VOLUME 54 / APRIL 2026

WORLD AIRNEWS

CONNECTING SKIES • BRIDGING CONTINENTS

POWERING FUTURE FLIGHT

SYSTEMS UNDER PRESSURE

ENERGY DRIVERS

AVIATION REVENUE REDEFINED

COVER IMAGE : EVE'S FULL-SCALE eVTOL ENGINEERING PROTOTYPE CREDIT: EVE AIR MOBILITY

NASA X-57 MAXWELLENGINEERING THE EDGE OF POSSIBILITY

The NASA X-57 Maxwell was never intended as a commercial aircraft, but as a platform to explore the limits of distributed electric propulsion. By placing multiple small electric motors along a high-aspect-ratio wing, the programme examined how energy, aerodynamics and efficiency interact at a system level. While the aircraft itself will not enter service, the questions it raises remain central to the future of electric aviation: not whether it is possible, but under what conditions it becomes practical.

OFFICIAL JOURNAL OF:– Commercial Aviation Association of Southern Africa, The Airlines Association of South Africa, The Association of South African Aircraft Traders, Association of Training Organisations of South Africa, Aerodromes & Airports Association of South Africa, Association of Aviation Maintenance Organisations, South African Society of Aerospace & Environmental Medicine, Helicopter Association of Southern Africa, Aircraft Owners & Pilots' Associations of Southern Africa, Airside Operators, Association of South Africa, South African Aerial Applicators Association, East African Commercial Aviation Association, African Airline Association (AFRAA) Media Partner.

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HECATE hybrid-electric architecture project. Credit: Collins Aerospace

THE DIRECTION OF CHANGE

Aviation continues to evolve across multiple fronts, but not all developments carry equal weight. This edition of World Airnews considers where meaningful progress is taking place, and where operational reality continues to shape the pace of change.

This month's edition explores a central theme: how aviation innovation is moving from concept toward application. While new technologies continue to attract attention, their long-term value is increasingly determined by how effectively they integrate into existing operational environments.

From hybrid propulsion and high-speed rotorcraft development to tiltrotor maturity and early-stage electric aircraft deployment, the articles that follow reflect a progression from future ambition to present-day reality. At the same time, established platforms continue to define reliability, reinforcing the gap that remains between innovation and scalable implementation.

Introducing Industry Signals

Beginning with this edition, World Airnews introduces a new recurring feature: Industry Signals.

Positioned at the front of the magazine, this page provides a concise, curated snapshot of the developments shaping aviation. Rather than reporting on individual events, Industry Signals draws together key patterns and directional indicators from across the industry.

The purpose is simple: to offer readers a clear sense of what is changing, why it matters, and how these developments connect to the broader aviation landscape.

Balancing Depth And Readability

As the scope of aviation continues to expand, so too does the range of perspectives required to understand it. This edition reflects an ongoing editorial focus on maintaining depth and relevance, while ensuring that the magazine remains accessible and engaging to a broad readership.

Alongside more detailed features, readers will find a continued emphasis on clarity, structure, and context, allowing each topic to be understood not in isolation, but as part of a wider industry narrative.

Looking Ahead

The role of aviation has always been shaped by the balance between possibility and practicality. As new technologies advance, that balance becomes increasingly important.

This edition of World Airnews aims to provide not only insight into where the industry is heading, but also a grounded understanding of how that future is likely to unfold.

Hybrid Pathways Gaining Practical Relevance

Hybrid configurations are increasingly positioned as a transitional solution, offering measurable efficiency gains without the infrastructure and range limitations that continue to constrain fully electric platforms.

Speed And Efficiency Driving Rotorcraft Evolution

Programmes such as high-speed compound helicopters reflect a clear focus on improving performance within existing design frameworks, rather than pursuing entirely new aircraft categories.

Alternative Vertical Lift Models Edge Toward Viability

Tiltrotor platforms are progressing beyond concept, suggesting that blended fixed-wing and rotorcraft capabilities may soon occupy a defined operational niche.

Electric Aviation Finds Its First Practical Foothold

Rather than broad disruption, electric aircraft development is aligning with specific use cases, particularly in training and short-range operations where limitations are more manageable.

Operational Reality Continues To Favour Proven Platforms

Aircraft with established reliability and versatility remain central to aviation operations, highlighting the gap between emerging technologies and scalable, day-to-day utility.

Training Ecosystems Under Increasing Pressure

As aircraft systems become more advanced, training requirements are evolving in parallel. This is placing growing demand on simulator availability, instructor capacity, and programme design.

Sustainability Framed By Operational Constraint

Industry momentum toward lower-emission aviation continues, but progress remains closely tied to practical considerations including infrastructure readiness, certification pathways, and cost viability.

AIRSHOWS IN CONTEXT

While this edition examines how aviation is being reshaped by energy systems, infrastructure and operational constraints, it is equally important to recognise the role of industry platforms that connect these elements in practice.

Airshows form part of that wider ecosystem. Beyond public display, they depend on structured governance, safety oversight, skilled personnel and sustained participation — all of which reflect the underlying health of the aviation sector.

In South Africa, that structure is currently undergoing a period of renewal. The following contribution offers an internal perspective from within the airshow community, outlining both the opportunities and constraints shaping its future direction.

The New Flight Path: Airshows South Africa Charts A Course For Renewal

The South African airshow circuit — long celebrated for its passion, skill and uniquely African character — stands at a point of renewal. With the recent election of a new committee, Airshows South Africa (ASSA) is

Pretoria Airshow 2025. Credit: © Flight Images positioning itself to address the operational, financial and participation challenges that have shaped the sector in recent years.

At the helm is Col (Ret) Keith Fryer, whose aviation career spans both operational command and safety leadership. During his time in the South African Air Force (SAAF), he flew as part of the Cheetah 2v1 Air Combat display alongside Cobus "Jester" Toerien of 2 Squadron.

He later commanded 21 VIP Squadron, operating the Presidential Boeing Business Jet, and concluded his service as Director of Aviation Safety — a role that reflects a deep understanding of governance, risk and operational discipline.

Fryer's contribution to the airshow environment has been equally significant. Over the past 15 years, he has served as Airboss at numerous local and international events, including the African Aerospace and Defence (AAD) airshows at AFB Waterkloof and the Swartkops Museum airshows. His appointment signals a continued focus on experienced, operations-led leadership.

Supporting him is Vice Chairman Johan Heine, CEO of Kishugu Aviation, whose long-standing involvement in the Lowveld and Mpumalanga airshows brings continuity and practical coordination experience in complex, safety-critical environments.

The committee's financial oversight is entrusted to Rehan van Tonder, an ex-SAAF fighter pilot and current airline training captain. His background spans aerobatics — including the Smirnoff Pitts team — as well as international exposure through events such as the Dubai Airshow, bringing both operational and commercial aviation perspectives.

Continuity within the organisation is maintained through Louse Hofmeyer, who continues in her role as secretary, overseeing regulatory compliance, airspace coordination and administrative functions.

The extended committee includes a number of co-opted members who contribute specialist expertise. Brian Emmenis of Capital Sounds, widely recognised as the long-standing voice of South African airshows, brings decades of experience in event presentation and audience engagement.

Among the co-opted members, Cobus Toerien returns with a post-SAAF career as an airline safety manager and respected presenter on Human Factors, Crew Resource Management (CRM), and aircraft accident investigation — bringing depth to the team's safety culture and operational insight.

Former chairman Rickus Erasmus, who has served the industry for more than a decade, has been co-opted to support the training and development of future airshow directors and flight committee personnel. Supporting the extended team is Jarryd Sinovich, responsible for media relations and the accreditation of photographer members — an increasingly important function as digital visibility and audience reach become integral to event success.

Additional regional experience is represented by Khotso Motsoeneng from the Bethlehem airshow circuit, recognised for consistently well-executed events within the region.

Goitseane Diale has also been co-opted, bringing strong enthusiasm for aviation and contributing to the next generation of industry participation.

Challenges Ahead, Priorities Defined

While the leadership structure is well established, the challenges facing the airshow sector are clearly understood.

A primary concern is the shortage of qualified display pilots and Display Authorisation Examiners — both essential to maintaining safety standards and sustaining future participation. Addressing this will require structured development, mentorship and oversight.

The role and structure of the Display Authorisation Committee (DAC) is also under review, with the objective of ensuring that it remains aligned with current operational requirements.

In parallel, there is a need to expand the pool of trained airshow officials, including Flying Display Directors, Safety Officers and programme coordinators — all critical roles in the safe execution of events.

Beyond operational capacity, ASSA is focused on growing the number of smaller regional airshows. This approach aims to broaden participation, strengthen grassroots involvement and create a more accessible entry point into the sector.

There is also a clear intent to present a more inclusive aviation showcase, incorporating the full spectrum of the industry — from gliders and balloons to commercial aviation, SAAF participation, unmanned systems and pyrotechnic display elements.

From an organisational perspective, ASSA is working to clarify its service offering, expand its role within the Southern African region and attract international participation. Supporting this is a commitment to structured planning, including formal strategic sessions, the development of an annual budget and a longer-term financial outlook.

A key industry issue under consideration remains the cost and availability of third-party insurance for airshow events — a factor that continues to affect organisers across the sector.

Central to all of these priorities is the recognition that sustained growth will depend not only on passion, but on building the knowledge base and support structures required for future organisers and participants.

A Future In Development

The formation of the new ASSA committee reflects a deliberate effort to stabilise and strengthen the South African airshow sector.

With a combination of operational experience, safety expertise and industry knowledge, the current leadership is positioned to address both immediate challenges and longer-term sustainability.

The direction is clear: to support a structured, safe and inclusive airshow environment that reflects both the heritage and the evolving demands of the aviation industry.

Credit: © Flight Images

FROM TECHNOLOGY TO INFRASTRUCTURE: AVIATION'S NEXT PHASE OF DECARBONISATION

The transition to lower-emission aviation is increasingly defined not by engine design, but by the infrastructure required to support new energy systems at scale.

From Concept To Implementation

As of early 2026, the aviation industry is moving beyond the initial phase of technology development into a period characterised by demonstrators, pilot programmes and early-stage deployment.

While improvements in engine efficiency remain important, the focus has shifted toward the broader systems required to support new forms of propulsion. This includes fuel production, airport infrastructure and the integration of hybrid-electric systems into existing aircraft architectures.

The challenge is no longer limited to engineering performance. It is increasingly centred on scalability, cost and operational integration.

Sustainable Aviation Fuel — From Biofuels To Synthetic Pathways

The shift toward e-SAF

Sustainable Aviation Fuel (SAF) remains a central component of the industry's decarbonisation strategy. However, limitations in traditional bio-based feedstocks have led to a growing emphasis on Power-to-Liquid (PtL) processes, often referred to as e-SAF.

These synthetic fuels are produced using renewable electricity to generate hydrogen, which is then combined with captured carbon to create liquid hydrocarbons suitable for aviation use.

Recent developments include plasma-based production methods capable of converting biomethane into synthesis gas at high temperatures, achieving significantly higher process efficiencies than conventional approaches.

The scaling constraint

Despite technological progress, SAF production remains constrained by cost and infrastructure. Industry data indicates that SAF can cost between two and five times more than conventional jet fuel, limiting widespread adoption.

This has led to the emergence of "book and claim" systems, allowing airlines to purchase the environmental attributes of SAF without requiring physical supply at specific airports. While this approach supports market development, it also highlights the gap between production capability and operational deployment.

Hydrogen — From Engine Concepts To Infrastructure Systems

Beyond propulsion

Hydrogen is increasingly being evaluated as a long-term solution for zero-emission aviation. However, the focus has shifted from engine design to the broader challenge of handling, storing and delivering liquid hydrogen within airport environments.

Unlike conventional fuels, liquid hydrogen must be stored at approximately −253°C, requiring specialised cryogenic systems and tightly controlled handling processes.

Aircraft-level developments

Recent milestones include the progression of hydrogen-powered aircraft concepts into more advanced design phases.

Smaller aircraft platforms are being used to test hydrogen propulsion due to their lower complexity and reduced energy requirements. In parallel, manufacturers are refining propulsion configurations to address safety considerations such as asymmetric thrust in engine-out scenarios.

Fuel cell systems are also being explored as an alternative to direct combustion, generating electrical power through chemical processes with water vapour as the primary by-product.

The infrastructure challenge

The primary constraint on hydrogen adoption lies in infrastructure. Airports must effectively evolve into energy hubs, capable of managing cryogenic fuel systems, high-flow refuelling processes and strict safety requirements.

Key developments include:

- Ground-based test rigs simulating full fuel distribution systems
- Research into thermal management, balancing extreme cold fuel with heat generated by onboard systems
- Exploration of on-site hydrogen liquefaction to reduce transport losses.

These developments highlight that hydrogen aviation is as much an infrastructure challenge as it is an engineering one.

Propulsion Ecosystems — The Rise Of Hybridisation

Distributed propulsion concepts

Hybrid-electric propulsion systems are emerging as a complementary pathway, particularly for short- to medium-range aircraft.

These systems combine traditional fuel turbines with electric motors, allowing power to be distributed across multiple points on the aircraft. This approach can improve aerodynamic efficiency and reduce fuel consumption.

System integration and testing

Recent testing programmes are focusing on integrating megawatt-class electric motors with existing turbofan engines. These systems are designed to provide additional power during high-demand phases such as take-off, while improving efficiency during cruise.

Advanced testing facilities are being used to simulate electrical loads, thermal behaviour and system integration challenges before flight testing.

Regional aircraft applications

Hybrid-electric systems are also being developed for regional aircraft, where shorter ranges and lower passenger capacity make early adoption more feasible.

These aircraft are currently progressing through flight testing and certification phases, with the aim of demonstrating both operational viability and economic performance.

A Shift Toward System-Level Thinking

The developments across SAF, hydrogen and hybrid-electric propulsion reflect a broader shift in how aviation approaches decarbonisation.

Rather than focusing solely on individual technologies, the industry is increasingly addressing the integration of multiple systems, including:

- Fuel production and distribution
- Aircraft design and propulsion
- Airport infrastructure and operations

Each of these elements must function together to enable meaningful reductions in emissions.

