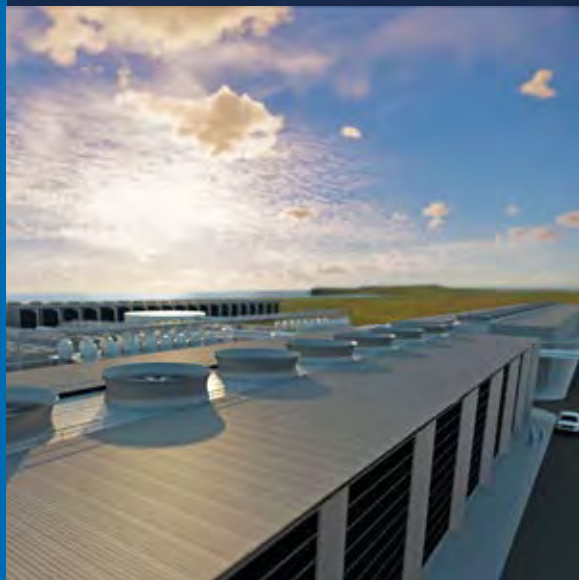




Department
for Transport



Jet Zero Strategy

Delivering net zero
aviation by 2050

July 2022

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Cover Images

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- 4 ZeroAvia Dornier 228 First Electric Propeller Spin aircraft. Image courtesy of Zero Avia.
- 5 Rendering of a large-scale direct air capture plant. Image courtesy of Carbon Engineering Limited.

Department for Transport
Great Minster House
33 Horseferry Road
London
SW1P 4DR



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Foreword

The early evolution of air travel in this country – from the first commercial flight to the first jet airliner, the British Comet – took just 30 years. In that short time, aviation technology developed at an astonishing pace. But it showed what we can achieve. We now have even less time to transform aviation again. Our target of net zero flying by 2050 is hugely challenging. Not just because aircraft have always relied on fossil fuels, but because aviation is only just restarting in earnest after two years of intense disruption. The COVID-19 pandemic has, however, also given us an opportunity to rebuild our economy in a stronger, fairer and greener way, with aviation as part of the solution to climate change, rather than just a major contributor of carbon emissions.

At current rates, aviation is expected to become one of the largest emitting sectors by 2050. We have to break the link between air travel and rising global temperatures. Aviation's success must no longer damage the planet. That is why we have developed the Jet Zero Strategy – not only securing a more sustainable future for our climate, but also for our aviation industry, and the critical role it plays in boosting trade, tourism and travel.

The strategy is underpinned by an overarching approach and three principles. We are setting clear decarbonisation goals; in addition to the 2050 net zero target, we want all domestic flights to achieve net zero by 2040 and for all airport operations in England to be zero emission by the same year. We will be setting an emission reduction trajectory for the sector and will be monitoring progress through five-year reviews. We recognise that many of the technologies needed to decarbonise the sector are at an early stage of development and therefore this approach is essential to allow new technology to be developed, tested and adopted across the industry.

Building on the UK's presidency of COP26 and our launch of a new International Aviation Climate Ambition Coalition¹, we will continue to spearhead international action on this issue. We know that domestic efforts alone won't achieve enough, so we will work closely with other states through the International Civil Aviation Organization (ICAO), and remain committed to the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The 41st ICAO Assembly is a key priority for the UK later this year and will be a vital moment in aviation's journey to agree an ambitious long-term emissions reduction goal for international aviation that is aligned with the Paris Agreement temperature targets. And for the first time, the sixth carbon budget will formally include the UK's share of international aviation and shipping emissions, which will allow for these emissions to be accounted for consistently with other sectors.

We will also continue to build and strengthen partnerships. The green transition can only succeed with the support and expertise of the sector, wider industry, academia, innovators, international partners, and the public. That's the thinking behind the Jet Zero Council – a forum bringing together government, industry and academia to speed up change.

The sector will have to undergo significant changes in the coming decades but with that comes opportunities to create new jobs, develop new industries with innovative new technologies, and improve our energy security as a nation, therefore maximising these opportunities will also be an integral part of our approach.

We have already seen real progress, with Phillips 66 producing and providing the first commercially produced sustainable aviation fuel (SAF) in the UK. We have committed £180 million of funding to support the development of a UK SAF industry, and our aim is to unlock further private financing to develop our very own SAF plants with a commitment to have at least five plants under construction by 2025. Finally,

we want to demonstrate transatlantic flight powered solely by SAF, and we have launched a competition to help the aviation industry achieve that target.

Fuel is just one way to cut carbon. Increasing the efficiency of our aircraft, airports, airfields, and use of airspace, accelerating the transition to zero emission aircraft, developing carbon markets and greenhouse gas removal methods, and helping consumers to make sustainable flying choices are also part of the mix. And government has a role to play in supporting Research and Development (R&D) to take these new technologies to market. For example, we recently committed a record £685 million over three years in UK aerospace R&D through the Aerospace Technology Institute (ATI) Programme.

To see how crucial this green transition is for aviation, we only need to look at its impact on our economy. Before the pandemic, aviation (including air transport and aerospace)

contributed at least £22 billion to our economy and directly provided at least 230,000 jobs.

Our aerospace exports, worth £34 billion, represent an estimated 13% of global market share² and domestic production of SAF could support up to 5,200 UK jobs by 2035³. The argument should therefore not be that aviation is too important to change, but that it's too important not to change. The Jet Zero Strategy is not intended to clip the wings of the sector. Rather it is designed to future-proof aviation so passengers can look forward to guilt-free travel. In doing so our economy can reduce its dependence on dirty energy. We can unlock the benefits of green technology and the thousands of new skilled jobs that come with it. And aviation, often criticised for its contribution to climate breakdown, can safeguard its future through a more sustainable industrial model. Aviation's capacity for innovation has long been evident and it must once again, embrace change.



