AEROSPACE TECHNOLOGY INSTITUTE

MAY 2026

ENGINEERING GROWTH

Delivering next generation aerospace technologies

FOREWORD

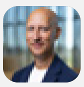
This is the fifth UK technology strategy from the Aerospace Technology Institute (ATI) and is critical in terms of the opportunities it offers for the sector. The ATI was established in 2014 to bolster sector competitiveness, bridge the gap between government and industry and provide technology leadership as we prepared for the next generation of aircraft. Since then, the ATI has evolved, and our impact has grown. For every £1 spent on aerospace R&D in the UK, it achieves £14 whole economy output and so the £4.2 billion invested to date through the ATI Programme is already generating fantastic returns for the country. In addition, we have been able to stimulate additional private investment which has supported the strengthening of UK aerospace and the jobs and growth it brings.

As we look ahead to 2035, the UK economy will continue to benefit from the investments that have already been made, and this will support a doubling of the UK's share of the global aerospace market. The government and industry have recognised this market potential with a long-term funding commitment to aerospace research and technology, and the ATI will continue to set the UK's technology priorities, invest in a portfolio of research and technology projects and support UK competitiveness from the smallest aerospace business to international primes.

Achieving our market potential on the next generation single-aisle and future widebody programmes, will require focus, leadership and additional investment. Our sector must deliver mature, competitive technology at the rate, cost and quality required and be able to demonstrate that capability around the end of the decade. We will need to continue to embed technologies and processes that support efficiency and productivity improvements to retain the many current strengths of the UK aerospace sector and build on them. We need to continue our commitment to decarbonising the sector, while also mitigating other emissions that have a negative impact on our environment.

"Achieving our market potential on the next generation single-aisle and future widebody programmes will require focus, leadership and additional investment."

Beyond the funding, the ATI will work with the sector to navigate this journey. Through the implementation of this strategy, we will work with government and industry to identify and address technology challenges, facilitate and support consortia to build solutions and help to attract the additional investment needed. If we, as a sector, get this right the returns are huge, and, as we implement this strategy, I look forward to working with you to deliver on that potential.



Gary Elliott
CEO, Aerospace Technology Institute

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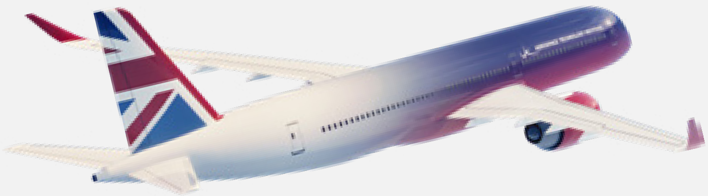


ABOUT THE ATI

The Aerospace Technology Institute (ATI) is an independent not-for-profit organisation working in partnership with the UK government and industry to enhance the competitiveness of the UK aerospace sector through technology leadership and funding. Since 2014, the ATI Programme has invested over £4.2 billion of joint government-industry funding in a balanced portfolio of research and technology projects.

The ATI Programme is delivered in partnership with the Department for Business and Trade and Innovate UK.

EXECUTIVE SUMMARY

- In 2024, government and industry set out an ambitious plan to double the UK share of the global aerospace market by 2035, creating growth, exports and high-value jobs across the UK, while demonstrating global leadership in technology development and decarbonisation. The ATI Funding Programme is the heart of that plan.
- The UK's aerospace industry pays more than double the UK average wage and is spread across the whole country, helping to reduce regional inequalities.
- By 2035, the ATI Programme will have invested £8 billion of joint government-industry funding in UK aerospace boosting efficiency, competitiveness and technology readiness.
- UK companies must prepare for the launch of a next generation aircraft programme at the end of the decade with mature, competitive technology and the ability to manufacture at unprecedented rates.
- The global race to secure market share on future aircraft platforms has begun. Maximising UK value relies on increasing competitiveness, including through adoption of advanced digital manufacturing, assembly and automation.
- Wings and engines represent the most significant technology levers for improving efficiency and reducing emissions on all future commercial aircraft while promising the most significant return on investment. Our strengths in these capabilities, and the systems underpinnng them mean the UK has a key role to play in the delivery of a new generation of ultra-efficient aircraft.
- New aircraft technology has the potential to avoid 3Gt aerospace carbon emissions by 2050 and 16Gt by 2070. Accelerating technology development and adoption de-risks the journey to Net Zero.
- Zero-carbon emission technologies have the potential to deliver the most significant reductions in aircraft emissions in the long-term. Achieving this at scale requires technology, regulation and infrastructure to develop at the same pace and with continued investment.
- Non-CO_2 emissions from aviation have an environmental impact, although there is work required to improve understanding and reduce uncertainty. The UK is a global leader in this area and we will deliver technology solutions to mitigate or prevent harmful non-CO_2 emissions during flight.
- Identifying and exploiting dual-use opportunities will accelerate technology readiness and create spillover to adjacent sectors.
- Additional investment into the sector is needed. The UK aerospace industry offers strong long-term returns for investors, in targeted technologies, driven by increasing global demand and new aircraft programmes.

2x Growth

In 2024, government and industry set out an ambitious plan to double the UK aerospace market value by 2035.

3Gt

New aircraft technology and operational improvements have the potential to avoid 3Gt of carbon emissions by 2050 and 16Gt by 2070

£8bn

By 2035, the ATI Programme will have invested £8 billion of joint government-industry funding in UK aerospace.

A VISION FOR GROWTH

The aerospace sector has the potential to grow in value over four times between 2025 and 2050, while decarbonising. This chapter sets out a vision for growth, explaining what drives this opportunity and why the UK is well placed to capitalise on it.

INTRODUCTION

The global aerospace sector is fast approaching a decisive period which will shape the next generation of aircraft for decades to come. Original equipment manufacturers (OEMs) are getting ready to launch new aircraft using the latest technological breakthroughs to deliver further increases in efficiency and reductions in fuel burn. To be considered for these programmes, technologies will need to demonstrate the required technology readiness level (TRL) and be commercially viable by the end of this decade. For the UK, technological progress now will lay the foundations for significant market growth out to 2050.

This market-led strategy:

- sets the direction for investment in aerospace technology development, and
- provides an ambitious but achievable blueprint for long-term, sustainable economic growth.

THE UK GROWTH AMBITION

Through the Aerospace Growth Partnership (AGP), government and industry set out an ambitious plan to increase the UK share of the global aerospace market from $9 billion in 2024 to circa $18 billion by 2035, creating exports and high-value jobs across the UK, while demonstrating global leadership in decarbonisation. This ambition was backed by the government's 2025 Modern Industrial Strategy, which identified aerospace as one of the UK's frontier industries and made a 10-year funding commitment to the ATI Programme worth up to £2.3 billion to 2035.

By 2035, the ATI Programme will have invested £8 billion of joint government-industry funding in UK aerospace, boosting competitiveness and advancing future technologies.

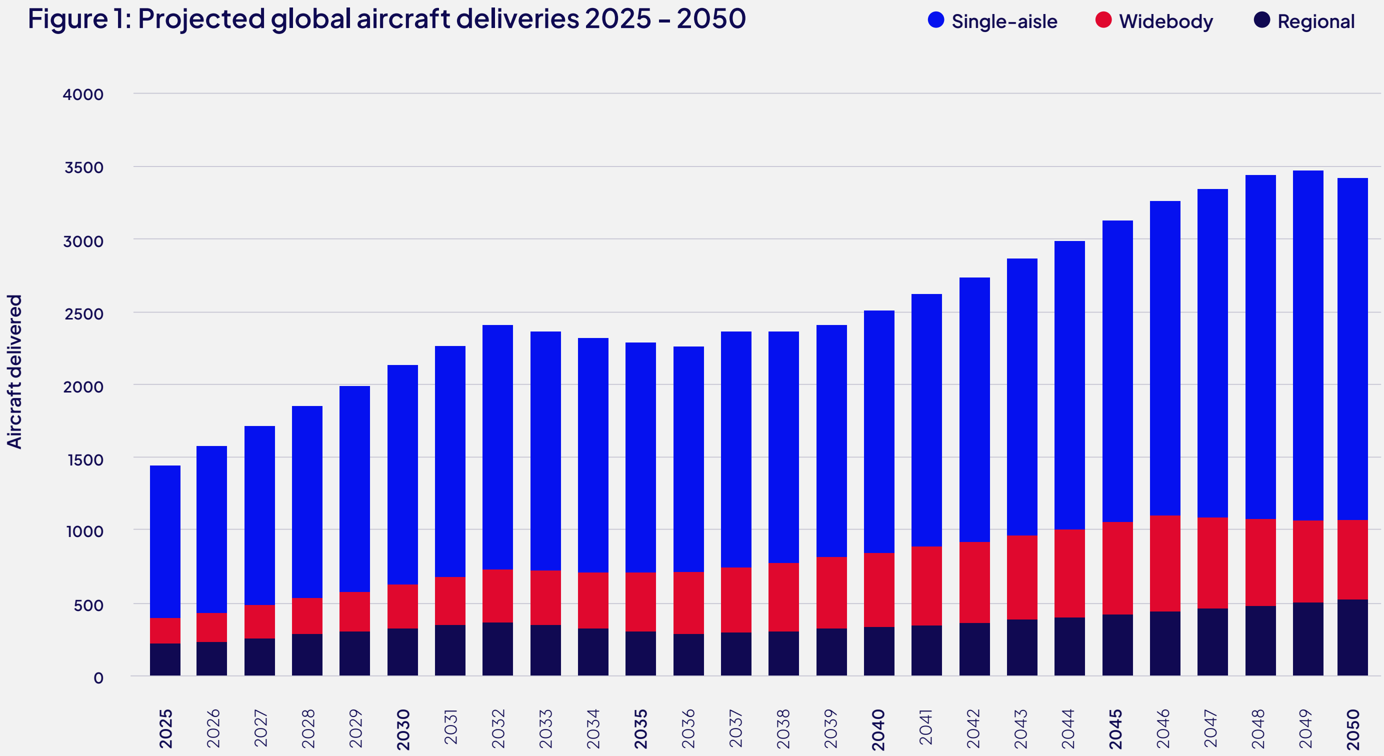
This long-term commitment gives international companies the confidence to invest in the UK and plays a crucial role in developing the ultra-efficient and zero-carbon emission aircraft needed to reach sustainability commitments.

THE GLOBAL CONTEXT

IATA's air passenger analysis shows global passenger traffic increased by 5.3% in 2025 compared with 2024, with demand now above 2019, reflecting a robust post-pandemic recovery supported by strong growth in emerging markets.

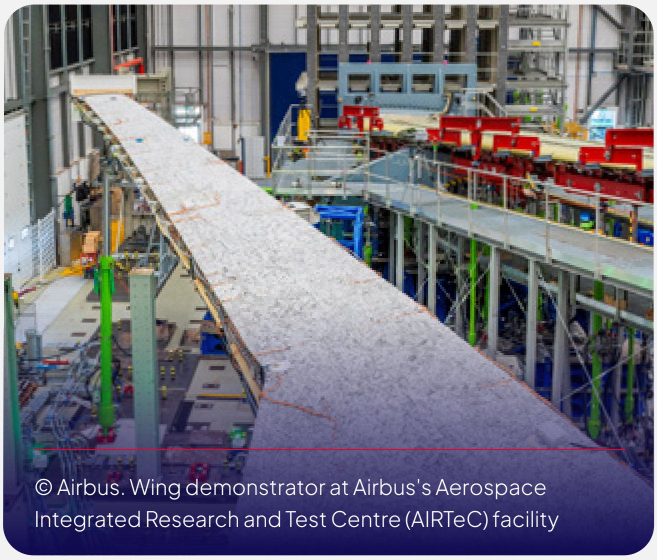
Over the next two decades, global airline passenger numbers are forecast to grow by around three percent per year.

