamentally from the previous ones: it relies not on individual, isolated measures but on integrating digital systems into a coherent control loop. Three lines of development mesh together. Digital air-ground communication turns the point-by-point voice dialogue into a consistent, plannable exchange: the aircraft shares its 4D trajectory, including mass and performance model, and the ground side gains, for the first time, a precise picture of airborne intentions. AI-assisted planning can help where complexity exceeds human processing but is not yet in use anywhere in safety-critical operations, because the requirements for certification and traceability are especially high. And contrail avoidance – the targeted circumvention of ice-supersaturated air layers – can reduce the formation of climate-relevant condensation trails, whose effect, according to current research, could be of a magnitude similar to aviation's CO_2 impact. All three aim at the same long-term goal: a multi-criteria optimization across four dimensions, in which separation, energy efficiency, contrail avoidance and operational constraints are weighed simultaneously. No promise for tomorrow, but the right direction for the aviation of the day after.

As important as their own contributions are, the decisive levers lie elsewhere. Fleet renewal brings a 15 to 20 per cent efficiency gain per generation but does not lead to zero consumption. SAF is subject to the efficiency trap: to hold emissions at today's level alone would, depending on growth, require a share of 17 to 32 per cent – a multiple of the ReFuelEU target of 6 per cent by 2030. New propulsion systems such as hydrogen promise transformative change in the long run, but their operational maturity is still decades away. For all three levers, air navigation services have options to intervene – and

here it becomes concrete, and partly uncomfortable: should they give preferential treatment to lower-emission aircraft, for instance along the lines of “best equipped, best served”? That is a politically highly sensitive intervention in competition, but a discussion that could be held. And entirely new requirements are emerging: were hydrogen aircraft to enter regular operation, air navigation services would have to develop separation rules based not only on safety distances but also on the emission characteristics of the aircraft involved.

Scientifically grounded, not politically positioned

As an organization that neither manufactures nor operates aircraft, neither sells fuel nor trades emission rights, an air navigation service provider holds a rare property in this debate: it is not an interest group, but a central system actor with a sovereign mandate. This carries an obligation: it means acting based on facts, not industry narratives or political wishful scenarios. It means placing one’s own contribution honestly: neither talking it down, nor selling as a solution what is in fact support. And it means asking uncomfortable questions - for instance about the proportionality of efficiency promises and traffic growth.

A closing thought

The decarbonization of aviation is one of the industry’s greatest challenges – a decades-long, shared effort. This transformation will not fail because of air navigation services; nor will it succeed through them alone. It will be decided by whether an incredibly safe industry built on growth musters the honesty to finish its own arithmetic, and whether it is prepared not merely to promise growth and climate goals at once, but to measure the plausibility of that ambition against the properties of the system. Air navigation services can help steer their own industry onto a realistic course towards greater environmental compatibility.

This contribution reflects the author’s personal views exclusively and was written in the context of his academic work. It represents neither an official position of DFS Deutsche Flugsicherung GmbH nor of Technische Universität Braunschweig.

AVIATION EMISSIONS IN 2025: EFFICIENCY GAINS STRUGGLE TO COUNTER GROWTH

By Andrew Doyle & Richard Evans - Senior Consultants at Cirium Ascend Consultancy (Cirium)

Despite decades of progress in aircraft efficiency, global aviation emissions continue to rise. That was the central message of a Cirium-led webinar reviewing aviation emissions in 2025, delivered to members of the Impact on Sustainable Aviation initiative. Drawing on highly granular flight-level data, the session examined why absolute emissions are now once again above pre-pandemic levels - and why efficiency alone will not be enough to reverse the trend.

The presentation was led by Andrew Doyle and Richard Evans of Cirium Ascend Consultancy and moderated by Finlay Grogan, Bank of China. Together, they walked participants through Cirium's emissions methodology, the global emissions picture for 2025, and the structural limits of operational and technological efficiency as a decarbonization strategy.

A granular approach to emissions modelling

Cirium's emissions analysis begins at the aircraft tail number level. Rather than relying on simplified great-circle distance assumptions, Cirium tracks individual flights using space-based ADS-B data, capturing real taxi times, airborne durations and routing deviations due to weather or airspace constraints.

To estimate fuel burn, Cirium builds each flight from the ground up. Aircraft operating empty weight is adjusted to reflect real-world airline configurations, then combined with estimated passenger payloads derived from installed seat counts and airline-reported load factors. For widebody aircraft, assumed belly cargo is also included, recognizing that cargo contributes materially to total fuel burn on long-haul routes.

Fuel consumption is then calculated using non-linear fuel burn models specific to each aircraft-engine combination, accounting for factors such as step climbs, winglet equipage and aircraft ageing effects. According to Andrew Doyle, this approach produces results that have been closely benchmarked against airline data and closely reflect operational reality when viewed in aggregate.

2025: Emissions surpass 2019 levels

Using this methodology, Cirium estimates that global aviation CO_2 emissions in 2025 exceeded 2019 levels by around 5 per cent, even before considering growth into 2026. While unit emissions - CO_2 per available seat kilometre or per revenue tonne kilometre - have continued to improve, these gains have been outweighed by increased traffic volumes.

The recovery has been uneven across aircraft types. Single-aisle fleets rebounded more quickly after COVID-19, partly because manufacturers have struggled to ramp up widebody production. At the same time, utilization of dedicated freighters has remained structurally elevated. Cargo aircraft now account for roughly 12 per cent of aviation emissions,

up from around 8 per cent in 2019, reflecting both higher utilization and the older, less efficient nature of many freighter fleets.

Regionally, most parts of the world had already exceeded 2019 emissions levels by 2024, with Europe following in 2025. While some Asian markets were still completing their post-pandemic recovery, the broader global picture is clear: absolute emissions are rising again.

Why efficiency improvements are slowing

Historically, aviation has delivered substantial efficiency gains through three main levers: improved aircraft technology, higher load factors, and increased seating density. All three are now approaching practical limits.

Average passenger load factors rose from roughly 55 per cent in 1970 to over 83 per cent by 2024–25. Low-cost carriers regularly operate above 90 per cent. However, Cirium's forecasts suggest little room for further improvement, with global load factors expected to increase by only around 1.5 percentage points over the next two decades.

Seating density has also increased dramatically, particularly in the narrowbody fleet. An A320 originally specified at around 150 seats is now commonly configured with more than 175, while some new aircraft on order exceed 180 seats. These changes have delivered substantial reductions in emissions per seat kilometre - but they cannot be repeated indefinitely.

Fleet renewal continues to deliver savings, with new-generation aircraft such as the A320neo, 737 MAX, A350 and 787 burning roughly 15–20 per cent less fuel than the aircraft they replace. By the end of 2025, these types accounted for nearly 40 per cent of the global fleet, up from around 14 per cent in 2019. Yet even under optimistic assumptions, continued fleet renewal may only deliver around a 10–15 per cent reduction in emissions intensity over the long term.

Absolute emissions versus intensity: A persistent tension

A recurring theme in the discussion was the divergence between efficiency metrics and absolute emissions. While CO_2 per revenue tonne kilometre has resumed its long-term downward trend since the disruption of the pandemic, it is only just back to 2019 levels. Meanwhile, total emissions are rising.

As Richard Evans noted, even if the industry extracted every plausible efficiency gain - from fleet renewal, air traffic management improvements and single-engine taxiing - the combined impact would fall well short of the reductions required for net zero. In his estimate, such measures might address perhaps 20–25 per cent of the total decarbonization challenge, leaving the majority unresolved.

The underlying problem is structural. Efficiency improvements reduce operating costs, which in turn stimulate demand and encourage additional flying. As a result, improved efficiency has historically been accompanied by growth in total traffic rather than a reduction in absolute emissions.

Operational inefficiencies still matter

While efficiency gains are slowing, the webinar highlighted several areas where operational improvements could still yield meaningful savings. Cirium's time-based modelling reveals substantial variation in emissions between flights of similar distance due to congestion, sub-optimal routings and extended taxi times.

Airspace constraints remain a major contributor. Detours around closed Russian airspace have increased fuel burn by up to 25 per cent on some long-haul routes, while Middle Eastern airspace disruptions have had more modest - but still measurable - effects. In China, constrained airspace management forces some aircraft to cruise at non-optimal altitudes for long portions of their flights, potentially adding significant fuel burn.

Ground operations are another "grey area". Practices such as single-engine taxiing, reduced auxiliary power unit (APU) usage and greater reliance on ground power can all cut emissions, but consistent, verifiable data remains scarce. Cirium can incorporate these effects into its models, but only when reliable operational data is available from airlines or airports.

Airline and route-level insights

One of Cirium's strengths is its ability to analyse emissions at the airline, market and route level. For 2025, Cirium compared airlines by passenger CO_2 per available seat kilometre, adjusting for belly cargo on widebody flights to isolate passenger emissions.

The rankings tend to favour airlines operating young fleets with high-density seating, but they also reveal how operational choices affect outcomes. Route-level analysis shows that year-on-year improvements are most often driven by aircraft up-gauging or replacement with new-generation types. In a small number of cases, airspace re-openings or routing changes produced substantial emissions reductions without any fleet change at all.

Such granularity, Andrew Doyle argued, is essential for understanding where emissions reductions are actually coming from - and where they are not.

The unresolved role of Sustainable Aviation Fuel

Sustainable Aviation Fuel (SAF) featured prominently in the Q&A. While SAF has the potential to deliver large lifecycle emissions reductions, Cirium does not yet include it in its core emissions estimates. The reason is not methodological, but data-related.

SAF is not allocated at flight or airport level and is increasingly claimed via book-and-claim mechanisms. This makes it impossible to attribute SAF usage reliably without transparent, standardized airline-level reporting. Compounding the problem, aggregate airline SAF claims currently appear to exceed estimated global SAF supply, raising concerns over double counting across scopes and geographies.

Both Andrew Doyle and Richard Evans stressed that once SAF usage becomes material and verifiable at airline level, Cirium fully intends to integrate it into its analysis. Until then, treating SAF claims cautiously remains essential for analytical credibility.

Conclusion: efficiency is necessary, but insufficient

The 2025 emissions review paints a sobering picture. Aviation continues to make real efficiency progress, but those gains are being overwhelmed by traffic growth. Fleet

renewal, operational improvements and better airspace management remain important—but they address only a fraction of the decarbonization challenge.

As the discussion underscored, meeting aviation's climate goals will require measures that go far beyond efficiency: large-scale deployment of SAF, credible carbon removal, and potentially much harder conversations about demand growth itself. In the meantime, transparent, flight-level data remains indispensable - not to tell a comforting story, but to clearly show where the industry really stands.

THE IMPACT FORUM: FROM AMBITION TO IMPLEMENTATION - WHERE ARE WE REALLY ON AVIATION'S TRANSITION?

By Ulrike Ziegler, impact

The IMPACT Forum 2026 brought together an invitation-only group of scientists, policymakers, investors, financiers, airlines, OEMs, airports, fuel producers and other senior decision-makers from across the aviation ecosystem. Hosted under the theme "Where are we really?", the Forum was designed as a reality check on aviation's transition - assessing progress across multiple decarbonization technologies, examining emerging risks and identifying the conditions required to move from ambition to implementation.

Held under Chatham House Rules, the event created a trusted environment for open and candid discussion, enabling participants to challenge assumptions, share lessons learned and openly explore areas of uncertainty that are often difficult to address in more public settings.

Aviation has entered the implementation era

A recurring observation throughout the Forum was that aviation has entered a new phase of its transition journey. For much of the last years, the industry's focus was on setting targets, developing technologies and establishing potential pathways to Net Zero. Today, few question that sustainable aviation fuels, next-generation aircraft, operational improvements, carbon removals and contrail mitigation will all have a role to play. The challenge is increasingly one of deployment rather than discovery.

Across discussions on fuels, aircraft technology, infrastructure, finance and climate risk, participants repeatedly returned to the same question: how can solutions be implemented at the speed and scale required?

The transition is therefore becoming less about identifying answers and more about creating the conditions that allow those answers to succeed.

One transition has become many

Another clear takeaway was that aviation is not managing a single transition.

The industry's decarbonization agenda now consists of multiple, interconnected solutions advancing simultaneously. Sustainable aviation fuels continue to dominate near-term discussions, but they are only one piece of a much broader picture that also includes aircraft technology, hydrogen, electrification, operational efficiencies, contrail mitigation, carbon removals and energy security. Each solution is progressing at a different pace, with different requirements, timelines, financing needs and levels of technological maturity.

As a result, the challenge facing industry leaders is increasingly one of coordination. Progress in one area often depends on progress elsewhere. Aircraft technologies require supporting infrastructure. Fuel pathways depend on energy systems. Investment decisions rely on regulatory certainty. Operational improvements require access to data and collaboration across stakeholders.

Success will therefore depend less on any individual breakthrough and more on the industry's ability to manage these transitions as part of a connected system.

Infrastructure is more than steel and concrete

Infrastructure featured prominently throughout the Forum, but often in a broader sense than traditionally understood. Physical infrastructure remains critical. Airports, fuel production facilities, blending systems, hydrogen logistics, electricity networks and future energy supply chains will all play essential roles in aviation's transition.

Yet participants repeatedly highlighted the importance of another form of infra-structure: the institutional frameworks that allow investment and deployment to occur. Standards, certification processes, financing mechanisms, revenue models, regulatory frameworks and market signals were all identified as essential components of a functioning transition ecosystem. Without them, capital remains hesitant, projects struggle to reach final investment decision and deployment slows.

Perhaps one of the more notable observations was that capital itself does not appear to be the primary constraint. Multiple speakers argued that debt and equity funding are available for well-structured projects. The greater challenge lies in creating investment environments characterized by sufficient certainty, transparency and commercial viability.

Energy security is changing the conversation

A theme that surfaced repeatedly throughout the Forum was the increasingly close relationship between decarbonization and energy security. Historically, the transition has been viewed largely through a climate lens. Increasingly, however, geopolitical developments, supply-chain resilience and strategic autonomy are influencing decision-making alongside emissions reduction objectives.

Questions around domestic fuel production, energy independence, supply-chain vulnerability and long-term resilience appeared across discussions on both fuels and infrastructure.

For some stakeholders, energy security is becoming a complementary rationale for investment. This does not diminish the importance of climate objectives, but it does broaden the case for action. As the transition progresses, resilience may become as important a consideration as decarbonization itself.

The cost of inaction is becoming clearer

While discussions often focus on the cost of transition, the Forum devoted considerable attention to another question: the cost of failing to transition. Research presented during the event highlighted the potential economic consequences of insufficient deployment of decarbonization solutions and the resulting constraints on future aviation growth. More broadly, participants discussed the implications of delayed investment decisions, postponed infrastructure deployment and continued policy uncertainty.

Historically, the industry has tended to focus on the risks associated with action. Increasingly, attention is shifting toward the risks associated with inaction.

Aviation's long asset lifecycles, complex infrastructure requirements and growing demand mean that delayed decisions can have consequences that persist for years.

One of the Forum's more thought-provoking conclusions was that waiting for certainty is not always the lowest-risk strategy.