Grant Shapps
Rt Hon Grant Shapps MP
Transport Secretary



Robert Courts
Robert Courts MP
Minister for Aviation



Trudy Harrison
Trudy Harrison MP
Minister for Transport
Decarbonisation



Executive summary

Jet Zero presents a unique opportunity as the sector recovers from COVID-19. The pandemic grounded most of the UK's aviation fleet, but the success of the UK's vaccination programme has enabled the UK's path to recovery. Recovery presents an opportunity to build back greener, focussing our attention on going further and faster to tackle aviation's impact on climate change.

Decarbonising aviation will be a challenge.

Whilst the medium- to long-term impact of COVID-19 is not yet fully understood, the Government's Net Zero Strategy published in October 2021 shows aviation to be one of the UK's largest residual emitting sectors in 2050. With one of the most ambitious climate change targets in the world, and commitments to take the UK more than three-quarters of the way to reaching net zero by 2050 in the sixth carbon budget period (2033 – 2037), it is vital that the aviation sector takes steps now and makes significant changes in the coming decades to reduce its emissions.

Meeting this challenge is vital for UK connectivity and growth. The Government recognises the aviation sector's role in making us one of the world's best-connected and most successful trading nations. We are committed to enabling the recovery of the sector to support our levelling up agenda through regional connectivity and to strengthen ties within the Union, as well our connectivity globally. We need solutions that reduce the sector's emissions whilst delivering economic benefits across the UK.

The sector is responding positively to Jet Zero.

Despite the recent challenges faced by the aviation industry, many parts of the sector have continued to take significant steps in ensuring that their businesses recover and grow with sustainability at their heart. Already over 290 airlines through the International Air Transport Association (IATA), and multiple aviation industry bodies have committed to goals aimed at achieving net zero emissions by 2050. The Jet Zero Strategy sets out the Government's vision for decarbonising aviation with the sector, focussing on the rapid development of technologies in a way that maintains the benefits of air travel, whilst maximising the opportunities that decarbonisation can bring for the UK.

Our strategy is informed by over 1,500 responses. We received over 1,500 responses to our Jet Zero Consultation and the Jet Zero: Further Technical Consultation and have published a summary of responses and government response alongside this strategy. We have carefully considered the consultation responses, alongside wider government policy and the very latest technological developments, and through this strategy, we are setting out a clear framework for how the sector will decarbonise.

We are committing the sector to achieve Jet Zero by 2050. Our strategy is largely consistent with the strategic framework and policies on which we consulted. Our updated framework puts our clear 'Jet Zero' goal – net zero UK aviation emissions by 2050 – at the heart of our strategy, acknowledging there are multiple pathways to see it achieved. We are including a further principle – Maximising opportunities – to reflect our intention to use the Jet Zero transition to deliver wider benefits in jobs, skills, and investment that these new technologies will bring.

We are publishing a five year delivery plan as part of the Strategy. This sets out the actions that will need to be taken in the coming years to achieve net zero by 2050, structured around the three principles (International leadership, Delivered in partnership and Maximising opportunities) and six measures (System efficiencies, SAF, Zero emission flight (ZEF), Markets and removals, Influencing consumers, and addressing non-CO₂).

We are introducing a CO₂ emissions reduction trajectory that sees aviation emissions peak in 2019. This trajectory from 2025 to 2050, is based on our "High ambition" scenario, and sets ambitious in-sector targets of 35.4 MtCO₂e in 2030, 28.4 MtCO₂e in 2040, and 19.3 MtCO₂e in 2050.

We are setting a target for domestic flights to reach net zero by 2040, and next year will launch a consultation on how this will be implemented. Our domestic aviation market is well-suited to pioneer new types of aircraft and can provide an early link to the market for greenhouse gas removals.

We are taking a leading role internationally, including negotiating for agreement on a long-term aspirational goal for the CO₂ emissions of international aviation that is aligned with the temperature goal of the Paris Agreement. The UK believes that it is paramount that ICAO adopt an ambitious long-term goal to help set the direction for future international and national policy, attract green investment, and show that the sector is taking credible action to tackle its emissions.

We will work through the Jet Zero Council, and with other partners, to deliver new technologies and innovative ways to cut aviation emissions. We have established two Jet Zero Council Delivery Groups on SAF and ZEF to accelerate progress on the objectives of the Council, and a Jet Zero Communications and Engagement Network to engage wider industry and the public, and better communicate successes on our path to achieve Jet Zero.

We will use the transition to Jet Zero to create new jobs, industries and technologies across the entire sector and the UK. We will continue to invest in our world-leading aerospace sector through the ATI programme and use the transition to SAF to build a new UK SAF industry, supporting up to 5,200 UK jobs from the domestic production of SAF, and a Gross Value Added (GVA) of up to £2.7 billion from UK production and global exports⁴.

We will target airport operations to be zero emission by 2040 and support further reductions within the existing aviation system.

In the short term, improvements in the operational efficiency of our existing aviation system will play an important role in reducing emissions and we want airports to play a key role in this with an ambition for all airport operations in England to be zero emission by 2040. We will issue a Call for Evidence this autumn to gather information on the scope and implementation route to see this achieved.

By 2025 we are committing to have at least five UK SAF plants under construction and a SAF mandate in place with a target of at least 10% SAF by 2030.

SAF are drop-in fuels and are commercially available now, but not at the scale that is required to decarbonise the sector. SAF will play a crucial part in reducing the UK's aviation emissions in the medium- and long-term and our commitment is for at least five commercial-scale plants to be under construction by 2025. SAF production and uptake will also be supported by the introduction of a SAF mandate by 2025 with an aim to see at least 10% of SAF (c.1.2 million tonnes)⁵ in the UK aviation fuel mix by 2030. This is in addition to the ongoing support through our advanced fuel competitions. We are actively looking at how to create the long-term conditions for investable projects in the UK, by continuing to engage stakeholders to gather key evidence and determine what further measures industry or government might be able to take. We would like to reach a preferred government position on how to further stimulate investment in a UK SAF industry by the end of the year.