Figure 1: Projected global aircraft deliveries 2025 - 2050



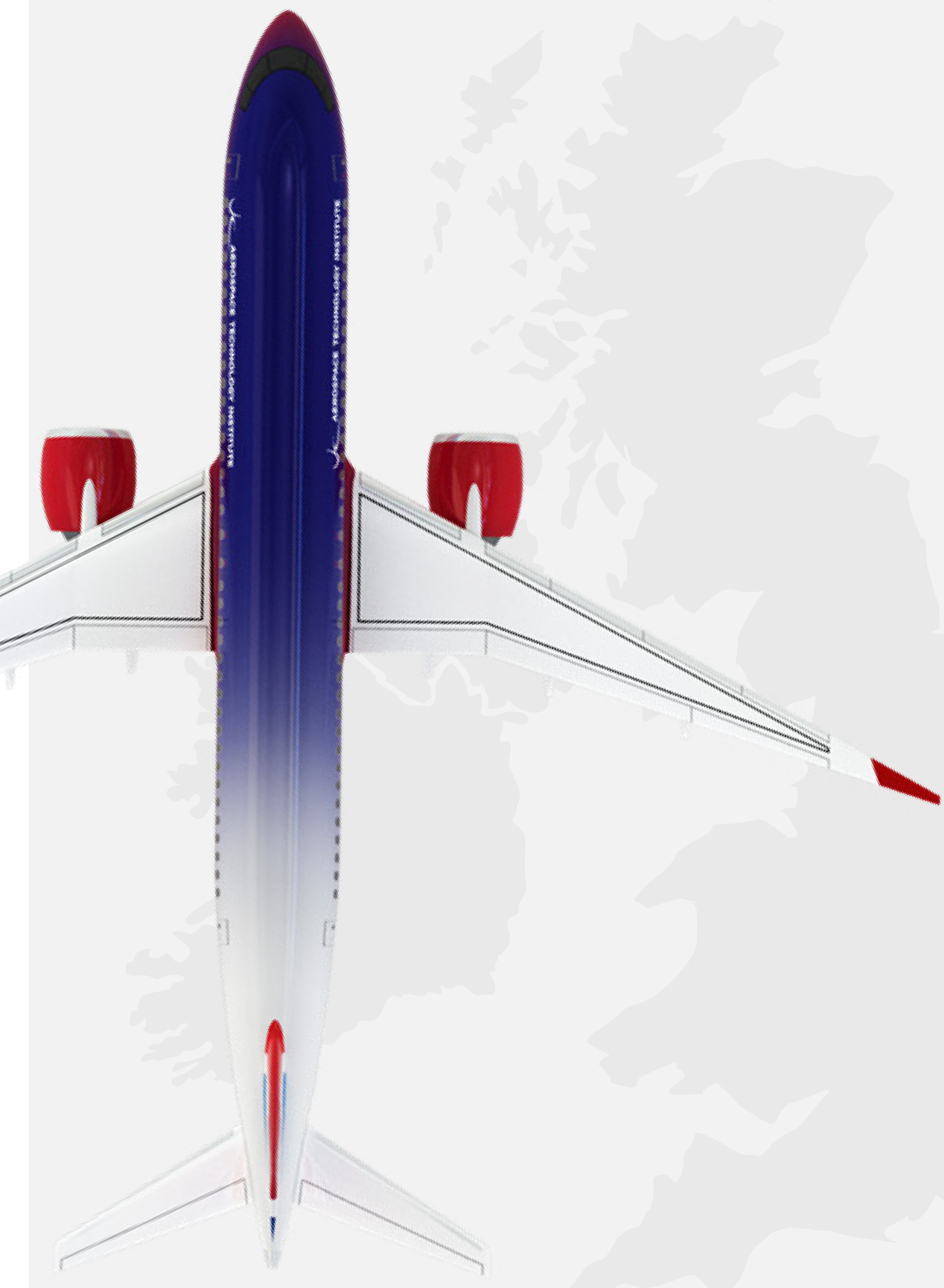
ATI analysis shows demand for over 65,000 new aircraft deliveries between 2025 and 2050, with nearly 70 percent of these single-aisle. The civil aerospace sector continues to be dominated by Airbus and Boeing, although there is growing competition from the Commercial Aircraft Corporation of China (COMAC), mainly driven by China's domestic market. Both Airbus and Boeing intend to increase manufacturing rates to meet their large order backlogs, demanding a substantial upturn across the global supply chain.

Despite this strong market outlook, today's aerospace supply chain faces challenges in balancing higher delivery rates, rising production costs and supply chain gaps with the need to innovate and invest for the future.



© Airbus. Wing demonstrator at Airbus's Aerospace Integrated Research and Test Centre (AIRTeC) facility

THE STRENGTH OF UK AEROSPACE



The UK has one of the largest and most successful civil aerospace sectors in the world. In 2025, the global aerospace market for delivered aircraft was valued at $95 billion excluding aftermarket, maintenance, repair and overhaul (MRO) and in-service support. UK-manufactured products contributed a 10 percent share, with this industrial strength coming from the presence of both major aerospace OEMs, key prime manufacturers, and a raft of SME companies at multiple tiers of the supply chain.

In addition, the UK's funding, research and development ecosystem is one of the most substantial and comprehensive globally. With support from the ATI Programme, technology centres, the catapult network and universities provide world-leading facilities and collaborate with industry to undertake cutting-edge research.

Global aerospace companies recognise the strength of the ecosystem and are investing, partnering and, in some cases, relocating to the UK to be able to benefit from it. This strategy focuses on sustaining the UK's competitive edge by developing the next generation of technologies to deliver further economic growth and Net Zero commitments.

UK STRENGTHS IN AEROSPACE

The UK's world-leading wing design and manufacturing centres produce half of the world's commercial wings supported by a broad supply chain.

Broughton, Filton, Prestwick, Belfast

The UK is a global leader in aircraft seating, producing over 50% of the world's aircraft seats and hosting major premium and economy-seat manufacturers with strong export markets.

Cwmbran, Kilkeel, Portadown, Rugby and Norwich

A strong pedigree in major aircraft systems such as landing gear, fuel systems and cabin interiors which feature on all major civil platforms.

National

A rich, multi-tier, internationally connected supply chain delivers high-precision components, advanced materials, manufacturing processes, and subsystem expertise into all major aircraft programmes.

National

Design and manufacture of advanced aeroengines gives the UK a dominant role in this high-value propulsion segment.

Derby, Bristol

Universities, research centres and the catapult network host world-class facilities fostering collaborative industry partnerships to drive technology innovation across all areas, including materials, manufacturing, aerodynamics, systems and propulsion.

National

THE MARKET BEYOND 2035

The ATI's future market scenario in figure 2 has informed the analysis in this strategy. It combines public and private data on likely technology development and entry-into-service timelines to estimate global and UK market value to 2050. It provides an overview of when technologies will need to achieve TRL 6, indicative entry-into-service windows, and target manufacturing rates. UK opportunities are dominated by the large civil aircraft programmes in the first two rows, with a modest opportunity to expand content on a new ultra-efficient turboprop.

Development of a zero-carbon emission regional aircraft, while of small initial value, is an important stepping stone to future larger civil zero-carbon emission aircraft and protects future aerospace skills.

The ATI analysis in figure 3 concludes that these programmes will boost the global aerospace market to approximately $278 billion by 2050. This strategy sets out how the UK sector can capture 15 percent of this value, worth $41 billion per year in that timeframe and deliver growth while accelerating towards Net Zero.

Figure 2: ATI's future market scenario

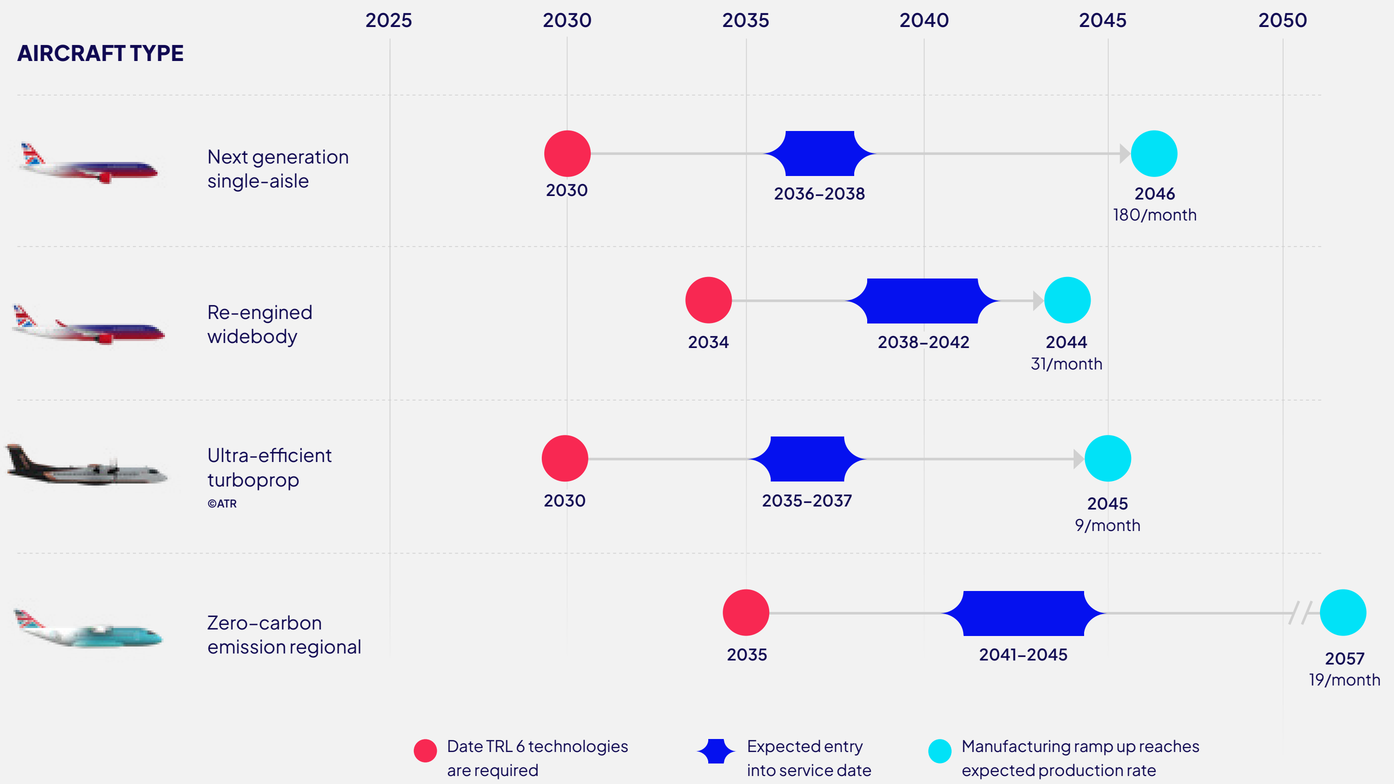
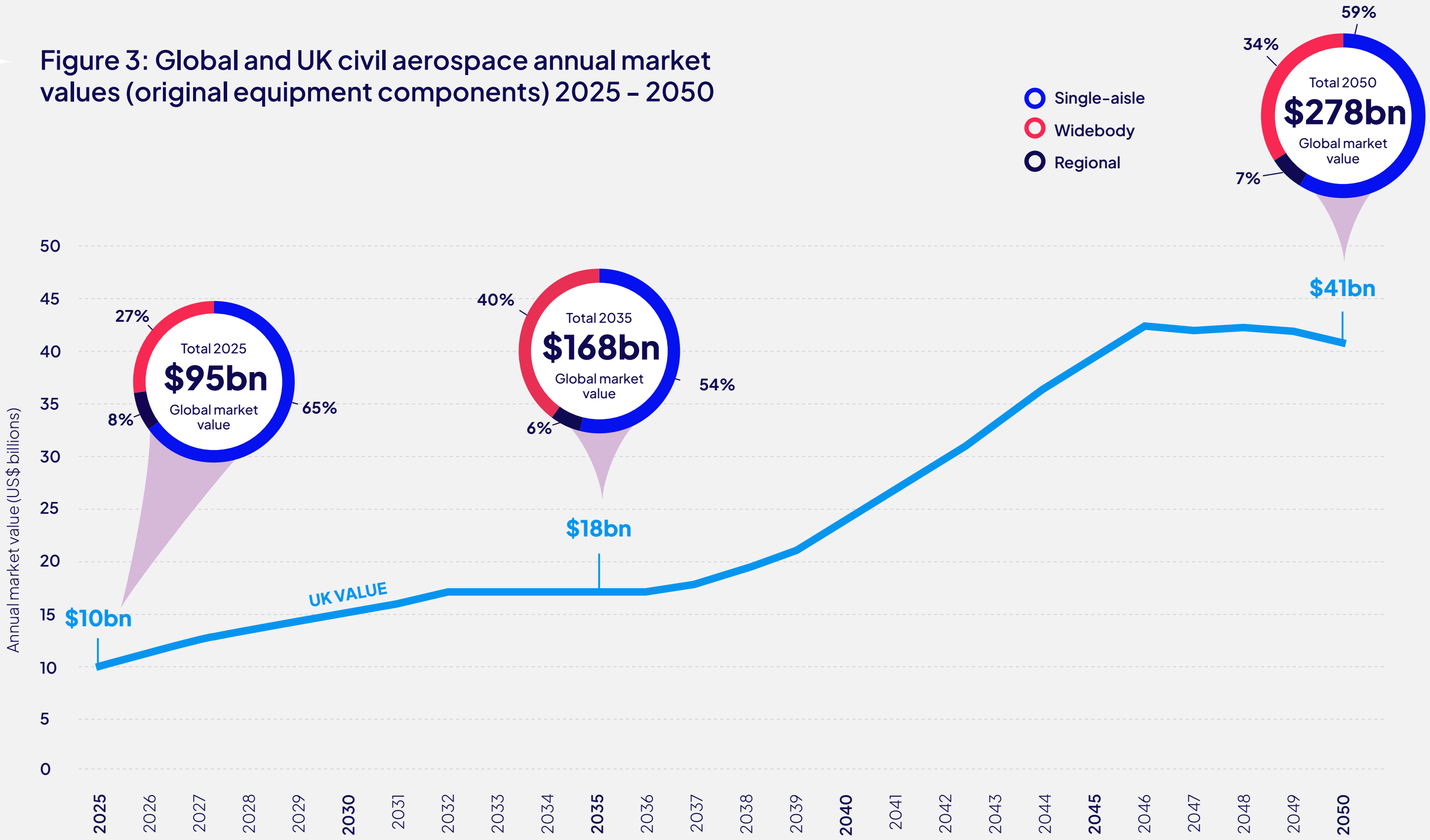


