

Department
for Transport

Jet Zero Strategy

One Year On



Department for Transport
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We are committed to decarbonising aviation and delivering Jet Zero

Last year we published our world-leading Jet Zero Strategy setting out the government's approach to achieving net zero 2050 (or "Jet Zero") for UK aviation. The Strategy focuses on the rapid development of technologies in a way that maintains the benefits of air travel, whilst maximising the opportunities that decarbonisation brings for the UK.

Since then, we've made significant progress in the delivery of our commitments, most notably:

- UK leadership helped secure a ground-breaking new goal for international aviation of net zero by 2050, sending a vitally important policy signal to the global market.
- We have published our second SAF mandate consultation and are delivering a further round of the Advanced Fuels Fund, crucial milestones towards achieving our aim for the UK to be a world leader in the development, production, and use of SAF.
- And most recently, the government response was published to the "Developing the UK Emissions Trading Scheme" consultation, with a range of new commitments for aviation, including a net zero consistent cap and aviation free allocation phase-out by 2026.

However, we know there is still so much more to do. Achieving Jet Zero is hugely challenging, and we need all parts of the sector to play their part. Through our well-established partnerships such as the Jet Zero Council, we must continue to deliver, and ensure we use the Jet Zero transition to unlock the benefits of green aviation technology for the UK.



Vere of Norbiton

Baroness Vere of Norbiton
**Minister for Aviation,
Maritime and Security**



Executive Summary

It is critical that the aviation sector plays its part in delivering the UK's net zero commitment and the government is already supporting a variety of technology, fuel and market-based measures to address aviation emissions.

The One Year On highlights our key successes in the past year across the three guiding principles and six core policy measures, outlining our next steps to achieve Jet Zero and the challenges we must overcome to get there.



The government remains committed to achieving Jet Zero, whilst being flexible over the pathway to achieve it. We continue to be guided by our three strategic principles of: **international leadership, delivered in partnership and maximising opportunities**; and our six core policy measures of: **system efficiencies, sustainable aviation fuels (SAF), zero emission flight (ZEF), markets and removals, influencing consumers**, and **addressing non-CO₂**.

International leadership is crucial given the interconnected global nature of the sector. Last year, the UK played a leading role in influencing adoption by the International Civil Aviation Organization (ICAO) of a new global goal for international aviation of net zero CO₂ emissions by 2050. We are now working towards the ICAO 3rd Conference on Aviation Alternative Fuels (CAAF/3) in November, where we want to agree a global target and framework for SAF.

Government cannot deliver Jet Zero alone, which is why over the past year we have continued to **deliver in partnership** with industry, academia and NGOs, including through the Jet Zero Council which has published Two-Year Plans for the work of the Council's SAF and ZEF Delivery Groups.

In transitioning to Jet Zero, we also need to make sure we **maximise opportunities** to grow new industries and technologies, and by protecting and creating jobs across the entire sector and UK.

We are focusing our efforts on unlocking the potential of a UK SAF industry and growing the UK's aerospace sector through continued R&D support to develop more efficient and zero emission aircraft through the Aerospace Technology Institute (ATI) programme.

We have also made significant progress across our six core policy measures.

Improving **system efficiencies** of our existing airspace, aircraft and airports remains a key foundation of our approach. In the last year, we published a Call for Evidence on our 2040 Zero Emission English Airports target, co-invested in the development of new ultra-efficient emission aircraft technology through the ATI programme and provided over £9m of financial support to the UK's Airspace Modernisation programme.

Sustainable aviation fuel (SAF) is crucial to our efforts to decarbonise, and we want the UK to be a global leader in its development, production and use. Some key successes this year include launching the £165m Advanced Fuels Fund to support the development of commercial scale SAF plants within the UK, publishing the second SAF mandate consultation, and publishing Phillip New's report on 'developing a UK SAF industry' alongside a government response, all as part of our efforts to support investment in UK SAF production.

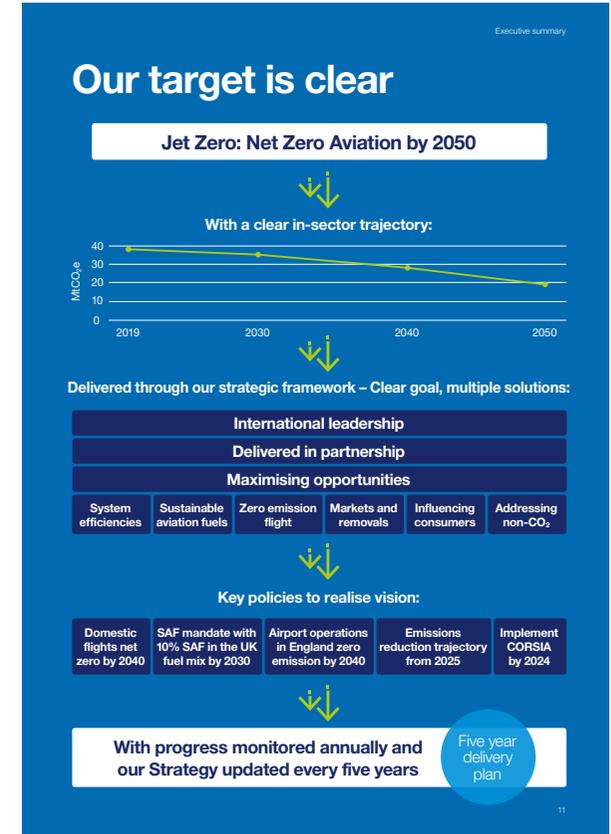
We also continue to see significant potential for **zero emission flight (ZEF)** in decarbonising the sector. We continued to co-invest in new zero-carbon emission aircraft technology through the ATI programme, and supported research into airport preparedness for handling hydrogen aircraft through £4.2m of funding to the Zero Emission Flight Infrastructure (ZEFI) Project.

We continue to consider that **carbon markets and removals** are essential levers for reaching Jet Zero. Some highlights from the past year include negotiating to uphold the environmental integrity of ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), publishing the government response to the Developing the UK Emissions Trading Scheme consultation, and supporting the development of greenhouse gas removals technologies.

Influencing consumers is a further important strand of our approach; we want to preserve the ability for people to fly, whilst supporting consumers to make sustainable aviation choices. We have worked closely with the Civil Aviation Authority (CAA) to publish a Call for Evidence on what environmental information should be provided to consumers when they are looking for and booking flights.

Addressing non-CO₂ impacts of aviation remains challenging, given significant scientific uncertainty regarding the magnitude of their effects on the climate, though we have made progress in the last year. We have developed a programme of research to advance our understanding of aviation's non-CO₂ impact and identify mitigation options, and established a Non-CO₂ Task and Finish group as part of the Jet Zero Council.

Whilst our Jet Zero goal is clear, we recognise that **big challenges** remain. Reaching our goal relies on emerging technologies with varying degrees of uncertainty around their commercialisation and deployment; the production of SAF and hydrogen will rely on significant supplies of feedstock and green electricity, and we must make progress internationally to achieve emissions reductions from international aviation without competitive disadvantage for the UK, or carbon leakage. We will continue to work closely with industry, academia, NGOs, other states and across government to address these challenges as we deliver Jet Zero.



Key successes a year on from the Jet Zero Strategy



October

ICAO adopts net zero 2050 CO₂ emissions goal for international aviation

The UK played a leading role in the technical work and negotiations over the last four years leading to the International Civil Aviation Organization (ICAO) adopting a new global goal for international aviation of net zero CO₂ emissions by 2050, at its 41st Assembly in October 2022. This places the sector on a trajectory firmly aligned with the Paris Agreement's 1.5°C global temperature target. It provides clear and collective policy direction, will help draw investment in technology and infrastructure, and creates a platform for developing further specific international measures through ICAO.



January

ZeroAvia reaches key milestone for zero emission flight

In January, ZeroAvia conducted a successful test flight of a 19-seater Dornier 228 twin-engine aircraft using hydrogen fuel cell propulsion— a key milestone in the transition to zero emission commercial aviation. The flight was conducted as part of the HyFlyer II project, a research programme backed by the UK government to develop a zero-emission powertrain for 9–19 seat commuter aircraft. ZeroAvia is targeting bringing the aircraft into commercial service by 2025.



February

Launch of the 2040 Zero Emission Airport Target Call for Evidence

In February, we held the seventh Jet Zero Council meeting where we launched the 2040 Zero Emission Airport Target Call for Evidence. The Call for Evidence, covering airports in England, will enable us to address the challenges raised by industry, such as residual emissions which may result from specific equipment, as well as better understand any support needed to achieve this target. We also announced £113 million of co-investment in hydrogen and battery electric flight technologies through the ATI programme.

Key successes a year on from the Jet Zero Strategy



March

Significant progress on SAF

In March, we delivered a significant package of announcements on SAF including: publication of the second SAF mandate consultation, outlining the proposed detailed design of a scheme that will seek to generate demand for SAF, provide an incentive to SAF producers and deliver carbon savings; launching a further round of the Advanced Fuels Fund, making a further £55.8m available to support UK SAF projects through to construction; and announcing the University of Sheffield as the delivery partner for the UK SAF Clearing House.



April

Jet Zero Council publishes Two-Year Plan

In April, we held the eighth Jet Zero Council meeting where we published the government response to Philip New's report on 'Developing a UK SAF industry', which sets out how the government is already taking action to address some of the report's recommendations, and what more could be done to secure meaningful investment in UK SAF production. In addition, the Council published its Two-Year Plan showing the action needed in the coming years to support the delivery of Jet Zero by 2050.



July

Government response to the UK ETS consultation

In July, we published the government response to the Developing the UK ETS consultation, setting out a range of commitments including a tighter emissions cap and the future of aviation free allocation. These commitments are intended to support a cost-effective approach to the aviation sector achieving net zero by 2050.

Part 1

Our 2050 trajectory



Rolls Royce easyJet hydrogen test engine.
Image courtesy of Rolls Royce.