Our aspiration is for zero emission routes connecting different parts of the UK by 2030.

Further advances will be required over the coming years for zero emission flight to enter into commercial service, though huge strides have been made through projects such as FlyZero and work by the likes of Airbus and ZeroAvia. Our General Aviation sector is well placed to encourage the early adoption of innovative zero emission aircraft, and we will use newly commissioned research to develop ambitious policies to allow this sector to pioneer zero emission flight. The new Jet Zero Council Zero Emission Flight Delivery Group will have an important role in helping the Government understand the barriers and challenges for bringing these new technologies to market. The transition to zero emission flight requires a workforce with the skills to work with new technologies and our Future Aviation Skills research project will consider this in further detail, and ensure our approach is aligned with the Aerospace Growth Partnership's (AGP) strategy Destination Net Zero.

Carbon markets will have a key role in delivering Jet Zero, and greenhouse gas removals (GGRs) are needed to address residual emissions.

By establishing a price signal on emissions and a decarbonisation trajectory, carbon markets help decarbonise and incentivise investment in technologies that reduce carbon emissions. We will seek to enhance the effectiveness of the UK Emissions Trading Scheme (UK ETS) working with the devolved administrations through the UK ETS Authority and we will work through the ICAO to increase the environmental ambition of CORSIA.

We will consider whether the provision of environmental information could encourage consumers to choose the most environmentally friendly flight. We will continue working with the Civil Aviation Authority (CAA) to gather more evidence on providing consumers with environmental information at the time of booking a flight.

We will accelerate work on understanding non-CO₂ impacts and potential mitigation. Aviation also has non-CO₂ impacts which some research suggests could be greater than the impact of CO₂ alone. Therefore our strategy includes a sixth measure which sets out our approach to better understand and mitigate the non-CO₂ impacts from aviation.

We will continue to support sustainable airport growth. Through both our consultations, we received a high volume of responses about the desire for demand management measures to reduce aviation emissions. Our approach for decarbonising aviation will focus on the rapid development of technologies: on operational improvements in the near term, use of SAF, adoption of ZEF in the longer term and continued use of markets and removal measures. Our analysis shows that the sector can achieve Jet Zero without the Government needing to intervene directly to limit aviation growth, with knock-on economic and social benefits. The Government's position on demand management is described in further detail in the Government response to the consultations which has been published alongside this Strategy.

We will monitor progress against our trajectory on an annual basis, followed by a major review of our Strategy every five years. We recognise that many of the technologies needed to decarbonise the sector are at an early stage of development and therefore, we have committed to reviewing our Strategy every five years and will use these reviews to take stock of how emerging technologies are developing, whether they are developing at the pace required and if they are being adopted by the sector. If we find that the sector is not meeting the emissions reductions trajectory, we will consider what further measures may be needed to ensure that the sector maximises in-sector reductions to meet the UK's overall 2050 net zero target.

Our target is clear

Jet Zero: Net Zero Aviation by 2050

With a clear in-sector trajectory:



Delivered through our strategic framework – Clear goal, multiple solutions:

International leadership

Delivered in partnership

Maximising opportunities

System
efficiencies

Sustainable
aviation fuels

Zero emission
flight

Markets and
removals

Influencing
consumers

Addressing
non-CO₂

Key policies to realise vision:

Domestic
flights net
zero by 2040

SAF mandate with
10% SAF in the UK
fuel mix by 2030

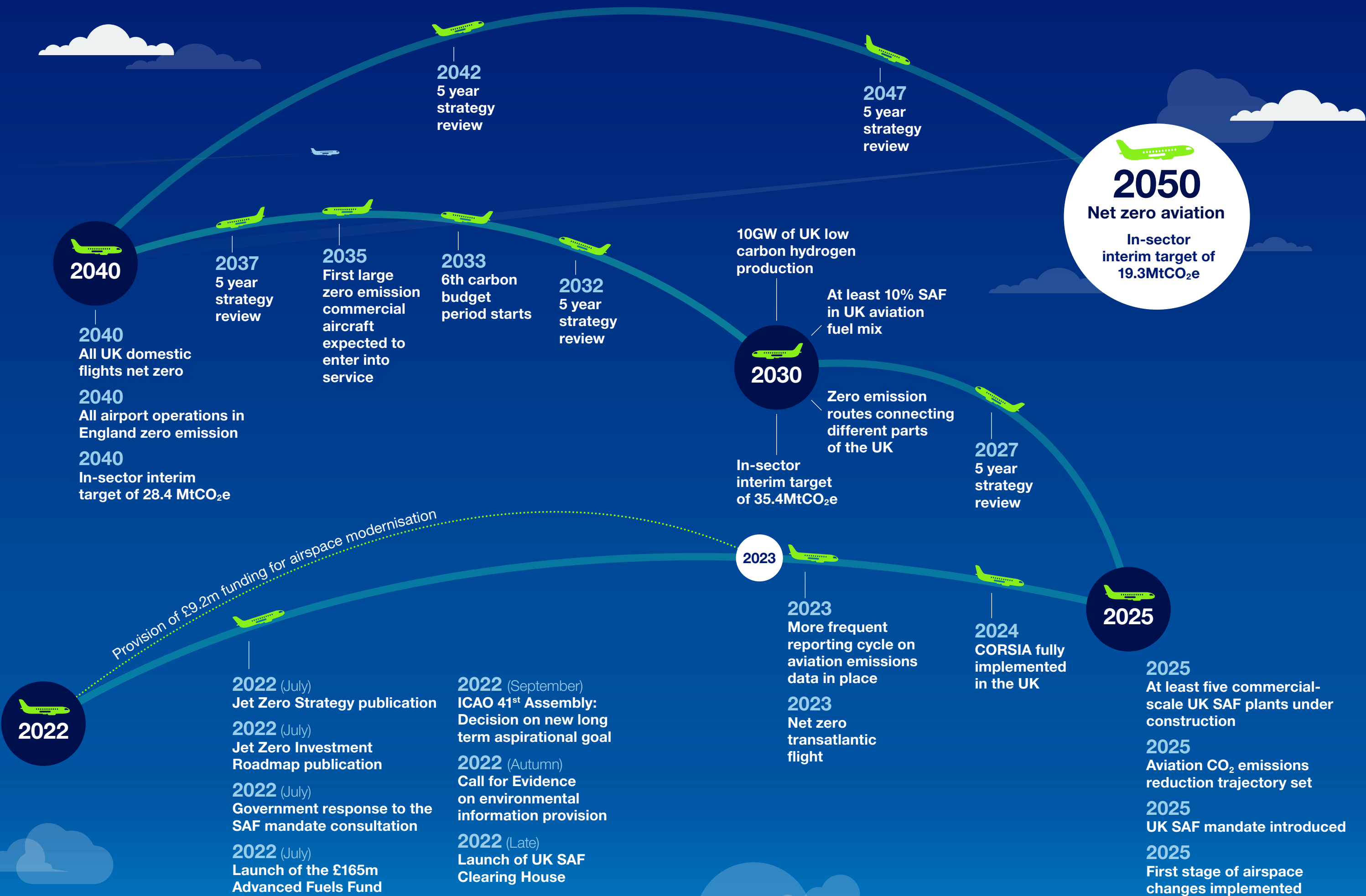
Airport operations
in England zero
emission by 2040