Non-CO_2 effects and climate risk are moving centre stage

The growing prominence of non-CO_2 effects was another notable development. Contrails, fuel composition and other non-CO_2 impacts are steadily moving beyond academic discussion and becoming part of the industry's broader strategic conversation. While scientific uncertainties remain, there was widespread recognition that future climate strategies are unlikely to focus exclusively on carbon emissions.

The same can be said of climate risk more generally.

Participants distinguished between transition risk - the risks associated with changing technologies, policies and markets - and physical climate risk, including weather disruption, airport resilience, infrastructure vulnerability and changing operating conditions.

One particularly interesting observation was that aviation's understanding of risk may still be at an early stage. Survey results presented during the Forum suggested that while many organizations recognize transition risk as a material issue, comparatively few have fully integrated it into decision-making frameworks.

This gap between awareness and implementation emerged as an important area for future work.

Credibility is becoming a strategic consideration

If one concept connected many of the Forum's discussions, it was credibility. Whether discussing transition plans, SAF pathways, carbon removals, climate reporting,

certification standards or capital allocation, participants repeatedly returned to the importance of trust, transparency and evidence.

As solutions multiply and stakeholders face increasing scrutiny, credibility is emerging as a strategic asset.

Future leadership may be defined less by the scale of ambitions announced and more by the ability to demonstrate measurable progress against them. Investors, regulators, customers and policymakers are increasingly looking for evidence of delivery rather than statements of intent.

Looking ahead

As aviation moves deeper into the implementation phase of its transition, a number of research priorities emerged from the Forum's discussions. These include transition risk, physical climate risk, non-CO_2 effects, infrastructure readiness and the systems required to support large-scale deployment of emerging technologies.

Building on the outcomes of the 2026 event, IMPACT intends to continue exploring some of these themes through its research activities and to convene a third edition of the Forum.

If there was one defining insight from the discussions, it was that aviation's challenge is implementing solutions at scale while managing an unprecedented level of technological, financial, operational and regulatory complexity.

The transition remains achievable. But success will depend not on any single technology or policy intervention, but on the industry's ability to coordinate multiple solutions simultaneously, understand both the risks of action and inaction, and build the physical, financial and institutional foundations required for long-term transformation.

In that sense, the 2026 Forum served as a reality check on execution. And increasingly, execution is where aviation's future will be decided.

PART 2: RISK, RESILIENCE & POLICY

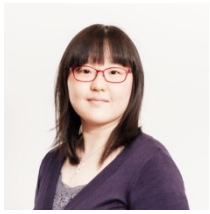
impact MEMBERS' CALL EXCLUSIVE: "RISK ALERT – MULTI-MILLION COST INCREASE FOR AIRLINES & MISLEADING METRICS"

Featuring Paul Conroy - Product Manager at PACE – and Prof. Philipp Goedeking - Expert on aviation economics and network strategy at Johannes Gutenberg University Mainz

The Members' Call session examined the growing financial materiality of transition risk in aviation, focusing on how tightening regulation, carbon pricing, and improved emissions data are reshaping the sector. The discussion highlighted the limits of efficiency gains amid rising traffic, the increasing exposure of airlines and financiers to carbon costs, and the need to embed forward-looking carbon assumptions into financial models. Particular attention was given to the Milestone Concept as a scientifically robust, impact-focused framework gaining market traction, alongside the broader need for aligned standards and cross-industry cooperation to manage transition risk effectively.

impact MEMBERS' CALL EXCLUSIVE: "CLEARING THE CLOUDS: NAVIGATING CHINA'S AVIATION DECARBONIZATION POLICY LANDSCAPE AND 2026 HIGHLIGHTS"

Featuring Yan Qin - Principal Analyst at ClearBlue Markets



Yan Qin provided insights into how China's aviation decarbonization mandates formalize under the 15th Five-Year Plan as China moves into "Carbon Dual Control". The session also discussed the strategic timeline and regulatory requirements for integrating the aviation sector into the national Emissions Trading Scheme (ETS) as well as China's role in CORSIA. Finally, the session evaluated the current landscape of SAF mandates and the policy frameworks accelerating its commercial adoption.

ESG SANCTIONS IN AVIATION: THE HIDDEN COST OF COMPLIANCE FAILURE

By Marina Efthymiou - Professor of Aviation Management and Director of the DCU Sustainable Aviation Hub

The airline industry operates in an increasingly rigorous regulatory environment. Beyond operational metrics like fuel costs and crew scheduling, carriers face constant scrutiny over environmental footprint, labour practices, and business conduct. When things go wrong, financial consequences extend far beyond a simple regulatory fine. New research conducted at Dublin City University's Sustainable Aviation Hub examining 45 enforcement actions against 15 publicly traded European and UK airlines between 2000 and 2024 reveals a sobering reality: shareholder losses from ESG-related sanctions exceed direct penalties by nearly three times. While regulators imposed approximately USD 770 million in fines during this period, the total market value destruction reached USD 2.1 billion, a striking 2.7 times multiplier. This gap underscores how capital markets penalize misconduct far more severely than regulators do.

This pattern carries profound implications for every stakeholder in aviation's capital chain: lessors evaluating counterparty risk, airlines designing compliance strategies, and investors building risk models. The story is not simply that ESG violations are costly. Rather, when and how violations become public determines the severity of market punishment far more than the eventual fine itself. The reputational damage and forward-looking valuation adjustments dwarf the regulatory penalties themselves. Understanding this temporal dynamic is essential for anyone with exposure to airline risk, as traditional risk models focusing only on direct penalties vastly underestimate true economic costs.

Table 1: Market Impact by Violation Type

Violation Type	Frequency	Avg CAR (-5, +5)
Social Violations	24 events (53%)	-3.81%
Governance Violations	19 events (42%)	-3.33%
Environmental Violations	2 events (4%)	-3.81%

Think of ESG violations like icebergs. When regulators announce investigations or preliminary findings, the market experiences an immediate jolt. Investors suddenly confront uncertainty about management quality, internal control systems, and the potential for cascading violations across multiple business units and regions. In the research sample, airlines saw cumulative abnormal returns of approximately minus 3.6% over a five-day window surrounding the first public disclosure of misconduct. Across an industry with market capitalizations in the tens of billions, this translates to billions in shareholder value destruction within days of announcement. The paradox becomes starkly clear when the final sanction arrives months or years later: the market's reaction reverses. Average returns turn slightly positive, around plus 1.3%, as investors view the resolution of uncertainty as a relief. This revelation-versus-resolution effect demonstrates that investors have already adjusted stock valuations when the violation first surfaced, not when regulatory penalties are ultimately imposed.

Not all ESG violations are created equal in investor eyes. Governance violations, particularly anti-competitive practices and regulatory failures, triggered the most severe

shareholder penalties at minus 3.3%. This reflects investor concerns about deeper organizational problems, board oversight effectiveness, and whether management discipline remains intact throughout the organization. When airlines engage in predatory pricing or market manipulation, investors question the strength of internal control systems and fear cascading additional violations. Social violations, though more frequent at 53% of all cases, generated more muted reactions. This pattern reflects investor perceptions that labour-related breaches carry smaller enterprise-wide cash flow consequences and represent an inevitable cost of operating customer-intensive, labour-heavy businesses. Environmental violations were least common in this historical sample, but this is likely to change significantly as the EU's aviation sustainability agenda intensifies through Sustainable Aviation Fuels mandates and emissions trading expansion.

Table 2: Market Reaction: Revelation vs Resolution

Event Window	Revelation	Resolution
(-2, +2)	-3.13%***	+0.68%
(-5, +5)	-3.61%***	+1.35%

Here lies perhaps the most actionable finding: the longer the delay between misconduct and public disclosure, the smaller the market reaction. Every doubling of the violation-to-announcement interval reduces abnormal returns by approximately 0.73 per centage points. This occurs because information inevitably leaks through informal networks and media channels before official announcements arrive. Rumors circulate among competitors and industry observers, whistleblowers share intelligence with journalists, regulatory preliminary findings appear in local press coverage, and speculative media reports gradually emerge. By the time formal disclosure arrives, much of the bad news is already embedded in the stock price through gradual adjustment rather than concentrated price declines on a single day. Airlines cannot meaningfully limit market damage through delayed disclosure strategies.

Instead, prompt and transparent acknowledgment of violations, while painful in the short term, may actually minimize cumulative losses and preserve long-term credibility with capital markets and stakeholders. For aircraft lessors, ESG investigations represent material credit risks extending well beyond formal sanctions and remediation timelines. Compliance vulnerabilities should factor heavily into lease pricing, covenant design, and counterparty assessment. For airlines, the business case for ESG compliance investment is now demonstrably financial, not merely ethical or reputational. A single major sanction can destroy shareholder value equivalent to multiple years of earnings. For investors, governance breaches trigger sudden destruction through mechanisms that traditional operating metrics do not capture. The research conducted at Dublin City University's Sustainable Aviation Hub demonstrates that effective ESG compliance and transparency preserve shareholder value in ways that extend far beyond regulatory minimums.

Note: This article is based on Agarwal, S., & Efthymiou, M. (2025). Market Reactions to ESG Sanctions in the European Airline Industry. Journal of the Air Transport Research Society, 100087.https://doi.org/10.1016/j.jatrs.2025.100087

AIR SERVICES REGULATION: THE EU'S 'OTHER' BIG AVIATION POLICY ITEM IN 2026

By Eduardo Mariz, Sustainability Lead and Senior Analyst at Ishka Airfinance Global

The European Commission's revision of the EU ETS rules in 2026 has been at the centre of debate for airlines, environmental groups, and other industry stakeholders at large. However, that policy item is far from the only consequential development taking place this year. The revision of the EU's Air Services Regulation, a 2008 piece of legislation that governs multiple aspects of European airline operations, from market access and liquidity requirements to ownership and how air fares are set, is also up for revision. For aviation decarbonisation, the implications may not be immediately obvious, but they are in fact highly consequential.

The revision of the regulation, also known as 1008/2008, provides a useful reminder of the vast scope for action areas and efficiency improvements across all operational aspects of aviation – from efficiency-key overflight safeguards to carbon leakage-relevant ownership rules. For clean propulsion technologies, it may also unlock a path to improved market access and targeted support mechanisms, and enhance the business case for scaling zero- and low-emission aircraft deployment across the EU.

The greening of PSOs

The revision of 1008/2008 is seen by many as an opportunity to pave the way for the early economic viability of cleaner aircraft. The main set of proposed rules to tackle this would update permissible criteria in European tenders for subsidised Public Service Obligation (PSO) routes – leading to the creation of what many are calling 'Green PSOs'. Many PSO routes are seen as the ideal starting place for battery-electric, hybrid-electric, and hydrogen propulsion technologies. Taxpayers already support many of these 'thin routes' throughout Europe, making them early deployment scenarios for the adoption of next-generation low- and zero-emission aircraft by operators and investors.

There is a variety of views on how restrictive 'Green PSO' criteria should be in dictating eligible or preferred aircraft in tenders (zero or low-emission, turboprops vis-a-vis regional jets, minimum SAF or e-SAF associated blends). However, most stakeholders agree that an extension of permissible PSO duration over the current maximum of five years would be one of the best enablers, as it would create the fleet planning certainty for airlines and lessors to invest in newer aircraft and technologies.

The main platform representing start-up OEMs is the **Alliance for Zero-Emission Aviation** (AZEA)[1], of which impact is also a member. AZEA recommends that a dedicated 'Green PSO' structure, applying to zero-emission aircraft in routes of less than 500 km, be funded by national EU ETS revenues from aviation and cover a minimum of six years in duration.

A number of new propulsion OEMs such as **AURA AERO**[2], **Elysian**[3], and **ZeroAvia**[4] are also supportive of these measures.

Carbon leakage

One of the main criticisms of EU policy by airline associations is the recent increase of asymmetrical costs for international itineraries starting in Europe and for which connecting

[1] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565259_en
[2] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565259_en
[3] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3564852_en
[4] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565453_en

hubs inside and outside the EU compete for. According to DLR data, passengers transferring via non-EU airports rose from 38% in 2010 to 49% in 2019 and 55% in 2023. Much of the feedback by airline associations focuses[1] [2] [3]on this and the consequences of non-EU transfers and non-EU holiday destinations for carbon leakage – when efforts to cut emissions in one area lead to increased emissions elsewhere due to shifting production or delivery of services.

To address carbon leakage, most airlines and industry associations advocate closer alignment between the EU ETS and CORSIA, or better management of exposure to these systems. Some airlines, like **easyJet**[4], have called for the creation of a mechanism that, while preserving consumer choice, "applies" to non-EU leg of journeys originating in the EU via a non-EU hub to a non-EU final destination.

However, whether these demands are best addressed through the 1008/2008 revision, remains a subject of discussion. Some stakeholders[5] believe the issue of carbon leakage belongs outside of this regulation, and warn against overburdening the revision. Others, like environmental group T&E[6], see the risk of carbon leakage as being overly-exaggerated by industry, but nevertheless propose options like targeted SAF allowances, differentiated carbon pricing for at-risk routes, or targeted SAF levies.

Other decarbonisation implications

Beyond decarbonisation-focused revisions, there are other possible revisions to the regulatory framework that may have indirect implications European aviation decarbonisation.

One of them is **ownership** restrictions. Some stakeholders, like airport association **ACI Europe**[7], see "openness to third-country carriers" as a way to develop "strategic connectivity" and resilience. Loosening non-EU investment rules for airlines, they argue, would enable them to source capital during crisis more easily. However, changes in ownership can also have an impact on the development of route networks. The **European Cockpit Association** (ECA), a pilot trade union, cautions[8] that "third country investors risk using their investment to privilege long-haul operations via hubs in third countries" – a situation that could aggravate carbon leakage.

Another is the regulation's potential for creating **safeguards for overflight** – flights passing through a country with departure and destination in other countries. In recent years, air traffic control (ATC) strikes in some European countries, notably France, have temporarily forced longer routes, impacting airline schedules and increasing the emissions of impacted flights. Several stakeholders propose mandatory arbitration among parties before strikes can be called, advanced notice of strikes, and protection of all flights overflying the country.

Finally, there is the regulation's role in enabling **domestic flight bans**. A 2022 European Commission decision allowing a pioneering (but controversial) French measure to restrict flights between French city pairs with adequate train connections was based on the application of Article 20 of the regulation. Article 20 allows countries to suspend traffic rights on specific city-pairs when pollution pose a serious public-health danger.

[1] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565436_en
[2] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565416_en
[3] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565392_en
[4] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565264_en
[5] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565511_en
[6] https://uploads.transportenvironment.org/production/files/TE-reply-to-Air-Services-Regulation-public-consultation.pdf?dm=1777364039
[7] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14620-Aviation-EU-air-services-rules-revision-/F3565427_en
[8] https://www.eurocockpit.eu/sites/default/files/2025-11/ECA_Position_PP_Revision_1008_2008_final_0.pdf

A coalition of NGOs[1] last year said the article is "playing a needed role in avoiding projected emissions growth in the aviation sector," but industry stakeholders see its role in the French ban as stretching beyond its original purpose. Airlines, OEMs, and other industry stakeholders vehemently oppose flight bans, arguing that such measures deliver only marginal climate benefits while undermining the integrity of the single market. Beyond France, a law approved in Spain[2] at the end of 2025 also empowers the government to "reduce" flights between city pairs with an alternative 2.5-hour railway connection, except to and from domestic international hubs.