Our UK net zero commitment

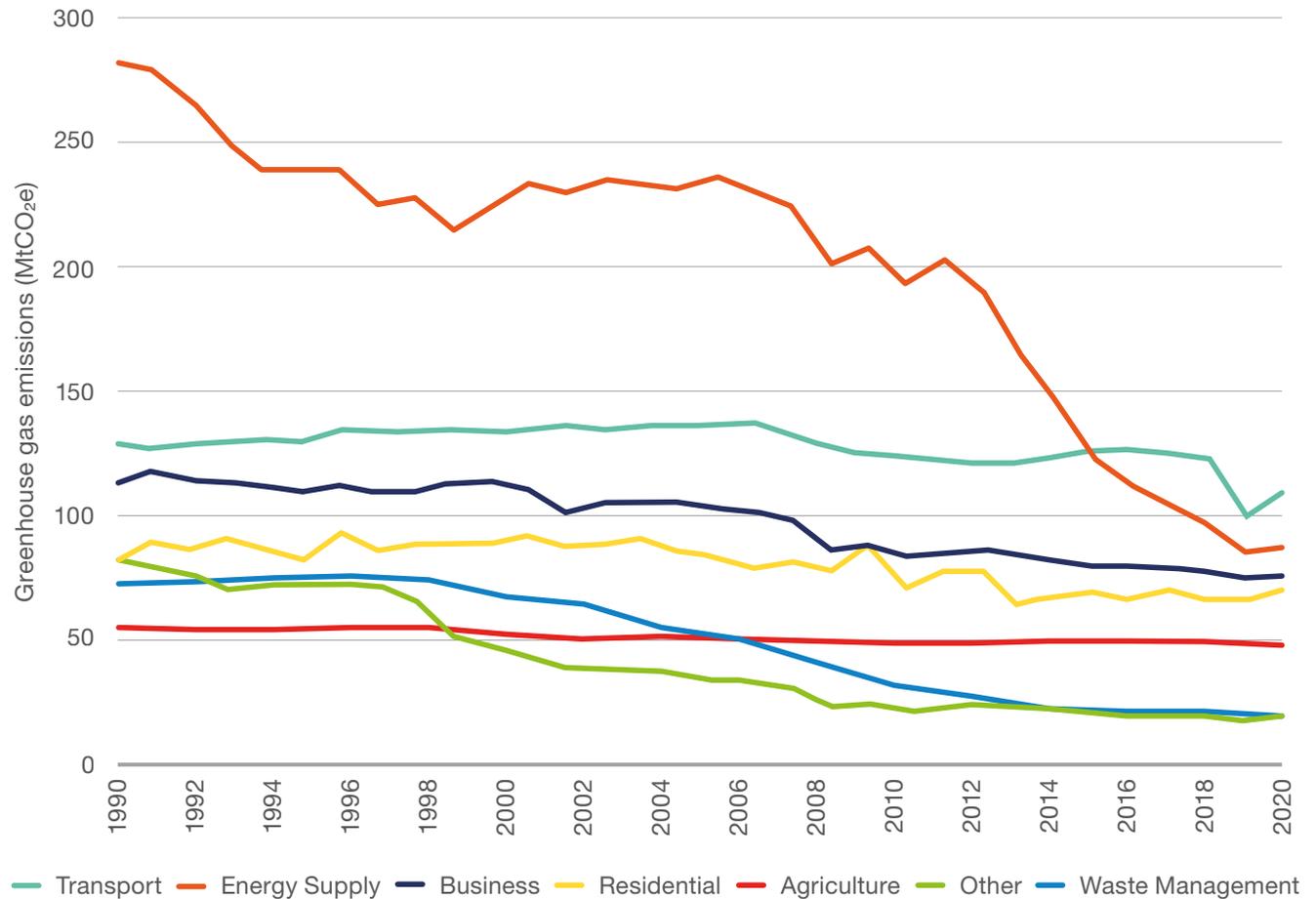
The government has continued to take major steps in driving the delivery of our net zero commitments across the whole UK economy, simultaneously providing new opportunities to grow the economy and support hundreds of thousands of green, high skilled jobs.

The UK has already made huge progress in decarbonising its economy and decoupling emissions from economic growth. Between 1990 and 2021, UK territorial emissions were cut by 48%, whilst the economy grew by 65%.

Over the past year the government has further set out the UK's approach to net zero and energy security, responding to the expert recommendations made in the *Independent Review of Net Zero*. The *Net Zero Growth Plan* – published as part of the wider *Powering Up Britain Plan* – sets out the actions the government will take to ensure the UK remains a leader in the net zero transition. The *Carbon Budget Delivery Plan* clearly lays out the policies and proposals that will enable us to meet carbon budgets.

It is in this context that aviation decarbonisation must take place, as we continue to transition to a sustainable future in which we maintain the benefits of air travel.

Territorial UK greenhouse gas emissions by National Communication (NC) sectors, 1990-2021 (MtCO₂e)



Source: Final UK greenhouse gas emissions national statistics 1990-2021 Excel data tables. **Note:** Other includes Public, Industrial Processes and the Land Use, Land Use Change and Forestry (LULUCF) sectors. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1134664/greenhouse-gas-emissions-statistical-release-2021.pdf.



Our CO₂ emissions reduction trajectory

Transport remains the largest emitting sector in the UK, and by 2035, aviation is expected to be one of the largest emitting transport modes.

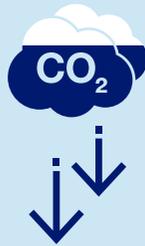
To generate momentum for reducing emissions in one of the most challenging sectors to decarbonise, we set a CO₂ emissions reduction trajectory in the Jet Zero Strategy. This sees UK aviation emissions peak in 2019, with interim targets of 35.4 MtCO₂e in 2030, 28.4 MtCO₂e in 2040, and 19.3 MtCO₂e in 2050.

The latest data from the Department for Energy Security and Net Zero greenhouse gas emissions statistics shows that **UK aviation activity and emissions remain below 2019 levels** due to the impact of the COVID-19 pandemic but are likely to continue to increase in the short-term as the sector recovers, making efforts to rapidly decarbonise vitally important.

In 2021, UK aviation greenhouse gas emissions were 14.0 MtCO₂e (13.3 MtCO₂e from international aviation and 0.7 MtCO₂e from domestic aviation) – 63% below 2019 levels, and a further **9% reduction on 2020 emissions.**

Provisional estimates for 2022 UK international aviation greenhouse gas emissions show that, as the sector began to recover throughout 2022, UK international aviation emissions increased to 26.0 MtCO₂e – a 95% increase on 2021 international aviation emissions, but **still 29% below 2019 levels.**

In-sector interim targets



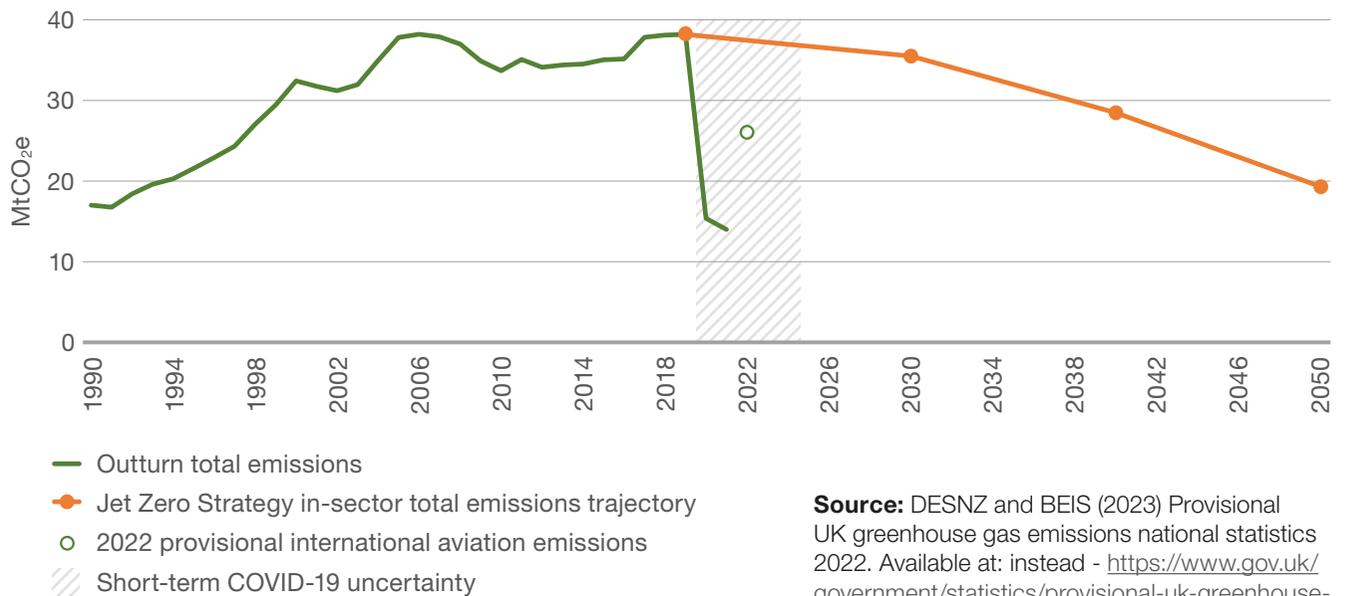
38.2 MtCO₂e in 2019

28.4 MtCO₂e in 2040

35.4 MtCO₂e in 2030

19.3 MtCO₂e in 2050

UK aviation emissions



Source: DESNZ and BEIS (2023) Provisional UK greenhouse gas emissions national statistics 2022. Available at: instead - <https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2022>.