The aviation industry's transition toward lower-emission operations is entering a new phase, defined less by conceptual innovation and more by implementation challenges.

While technologies such as SAF, hydrogen and hybrid-electric propulsion continue to advance, their success will depend on the ability to scale production, develop infrastructure and integrate systems across the entire aviation ecosystem.

This shift from engineering to implementation represents a critical stage in the industry's evolution, where progress will be measured not only by technological capability, but by the ability to deploy these solutions at scale.

POWERING THE VERTICAL FUTURE: HOW BATTERY TECHNOLOGY IS ENABLING EVTOL FLIGHT

By Keith Fryer

The dream of electrically powered aircraft is almost as old as aviation itself. For decades, engineers understood that electric motors could deliver exceptional efficiency, reliability and low maintenance compared with combustion engines. Yet one critical barrier prevented practical electric flight: energy storage.

Only in the past decade have battery technologies advanced sufficiently to allow the emergence of electric vertical take-off and landing aircraft (eVTOLs), autonomous drones and urban air mobility vehicles capable of carrying both their own power source and human passengers.

Today, the rapid evolution of high-density battery technology is reshaping aviation propulsion and opening the door to a new generation of aircraft designed around distributed electric propulsion and battery-electric power systems.

The Historical Limitation: Energy Density

The fundamental challenge in electric aviation has always been energy density—the amount of energy stored per unit mass. Aviation is uniquely sensitive to weight, and traditional rechargeable batteries have historically offered far less energy per kilogram than aviation fuels.

Jet fuel, for example, contains roughly 12,000 Wh/kg (watt hours per kilogram), whereas early lithium-ion batteries offered only around 100–150 Wh/kg. At such levels, batteries were simply too heavy to power an aircraft carrying passengers.

The breakthrough came with the steady evolution of lithium-ion (Li-ion) chemistry, driven primarily by

Credit: JOBY©

Credit: © BETA technologies

the expanding electric vehicle sector. Modern high-performance lithium batteries now reach 250–300 Wh/kg, with aviation-focused cells approaching or exceeding 400 Wh/kg.

Industry experts generally consider 400 Wh/kg the threshold at which practical eVTOL operations become feasible for short-range missions. That threshold is now being reached.

Lithium-Ion Maturity And The First Electric Aircraft

Lithium-ion battery technology—refined through consumer electronics and electric vehicle development—has become the foundation for the first generation of electric aircraft and drones.

Several enabling characteristics have made lithium-ion suitable for aviation applications:

- High power output for vertical lift phases
- Relatively high energy density
- Rechargeability and long cycle life
- A mature manufacturing ecosystem

However, eVTOL aircraft present far more demanding conditions than ground vehicles. Take-off and landing phases require 10–15 times higher instantaneous power than electric cars, while total energy consumption can be three to five times greater per kilometre.

This means aviation batteries must simultaneously provide:

- High energy density for endurance
- High power density for vertical lift
- Thermal stability and safety
- Rapid charging capability

Meeting these requirements has driven continued innovation in battery chemistry and system design.

Solid-State Batteries: A Major Development

One of the most promising developments in electric aviation is the emergence of solid-state batteries.

Unlike conventional lithium-ion batteries that use liquid electrolytes, solid-state designs employ ceramic or polymer electrolytes.

The advantages are significant:

- Higher energy density
- Reduced fire risk
- Wider operating temperature ranges
- Improved durability and cycle life

Recent test programmes have demonstrated solid-state batteries achieving energy densities of approximately 480 Wh/kg, improving endurance for electric aircraft.

In one test, an autonomous passenger-carrying eVTOL aircraft completed a 48-minute continuous flight using solid-state batteries, with endurance improvements of up to 90% compared with earlier systems.

Manufacturers are now targeting 500 Wh/kg cells, which would enable increased payload capacity and extended urban air mobility routes.

Beyond Lithium-Ion: Next-Generation Chemistries

While improved lithium-ion technology has enabled the first generation of electric aircraft, the industry is actively exploring next-generation battery chemistries.

Lithium-Sulfur Batteries

Lithium-sulfur (Li-S) technology is widely regarded as a promising option for aviation. With theoretical energy densities exceeding 600 Wh/kg, these batteries could significantly extend aircraft range and support multi-passenger urban operations.

Lithium-Metal Batteries

Lithium-metal batteries represent another pathway, with prototypes achieving energy densities of up to 760 Wh/kg. Reducing battery mass by even 20–30% could materially improve payload capability and flight duration.

Advanced Solid-State Architectures
Research programmes, including NASA's SABERS initiative, have demonstrated prototype cells exceeding 800 Wh/kg, with theoretical potential above 1,000 Wh/kg. These designs reduce structural weight and improve thermal performance, making them particularly relevant for aviation applications.

The Role Of Distributed Electric Propulsion

Battery advances have coincided with a parallel shift in aircraft design: distributed electric propulsion (DEP). Electric motors are:

- Lightweight
- Highly efficient (often exceeding 90%)
- Easily distributed across the airframe

This enables configurations using multiple smaller propellers rather than a single large engine, improving efficiency, redundancy and control.

The combination of modern battery systems and electric propulsion has therefore enabled aircraft configurations that were previously impractical using conventional propulsion systems.

Hybrid And Multi-Energy Systems

Despite rapid advances in battery technology, many experts consider hybrid architectures a likely near-term pathway.

These systems combine batteries with alternative energy sources such as:

- Hydrogen fuel cells
- Range-extending generators
- Metal-air batteries

Hybrid systems can deliver high power for vertical take-off using batteries while relying on alternative energy sources for sustained cruise, improving range and operational flexibility.

Economic And Operational Considerations

Battery cost and lifespan remain key considerations. Aviation-grade batteries are currently three to five times more expensive than those used in electric vehicles, reflecting stricter safety requirements and lower production volumes.

However, costs are expected to decline as production scales increase. Improvements in battery life, charging speed and thermal management are also contributing to more viable operational models for electric aircraft.

Credit: ETEON ©

Enabling Urban Air Mobility

Battery development is progressing alongside increasing investment in urban air mobility (UAM). More than 900 eVTOL aircraft concepts are currently under development worldwide, supported by both aerospace and automotive manufacturers.

These aircraft are intended for short-range missions such as:

- Urban air taxi services
- Medical transport
- Cargo operations
- Regional commuter flights

Their viability depends directly on continued improvements in energy storage capability.

The Road Ahead

The evolution of battery technology is bringing electric flight from concept to operational reality. What was once constrained by the weight of energy storage is now increasingly feasible due to improvements in energy density, safety and power output.

While batteries still do not match the energy density of liquid aviation fuels, ongoing developments in solid-state, lithium-sulfur and lithium-metal technologies indicate that the gap is narrowing.

In time, battery-powered propulsion may support a range of aviation applications, from urban mobility platforms to regional aircraft.

The transition is ongoing, but the underlying technology is now enabling, rather than limiting, the development of electric flight.

HYBRID LIFT: HOW DISTRIBUTED ELECTRIC ARCHITECTURE EXTENDS EVTOL RANGE

While many eVTOL programmes focus on fully electric propulsion, Bell's Nexus programme takes a different approach—one that acknowledges current battery limitations and integrates hybrid systems to support range, payload, and operational viability.

The Role Of Hybrid Propulsion In Evtol Development

Bell's Nexus programme represents a deliberate departure from purely battery-electric eVTOL designs. Instead, it explores a hybrid-electric architecture that combines conventional fuel-based energy generation with electric propulsion systems.

This approach addresses one of the most persistent limitations in urban air mobility: energy density. Current battery technologies impose constraints on range, payload, and utilisation rates—factors that directly affect commercial viability.

By incorporating a hybrid system, the Nexus concept seeks to extend operational range while maintaining the benefits of electric propulsion, including reduced local emissions and lower noise profiles during key flight phases.

Distributed Electric Propulsion As A Design Enabler

A defining feature of the Nexus concept is its use of distributed electric propulsion (DEP). Multiple electrically driven rotors are integrated across the airframe, providing both lift and forward thrust.

This configuration offers several advantages:

- Enhanced control and redundancy through multiple propulsion units
- Potential improvements in safety and fault tolerance
- Greater flexibility in airframe design compared to conventional rotorcraft

The distributed architecture also supports vertical take-off and landing capability while enabling efficient transition to forward flight, positioning it within the broader eVTOL category.

Energy, Infrastructure And Operational Reality

Beyond the aircraft itself, Bell's approach highlights a broader systems challenge: infrastructure.
Urban air mobility will depend on more than vehicle design. Vertiports, energy supply systems, and high-

frequency operational logistics will play a central role in determining feasibility.
Hybrid systems introduce an additional layer to this equation. While they reduce reliance on large battery packs, they still require integration with fuel supply chains and maintenance frameworks that differ from fully electric models.

This raises important considerations:

- How will vertiports accommodate both electric charging and fuel logistics?
- What energy mix will support scalable, high-frequency operations?
- How will regulatory frameworks adapt to hybrid propulsion systems?

These questions underline that urban air mobility is as much an infrastructure challenge as it is an aircraft design problem.

Positioning Within The Evtol Landscape

Bell's Nexus programme sits within a broader spectrum of eVTOL development strategies.

At one end are fully electric aircraft prioritising zero-emission operations but constrained by battery performance. At the other are hybrid concepts, such as Nexus, which trade some system complexity for extended range and operational flexibility.

This positioning reflects a pragmatic recognition: near-term urban air mobility solutions may require compromise between ideal environmental outcomes and operational practicality.

A Transitional Architecture For Scalable Operations

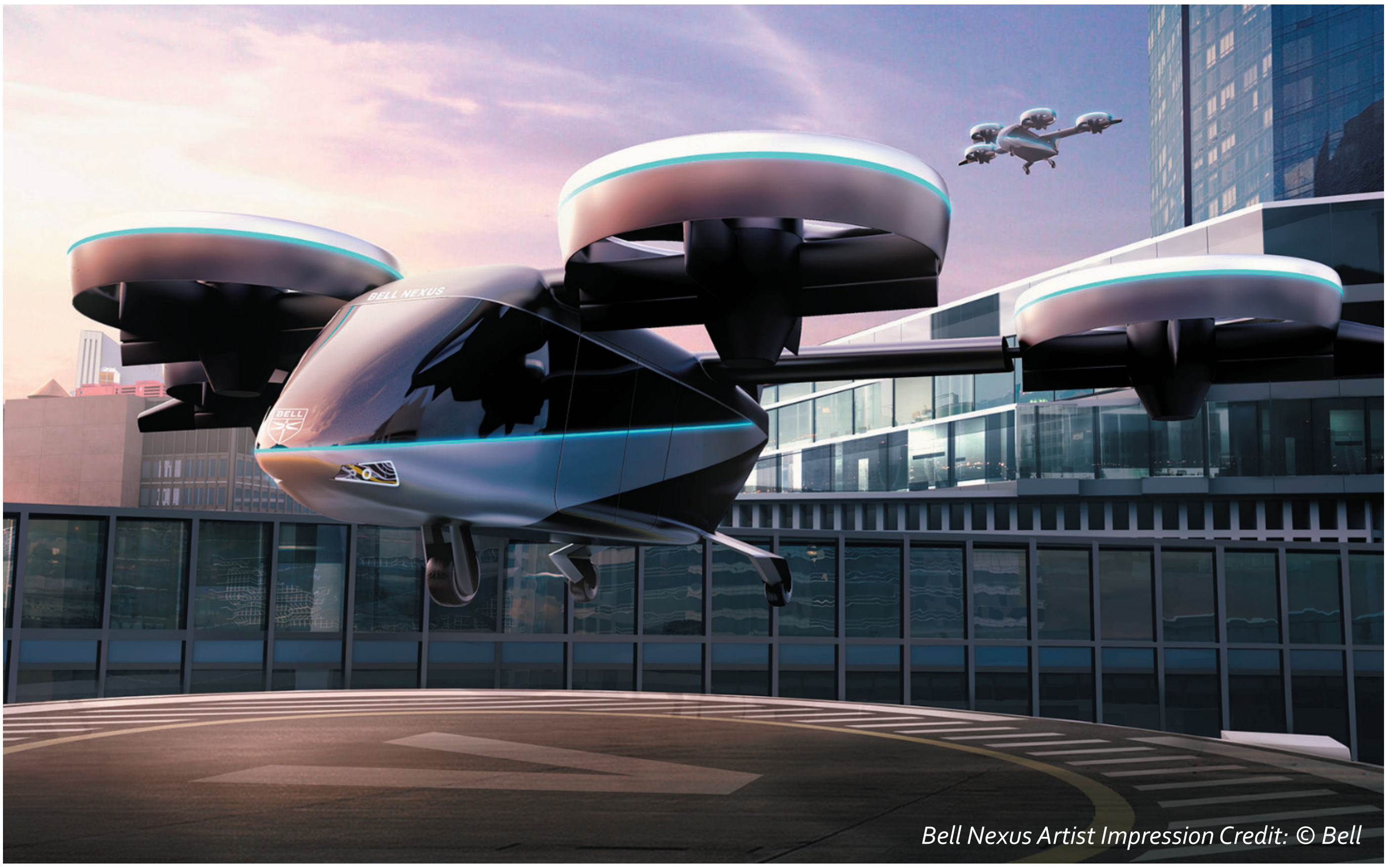
Rather than representing a final solution, the Nexus concept can be viewed as a transitional architecture—bridging current technological limitations while enabling early-stage deployment.

As battery technologies evolve, the balance between hybrid and fully electric systems may shift. However, in the near term, hybrid-electric propulsion provides a pathway to:

- Increased mission range
- Higher utilisation rates
- Greater payload flexibility

These factors are likely to influence which concepts move from demonstration to sustained commercial operation.

Bell's Nexus programme underscores a central reality in the development of urban air mobility: aircraft design is fundamentally shaped by energy constraints.
By adopting a hybrid-electric, distributed propulsion approach, Bell highlights an alternative pathway—one that prioritises operational viability alongside technological advancement.
As the sector continues to evolve, the success of such concepts will depend not only on engineering innovation, but on how effectively they integrate into the broader ecosystem of infrastructure, regulation, and energy supply.