Note: The European Commission was expected to adopt a proposal to revise the Air Services Regulation in Q2 2026. As of 1 July 2026, when this report was finalised for publication, no proposal had yet been published.

[1] https://www.transportenvironment.org/articles/t-e-greenpeace-and-10-organisations-call-on-the-eu-to-maintain-the-law-promoting-alternatives-to-short-haul-flights
[2] https://www.boe.es/buscar/act.php?id=BOE-A-2025-24545

THE HORMUZ WAKE-UP CALL. A DEAL SIGNED, A DEAL BROKEN: WHY ENERGY SOVEREIGNTY DEMANDS URGENT SAF INVESTMENT

By Aymeric Angotti, Head of Aircraft Finance at AEW

Updated on 15 July 2026, find the original article here.

On 28 February 2026, US-Israeli strikes on Iranian military targets triggered the most severe energy disruption since the 1970s oil crises. The Strait of Hormuz - the world's most critical energy chokepoint, carrying roughly one fifth of global oil supply - effectively closed within 48 hours. A peace deal signed in June reopened it, partially, for four weeks. Then the deal collapsed. As of mid-July, the strait is once again contested territory.

For aviation finance professionals, the past five months have been a live stress test of every assumption underlying airline credit analysis. Prices spiked, collapsed back to pre-war levels, and are spiking again. Strategic reserves have been spent. Refining capacity has partially recovered but remains fragile. The conclusions are uncomfortable — and they point urgently toward Sustainable Aviation Fuel (SAF), not just as a climate tool, but as an energy sovereignty imperative.

From Islamabad to relapse: Four weeks of reopening

The Islamabad Memorandum of Understanding (MOU), signed on 17 June, was in essence a Hormuz deal: sanctions relief and frozen-asset release for Iran, in exchange for a toll-free reopening of the strait for 60 days, mine clearance within 30 days, and a 60-day nuclear negotiation window expiring 17 August (Council on Foreign Relations - CFR). The US lifted its naval blockade on 18 June; commercial traffic surged from 19 June.

The recovery was real but partial. Transits stabilised near 35 per day - against a pre-war baseline of roughly 90–140 depending on the measure - through two temporary corridors, with an estimated 80 sea mines still in the main navigation lanes. Iran moved fastest: it exported roughly 80 million barrels of crude and products, worth over $6 billion, in the first two weeks, while Gulf competitors struggled to secure war-risk insurance that had risen a hundredfold, from 0.05% to over 5% of hull value.

The relapse came in July. Iranian strikes on commercial vessels on 7 and 11 July - including a Cyprus-flagged container ship set ablaze - prompted President Trump to declare the deal "over." The IRGC (Islamic Revolutionary Guard Corps) declared the strait closed on 12 July; the US struck some 140 Iranian military targets overnight and reinstated its blockade on 14 July. Transit counts collapsed to between 7 and 34 per day depending on the tracker. Iran retaliated against US-allied bases in Bahrain, Kuwait, Qatar, Jordan and Oman.

> *"Iran has no intention of restoring the Strait of Hormuz to the status quo ante, when it functioned as a free and open international waterway."*
>
> *— Council on Foreign Relations, 8 July 2026*

Prices: A full round rrip — and back up again

Recent price action traces the diplomacy almost perfectly. Brent crude fell steadily through June as the MOU held, touching pre-war levels of $72–73 per barrel in early July — its

worst quarterly decline since 2020. WTI (the US benchmark) briefly traded below $70. Then the relapse: Brent jumped 4.5% on 14 July and stands near $86 per barrel on 15 July, with WTI around $80.

At the height of the crisis, Brent futures peaked at $126.41 intraday on 29 April (ICE Brent front-month), while physical cargoes changed hands near $150 per barrel, according to IATA. The EIA (US Energy Information Administration) expected, in its July outlook finalised before the relapse, most shut-in crude production to return by end-2026 - a forecast that now carries obvious downside risk. Notably, the EIA also found that global oil demand fell by 1.2 million barrels per day in 2026, mostly in Asia: demand destruction, not just supply response, closed the gap.

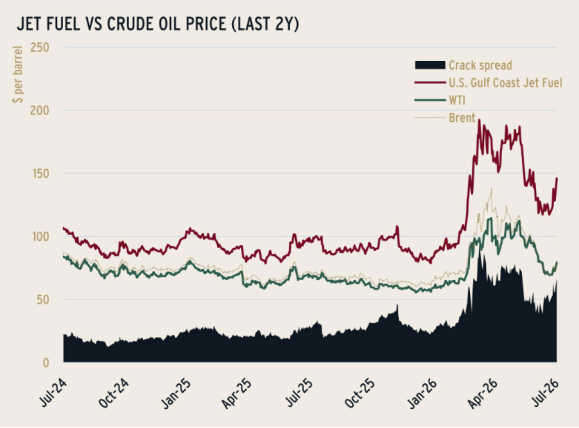
$72–73/b Brent early July (pre-war level)	**$86/b** Brent 15 July (post-relapse)	**$126.41** Futures peak (29 Apr)	**~$150/b** Physical peak (IATA)

Sources: Forbes Advisor, Investing.com, EIA STEO July 2026, IATA Fuel Fact Sheet June 2026.

Jet fuel: Relief, but from extreme levels

Jet fuel followed crude down - from extraordinary heights. IATA's global benchmark fell from $141.64 per barrel in June to $116.63 in early July, still well above the ~$90 pre-war norm. Prices had exceeded $200 per barrel in mid-April. On the US Gulf Coast, spot kerosene eased to $2.71 per gallon in June from a March–May average of $3.91 - roughly double the start-of-year level.

The refining margin story is equally telling. The jet 'crack spread' - the gap between crude and finished jet fuel, normally $10–25 per barrel - spiked above $121 per barrel in North West Europe at the peak, more than four times its usual ceiling. IATA estimates that if disruption persists, the 2026 average crack spread could exceed $57 per barrel. US refiners responded by maximising jet fuel output, with Gulf Coast production margins at their strongest in years.



Source: EIA as of 16/07/2026

The buffers are spent: Reserves and refining

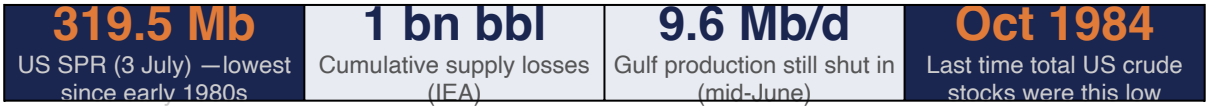
The crisis has consumed a significant share of the world's emergency stockpiles. The US Strategic Petroleum Reserve (SPR) - the government-controlled emergency stockpile - stood at 319.5 million barrels in the week ending 3 July, down roughly 90 million barrels

since February as part of the US's 172-million-barrel commitment to the IEA-coordinated release. That is its lowest level since the early 1980s.

Total US crude inventories, including the SPR, sit at multi-decade lows last matched in October 1984. EU member states remain bound by their standing 90-day strategic-stock obligation — a buffer this crisis has already drawn on heavily.

Refining capacity tells a partial-recovery story:

- Saudi Arabia's Ras Tanura refinery (550,000 b/d) restarted as early as 13 March after its drone-strike shutdown; the crude export terminal - which handled ~90% of Saudi exports pre-war - reopened on 26 June after a near four-month halt. But Bloomberg reports buyers remain reluctant to load there since the July relapse.
- Up to 3.5 million barrels per day (Mb/d) of Gulf refining capacity was affected at the peak, per Reuters, with Kuwait's three refineries - including Al-Zour, a major jet fuel supplier to Europe - running at reduced rates. Rystad Energy estimated shut-in Gulf production at 9.6 Mb/d in mid-June, down from 11.7 Mb/d, with 2 Mb/d restored in three weeks. That recovery is now paused, hostage to the security situation.
- Cumulative supply losses from the crisis now exceed 1 billion barrels (IEA) - a hole in global inventories that will take quarters, not weeks, to refill even under a durable peace.



Sources: EIA weekly data, Global Energy Flow, Rystad Energy via CNBC, IEA.

What five months have proven

The deal-reopening-relapse sequence has settled a structural question: this vulnerability cannot be fixed by diplomacy alone. Even during the four 'good' weeks, traffic never re-covered beyond 25–40% of pre-war levels, depending on the baseline used; mines stayed in the water; insurance stayed prohibitive; and Iran established that access to the strait is now conditional, with transit fees explicitly on the table for August.

The UK's open-ended licence for Russian-refined jet fuel, issued on 20 May, remains in force - a standing reminder that a G7 government chose to erode its own sanctions architecture rather than face physical fuel scarcity. Meanwhile, the demand side has done much of the balancing: global oil consumption fell by 1.2 Mb/d in 2026, and in aviation that meant cancelled flights, suspended routes, and capacity cuts across Europe and Asia during peak season.

The SAF imperative, reinforced

Every element of the past six weeks strengthens the energy sovereignty case for SAF. A negotiated reopening delivered barely a third of normal traffic before collapsing. Strategic reserves — the designed buffer against exactly this scenario — are at forty-year lows with the crisis still unresolved. Refining recovery is hostage to drone strikes. And the marginal barrel of jet fuel for Europe now depends on a strait whose reopening Iran treats as a revenue opportunity, with transit fees scheduled for mid-August.

SAF represents less than 1% of global jet fuel consumption, with EU production capacity just above one million tonnes annually (EASA). That number is the central fact of aviation's exposure. The proof is now empirical: fossil kerosene's supply chain has failed twice in five months, and the mechanisms designed to absorb such failures - reserves, bypass pipelines, diplomacy - have all shown their limits within a single crisis.

> *The buffers are spent, the deal is broken, and the strait reopens only on Iran's terms. Energy sovereignty is no longer an argument for SAF investment. It is the argument.*

The conclusion stands, with greater urgency: scaling SAF requires building production plants now, at industrial scale, backed by long-term offtake agreements and public frameworks that treat SAF as energy security infrastructure. Every month without new capacity is another month in which European aviation's summer schedule depends on the durability of a ceasefire that has already failed once. The question is not whether aviation can afford this investment. It is whether aviation can afford to keep making this bet.

Aymeric Angotti is a specialist in aviation-secured private debt and infrastructure finance with 25 years of industry experience. This article is written in a personal capacity and does not represent the views of his employer or any affiliated entity. *Sources: Articles of CNN, Times, Investing.com, Forbes Advisor, Trading Economics, Global Energy Flow, CNBC, Bloomberg, Reuteers, dated July 2026, EIA, IATA, EASA.*

impactful VOICES 2026: "FINANCING AVIATION'S TRANSITION: RISK, UNCERTAINTY & THE AVIATION SUSTAINABILITY INDEX"

Featuring Tom Conlon - Professor of Finance at University College Dublin School of Business

This episode focused on one of the defining characteristics of aviation decarbonisation: uncertainty. Tom Conlon explored why aviation remains one of the most difficult sectors to decarbonise and how uncertainty around technology pathways, regulation, fuel costs, and future demand continues to delay investment decisions and capital deployment. The discussion examined the distinction between transition risk and physical climate risk and their growing relevance for financiers and investors. The episode also introduced the Aviation Sustainability Index (ASI), a scientifically grounded framework designed to support sustainability-linked finance, improve comparability across the sector, and reduce the risk of greenwashing in aviation financing decisions.

Watch the recording here.

impactful VOICES 2026: "CORSIA, EU ETS & GEOPOLITICS: RETHINKING RISK IN AVIATION'S TRANSITION"

Featuring Barry Moss - Managing Director at Avocet

This episode examined the evolving risk landscape surrounding aviation decarbonization, with a particular focus on the interaction between climate policy, financial risk, and geopolitics. Barry Moss explored two of the sector's most important regulatory frameworks: CORSIA and the EU ETS, and discussed their implications for airlines, financiers, and lessors. Moving beyond compliance, the conversation highlighted how environmental regulation is increasingly be-coming a material financial risk and how uncertainty around policy developments, carbon markets, and offset availability is reshaping decision-making across the industry. The episode also considered how geopolitical developments are becoming increasingly intertwined with transition risks, requiring aviation stakeholders to adopt a broader and more integrated approach to risk management.

Watch the recording here.

PART 3: SAF SCALING: MARKETS, FINANCE & IMPLEMENTATION

impact MEMBERS' CALL EXCLUSIVE: "NAVIGATING THE UK SAF MANDATE: KEY IMPLICATIONS FOR AVIATION FINANCE AND SAF INVESTMENT"

Featuring Rupali Sharma, Aviation litigator at Stephenson Harwood

The session explored the UK Sustainable Aviation Fuel (SAF) regulatory framework and its growing divergence from the EU approach. Rupali Sharma outlined the UK SAF mandate, rising blending targets, and compliance mechanisms, with a particular focus on the proposed Revenue Certainty Mechanism and its role in unlocking investment in advanced SAF pathways. The discussion also highlighted practical implications for fuel suppliers, airlines, and investors, as well as the challenges of aligning regulation, supply availability, and market readiness.

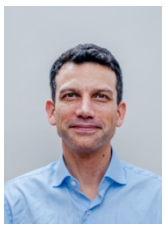
impact MEMBERS' CALL EXCLUSIVE: "SAF IN EUROPE: ONE YEAR AFTER THE MANDATE – MARKET UPDATE & INFRASTRUCTURE ACCESS"

Featuring Danile Chereau – Head Fuel Energy Transition at IATA – & Camille Mutrelle – Aviation Policy Offer at T&E

The Members' Call explored the evolving Sustainable Aviation Fuel (SAF) landscape in Europe, focusing on market dynamics, pricing, and infrastructure access. Daniel Chereau provided an overview of SAF pricing under the RefuelEU mandate, highlighting the significant premiums charged to airlines and the structural factors influencing these costs, including limited competition and compliance surcharges imposed by suppliers. Camille Mutrelle examined how control of jet fuel storage and pipeline infrastructure by incumbent suppliers can limit market entry for new SAF producers. The discussion also addressed policy challenges, transparency in SAF markets, and potential regulatory solutions to support competition and accelerate SAF scale-up in Europe.

impact MEMBERS' CALL EXCLUSIVE: "FROM PIPELINE TO TAKEOFF: THE SAF BANKABILITY PLAYBOOK"

Featuring Adam Klauber, Chief Sustainability Officer at World Energy



Adam explored the key barriers to scaling SAF production and the role of bankable offtake agreements in unlocking investment. The discussion highlighted how long-term, creditworthy contracts-similar to Power Purchase Agreements in the renewable energy sector-could reduce financing costs, attract debt capital, and accelerate SAF deployment. Participants also examined the importance of contract standardization, transparent pricing mechanisms, SAF certificates, and robust book-and-claim systems to build confidence

among buyers, producers, and financiers. Overall, the session underscored that creating bankable SAF demand structures will be critical to mobilizing capital at scale and advancing aviation's decarbonization pathway.