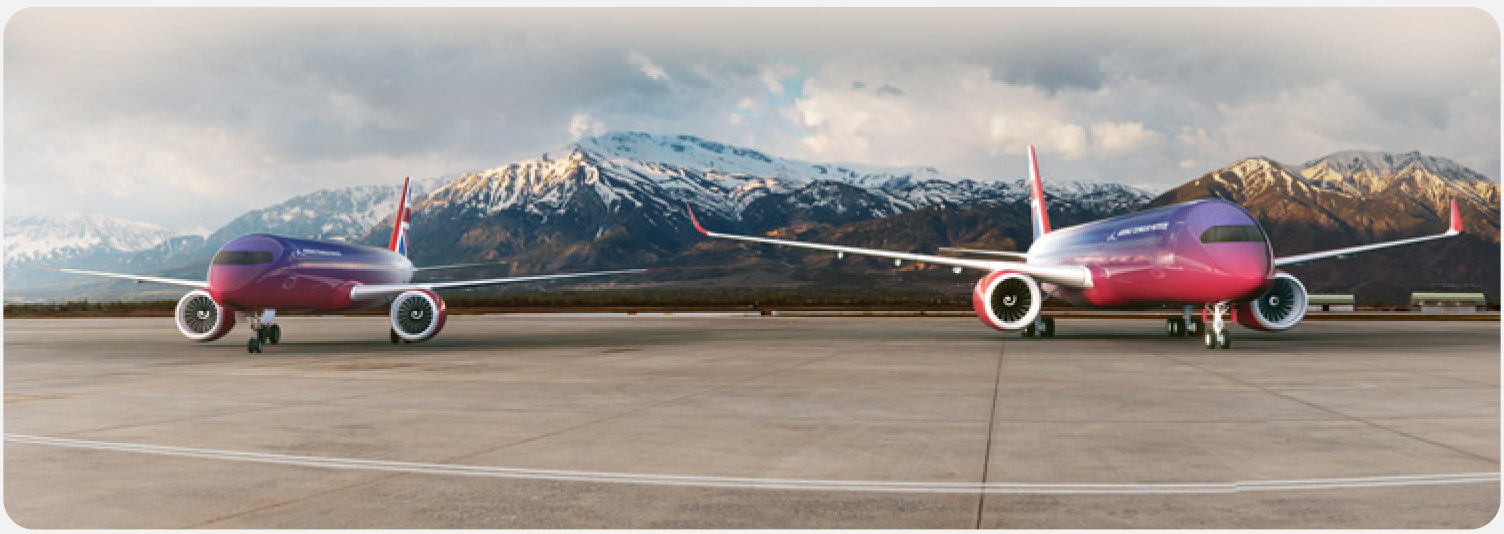
Figure 3: Global and UK civil aerospace annual market values (original equipment components) 2025 - 2050



THE GENERATIONAL PRIZE: NEXT GENERATION SINGLE-AISLE

Today's most modern single-aisle aircraft, the Airbus A320neo family and Boeing 737 MAX, were introduced around 2016 as derivatives of their respective original aircraft families. The next generation of single-aisle aircraft will be clean-sheet designs, enabling the integration of ultra-efficient engines, lighter composite materials, improved aerodynamics and enhanced systems, with higher production rates achieved through advanced, automated manufacturing.

The UK has the chance to grow its $5.3 billion share to $24 billion by 2050. UK engagement in a future single-aisle engine, plus increased wing, systems, landing gear and interiors deliveries are the driving contributors to this growth.



SIGNIFICANT OPPORTUNITY: RE-ENGINED WIDEBODY

The current widebody market is dominated by long-range, high-capacity, twin-engine aircraft, including the Airbus A350 and A330neo and Boeing 787 and 777, powered by Rolls-Royce or GE Aerospace. All Airbus widebody wings are assembled in the UK alongside UK-supplied landing gear, other systems and structural parts. Boeing's 777X is the most recent derivative and is expected to enter service in 2027.

The ATI's future market scenario anticipates further Airbus derivative widebody developments from the late 2030s, with improvements mainly driven by the engines and wings. This presents attractive opportunities for the UK to expand its market share from $4.1 billion to $15 billion by 2050. Technology innovations in the later 2030s and 40s will pave the way for new future clean-sheet widebody developments entering service in the late 2050s.

THE ENVIRONMENTAL IMPACT OF AIRCRAFT

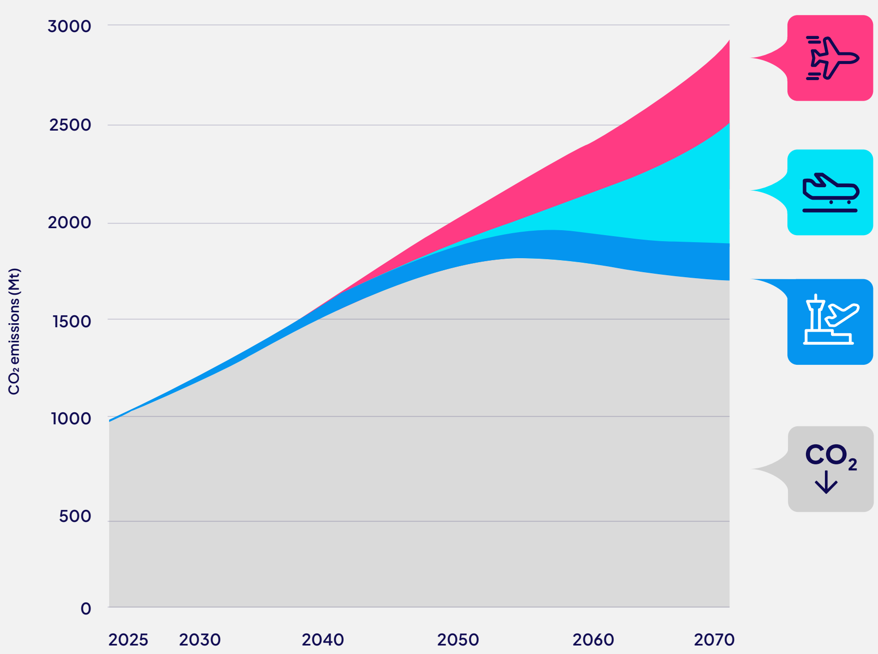
In 2025, aviation contributed around 2.5 percent to global warming through carbon dioxide (CO_2) emissions, and this is higher when non-CO_2 emissions, such as oxides of nitrogen (NO_x) and contrails are included. Without lower-carbon aircraft and other mitigations, the Climate Change Committee's Seventh Carbon Budget forecasts aviation's share of UK carbon emissions rising from 9 percent today to 27 percent in 2040 as other sectors cut emissions.

Achieving Net Zero aviation by 2050 relies on technological innovation, improved operations, policy support and coordinated sector action including the scale-up of sustainable aviation fuels and carbon capture and storage. The ATI's assessment shows that the increase in aviation growth can be partially offset by newer, more efficient aircraft, revolutionary hydrogen-fuelled aircraft, and improved operational efficiency of the global fleet. Under the future market scenario, technology and operational improvements will avoid 3Gt CO_2 emissions by 2050, increasing significantly beyond that, as shown in figure 4, which presents data out to 2070.

Each aircraft that enters into service today is up to 30 percent more efficient than the fleet they replace, through more efficient engines and aerodynamics, structural and system improvements. This delivers an immediate impact on carbon emissions, which will increase over the lifecycle as SAF usage grows. Next generation aircraft will target another 30 percent efficiency improvement on today's modern aircraft, avoiding 6Gt CO_2 by 2070. From the late 2040s zero-carbon emission aircraft will start to eliminate CO_2 tailpipe emissions, avoiding an additional 5Gt of CO_2 emitted by 2070.

Figure 4: Impact of future market scenario on global aviation CO_2 emissions

This figure presents carbon emissions only. Significant research is underway into the effects of non-CO_2 emissions, an area where the UK demonstrates global leadership. The ATI's non-CO_2 roadmap, the first-of-its-kind globally, identifies research areas to increase sector understanding and develop solutions to mitigate these impacts.



ULTRA-EFFICIENT TECHNOLOGIES
Ultra-efficient technologies on current and next generation aircraft will avoid 1 Gt carbon emissions between 2025 and 2050, avoiding 6 Gt to 2070.