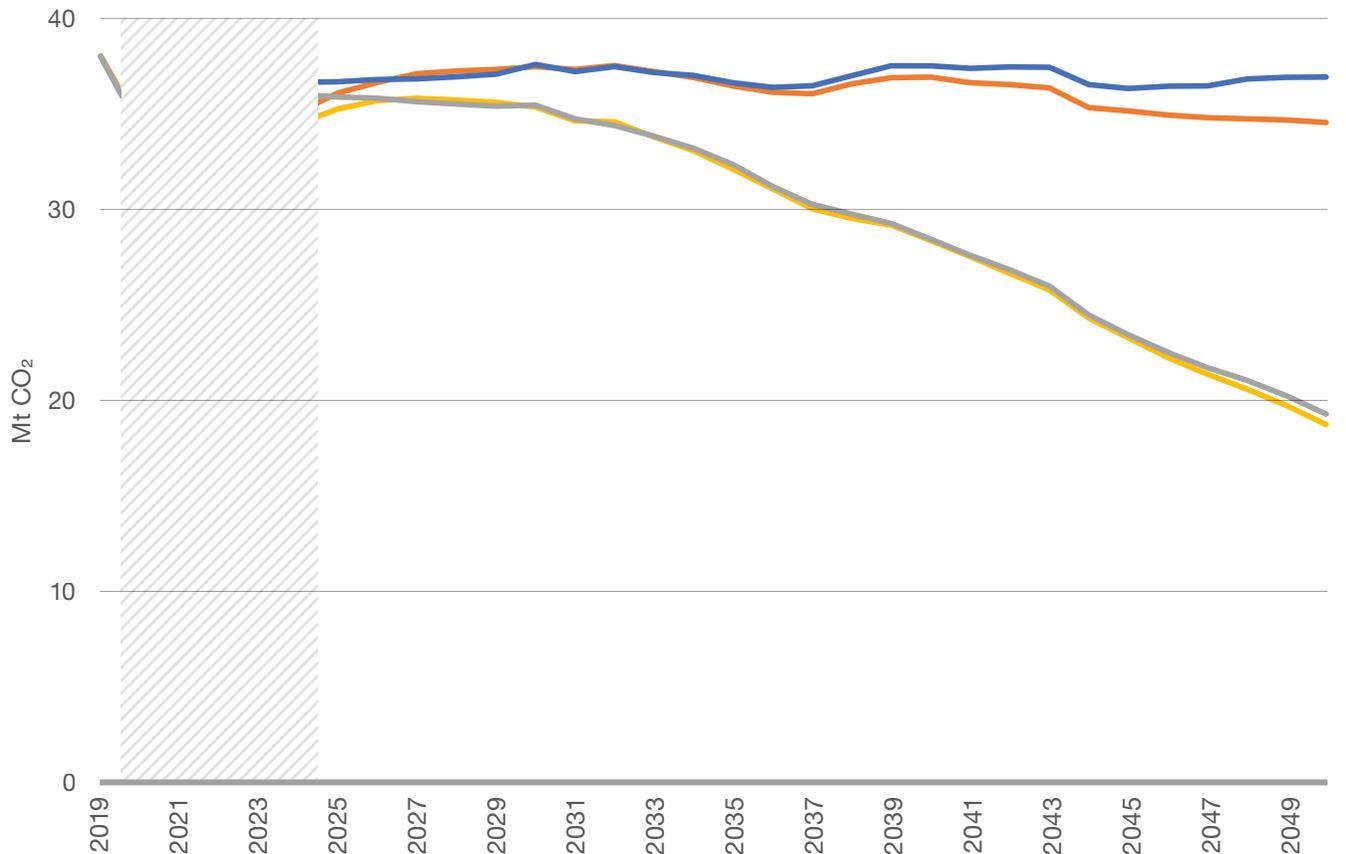
Our Jet Zero Strategy modelling

Our CO₂ emissions reduction trajectory is based on our Jet Zero Strategy High Ambition scenario, which sees a combination of fuel efficiency improvements, zero-emission aircraft, SAF and carbon markets reduce UK aviation emissions by 63% by 2050, with 37% of emissions to be abated outside of the aviation sector using greenhouse gas removal technologies.

This year, we have updated our scenarios to reflect the latest macroeconomic conditions, including updating inputs on oil prices, GDP and consumption growth, and foreign exchange rates. This has had the impact of reducing forecast passenger demand growth under our High Ambition scenario to 52% in 2050, relative to 2018 levels, compared to 70% in the published Jet Zero Strategy.

The updated High Ambition scenario has **18.7 MtCO₂e residual emissions in 2050** compared to 19.3 MtCO₂e in the original analysis. We will continue to keep our modelling under review in light of the latest data and new evidence as it emerges.

Updated Jet Zero Strategy analysis



Source: Internal DfT analysis undertaken to inform the Sustainable aviation fuel mandate consultation-stage cost benefit analysis (available at [UK sustainable aviation fuel mandate: consultation-stage cost benefit analysis \(publishing.service.gov.uk\)](https://www.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/115421/uk_sustainable_aviation_fuel_mandate_consultation-stage_cost_benefit_analysis_publishing_service.gov.uk)). These macroeconomic inputs are based on the latest release as of March 2023, from ONS, OBR, IMF, OECD and BEIS (preceding DESNZ).

- Continuation of Current Trends - Jet Zero Strategy version
- Continuation of Current Trends - Latest analysis
- High Ambition - Jet Zero Strategy version
- High Ambition - Latest analysis
- ▨ Short-term COVID-19 uncertainty

Monitoring and reviewing our progress to Jet Zero

We are committed to a data led approach in our policy making and we remain transparent in our modelling towards Jet Zero. We have also committed to reviewing progress against our CO₂ emissions reduction trajectory on an annual basis from 2025, once the sector has recovered from the short-term impacts of COVID-19.

In order to respond quickly to emerging trends and ensure transparency of information, through the Jet Zero Strategy we committed to publishing more timely aviation emissions data from 2023. In March, the government's annual provisional UK greenhouse gas emissions statistics for 2022 included estimates of international aviation emissions for the first time, reducing the time lag for official statistics on international aviation emissions by nearly a year.

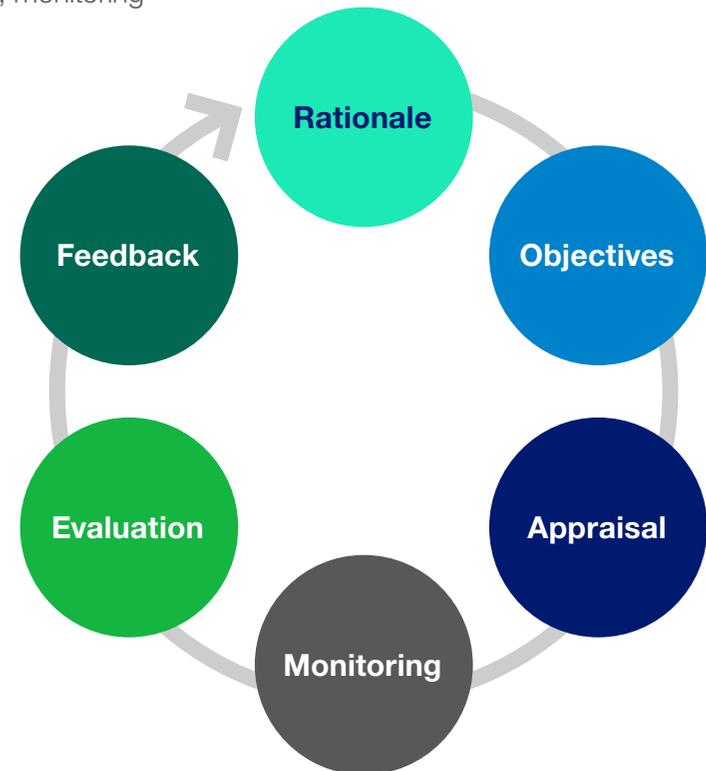
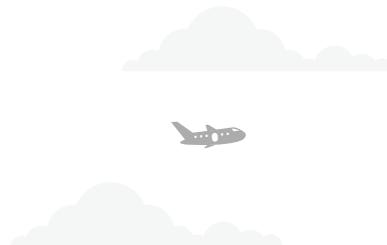
To further increase transparency, by December this year we plan to publish an explanation of available aviation emissions data and a comparison of different methodologies, alongside the CAA's UK Aviation Environmental report. This will include a short user engagement survey to better understand the public need for aviation emissions statistics and to inform future statistical development.

We will use this exercise to continue to explore the most appropriate methodology to monitor aviation emissions and use this to monitor the sector's progress against our emissions reduction trajectory.

We have committed to reviewing our Jet Zero Strategy every five years, with the first review in 2027. As part of this, we will review our overall strategic approach and associated Jet Zero scenarios.

To further our monitoring and to effectively track progress against our Jet Zero targets, we plan to produce a comprehensive monitoring and evaluation framework which will include suggestions for appropriate data collection methods, monitoring metrics, and evaluation activities.

As the Jet Zero Strategy contains a range of strategic principles and policy measures this adds complexity to evaluating the strategy and means we must sufficiently plan and prioritise monitoring and evaluation activity to develop a suitable approach. This framework will outline our future evaluation workplan, which will also feed into the five-year reviews of the Jet Zero Strategy.



Part 2

Progress against our strategic framework

A blue and white ZeroAvia aircraft, registration G-HFZA, is shown in flight against a clear blue sky with some light clouds. The aircraft is a twin-engine turboprop plane with a high-wing configuration. The tail features the word "HYDROGEN" written vertically. The ZeroAvia logo is visible on the fuselage. The aircraft is flying over a green field.

ZeroAvia flight using hydrogen fuel cell propulsion.
Image courtesy of ZeroAvia.