SAF MANDATE COMPLIANCE IN ASIA-PACIFIC: A LEGAL AND COMMERCIAL FRAMEWORK FOR AIRLINES ENTERING THE TRANSITION

By Sonia Motwani - Associate -, Hui Ling – Founder at Beyond Horizons by Bethel Chambers LLC, and Fabrice Espinosa, CEO & Founder at ASAFA, the Asia SAF Association



Key takeaways

- SAF mandates are accelerating across APAC
- Regulatory fragmentation is the biggest legal challenge
- Documentation and certification risks remain significant
- Singapore's SAF levy delay highlights policy volatility
- Airlines need jurisdiction-specific compliance strategies

The mandate wave reaches Asia-Pacific

The sustainable aviation fuel (SAF) policy landscape is no longer a purely European story. As we enter 2026, the regulatory frameworks that have reshaped fuel procurement in Europe are finding their equivalents across Asia-Pacific, albeit in forms that reflect the distinct legal, economic, and infrastructure realities of each jurisdiction.

Japan is finalising a 10% SAF blending target by 2030[1]. Singapore's Civil Aviation Authority (CAAS) has advanced its SAF levy framework under the Singapore Sustainable Air Hub Blueprint, though implementation has been deferred following recent energy market disruptions discussed further below[2]. Australia's Jet Zero Council has signalled an accelerating transition from voluntary commitments toward binding obligations with various stakeholders[3]. South Korea's K-SAF roadmap introduces a 1% blending obligation starting in 2027, rising to 7-10% by 2035[4]. Other countries in APAC, while at earlier stages, are also moving with increasing purpose.

For airlines, fuel producers, investors, and their advisers, the question is no longer whether APAC SAF mandates will arrive. It is whether the contractual and compliance frameworks being put in place today are adequate for the obligations that will be enforceable tomorrow.

[1] https://www.sustainableaviationfutures.com/saf-spotlight/apac-report
[2] https://www.caas.gov.sg/who-we-are/newsroom/Detail/new-SAF-levy-to-apply-from-1-apr-2026-for-flights-departing-from-1-oct-2026
[3] https://www.infrastructure.gov.au/infrastructure-transport-vehicles/aviation/australian-jet-zero-council
[4] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjm7J7wwsyTAxUTsFYBHQYBLO4QFnoECBgQAQ&url=https%3A%2F%2Fwww.molit.go.kr%2FLCMS%2FDWN.jsp%3Ffold%3D%2Feng0301%2F%26fileName%3DSAF%2520Blending%2520Becomes%2520Mandatory%2520for%2520International%2520Flights%2520Departing%2520Korea%2520in%25202027.pdf&usg=AOvVaw0okT2hGCq1ZK2pImXthJXf&opi=89978449

ASAFA's core mission in this environment is to bridge the gap created by the region's regulatory fragmentation — working across jurisdictions to align policies, harmonise standards, and reduce the legal and commercial uncertainties that airlines, producers, and investors face as mandates take effect at different speeds and in different forms across Asia-Pacific.

A fragmented regulatory architecture

The fundamental legal and commercial challenge in Asia-Pacific is one of fragmentation. Unlike the EU, which imposed a single harmonised mandate through ReFuelEU Aviation Regulation[1] across all member states, the Asia-Pacific region presents a series of nationally designed frameworks with differing scope, obligation structures, certification requirements, and enforcement mechanisms. For airlines operating across multiple jurisdictions in the region, there is no single compliance posture that adequately addresses the full picture. Bridging this fragmentation - through policy alignment, shared certification standards, and coordinated stakeholder engagement - is precisely the work ASAFA is engaged in across the region.

- **Japan** places blending obligations primarily on fuel suppliers at designated airports, but the downstream documentation obligations for airlines, particularly those on international routes subject to CORSIA[2], remain in development. Japan's Ministry of Economy, Trade and Industry and Ministry of Land, Infrastructure, Transport and Tourism are working through the legal architecture for SAF certification recognition under Japan's Act on Sophisticated Methods of Energy Supply Structures[3] in respect of supply target volumes, but the interaction between domestic blending obligations and CORSIA-eligible emissions reductions is not yet been clarified in Japanese regulatory guidance, leaving a material compliance gap that practitioners should monitor closely. As at June 2026, no formal METI or MLIT guidance has been issued clarifying the treatment of domestically blended SAF under CORSIA-eligible emissions reductions, and the public-private SAF Council's work continues to focus on supply-side certification and feedstock issues rather than the interface with airline-level CORSIA accounting.
- **Singapore** is among the most operationally advanced markets in the region, though its trajectory has been complicated by a significant policy development in early 2026, addressed separately below. The CAAS SAF levy framework had been expected to take effect progressively from 2026. The legal questions around how the levy interacts with existing fuel supply agreements, and whether SAF certification under ISCC EU[4] or RSB[5] standards satisfies CAAS eligibility criteria, remain live issues that procurement teams and their legal advisers need to resolve regardless of the revised implementation timeline.
- **Australia's** regulatory trajectory is becoming clearer as government and industry investment accelerates. Australian Renewable Energy Agency (ARENA)'s SAF funding programs and feasibility studies led by Jet Zero Australia, Ampol and GrainCorp indicate a coordinated move toward domestic production capacity that is expected to influence future compliance expectations.[6] Although no binding mandate has been introduced, the federal position indicates that any certification mandate will not be considered before mid 2028,

[1] https://transport.ec.europa.eu/transport-modes/air/environment/refueleu-aviation_en
[2] https://www.icao.int/CORSIA
[3] https://www.mmn-law.gr.jp/en/assets/img/mmn/Regulation%20under%20the%20Act%20on%20the%20Sophistication%20of%20Energy%20Supply%20Structures_251222MMN.pdf
[4] https://www.iscc-system.org/wp-content/uploads/2023/04/ISCC-Certification-for-Sustainable-Aviation-Fuels-1-1.pdf
[5] https://rsb.org/certification/certification-schemes/rsb-corsia-certification/
[6] https://www.australianmanufacturing.com.au/australia-accelerates-aviation-decarbonisation-with-new-saf-projects/

consistent with the policy signals in the Aviation White Paper published by the Australian government.[1] Recent research commissioned by Sydney Airport shows strong public support for locally produced SAF, reinforcing the likelihood that Australia's SAF framework will tighten as domestic supply matures.[2]

- **South Korea** introduces an additional complexity that deserves specific attention. K-SAF mandate explicitly aligns with ICAO CORSIA: only fuels meeting CORSIA carbon-reduction standards - including a minimum 10% lifecycle GHG reduction - will qualify as SAF under the new rules, and South Korea has actively sought harmonisation of ISCC CORSIA and ISCC EU certification standards at the ICAO level[3]. The more material certification risk is not between K-SAF and CORSIA, but between K-SAF and EU ReFuelEU, which imposes distinct feedstock eligibility criteria and chain-of-custody requirements that do not map directly onto CORSIA-certified SAF. An airline purchasing CORSIA-eligible SAF for Korean mandate compliance cannot assume that the same fuel satisfies ReFuelEU requirements for flights departing EU airports, creating a genuine risk of double-cost exposure. Additionally, from 2030 onwards, Korea plans to consider SAF with higher GHG emissions more favourably than CORSIA's baseline threshold, potentially creating a divergence between Korean compliance eligibility and CORSIA eligibility for the same physical fuel[4]. Airlines with mixed Korean and EU route networks should structure their procurement and documentation frameworks to address this asymmetry explicitly.

- **India** is moving rapidly from early intent to structured policy development and now represents one of the most active SAF markets in Asia-Pacific. The Ministry of Civil Aviation, in partnership with ICAO and the European Union, released India's SAF Feasibility Study in September 2025, confirming the country's capacity to become a major SAF producer and establishing indicative blending targets of 1 per cent by 2027, 2 per cent by 2028 and 5 per cent by 2030 in line with the CORISA mandate[5]. Indian Oil Corporation's Panipat Refinery has already been certified as the country's first SAF production facility, and COTECNA Inspection India has been designated as the first domestic SAF certification body, marking early progress toward an integrated regulatory system.[6] The DGCA has begun drafting India's first dedicated SAF policy and continues to lead technical work under the ACT-SAF programme, with officials signalling that policy design will align with CORSIA sustainability standards and will be shaped by national biomass availability studies now underway[7].

- **Thailand** introduced regulations establishing a 1% SAF blend in Jet A-1 fuel from January 1, 2026, with production at this initial stage limited to the HEFA pathway and feedstocks required to comply with ASTM D7566[8]. Practitioners should note an important implementation nuance: the initial phase relies on stakeholders signing memoranda of understanding to demonstrate commitments to produce and use SAF, before any move towards hard mandatory enforcement in later phases[9]. The regulatory standard is in force, but the practical compliance architecture for the initial period is MOU-based rather than fully binding. The blending requirement is expected to increase to 8% by 2036 under Thailand's National Energy Plan (NEP 2024), with a surplus of ethanol from road fuel restructuring earmarked

[1] https://www.infrastructure.gov.au/sites/default/files/documents/awp-aviation-white-paper.pdf
[2] https://eglobaltravelmedia.com.au/2026/03/17/australias-saf-push-gains-altitude-as-fuel-security-fears-rise/
[3] https://www.argusmedia.com/en/news-and-insights/latest-market-news/2733657-south-korea-releases-saf-roadmap-launches-alliance
[4] https://www.greenairnews.com/?p=8125
[5] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2163273&reg=3&lang=2
[6] https://www.cotecna.com/en/media/news/cotecna-india-certifies-indian-oil-s-panipat-refinery-for-producing-saf
[7] https://www.energywatch.in/energy-transition/govt-begins-drafting-saf-policy-biomass-study-underway-to-aid-aviation-decarbonisation
[8] https://www.nationthailand.com/sustaination/40060773
[9] https://www.spglobal.com/energy/en/news-research/latest-news/agriculture/111725-caat-thai-airlines-agree-2026-saf-rollout-regulator-weighs-carbon-fee-mechanism

for SAF production[1]. A SAF working group is being established in 2026 to set escalating targets, bringing together public and private sector representatives on both the demand and supply sides. As at June 2026, formal establishment of that group has not been publicly confirmed; in the interim, the 17 November 2025 memorandum of understanding between CAAT and eight Thai carriers (Thai Airways International, Bangkok Airways, K-Mile Air, Nok Air, Thai AirAsia, Thai AirAsia X, Thai Lion Air and Thai Vietjet)[2] provides the principal industry-level coordination framework, and sector-wide engagement on targets and policy design was advanced at the ASAFA Innovation and Policy Summit hosted in Bangkok on 24 to 26 June 2026[3]. Initial SAF services are focused on Suvarnabhumi and Don Mueang airports. The certification framework and institutional architecture, however, remain works in progress - and the interaction between Thailand's domestic mandate and CORSIA eligibility criteria is not yet clarified, a gap that practitioners and airlines should monitor.

- **Indonesia** is one of the region's most significant feedstock nations and has been developing its SAF policy architecture, though mandate implementation has been subject to repeated timeline revisions. Indonesia's energy ministry has proposed requiring international flights from Jakarta and Bali to use a 1% SAF blend from 2026, with a gradual increase to 5% by 2035[4]. A SAF National Action Plan 2025–29 has been published, focused on installing domestic SAF production capacity via the HEFA pathway, supported by incentives for SAF and containment of used cooking oil (UCO) exports[5]. The critical legal and commercial risk in Indonesia is enforcement credibility: Indonesia's bio-avtur blending obligations span two regulatory instruments - MEMR Decree No. 25/2013, which set a 2% bio-jet fuel target by 2016, and MEMR Regulation No. 12/2015, which set subsequent targets of 3% by 2020 and 5% by 2025[6]. None of these targets were achieved; the Indonesian Aviation Biofuels and Renewable Energy Task Force established to implement them missed the initial 2016 deadline, and enforcement of subsequent targets remained effectively absent. MEMR Regulation No. 4/2025 has since superseded the 2015 framework and formally designates SAF (J100/Bioavtur) as a regulated fuel category for the first time - a significant step - though the enforcement architecture for aviation obligations under the new regulation remains nascent[7]. Airlines and investors structuring supply or offtake agreements linked to Indonesian mandate compliance should treat enforcement timelines as genuinely uncertain and calibrate force majeure and price adjustment provisions accordingly.

  Indonesia's broader biofuel policy agenda adds further complexity to the SAF feedstock outlook. A mandatory B50 biodiesel blend (50% palm oil) is confirmed for launch on 1 July 2026, stepping up from the current B40 mandate, with full mandatory coverage across all diesel users by 2028[8]. Simultaneously, a mandatory 5% ethanol blend (E5) in gasoline is being phased in from 2026, starting with Java, rising to E10 by 2028 and targeting E20 over the longer term[9]. To bridge a severe domestic supply gap - current fuel-grade ethanol output stands at approximately 60,000 kiloliters against a requirement of 1–1.2 million kiloliters for E5 alone, local companies are looking at partnering with international suppliers. These overlapping mandates create a structural competition for Indonesia's finite biofuel feedstocks - CPO, UCO, sugarcane, and cassava - between the biodiesel, ethanol, and

[1] https://www.reccessary.com/en/news/thailand-saf-standard-preparation
[2] https://www.caat.or.th/en/do-you-know/196824/
[3] https://www.bangchak.co.th/en/newsroom/bangchak-news/1943/bangchak-group-showcases-thailand-s-saf-leadership-at-asafa-ips-2026
[4] https://www.hydrocarbonprocessing.com/news/2025/10/indonesia-considering-1-saf-blend-by-2026/
[5] https://www.safinvestor.com/news/146989/indonesia-2/
[6] https://www.pjlss.edu.pk/pdf_files/2024_2/15425-15433.pdf][https://eu-opensci.org/index.php/ejbmr/article/view/52545
[7] https://ecadin.org/minister-of-energy-and-mineral-resources-regulation-no-4-2025-a-landmark-move-towards-indonesias-biofuel-future/
[8] https://esgnews.com/indonesia-sets-b50-biofuel-mandate-by-2028-to-cut-imports-strengthen-energy-security/
[9] https://english.news.cn/20250516/17561ec4b9b84739bfbde1053281c735/c.html

SAF programmes, with direct implications for regional HEFA-SAF feedstock pricing and availability.