Bell Nexus Artist Impression Credit: © Bell

Alia in flight Credit: © BETA Technologies

BETA TECHNOLOGIES AND THE SYSTEMS LOGIC OF ELECTRIC AVIATION

Rather than focusing on aircraft alone, BETA Technologies is building an electric aviation platform that links propulsion, infrastructure and market entry strategy.

Systems, Not Just Aircraft

BETA Technologies is presenting a distinctly integrated view of electric aviation. In discussion on the Sustainability in the Air podcast, founder and CEO Kyle Clark set out an approach that does not treat the aircraft as an isolated product, but as one element within a broader operational system that includes propulsion, batteries, charging infrastructure and early-use markets.

That framing is important. Much of the wider discussion around electric aircraft continues to centre on a single constraint: battery energy density. Clark's position is that this focus, while valid, is incomplete.

His argument is that aircraft performance is shaped by the interaction of multiple design factors, and that improvements in propulsion efficiency, motor weight, thermal behaviour and drag can recover some of the gap created by battery limitations.

BETA's ALIA platform reflects this approach. The company is developing both conventional take-off and landing (CTOL) and vertical take-off and landing (VTOL) variants for passenger and cargo transport over several hundred miles. The strategy is not presented as a concept study, but as a step towards operational deployment in defined markets.

Rethinking The Battery Question

Looking beyond energy density Clark's comments suggest that BETA's approach begins with reframing the standard criticism of electric aircraft. Batteries remain far less energy-dense than conventional fuel, but he argues that the comparison becomes more meaningful when considered alongside the rest of the propulsion system. Electric motors are materially lighter than conventional piston engines, and electric propulsion is described as operating at around 95% efficiency, compared with roughly 30% for combustion engines.

This matters because the energy stored onboard is only one part of the equation. Lower motor weight, reduced thermal loss and lower drag can improve the efficiency of the aircraft as a whole. Clark's assessment is that these factors help recover a meaningful share of the performance gap between batteries and liquid fuel. On that basis, BETA believes its aircraft can perform several hundred-mile missions, which it characterises as roughly half the range of an equivalent conventional aircraft.

Economic implications
BETA's argument is not purely technical. It is also commercial. Clark states that the aircraft can deliver significant energy-cost advantages, describing the operating energy cost as roughly a fortieth of that associated with conventional propulsion. That claim sits at the centre of the business case: range may be lower than for conventional aircraft, but the economics of the missions that remain viable could still be compelling.

The company expects aircraft pricing to fall in the region of USD 4 million to USD 6 million, depending on configuration. It also anticipates substantial revenue from battery replacements over the life of the aircraft, with Clark noting that lifetime battery revenue could exceed the initial aircraft sale value. In BETA's model, batteries are not simply a cost burden; they are also part of the long-term commercial structure.

Why Beta Is Starting Where It Is

Choosing lower-friction markets
BETA is not attempting to begin with the most complex public-facing use case. Instead, it is targeting cargo, medical logistics and defence applications as early operational markets. The logic is straightforward: these sectors already have infrastructure, operational urgency and fewer barriers to adoption than passenger urban air mobility.

Hospitals and military facilities already use helipads and related aviation infrastructure. Cargo operators, meanwhile, remove the challenge of persuading large numbers of passengers to adopt a new form of aircraft. Clark presents this as a pragmatic sequencing decision rather than a compromise. BETA's early market strategy is designed to generate activity and revenue within operating environments that already exist.

CTOL first, VTOL later
That pragmatism also appears in the certification plan. BETA is developing both CTOL and VTOL versions of ALIA, but intends to bring the CTOL aircraft to market first. According to Clark, this offers an easier certification path and allows the company to begin operations sooner, without requiring changes to airspace structure. The company's sequencing suggests that BETA views market entry and certification timing as central parts of its engineering strategy, rather than downstream considerations.

The Charging Network As Strategy

From internal tool to commercial product
One of the more revealing aspects of BETA's approach is that it did not stop with the aircraft. Clark explains that the company developed its own charging system because suitable high-voltage, high-rate charging equipment was not readily available for the operational flying it wanted to do. What began as an internal requirement was then refined into a certifiable commercial product as demand emerged from airports and operators.

This charging architecture is based on an industry standard agreed through the General Aviation Manufacturers Association (GAMA) and uses CCS charging technology. The system supports currents of roughly 500 amps and voltages of up to 1,000 volts. Clark also notes its multimodal potential, suggesting common infrastructure could serve aircraft as well as ground vehicles in some operating environments.

Infrastructure as value
The charging network is already being deployed along much of the US East Coast and at international sites including Abu Dhabi Airports. Clark indicates that the network could ultimately be as strategically significant as the aircraft themselves. That is a notable position.

It suggests BETA sees infrastructure not merely as a support function, but as a core part of the company's long-term value proposition.

Defence As An Early Revenue Market

BETA's materials indicate that defence has become an important near-term market. Clark says the company has secured a substantial number of defence contracts, and he presents this not simply as future potential but as current revenue-generating activity. He also links BETA's aircraft characteristics to defence requirements, including low noise, lower thermal signature and lower cost.

For longer-range military missions, the company is also working with GE Aerospace on hybrid-electric configurations using turbogenerators. This is an important detail because it shows BETA is not presenting battery-electric propulsion as the sole answer to every mission. Rather, it appears willing to incorporate hybrid architectures where range extension is required, while retaining the operational advantages associated with electric propulsion.

A Vertically Integrated Model

Control over core technologies
BETA's approach is described as vertically integrated, with the company developing many of its core technologies in-house, including propulsion systems, batteries and charging infrastructure. That level of internal control appears central to its philosophy.

Instead of relying on a fragmented supplier ecosystem for foundational technologies, BETA is seeking to shape the critical parts of the operating system itself.

Culture as part of execution
The second document also places some emphasis on company culture. BETA refers to all employees as "team members", gives equity broadly, and encourages direct engagement with aviation, including flight training.

Regular coordination meetings are used to align activity across the business. While this sits outside the aircraft itself, it reinforces the broader picture of BETA as a company trying to organise engineering, operations


Charging station Credit: © BETA Technologies

and commercial execution around a single framework.

Investment, Partners And Positioning

BETA is based in Vermont and completed its initial public offering in 2025. Early customers include United Therapeutics and UPS. The company also attracted significant pre-listing investment from GE Aerospace, reported at around USD 300 million, while Amazon disclosed a stake of roughly 5.3%. These details matter because they indicate that BETA's platform has attracted backing not only from financial markets, but from organisations with direct operational and industrial interest in logistics, aerospace and transport systems.

What This Feature Reveals About Beta

Taken together, the supplied material presents BETA Technologies not simply as an aircraft developer, but as a company attempting to build an electric aviation operating model. Its strategy rests on several linked assumptions:

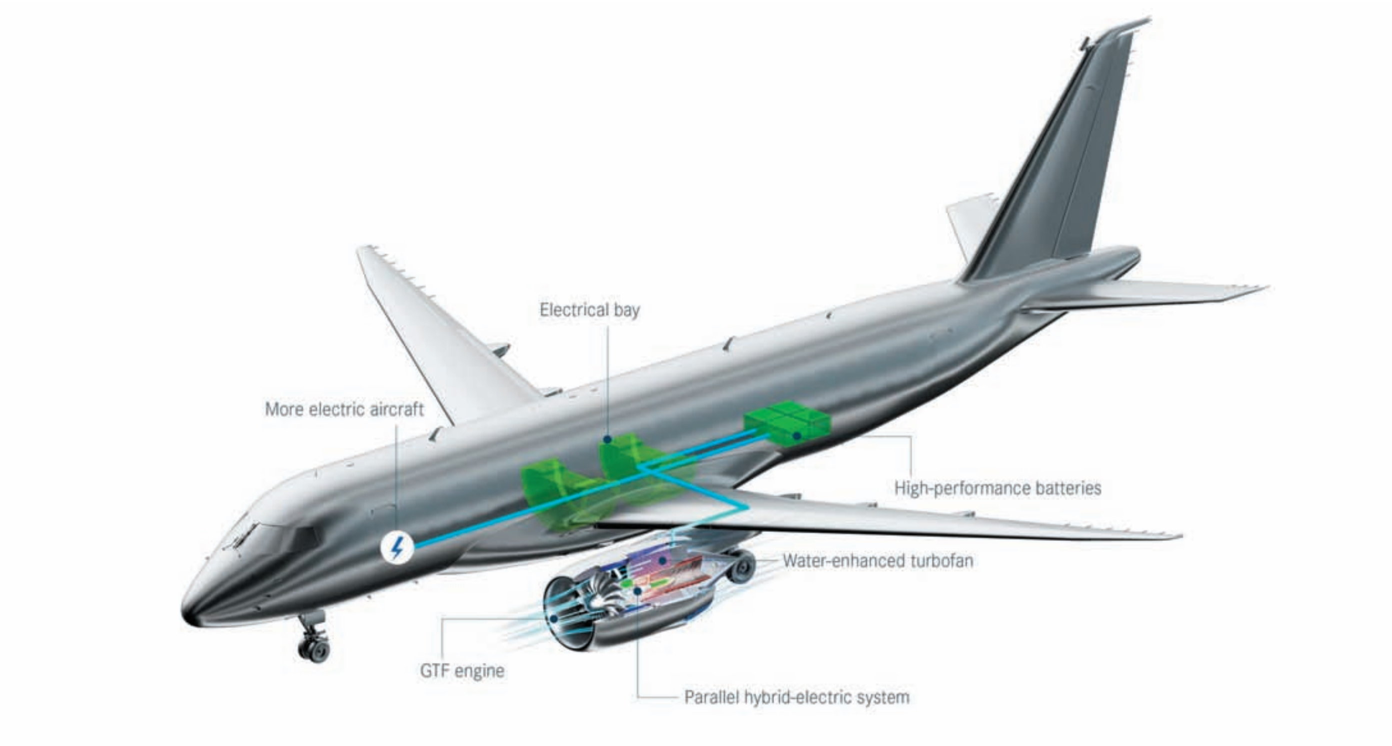
- that electric aviation should be assessed at system level, not battery level alone
- that early deployment should begin in markets with lower regulatory and infrastructure friction
- that infrastructure should be developed alongside aircraft, not after them
- that recurring battery and charging revenue may become as important as the aircraft sale itself
- that operational execution matters as much as technical ambition

BETA Technologies' feature is strongest when read not as a story about a single aircraft, but as an account of how one company believes electric aviation can move from concept into service.

Its central proposition is that viability will depend on coordinated system design: lighter propulsion, efficient aircraft, practical entry markets, phased certification and deployable charging infrastructure. Whether that model proves scalable will depend on execution over time, but the materials supplied make clear that BETA is attempting to solve more than an airframe problem.

It is building aircraft, but it is also building the conditions under which those aircraft might operate.

COLLINS AEROSPACE BEGINS HYBRID-ELECTRIC POWERTRAIN TESTING FOR CLEAN AVIATION SWITCH PROJECT



Clean Aviation SWITCH Project Credit: © MTU Aero Engines

Collins Aerospace has initiated ground-based testing of hybrid-electric powertrain systems under the Clean Aviation SWITCH project, marking a step toward integrating electric propulsion components with conventional turbofan engines.

Powertrain Testing Underway

Collins Aerospace has begun testing key elements of a hybrid-electric powertrain as part of the European Union's Clean Aviation SWITCH programme. The work is being conducted at the company's "Grid" electric power systems facility in Rockford, Illinois.

The testing focuses on integrated subsystems, including electric motor-generators, controllers and power distribution systems. These components form the basis of a hybrid-electric architecture intended for future short- and medium-range aircraft applications.

Focus On System Integration

The current phase of the programme centres on validating how electric propulsion elements can be integrated with an existing turbofan platform. The SWITCH demonstrator is based on a Pratt & Whitney geared turbofan (GTF) engine, with hybrid-electric components designed to operate alongside the conventional gas turbine.

Two megawatt-class motor-generators are among the primary systems under evaluation. These units are intended to support different phases of flight, providing additional power when required and contributing to overall efficiency optimisation.

The objective is not to replace the turbofan, but to augment its performance through electrical power integration.

The Role Of "The Grid"

Testing is being conducted at "The Grid", a specialised facility designed to simulate high-power electrical systems under controlled conditions. The environment allows engineers to evaluate system behaviour, electrical loads and thermal performance before progressing to full engine-level integration.

This approach enables validation of complex interactions between mechanical and electrical systems, which is a central challenge in hybrid-electric propulsion development.

Collaborative Programme Structure

The SWITCH project forms part of the European Union's Clean Aviation initiative and involves multiple industry and research partners. Participants include Collins Aerospace, Pratt & Whitney, MTU Aero Engines, Airbus and GKN Aerospace, alongside a network of European research institutions.

Subsystem development is distributed across several locations, reflecting the collaborative nature of the programme. Electric motor systems have been developed in the United Kingdom, power distribution components in Germany, and electrical interconnection systems in the Netherlands.

Position Within Hybrid-Electric Development

Hybrid-electric propulsion is being explored as a means of improving efficiency by combining traditional gas turbine performance with electric power systems. In this configuration, electric motors can provide additional power during high-demand phases such as take-off, while enabling more efficient operation during cruise.

The SWITCH programme focuses on validating this concept at a subsystem and integration level, rather than introducing a new propulsion system architecture.