A clear goal, with multiple solutions

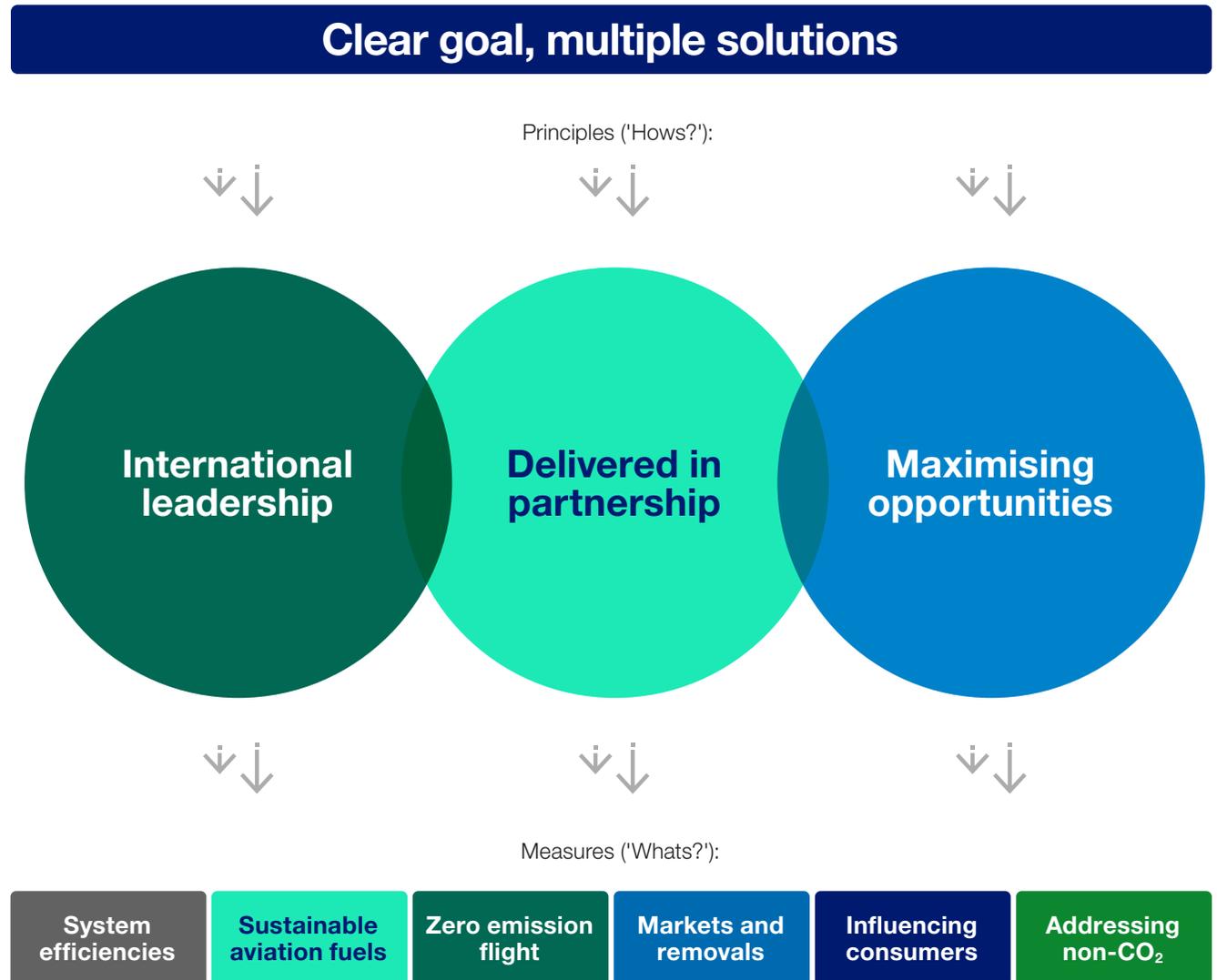
The government remains committed to achieving net zero aviation by 2050, whilst being flexible over the pathway to achieve it. We continue to use our strategic framework – a clear goal, with multiple solutions – to deliver on Jet Zero.

This publication reflects on progress across the three principles and six core policy measures set out in the Jet Zero Strategy.

We recognise that a range of technologies are likely to be required in parallel to reach net zero aviation in 2050. We have set out expectations of progress including mandating the use of at least 10% SAF in the UK jet fuel mix by 2030 and completion of the Airspace Modernisation programme by 2040.

Within our strategic framework we have also set an earlier target for UK domestic aviation to reach net zero by 2040. We know there are a range of opportunities for achieving the target, including across the technology pillars of SAF, zero emission flight and greenhouse gas removals. In due course we will launch a call for evidence on achievement of the target.

Our strategic framework ('Approach'):



Jet Zero Strategy Principles

**International
leadership**

**Delivered in
partnership**

**Maximising
opportunities**

International leadership

Given the interconnected global nature of the sector, international action is critical to achieving our Jet Zero ambitions. Through the International Civil Aviation Organization (ICAO) we are influencing global ambition and action on aviation decarbonisation.

Last year ICAO adopted a new global goal for international aviation of net zero CO₂ emissions by 2050, after several years of technical work and negotiations, in which the UK played a leading role. This places the sector on a trajectory firmly aligned with the Paris Agreement's 1.5°C global temperature target.

It provides clear and collective policy direction, will help draw investment in technology and infrastructure, and creates a platform for developing further specific international measures through ICAO. We are now working towards the ICAO 3rd Conference on Aviation Alternative Fuels (CAAF/3) in November, where we are aiming to secure a quantified target for the uptake of SAF that reflects its key role in meeting net zero by 2050.

Additionally, the International Aviation Climate Ambition Coalition, launched by the UK at COP26, provides a forum for coordination and collaboration between likeminded states. Its membership has now grown to 60 states from all world regions. The Coalition played an important role in securing the ICAO net zero by 2050 agreement, and we will continue to convene the Coalition and work to deliver our shared ambitions, for CAAF/3 and beyond.

We are also drawing on UK expertise to support other states tackle their emissions, as part of our commitment to the ICAO principle of 'No Country Left Behind'. The UK launched a pilot project in partnership with Kenya to assist states in East Africa in implementing CORSIA effectively. We are also one of the first participants in the ICAO Assistance, Capacity Building, and Training for Sustainable Aviation Fuels (ACT-SAF) programme and we will continue to play a leading role by expanding our CORSIA and SAF capacity building programmes to additional states in 2023.



Alok Sharma ICAO. Image courtesy of DfT



Delivered in partnership

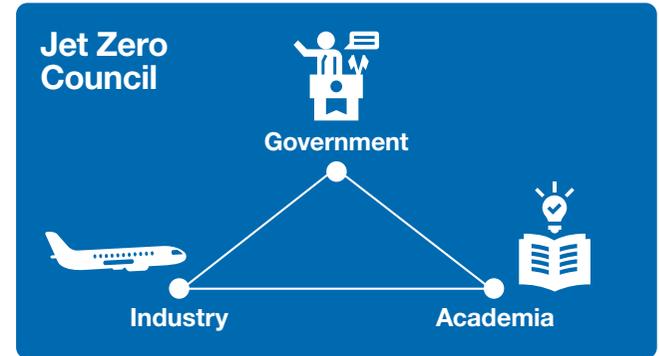
All parts of the sector must continue to work together to develop, test, implement and invest in the solutions needed to decarbonise aviation.

In the past year we have continued to strengthen the work of the Jet Zero Council, our key forum for partnership working between industry, government and academia. The council brings together senior leaders in aviation and aerospace to drive the delivery of new technologies and innovative ways to cut aviation emissions. The Council is now chaired by the Secretaries of State for Transport, Business and Trade, and Energy Security and Net Zero recognising the vital roles that all these sectors – aviation, aerospace and energy – will need to play in the Jet Zero transition.

The Council has met twice already in 2023, and the Council's Delivery Groups (focused on SAF and zero emission flight) have published their Two-Year Plan setting out the actions required to support Jet Zero by 2050. The Council has hosted four Jet Zero webinars to engage the wider community through our Jet Zero Council Associate Membership, showcasing the work of the Council and taking a deeper dive into the SAF mandate, aviation's non-CO₂ impact and airspace modernisation. Further webinars will take place this year, and the Council will meet again in the autumn.

In addition to the Jet Zero Council, we continue to work through other partnerships including the Aerospace Growth Partnership and the Aviation Council which is leading on Airspace Modernisation.

We are also working with the Airspace Change Organising Group (ACOG) and have now received draft Iteration 3 of their Masterplan (Scottish cluster), the coordinated implementation plan for airspace changes in the UK up to 2040. This is currently being reviewed by stakeholders and will be put out for public consultation over the summer prior to publication in the autumn.



Delivered in partnership case study

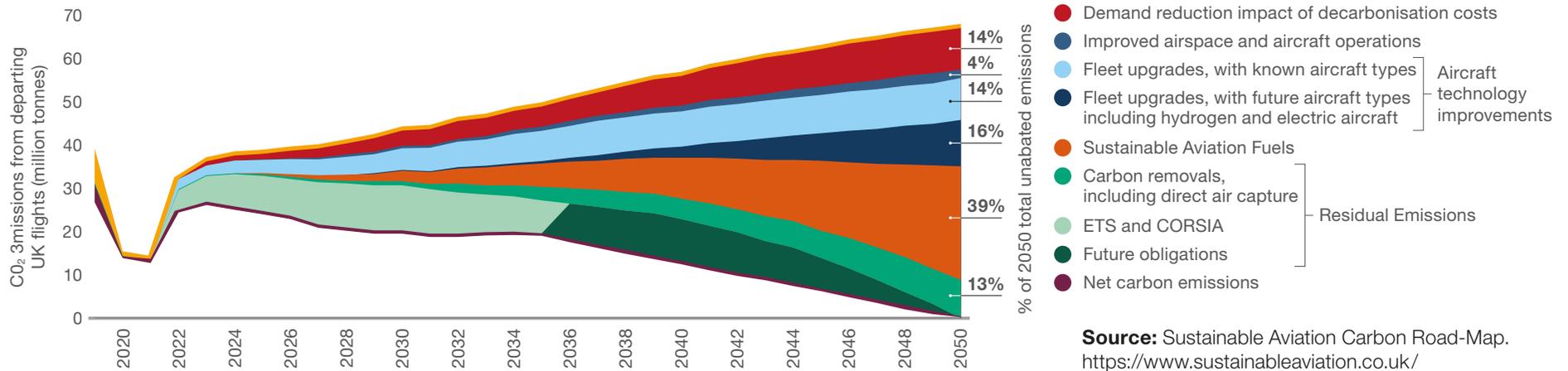
Sustainable Aviation Carbon Road-Map

In April, Sustainable Aviation, a coalition of UK airlines, airports, aerospace manufacturers, air navigation service providers, SAF producers and other key business partners, published their updated decarbonisation road-map. The updated road-map confirms that UK aviation can continue to grow whilst meeting its commitment to net zero carbon emissions by 2050, reflecting advances in sustainable aviation technology already delivered in the UK which will accelerate the industry's transition to net zero around the world.