ZERO-CARBON TECHNOLOGIES
Zero-carbon emission aircraft will have an impact from the late-2040s, avoiding 5 Gt to 2070.

AIRCRAFT OPERATIONS
Operational improvements both in flight and on the ground will avoid 2 Gt between 2025 and 2050, increasing to 5 Gt to 2070.

ADDITIONAL MEASURES
This chart forecasts the impact of aircraft technology and operations on decarbonisation however measures such as adoption of Sustainable Aviation Fuels (SAF) and Carbon Removals will be essential to achieving Net Zero.

SECTION SUMMARY

- The UK aerospace market value has the opportunity to double by 2035 and quadruple by 2050.
- OEMs have indicated that next generation aircraft programmes may launch towards the end of this decade. The sector must be ready by 2030 with both new technologies and a demonstrated means of supply.
- The biggest market opportunities are related to aerostructures, propulsion and their associated systems. This could be worth $41 billion per year to the UK economy in 2050.
- Technology contributes towards decarbonisation by 2050, but the impact it has increases substantially beyond that point.

DELIVERING THE UK AEROSPACE TECHNOLOGY PLAN

Delivering competitive world-leading technology at scale requires the right partnerships, investment and capability. This chapter sets out the technologies that the UK should focus on developing, the rate of development needed and the enablers to productivity. It sets realistic targets and defines the scope of the ATI funding programme.

© Alloyed

UK INVESTMENT PRIORITIES

This ATI strategy comes at a time of strategic imperative for UK aerospace to develop mature, competitive technologies in the near-term for down-selection onto next generation aircraft. This will enable the UK to retain and grow its world-class standing beyond today's platforms.

The four roadmaps in this strategy form a technology investment plan, setting out the priorities for UK aerospace industrial research through a combination of public and private funding. They target areas with the greatest potential to deliver our economic ambitions and sustainability commitments, focused on new single-aisle and widebody aircraft due to the market dominance of these segments.

The ATI Programme will support a portfolio of commercial aircraft technology development and associated manufacturing projects that align with these roadmaps, however additional UK value can be unlocked by complementary private investment. Highly collaborative projects that bring together complementary activity across the sector, including globally, should be considered to accelerate progress and deliver greater impact.

Applications that address other segments, including dual-use, may be considered where the technology has future applicability for large commercial aircraft or can deliver substantial economic, sustainability and technological advantages for the UK. While broader aviation technologies are out of scope for ATI Programme funding, the ATI will continue to collaborate with the wider ecosystem.

All applicants are encouraged to engage with the ATI before submitting an application for funding.

Figure 5: ATI Programme funding scope

USING THE TECHNOLOGY ROADMAPS

The technology roadmaps included in this strategy form guidance for industry and investors on the technology development goals for UK aerospace. They also set the scope for ATI programme investment decisions and should be used by applicants to ensure their projects fall within this. The placement of technology bricks indicates target dates for technologies to reach TRL 6, aligned with exploitation opportunities on current or future platforms, but brick size does not necessarily reflect development timescales. Each technology brick can be explored in more detail on the ATI website.

EXPLORE OUR INTERACTIVE TECHNOLOGY ROADMAPS

View

ULTRA-EFFICIENT TECHNOLOGIES

Ultra-efficient technologies are the cornerstone of aerospace research. Each generation of aircraft is more efficient than the one it replaces, with advances in aerodynamics, propulsion, lightweight airframes, and systems combining to reduce fuel use and emissions.

These technologies have the potential to reduce fuel use per aircraft for all future fuels and will deliver the most significant reductions in aircraft tailpipe emissions to 2050. The technology bricks detailed on this roadmap apply to all aircraft and will be increasingly important as we transition to new fuels such as sustainable aviation fuels (SAF) and, in future, hydrogen, given likely availability constraints.

The UK's strengths in wings, engines and associated systems mean we are uniquely placed to translate ultra-efficient technologies into significant fuel burn reductions on the next generation of aircraft. ATI analysis shows that ultra-efficient single-aisle and widebody aircraft could achieve energy improvements of 25 percent and 20 percent respectively, by the next generation.

Examples of ultra-efficient technology progress since Destination Zero

© Rolls-Royce's scalable ultra-high-bypass-ratio turbofan demonstrator, UltraFan®, has run to full power at Testbed 80 in Derby, paving the way for next generation opportunities.

In Bristol, Airbus's Wing Technology Development Centre opened, supporting the Wing of Tomorrow programme to develop high-performance, lightweight composite wings that deliver more aerodynamically efficient, high-aspect-ratio wings in flight.

In Sheffield, Boeing's Composites at Speed and Scale (COMPASS) facility at the University of Sheffield Advanced Manufacturing Research Centre (AMRC) is preparing to support organisations advancing large-scale, high-rate composite parts.

Through project IHSS, Prestwick Aerosystems Limited, reduced the takt time for large component fabrication from around 40 hours to less than four hours using an automotive-derived, fully automated dry fibre/resin infusion process, enabling the reshoring of production to the UK.

ROADMAP STRUCTURE

The new Ultra-Efficient Technologies Roadmap builds on the UK's strengths and increases its contribution to current and future aircraft with milestones for technology development out to 2050. Technology bricks positioned around 2030 represent technologies that must reach TRL 6 in time to be selected for the next generation single-aisle aircraft entering service in the 2030s.

The roadmap's three streams are:

Propulsion

Priorities include further reducing weight and maximising efficiency, durability, and time-on-wing, as well as increasing levels of electrification.

© Dowty. UK test capability includes Dowty's propeller spin-testing facility to assess structural and dynamic performance

Advanced systems

Priorities support growth across areas such as future landing systems, actuation, electrification, avionics, fuel systems, flight control, environmental control, and cabin systems.

© Safran

Aerostructures

Priorities focus on technologies that deliver superior aerodynamic performance from high-aspect-ratio wings, considering all associated functionality, and looking ahead to alternative architectures.

© Prestwick Aerosystems' A320 spoiler line utilises pioneering Resin Transfer Moulding (RTM) technology to deliver at rate and quality

ULTRA-EFFICIENT TECHNOLOGIES ROADMAP

2025 | 2030 | 2040 | 2050

PROPULSION

- Gas turbine durability
- High-pressure ratio small core
- Low-noise propellers and open fans
- Scalable, high power gearbox
- MW hybrid systems
- More-electric gas turbine
- Durable materials
- Alternative gas turbine architectures
- Advanced controls
- Low-noise propulsion and nacelle architectures
- Low-speed composite fan
- MW scale distributed power system architectures
- Low-emissions combustor
- High-temperature materials and coatings
- Alternative fuels gas turbine enablers and architecture
- Auxiliary power generation

ADVANCED SYSTEMS

- SAF compatible materials and fuel system components
- Fuel systems
- High power density non-propulsive electrical machines
- AI-enabled onboard systems
- Electrical actuation systems
- More-electric, lightweight landing systems
- Fibre-optic and photonics based avionics
- Advanced systems for novel airframe configurations
- High-voltage power systems
- Cyber-secure avionics
- Cabin experience and connectivity
- Quantum-enabled avionics
- Bleed air-driven environmental control system
- Bleedless environmental control system
- Lightweight sustainable interiors
- High-integrity lightning strike protection
- Low-power ice detection and protection

AEROSTRUCTURES

- Future wing and airframe configurations
- Folding wings and semi-aeroelastic hinges
- Airframe / propulsion integration
- Propulsion integration for new configurations
- High-aspect ratio wings
- Moveables and structures
- Load alleviation and flutter suppression
- Low-drag surface materials
- Wing assembly and major component production
- Large thermoplastic aerostructures
- Laminar flow structures and devices

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ULTRA-EFFICIENT TECHNOLOGIES ROADMAP

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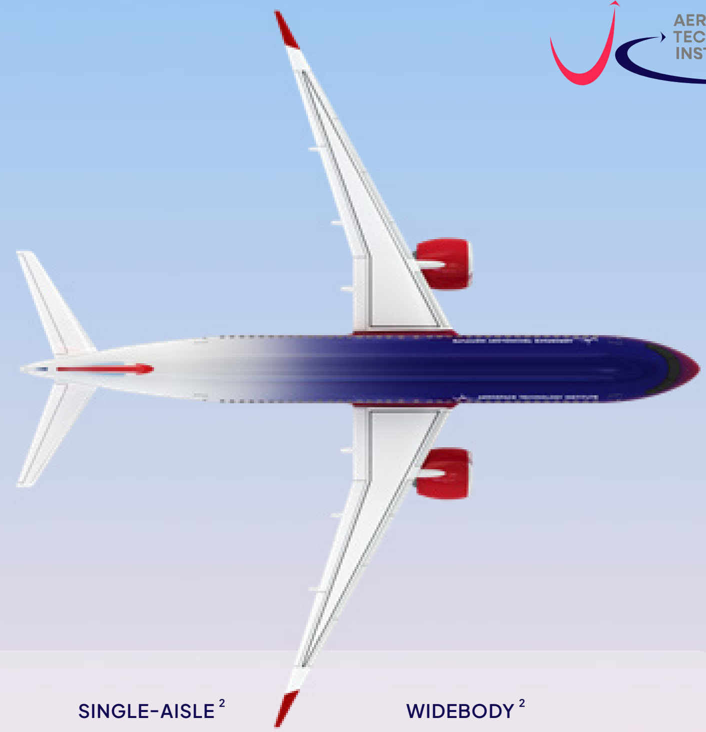
The ultra-efficient roadmap defines the technologies required to enable major fuel burn and emissions reductions including aerodynamics, propulsion, lightweight structures and systems. These technologies leverage national strengths, especially in engine and wing design, to boost competitiveness, deliver future aircraft performance and power growth.



KEY DELIVERABLES

- **World-leading** next generation wing architecture and technologies
- Wing **high-rate production system** demonstrators
- **Next generation engine performance** and production rate demonstrators
- **Systems electrification** and **lightweighting technologies**
- **Hybrid engine** ground and flight demonstrators
- **100% SAF enabled** propulsion and airframe
- **Cyber-secure** future systems and avionics

TARGETS[1]

	SINGLE-AISLE[2]	WIDEBODY[2]
Fuel burn[3]	-25%	-20%
Aircraft weight[4]	-20%	-12%
Aircraft drag	-10%	
Engine time on wing[5]	10,000 Cycles	3,000 Cycles
Noise[6]	-65%	

1: Targets are relative to the latest generation of in-service aircraft for each market segment
2: Clean-sheet new aircraft architecture
3: Fuel burn improvement is a combination of improved engine efficiency, aircraft weight and drag reductions. Values are taken from the ATI SAFAM and WiFAM aircraft models against their respective reference models (for more information, see the ATI toolkit).
4: Aircraft structural and systems mass
5: Equivalent cycles based on reference mission profile
6: Reduced perceived noise per aircraft operation by 2050 vs 2000s platforms in accordance with ACARE and ICAO goals.

ZERO-CARBON EMISSION TECHNOLOGIES

Zero-carbon emission propulsion will form part of a portfolio approach to decarbonising aviation, by eliminating tailpipe carbon emissions and reducing reliance on out-of-sector measures.

The UK's expertise in fuel system design and propulsion systems provides a strong foundation for development of applications for zero-carbon emission energy sources. Investment over this period will secure this capability in the UK in the longer-term. The Zero-Carbon Technologies Roadmap focuses on hydrogen and battery-electric technologies as having the greatest potential to realise zero-carbon emission flight.