Emissions
reduction trajectory
from 2025

Implement
CORSIA
by 2024

With progress monitored annually and
our Strategy updated every five years

Five year
delivery
plan



1 A clear goal, with multiple solutions

Our strategic framework & trajectory

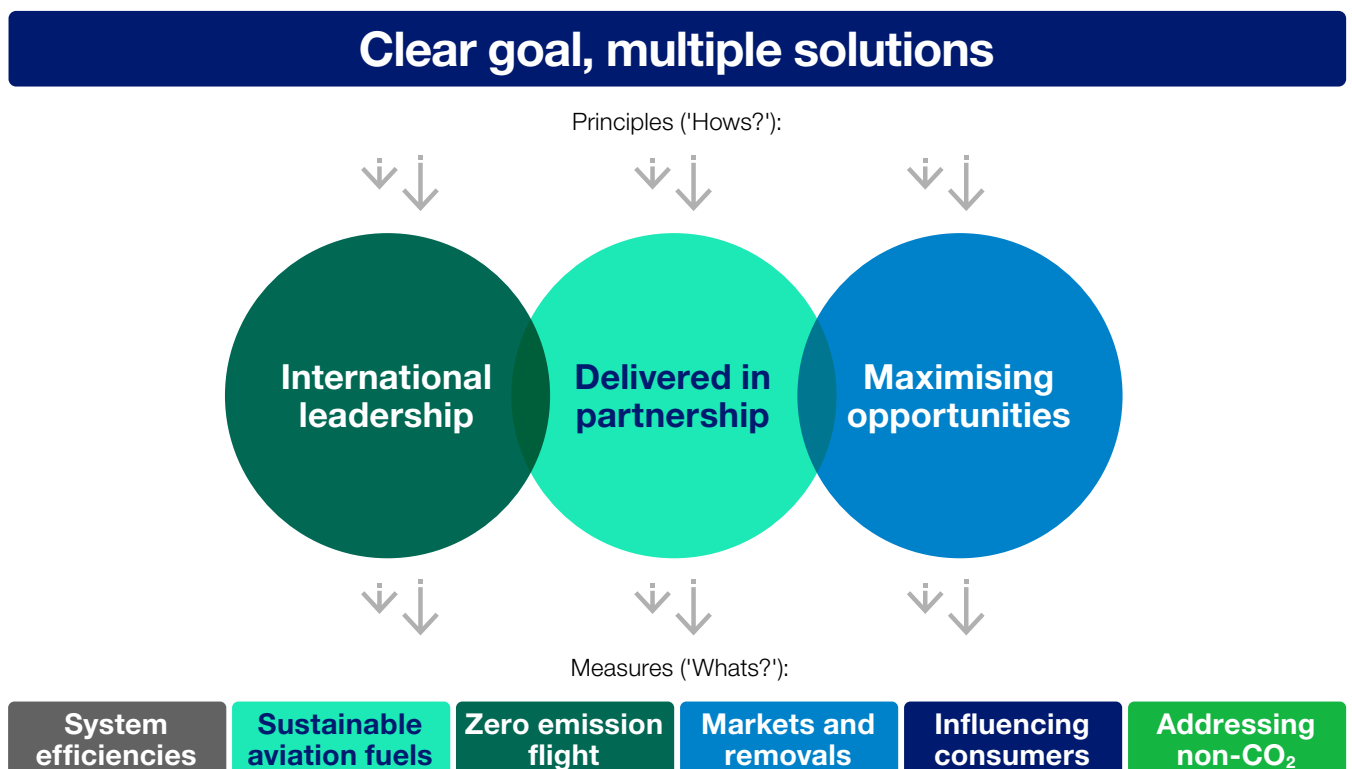
- 1.1 Decarbonising aviation will not be straightforward. This is a hard-to-decarbonise sector, with solutions at different stages of technological and commercial readiness. Yet it is a sector that is committed to decarbonisation and one that simply must deliver. Success requires us to be completely clear on the goal, yet acknowledge the multiple possible pathways and solutions through which it could be realised. This is the overarching approach taken through our Strategy - **clear goal, multiple solutions** - which will support different pathways to deliver our objectiveⁱ.
- 1.2 **We are committing the UK aviation sector to reaching net zero, or Jet Zero, by 2050.** The UK has demonstrated its commitment to net zero through the Climate Change Act, where we have pledged to reduce greenhouse gas emissions by 100% by 2050. We are clear that aviation must play its part in achieving this goal, and through the implementation of the approach and policies in this Strategy, we will achieve Jet Zero – net zero emissions from aviation by 2050.
- 1.3 In addition, **we are setting an earlier target for UK domestic flights to reach net zero by 2040.** Although domestic aviation accounts for only a small proportion of our overall emissions from aviation (4% in 2019), this target is an important stepping-stone on our way to achieving net zero for all UK commercial passenger and freight flights. Technologies needed to decarbonise international flights may be available earlier for shorter, domestic routes, and this target could act to incentivise the adoption of low, and zero emission fuels and technology in the UK. We also believe that this target could help provide an early demand for greenhouse gas removals (GGRs) from the aviation sector and help establish a crucial link with this market, which will be vital to achieving Jet Zero by 2050. We will carry out a consultation in 2023 to seek views on the different approaches that could be taken to implement the domestic target.
- 1.4 To enable delivery of our Jet Zero goals, our strategy focusses on two key aspects: a strategic framework for delivery, and a trajectory against which we will measure progress. Due to the nascent nature of the technologies required to decarbonise aviation, **we will review our Strategy every five years and adapt our approach based on progress made.** We will measure progress against our emissions reduction trajectory and key performance indicators (KPIs) which have been set out across each of our policy measures.