The road-map forecasts UK aviation emissions to reach around 67 MtCO₂e by 2050, without any intervention. Their modelling suggests around 40% of these emissions could be removed using SAF, 33% by operational and fleet efficiency improvements, including moving to zero emission aircraft, 14% by reduced demand due to the additional costs of decarbonisation measures, and the remaining 13% of residual emissions by greenhouse gas removals (GGRs) outside of the aviation sector.

These measures are in line with those considered in our Jet Zero Strategy. Unsurprisingly, given the complexity of decarbonising the aviation sector and high levels of uncertainty, the contributions of individual measures do not align exactly with those implied by our modelling. Under the Jet Zero Strategy High Ambition scenario, 17% of the required emission reductions in 2050 come from SAF. 15% from fuel efficiency improvements, 4% from zero carbon aircraft, 27% from ETS and CORSIA and 37% from abatement outside the sector. We will continue to work with industry to identify the challenges and barriers we need to work together to overcome.

Sustainable Aviation Carbon Road-Map: A path to Net Zero



Delivered in partnership case study

MOD's Defence Aviation Net Zero Strategy

This summer the Ministry of Defence published their Defence Aviation Net Zero Strategy.

Emissions from military flying are not currently included in our Jet Zero Strategy or emissions reduction trajectory, however the new MOD strategy will bring defence in line with the Jet Zero Strategy approach and will lead the military activity necessary for the UK's Defence Aviation Sector to contribute to net zero by 2050, in line with wider Defence aspiration.

Defence is committed to playing its full part in the government's goal to reach net zero. The previous Chief of the Air Staff has also outlined his ambition for the RAF to act as a Defence leader in this area and become the first net zero air force by the year 2040. This provides an excellent opportunity for collaboration across government as we develop the new technologies required for Jet Zero.



Sustainable aviation fuel on voyager trail. Image courtesy of MOD

Delivered in partnership case study

General Aviation

The General Aviation sector is well placed to encourage the early adoption of innovative zero emission aircraft. In the last year we have commissioned and published independent research which provides an evidence baseline of the carbon emissions emitted by General Aviation activities, including a range of policy options for consideration.

The research concluded that General Aviation activity in the UK (in 2019) emitted approximately 800,000 tonnes of CO₂e (in comparison to 38.2 million tonnes of CO₂e emitted by the total aviation sector). Business aviation flights are responsible for approximately 75% of this total. The research also considered a number of high-level solutions that could help General Aviation achieve net zero by 2050. These include zero carbon aircraft, zero emissions ground vehicles, smart heating, lighting and energy management, smart runways and both on-site and off-site renewable energy generation.

We are working with the CAA, following their work with Open Innovation, to further develop policy options for providing support

to the General Aviation sector to assist them in reducing their environmental impact, including the potential for unleaded and SAF.

This will also include ensuring the General Aviation sector are kept apprised of policy developments on our work to decarbonise the commercial aviation sector.



General Aviation light aircraft that can be used as a test bed for new technologies. Image courtesy of Flickr account GH@BHD

Maximising opportunities

The transition to Jet Zero presents unique opportunities to grow new industries and technologies, and protect and create jobs across the entire sector and UK.

Alongside the Jet Zero Strategy we published the Jet Zero Investment Flightpath showcasing the UK's leading role in the development and commercialisation of new, low and zero emission aviation technologies, and the associated investment opportunities.

We continue to focus on the economic benefits of the Jet Zero transition. By 2030, a UK SAF industry could contribute £1.8bn in Gross Value Added (GVA), including upstream activities. This could increase to £10.1bn by 2050. Domestic production of SAF could also support 10,350 jobs by 2030 across the supply chain, rising to 60,000 in 2050.

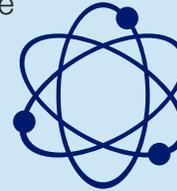
For zero emission flight, there are notable UK economic opportunities in relation to the design and manufacture of such aircraft or parts, as well as the expertise in rolling out zero emission flight infrastructure. The ATI's Flyzero project estimated that zero emission aircraft could constitute 50% of the global fleet by 2050 requiring 29,200 aircraft deliveries worth between \$1.9 to \$2.1tn.

We will continue to work with industry, investors and across government through the Jet Zero Council and other forums to ensure we maximise these opportunities and work together to address barriers to investment.

To ensure we have the right future aviation skills in place, we have commissioned independent research by Connected Places Catapult to determine what skills the workforce will need in order to fully integrate into all emerging aviation technologies, including decarbonisation. We will continue to explore what additional, aviation-focused research on future skills could be of value in supporting the industry's transition to Jet Zero.

The ATI's Flyzero project estimated that **zero emission aircraft** could constitute

50% of the global fleet by 2050



By 2030, a UK SAF industry could contribute £1.8bn in Gross Value Added (GVA), including upstream activities.

This could increase to **£10.1bn by 2050.**

Domestic production of SAF could also support 10,350 jobs by 2030 across the supply chain, rising to 60,000 in 2050

Note: Forecasts are based on independent analysis conducted by ICF consulting firm for the Sustainable Aviation Net Zero Carbon Road-Map 2023. The jobs and GVA figures are based on direct, construction and upstream jobs benefits. Analysis assumes UK SAF production costs are equivalent to wider global SAF production costs.



Jet Zero Strategy Policy measures

System
efficiencies

Sustainable
aviation fuels

Zero emission
flight

Markets and
removals

Influencing
consumers

Addressing
non-CO₂

System efficiencies

Continuing to realise efficiencies from our airspace, aircraft and airports remains a key lever in decarbonising the sector in the near term.

Under our Jet Zero Strategy High

Ambition scenario, **system efficiencies deliver 15% of the reduction in UK aviation emissions** required to meet Jet Zero



In the past year, we have...

- Published a Call for Evidence on our 2040 Zero Emission Airport target which seeks views on the scope and design of achieving zero emissions at airports in England.
- Industry and government have co-invested £105m in the development of new ultra-efficient aircraft technology, such as high aspect ratio wings and lightweight composite structures, through the ATI programme. These technologies could be applied to improve the energy efficiency

of future SAF or zero-carbon emission aircraft. We also co-invested £147m in cross-cutting and enabling technologies, such as digital design and optimising material utilisation, that underpin both ultra-efficient and zero-carbon aircraft opportunities.

- Agreed and provided UK expertise for a new workstream within the ICAO Committee on Aviation Environmental Protection to update the stringency of the international standard for aeroplane CO₂ emissions by 2025.
- Provided over £9m of financial support to the Airspace Modernisation programme as part of the government's continued commitment to both supporting recovery in the aviation sector post-pandemic, and to our net zero decarbonisation aims.
- Worked with the CAA to publish the refreshed Airspace Modernisation Strategy, extending the Strategy to 2040 and reaffirming our commitment to delivering this key infrastructure programme.
- Worked with NATS who have implemented Free Route Airspace above Wales and South West England, saving 12,000+ tonnes of CO₂/year and 150,000 nautical miles of flying, which is the equivalent of seven trips around the world.

Next, we plan to...

- Publish an independent research project later this year, to understand the commercial feasibility of adopting zero carbon technologies required to reach zero emissions airport operations by 2040. This report will provide further evidence on the viability of the 2040 target and give an increased understanding of the requirements, timeliness and costs of infrastructure adaptation.
- Analyse responses to the Call for Evidence on the Zero Emission Airport Operations Target, publish a summary of responses, and the government response and publish a consultation early next year, setting out our proposals for implementing the target.
- Continue to support the development of ultra-efficient manufacturing processes and technologies through the ATI programme.
- Implement Free Route Airspace across the North of England in autumn 2025, and over London and the South East in autumn 2026.

System efficiencies case study

Rolls-Royce tests on the new UltraFan engine

The Rolls-Royce UltraFan demonstrator aeroengine – the largest in the world – proves a suite of new technologies that deliver greater fuel efficiency and can be scaled to suit both narrow and wide body markets.

Its greater efficiency and sustainability is achieved through a combination of new engine and core architecture, composite fan technology, lean burn combustor, and power gearbox. UltraFan can be 25% more efficient than the first-generation Trent and offers 40% less NOx, 35% less noise and almost zero non-volatile particulates at cruise.

UltraFan is designed to be future-proof, ready to run on 100% SAF from day one and with scope to develop into hybrid-electric and hydrogen variants. The cutting edge technologies in UltraFan reduce fuel burn and therefore the cost of flying whatever the fuel mix in the future; SAF, hydrogen, hybrid-electric and traditional jet fuel. Many of these technologies can be retrofitted into Trent engines to increase efficiency and reduce the environmental impact of today's engines too.

Importantly, development of the UltraFan has been accelerated through partnership between Rolls-Royce and the UK government via the ATI programme. This partnership draws on and strengthens the UK's world-leading aerospace R&D ecosystem, including universities, industry partners, SMEs, and research centres, and grows the next generation of skills the UK needs to deliver the energy transition in aviation and beyond.



Rolls Royce UltraFan in the final build stage.
Image courtesy of Rolls Royce

Sustainable Aviation Fuel



Our vision is for the UK to be a global leader in the development, production and use of SAF, helping us to achieve Jet Zero.



In the past year, we have...

- Launched the £165m Advanced Fuels Fund to support the development of commercial scale SAF plants within the UK. Five projects have already been awarded a share of £82.5m and we are now considering applications for the second round of funding. This competition drives our ambition to see at least five commercial-scale SAF plants under construction in the UK by 2025. Once operational, the five projects alone will produce over 300,000 tonnes of SAF each year and create thousands of green jobs across the UK.