Beyond the technologies shown on the roadmap, hydrogen aircraft will also require lower-TRL and fundamental research to address the significant technology and certification challenges associated with the supply, storage, distribution, and use of liquid hydrogen as an aviation fuel. Collaboration between academia and industry is essential to deliver targeted hydrogen research, particularly in cryogenics.

Examples of zero-carbon technology progress since Destination Zero

© Safran's ENGINeUS™ 100 electric motor, supported by projects AEPEC and SMPP, became the first electric motor certified by the European Union Aviation Safety Agency (EASA) to power new air mobility, with rotor and stator production in Pitstone.

Groundbreaking technologies are also progressing through flight testing. ZeroAvia tested the ZA600 hydrogen fuel cell propulsion system and Vertical Aerospace achieved two-way piloted in-flight transition with the VX4, a first under CAA regulatory oversight. New commercial partnerships have also been formed between ATI-funded organisations, such as Vertical Aerospace selecting Evolito as a partner for their electric propulsion unit.

Across projects HYEST, LH2GT and RACHEL, Rolls-Royce is leading a consortium of 15 companies, which has ground-tested proof-of-concept hydrogen gas turbine combustion technologies.

In Bristol, H2FlyGHT led by GKN Aerospace is developing critical elements of a multi-megawatt cryogenic hydrogen-electric propulsion system, building on a strong systems architecture formed in its predecessor, H2GEAR, which established a scalable pathway to exploitation in larger aircraft.

ROADMAP STRUCTURE

The updated Zero-Carbon Technologies Roadmap sets out the technologies required to reach TRL 6 to enable first-of-their-kind vehicles and indicates the strategic direction beyond the next generation.

The roadmap's two streams are:

Energy storage and fuel systems

Priorities include fuel cells, sensing, pumps, thermal management, storage tanks, and battery technologies.

© Melrose/GKN Aerospace Cyrogenic technology development at the Global Technology Centre

Power distribution and control

Priorities include electrical machines, power systems, electrical propulsion, and cryogenic power conduits.

© Evolito. Automated copper coil winding machine supporting Evolito's scalable electric motor production.

© Vertical Aerospace. ATI Programme funded technologies take to the skies as Vertical achieves two-way piloted transition under civil aviation Design Organisation Approval regulatory oversight.

ZERO-CARBON TECHNOLOGIES ROADMAP

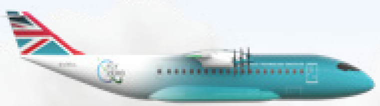
2025 | 2030 | 2040 | 2050

ENERGY STORAGE AND FUEL SYSTEMS

- Hydrogen capable materials
- Durable cryogenic pump
- Hydrogen combustor
- GH2 sensing and leak detection
- LH2 sensing
- LH2 storage tanks
- Hydrogen gas turbine integration
- Low-drag efficient fuel cell thermal management
- Isolation capable cryogenic valves
- Sub-MW fuel cell system
- MW class fuel cell system
- Durable insulated cryogenic pipes
- Fuel cell control system
- High performance Li-ion aerospace battery
- Electric compressors for large fuel cell systems
- High cell-to-pack efficiency battery pack design
- Future aerospace batteries
- Battery management system
- Dry wing configurations

POWER DISTRIBUTION AND CONTROL

- Magnetic materials for electrical machines
- Cryogenic heat exchanger
- Cryogenic electrical power conduits
- Cryogenic power distribution
- Integrated energy management system
- Cryogenic propulsion unit
- High-voltage power systems
- Lightweight electric propulsion unit
- Rare earth free motor



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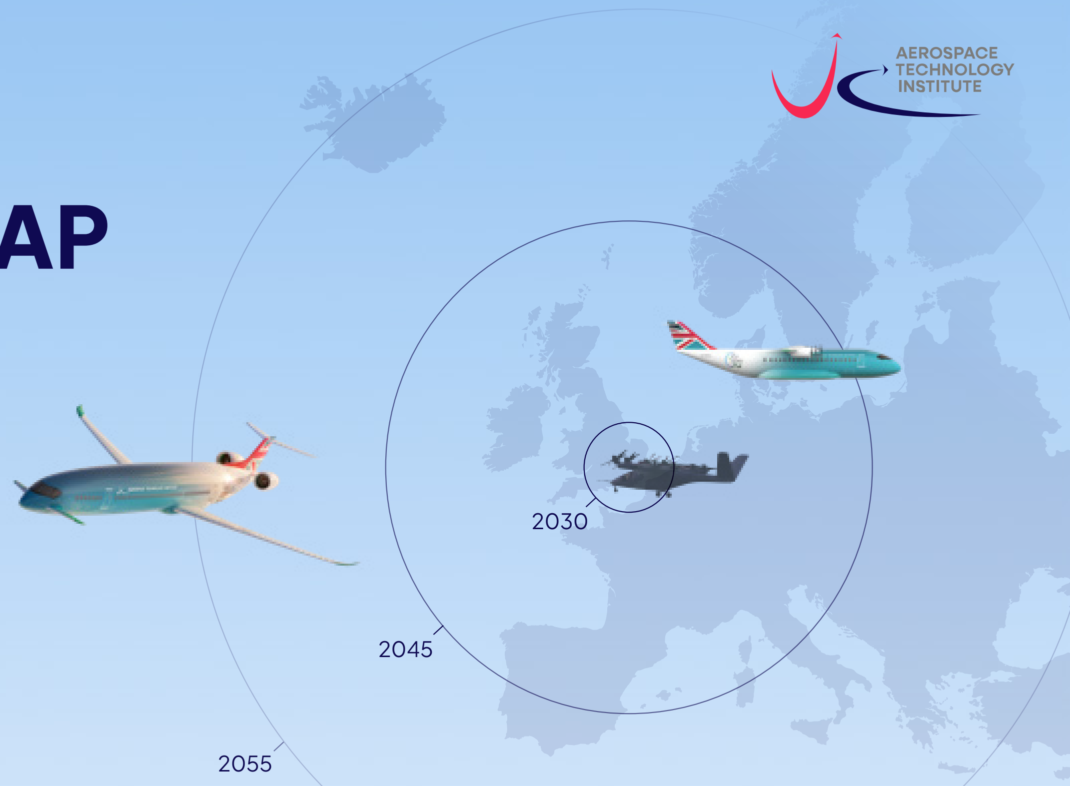
ZERO-CARBON TECHNOLOGIES ROADMAP



The UK drives revolutionary research to secure long-term competitiveness in breakthrough technologies such as high-power electrification and hydrogen. The Zero-Carbon Technologies Roadmap defines the technologies needed to build on current progress and sets development milestones through 2050.

KEY DELIVERABLES

- **Cryogenic fuel system** demonstrators
- Optimised **dry wing** design
- **Qualified materials** for cryogenic and hydrogen environments
- **Megawatt (MW) fuel cell** system demonstrator
- MW class **electrical power distribution** system demonstrator
- Cryogenic **electric propulsion** demonstrators

TARGETS

	2030	2045
Fuel cell system performance	2.5kW/kg	>5.0kW/kg
Aerospace battery energy density	250Wh/kg	>500Wh/kg
Electric propulsion unit performance (MW plus scale)	10kW/kg	15kW/kg
Cryogenic H2 tank gravimetric efficiency	40%	75%
Electrical power system architecture	High-voltage	Cryogenic

INDUSTRIAL PRODUCTIVITY AND COMPETITIVENESS

Technologies driving industrial competitiveness in UK aerospace are fundamental to realising the sustainability and economic benefits of ultra-efficient and zero-carbon emission aircraft technologies, and they provide significant spillover benefits to other advanced manufacturing sectors.

Industrial productivity and competitiveness comprises multiple enablers and capabilities that support competitive aircraft design, analysis, and manufacturing across the whole aircraft lifecycle. The technologies in this roadmap will drive improvement in UK productivity, enabling the sector to exploit current market opportunities and achieve future market share targets.

Preparation is necessary to meet the unprecedented manufacturing rates needed. Current forecasts indicate that Airbus and Boeing single-aisle aircraft monthly production rates could each increase from around 50 today, to 75 by 2028 and 100 for the next generation aircraft. Adoption of advanced manufacturing, assembly and automation technologies offers opportunities to meet this demand.

The sector will also need to accelerate the adoption of AI and the power of quantum computing in support of sector goals. AI is already helping to address longstanding challenges such as reducing operational costs and improving quality inspection. Further opportunities exist to reduce design and certification timescales and to support predictive maintenance and in-service health monitoring. AI and quantum computing are key enablers of improved productivity and can be applied across many of the technology bricks in the roadmaps.

Examples of industrial competitiveness progress since Destination Zero

© NMIS. FutureForge, Europe's largest hot forging research and innovation platform, opened at the University of Strathclyde's Advanced Forming Research Centre (AFRC) in Renfrewshire, part of the National Manufacturing Institute Scotland.

In Cambridge, the Whittle Laboratory's National Centre for Propulsion and Power (NCPP) has installed a new 60-tonne 4-megawatt rapid turbomachinery test facility, enabling faster testing and generating the large volumes of data needed to train an aerothermal AI world model.

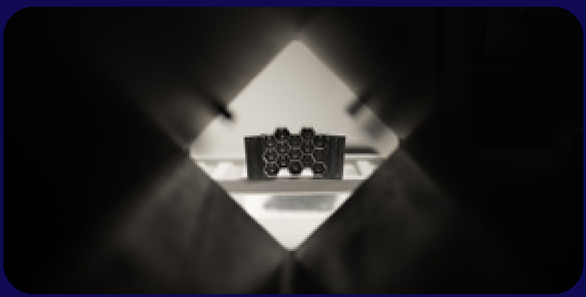
2025 saw the first SME Programme projects announced supporting a range of innovation from modelling tools (SoraAero by Sora) and artificial intelligence (AAIFC by Luffy AI) to printable aluminium alloys (PACE-AM by Alloyed) and cryogenic valves (DRAGONFLY by Actuation Lab).

ROADMAP STRUCTURE

The Industrial Competitiveness Technologies Roadmap is presented across four streams:

Advanced materials

High-strength, resilient, durable, sustainable alloys, composites and coatings for structures, propulsion, and equipment, with robust manufacturability, rapid qualification and potential multi-functional hybrid uses.



© Qdot

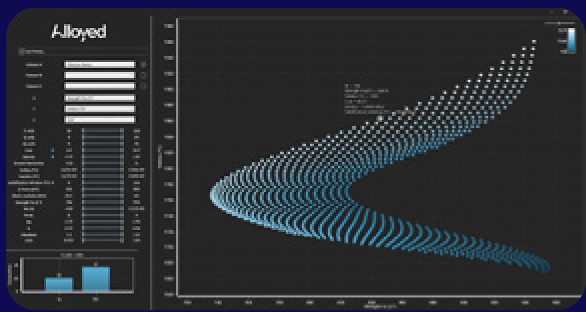
Design and validation

Rapid, multiphysics design methods and simulation with increased automation and data for multiple 'design for X' parameters through advanced use of high performance computing, AI and eventually quantum computing. Significantly reducing design and certification timescales and delivering higher product performance at entry-into-service.

Advanced manufacturing

Sustainable, near-net-shape, rate-capable processes for part manufacture, unlocking productivity and advanced design through additive and composites processing, alongside highly automated assembly, using robotics and AI in smart, digitally connected, adaptable factories.

©Alex Wilkinson Media/University of Nottingham OMNIFACTORY



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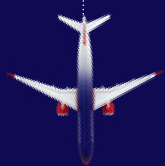
Through-life support

Digital passports for traceability of part lifecycles from material and production to in-service health monitoring, efficient maintenance planning and eventual recyclability or reuse, plus prognostic tools to support maintenance decisions, inspection and repair for competitive MRO.