- **Malaysia** is positioning itself as a regional SAF production hub, leveraging its palm oil waste streams and refining infrastructure, while its domestic mandate architecture is still taking shape. Under its 2023 National Energy Transition Roadmap, Malaysia is targeting a 47% SAF blending mandate by 2050, with a 1% blending mandate for international flights departing from KLIA planned to take effect from January 2027[1]. Malaysia's feedstock policy creates a specific legal complexity: the Malaysian Palm Oil Board is actively reviewing UCO and sludge palm oil export policies to prevent discrepancies, and practitioners may anticipate regulatory changes affecting the availability and classification of palm-derived SAF feedstocks in supply agreements[2].
- **Vietnam** is at an earlier stage of policy development. No binding SAF blending obligation has yet been enacted, but Vietnam's feedstock abundance - it is among the ASEAN nations with the largest potential SAF supply from agricultural and forestry residues - positions it as a potential net exporter as regional demand scales[3].The absence of a domestic mandate and a formal certification framework means that SAF produced in Vietnam for international markets must navigate external eligibility criteria (CORSIA, ISCC, RSB) without a domestic regulatory anchor, a gap that creates both commercial opportunity and compliance risk for offtakers.
- **The Philippines** is drafting a SAF roadmap, with readiness assessments and feedstock research underway[4]. Rice waste, coconut waste, and forestry residues give it significant potential supply — but no blending obligation or certification framework has yet been enacted. Airlines operating through Manila should not anticipate Philippine compliance obligations in their near-term procurement planning, but practitioners advising investors in Philippine SAF production should track the roadmap development closely.
- **China** warrants specific attention given its scale and the direct implications for regional feedstock markets. China introduced a 50,000-tonne SAF production target in its 14th Five-Year Plan, and some industry leaders expect a 5% SAF mandate by 2030, though this has not yet been formally announced[5]. China's SAF policy trajectory has direct implications for the rest of Asia-Pacific: as the world's largest consumer of UCO and a growing SAF producer, Chinese domestic policy choices on feedstock availability and export controls significantly affect the feedstock cost and supply calculus for HEFA producers across Southeast Asia[6].
- **New Zealand** remains at an early but increasingly coordinated stage of SAF development, with momentum accelerating through 2025 and 2026. The release of the New Zealand Aviation Action Plan[7] and the establishment of the SAF Industry Roundtable[8] signal a shift toward structured policy design, with industry urging the government to move quickly to keep pace with regional developments[9]. Recent economic studies supported by Boeing indicate that domestic SAF production could generate up to NZD 1.3 billion in economic value and create approximately 5,700 jobs, while also addressing New Zealand’s reliance

[1] http://www.hydrocarbonprocessing.com/news/2025/09/petronas-delivers-first-local-saf-to-malaysia-airlines/
[2] https://www.nortonrosefulbright.com/en/knowledge/publications/916218d2/taking-flight-sustainable-aviation-fuels-in-asia
[3] https://asean.org/asean-poised-to-produce-8-5-million-barrels-of-sustainable-aviation-fuel-daily-by-2050/
[4] https://www.carbon-direct.com/insights/beyond-the-transatlantic-core-emerging-saf-mandates-in-global-markets
[5] https://www.carbon-direct.com/insights/beyond-the-transatlantic-core-emerging-saf-mandates-in-global-markets
[6] https://www.hydrocarbonprocessing.com/news/2024/02/asias-saf-projects-and-agreements/
[7] https://www.transport.govt.nz/assets/Uploads/Aviation-Action-Plan-2025.pdf
[8] https://nzairports.co.nz/tag/saf-industry-roundtable/
[9] https://nzairports.co.nz/news/new-zealand-industry-supports-rapid-saf-action/

on imported jet fuel and the associated energy security concerns[1]. These studies also warn that without timely policy signals, New Zealand risks falling behind regional competitors as SAF adoption becomes a business and passenger expectation. The government has begun updating aviation regulations and supporting early SAF uptake through Air New Zealand's increased procurement, positioning the country to align with international frameworks and wider Asia-Pacific SAF trajectories.

The lessons of European implementation

The European experience in 2025 provides instructive, and in some respects cautionary, precedent for what Asia-Pacific airlines can expect as mandates become enforceable.

The EU and UK mandates generated a series of unintended consequences. Compliance costs passed through by fuel suppliers at airports effectively doubled the market SAF price premium, leaving airlines paying for SAF they could not procure directly, could not verify had been delivered, and could not obtain adequate documentation for. The result was a cost burden that exceeded what airlines would have paid under direct procurement, with no corresponding certainty of environmental attribute allocation.

Several of these failure modes are directly applicable to Asia-Pacific markets, and some are amplified by regional supply chain characteristics. SAF supply in the region remains heavily concentrated. As the EASA ReFuelEU Aviation Annual Technical Report 2025[2] noted in the context of EU supply, feedstock origin is heavily weighted toward Asia-Pacific sources including China and Malaysia, yet the production infrastructure required to convert that feedstock into certified SAF for domestic consumption in the region is at an early stage of development. Airlines operating in markets where SAF supply is thin will face the same procurement optionality constraints that have characterised the European experience, potentially without the regulatory corrections the EU is now implementing through the Sustainable Transport Investment Plan (STIP)[3].

The European experience highlights the challenges that arise when SAF policies evolve across jurisdictions without sufficient alignment. Differences in certification recognition, documentation standards, and compliance timelines can significantly increase the compliance burden for airlines operating globally. ASAFA's work to align regulatory frameworks across Asia-Pacific — reducing duplication, addressing certification mismatches, and promoting policy coherence — is directly aimed at avoiding these inefficiencies as SAF mandates emerge in the region.The UK's Sustainable Aviation Fuel Mandate, which came into force in 2025, now sets binding supply obligations that rise from 2 per cent in 2025 to 10 per cent by 2030, with a dedicated power to liquid sub-obligation commencing in 2028 and increasing thereafter[4]. The EU's ReFuelEU Aviation Regulation similarly embeds escalating synthetic fuel requirements, beginning with a 1.2 per cent synthetic share in 2030 and rising significantly toward 2050.[5] These updated frameworks provide increasingly detailed reference points for APAC policymakers designing their own mandate architectures, particularly given the documented issues in Europe and the United Kingdom relating to certificate structures, feedstock limitations, and the cost and supply implications of synthetic fuel sub mandates. The legal and commercial challenges that have emerged in these markets are now well understood and remain avoidable for APAC jurisdictions that

[1] https://www.boeing.com.au/news/2025/boeing-helps-chart-path-to-sustainable-aviation-in-nz
[2] https://www.easa.europa.eu/en/document-library/general-publications/refueleu-aviation-annual-technical-report-2025
[3] https://transport.ec.europa.eu/transport-themes/clean-transport/sustainable-transport-investment-plan_en
[4] https://www.gov.uk/government/collections/sustainable-aviation-fuel-saf-mandate
[5] https://www.argusmedia.com/en/news-and-insights/latest-market-news/2562153-uk-publishes-saf-mandate-targets-22pc-by-2040

move early to incorporate clearer documentary pathways, technology neutral eligibility criteria and realistic synthetic fuel trajectories into their regulatory models.

Key legal risk areas for practitioners

Against this backdrop, there are three areas where legal risk is most acute and where early attention is most valuable.

Certification and documentation integrity is the most immediate concern. SAF sustainability certification under ISCC EU, RSB Standard for Advanced Products, ICAO CORSIA Eligible Fuels, or equivalent schemes must align precisely with the eligibility criteria of each applicable mandate. In a multi-jurisdiction operating environment, this requires airlines to establish procurement frameworks that can generate and retain the documentation necessary to demonstrate compliance in each relevant jurisdiction, and to address in their supply contracts what happens when documentation is incomplete, delayed, or disputed. The EASA Annual Technical Report 2025[1] identified documentation mismatches as one of the primary compliance failures in the EU's first reporting year, a lesson that APAC airlines should heed. The certification fragmentation across APAC jurisdictions - where ISCC EU, RSB, and CORSIA eligibility criteria do not yet fully converge - is an area where ASAFA is actively engaging policymakers to promote mutual recognition and reduce the compliance burden on airlines operating across multiple markets.

Offtake agreement structuring requires particular care in nascent supply markets. The analysis in this publication of what constitutes a bankable SAF offtake provides a useful commercial framework. From a legal perspective, airlines entering long-term SAF supply agreements in APAC markets need to ensure that those structures are enforceable under applicable local law, that force majeure provisions are calibrated to the realities of an immature supply chain, and that price adjustment mechanisms do not inadvertently allocate mandate compliance cost risk to the airline in ways that replicate the European pass-through problem. The draft RSB Market Acceleration Indicator Module[2], published in December 2025, provides a useful reference framework for practitioners assessing the bankability of SAF offtake structures. The demand aggregation models operated by ATOBA energy[3] are also directly relevant to how APAC airlines might structure compliant procurement at scale.

CORSIA interaction remains legally unsettled across the region. The 130 of 193 member states that have opted into the CORSIA Phase 1 obligations[4] and the interaction between national SAF mandates and CORSIA offsetting credits is not yet resolved in the domestic regulatory frameworks of most APAC jurisdictions. Whether SAF purchased for domestic mandate compliance generates CORSIA-eligible emissions reductions, and how that is documented and verified, needs to be resolved contractually before supply agreements are executed. The ICAO CORSIA Implementation Elements[5] framework provides the international baseline, but the domestic legal translation of those elements varies considerably across the region. This is not a question that can be addressed retrospectively. Achieving greater consistency in how APAC jurisdictions transpose CORSIA obligations into domestic law is a priority area for ASAFA's policy alignment work.

[1] https://www.easa.europa.eu/en/document-library/general-publications/refueleu-aviation-annual-technical-report-2025
[2] https://rsb.org/wp-content/uploads/2025/12/rsb-pro-20-004-market-acceleration-indicator-module-1.0-draft.pdf
[3] https://atoba.energy/blog/unlocking-bankable-saf-long-term-offtake-agreements-atoba%E2%80%99s-pathway-in-bridging-the-gap
[4] https://www.climateimpact.com/news-insights/insights/corsia-explained-what-the-aviation-carbon-scheme-is-and-what-recent-developments-mean-for-the-market/
[5] https://www.icao.int/CORSIA/implementation-elements

Energy security shocks and fuel supply contract resilience is a fourth area that has moved to the foreground in 2026. The Middle East conflict that began in late February 2026 has had implications for Asia-Pacific SAF compliance well beyond the Singapore levy deferral discussed below. Three dimensions are particularly relevant for practitioners. First, jet fuel supply contracts that specify Jet A-1 only may require review in light of guidance now permitting the use of Jet A as a substitute in certain circumstances, with knock-on consequences for SAF blend specifications, quality control procedures, and the chain-of-custody documentation that underpins certification claims. Second, the price shock in conventional jet fuel through the first half of 2026 has simultaneously strengthened the long-term energy security argument for domestic SAF investment across Asia-Pacific and increased near-term cost pressure on airlines, which may produce further mandate deferrals of the kind seen in Singapore in jurisdictions where SAF cost premiums are politically sensitive[1]. Third, force majeure, war risk, regulatory change, and material adverse change provisions in long-term SAF offtake and fuel supply agreements across the region require careful calibration to address airspace closures, Strait of Hormuz disruption, feedstock and shipping cost volatility, and insurance market hardening - not only in Singapore-connected agreements but across all multi-jurisdictional supply structures with Middle East exposure in the underlying fuel or feedstock supply chain.

Singapore: A proving ground navigating headwinds

Of all the jurisdictions considered in this article, Singapore warrants particular focus for practitioners advising airlines and fuel suppliers in 2026, though not solely for the reasons that were anticipated at the close of 2025.

In early 2026, Singapore announced a six-month deferral of its SAF levy implementation following significant disruption to regional energy markets[2]. Specifically, on 25 March 2026, CAAS announced that the levy - originally set to apply to tickets sold from 1 April 2026 for flights departing from 1 October 2026 - will now apply to tickets sold from 1 October 2026 for flights departing from 1 January 2027[3]. Singapore also adjusted its 1% SAF uplift target from 2026 to 2027 as part of the same revision. The energy crisis, which drove conventional jet fuel prices sharply higher across Southeast Asia, created conditions in which the imposition of an additional SAF-related levy was assessed as commercially and politically untenable in the near term. The deferral is presented as a pause rather than an abandonment of Singapore's SAF policy ambitions, and the Singapore Sustainable Air Hub Blueprint framework and the 3–5% SAF usage target by 2030 remain formally in place.

The legal implications of the deferral are nonetheless significant. Airlines that had structured their SAF procurement and supply agreements in anticipation of the levy taking effect in October 2026 now face a period of regulatory uncertainty with direct contractual consequences. Agreements that included levy pass-through provisions, compliance cost allocations, or SAF volume commitments calibrated to levy-driven demand may require renegotiation. Given the deferral is limited to six months, the most immediate contractual questions concern agreements with volume or pricing provisions specifically tied to Q4 2026 or the original 1 October 2026 effective date rather than broader force majeure considerations; however, force majeure and material adverse change clauses in SAF supply agreements should be reviewed carefully, particularly where they contain regulatory change triggers. Practitioners advising clients with Singapore-connected SAF obligations

[1] https://www.weforum.org/stories/2026/05/middle-east-conflict-sustainable-aviation-fuels-can-help/
[2] https://biomassmagazine.com/articles/singapore-delays-saf-levy-in-response-to-middle-east-conflict
[3] https://www.caas.gov.sg/who-we-are/newsroom/Detail/sustainable-aviation-fuel-(saf)-levy-to-be-deferred

should be reviewing existing arrangements now under the Sale of Goods Act (Cap. 393)[1] and considering whether the deferral constitutes a frustrating event or a regulatory change, triggering contractual adjustment mechanisms under Singapore contract law principles.

The deferral also raises a broader question that is relevant across the region: what happens to SAF compliance frameworks when energy market volatility collides with the cost premium that SAF inherently carries? The Singapore experience suggests that even the most policy-committed jurisdictions in Asia-Pacific may find their SAF implementation timelines vulnerable to macroeconomic pressure. This has direct implications for how force majeure, regulatory change, and material adverse change provisions should be drafted in long-term SAF supply agreements across the region. It also reinforces the importance of ASAFA's policy alignment mission: the more coherent and mutually reinforcing the regional regulatory architecture, the more resilient individual jurisdiction frameworks are to shocks of this kind.

Notwithstanding the deferral, Singapore retains structural advantages that make it the natural centre of gravity for regional SAF legal and commercial development. Its well-developed arbitration and dispute resolution infrastructure, anchored by the SIAC Arbitration Rules 2025[2] and the Singapore International Commercial Court Rules 2021[3], makes it a natural governing law and dispute resolution jurisdiction for SAF supply agreements with regional reach. As long-term SAF offtake agreements become a standard feature of airline procurement across APAC, the choice of Singapore law and dispute resolution forum offers a level of legal certainty and enforceability that is not yet available in many of the other jurisdictions discussed in this article. Practitioners structuring regional SAF agreements should consider this actively, irrespective of the levy deferral.

Singapore is the jurisdiction where the interaction between regulatory ambition, energy market reality, and legal risk is most visibly playing out in 2026. The decisions made here, including how the deferral is managed contractually and how the levy framework is ultimately redesigned, will set precedents that shape SAF compliance architecture across the broader region for years to come.

Conclusion

Asia-Pacific's transition from SAF aspiration to SAF obligation is underway, but the path is neither linear nor uniform. The Singapore deferral is a reminder that energy market conditions can disrupt even the most advanced regulatory frameworks, and that the legal infrastructure around SAF compliance needs to be robust enough to accommodate that volatility. Airlines and their legal advisers that treat SAF compliance as a stable, predictable regulatory matter risk being unprepared for the contractual and commercial consequences of the disruptions that will inevitably arise. The time for legally robust, jurisdiction-specific preparation is now.