- Announced Virgin Atlantic as the winner of up to £1m of government grant funding to run the world's first transatlantic flight on 100% SAF, from London to New York.
- Published the second SAF mandate consultation, outlining the proposed detailed design of a scheme that will seek to generate demand for SAF, provide a financial incentive / price support to SAF producers and deliver carbon savings.
- Appointed the University of Sheffield as the delivery partner for the UK SAF Clearing House, supported by Ricardo, to accelerate the testing and approval of new SAF.
- Commissioned and published Phillip New's report on 'developing a UK SAF industry' alongside a government response which sets out how we are already taking action to address some of the report's recommendations, and what more could be done to secure meaningful investment in UK SAF production.
- Further progress the consideration of options for additional revenue certainty for a UK SAF industry. This would need to be provided via an industry funded intervention and if required, we will launch a formal government consultation later this summer.
- Negotiate to secure strong outcomes from the ICAO 3rd Conference on Aviation Alternative Fuels (CAAF/3) in November, including a quantified target for the global uptake of SAF that reflects its key role in meeting net zero by 2050, and a robust framework to support states with its development and deployment.
- By the end of 2023, publish the government response to the second SAF mandate consultation and support Virgin Atlantic to successfully operate the world's first transatlantic flight on 100% SAF, from London to New York.
- Build on the success of the *Clean Skies for Tomorrow* SAF Ambassadors Group by utilising the group to further support our international SAF ambitions.
- In 2025, bring the SAF mandate into force and complete the funding period for projects supported by the Advanced Fuels Fund.

Next, we plan to...

- In Summer 2023, launch the UK SAF Clearing House to begin supporting the testing and approval of innovative new fuels. We will also announce the winners of the second application round of the Advanced Fuels Fund.

SAF case study

Investment wins

In December 2022, the first round of the £165m Advanced Fuels Fund awarded a share of £82.5m to five projects:

alfanar Energy Ltd (Lighthouse Green Fuels, Teesside)

Developing a commercial scale plant that uses gasification and Fischer-Tropsch technology to convert black bin bag waste into SAF. The plant is expected to be operational in 2028 and produce 86.6 kt/y of SAF when at full operational capacity.

Fulcrum BioEnergy Ltd (NorthPoint, Ellesmere Port)

Developing a commercial scale plant that uses gasification and Fischer-Tropsch technology to convert black bin bag waste into SAF. The plant is expected to be operational in 2027 and produce 83.7kt/y of SAF when at full operational capacity.

LanzaTech UK Ltd (DRAGON, Port Talbot)

Developing a commercial scale plant that converts industrial off-gases into ethanol and then uses alcohol-to-jet technology to produce SAF. The plant is expected to be operational in 2026 and produce 79kt/y of SAF when at full operational capacity.

Velocys Plc (Altaito, Immingham)

Developing a commercial scale plant that uses gasification and Fischer-Tropsch technology to convert black bin bag waste into SAF. The plant is expected to be operational in 2028 and produce 37.4kt/y of SAF when at full operational capacity.

Velocys Plc (e-Alto, location tbc)

Developing a large demonstration plant that uses power-to-liquid technology to convert carbon dioxide from a fossil gas-powered electricity plant and hydrogen made from renewable electricity into SAF.



Baroness Vere at Alfanar's Teesside project. Image courtesy of Alfanar

Zero Emission Flight

Zero Emission Flight is a technically challenging endeavour however the last year has seen a number of exciting developments.

Under our Jet Zero Strategy High



Ambition scenario
Zero Emission Flight delivers 4% of the reduction in UK aviation emissions required to meet Jet Zero

In the past year, we have...

- Co-invested £119 million with industry in the development of new zero-carbon emission aircraft technology, such as high-end batteries and liquid hydrogen combustion jet engines, through the ATI programme. We also co-invested £147m in cross-cutting and enabling technologies, such as digital design and optimising material utilisation, that underpin both ultra-efficient and zero-carbon aircraft opportunities.
- Seen Rolls-Royce and easyJet undertake a ground demonstration of a hydrogen powered gas turbine. With support from government: Rolls-Royce launched projects to develop a liquid hydrogen combustion jet engine; in January ZeroAvia initiated flight testing of a Dornier 228 aircraft using a hydrogen-electric engine and Cranfield Aerospace Solutions are preparing to commence a programme to flight test their hydrogen-electric aircraft in early 2024.
- Supported research into airport preparedness for handling hydrogen aircraft through £4.2m of funding to the Zero Emission Flight Infrastructure (ZEFI) Project. The findings from the projects second year were published by Connected Places Catapult in March 2023, setting out operational changes and infrastructure requirements needed for different airport archetypes to successfully adopt hydrogen powered flight.
- Building on the recommendations of the FlyZero project, government is now funding the initial phase of a Hydrogen Capability Network. Led by the ATI, the Phase 0 project aims to define the operating model for a group of open-access facilities designed to accelerate the development of liquid-hydrogen aircraft technologies and capabilities.

Next, we plan to...

- Continue to co-invest in new zero-carbon aircraft technology development projects through the ATI programme.
- Support the CAA through £939,150 of funding from the Government's Regulatory Pioneers Fund to initiate a Hydrogen Regulatory Challenge to enhance the understanding of hydrogen-related risks to aviation safety.
- Take forward work in the Jet Zero Council's Zero Emission Flight Delivery Group's recently published Two Year Plan.
- This summer, announce projects successful in the Tees Valley Transport Hydrogen Hub competition. Following a successful phase one, the Hub's phase two is co-locating supply (hydrogen fuel and refuelling infrastructure) and demand (vehicles). The Hub is already creating significant levels of industry interest, with BP and Protium Green Solutions announcing their intentions to build large scale green hydrogen production in the area.



Zero emission flight case study

Project NAPKIN

The New Aviation Propulsion Knowledge and Innovation Network (NAPKIN), a coalition of manufacturers, airports and universities, published a report in November 2022 on the potential for hydrogen as a fuel for zero emission flight, with a focus on modelling the introduction of zero emission aircraft into regional and short-haul aviation within the UK. Part of Innovate UK's Future Flight Challenge – a five-year programme with £300m of joint government and industry funding – the report took a whole systems approach to understand the UK Zero Emission Flight challenge, covering technology challenges, market conditions and infrastructure requirements. The report's findings support the feasibility of the Jet Zero Strategy's ambition to have zero emission flight in the UK by 2030 and net zero UK domestic aviation by 2040 target. The findings of the project may be found on the Heathrow Airport Limited website here:

[NAPKIN | Heathrow](#)





Markets and removals

The UK remains a leader in the establishment and development of carbon markets and views carbon pricing and greenhouse gas removals (GGRs) as essential levers for reaching net zero. They play an important role for aviation given the challenge of zero emission technology.

Under our Jet Zero Strategy High Ambition scenario, **the impact of carbon pricing delivers 27% of the reduction in UK aviation emissions** required to meet Jet Zero

Greenhouse Gas Removals will address the residual 37% emissions outside the aviation sector



In the past year, we have...

- Negotiated to uphold the environmental integrity of ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSA) at its first Periodic Review, with offsetting expected to begin from 2024.
- Introduced legislation setting out a near-term approach to the offsetting requirements of CORSA in the UK.
- Published the government response to the Developing the UK Emissions Trading Scheme consultation, which includes a tighter overall emissions cap and aviation free allocation phase-out by 2026.
- Confirmed that we believe the UK ETS is an appropriate long-term market for GGRs, subject to robust monitoring, reporting and verification and the management of wider impacts.
- Expanded the scope of the UK ETS to include flights from Great Britain to Switzerland.
- Confirmed that the government intends to develop a GGR business model to support a portfolio of UK GGR projects to deploy this decade, based on a 'contracts for difference' structure, subject to value for money considerations.
- Announced in the Net Zero Growth Plan that government is minded to enable engineered GGR projects to apply for both Track-1 Expansion (ie mid-2020s) - and Track-2 (ie by 2030) of the Carbon Capture, Usage and Storage Programme subject to criteria under development.
- Launched a pilot project in partnership with Kenya under the ICAO capacity building programme to assist East African states in implementing CORSA.

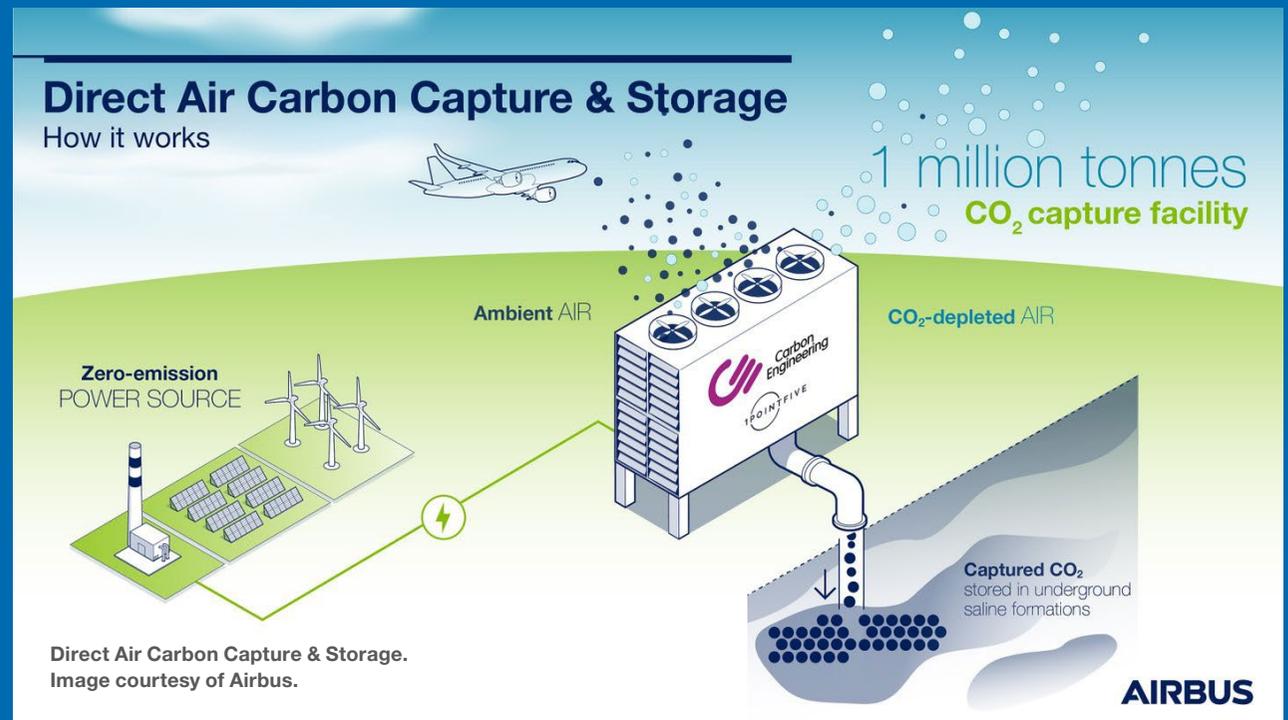
Next, we plan to...