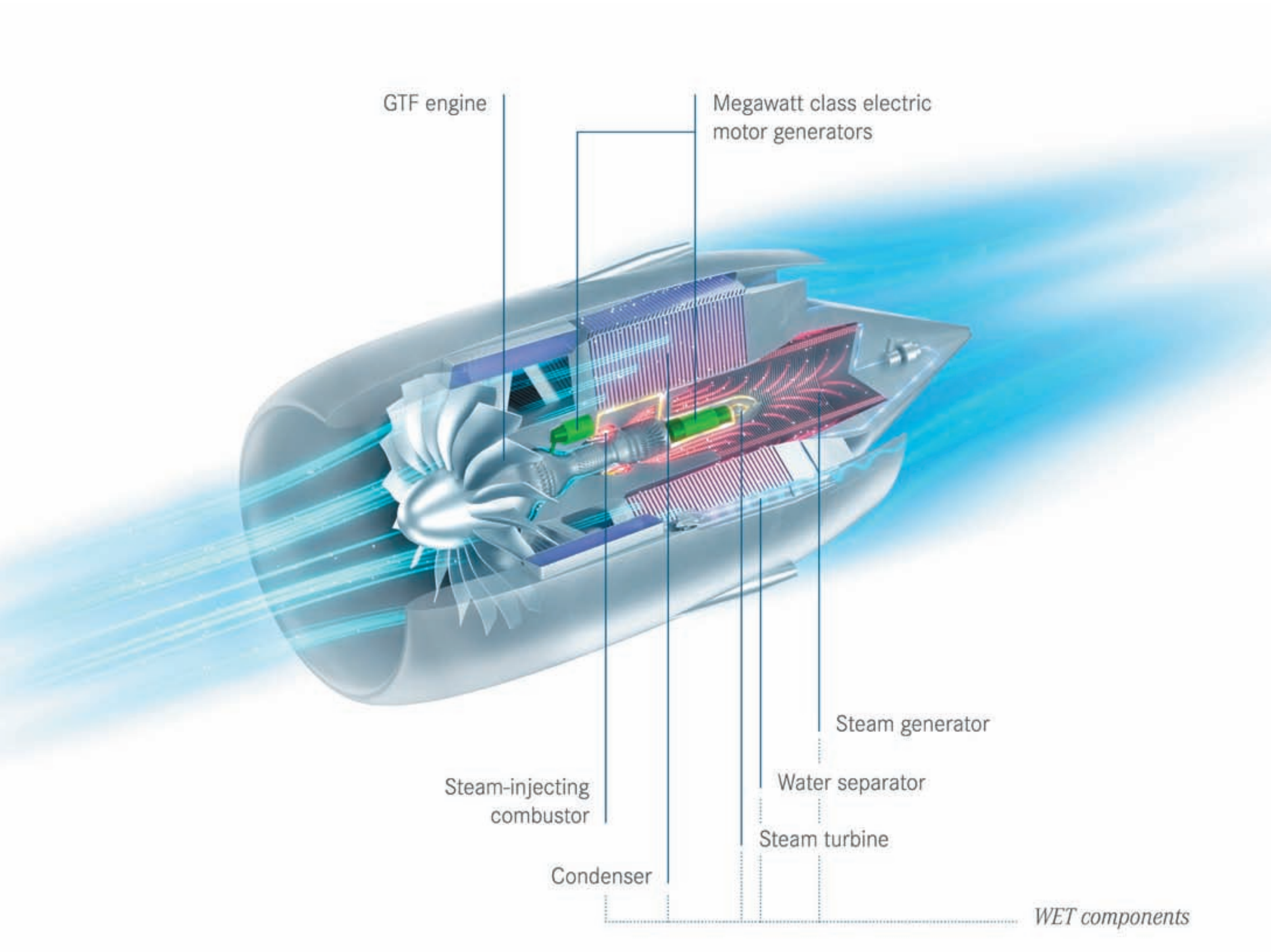
Industry Context

The testing activity reflects a broader shift within the aviation sector toward evaluating hybrid-electric systems as part of a wider set of decarbonisation strategies. While sustainable aviation fuel and hydrogen remain central to long-term emissions reduction, hybridisation is being considered as a nearer-term pathway, particularly for short- and medium-range aircraft.

However, the integration of high-power electrical systems introduces new challenges, including thermal management, system weight and electrical distribution complexity.

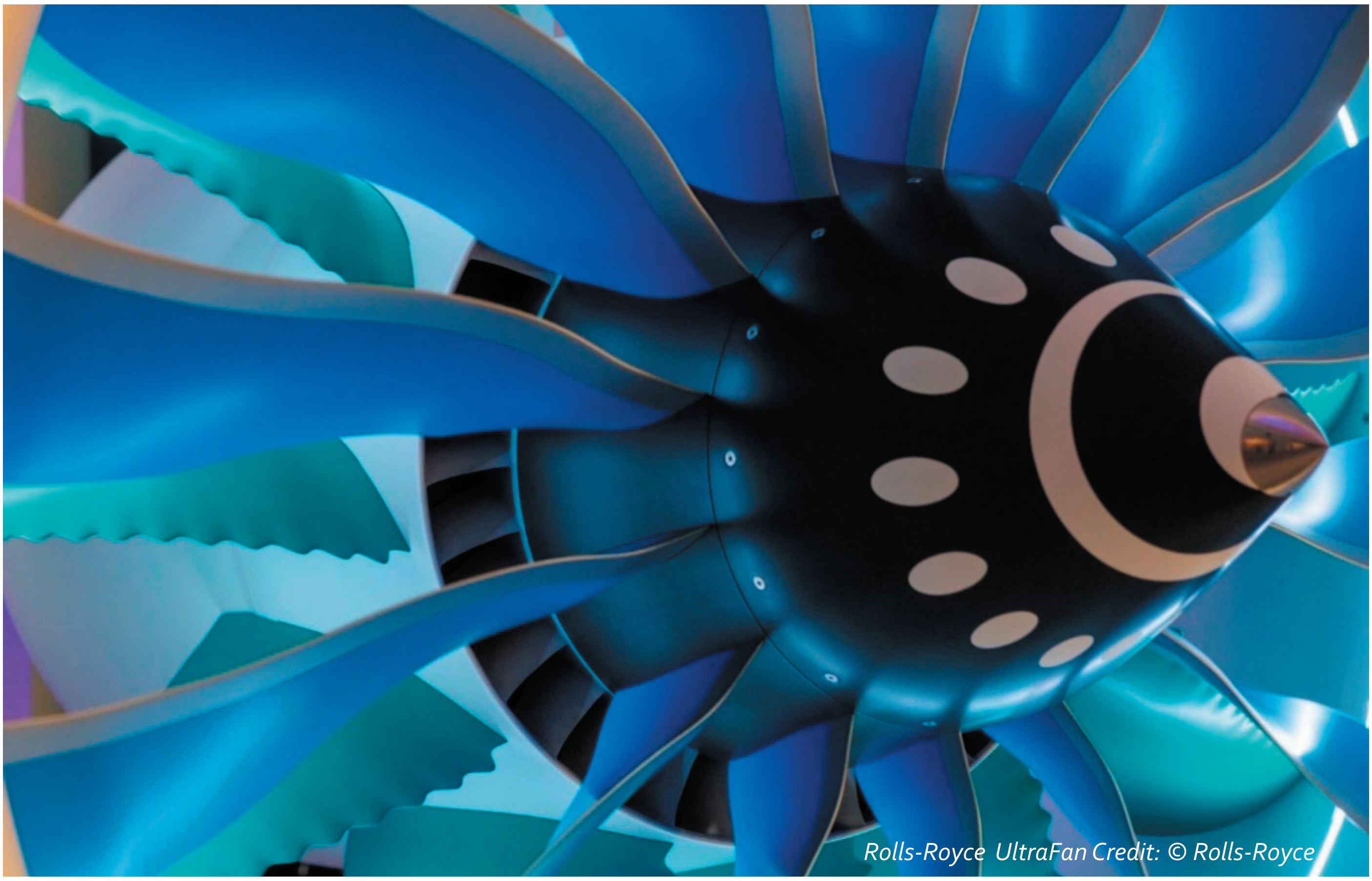
The initiation of powertrain testing under the SWITCH programme represents a measured step in the development of hybrid-electric propulsion systems.

While the technology remains in the validation phase, the focus on subsystem integration and engine compatibility reflects a shift toward practical implementation, with future progress dependent on successful system-level testing and demonstration.



Clean Aviation SWITCH Project Credit: © MTU Aero Engines

ROLLS-ROYCE ULTRAFAN AND THE EVOLUTION OF FUTURE PROPULSION



Rolls-Royce UltraFan Credit: © Rolls-Royce

The UltraFan demonstrator represents more than an incremental upgrade in engine design, combining new materials, geared systems and combustion technologies to support future propulsion requirements across multiple aircraft categories.

Rolls-Royce has historically played a central role in the development of aero-engine technology, from early piston engines to the high-bypass turbofan systems that underpin modern commercial aviation.

The UltraFan programme builds on this legacy, integrating multiple technology streams into a large-scale demonstrator intended to support future aircraft development. First unveiled in 2014, the programme centres on a modular architecture that can be adapted across different thrust classes and aircraft types.

Rather than representing a direct product launch, UltraFan serves as a technology platform, allowing Rolls-Royce to validate design approaches that may be introduced progressively into service over time.

Engine Architecture And Technology

Geared architecture and system integration
A defining feature of UltraFan is its geared turbofan architecture, allowing the fan and core to operate at different speeds for improved efficiency. This configuration differs from traditional direct-drive systems and enables better optimisation of airflow and thermal performance.

The engine incorporates a high-capacity power gearbox capable of transmitting approximately 64 megawatts, representing a significant engineering development at this scale.

Advanced materials and manufacturing

The use of composite fan blades with titanium leading edges contributes to both weight reduction and durability, with a reported reduction of approximately 700 kg on a twin-engine aircraft.

Ceramic matrix composites are applied in high-temperature sections of the engine, enabling higher operating temperatures and improved efficiency. Additive manufacturing techniques are also used in component production, supporting more complex geometries and reduced material waste.

Core and combustion system

UltraFan incorporates the Advance3 core and ALECSys lean-burn combustor, both designed to improve fuel efficiency and reduce emissions. Testing has included operation on 100% Sustainable Aviation Fuel

(SAF), aligning with current industry decarbonisation strategies.

Variable pitch fan
The variable pitch fan system allows optimisation across flight phases and removes the requirement for a conventional thrust reverser, contributing to lower weight and improved aerodynamic efficiency.

Efficiency And Environmental Performance

The UltraFan architecture is designed to deliver a 25% improvement in fuel efficiency relative to the first generation of Trent engines and around 10% compared with the Trent XWB.

In addition, the engine targets reductions of approximately 40% in nitrogen oxide emissions and 35% in noise levels, reflecting increasing regulatory and operational pressures on environmental performance.

Full-power testing conducted in 2023 demonstrated the engine's operational capability, with runs performed using 100% SAF to validate compatibility with current alternative fuel pathways.

From Widebody To Narrowbody: The Ultrafan 30 Programme

The scalability of the UltraFan architecture is central to its long-term relevance. While the initial demonstrator has focused on large engine applications, Rolls-Royce is extending the concept into the narrowbody segment through the UltraFan 30 programme.

UltraFan 30 is designed as a 30,000 lb thrust-class geared turbofan, targeting the next generation of single-aisle aircraft expected to replace current Airbus A320neo and Boeing 737 MAX families.

The engine incorporates a 90-inch fan, high bypass ratios between 12:1 and 15:1, and a geared system enabling improved efficiency without moving to open-rotor configurations.

Performance targets include fuel burn improvements of up to 20–25% relative to current narrowbody engines, alongside similar reductions in emissions and noise.

Comparative Approaches To Next-Generation Propulsion

The development of UltraFan takes place within a broader industry effort to improve propulsion efficiency, where different architectural approaches are being explored.

One alternative under evaluation across the sector is the open-fan or unducted engine configuration, which seeks to achieve higher propulsive efficiency by eliminating the nacelle and allowing larger, slower-turning fan blades. This approach has the potential to deliver further fuel burn reductions but introduces additional considerations related to noise, integration and certification.

In contrast, UltraFan retains a ducted turbofan configuration while incorporating a geared architecture and very high bypass ratios. This reflects a design pathway that prioritises incremental efficiency gains within a configuration that remains closer to current aircraft integration frameworks.

Both approaches aim to address the same underlying challenge: improving fuel efficiency and reducing emissions in the next generation of aircraft. The divergence lies in how each balances aerodynamic efficiency, operational considerations and integration complexity.

Market Timing And Strategic Context

The UltraFan 30 programme reflects a broader strategic move by Rolls-Royce to re-enter the narrowbody market, which it exited in 2012 following its withdrawal from the IAE consortium.

This segment represents the largest and fastest-growing portion of the commercial aviation market, with significant production increases forecast over the coming decades.

Development timelines suggest ground testing around 2028, with potential entry into service aligned with next-generation aircraft programmes expected in the mid-2030s.

The programme is being supported through collaborative initiatives such as the UNIFIED project, bringing together industrial and academic partners across Europe to advance technology readiness.

Operational And Industry Implications

The integration of UltraFan technologies has implications beyond individual engine performance. Improvements in fuel efficiency directly influence airline operating costs, particularly on high-utilisation routes.

At the same time, the programme reflects a broader industry shift toward propulsion systems that can accommodate multiple energy pathways, including SAF and potential future hybrid or hydrogen configurations.

The scalable nature of the architecture also aligns with anticipated aircraft replacement cycles, positioning UltraFan as a potential enabler for future platform development rather than a standalone solution.

The UltraFan programme represents a consolidation of several advanced propulsion technologies into a single demonstrator, providing a framework for future engine development rather than an immediate production solution.

Its significance lies in the integration of geared architecture, advanced materials and scalable design, offering a pathway toward improved efficiency and reduced emissions across both widebody and narrowbody aircraft.

As aircraft manufacturers move toward defining the next generation of commercial platforms, different propulsion architectures, including geared turbofans and open-fan concepts, will continue to be evaluated in parallel, reflecting a period of active transition in engine design.

FASTER, FURTHER, LEANER: COMPOUND ROTORCRAFT AND THE ENERGY EFFICIENCY RACE

In the pursuit of more efficient vertical flight, Airbus Helicopters is taking a different approach—refining the helicopter itself. The RACER demonstrator combines traditional rotor systems with fixed-wing elements to improve speed, range, and fuel efficiency.

Rethinking Rotorcraft Aerodynamics

The Airbus RACER (Rapid and Cost-Efficient Rotorcraft) demonstrator forms part of the Clean Sky 2 research programme and is designed to explore how compound rotorcraft configurations can improve both speed and efficiency.