ⁱ The approach set out in this Strategy is aligned with the Net Zero Strategy (NZS), Transport Decarbonisation Plan (TDP), and Flightpath to the Future. The NZS set out our economy-wide plan for achieving net zero by 2050, for meeting our carbon budgets and Nationally Determined Contribution under the Paris Agreement. The TDP set out the Government's commitments and actions needed to decarbonise the entire transport system. The Flightpath to the Future set out our strategic framework for the aviation sector, which focusses on establishing a modern, innovative and efficient sector over the next ten years with decarbonisation and sustainability key priorities. The Jet Zero Strategy builds on these three documents setting out our framework and plans for decarbonising aviation.

Strategic framework

- 1.5 Our strategic framework sets out the approach we will take to deliver our Jet Zero goal, with **three guiding ‘principles’ and six core policy ‘measures’**.
- 1.6 **The ‘principles’ guide our approach to delivery.** Aviation is a globally competitive sector, through taking an **international leadership** role we can go further, faster, and secure more global emissions reductions. Success will require all stakeholders to work together on the Jet Zero transition, and therefore it’s crucial we **deliver in partnership**. Decarbonisation is an opportunity to create new jobs, develop new industries with innovative new technologies, and improve our energy security as a nation. Our approach will **maximise opportunities** that this transition brings.
- 1.7 **The policy ‘measures’ are the key levers** we hold to reduce the climate impacts of aviation, both CO₂ emissions and any non-CO₂ impacts. They will be influential over different timescales: increasing the efficiency of the aviation system and carbon markets can help address emissions over the short and medium term; we have ambitious plans for SAF uptake this decade and beyond; and zero emission flight will likely be significant beyond 2035. Each of these measures will play a key role – we have set out 62 individual commitments and in our five year delivery plan we have set out the actions which will be taken over the coming years to meet our goals.
- 1.8 The Net Zero Strategy showed that there are pathways to achieving our economy-wide net zero obligations with no step-up in ambition on reducing aviation emissions, but we want to go much further than this. **Our strategy aims to reduce in-sector emissions from aviation by more than 60% by 2050**, and although we recognise the high level of uncertainty associated with new technologies, we believe the principles and measures set out in this Strategy will provide the framework required to achieve ambitious in-sector emissions reductions.

Our strategic framework ('Approach'):



2050 trajectory

- 1.9 Jet Zero is a clear goal that can be achieved through multiple pathways and solutions. Many of the technologies we need to achieve it are at an early stage of development or commercialisation; their nascent nature means that we do not yet know the optimal technological mix out to 2050. However, it is crucial that we use the best available evidence to set out an ambitious yet realistic pathway for the sector to decarbonise, which sees emissions reduce over the short and longer term.
- 1.10 **Through this Strategy we are committing to our “High ambition” scenario, which sees aviation CO₂ emissions peak in 2019.** This scenario results in 19.3 MtCO₂e of residual emissions in 2050 to be offset or removed.ⁱⁱ
- 1.11 We consulted on four illustrative scenarios with different technological mixes to reach net zero aviation by 2050, reflecting possible routes to achieve our goal.ⁱⁱⁱ We believe that our “High ambition” scenario represents the right level of ambition for aviation and is achievable if technology development continues as expected.^{iv}
- 1.12 We will therefore use this scenario to **set an in-sector CO₂ emissions reduction trajectory for aviation from 2025 to 2050^v**. We believe that setting an in-sector trajectory provides clear messaging on the need for progress from the sector, as well as providing clarity on the GGR capacity required to meet net zero. The trajectory results in **ambitious in-sector interim targets of 35.4 MtCO₂e^{vi} in 2030, 28.4 MtCO₂e in 2040, and 19.3 MtCO₂e in 2050^{vii}**.

ii Under the GHG accounting rules used in the analysis for the Government’s Net Zero Strategy, where SAF is presented as delivering 100% emission savings relative to kerosene in the transport sector, this scenario results in 15.4 MtCO₂e of residual emissions in 2050. For more details see the supporting analytical document – Jet Zero illustrative scenarios and sensitivities.

iii Further scenarios are set out in the supporting analytical document.

iv Further detail of the underlying assumptions for the “High ambition” scenario and our other Jet Zero illustrative scenarios can be found in the supporting analytical document, including the challenges in achieving each scenario.

v Emissions from military aircraft are not included in the scenario modelling and are therefore not included in the emissions reduction trajectory presented in this chapter. We are exploring options to enable us to model military aviation emissions in future and will review whether to include them in the emissions reduction trajectory as part of the first five-year review. In the five years prior to the pandemic, military aviation emissions were around 1.1-1.2 MtCO₂e per annum. Last year the Royal Air Force set a goal to be net zero by 2040⁶.

vi CO₂e emissions are defined ‘CO₂ equivalent emissions’ which includes the emissions from other greenhouse gases including methane (CH₄) and nitrous oxide (N₂O).

vii The equivalent emissions under the GHG accounting rules used in the analysis for the Government’s Net Zero Strategy, where SAF is presented as delivering 100% emission savings relative to kerosene in the aviation sector, are 34.3 MtCO₂e in 2030, 26.6 MtCO₂e in 2040 and 15.4 MtCO₂e in 2050.