- Continue to support CORSA and begin moving to strengthen the scheme, working through ICAO's next Periodic Review (to be concluded in 2025).
- Publish a second consultation on CORSA, including interaction with the UK ETS, seeking to have all legislation to implement CORSA in place by 2024.
- Develop proposals for consultation through the UK ETS Authority on how the UK ETS should treat the use of SAF by aircraft operators in future.
- Aim to carry out a further consultation in 2023 on the inclusion of engineered and nature-based GGRs in the UK ETS, through the UK ETS Authority. This will address market design and eligibility requirements alongside other relevant considerations.
- Consider further how the UK ETS should cover aviation's non-CO₂ climate impacts.

Markets and removals case study

Airbus and Direct Air Carbon Capture and Storage

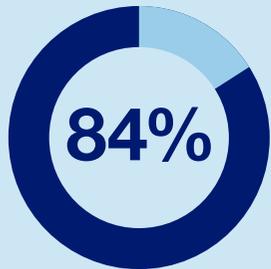
Airbus and a number of major airlines – including easyJet, International Airlines Group, and Virgin Atlantic – signed Letters of Intent last July to explore opportunities for a future supply of carbon removal credits from direct air carbon capture technology. Direct Air Carbon Capture and Storage (DACCS) is a high-potential technology that involves filtering and removing CO₂ emissions directly from the air using high powered fans. Once removed from the air, the CO₂ is safely and permanently stored in geologic reservoirs. As the aviation industry cannot capture CO₂ emissions released into the atmosphere at source, a direct air carbon capture and storage solution would allow the sector to extract the equivalent amount of emissions from its operations directly from atmospheric air. As part of the agreements, the airlines have committed to engage in negotiations on the possible pre-purchase of verified and durable carbon removal credits starting in 2025 through to 2028.



Influencing consumers

We are clear that we want to preserve the ability for people to fly whilst supporting consumers to make sustainable aviation choices.

Our public attitudes tracker shows that **84% of people are concerned about climate change,**



and up to 68% of respondents would be willing to pay more for flights using greener alternatives.



In the past year, we have...

- Worked with the CAA in publishing their Call for Evidence on what environmental information should be provided to consumers when they are looking for and booking flights. The Call for Evidence closed in April and we are currently analysing response.
- Undertaken a cross-sector literature review on eco-labelling to understand what factors influence consumer behaviours.
- Asked car users to indicate whether they travelled to airports in an electric car through the CAA's Departing Passenger Survey recognising the government's wider ambitions to increase the use of electric cars. In time this will allow government and airports to track the % of electric vehicle use by passengers over time and help monitor progress in improving surface access.

Next, we plan to...

- Work with the CAA to publish a consultation on environmental information provision setting out our proposed approach and methodology for implementation.
- Through our engagement with airports, we will continue to encourage them to work with airlines, local authorities and local transport providers to consider how they can develop integrated service offerings with surface transport providers. Our expectations are that airports, through their surface access strategies, set targets for sustainable passenger and staff travel to the airport which meet where possible the ambitions set by government and for these to be monitored by their respective Airport Transport Forums. Improvements to surface access to airports are generally funded by the airports themselves.



Influencing consumers case study

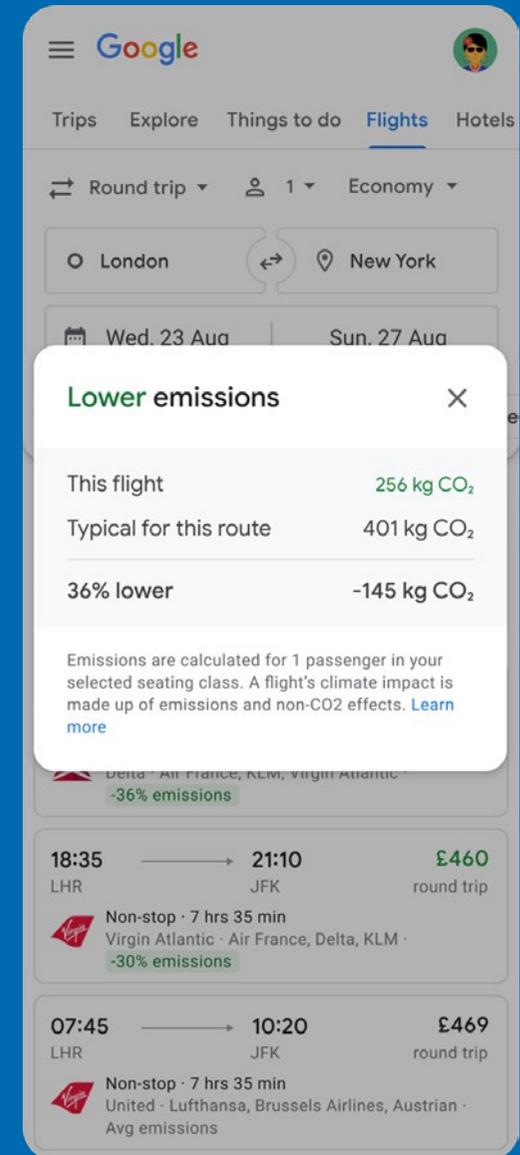
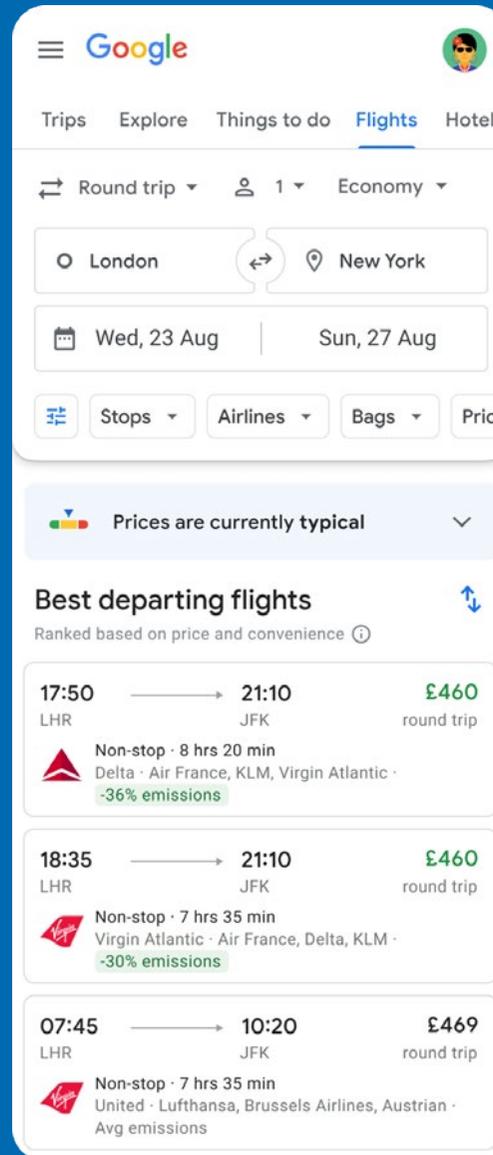
Google's Travel Impact Model

Google has been displaying flight emissions information to travellers alongside the price and duration of the flight since 2021. When users are choosing among flights of similar cost or timing, they can also factor carbon emissions into their decision to make an informed choice. Google's internal research shows that consumers find it helpful to be presented with clear, accurate, consistent, transparent and easy-to-understand information about kg/CO₂ of their flight options.

It's critical that travellers can find a single, rigorous answer about their air travel emissions footprint no matter where they want to research or book their trip. Therefore, in 2022, Google made the methodology used on Google Flights publicly available as the [Travel Impact Model \(TIM\)](#). The Travel Impact Model is a public and freely-accessible methodology for predicting the per-passenger CO₂ emissions produced by an upcoming flight. The model combines flight's origin and destination, aircraft type, cabin class, seat configuration, load factors and average aircraft utilisation to estimate CO₂ emissions per flight and per passenger. Today, the Travel Impact Model powers emissions estimates on Google Flights, as well as other leading travel sites through Google's work in the [Travalyst](#) coalition.

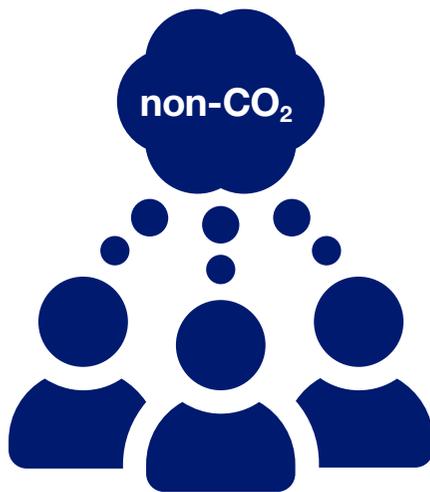
For any inquiries please contact:
jsoosova@google.com

Google's Travel Impact Model.
 Images courtesy of Google.



Addressing non-CO₂

Whilst the impact of CO₂ emissions are well understood and can be quantified, academic research shows that there continues to be significant uncertainty regarding the magnitude of aviation's non-CO₂ impacts on the climate.



In the past year, we have...