At the regional level, the fragmentation of APAC's SAF regulatory landscape remains the single greatest structural risk to an efficient and equitable transition. ASAFA's work to bridge that fragmentation - aligning policies, harmonising certification standards, and reducing the legal and commercial uncertainties that compound across jurisdictions - is essential to ensuring that Asia-Pacific's mandate wave delivers decarbonisation outcomes rather than compliance costs without corresponding environmental benefit.

[1] https://sso.agc.gov.sg/Act-Rev/SGA1979/Published/19990801?DocDate=19940520
[2] https://siac.org.sg/siac-rules-2025
[3] https://sso.agc.gov.sg/SL/SCJA1969-S924-2021?DocDate=20211202

AIRPORT SUSTAINABILITY-LINKED BONDS: CLEARED FOR TAKE-OFF, OR STILL TAXIING?

By Jonas David - Research Director at Anthropocene Fixed Income Institute

When an airport borrows money and promises to cut its carbon, who is really on the hook and for how much? That question sits behind a sustainability-linked bond, or SLB: a financing instrument that has become popular among some airport operators.

In February, Aeroporti di Roma returned to the market with its fourth SLB, a EUR 500mn note maturing in 2034[1]. Investors showed interest: the order book was covered 3.4 times and the bond priced well inside guidance. Its targets are the same as in the previous issuance: a 100% cut in Scope 1 and 2 emissions by 2030, and a 18.9% reduction in Scope 3 emissions per passenger, relative to 2024. Whether such goals are reachable and whether the coupon step-up for missing them is meaningful, is the question every SLB poses.

A coupon with a conscience

An SLB is in essence an ordinary corporate bond with sustainability performance targets embedded into it. The issuer can spend the proceeds freely; unlike a green bond, which must allocate proceeds to specific projects. The "sustainability" is reflected in the interest payments.

Miss your targets, and the coupon steps up. The logic is elegant: a company that risks paying more if it fails to decarbonise has skin in the game. As bondholders receive higher payments if targets are missed, this structure provides investors a hedge against an unsuccessful transition.

The catch is that the discipline only works if the target measures the right thing and the structure is financially material.

The 95% problem

The truth about airports: their own emissions are not the main issue. The ground vehicles, boilers, and electricity an airport directly controls (i.e. Scope 1 and 2 emissions) are relatively small. The aircraft emissions are everything, as illustrated by emissions disclosure from Heathrow and Gatwick.

At Heathrow, emissions "in the air" account for roughly 95% of the total footprint, according to the airport's own reporting, analysed by the Anthropocene Fixed Income Institute (AFII)[2]. These are Scope 3 emissions related to landing and take-off cycles and importantly cruise emissions; they are outside the airport's direct control but squarely within its respon-sibility, one can argue.

And this is an area where progress is uncertain. Air France-KLM, a carrier, has also recently missed emissions reduction targets that were used in an SLB[3]. It cited both delays

[1] "Aeroporti di Roma: SLB comparison in light of issuance", AFII, 10 Feb 2026.

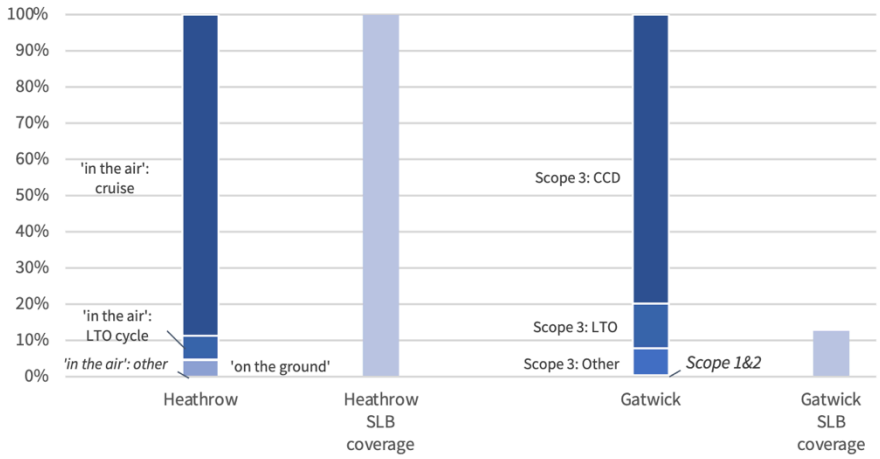
[2] "Airport SLBs: Heathrow at cruising altitude, Gatwick still taxiing", AFII, 17 Jun 2026.

[3] "Air France bonds slow to digest SLB target miss", AFII, 23 Feb 2026.

in fleet renewals (i.e. the shift to more efficient aircraft), but also geopolitical concerns driving longer routes as the reasons. Here the SLB has served to support transparency on progress, and highlight where increased focus may be needed. While aviation is generally considered a hard-to-abate sector, an airport that targets only its own operations and direct emissions does not really fall into this category. But the inclusion of Scope 3 emissions in airport bonds keeps investors eyes on the bigger pictures, which is the true decarbonisation of air travel.

This is why coverage is the one of the first tests of any airport SLB. Heathrow's sustainability performance targets cover all its reported emissions, including the dominant aircraft contribution. Gatwick, by contrast, omit the climb, cruise and descent phase of flight, which accounts for an estimated 80% of its emissions.

Composition of Heathrow's and Gatwick's total emissions (as of 2023) and estimated share of emissions covered in their respective SLB structures. Source: Heathrow, Gatwick, AFII.



So how do you cut emissions you do not directly produce? Largely by leaning on others. Heathrow is expecting more efficient aircraft and sustainable aviation fuel (SAF), aiming for it to make up 11% of its fuel by 2030, ahead of the UK's 10% mandate. The airport sets the incentives; airlines and fuel makers do the heavy lifting.

What's positive is that Heathrow looks at absolute emissions across the board. Meanwhile, Gatwick only does that for direct emissions, but uses intensity metrics for the landing and take-off cycle. The distinction between absolute and intensity targets is critical.

An absolute target focuses on reducing the total tonnes of carbon emissions. An intensity target looks at emissions per passenger, which sounds rigorous but hides a potential loophole: as traveller numbers grow, the total footprint can climb even as the per-head figure falls.

From targets to market pricing

Emissions coverage is only half the story. The bond structure matters just as much, particularly the size of the coupon step-up and the period it applies to, if targets are missed. These vary more than investors sometimes realise.

Despite having the same targets and cumulative, undiscounted coupon adjustments, the four SLBs issued by Heathrow have varying options values due to their different

specifications. The same applies to Gatwick, while the maximum cumulative coupon adjustments differ for Aeroporto di Roma.

Investors can price the optionality embedded in the bond structure. Because a step-up is a contingent payment, it can be valued like a financial option: the probability of a target miss, the size of the coupon adjustment, and the time until payout. All else equal, a sizable step-up paid sooner and triggered with a higher likelihood is worth more to the investor.

On the flip side, a higher option value for the issuer should result in a lower cost of capital for the issuer compared to a traditional bond.

So, do they work?

SLBs are only as good as their targets and option value, which ultimately drives financial materiality. At their best they have comprehensive emissions coverage with absolute reductions, meaningful coupon adjustments and independent validation, thereby offering investors an opportunity to support airports' decarbonisation pathways. At their weakest, they let an issuer celebrate hitting a target with little decarbonisation.

The difference between the two is buried in the details: in the choice of scope, the wording of the metric and the maths of the coupon. For investors and the flying public alike, the lesson is the same. Do not be dazzled by the label, analyse what the bond promises to measure, and what it costs the borrower to miss targets.

impactful VOICES 2026: "NAVIGATING THE SAF LANDSCAPE IN NORTH AMERICA: SAF POLICIES

Featuring Ken Hill - Managing Director at BioCarbon Strategies

The episode explored the rapidly evolving policy landscape for Sustainable Aviation Fuel (SAF) in North America, with a particular focus on developments in the United States and Canada. Ken Hill discussed the role of incentives such as the Clean Fuels Production Tax Credit, the growing importance of state-level initiatives, and the contrasting policy approaches adopted in North America and Europe. The conversation highlighted California's experience with low-carbon fuel standards, Canada's increasing engagement in SAF deployment, and the broader economic drivers underpinning investment decisions. Despite continued regulatory uncertainty, the discussion pointed to 2026 as a pivotal year for the North American SAF market and reflected cautious optimism regarding the sector's future growth trajectory.

Watch the recording here.

impactful VOICES 2026: "SOLVING SAF'S OFFTAKE PROBLEM: DEMAND AGGREGATION AND PRICE CERTAINTY"

Featuring Arnaud Namer - Co-Founder and CEO at Atoba Energy

This conversation explored one of the most significant barriers to scaling Sustainable Aviation Fuel: demand certainty. Arnaud Namer explained the so-called "offtake dilemma", whereby producers require long-term contracts to secure financing for new facilities while airlines remain hesitant to commit due to uncertainty around future prices, technologies, and market developments. The discussion introduced demand aggregation as a potential solution, with Atoba Energy acting as a central risk management layer between producers and buyers. By creating diversified portfolios across technologies and feedstocks, this approach aims to reduce uncertainty and improve long-term price visibility. The episode also explored the role of price indices, book-and-claim systems, and complementary policy mechanisms in creating more investable SAF markets.

Watch the recording here.

impactful VOICES 2026: "TURNING WASTE CARBON INTO JET FUEL: THE FUTURE OF CARBON RECYCLING"

Featuring Freya Burton - Chief Sustainability Officer at LanzaTech

This episode examined carbon utilisation and recycling as an alternative pathway for Sustainable Aviation Fuel production. Freya Burton explained how industrial waste emissions from sectors suchas steel manufacturing can be captured before entering the atmosphere and converted into ethanol, which can subsequently be transformed into products including packaging materials, textiles, and aviation fuel. The discussion introduced the concept of "carbon prevention" as distinct from carbon removal and explored how waste carbon can be reframed as a resource rather than a liability. The episode also addressed questions surrounding emissions accounting, circularity, and the long-term potential for carbon recycling technologies within aviation. Overall, the conversation highlighted the ecosystem-wide challenges facing emerging SAF technologies, including infrastructure, regulation, and investment certainty.

Watch the recording here.

PART 4: FUTURE AVIATION & ECOSYSTEM TRANSFORMATION

NORWAY AS AN OPERATIONAL TESTBED FOR ZERO- AND LOW-EMISSION AVIATION

By Trine Åsheim Bernhardsen - Senior Advisor Sustainability, Innovation and Research & Jan Petter Steinland - Director Strategic Analysis & Transformation at CAA Norway

Norway has positioned itself as an operational testbed for the transition into zero- and low-emission aviation. Long distances, deep fjords and mountainous terrain make aviation an essential mode of transport, integrated into Norwegians' everyday life. Short-haul routes, including publicly procured Public Service Obligations (PSO), form the backbone of regional connectivity in rural areas. These routes connect communities, support economic activity and ensure access to essential services. Beyond passenger transport, air mobility supports a broad range of logistical demand such as transport of critical parts for various industries, infrastructure inspection, and access to healthcare and emergency services. In this context where aviation is a necessity, regional aviation is a candidate for early adoption of zero-emission technologies. Zero- and low emission aviation therefore represents an opportunity to achieve both connectivity and decarbonization.

Backed by political support and funding, the International Test Arena was established as a programme jointly managed by CAA Norway and Avinor. By actively involving industry partners, International Test Arena moves zero- and low-emission concepts from discussion into real-world operations. At its core, the initiative addresses a key question: *what does the transition towards zero- and low emission imply for the aviation ecosystem, not only for individual technologies?*

From technological innovation to system-level transition

The systemic approach of the International Test Arena proves that the transition towards sustainable aviation cannot be achieved through technological advances in isolation. By testing aircraft in real operational environments, across airports, routes and in all-weather conditions, the programme shifts focus from technology pilots to system integration. The International Test Arena functions as an orchestrator of the ecosystem, not merely a technology testing programme. Such an approach requires infrastructure, regulation, operations and financing evolving in parallel.

The first real-world demonstration flight took off in August 2025 from Sola Airport in Stavanger. This milestone brought together four partners: The US aircraft manufacturer BETA Technologies provided the ALIA CX300 aircraft; Bristow Norway acted as operator; CAA Norway enabled regulatory approvals and traffic permissions; and Avinor provided airport infrastructure and airspace management. Over six months, 126 eCTOL flights were conducted across seven Norwegian airports. These operations contributed to advancing the technology from approximately Technology Readiness Level (TRL) 6 to TRL 7. More importantly, these real-world operations provided system-level learning that can only be gained through operational experience. Norway's experience from these demonstrations might also provide valuable insights for other regions with similar geographical and transport characteristics.

Balance between public support and market-driven development

The transition to zero- and low emission aviation is both system-wide and capital-intensive, making shared learning essential in the early stages. A key lesson from the International Test Arena is that shared learning and a framework for data-sharing built on Just Culture are important success factors. The International Test Arena demonstrates that collaboration is a strategic enabler that drives learning and iteration, efficient resource allocation and clearer paths to scaling.

Although public authorities play a critical role in reducing uncertainty for early technology adoption, an important principle is that market dynamics are drivers for the choices and decisions made in the International Test Arena. For example, public procurement follows formal tendering processes and industry stakeholders play a key role in shaping both the scope and location. This balance between public support and market-driven development ensures both innovation and commercial viability.

CAA Norway as an active transition partner

CAA Norway's role in the International Test Arena goes beyond the traditional regulatory oversight. The authority actively contributes to regulatory co-creation, working actively alongside industry and EASA to enable safe and efficient innovation. Key elements include regulatory sandbox approaches to accelerate development. Yet, the need for innovation is uncompromisingly balanced with the highest safety standards. This approach enables faster learning cycles while maintaining the integrity of a safe aviation system.

Taking stock for next generation sustainable aviation

While the first demonstration project proved that zero- and low emission aviation is viable, important questions remain. The first demonstration project therefore marked only the beginning. Building on the experiences gained, a second project has been launched. The EL2, developed by US manufacturer Electra will be operated by Bristow to explore hybrid-electric aircraft with ultra-short take-off and landing (uSTOL) capabilities. This second demonstration project will explore operations on short runways, novel access points, in

underserved communities, and in connection with larger airports. The aim is to assess how such concepts can work in practice and to generate further regulatory, operational and market insights.

In summary, the experiences of CAA Norway and the partners of the International Test Arena highlight that achieving zero- and low-emission aviation requires a coordinated transformation across the entire ecosystem, grounded in real-world learning, joint commitment and mutual trust. Through real-world operations, the activities in International Test Arena shows how individual demonstrations can develop into knowledge that supports scaling and future commercial operations. Ultimately, the transition must carefully balance high paced progression with safety, ensuring that innovation does not compromise the robust safety standards on which aviation depends.

Please find the Final Report here.

Read more about the International Test arena.

A CLOSE LOOK AT NEW PROPULSION AIRCRAFT ENTRY INTO SERVICE – WITH REAL NUMBERS

By Eduardo Mariz, Sustainability Lead and Senior Analyst at Ishka Airfinance Global

Delays in new propulsion aircraft programmes are widely discussed across the industry, increasingly reflected in updated net zero roadmaps, and evident in the steady pushback of programme milestones. Yet, they are rarely quantified with precision.