Unlike conventional helicopters, which rely solely on a main rotor for both lift and propulsion, the RACER integrates additional aerodynamic elements. These include lateral wings that provide lift in forward flight and rear-mounted propellers that generate thrust.

This redistribution of aerodynamic roles reduces the workload on the main rotor, allowing it to operate more efficiently across different phases of flight.

Efficiency Through Distributed Aerodynamic Load

One of the central principles behind the RACER design is the distribution of lift and propulsion across multiple components.

In forward flight:

- The wings assume a portion of the lift requirement
- Pusher propellers provide forward thrust
- The main rotor operates under reduced aerodynamic load

This contrasts with conventional helicopters, where the main rotor must perform all three functions simultaneously, leading to higher energy demand. By separating these roles, the RACER reduces drag and improves overall aerodynamic efficiency, particularly at higher speeds.

Airbus Racer Credit: © Airbus

Reducing Fuel Burn Per Kilometre

A key objective of the RACER programme is to reduce fuel consumption relative to traditional rotorcraft operating at similar mission profiles.

Efficiency gains are achieved through:

- Increased cruise speeds, reducing total flight time
- Lower aerodynamic drag in forward flight
- More efficient lift generation via fixed-wing elements

The result is a reduction in fuel burn per kilometre, rather than simply per hour—an important distinction for operators focused on mission efficiency and cost control.

This approach aligns closely with broader industry goals of lowering emissions without requiring immediate shifts to alternative energy sources.

High-Speed Rotorcraft And Regional Mobility

The RACER is designed to operate at significantly higher cruise speeds than conventional helicopters, positioning it within a niche between traditional rotorcraft and fixed-wing aircraft.

This capability opens up new possibilities for regional mobility, where:

- Distances exceed the efficient range of helicopters
- Runway infrastructure is unavailable or impractical
- Rapid point-to-point transport is required

By increasing speed without sacrificing vertical take-off capability, compound rotorcraft offer an alternative model for connecting regional centres.

Positioning Within The Evolving Aviation Landscape

While electric and hybrid propulsion systems continue to dominate long-term discussions, the RACER demonstrates that substantial efficiency improvements can be achieved through aerodynamic optimisation alone.

This positions compound rotorcraft as:

- A near-term solution for reducing operational fuel consumption
- A bridge between conventional helicopters and more advanced propulsion concepts
- A platform that leverages existing certification pathways and infrastructure

In this context, the RACER complements rather than competes with emerging electric aircraft, addressing efficiency within current energy systems.

A Different Path To Efficiency

The RACER programme reflects a broader shift in aviation thinking: that efficiency gains do not depend solely on new energy sources, but also on how aircraft interact with the air through which they move.

By redistributing aerodynamic loads and reducing reliance on a single lift system, Airbus is refining the helicopter into a more efficient machine—without fundamentally changing its operational model.

The Airbus RACER highlights the role of aerodynamic optimisation in reducing the energy cost of flight.

Through its compound configuration, it achieves higher speeds and lower fuel burn by addressing the inefficiencies inherent in traditional rotorcraft design.

As the aviation industry balances innovation with operational practicality, the RACER demonstrates that meaningful progress can be achieved through new propulsion technologies, and through smarter use of existing ones.

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THE EFFICIENCY EQUATION: TILTROTOR TECHNOLOGY AND THE ENERGY COST OF VERTICAL FLIGHT

Leonardo AW609. Images Credit: © Leonardo/Wiki Commons

Positioned between helicopter and aeroplane, the Leonardo AW609 demonstrates how tiltrotor technology can reshape operational efficiency, particularly in missions where range and speed are critical.

Bridging Vertical Lift And Fixed-Wing Efficiency

The Leonardo AW609 represents a significant development in civil aviation as the first tiltrotor designed for commercial operations. Its defining capability lies in its ability to take off and land vertically like a helicopter, before transitioning to forward flight as a turboprop aircraft.

This transition fundamentally alters the aircraft's energy profile. While helicopters rely on continuous rotor-driven lift—an inherently energy-intensive process—the AW609 shifts to wingborne lift in cruise. This reduces the power required to maintain flight, particularly over longer distances.

The result is a platform that combines vertical access with improved cruise efficiency, addressing one of the longstanding limitations of rotorcraft operations.

The Energy Cost Of Hover Versus Forward Flight

Vertical lift is inherently energy-demanding. Helicopters must continuously generate lift through powered rotors, even in forward flight, which leads to higher fuel consumption compared to fixed-wing aircraft.

Tiltrotor technology mitigates this by limiting the duration of hover. Once airborne, the AW609 rotates its nacelles forward, allowing the wings to generate lift more efficiently.

This shift delivers measurable advantages:

- Reduced fuel burn during cruise compared to conventional helicopters
- Higher cruise speeds, enabling shorter mission times
- Extended operational range without proportional increases in fuel consumption

In practical terms, energy is conserved not by eliminating vertical lift, but by minimising the time spent in its most demanding phase.

Mission Profiles And Operational Advantage

The AW609's efficiency gains are most evident in

missions that combine vertical access with medium- to long-range travel.
Typical use cases include:

- Offshore transport to oil and gas installations
- Search and rescue operations requiring extended reach
- Corporate and VIP transport between urban centres and remote locations
- Medical evacuation over long distances

In these scenarios, a conventional helicopter would incur higher fuel costs and longer transit times, while a fixed-wing aircraft would lack direct access to the destination. The tiltrotor bridges this gap.

Infrastructure Implications: Helipads Or Runways

One of the defining operational advantages of the AW609 is its compatibility with existing helicopter infrastructure. It can operate from helipads and vertiports, removing the need for conventional runways.

However, its aeroplane-like cruise performance introduces new considerations:

- Airspace integration with fixed-wing traffic
- Maintenance frameworks that reflect both rotorcraft and turboprop systems
- Operational planning that balances vertical access with efficient cruise segments

This duality highlights a broader theme in aviation development: efficiency gains often require corresponding adjustments in infrastructure and operational thinking.

Positioning Within The Energy Transition Context

While much of the current industry focus is on electrification, the AW609 demonstrates that significant efficiency improvements can be achieved through aerodynamic and propulsion integration alone.
Rather than relying on new energy sources, tiltrotor technology optimises how energy is used.

This positions the AW609 as a practical, near-term solution:

- It reduces fuel consumption relative to helicopters in suitable missions
- It leverages existing propulsion technologies
- It avoids the current limitations associated with battery energy density

In doing so, it offers a complementary pathway to more radical concepts such as hybrid and fully electric aircraft.

A Practical Step In The Evolution Of Vertical Flight

The Leonardo AW609 does not represent a conceptual future—it represents an operational shift already underway.
Its significance lies in demonstrating that efficiency gains in aviation do not depend solely on new energy sources, but also on how aircraft transition between flight regimes.
By combining vertical lift with fixed-wing cruise, the tiltrotor redefines the balance between access, speed, and energy consumption.
The AW609 highlights a central principle in aviation: efficiency is not only about propulsion, but about how and when energy is used.
Through its tiltrotor architecture, it reduces the energy burden of sustained vertical flight, offering a more efficient solution for missions that demand both flexibility and range.
As the industry continues to explore hybrid and electric propulsion, the AW609 stands as a reminder that aerodynamic efficiency remains one of the most immediate and effective tools for reducing the energy cost of flight.

ELECTRIC REGIONAL AVIATION: THE SHORT-RANGE ENERGY EQUATION

TECNAM P-Volt Credit: © TECNAM

While long-range electric aircraft remain limited by battery technology, regional aviation presents a different opportunity. The Tecnam P-Volt demonstrates how shorter routes and predictable mission profiles support early adoption of electric propulsion.

Electrification Begins With Short-Haul Operations

Tecnam's P-Volt programme focuses on the electrification of regional aircraft, building on the P2012 Traveller platform. The concept reflects a broader industry strategy: introducing electric propulsion in sectors where operational demands align with current battery capabilities.

Short-haul routes, typically under 200 kilometres, offer a more manageable environment for electric aircraft. These missions require less onboard energy, allowing battery systems to support viable payloads and flight durations without excessive weight penalties. By targeting this segment, the P-Volt positions itself within a realistic pathway toward broader electrification.

Energy Density And Operational Limits

At the core of electric aviation is a fundamental constraint: battery energy density.

Compared to conventional aviation fuel, current battery technologies store significantly less energy per unit of weight. This limits:

- Aircraft range
- Payload capacity
- Operational flexibility
- The P-Volt programme acknowledges these limitations rather than attempting to overcome them through scale. Instead, it aligns aircraft capability with mission requirements, ensuring that energy demand remains within practical limits.

This approach reinforces a key principle: electric aviation is not a direct replacement for all aircraft types, but a targeted solution for specific use cases.

Charging Infrastructure And Airport Readiness

The adoption of electric aircraft introduces new infrastructure requirements at regional airports.

Unlike conventional refuelling, electric operations depend on:

- High-capacity charging systems
- Reliable electrical grid access
- Turnaround processes that integrate charging cycles

For high-frequency operations, turnaround time becomes a critical factor. Aircraft utilisation depends not only on flight duration, but also on how quickly energy can be replenished.

This raises important operational considerations:

- Can regional airports support the required electrical load?
- How will charging infrastructure be standardised?
- What role will renewable energy play in supplying aviation power needs?

These questions position infrastructure as a central component of electric aviation viability.

The Economics Of Short Commuter Routes

Electric propulsion introduces a different cost structure compared to conventional aircraft.

While upfront investment in aircraft and infrastructure may be higher, potential advantages include:

- Lower energy costs per flight hour
- Reduced maintenance requirements due to fewer moving parts
- Simplified propulsion systems

For short commuter routes, these factors can improve operational economics, particularly where flight frequency is high and distances are consistent.

However, these benefits remain closely tied to energy pricing, battery lifecycle costs, and infrastructure investment—variables that will influence the pace of adoption.

Positioning Within The Broader Aviation Transition

The P-Volt represents a pragmatic step within the broader transition toward lower-emission aviation.

Rather than attempting to address long-haul or high-capacity markets, it focuses on:

- Regional connectivity
- Training and utility operations
- Predictable, repeatable mission profiles

This positioning reflects a phased approach to electrification, where smaller aircraft act as the proving ground for new technologies before wider adoption becomes feasible.

A Realistic Entry Point For Electric Flight

Tecnam's P-Volt does not attempt to redefine aviation in a single step. Instead, it aligns technology with operational reality, demonstrating where electric propulsion can be applied effectively today.

By focusing on short-range missions, it provides a clear example of how energy constraints can be managed through careful matching of aircraft capability and route structure.

The P-Volt programme underscores a central reality in electric aviation: range is not the only measure of progress—alignment between energy capability and mission profile is equally important.

In the near term, regional operations offer the most practical pathway for electrification, where shorter distances and predictable usage patterns support viable deployment.

As battery technology evolves, this foundation may expand. For now, aircraft such as the Tecnam P-Volt define the early boundaries of electric flight—grounded not in ambition, but in operational feasibility.

TECNAM P-Volt Credit: © TECNAM

THE BENCHMARK: WHY TURBOPROP STOL AIRCRAFT STILL SET THE STANDARD

As aviation explores hybrid and electric propulsion, one question remains central: how do these new technologies compare to what already works? The Pilatus PC-12 provides a clear benchmark—combining efficiency, range, and short take-off and landing performance in a proven operational platform.

A Proven Platform In A Changing Landscape

The Pilatus PC-12 has established itself as one of the most versatile single-engine turboprop aircraft in operation. Its combination of range, payload capability, and short take-off and landing (STOL) performance has enabled it to operate in environments where both jets and larger turboprops are less practical.

In the context of evolving propulsion technologies, the PC-12 serves as a critical reference point—demonstrating what current aircraft can achieve using conventional fuel and mature design principles.

Efficiency Through Turboprop Design

Turboprop aircraft remain among the most efficient platforms for regional aviation, particularly on sectors where cruise speeds and fuel burn must be balanced against operational flexibility.

The PC-12 exemplifies this efficiency through:

- Optimised cruise performance for medium-range sectors
- Lower fuel consumption compared to similarly sized jet aircraft
- The ability to operate efficiently across variable mission profiles

Unlike emerging propulsion systems, turboprop efficiency is not theoretical. It is supported by decades of operational data across commercial, medical, cargo, and private aviation sectors.

PILATUS PC-12 Credit: © PILATUS

Stol Performance And Operational Access

A defining characteristic of the PC-12 is its ability to operate from short and unprepared runways.
This capability enables:

- Access to remote and underserved regions
- Reduced dependency on major airport infrastructure
- Greater flexibility in route planning and mission execution

STOL performance is not only a matter of convenience—it directly influences the economic viability of regional operations by expanding the number of accessible destinations.

For emerging aircraft technologies, matching this level of operational access remains a significant challenge.

The Real-World Efficiency Comparison

While hybrid and electric aircraft aim to reduce emissions and energy consumption, they must ultimately be measured against existing platforms such as the PC-12.
Key considerations include:

- Range relative to payload capacity
- Turnaround time and operational readiness
- Infrastructure requirements at departure and destination points
- Total energy or fuel consumption per mission

In many current scenarios, conventional turboprops continue to offer a balanced combination of these factors, particularly where infrastructure is limited or distances exceed the practical range of electric aircraft.

Infrastructure And Practical Deployment

One of the PC-12's enduring strengths is its compatibility with existing aviation infrastructure.
It requires:

- Minimal ground support
- No specialised energy systems or charging networks
- Standard aviation fuel supply chains

This simplicity contributes to its reliability and global adoption, particularly in regions where advanced infrastructure is not readily available.

In contrast, newer propulsion systems often depend on infrastructure that is still under development, adding complexity to their deployment.

Positioning Within The Energy Transition

The inclusion of the PC-12 in the broader discussion of aviation innovation is not to resist change, but to contextualise it.
It highlights that:

- Efficiency gains must be measured against proven operational benchmarks
- New technologies must match or exceed existing capabilities to achieve adoption
- Infrastructure readiness plays a decisive role in determining feasibility

In this sense, the PC-12 represents not the past, but the current standard against which future developments are evaluated.