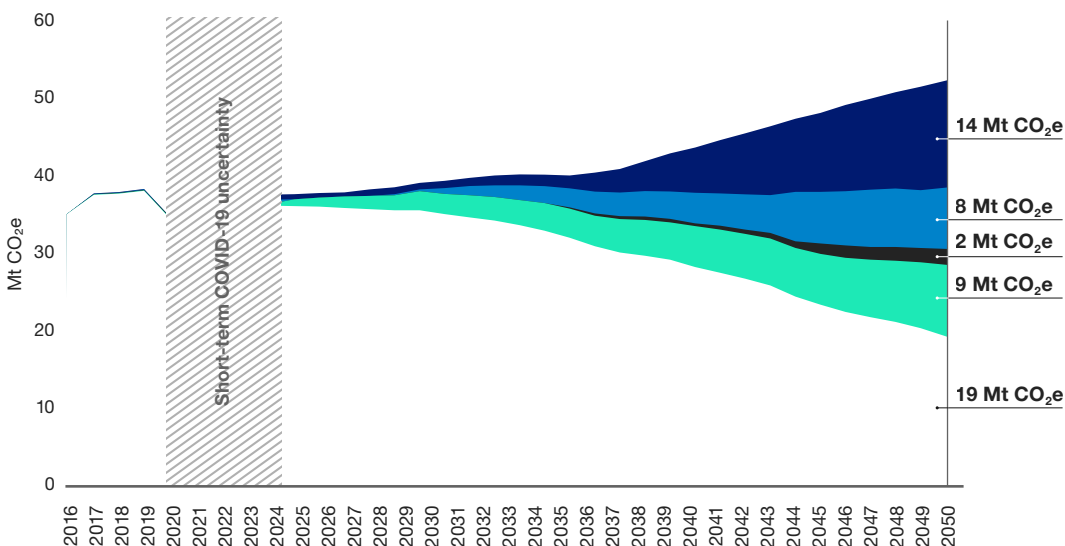
In-sector interim targets



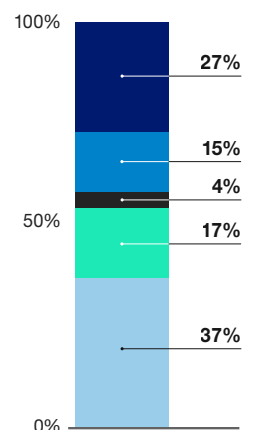
1.13 We also recognise that the urgent nature of climate change calls for continuous monitoring of aviation emissions, and that more frequent and transparent reporting will enable industry and government to respond quickly to emerging trends. We are therefore aiming for **more timely annual reporting of aviation emissions data from 2023**, working with the CAA and other partners.

1.14 As a responsible government, we will need to regularly review the sector's progress and adapt our approach depending on progress made. **We will monitor progress against our emissions reduction trajectory annually from 2025 and review the overall trajectory as part of the five-year review process (starting in 2027).**

Our High Ambition Scenario



% abatement from each measure in 2050



● ETS and CORSIA ● Fuel efficiency improvements ● Zero Carbon Aircraft ● SAF ● Abatement outside aviation sector

2 Our principles

2.1 Our Strategy is underpinned by our three guiding principles. These will be used to frame our approach to the measures set out (Chapter 3) and all our work to deliver Jet Zero:

- **International leadership:** Leading coordinated global efforts to tackle international aviation emissions, including through our ongoing work in the International Civil Aviation Organization.
- **Delivered in partnership:** Working with all parts of the sector and different partners to develop, test, implement and invest in the solutions we need.
- **Maximising opportunities:** Using the opportunity of the Jet Zero transition to boost our economy, create new jobs, develop new industries, and become a more energy secure nation.

2.2 These three principles apply to all of our policy measures, where we will need an internationally aligned approach to tackle all aviation emissions, to work in collaboration with a range of partners to succeed, and to follow an approach which maximises opportunities for the UK.

Our principles

International leadership

Leading coordinated global efforts to tackle international aviation emissions, including through our ongoing work in ICAO.

- Agree an ambitious **long-term aspirational goal**
- Agree and support measures to meet the goal, including strengthening **CORSIA** and introducing a **global SAF objective**
- Build on our **COP26 legacy** and collaborate with like-minded states through global fora such as our **International Aviation Climate Ambition Coalition**

Delivered in partnership

Working with all parts of the sector to develop, test and implement the solutions we need:

- **Jet Zero Council**
- **Airspace Change Organising Group**
- **Aerospace Technology Institute**
- **Aerospace Growth Partnership**
- **Civil Aviation Authority**



Maximising opportunities

Boosting our economy, creating new jobs, developing new industries, and becoming a more energy secure nation.