INDUSTRIAL COMPETITIVENESS TECHNOLOGIES ROADMAP

2025 | 2030 | 2040 | 2050

ADVANCED MATERIALS

- Rapid validation and qualification of novel alloys and processing
- Life and performance enhancing coatings
- Metal matrix composites for high loads
- Resilient composites
- Sustainable composite matrices for high-rate production
- Efficient qualification of new materials
- Sustainable alloys and composites
- Integrated material supply chains
- Performance enhancing hybridised materials

DESIGN & VALIDATION

- High-fidelity, rapid design and simulation methods
- Aerodynamic and aeroacoustic testing
- Methods for composite and metallic architectures
- Aero and noise simulation for novel architectures
- Automated, data-enabled, design for X tools
- Icing modelling and analysis
- Rapid product qualification and certification
- Quantum in design and simulation
- Trusted AI in design and validation
- Multiphysics design tools
- Integrated intelligent structures
- Advanced design and manufacturing of unitised structures

ADVANCED MANUFACTURING

- Joining of materials
- Evaluation and real time data analytics
- Rate-enabling subtractive manufacturing
- Sustainable composite and metallic processing
- Rate-enabling equipment, tooling and jigs
- Determinate assembly for large aerostructures
- One-way assembly and enablers
- High-rate assembly and disassembly of propulsion and systems
- Rapid large volume metrology
- High-rate manufacturing systems
- Scalable near net shape metallics
- Rapidly adaptable manufacturing lines
- Digital manufacturing and supply chains
- Autonomous connected facilities
- Extended laminar flow manufacturing technologies

THROUGH-LIFE SUPPORT

- Material-to-product operational digital passport
- Tools and processes for maintenance productivity
- Prognostic and health management
- AI assisted assessment and decision
- Repair methods for advanced materials
- Composites and metallics recycling

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IN FOCUS: COMPOSITES

Published in March 2025, Market Spotlight: Composites concluded that the UK could grow its market share in aerospace composites by more than six times between now and 2050. Achieving the required technology readiness and demonstrating capability across rate, quality and cost will demand cohesive, strategic action. Following publication, the ATI established a Composites Working Group to develop a shared strategic approach to addressing technology gaps and capitalising on the market opportunity.

> "The UK is ideally positioned to seize the composites opportunity, but we'll need to move fast… maintaining and growing our market share will drive growth across the nations and regions while delivering on our environmental commitments."

— Gary Elliott, CEO, ATI

INDUSTRIAL COMPETITIVENESS TECHNOLOGIES ROADMAP

Industrial competitiveness technologies are essential to realise the ultra-efficient and zero-carbon aircraft sustainability and economic benefits and maximise UK aerospace's growth. The roadmap defines research priorities to deliver the advanced materials, design methods and competitive manufacturing processes necessary to scale to meet rising production demands and advanced products for next generation aircraft.

©University of Sheffield. Boeing's Composites at Speed and Scale (COMPASS) facility at University of Sheffield AMRC.

TARGETS	2030[1]	2045[1]
Gross value added per employee[2]	+15%	+80%
Resource intensity in manufacturing[3]	-10%	-60%
Rate capability for single-aisle[4]	75	100
Design and manufacturing lead time[5]	-10%	-50%

1: Targets are relative to the 2025 baseline year.
2: Percentage increase in Gross Value Added (GVA) per employee on an annual basis. Calculation aligns with UK national productivity methodology.
3: Resources include material input, energy and time.
4: Monthly single aisle aircraft production rate targets for Airbus and Boeing.
5: Targets reflect consolidated stakeholder ambition. Lead time encompasses full design, engineering, and manufacturing cycle reduction.

NON-CO_2 TECHNOLOGIES

The ATI's Non-CO_2 Technologies Roadmap sets out the research actions needed to improve understanding of, and address, aviation's broader atmospheric emissions.

This roadmap informs activities funded under the ATI's Non-CO_2 Programme, building on fundamental climate science to develop technologies and scale up solutions for practical implementation. In some instances, there may be overlap with other technology areas due to regulations such as local air quality, oxides of nitrogen and noise.

Collectively, non-CO_2 emissions refer to the direct and indirect effects of combustion found in aircraft exhaust plumes, aside from carbon dioxide. Depending on the engine's fuel type, exhaust plumes contain CO_2 and other gases, as well as aerosols.

Non-CO_2 emissions from aviation contribute to global warming. However, there remains a high level of uncertainty about their quantified impacts, usually expressed in terms of radiative forcing. The level of uncertainty varies by emission type, and in some cases, emissions may impart a cooling effect.

The climate impact of non-CO_2 emissions is highly complex and depends on many factors, including emission altitude, weather, and regional specifics such as the occurrence of ice-supersaturated regions (ISSRs).

Non-CO_2 emissions in aviation may include (non-exhaustively):

- Contrails
- Oxides of nitrogen (NO_x) and products of their interaction with other gases such as ozone (O_3) and methane (CH_4)
- Carbon monoxide (CO)
- Water vapour (H_2O)
- Sulphur compounds, including sulphur oxides (SO_x) and sulphate aerosols
- Particulates, soot, and unburnt hydrocarbons (HC)
- Hydrogen (H_2)

Complex interactions exist between emission types, and their climate impacts vary in persistence and duration. Addressing these priority areas will reduce uncertainty in the fundamental science and deliver technologies to mitigate or prevent harmful non-CO_2 emissions during flight.

Examples of progress since programme launch:

The ATI Non-CO_2 Programme launched in 2025 following the development of the roadmap. Recipients of funding have included:

© OXFUEL: An ATI-funded project exploring how OXCCU's innovative SAF formulations reduce soot and particulate emissions, a major driver of persistent warming contrails.

Project MIST, led by Honeywell in collaboration with Boeing and the University of Reading, is aiming to advance in-flight sensing capabilities to improve the accuracy of contrail forecasting.

ROADMAP STRUCTURE

The Non-CO_2 Technologies Roadmap has three streams of activity:

Fuel characteristics

Research on the introduction and ramp-up of SAF and other alternatives, including hydrogen, adaptations to kerosene specifications to improve non-CO_2 performance and optimised operational use of hybrid fuel combinations.

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Aircraft technologies

Research on instrumentation and sensing for emissions measurement and management; systems and controls related to the use of hydrogen, including water-vapour release; engine controls or combustion developments; and technologies to manage hybrid or dual-fuel systems.

© Airbus

Knowledge, data and operations

Research on modelling, measurement, and data correlation activities; atmospheric understanding of particulates and contrail formation; NOx interactions at altitude; water vapour from hydrogen use; and data management systems for flight operation mitigations and through-life modelling.

NON-CO$_2$ TECHNOLOGIES ROADMAP

2025 | 2030 | 2040

FUEL CHARACTERISTICS (FOSSIL, SAF, H2 OR ALTERNATIVES)

- Modelling / testing of fuel hydro treating / de-sulphuring influence
- Modelling / testing of SAF particulates influence
- Modelling / testing of fuel aromatic content influence
- SAF pathways data for trade studies
- Drop-in versus non-drop-in SAF data for trade studies
- Modelling / testing of optimal SAF blends utilisation logic
- Modelling / testing of hybrid fuels utilisation logic
- Fuel optimisations based on findings

AIRCRAFT TECHNOLOGIES

- Emission management instrumentation
- Water vapour release systems and controls
- Engine combustion
- Engine controls
- Fuel management technologies for hybrid and dual fuel systems
- Techonology enablement based on findings

KNOWLEDGE, DATA & OPERATIONS

- Data to inform particle size as nuclei for contrails
- Modelling / testing of NO_x at cruise altitude
- Modelling / testing of water vapour from H_2 combustion
- Modelling / testing of water vapour from H_2 fuel cells
- Modelling / testing of combustion correlation with contrails
- Through-life modelling of emissions
- Climate data to understand CO_2 and non-CO_2 trades
- Data management systems for flight operations
- Operational testing / implementation based on findings

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AIRCRAFT EMISSIONS AND THEIR CLIMATE INTERACTIONS

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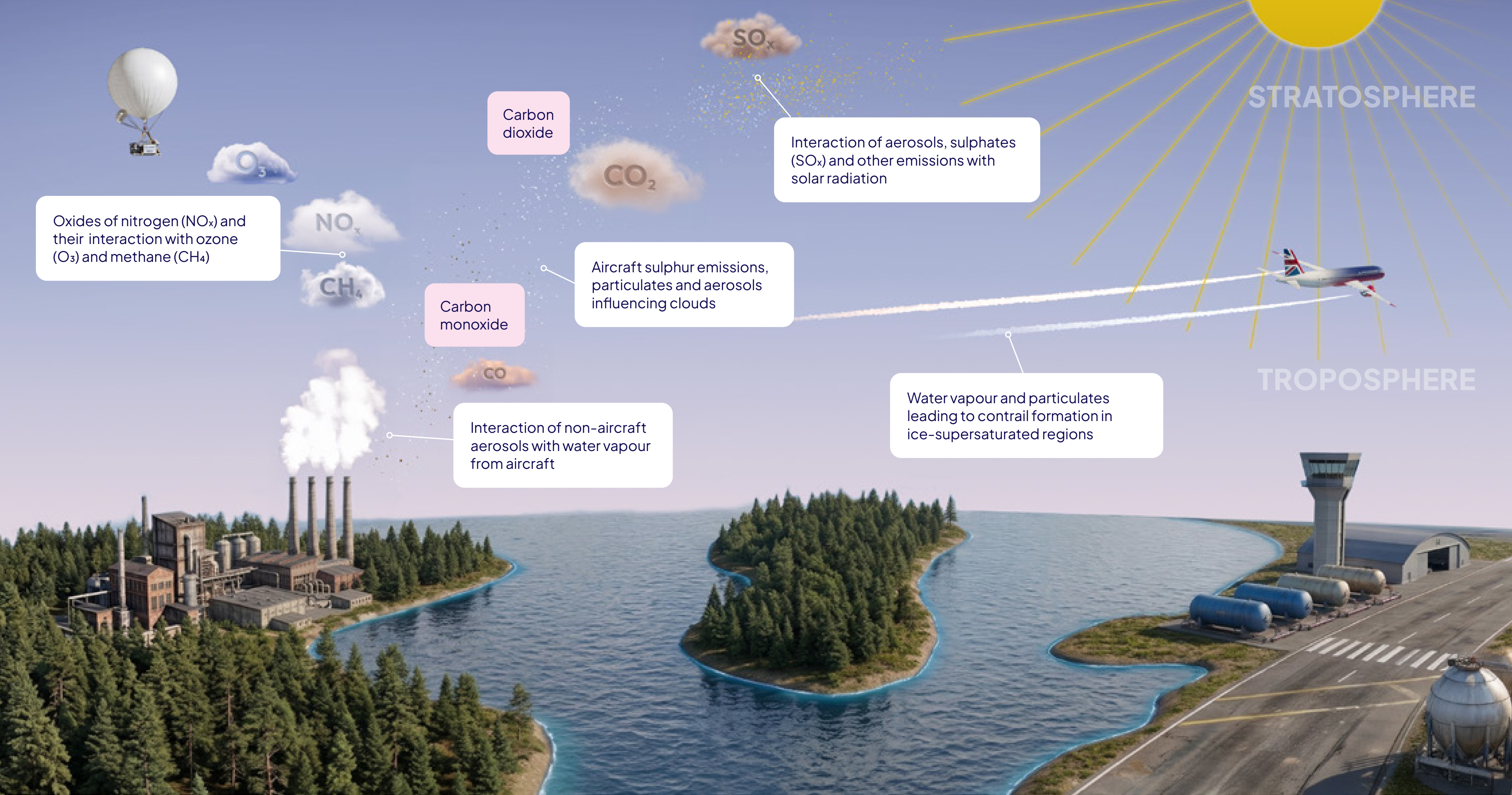
Aircraft emissions have complex and varying levels of direct and indirect radiative effects on the climate that are likely to result in a warming impact. Aircraft technologies and operational changes hold the potential to manage, avoid or reduce aviation's climate impact.