A Continuing Role In Regional Aviation

Even as electric and hybrid aircraft evolve, platforms such as the PC-12 are likely to remain central to regional aviation.
Their combination of:

- Range
- Payload
- Efficiency
- Operational flexibility

ensures continued relevance, particularly in environments where reliability and infrastructure independence are critical.

The Pilatus PC-12 underscores a fundamental principle in aviation: progress must be measured against what is already effective.

As the industry moves toward new propulsion technologies, the benchmark remains clear—aircraft must deliver not only reduced emissions, but also operational efficiency, flexibility, and reliability.

Until those criteria are consistently met, turboprop aircraft such as the PC-12 will continue to define the standard for real-world performance.

AIRSPACE MODERNISATION AND THE GROWING GAP BETWEEN AIRCRAFT AND INFRASTRUCTURE

While next-generation aircraft continue to improve in efficiency and automation, airspace infrastructure remains constrained by legacy systems, creating increasing pressure on capacity and operational efficiency.

Introduction — A System Under Pressure

Modern aircraft are equipped with increasingly advanced avionics, automation and navigation systems, enabling higher levels of precision and operational efficiency. However, these capabilities are constrained by air traffic management (ATM) systems that, in many regions, still rely heavily on radar surveillance, voice communication and manual controller intervention.

As air traffic volumes increase and new types of aircraft enter service, this gap between airborne capability and ground-based infrastructure is becoming more pronounced.

Legacy Systems In A Modern Environment

Air traffic management systems were designed for a more predictable operating environment, dominated

Image Credit: © WAN

by conventional aircraft flying structured routes under direct human control.

Today's environment is more complex, with aircraft capable of advanced navigation, data exchange and increasingly automated operations. Despite this, the underlying ATM framework has evolved incrementally rather than through fundamental redesign.

This mismatch limits the efficiency gains that modern aircraft are capable of delivering and places additional pressure on already congested airspace.

Growth And Complexity

Forecasts indicate continued growth in air traffic over the coming decade, with passenger volumes expected to increase significantly.

At the same time, the introduction of Advanced Air Mobility (AAM) platforms, including electric vertical take-off and landing (eVTOL) aircraft, and the expansion of drone operations, are expected to further increase airspace complexity.

These developments introduce new operational requirements, including low-altitude traffic management, high-density routing and integration with existing flight operations.

From Control To Coordination

The transition underway in airspace management is not simply about increasing capacity, but about changing how traffic is managed.

Future systems are expected to move toward:

- Greater automation
- Increased use of data exchange
- Integrated traffic management across multiple aircraft types

This represents a shift from traditional controller-led systems toward more distributed and collaborative approaches to airspace management.

Infrastructure And Implementation Challenges

Modernising airspace systems involves more than upgrading technology. It requires:

- Replacement of legacy infrastructure
- Integration of new communication and navigation systems
- Addressing workforce constraints, including air traffic controller availability

In addition, implementation must occur without disrupting ongoing operations in some of the world's busiest airspace environments.

These challenges highlight the scale and complexity of transitioning to a modernised air traffic management system.

Global Collaboration And Standardisation

Airspace modernisation is inherently a global issue. Aircraft operate across international boundaries, requiring interoperability between different national systems.

Progress therefore depends on collaboration between:

- Regulators
- Industry
- Technology providers
- International aviation bodies

Alignment of standards and regulatory frameworks will be essential to ensure safe and efficient integration of new aircraft types and technologies.

Industry Context — Completing The System

The evolution of propulsion systems, materials and aircraft design is advancing rapidly. However, without corresponding progress in airspace infrastructure, the full benefits of these technologies cannot be realised.

The aviation system must therefore be viewed as an integrated whole, where aircraft capability and infrastructure development progress in parallel.

The modernisation of airspace systems represents a critical component of aviation's future development. As new aircraft technologies move toward operational deployment, the effectiveness of these innovations will depend on the ability of air traffic management systems to support increased complexity, higher traffic volumes and new operational models.

Bridging the gap between aircraft capability and infrastructure readiness will be central to delivering the safety, efficiency and capacity improvements expected from the next generation of aviation.

Image Credit: © EYEFLY iO

FUTURE AIR TRAFFIC CONTROL: AUTONOMOUS DRONES AND THE SAFETY OF URBAN SKIES

By Keith Fryer

The aviation world stands on the threshold of a profound transformation. Over the past century, air traffic control (ATC) has evolved from simple visual separation into a sophisticated radar- and satellite-based system that safely manages tens of thousands of flights daily. Yet a new challenge is emerging: the integration of large numbers of autonomous drones and eVTOL aircraft into urban airspace.

From cargo delivery and infrastructure inspection to air taxis and emergency response, drones promise to reshape transportation and logistics in cities and urban environments. However, the prospect of hundreds—and eventually thousands—of autonomous aircraft sharing low-altitude airspace raises a critical question: how will these aircraft avoid each other and protect people on the ground?

The answer lies in a new generation of digital air traffic systems and autonomous collision-avoidance technologies designed to support operations at scale.

A New Layer Of Airspace

Future drone operations will primarily occur in the low-altitude urban environment, typically below 400 ft above ground level. This layer—currently used by helicopters, light aircraft, and general aviation—was not designed to accommodate large numbers of autonomous systems. To address this challenge, aviation authorities and technology companies are developing Unmanned Aircraft System Traffic Management (UTM) systems. Unlike traditional ATC, UTM is designed to operate with a high degree of automation, coordinating the movements of many drones simultaneously.

With the limited number of qualified ATCs globally, these systems cannot rely solely on the resources and concepts of the past.

In practical terms, UTM functions as a digital ecosystem connecting drones, operators, regulators, and infrastructure providers. It manages:

- flight plan approvals
- geofencing and no-fly zones
- real-time traffic information
- weather and hazard updates
- conflict detection and resolution

Advanced prototypes have demonstrated the ability to manage large numbers of drones within a single service region, providing real-time tracking and automated conflict alerts.

In essence, UTM represents an automated approach to managing drone traffic, operating at a scale not achievable through conventional human-controlled systems.

From "See And Avoid" To "Sense And Avoid"

Traditional aviation safety relies heavily on the principle of "see and avoid", where pilots visually scan for other aircraft and manoeuvre to maintain safe separation.

TCAS has been widely adopted in commercial aviation to assist crews, particularly in reduced visibility.

Autonomous drones, however, cannot rely on human observation. Instead, they employ Detect-and-Avoid (DAA) technologies—systems that combine sensors, communications networks, and onboard processing to identify and avoid conflicts.

These systems typically use a combination of:

- ADS-B and electronic conspicuity broadcasting aircraft position and identity
- onboard sensors such as radar, lidar, or optical cameras
- satellite navigation and inertial systems
- vehicle-to-vehicle communications between drones

Electronic conspicuity enables drones to broadcast their position and receive real-time data from nearby aircraft, reducing the risk of mid-air conflict in dense environments.

Once a potential conflict is detected, onboard systems can calculate an avoidance manoeuvre and execute it without human intervention.

A Drone Equivalent Of Tcas?

A natural comparison arises with the Traffic Collision Avoidance System (TCAS) used on airliners. TCAS provides pilots with traffic advisories and resolution guidance when another aircraft approaches dangerously close.

In the autonomous drone environment, the equivalent concept is evolving under Detect-and-Avoid systems and cooperative collision-avoidance networks.

Unlike TCAS, which typically resolves conflicts between two aircraft, drone systems must operate in much denser traffic environments. Some concepts therefore rely on decentralised communication between drones, allowing them to share position data and coordinate manoeuvres cooperatively.

Artificial intelligence algorithms can predict potential conflicts and adjust trajectories rapidly, beyond typical human reaction times.

Experimental systems have demonstrated high success rates in resolving collision scenarios in simulations involving multiple UAVs.

"Digital Traffic Lights" In The Sky

Another concept being explored is the creation of structured aerial corridors over cities—effectively defined routes through urban airspace.

These routes could incorporate automated control mechanisms, sometimes described as "digital traffic lights". When a drone approaches a potential conflict point, such as an intersection between corridors, the system can sequence aircraft to maintain safe spacing.

This approach offers several advantages:

- predictable traffic flows
- reduced complexity for onboard systems
- simplified integration with conventional ATC

The concept mirrors highway traffic management, with aircraft following defined routes while automated systems regulate movement and spacing.

Integration With Traditional Air Traffic Control

A key safety consideration is the integration of drones with conventional aviation.

Future systems are expected to operate through UTM-ATM integration, where drone traffic data is shared with national air navigation service providers. This allows controllers to maintain awareness of both manned and unmanned aircraft.

In practical terms:

- low-altitude drone traffic may be managed primarily by UTM
- higher-altitude or mixed traffic zones will remain under ATC oversight
- real-time data sharing supports mutual situational awareness

This integration will be particularly important near airports, heliports, and emergency operations.

Safety Beyond Collision Avoidance

While mid-air collision prevention is central, safety in urban drone operations involves additional layers:

- redundant flight systems to prevent single-point failures
- geofencing and dynamic airspace restrictions
- remote identification systems
- predictive traffic management

These systems aim to support safe operations in complex and evolving urban environments.

The Road Ahead

Despite rapid technological progress, several challenges remain. Certification standards for autonomous systems, cybersecurity, and interoperability between different UTM providers are still under development.

However, the direction of travel is clear. Urban airspace is expected to accommodate increasing levels of autonomous activity, requiring systems that can manage traffic reliably and at scale.

In the longer term, autonomous drones may evolve into networked airspace participants, continuously sharing data and coordinating movements in real time.

If successfully implemented, urban airspace could become a digitally coordinated environment, where aircraft operate within structured systems designed to maintain safety for both airspace users and the public.

5G INTERFERENCE AND THE COST OF COMPLIANCE

The intersection of aviation safety systems and telecommunications infrastructure is prompting regulatory proposals that carry significant operational and financial implications.

The Role Of Radio Altimeters In Flight Operations

Radio altimeters are a fundamental component of modern aircraft systems, providing precise measurements of an aircraft's height above ground level. Unlike barometric altimeters, which rely on atmospheric pressure to indicate altitude relative to mean sea level, radio altimeters use radar signals to determine the aircraft's true height above terrain.

Installed on the underside of the aircraft, these systems transmit radio waves toward the ground and measure the time taken for the signal to return. This enables accurate altitude readings, particularly during the most critical phases of flight, including final approach and landing.

Radio altimeter data supports a range of safety-critical systems, including:

- Terrain awareness and warning systems
- Ground proximity warning systems
- Autoland and low-visibility landing operations
- Flight control system inputs

Because these systems rely on precise, real-time altitude information, the integrity of radio altimeter data is essential for maintaining safe operations.

Concerns Over Signal Interference

Recent attention has focused on the potential for interference between radio altimeters and 5G telecommunications systems operating in adjacent frequency bands.

Radio altimeters operate in spectrum close to the Upper C-band (approximately 3.98–4.2 GHz), where telecommunications authorities are expanding wireless services. This proximity has raised concerns about signal interference affecting the reliability of altitude data.

Interference could result in degraded or erroneous altitude readings, particularly during low-altitude operations where accuracy is most critical. This introduces potential risks to systems that depend on reliable altitude data, including automated landing and terrain warning functions.

FAA Proposal And Regulatory Response

In response, the Federal Aviation Administration (FAA) has proposed a mandate requiring the installation of new radio altimeters that are more resilient to interference.

The proposal is directly linked to spectrum expansion by telecommunications regulators, creating a situation where aviation systems must adapt to external changes in the electromagnetic environment.

Industry stakeholders, including the National

Conceptual illustration of potential interaction between 5G telecommunications signals and aircraft

Business Aviation Association (NBAA) and a broad coalition of manufacturers and operators, have formally engaged with the proposal through a coordinated response.

Cost, Scale And Implementation Challenges

The scale of the proposed retrofit requirement is significant.

According to industry coalition submissions, the FAA's proposal could affect:

- Nearly 40,900 aircraft operating in US airspace
- Approximately 58,600 individual radio altimeter units
- Around 14,000 owners and operators

The financial implications are substantial. While the FAA has estimated retrofit costs at approximately USD 4.49 billion, industry stakeholders believe this figure may be understated.

Coalition estimates suggest:

- Costs could rise to over USD 7 billion in total
- Individual altimeter replacement costs may reach USD 120,000 per unit, exceeding earlier assumptions

In addition to direct costs, implementation presents operational challenges:

- Aircraft downtime for retrofit and certification
- Supply chain and equipment availability constraints
- Scheduling pressures across large and diverse fleets

Smaller operators, particularly those under Part 91 and Part 135 operations, are expected to face disproportionately higher financial burdens.

Industry Response And Call For Balanced Implementation

Industry groups have emphasised that aviation remains fully committed to maintaining safety standards, but have raised concerns about how the mandate is implemented.

The Joint Aviation Community coalition has called for:

- Financial incentives or compensation mechanisms to offset retrofit costs
- Recognition that the requirement arises from external spectrum changes, not internal aviation system failures
- A practical and achievable timeline, with current targets extending to 2034 for compliance

Stakeholders have also highlighted the importance of collaboration between regulators and industry to ensure that implementation does not introduce unintended operational disruption.

Industry Implications And Cross-Sector Complexity

The radio altimeter issue illustrates a broader challenge facing aviation: operating safely within an increasingly complex and shared technological environment.

As telecommunications infrastructure expands, aviation systems must coexist within overlapping spectrum usage. This creates dependencies between sectors that have historically operated independently. The current situation demonstrates that:

- Aviation safety systems can be affected by external technological developments
- Regulatory decisions in one sector can have direct consequences in another
- Cross-industry coordination is becoming increasingly important

Radio altimeters remain essential to modern aviation, particularly during low-altitude operations where precision is critical.

The emergence of potential interference from 5G networks has prompted regulatory action aimed at ensuring system resilience. However, the proposed solutions introduce significant financial and operational challenges across the global fleet.