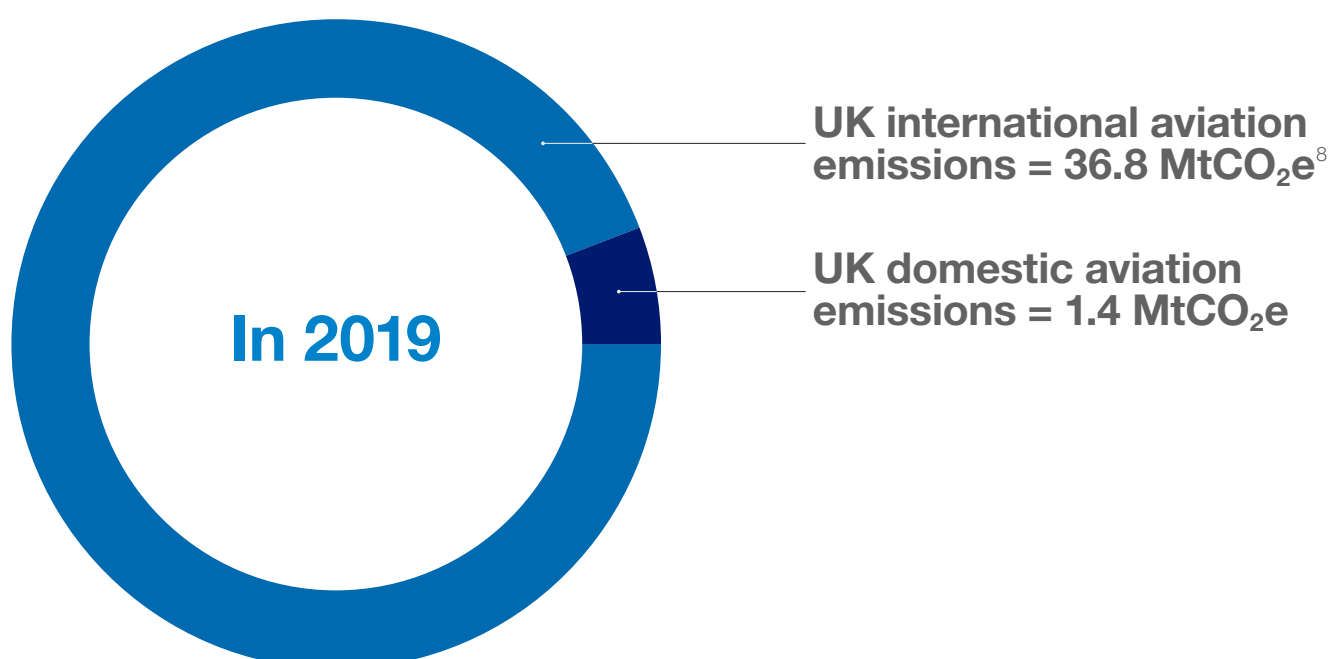
Over the next 3 years, we will:

- Provide **£685m funding** for the ATI programme
- Provide **£180m funding** to support the commercialisation of SAF plants and fuel testing in the UK

International leadership

- 2.3 The vast majority of the UK's aviation emissions come from international flights. The global nature of the sector means that international collaboration is crucial for effectively addressing international aviation emissions, and the UK is committed to tackling aviation emissions through the ICAO.
- 2.4 At ICAO's 41st Assembly, we will **negotiate for agreement on a long-term aspirational goal for the CO₂ emissions of international aviation that is aligned with the temperature goal of the Paris Agreement.** The UK believes that it is paramount that ICAO adopts an ambitious long-term goal to help set the direction for future international and national policy, attract green investment, and show that the sector is taking credible action to tackle its emissions. On 21 March 2022, ICAO published the report of its comprehensive study exploring the feasibility of a long-term goal, and we believe this provides a strong technical basis for negotiating an ambitious goal.
- 2.5 The UK played an instrumental role in agreeing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)⁷, which requires airlines to offset the growth in international aviation emissions above 2019 levels. **We will work closely with other states at the 41st ICAO Assembly and beyond to maintain and strengthen CORSIA.** We believe that it is paramount to sustain the momentum behind CORSIA and to use the CORSIA Periodic Reviews to improve the operation of the scheme and increase its environmental integrity.
- 2.6 **We will also begin providing direct support to other states that may need help implementing CORSIA effectively, drawing on the experience and expertise of the CAA and Environment Agency.** We will assist these states to comply with their obligations under the scheme, ensuring that international emissions from their airlines are appropriately monitored, reported and, when necessary, offset.

Total UK aviation emissions in 2019





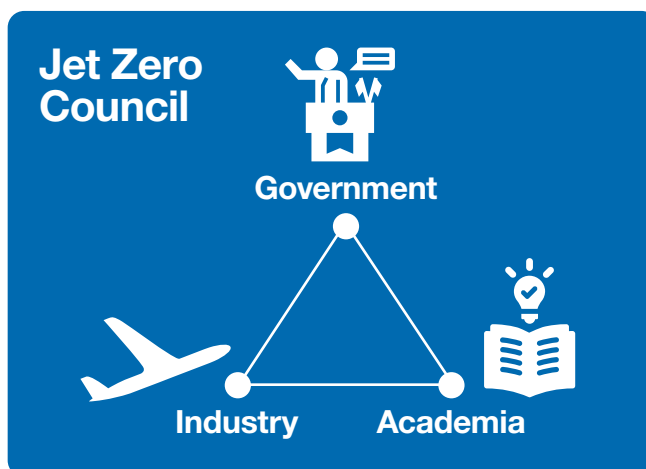
Minister Harrison at COP26.
Image courtesy of COP26

- 2.7 During COP26, we launched the **International Aviation Climate Ambition Coalition** and 28 states, including the UK, representing over half of global aviation emissions, have now signed a declaration⁹ showing their support for high climate ambition for international aviation. **We will continue to grow the Coalition to build wider global support for ambitious action on aviation emissions.** The Coalition will first focus on securing strong outcomes for a long-term aspirational goal and CORSIA at the ICAO Assembly, before turning to its other commitments, which include supporting global deployment of SAF and promoting capacity building.
- 2.8 **Through bilateral engagement, we will set higher expectations for ambitious environmental provisions in negotiating air services agreements.** We will seek to include commitments in our air services agreements reflecting the level of ambition that we believe is required to reduce international aviation emissions, recognising that use of UK airspace and airports must come with a responsibility to minimise environmental impacts.
- 2.9 We will also **work with the CAA and key partner countries to collaborate on developing the most effective regulatory frameworks that can support our net zero and Jet Zero ambitions.** Through these networks and collaboration on key global regulatory challenges, we will work to share best practise and help influence the development of future global standards.