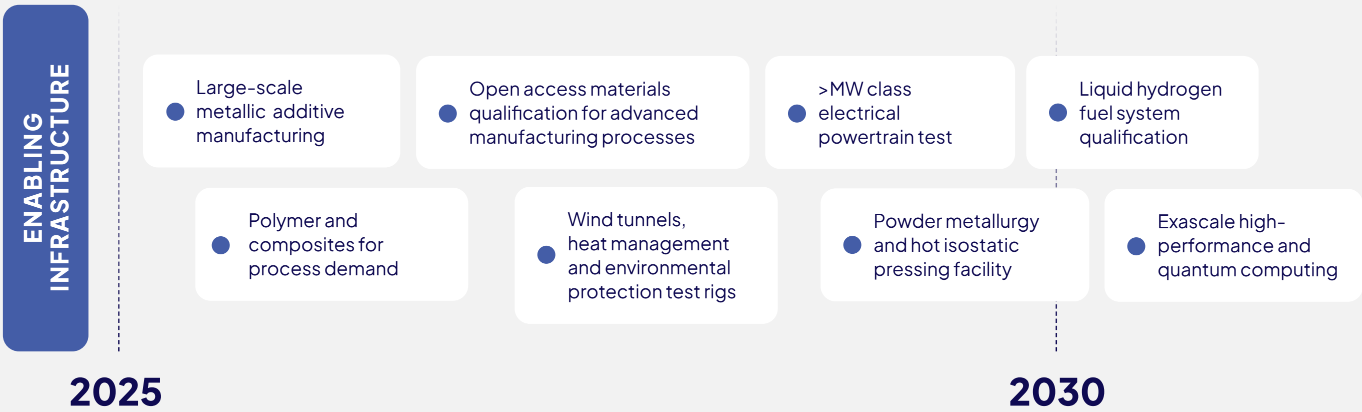


INFRASTRUCTURE

In discussions with industry, the ATI has identified key infrastructure capabilities currently absent in the UK that are needed to realise technology development ambitions and unlock future aerospace value. These include sovereign production facilities for advanced materials and manufacturing techniques, electrical power systems, test rigs and digital qualification facilities.

Although infrastructure projects (figure 6) may be supported by the ATI Programme, their potential scale sits outside the core programme scope, so they are not specifically identified on the technology roadmaps. However, as important enablers with multi-sectoral applications (e.g. defence, energy, medical), the ATI will work with other stakeholders and complementary funding bodies towards progress in these areas.

Figure 6: Enabling infrastructure



SECTION SUMMARY

- Ultra-efficient technologies target fuel burn reductions through improved aerodynamics, propulsion, advanced systems and aerostructures. These technologies have the greatest return on investment and decarbonisation benefits to 2050.
- The UK supply chain needs to reach unprecedented rates to retain and win business on new aircraft programmes. Adoption of technologies and processes to boost capability and productivity will be critical enablers to success.
- Zero-carbon technologies focus on energy storage and fuel systems, and power distribution and control. Technology development needs to be matched by regulation and infrastructure to maximise returns.
- Increasing understanding of harmful non-CO_2 effects and how to mitigate them is essential to decreasing aviation's impact on the environment.

INVESTING IN A SUSTAINABLE FUTURE FOR AEROSPACE

This chapter outlines how public and private investors can use the technology roadmaps to target investment beyond the ATI Programme and how the ATI will provide investment and leadership, in collaboration with partners, to maximise our success.

THE WIDER FUNDING LANDSCAPE

In addition to the ATI Programme, the UK aerospace sector has access to diverse funding at national, regional, local and international levels. Key national calls include those delivered through Innovate UK's Innovation Funding Service, while local investment grants may be available from Mayoral Combined Authorities and councils; the ATI, Regional Aerospace Associations and Trade Associations can help explain and guide applicants through the regional differences.

EU funding for aerospace is delivered through Horizon Europe, including the Clean Aviation Joint Undertaking and related programmes supporting the transition to climate-neutral aviation, competitiveness and technological sovereignty. The ATI works alongside UK Research and Innovation (UKRI) to help UK organisations align with and maximise participation in these opportunities.

UK government-backed institutions such as the British Business Bank and the National Wealth Fund, alongside support provided by devolved governments across the UK, stimulate longer-term investment, including beyond TRL 6, with a return for investors and the UK economy. In addition, the ATI works with the sector to develop market-led investment propositions to attract potential investors, partners and buyers to the UK, and supports innovators and investors with private equity and venture capital opportunities including through the ATI Hub. Public funding and ATI-backed validation can play an important role in attracting private capital.

STRUCTURE OF THE UK ECOSYSTEM

To reach its full future potential the UK aerospace sector requires investment from a breadth of sources alongside, and beyond, the funding provided by the ATI Programme. As well as significant presence from all of the 10 biggest global aerospace industrials, the UK ecosystem is home to companies owned and backed by many of the world's largest investment funds, sovereign wealth funds and numerous other forms of ownership and investment. However, with the major growth forecast across the sector, there remains a major role for further private and public investment.

Of the nearly 3,000 businesses participating in the sector, 95% are SMEs. Over two thirds of the output of those organisations is exported, making the UK sector 10.8% of all global aerospace exports. The UK aerospace sector continues to improve its efficiency and effectiveness and has delivered over 3% productivity growth consistently since 2014, the highest of any developed nation in the industry.

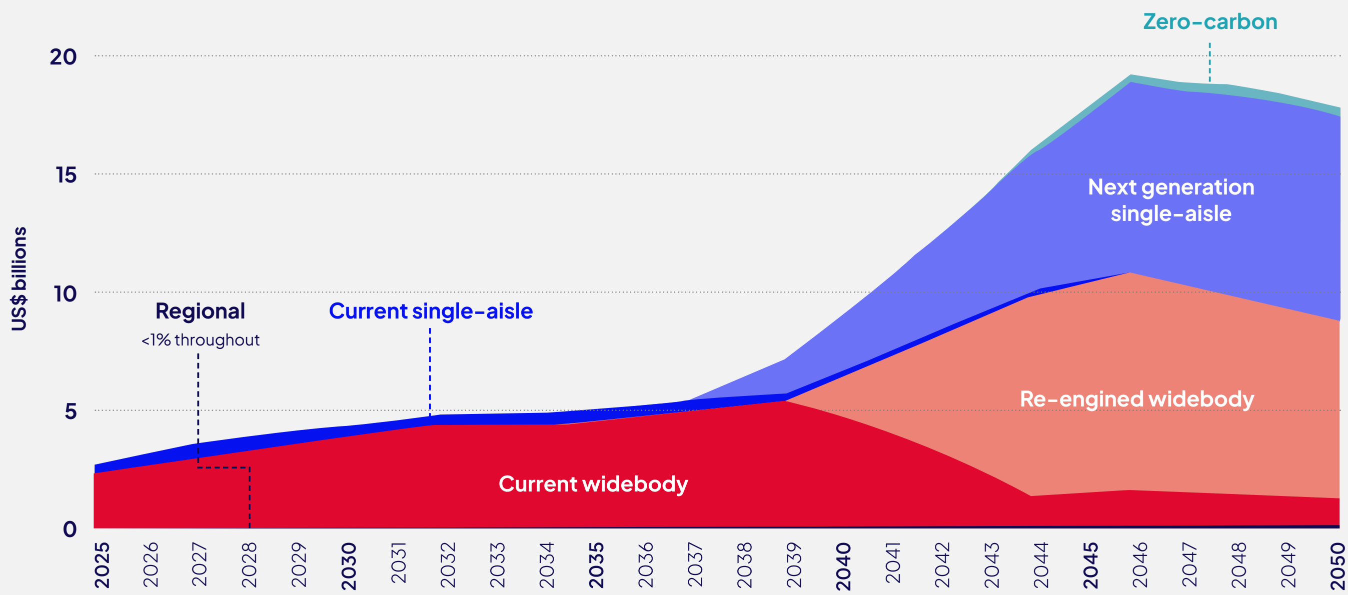
In its funding decisions, the ATI Programme evaluates technical, market and business viability and has consistently acted as a signal for private investment in innovation. A good example of this is the ATI's SME Programme. Since opening in 2024, the SME Programme has awarded £23.9m grant funding to 31 projects, including 29 unique SMEs. This grant funding has been matched by an additional £11.9m in industry investment. Around 30% of the SMEs that were awarded ATI funding subsequently raised private capital, totalling over £65m in equity capital post-ATI award. Many of those organisations cite ATI backing as a key factor for investors. This represents a collective investment of over £100 million in innovative SMEs over a 2-year period.

PRIORITY TARGETS FOR INVESTMENT

Opportunities on next generation aircraft fall into three broad categories: propulsion, aerostructures and systems. The technology itself, and the ability to produce it competitively, are key, and investments in digitalisation, automation and advanced manufacturing capabilities are crucial for lifting UK supply chain productivity.

PROPULSION

Figure 7: UK propulsion annual market share and opportunity (2025 - 2050)

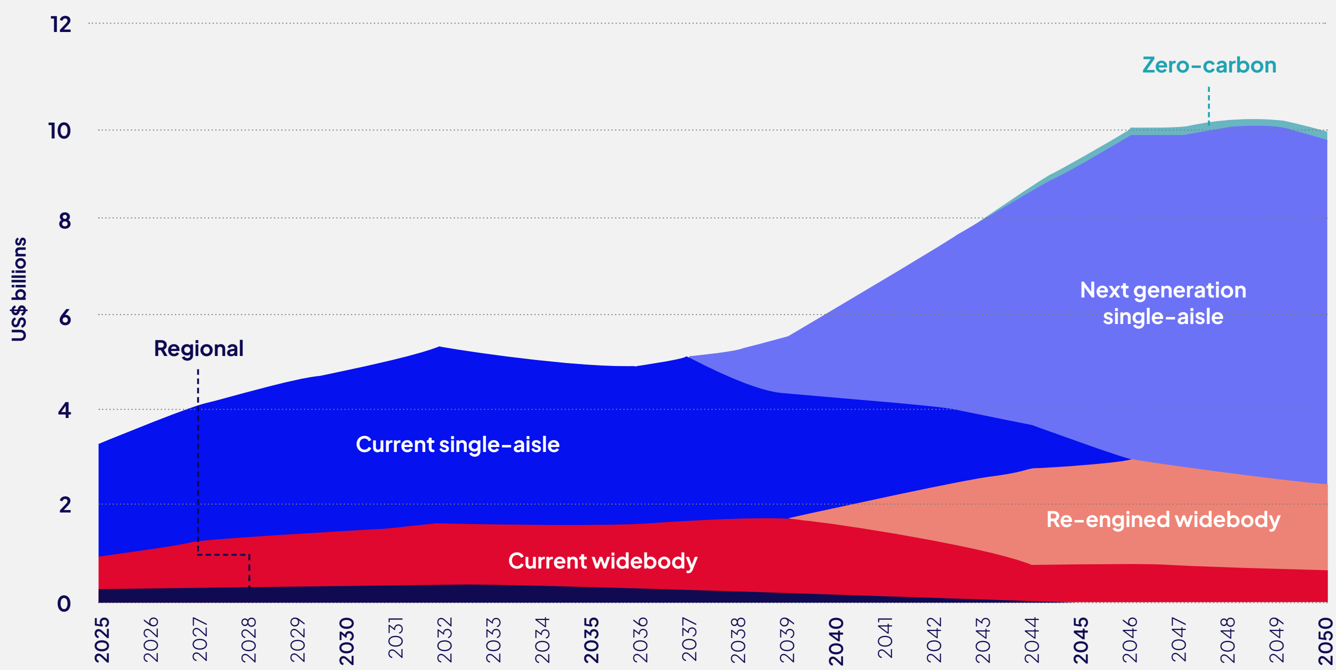


The UK's biggest market opportunity lies in winning propulsion workshare on next generation single-aisle aircraft, as current aircraft are powered by CFM Leap and Pratt & Whitney PW1000G engines, with limited UK components. UK engines feature more heavily on widebody aircraft with UK-manufactured propulsion products valued at around $2.6 billion in 2025, excluding aftermarket and in-service support.