This short analysis looks at low and zero-tailpipe emission aircraft programmes and powertrains (hybrid-electric, battery-electric, and hydrogen) in the conventional take-off and landing (CTOL) space – i.e. excluding e-VTOLs, to focus on the equipment most suited to replacing sub-regional, regional, and, one day, narrowbody short-haul air services.

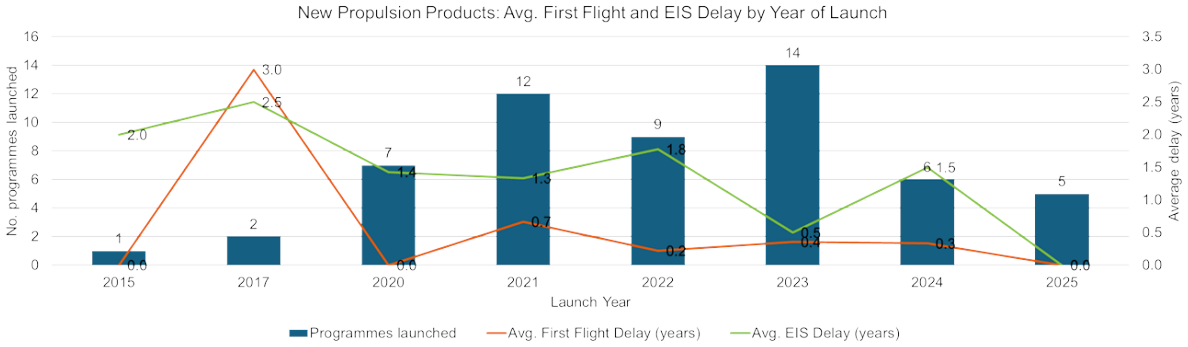
By putting real numbers behind initially announced and latest-disclosed timelines, we aim to clarify where and when programmes are slipping.

The big number: 57% are delayed

By Ishka's estimate, more than half of new propulsion CTOL products with stated entry-into-service (EIS) targets are running at least one year behind their original timelines. Overall, 25 of the 56 products currently under active or planned development are delayed by an average of 2.6 years. Excluding products without any public EIS estimates (and whose progress can't be quantified), the delays affect 25 out of 44 products (57%).

In total, Ishka SAVi – Ishka Airfinance Global's sustainability data and intelligence platform – looked at 70 new propulsion products by 45 OEMs: clean-sheet aircraft, retrofit solutions, and powertrains. The analysis covers target EIS delays since the product's initial announcements. Fourteen of the 70 products have been discontinued, most within the past two years.

As for first-flight targets, among the 51 products under active or planned development that are yet to fly (as of February 2026, five had already flown), targeted first flight years were found for 23 products. Nearly half (10) are at least one year behind targeted first flight date, with an average delay across them of 2.3 years.



***Source**: OEM disclosures analysed by Ishka SAVi*

***Note**: 'Launch year' denotes the first public disclosure of a programme. For established OEMs, this may refer to the initial announcement of concept development rather than a formally launched programme.*

First flight target and EIS target average delays between the initially stated target and the latest stated targets as of February 2026 by year of programme launch date (e.g. for the 7 programmes launched in 2020, the average EIS delay based on the latest stated targets is 1.4 years).

The immediate take-away is that start-up OEMs face significantly greater challenges in achieving certification and entry into service than in building and flying a prototype.

Caveats

It is important to note that disclosure of information varies across OEMs. As a result, the absence of delay in some programmes does not necessarily mean that no delays occurred, but rather that such delays may not have been reported or made publicly available.

Unlike larger and well-established OEMs, most start-up OEMs analysed are not public companies, they have no duty to publicly disclose the pace of their progress and are not beholden to customer pressures in the same way.

Conclusions

It is important to stress that programme delays are not unique to new propulsion technologies. Across the industry, most commercial aircraft programmes see their first flight and entry-into-service timelines revised as they move from launch through development and certification.

It is also important to recognize that early disruptors (some start-up OEMs were established over a decade ago) face structural barriers that later entrants are likely to navigate more easily. Early movers are effectively de-risking the pathway for those that follow, so this recurring tendency towards delays may not necessarily last. For a detailed look into the hurdles that need to be cleared, the Alliance for Zero-Emission Aviation's (AZEA) roadmap released in April 2026, a milestone 92-page document based on contributions by AZEA's members (including ***impact***), is worth a detailed look.

Despite these hurdles, there are reasons for optimism. Several programmes are making tangible progress toward certification at this moment - notably Ampaire, BETA Technologies, and ZeroAvia. In short, there are credible reasons to believe that the very first low- and zero-emission commercial aircraft operations - beginning with small cargo services, and followed by air taxi and private charters - are drawing ever closer.

Note to readers: *This analysis is based on public disclosures from various companies, where definitions of EIS dates can vary. For first flight, initial full-size prototypes are considered, which may occasionally differ from certification-ready prototypes. The analysis does not take into account Airbus' ZEROe – which, until recently, remained a family of concepts. Since the analysis was completed, Airbus has confirmed technical feasibility of the hydrogen-electric 100-seater concept. The EIS estimate for that aircraft was updated last year from 2035 to the 2040s.*

The 56 active programmes reviewed in the analysis comprise: Ampaire (Eco Otter conversion kit, Eco Caravan conversion kit, Tailwind), Ascendance (STERNA Hybrid Pack), ATR (ATR EVO), AURA AERO (ERA (Electrical Regional Aircraft)), BETA Technologies (Alia CX300), Beyond Aero (BYA-1), Blue Spirit Aero (Dragonfly 4S, Dragonfly 6S), Bye Aerospace (eFlyer 800), Conscious Aerospace (CA2100), Cosmic Aerospace (Skylark), DESAER (ATL-100H), Deutsche Aircraft (Dornier D328 (hydrogen)), Dovetail Electric Aviation (DovePower (battery-only application), DovePower (hybrid-electric application), DovePower (hydrogen-electric application)), ELECTRON (ELECTRON 5), Electra (EL9), Electric Aviation Group (EAG) (Hydrogen Hybrid Electric Regional Aircraft (H2ERA)), Elysian Aircraft (E9X), EVIO (EVIO 810), Fokker Next Gen (Fokker Next Gen aircraft), H55 (H55 Electric Propulsion System (EPS)), Heart Aerospace (ES-30), Jekta (Passenger Hydro Aircraft Zero Emission 100 (PHA-ZE 100)), JetZero (Z4 (Hydrogen – potential variant)), Maeve Aerospace (MJ 500), MagniX (Magni350, Magni650), Magpie (Magpie Aerotowing), MD Aircraft (MDA1 eViator), Natilus (Horizon (hydrogen – potential variant)), NOEMI Aerospace (NoEmi), REGENT (Monarch, Viceroy), Smartflyer(SF-1), Stralis Aircraft (B1900D-HE, Bonanza A36-HE, SA-1-HE), Surf Air Mobility (SAM powertrains (AeroTEC + MagniX)), The AirCraft Company (SY30J Pangea), Tidal Flight (Polaris), Vaeridion (Microliner), VoltAero (HPU 210, Cassio 330, Cassio 480, Cassio 600), Wright Electric (WM2500, Wright 1, Wright C-130, Wright Spirit), and ZeroAvia (ZA600, ZA2000, ZA2000RJ).

BLUE SKY THINKING MEETS MARKET REALITIES

By Gabriel Hanot, Senior aviation consultant at GH Aviation Consulting

Why new propulsion aircraft must be designed around markets, not just technologies

Regional aviation has always carried a particular promise. It can connect places that are too far apart for a comfortable car journey, too small for large aircraft, and too dispersed to justify major rail infrastructure. In a world looking for lower-carbon mobility, that promise is becoming attractive again.

Many regions already have airports. Some are underused. Many are closer to passengers than large hubs. If a new generation of quieter, lower-emission aircraft could operate from this existing infrastructure, regional aviation could offer a cleaner form of connectivity without waiting for decades of new ground infrastructure to be built.

It is a compelling vision: short access times, simplified airport processes, direct regional links, and aircraft powered by battery-electric, hybrid-electric or hydrogen-electric propulsion.

But this vision must be tested against market reality. New propulsion aircraft will not enter an empty market. They will compete against thousands of existing piston and turboprop aircraft, operated by customers that already have aircraft, maintenance arrangements, pilot training, spare parts, established procedures, and financing habits.

The question is therefore not only whether new propulsion aircraft can fly. It is whether they can fit real missions, real economics, and real customer behaviour.

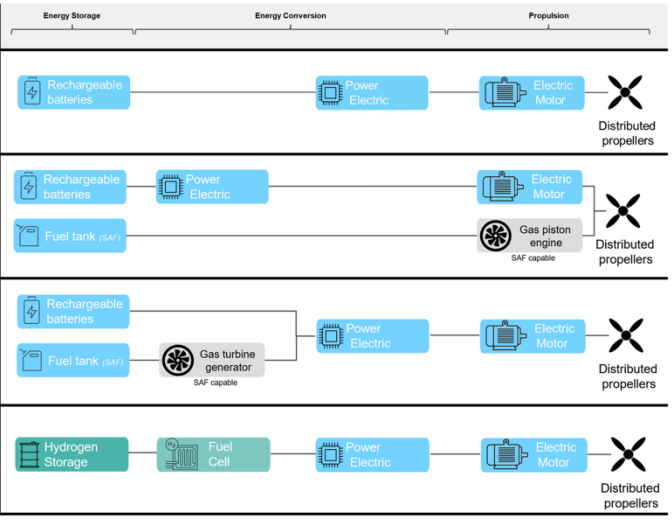
Technology may define what is possible, but market fit will define what scales.

Several technologies, different trade-offs

“New propulsion” covers several architectures with different strengths and limitations, as illustrated in the figure below.

- **Battery-electric aircraft** are attractive because electric motors are highly efficient and mechanically simpler than combustion engines. This can reduce energy use, noise, and maintenance. The difficulty is energy storage: batteries remain heavy, which limits range, payload and flexibility, especially once reserves are included.
- **Hybrid aircraft** offer a more pragmatic path. Parallel hybrids retain a combustion engine (preferably a piston engine), supported by electric power during high-demand phases such as take-off and climb. Series hybrids use fuel to generate electricity, which then powers electric motors. Both can reduce fuel burn and create a bridge toward future electric operation, but they still depend on liquid fuels and carry the complexity of dual systems.
- **Hydrogen-electric aircraft**, usually based on fuel cells, offer another route. Hydrogen can store more usable energy than batteries for some missions, and fuel cells produce no CO_2 emissions during aircraft operation. But hydrogen also brings major integration challenges: production, storage, distribution, refuelling, cooling, and the need to add new airport infrastructure.

	Production & storage	Conversion	Propulsion	Total efficiency*
Battery electric	95%	98%	92%	85%
Parallel Hybrid	Elec 95%	98%	92%	85%
	35% SAF*		35%(Pist)	12%
Series Hybrid	Elec 95%	98%	92%	85%
	35% SAF*	27%(Turb)		8%
H2 electric	65% (gaseous)	45%	92%	26%



(*)Efficiency calculated from electricity, not accounting for the transport of energies

Technology efficiency comparison: Indicative efficiency comparison of battery-electric, hybrid and hydrogen-electric propulsion pathways. Each architecture involves different trade-offs between energy conversion, storage, propulsion efficiency and operational practicality. Source: GH Aviation Consulting analysis.

The practical conclusion is simple: there is no universal winner. The right propulsion system depends on the mission. A short island-hopping route, a medical evacuation aircraft, a low-density regional service and a special-mission aircraft may each require a different answer.

This matters because much of the public discussion focuses on entry-into-service dates and headline range figures. Yet range, payload, reserves, infrastructure, and utilization determine whether an aircraft is commercially useful. A technical possibility only becomes a market opportunity when it fits the operator's mission.

The first wave will be small

Most first-generation new propulsion aircraft are small. Many projects target aircraft below 19 seats, where certification pathways (CS/FAR 23) are more accessible than for larger commercial aircraft and where propulsion power requirements are lower.

This is a logical starting point. Smaller aircraft allow manufacturers to test technologies, develop certification experience, build operational knowledge and establish customer confidence. In aviation, scaling too quickly is rarely a safe strategy.

However, it also means that the first wave will not replace today's regional aviation network as a whole. Battery-electric aircraft are likely to remain focused on relatively short routes. Hybrid and hydrogen-electric aircraft may extend the range envelope, but they will still be constrained by payload, reserves, infrastructure and aircraft economics.

The first commercial opportunities will therefore be selective. These aircraft will be used where the distance is short enough, where charging or fueling infrastructure can be provided, where utilization works, and where the operator sees a clear benefit.

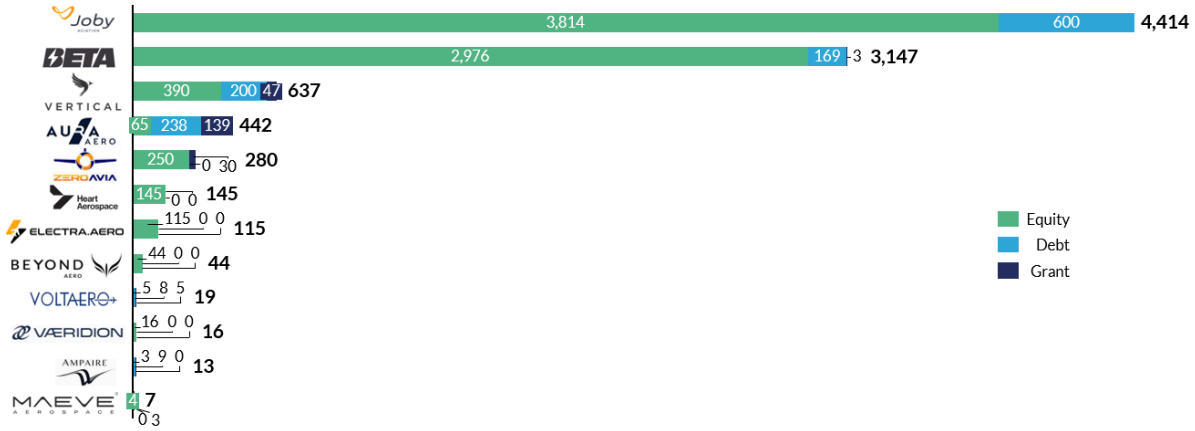
From demonstrator to certified aircraft

The aviation sector has seen many ambitious announcements from new aircraft manufacturers. Some have flown prototypes or demonstrators. Others have presented attractive concepts with claimed entry-into-service dates before 2030.

These announcements show momentum. They help attract investors, partners, suppliers and customers. But there is a major difference between flying a demonstrator and delivering a certified, supportable commercial aircraft.

Certification requires much more than proving that an aircraft can take off and land. It requires a complete safety demonstration, a structured flight-test campaign, mature systems, production quality, maintenance documentation, training programmes, spare parts, continued airworthiness processes and regulatory confidence. After certification, operators also need reliability, support and long-term manufacturer stability.