The response from industry stakeholders reflects a need to balance safety priorities with practical implementation. As aviation and telecommunications systems continue to evolve in parallel, ensuring compatibility between them will remain a central consideration for regulators and operators alike.

INTERMODAL TRAVEL AND THE CHALLENGE OF COORDINATED JOURNEYS

A new SITA white paper highlights how collaboration, rather than new infrastructure, is central to improving intermodal travel.

Where Journeys Break Down

Intermodal travel depends on the coordination of multiple transport systems, including aviation, rail, maritime and urban mobility. While networks are expanding, the journey often breaks down at transfer points where passengers move between modes.

At these points, information is frequently lost between operators, accountability becomes unclear, and passengers are left to manage disruptions independently. Missed connections and conflicting operational rules create inefficiencies that affect both passenger experience and operator performance.

These gaps introduce operational blind spots across the transport system and can reduce revenue through disruption and inefficiency.

Fragmentation And Operational Risk

As demand for intermodal travel increases, fragmented systems create additional operational risk. Disruptions in one mode can cascade across the wider network when coordination is limited.

A key issue identified in the SITA white paper is the lack of shared data across organisational boundaries.

Without real-time visibility of passenger flows and operational conditions, operators are unable to respond collectively when disruptions occur.

This results in delayed responses, reduced situational awareness and a fragmented passenger experience.

Collaboration As A Practical Solution

The SITA paper argues that improving intermodal travel does not require new infrastructure or standalone platforms. Instead, progress depends on connecting existing systems and enabling coordinated action.

When operators share data and align their response strategies, they can provide a unified and reliable view

Intermodal Travel Image Credit: WAN ©

of the journey. This allows passengers to move through transfer points with greater clarity and reduces the operational impact of disruptions.

The approach focuses on:

- Shared visibility of passenger movement
- Coordinated disruption response
- A single, trusted source of real-time information

Managing Disruption Through Information

A central theme of the paper is the need to change how disruption is handled.

When connections are at risk, passengers often face uncertainty and limited information. A coordinated system enables operators to offer clear alternatives in real time, such as continuing the original journey, accepting rebooking options, or switching transport modes.

This approach shifts disruption from an uncertain experience to a managed process, where responsibilities are defined and passengers are supported with timely information.

A Practical Framework For Implementation

The white paper proposes a structured approach to improving intermodal travel, centred on practical implementation rather than large-scale transformation.

Key elements include:

- Passenger-focused design
- Modular and interoperable systems
- Integration with existing infrastructure
- Use of pilot projects to demonstrate value before scaling

This staged approach allows operators to build confidence and demonstrate measurable improvements in operational performance and passenger experience.

Case Study: Athens Travelwise

The Athens TravelWise initiative provides an example of how coordinated systems can improve intermodal operations.

Previously, disruption management between the airport, airline, port authority and rail operator relied on manual processes and communication. The introduction of an Intermodal Data Collaboration Platform has created a shared operational view.

The system integrates data from multiple sources, including:

- Flight schedules
- Rail and maritime services
- Weather conditions
- Local events

Through shared dashboards and application interfaces,

operators can respond more quickly and provide passengers with clearer options when connections are disrupted.

A Staged Path Forward

Rather than proposing large-scale transformation programmes, the paper recommends a targeted approach focused on high-traffic corridors and major event networks.

Operators are encouraged to identify specific points where journeys break down and address them through coordinated data sharing and governance. This allows measurable improvements to be achieved incrementally.

The emphasis is on building trust between stakeholders and developing shared operational practices that can scale over time.

Intermodal travel is becoming an increasingly important part of global transport systems, but its effectiveness depends on coordination between operators.

The SITA white paper highlights that the primary challenge lies not in infrastructure, but in the points where journeys transition between systems. Addressing these gaps through shared data, coordinated action and practical implementation offers a path toward more reliable and efficient travel.

As transport networks continue to expand, the ability to manage these transfer points effectively will remain central to both passenger experience and operational performance.

AIRLINE ANCILLARY REVENUE MODELS CONTINUE TO EVOLVE AS CORE INCOME STREAMS

New industry analysis indicates that airlines are increasingly dependent on ancillary revenue streams, with operational focus shifting towards optimising baggage, seating, and onboard retail performance. These revenue models have become a central pillar of airline profitability, with baggage fees, seat selection, and branded fares now accounting for the majority of non-ticket income across global carriers.

Image Credit: WAN ©

The Structure Of Ancillary Revenue

Baggage, seats and fares dominate revenue mix

Analysis from IdeaWorksCompany indicates that baggage fees, seat assignments, and branded fare products account for more than 95% of ancillary revenue for airlines without large co-branded credit card programmes. Baggage remains the largest single contributor, supported by the widespread adoption of both checked and carry-on fee structures. Data presented in the report shows that leading low-cost carriers generate more than $20 per passenger from baggage-related charges, with pricing strategies often linked to demand and booking stage. However, revenue visibility is affected by bundled fare products and credit card benefits, where baggage fees may be included or offset through third-party agreements.

Seat Assignment Revenue Gains Ground

Shift from optional service to standardised revenue stream

Seat assignment fees have expanded significantly over the past decade, evolving from optional upgrades to a widely applied revenue category across most airline cabins. Data referenced in the report shows that United Airlines generated approximately $1.3 billion from seat selection fees in 2023, exceeding the $1.2 billion reported from checked baggage in the same period.

This shift reflects broader adoption across both low-cost and network carriers, with pricing structures extending across entire cabins and increasingly linked to seat location, legroom, and boarding priority. The report also highlights that pricing transparency and structured seat mapping are used to influence passenger choice, with tiered pricing models communicating relative value across seating options.

Buy-On-Board: Lower Revenue, Higher Complexity

Operational challenges limit profitability

Buy-on-board food and retail programmes remain a consistent feature of airline ancillary strategies, although they typically generate lower margins compared to baggage and seat fees. Financial data cited in the report shows that easyJet achieved onboard revenue of approximately £2.38 per passenger, with a reported profit margin of 28.6%, reflecting ongoing efforts to optimise product selection and operational efficiency.

The report identifies several operational challenges, including supply chain complexity, product spoilage, and variability in passenger demand. Successful programmes are typically characterised by simplified menus, limited fresh offerings, and the development of a small number of high-demand products.

Pre-Order And Retail Integration

Balancing efficiency with passenger behaviour

Pre-order meal systems are increasingly used to improve inventory management and reduce waste, allowing airlines to load only confirmed orders for specific flights. While this approach offers operational benefits, it requires alignment with passenger booking behaviour and reliable onboard delivery processes.

The report notes that service consistency and recovery mechanisms remain critical to maintaining passenger satisfaction when pre-ordered services are not delivered as expected.

Regional And Product Differentiation

Airlines adapting models across markets and customer segments

The report highlights variation in ancillary strategies across different airline types and regions. Low-cost carriers continue to lead in the development of detailed pricing models for baggage and seating, while network carriers increasingly integrate ancillary services into broader fare structures and loyalty programmes.

Examples include the introduction of carry-on baggage fees in certain markets and the use of branded fare structures to bundle services such as seat selection and baggage allowances.

Focus On Core Revenue Drivers

Operational prioritisation shaping future strategy

A key conclusion of the analysis is that airlines are concentrating efforts on optimising a limited number of high-impact ancillary products. Baggage fees, seat assignments, and branded fares remain the primary focus areas, with additional services such as flexible booking options and onboard retail providing incremental revenue rather than core contribution.

This concentration reflects both operational efficiency and revenue predictability, allowing airlines to refine pricing strategies while maintaining control over service delivery.

Industry Outlook

Ancillary revenue remains central to airline economics

The continued evolution of ancillary revenue models reflects broader changes in airline commercial strategy, where base fares are complemented by a growing range of optional services. As airlines balance cost pressures, passenger expectations, and operational complexity, ancillary revenue is expected to remain a critical component of financial performance, with further refinement likely in pricing structures, product bundling, and digital retail integration.


Image Credit: WAN ©

SIMPLICITY, CLARITY AND TRUST: REASSESSING THE FOUNDATIONS OF AIRLINE BUSINESS MODELS

Long-standing assumptions continue to shape airline business models, but growing evidence suggests that many of these practices no longer serve either airlines or their customers effectively.

Questioning The Status Quo

The global airline industry operates within a framework shaped by decades of incremental change. Many of its commercial and operational practices are widely accepted as standard, yet recent analysis suggests that several of these assumptions persist more out of convention than proven effectiveness.

A report by IdeaWorksCompany highlights how established approaches — from pricing mechanisms to customer experience design — can limit profitability, reduce clarity, and weaken trust between airlines and passengers .

At its core, the analysis presents a simple premise: challenging entrenched practices is essential for the industry's continued evolution.

The Myth Of Seamless Travel

One of the most persistent narratives in aviation is the concept of "seamless travel." While widely used in marketing, the reality is often far more fragmented.

Interline agreements, codeshares and joint ventures are designed to create integrated travel experiences. However, inconsistencies in systems, policies and accountability frequently result in disruptions that passengers must navigate themselves. As noted in the report, even well-established airline partnerships can struggle to deliver basic service continuity, such as maintaining seat assignments across carriers .

The issue is not the ambition of seamless travel, but the gap between expectation and delivery. Addressing this gap requires not only technological integration but also greater operational accountability and frontline support.

Pricing Complexity And Product Integrity

Airline pricing strategies have evolved significantly, particularly with the growth of ancillary revenue streams. However, some mechanisms intended to maximise revenue may have unintended consequences.

Upgrade auctions, for example, can generate incremental income but may weaken pricing integrity by introducing uncertainty into the value of premium products. When passengers perceive that prices are variable or negotiable, the perceived worth of those products can diminish.

Similarly, fare structures and change policies have grown increasingly complex. Originally designed to segment markets and protect yield, these rules often create confusion and frustration for passengers.

The persistence of restrictive fare conditions, even as other aspects of pricing have evolved, reflects a legacy approach that may no longer align with modern consumer expectations.

Profitability: A Question Of Management, Not Model

The perception that airlines are inherently low-margin businesses remains widespread. However, industry data presents a more nuanced picture.

According to the report, global airline operating margins average below those of some other sectors, yet well-managed carriers across different regions and business models have achieved significantly stronger results, in some cases exceeding 20 percent operating margins .

This variation suggests that profitability is not solely determined by industry structure, but by strategic execution. In particular, the ability to manage costs, optimise pricing and develop effective ancillary revenue streams plays a critical role.

The report also highlights the concept of incremental revenue, where the cost of carrying an additional passenger can be relatively low compared with the revenue generated. This dynamic underscores the importance of pricing strategies that balance volume and yield without undermining long-term value.

Loyalty Programmes And Their Limits

Airline loyalty programmes have become major revenue contributors, driven largely by partnerships with financial institutions. In some cases, these programmes account for a significant proportion of total airline revenue.

Despite this growth, the report emphasises that loyalty programmes remain fundamentally linked to airline operations. The majority of reward redemptions continue to be for air travel, reinforcing the dependence of these programmes on the core airline product .

This relationship highlights a critical point: while loyalty programmes can diversify revenue streams, they cannot function independently of the airline's operational performance and customer offering.

Baggage Policies And Operational Consequences

Few aspects of airline operations illustrate the impact of policy design more clearly than baggage handling.

The widespread introduction of checked baggage fees has influenced passenger behaviour, often leading to increased use of cabin baggage and resulting congestion at boarding gates. In some cases, policies intended to generate revenue have contributed to operational inefficiencies and inconsistent passenger experiences.

The report identifies this as a systemic issue rather than an unavoidable outcome. Aligning commercial strategy with operational execution is essential to avoid creating friction points that affect both efficiency and customer satisfaction .

Digital Transformation And Customer Experience

Airline digital platforms have become highly sophisticated in facilitating transactions, offering a wide range of products and services within the booking process. However, this transactional focus may come at the expense of broader customer engagement.

Rather than inspiring travel, many airline websites prioritise functionality over experience. At the same time, increasing reliance on automation can create barriers for passengers who are less familiar with digital technologies.

The report notes that while efficiency gains are important, airlines must ensure that customer support remains accessible. As common carriers, airlines serve a diverse passenger base, and inclusivity should remain a central consideration in service design .

Trust, Clarity And Long-Term Performance

Across all these areas, a consistent theme emerges: complexity often undermines clarity, and reduced clarity erodes trust.

Practices such as unclear pricing, inconsistent policies and over-reliance on automation may deliver short-term benefits but can weaken long-term relationships with customers. The cumulative effect is a gradual decline in confidence, which ultimately impacts both brand perception and revenue performance.

The report concludes that simplifying policies, improving transparency and aligning operational practices with customer expectations can strengthen both financial outcomes and passenger trust .

The airline industry is not static, but many of its underlying assumptions remain deeply embedded.

Reassessing these assumptions is not simply an academic exercise — it is a practical necessity.

By focusing on clarity, consistency and customer-centric design, airlines have the opportunity to move beyond legacy practices and build more resilient, effective business models.

In an increasingly competitive and transparent market, those that succeed are likely to be the ones that replace complexity with coherence — and align their operations with the expectations of the passengers they serve.

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737 MAX Grounding Image Credit: BOEING ©

MCAS AND THE 737 MAX CRISIS: THE AUTOMATION LESSON THAT RESHAPED AIRCRAFT CERTIFICATION

Following two fatal accidents, the aviation industry was forced to examine the role of automation, oversight and system transparency in an increasingly software-driven environment.

The Aircraft And The Design Context

The Boeing 737 MAX was introduced as an evolution of the long-established 737 family, developed to compete with the Airbus A320neo while offering improved fuel efficiency.

A key design change was the installation of larger and more efficient CFM LEAP-1B engines. Due to the limited ground clearance of the 737 airframe, these engines were positioned higher and further forward on the wing than on previous variants. This altered the aircraft's aerodynamic characteristics, particularly at high angles of attack.

To maintain handling characteristics consistent with earlier 737 models, Boeing introduced the Maneuvering Characteristics Augmentation System (MCAS), a flight control function designed to automatically adjust stabiliser trim under specific conditions during manual flight.