- Launched Expressions of Interest (EOIs) for two DfT-funded research projects. The first of these projects will support a literature review of existing research on aviation's non-CO₂ impacts and evaluate methodologies for measuring aviation's non-CO₂ impacts, with a view to shaping further research and mitigation options. The second project will investigate the impact of reducing the aromatic content of kerosene on contrail formation.
- Worked closely with academics, industry, and the Natural Environmental Research Council (NERC) to scope out a multi-year research programme to further develop our understanding of aviation's non-CO₂ impact and identify mitigation options.
- Established a Non-CO₂ Task and Finish group as part of the Jet Zero Council. The first meeting took place in June. The group will be supporting the government's non-CO₂ research programme and also looking to collectively accelerate the work on addressing aviation's non-CO₂ impact.

- Continued to fund scientific research into aviation's non-CO₂ climate effects through our contract with Manchester Metropolitan University. An important recent publication that in part used HMG funding "A greenhouse gas balance for aviation in line with the Paris Agreement".
- Responded to calls for evidence on the development of the UK Emissions Trading Scheme (UK ETS), including exploring whether and how aviation's non-CO₂ climate impact could be included in the UK ETS.

Next, we plan to...

- Further develop the multi-year non-CO₂ research programme in collaboration with NERC and initiate the research projects. The projects will seek to improve our understanding of aviation's non-CO₂ impact as there continues to be significant uncertainty regarding the magnitude of these impacts. Through this project we will also seek to identify, better understand, and develop potential options for addressing aviation's non-CO₂ impact such as using SAF, hydrogen, and contrail avoidance technology.
- Undertake further work on how non-CO₂ impacts could be monitored and included in the UK ETS, in line with our aim to price aviation's non-CO₂ climate impact once scientific understanding and consensus permit.



Addressing non-CO₂ case study

Airbus non-CO₂ projects

Airbus is actively working on a large portfolio of projects focused on improving the scientific understanding of non-CO₂ emissions, reducing uncertainties and creating strategies and operating procedures to reduce their climate impact. They are also evaluating and developing solutions which include SAF and Hydrogen fuels, improvements to engines, and optimising flight operations. Current work streams include measuring emissions and their impacts on contrail formation using different types of engine technologies and fuels including through the use of 100% SAF.

In preparation for operational scenarios for contrail avoidance, Airbus is leading a SESAR project CICONIA. This explores the hypothesis that re-routing aircraft around the worst-case ice supersaturated regions at high altitude will minimise the generation of the most warming contrails. CICONIA aims at providing a complete picture of the operational non-CO₂ mitigation strategies and their associated real impact on climate (including balance with CO₂), economics and operations. Real time simulation and flight trials will be used, testing new air traffic management concepts.

To complement this project, Airbus will continue to work further with partners to investigate enhanced weather forecast solutions, including potential for integration of additional weather data sources, to formulate requirements for consideration.



Airbus A350 flight testing with 100% SAF, with a DLR chase aircraft to directly measure Non-CO₂ emissions

Part 3

Conclusion & summary of next steps



RAF voyager completing an air-to-air refueling with SAF.
Image courtesy of RAF.

We have made great strides over the last year, but big challenges remain

We need to continue to work across the aviation sector, and with experts across the economy to ensure we continue to make progress on our path to decarbonise aviation.



Technological readiness

SAF, zero-carbon emission aircraft and Greenhouse Gas Removals (GGRs) are emerging technologies with varying degrees of uncertainty around the timeline for bringing into service. We are continuing to work closely with industry, including through the Jet Zero Council and the Aerospace Growth Partnership, to drive forward their development at pace for use in the aviation sector.

International ambition

International ambition is essential to achieving emissions reductions from international aviation without competitive disadvantage for the UK, and to avoid carbon leakage. We are continuing to work with other states through ICAO and beyond, with a focus on implementation of the new net zero 2050 global goal.

Revenue uncertainty

A SAF mandate will give a clear signal to investors of the vital role government believes this technology will play in the UK while also providing a level of price support. We do, however, recognise that the long-term revenue certainty of UK production facilities remains a concern for investors and the aviation sector. That is why we have committed in our response to Philip New's report to consider industry funded options to increase future revenue certainty of UK SAF plants, working in partnership with the sector.

Energy and feedstock demand

We recognise there is uncertainty around SAF feedstock availability and continue to work closely with colleagues across government to ensure that the most up-to-date evidence and modelling is reflected throughout the policy design of the SAF mandate. In addition the direct use of hydrogen in aviation (either through its combustion or in a fuel cell) is dependent upon the production of low carbon hydrogen with implications for electricity demand.

Summary of next steps

Summer 2023

Launch the UK SAF Clearing House

Announce the winners of the second application round of the Advanced Fuels Fund

Further progress the consideration of revenue certainty options for supporting the development of a UK SAF industry. If required, following further engagement, we will launch a formal government consultation this summer

Autumn 2023

Ninth meeting of the Jet Zero Council

October 2023

Respond to the CCC's 2023 progress report aviation recommendations

November 2023

Negotiate to secure strong outcomes from the ICAO 3rd Conference on Aviation Alternative Fuels (CAAF/3)

By the end of 2023

Publish the government response to the second SAF mandate consultation

Support Virgin Atlantic to successfully operate the world's first transatlantic flight on 100% SAF, from London to New York

2025

First review of progress against our emissions reduction trajectory

Implement Free Route Airspace across the North of England

At least five commercial-scale UK SAF plants under construction

UK SAF mandate introduced

2024

Consult on our proposals for implementing the Zero Emission Airport operations Target

All legislation to implement CORSIA in place

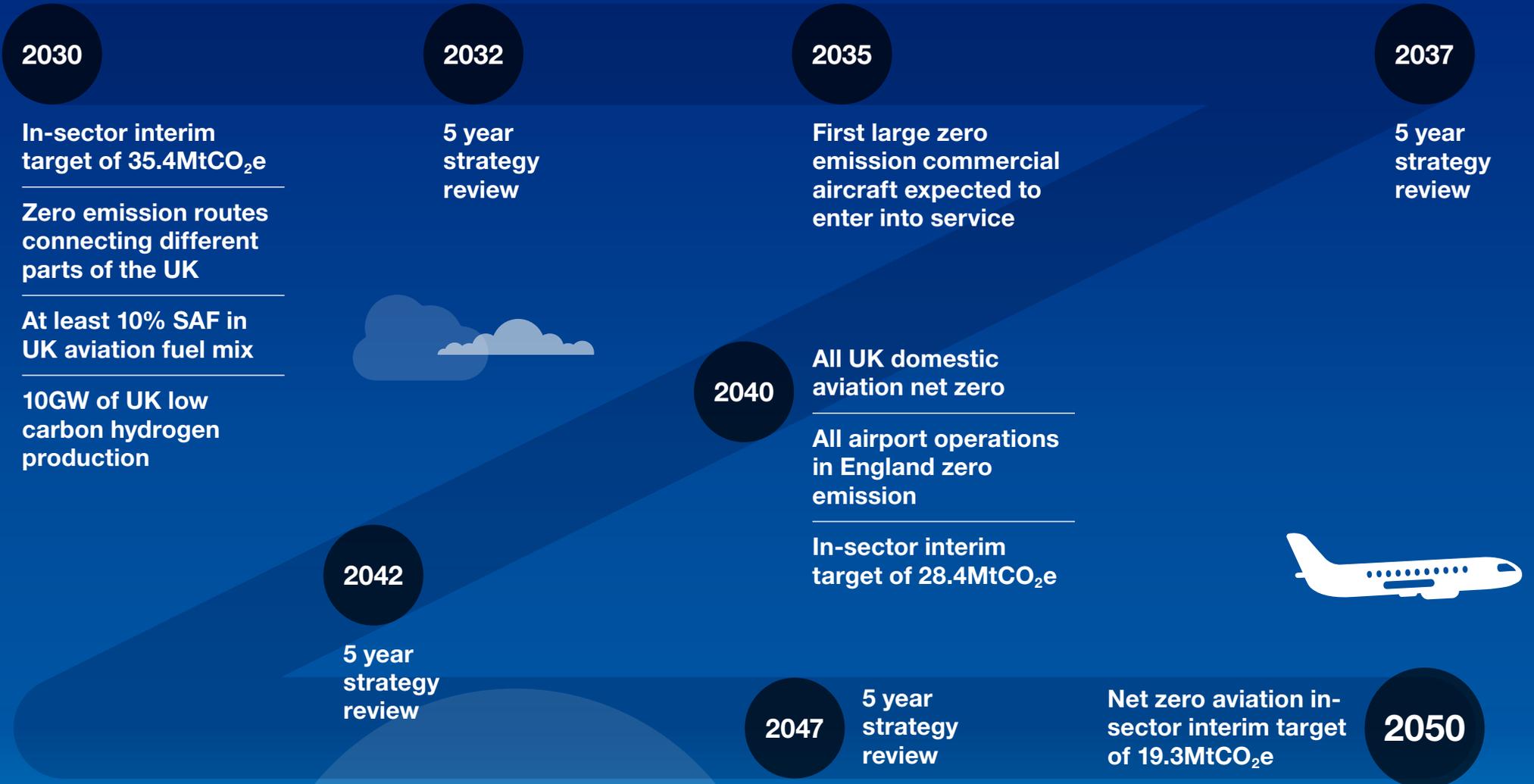
Publish a second consultation on implementing CORSIA in the UK, including its interaction with the UK ETS

Analyse responses to the Zero Emission Airport operations Target Call for Evidence and publish the government response

Work with the CAA to consult on environmental information provision

Launch a Call for Evidence on our target for domestic aviation to reach net zero by 2040

Key milestones on our pathway to Jet Zero beyond 2027



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This updated modelling has fed into recent government publications, including the Carbon Budget Delivery Plan, and the second SAF mandate consultation.

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Flights from Great Britain to Switzerland have been included in the UK ETS since the start of 2023. Flights from Northern Ireland to Switzerland will be included when the Northern Ireland Assembly is able to progress legislation.

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