As airframers trade engine efficiency against integration complexity, ultra-high-bypass ratio turbofan engines (such as Rolls-Royce's UltraFan) will be evaluated alongside open-rotor designs (such as CFM-RISE). The UK's expertise as one of only two countries in the world that have large civil whole-engine design and manufacturing capability, is key to retaining and growing workshare on future programmes. Targeted investments in these areas could increase the total value of UK propulsion by a factor of six over the next 25 years to over $17 billion.

AEROSTRUCTURES

Figure 8: UK aerostructures annual market share and opportunity (2025 - 2050)



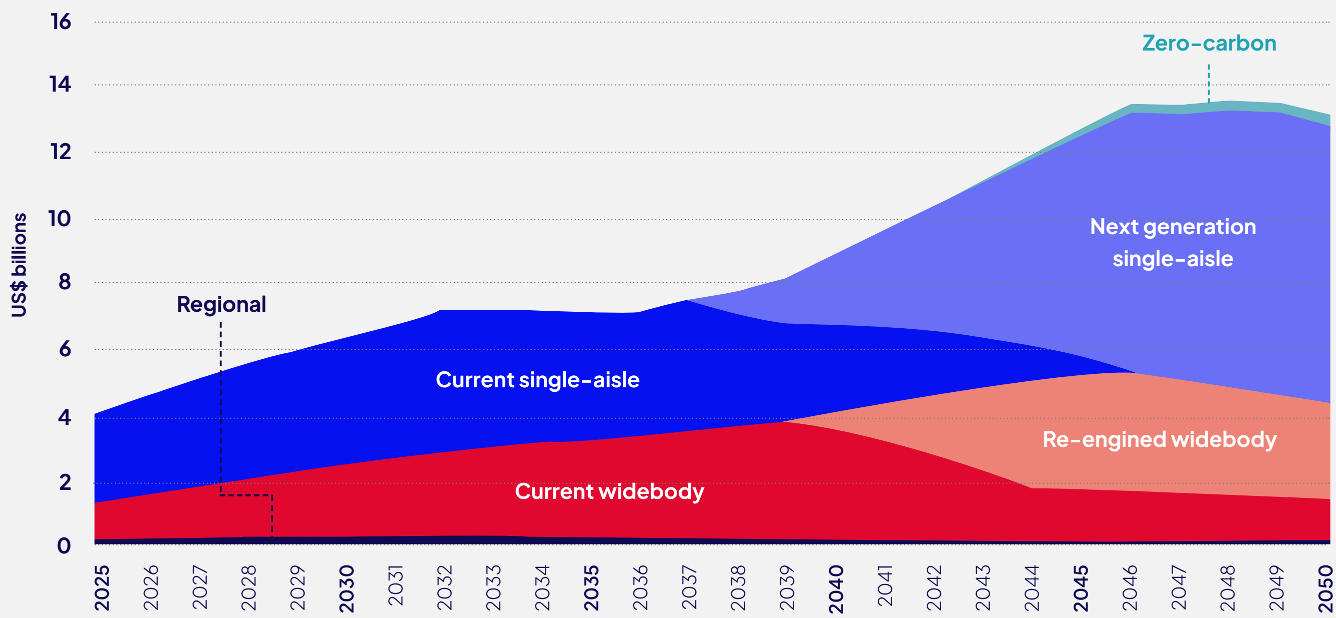
The value of UK-manufactured aerostructures was $3.3 billion per annum in 2025 and could grow to $9.7 billion by 2050, underpinned by investments in advanced design and manufacturing technologies that enable higher aspect ratio, more aerodynamically efficient wings with lower fuel consumption and emissions.

With 50 percent of the world's wings coming out of Airbus's UK operation, the UK has a strong base for this growth ambition, but future composite wings will require additional investment in materials, tooling and high-rate manufacturing processes to maximise high-value wing component manufacture in the UK. Targeted support for advanced metallic materials, including raw material processing and additive manufacturing, is also important.

© NCC 2026 FibreLINE at National Composites Centre

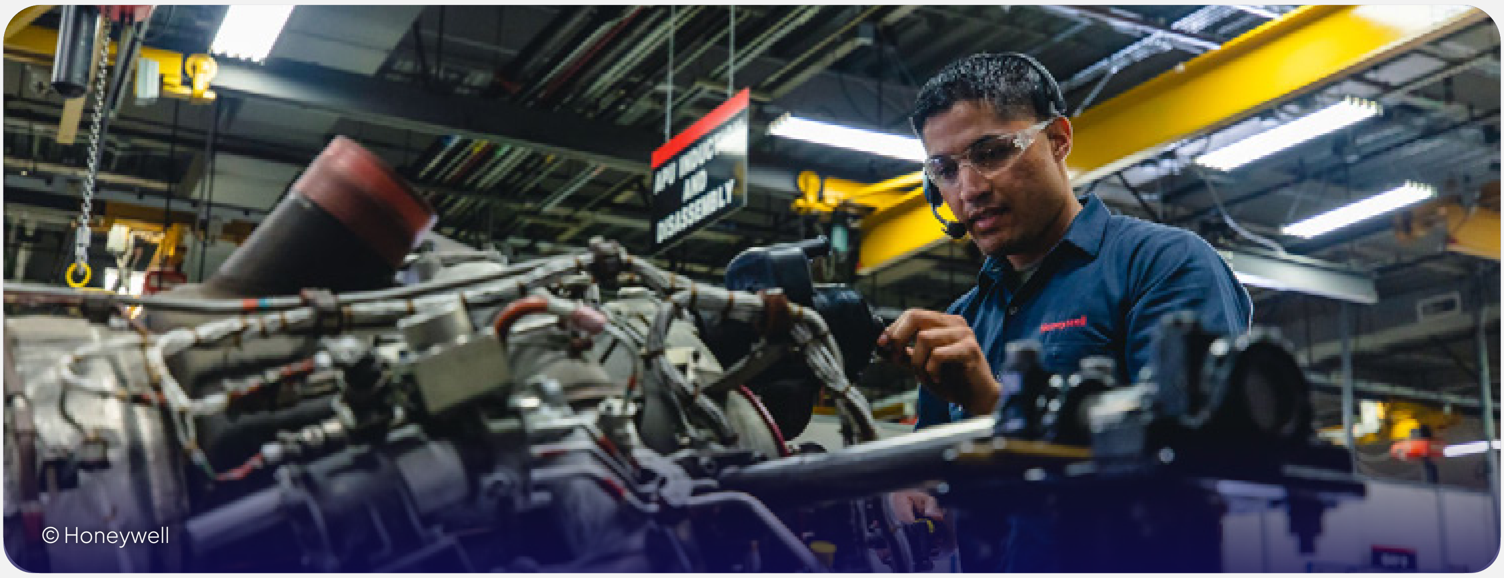
AIRCRAFT SYSTEMS

Figure 9: UK systems annual market share and opportunity (2025 – 2050)



The UK has deep expertise in the design and manufacture of diverse aircraft systems, including electrical systems, landing gear, fuel systems, actuation, thermal management and avionics. Major aerospace OEMs and primes such as BAE Systems, Collins Aerospace, Safran, Honeywell, Parker-Meggitt and Eaton are supported by a strong SME base. New start-up and scale-up organisations are also showing world-leading potential alongside the UK's vibrant university ecosystem.

As aircraft architectures move towards more-electric systems, hybrid electric propulsion and increasingly integrated architectures, the complexity and value of onboard systems is increasing. This creates a substantial opportunity for the UK to both protect existing workshare worth approximately $4 billion per annum in 2025, while expanding into emerging areas, with the potential to grow to $13 billion by 2050.



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BUILDING SOVEREIGN CAPABILITY IN ADVANCED COMPOSITE MANUFACTURE

© iCOMAT. Founded as spin-out from the University of Bristol, iCOMAT has developed and commercialised Rapid Tow Shearing (RTS) for composites. This novel manufacturing process enables high-rate, low-cost production of lightweight structures.

Over recent years, iCOMAT has transitioned from an R&D-led SME into an industrial manufacturer, establishing multiple production facilities in the UK and the US. The company is now moving from technology validation to global industrial scaling, supplying production components for civil and defence aerospace platforms.

Public sector funding played a pivotal role in de-risking and accelerating this journey and leveraging further private investment. ATI-funded projects helped mature their RTS systems into an industrially deployable process, providing independent validation of cost, rate and quality advantages using real manufacturing data. This credibility, combined with growing customer traction, underpinned significant inward investment, including a landmark £16.7m Series A round led by international investors, the largest ever in composites manufacturing.

"ATI's support has been instrumental in helping iCOMAT bridge the gap between breakthrough research and industrial reality. It gave both us and our investors the confidence to accelerate manufacturing scale-up and build a globally competitive capability in the UK."

— Dr Evangelos Zympeloudis, Founder & CEO, iCOMAT

SECTION SUMMARY

- Additional investment into the sector will be needed beyond the ATI Programme to reach four times growth by 2050. There is a strong business case for targeted public and private sector investment.
- The wider funding landscape offers support to aerospace companies and help is available to navigate it.
- The impact of public funding, including through the ATI, can be multiplied as it helps to leverage private finance.
- Investment, leadership and collaboration are needed to achieve the ambitious goals set out in this strategy. ATI will work with the rest of the sector to deliver success.

DELIVERING FOR THE SECTOR

This strategy provides a blueprint for sustainable economic growth in UK aerospace and sets the direction for technology development to 2050. Achieving the goals set in this strategy will require investment, leadership and collaboration across the ecosystem.

The ATI is committed to delivering for the sector across:

INVESTMENT

The ATI Programme will invest in projects delivering economic and sustainability benefits to the UK. We will also work with public funding sources and private investors to highlight the business case for additional investment into priority capability areas.

LEADERSHIP

To support sector growth, the ATI will develop and share independent market intelligence and technical insight to help organisations across the UK understand where they can benefit from emerging opportunities. Through publications, the ATI Toolkit, events and more, we will boost innovation and help organisations of all sizes to thrive in the sector.

COLLABORATION

To maximise sector potential, the ATI will work closely with partners across the wider innovation and investment landscape, including public and private bodies, to unlock barriers to UK competitiveness and align funding, regulation, policy and decision-making with the capability priorities identified in this strategy. Where it will boost sector competitiveness and readiness, the ATI will also support government to attract inward investment and bolster UK company growth by improving access to finance and connecting firms with potential investors.

MONITORING PROGRESS

This strategy sets an ambitious target for UK aerospace sector growth. Key to our success will be understanding the progress we are making and responding to factors that might drive us off course. The ATI will publish a report of progress against the strategy annually in June, including recommendations for action. This will be combined with our annual reporting on the ATI Programme.