Understanding Mcas

Function and purpose
MCAS was intended to activate in high angle-of-attack situations, automatically commanding nose-down stabiliser trim to reduce pitch and mitigate the risk of a stall. The system aimed to ensure that the aircraft's handling remained consistent with earlier 737 variants.

System design
In its original configuration, MCAS relied on input from a single angle-of-attack sensor. If that sensor transmitted incorrect data indicating a high angle-of-attack condition, the system could activate and command stabiliser movement.

Investigations later established that erroneous sensor data played a central role in both accidents. Because MCAS could repeatedly apply nose-down trim, flight crews were required to recognise the condition and use stabiliser trim cut-out procedures to regain control.

Two Accidents And A Common Failure Path

On 29 October 2018, Lion Air Flight 610 crashed shortly after departing Jakarta, resulting in the loss of all 189 people on board. Investigators determined that faulty angle-of-attack data had triggered repeated MCAS activation.

On 10 March 2019, Ethiopian Airlines Flight 302 crashed six minutes after departure from Addis Ababa, killing all 157 people on board. The investigation identified a similar sequence involving erroneous sensor input and repeated nose-down trim commands.

The similarity between the two accidents raised immediate concern among regulators and investigators worldwide. Together, the events resulted in the loss of 346 lives.

A Global Grounding

In the days following the second accident, aviation authorities across multiple regions grounded the Boeing 737 MAX.

China was among the first to suspend operations, followed by regulators in Europe, Asia and the Middle East. On 13 March 2019, the US Federal Aviation Administration (FAA) issued an emergency grounding order.

At the time, nearly 400 aircraft were in service globally. The grounding halted operations and initiated an extensive period of technical investigation and regulatory review.

Certification Under Scrutiny

Beyond the technical issues with MCAS, the crisis prompted broader examination of aircraft certification processes.

The FAA's Organisation Designation Authorization (ODA) framework, which allows manufacturers to perform certain certification activities under regulatory oversight, came under review. Investigations examined how MCAS had been assessed during certification and how its function had been communicated to operators and flight crews.

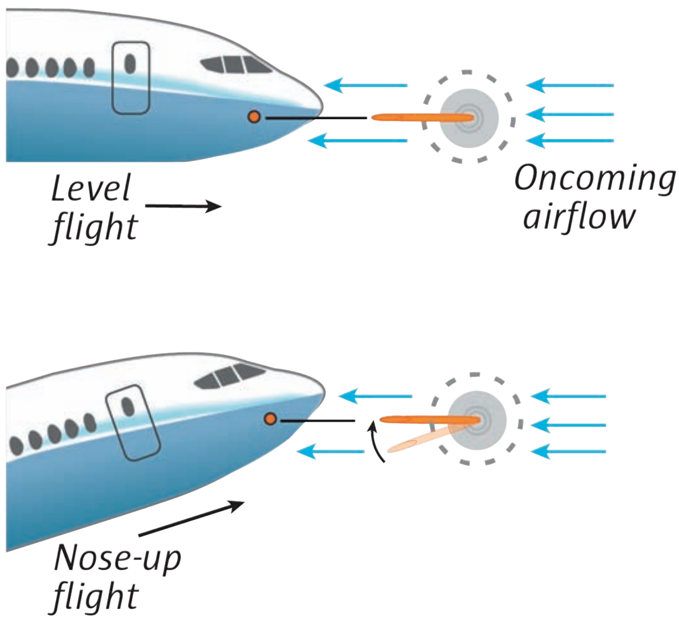
The Joint Authorities Technical Review (JATR) identified areas where increased scrutiny of automated systems and associated assumptions would be beneficial. These findings contributed to wider discussions on transparency, documentation and oversight in the certification of increasingly complex aircraft systems.

System Redesign And Modification

During the grounding period, Boeing implemented several changes to the MCAS system and associated flight control software.

The updated system now:

- Compares input from two angle-of-attack sensors
- Disables activation if sensor data differs beyond a defined threshold
- Limits MCAS activation to a single occurrence per high angle-of-attack event
- Reduces the authority of stabiliser trim inputs



In addition, pilot training programmes were revised to include specific instruction on MCAS and stabiliser trim procedures.

These modifications formed part of the certification package reviewed by regulators prior to return to service.

Return To Service

Following extensive testing and evaluation, the FAA approved the return to service of the 737 MAX in November 2020.

Other regulators, including the European Union Aviation Safety Agency (EASA), Transport Canada and Brazil's ANAC, conducted independent reviews before clearing the aircraft for operation.

Airlines gradually reintroduced the aircraft into service as modifications were completed and updated training programmes implemented.

Lessons For An Automated Aviation Era

The 737 MAX crisis underscored the increasing role of software and automation in modern aircraft systems.

For regulators, the events prompted renewed focus on certification oversight and the evaluation of automated flight control systems. For manufacturers, they highlighted the importance of clear communication regarding system functionality and operational behaviour.

The relationship between pilots and automated systems also came into sharper focus, particularly in situations where system behaviour may not be immediately apparent.

As aircraft systems continue to evolve, incorporating greater levels of automation and new technologies, the lessons of the MCAS crisis remain relevant. The events represent a significant

MAYDAY-SA: BUILDING PEER SUPPORT ACROSS THE AVIATION COMMUNITY

While aviation training prepares professionals to manage emergencies in the air, the most difficult moments can occur after the event. Mayday-SA, a South African non-profit organisation, provides confidential peer support to aviation personnel facing critical incidents or life stressors.

Peer Support For Aviation Professionals

Understanding the human dimension of aviation
Mayday-SA operates as a non-profit organisation and peer-support network focused on the mental wellbeing of aviation professionals. Its services are offered free of charge and are designed to assist individuals within the aviation sector who may be experiencing the impact of critical incidents or personal stress.

The organisation recognises that aviation professionals are often required to maintain high levels of performance under demanding operational conditions. Access to peer support can provide an important channel for individuals seeking confidential conversation with someone who understands the realities of the aviation environment.

Confidential Support From Within The Industry

A network built on shared aviation experience
The Mayday-SA peer-support network connects aviation professionals with trained volunteers drawn from within the industry. The initiative focuses on providing confidential support and guidance from individuals who understand the operational context in which aviation personnel work.

The organisation provides support to professionals navigating difficult situations, including the aftermath of critical incidents or other significant life stressors.
This peer-based model is intended to ensure that individuals seeking support are able to engage with someone familiar with the operational pressures and responsibilities associated with aviation careers.

Volunteer Network Expansion

Experienced aviation professionals invited to participate
Mayday-SA is currently expanding its volunteer network and is inviting experienced aviation professionals to apply to become peer-support volunteers.

According to the organisation's current recruitment campaign , volunteers may come from a range of aviation backgrounds, including:

- Pilots
- Maintenance and engineering professionals
- Recreational and paragliding members
- General aviation professionals

Selected volunteers will provide confidential peer support to colleagues and will receive specialised peer-support training as part of the programme.

Volunteer Criteria And Training

Requirements for applicants
Prospective volunteers should have a minimum of five years' experience within the aviation industry and demonstrate strong listening and interpersonal skills.

Applicants should also:

- Preferably be 27 years or older
- Demonstrate professionalism and empathy
- Commit to maintaining confidentiality
- Be willing to complete a three-day peer-support training programme

The next training session is scheduled for 3–5 September 2026 .

Application Process

How aviation professionals can get involved
Applications for the Mayday-SA peer volunteer network are currently open, with submissions requested by 30 April 2026 .

Interested applicants are asked to submit:

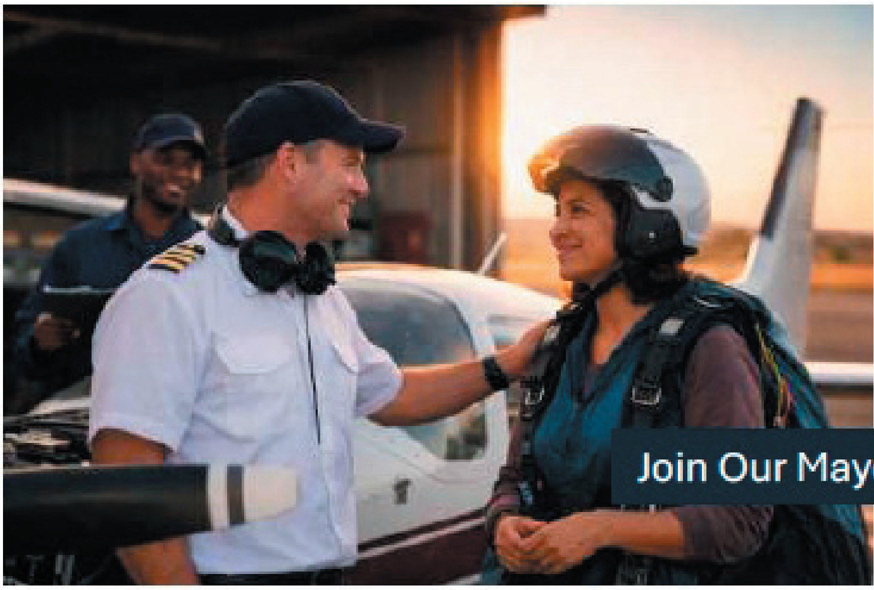
- Name and contact details
- Licence type or aviation role
- Aviation experience
- A short motivation for becoming a peer volunteer
- Any relevant skills or experience

Applications can be submitted via email to:
general.enquiries@mayday-sa.org.za
A selection process will follow, after which shortlisted applicants will be contacted to arrange an interview.

Supporting The Human Side Of Aviation

The expansion of the Mayday-SA peer-support network reflects the organisation's focus on strengthening the human support structures within aviation.

By connecting experienced aviation professionals through confidential peer support, the initiative seeks to provide an additional layer of assistance mayday-sa



Even the strongest sometimes need someone who understands.

Join Our Mayday-SA Peer Support Network.

Aviation professionals are trained to handle emergencies in the air — but sometimes the toughest moments happen after the flight.

Mayday-SA provides confidential peer support to aviation professionals facing critical incidents or life stressors.

We are expanding our volunteer network and invite **experienced aviation professionals** to join us, including-

- Pilots
- Maintenance & Engineering Professionals
- Recreational & Paragliding Members
- General Aviation Professionals

As a Mayday-SA volunteer, you will -

- Provide confidential peer support to colleagues
- Help fellow professionals navigate difficult moments
- Receive specialised peer-support training
- Be part of a trusted aviation support network

Volunteer Criteria –

- Minimum 5 years in the aviation industry
- Preferably 27 years or older
- Good listener, empathetic, and professional
- Willingness to complete a 3-day peer-support training programme (3, 4 & 5 September 2026)
- Commitment to confidentiality

Are you an empathic listener with a passion for supporting your peers?

If you have what it takes and are interested in joining the **Mayday-SA peer volunteer network**, we would love to hear from you.

Please submit your application to **general.enquiries@mayday-sa.org.za** by **Thursday, 30 April 2026**, including the following information -

- Name and contact details
- Licence type or aviation role
- Aviation experience
- A short motivation for becoming a peer volunteer
- Any relevant experience or skills (no prior qualifications required)

There will be a selection process, and we will be in touch to arrange an interview.

Help strengthen the human side of aviation — join the network that supports aviation's people.

WHAT DRIVES ME (AND MY AIRCRAFT)

By Rob Garbett

Sustainably driven, or by a vanishing resource — that is the question for the near future.

Innovation in aircraft design has traditionally been driven by performance and safety. Modern dynamics such as flight management systems, sustainable fuels, airport design and other factors now influence development, and at times demand incorporation. However, safety should never be compromised.

Much has been written about sustainable aviation fuels (SAF). Their introduction is inevitable — but when, and at what cost?

Recent geopolitical tensions in the Middle East bring the issue into sharp focus, illustrating how easily global supply chains can be disrupted. SAF has the potential to reduce this vulnerability by enabling fuel production in regions that are politically and economically stable. There is also a widely held view that SAF may reduce environmental impact, including effects on the ozone layer.

There is, however, both good and less encouraging news.

At present, SAF accounts for only around one percent of global aviation fuel production. The cultivation of crops specifically for SAF may not always align with the most efficient or nutritionally valuable agricultural use. In addition, competition from other sectors — including road and maritime transport — is likely to create pricing pressure.

The overall environmental benefit of SAF remains a subject of debate. While lifecycle CO_2 emissions may be reduced, large-scale crop production raises concerns around deforestation, biodiversity loss and the displacement of food crops. SAF is therefore not a complete solution. Aircraft will continue to produce nitrogen oxides, and contrail cirrus — ice cloud formations that contribute to atmospheric warming — remain a factor comparable in impact to CO_2 emissions. In practice, SAF is often blended with Jet A1 or other fuels, which further moderates its environmental benefit. Unleaded alternatives to Avgas are emerging, but remain limited in availability.
There is also a practical constraint: there is simply not enough waste oil or agricultural residue available to meet global SAF demand.

For South Africa, the challenge is particularly acute. As a water-scarce country with limited surplus agricultural land, producing SAF feedstock at scale is unlikely. This suggests continued reliance on imported aviation fuels.

Cost remains one of the most significant barriers. SAF production can be several times more expensive than conventional fuel. Estimates have suggested costs up to four times higher, and without government subsidies or strong incentives, widespread adoption may remain difficult to achieve.

Hybrid propulsion may offer some mitigation, but is unlikely to provide a complete solution.

Electric propulsion is another possibility, although current battery weight and energy limitations make it impractical for most aviation applications. That said, advances over the past decade suggest that it should not be dismissed entirely.

Historically, even more radical alternatives have been explored. In 1946, the United States Air Force investigated nuclear energy in aviation, not as a propulsion source initially, but to test radiation shielding for crew. By the 1950s, both General Electric and Pratt & Whitney had made progress toward nuclear-powered propulsion concepts. These programmes were ultimately abandoned as priorities shifted toward the space race.

Advances in nuclear technology may one day reopen this discussion, although the risks — particularly radiation exposure in the event of an accident — remain significant.

Global oil reserves are often projected to last another fifty years. When they begin to decline, the aviation industry will need to be ready with viable alternatives.

Credit: WAN ©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