Publicly available funding data for selected new project OEMs, in M$



Source: GH Aviation Consulting research based on Crunchbase, Tracxn, Manufacturer news & published financial statements, extracted as of 06/2026

Publicly available funding data for selected new propulsion OEMs: Potential early market-entry points for new propulsion aircraft include secondary airport services, low-demand regional routes and selected modal-shift opportunities from ground transport. Source: GH Aviation Consulting analysis.

For some companies, the challenge may not be the attractiveness of the concept, but the amount of capital needed to bring the aircraft to market. Aircraft development is expensive because certification, industrialisation and support networks are expensive. A prototype can demonstrate promise; a certified aircraft programme must demonstrate endurance.

This does not mean that new entrants cannot succeed. It means that investors, customers and policymakers should distinguish carefully between technological progress and programme maturity. The market will need credible manufacturers, not only credible concepts.

The market is not empty

New propulsion aircraft are sometimes presented as if they were creating an entirely new category. In reality, many of their early target markets are already served by existing aircraft.

The 9-seat and 19-seat segments are good examples. They are often grouped together because both belong to the small-aircraft universe. But commercially, they are not the same.

The 9-seat market is larger and more dynamic. It includes private aviation, business aviation, air taxi, medical transport, special missions, and small commercial operations.

Many of these customers value speed, flexibility, range, runway performance, and payload capability. For first-generation low-carbon aircraft, this can be a difficult competitive environment if they offer lower range, lower speed, or more operational constraints.

The 19-seat market is different. It is smaller and has been declining, but it includes older fleets and more visible passenger airline opportunities. Some aircraft in this category are no longer produced, and replacement options can be limited. For new propulsion aircraft, that may create a more attractive opening, particularly where the mission is short, regular, and compatible with new infrastructure.

But both markets share one major characteristic: fragmentation.

Many operators in these segments fly very small fleets. Some operate only one or two aircraft. From a commercial perspective, this matters enormously. Selling to many small operators requires repeated sales effort, customer education, financing support, training, infrastructure planning, and after-sales coverage.

New propulsion aircraft do not just need to fly. They need to replace aircraft that already work.

Existing aircraft also have a powerful advantage: familiarity. Operators know their performance, maintenance needs, dispatch reliability, resale value, and operating costs. Mechanics know how to maintain them. Pilots know how to fly them. Regulators, insurers, and financiers understand them.

A new propulsion aircraft must therefore compete not only against the fuel burn of an existing aircraft, but against the entire ecosystem around it.

Economics and policy will shape adoption

New propulsion aircraft can bring meaningful benefits: lower energy costs, lower maintenance, lower noise, and lower emissions. They may also support regional or corporate decarbonization goals.

But those benefits do not automatically create a positive business case. Operators will assess aircraft productivity, cruise speed, turnaround time, crew cost, navigation charges, battery replacement, infrastructure, residual value, dispatch reliability and financing risk.

This is why policy matters. Carbon pricing, fuel taxation, subsidies, public-service obligations, airport incentives and infrastructure funding can all influence the economics of new propulsion. Where carbon reduction is rewarded, low-carbon aircraft become more competitive. Where fossil fuel use remains relatively cheap and externalities are not priced, the business case becomes harder.

This is especially relevant for small aircraft. In some regulatory frameworks, smaller operators may fall below emissions or activity thresholds. If they are not exposed to carbon costs, the immediate financial incentive to switch propulsion technology may be limited. The environmental case may still be strong, but the operator’s cash-flow case may be weaker.

In other words, technology alone will not determine adoption. The surrounding economic system will play a decisive role.

Where new propulsion may work first

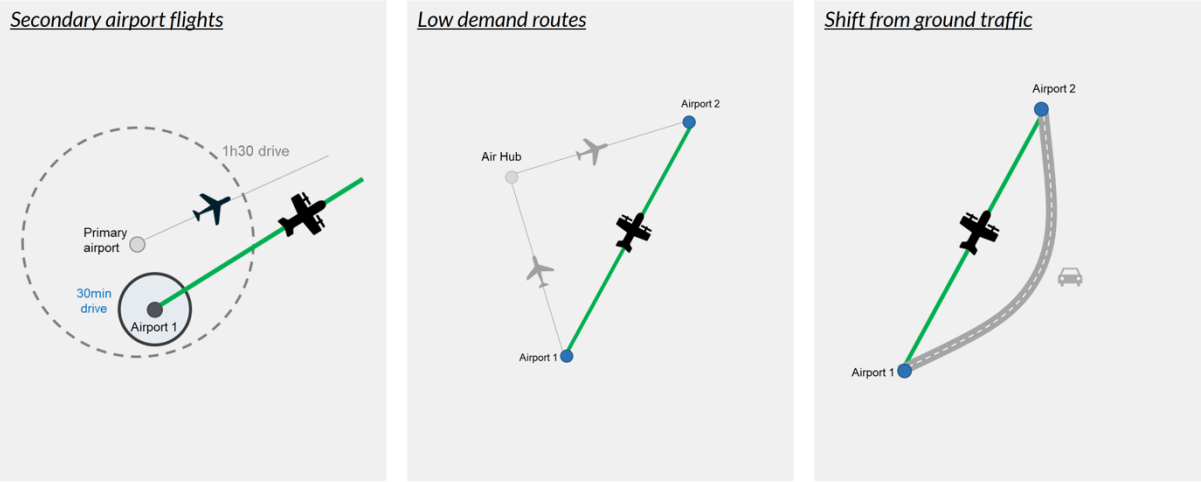
The right question is not whether new propulsion aircraft can replace every existing small aircraft. They cannot, at least not in the first generation. The better question is: where can they create the most value first?

Several early opportunities stand out.

Secondary airport connections are one. Many regions have airport infrastructure that is underused or poorly connected to major networks. A small, quieter, lower-emission aircraft could make some of these routes more acceptable and more economically viable.

Low-demand routes are another. Some city pairs do not justify larger aircraft but may still have enough demand for a small aircraft, especially if the service is direct and saves substantial ground travel time.

A third opportunity is modal shift from ground transport, but only in selected cases. New propulsion aircraft are unlikely to replace high-density rail corridors. But they may compete with long car journeys where rail is unavailable, indirect or slow.



Passenger airline opportunities / business cases

This points toward a more selective commercial strategy. Instead of trying to address all 9-seat and 19-seat missions, manufacturers should identify the missions where their technology creates a clear advantage. That means designing aircraft around use cases, not only around propulsion systems.

The first successful markets may be niches. But in aviation, niches can matter. They can create operational experience, build passenger confidence, mature maintenance practices and give regulators real-world data. They can also provide a stepping stone toward larger aircraft.

Innovation scales from the right market

Next-generation propulsion has a role to play in aviation decarbonization. It can reduce emissions, lower noise, improve energy efficiency and make better use of regional airport

infrastructure. It can also help aviation explore technologies that may later scale toward larger aircraft.

But optimism must be disciplined by market reality.

The first generation of aircraft will be range-limited and mission-specific. Many manufacturers will face significant funding and certification challenges. The target markets are already served by existing aircraft. The 9-seat and 19-seat segments have different dynamics. Both are fragmented. And operator adoption will depend on economics, infrastructure, support and policy incentives as much as on technology.

This does not weaken the case for new propulsion. It clarifies it.

The first successful aircraft may not be the most advanced one, but the one designed around the right mission.

In new propulsion, blue sky thinking matters. It attracts talent, capital and ambition. But market realities will decide which aircraft actually take off.

BEYOND FLIGHT CONNECTIONS, SKYTEAM ALIGNS SUSTAINABILITY AMONG MEMBERS

Written by Eduardo Mariz, Sustainability Lead and Senior Analyst at Ishka Airfinance Global for impact, with questions facilitated by impact's Reporting Workstream.

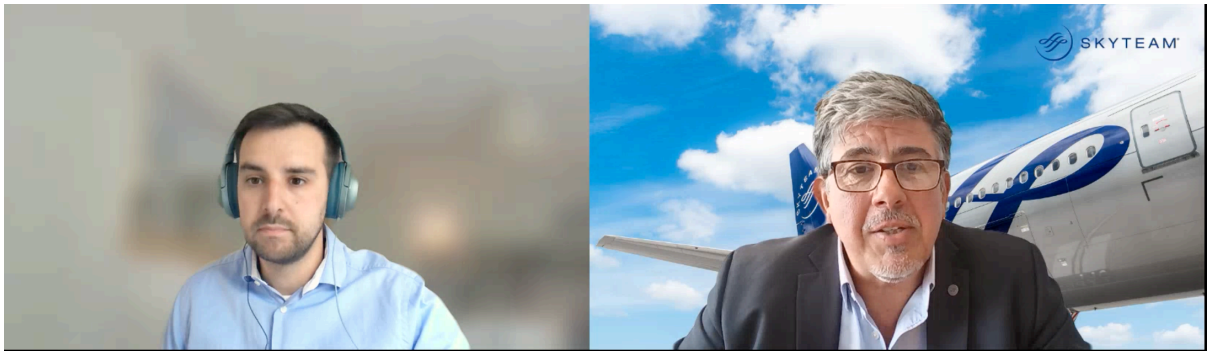


Photo: Eduardo Mariz (left) and Paul Zissermann, Sustainability Director at SkyTeam (right).

Airline alliances were born to seamlessly connect all four corners of the world. In the process, they have achieved far more than that, from expanding global reach and harmonising customer experience to enabling operational efficiencies and shared innovation. In recent years, sustainability has emerged as one of the main pillars of alliances, allowing commercial partners to leverage collective scale and shared expertise in pursuit of common climate goals.

SkyTeam, one of the world's three major alliances, has been particularly effective at harnessing the collective expertise of its 18 global airlines, with initiatives like its flagship The Aviation Challenge (TAC) driving friendly competition in innovative solutions – now in its fifth year. To better understand how SkyTeam is accelerating progress on SAF and other areas, we spoke with Paul Zissermann, SkyTeam's Sustainability Director.

18 airlines leading together

Sustainability teams at airlines are often stretched across a wide range of priorities, and one of SkyTeam's key functions is to enable members to share expertise and improve collectively. "The beauty of the alliance approach [for sustainability] is that we have certain members that are industry leaders," explains Zissermann, who oversees the alliance's sustainability engagement from its Amsterdam headquarters. "It could be the Net Zero transition, it could be operational efficiency techniques, the adoption of SAF, or ESG reporting, or even topics like anti-human trafficking."

To illustrate how expertise is shared across the alliance, Zissermann points to the latter. Members such as Delta, Aeromexico, and Kenya Airways have taken leading roles in anti-human trafficking, helping others accelerate the rollout of key measures. "Streamlining reporting of human trafficking incidents, how to train frontline staff, how to deal with compliance issues on a state-by-state level, and also engagement with law enforcement agencies," he cites as examples.

SAF adoption, among nine key targets

To become a more integrated alliance, SkyTeam has encouraged joint target-setting among members, starting with nine areas for joint action. Going forward, it is also hoping to make reporting on the targets a membership requirement. The nine areas include employee satisfaction, increase of women in senior positions, waste reduction, supply chain ESG performance, checks on ethical cargo, low-emission ground equipment, renewable energy across ground facilities, reduction of flight emissions intensity, and SAF adoption.

Among those nine, Zissermann says "all 18" members have named SAF as the "number one sustainability challenge in the coming years," and tasked SkyTeam to play a leading role in facilitating SAF knowledge and best practices. "They wanted to hear from industry leaders, SAF producers, verification and certification bodies, but they also wanted to explore joint procurement opportunities as well."

Those priorities have led to the creation of a "SkyTeam SAF Hub" and the hosting of "numerous briefings" with key SAF stakeholders. The alliance has also launched an internal newsletter focusing on SAF announcements and developments across its main global hubs.

Joint SAF procurement – which rival airline alliance Oneworld began trialling in 2022 – is being explored, but "discussions are still ongoing," Zissermann says. It is, he adds, "a surprisingly complex topic," given the difference in SAF definitions across jurisdictions, contractual requirements, existing fuel supply contracts, and antitrust considerations. "But we're always looking at new ways of addressing these challenges and delivering solutions that will provide value to our members and to their customers as well. So, you know, watch this space."

The aviation challenge

SkyTeam's flagship Aviation Challenge has attracted the attention of key players across the aviation sustainability ecosystem, setting an example for how friendly competition can boost industry collaboration and improve mutual learning. While the Challenge started with

SkyTeam member airlines, it has expanded into a broader industry collaboration involving other airlines and aviation companies.

“[One] core component of The Aviation Challenge is the performance of demonstration flights through a specific flight window in September and October every year. On those flights, the participants can showcase all the different solutions and collect real data, which is then analyzed by the NLR, the Netherlands Aerospace Centre.”

Last year, SkyTeam showcased a variety of solutions across 80 flights, delivering “significant improvements to key performance indicators” such as fuel efficiency, SAF used, and overall emissions intensity. “We say something like a 14% reduction in carbon intensity compared to the standard flights that the airlines were performing on those city pairs.”

Openness to cross-industry collaboration

Beyond collaboration outside the alliance through The Aviation Challenge, SkyTeam has also played a role in bridging different emissions-intensity methodologies between its member airlines and the broader IATA community. “It's also super important now that several jurisdictions are introducing flight emissions labels; we want to really align across the industry on the methodology to use that. And that quite often involves working with other airlines and other alliances.”

That need for standardisation also extends to Net Zero transition plans, which Zissermann sees as essential to addressing doubts about the aviation industry’s ability to reduce and mitigate its environmental impact by 2050. He adds elsewhere in the conversation that greater implementation of ICAO targets and recommended actions within the action plans of individual member states will also be critical.

As for sustainable finance, Zissermann believes it has the potential to be “used more” in aviation, keeping with their growing popularity among airport financings. Specifically, for SAF, he sees a need for the oil and gas sector to step up investment into the nascent SAF industry.

impact`s CLOSING REFLECTION

By Ulrike Ziegler, impact

One of the striking observations from the contributions gathered in this publication is how often different stakeholders arrive at similar conclusions from very different starting points.

Whether discussing SAF mandates, project finance, new propulsion technologies, air traffic management, airport financing, carbon markets, regulatory developments, or airline operations, contributors repeatedly identify the same underlying challenge: the need to connect individual initiatives into a functioning ecosystem.

Many of the technologies required for aviation's transition already exist in some form. Many policy frameworks are emerging. Capital is available. Expertise is abundant. Yet progress continues to depend on something less tangible: the ability of stakeholders to align incentives, manage risk, create investment certainty, and scale solutions beyond individual projects.

This publication intentionally brings together perspectives that do not always agree. That diversity is valuable. Aviation's transition will not be advanced by consensus alone, but by informed debate, rigorous analysis, and a willingness to challenge assumptions.

If there is one conclusion that emerges from the first half of 2026, it is that the conversation is becoming more mature. The central question is no longer whether aviation should transition. Increasingly, the focus is on how that transition can be delivered in practice, financed at scale, and implemented across a complex and interconnected global industry.

The discussions will continue. The questions will evolve. And ***impact*** will continue to provide a platform where stakeholders can engage with them openly, constructively, and with a shared commitment to advancing sustainable aviation.