Delivered in partnership

2.10 Achieving Jet Zero requires all parts of the sector to work together to develop, test, implement, and invest in the solutions we need. That is why, in July 2020, we established the **Jet Zero Council**¹⁰, a partnership between government, industry and academia to drive the delivery of new technologies and innovative ways to cut aviation emissions. The Council is jointly chaired by the Transport and Business Secretaries, who are supported by an industry CEO. The CEO is responsible for ensuring the Council delivers at pace and that we see real collaboration between government and all parts of the sector.

2.11 To accelerate progress on the objectives of the Jet Zero Council, **we have established focussed Delivery Groups on SAF and ZEF**. The SAF Delivery Group was established in November 2020 and brings together experts on SAF to provide advice on how government and industry can work together to establish UK SAF production facilities, deliver the fuel to market, and increase the uptake of SAF in the UK. In April 2022, we launched the ZEF Delivery Group, which will provide advice on how government and industry can work together and put the UK in a leading position in the race to achieve zero emission flight. It will build on the work of the ATI's FlyZero project and the Zero Emission Flight Infrastructure (ZEFI) project.



- 2.12 **We will strengthen the work of the Jet Zero Council.** We will produce, publish and regularly update two-year delivery plans for the Jet Zero Council Delivery Groups, which will set out the action needed in the coming years to support the delivery of Jet Zero by 2050. We will use the **newly established Jet Zero Communications and Engagement Network** to engage wider industry and the public and better communicate the work happening across government and industry to achieve Jet Zero.
- 2.13 In addition to the Jet Zero Council, we continue to work with industry through key partnerships, including **Sustainable Aviation, the Aerospace Growth Partnership (AGP); and the Airspace Change Organising Group (ACOG).** The independent advice of the **ATI** will also continue to inform our work and has been crucial in driving the progress that we have seen on low and zero emission aerospace technologies to date. We will also continue to work with our international partners, as set out in the International leadership section.
- 2.14 In 2021, Sustainable Aviation published interim targets for the sector to achieve net zero in 2050¹¹. Their Decarbonisation Roadmap is due to be updated later in 2023.
- 2.15 **We will maintain our participation in the AGP** as we move forward with our decarbonisation strategies in parallel. A refresh to the AGP's strategy, Destination Net Zero, has been published alongside the Jet Zero Strategy, with a renewed focus for the next decade on making aerospace truly sustainable by supporting innovation in more sustainable technologies, creating a world leading manufacturing chain and building skills for the next era of flight.
- 2.16 **We will work closely with ACOG as they develop iteration 3 of their Masterplan, due later early 2023, to ensure emissions saving potentials are capitalised on.** We work with ACOG in their role of delivering key aspects of the Airspace Modernisation Strategy which reflects our vision for quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. In January 2022, ACOG published the second iteration of their Airspace Masterplan¹² identifying the areas where interdependencies occur between different airspace change proposals and identifying the initial benefits of the programme for emissions savings.
- 2.17 A number of areas of the Strategy will require continued research to bring forward new technologies and fuels in addition to building our understanding of the opportunities and impacts from new technologies. The UK has a world leading University sector and research bodies which we will work closely with to deliver the Strategy.
- 2.18 We will continue to gather a wide range of views on our approach to decarbonising aviation as we further develop and implement our policies.

Maximising opportunities

- 2.19 The Jet Zero transition presents unique opportunities to **create new jobs, industries and technologies across the entire sector and UK** whilst also decarbonising air travel. It also complements our vision to be a world leader in innovative technology and its uses, such as drones and advanced air mobility. We will set out our plan to capture the potential of these technologies in the forthcoming Future of Flight Plan.
- 2.20 The aviation sector (including air transport and aerospace) already makes a significant contribution to our economy across all parts of the UK¹³. Before the COVID-19 pandemic, the aviation sector contributed at least £22 billion to GDP each year and directly employed at least 230,000 people. This is a sector that levels up the economy; anchoring communities through our supply chains and championing the potential of people through high-skilled, well-paid jobs.
- 2.21 Unlocking local benefits and levelling up are key priority areas in our recently published aviation strategic framework – Flightpath to the Future. Our approach to achieving Jet Zero will look to build upon the successful aviation and aerospace sectors, and exploit and maximise the opportunities created by the net zero transition for UK jobs, investment and levelling up.
- 2.22 **We will continue to invest in our world-leading aerospace sector** through the ATI programme where the Government has committed **an additional £685m in funding for the programme over the next three years**. In April 2022, the ATI published a new Technology Strategy, DestinATIon Zero¹⁴, focussing on UK aerospace achieving its 2050 net zero target and maintaining its global competitiveness. To achieve this, it sets out investment priorities over three technology areas: zero-carbon emission aircraft; ultra-efficient aircraft; and cross-cutting enabling technologies and infrastructure.
- 2.23 The AGP's Destination Net Zero for UK Aerospace sets **out a joint industry and government commitment to co-invest at least £1.37 billion in research and development to 2025 for development of ultra-low and zero emission technologies**; increasing overall civil aerospace business R&D investment from 2019 levels; and identifying opportunities for investment in UK suppliers, skills and infrastructure to best exploit industrialisation opportunities arising from UK R&D activity. This could help increase the UK's share of global aerospace workshare from 13% to 18% by 2050 and support the UK supply chain with the aim to double aerospace's estimated contribution to the UK economy to at least £17 billion gross value added (GVA) per annum by 2035.
- 2.24 As we transition towards SAF and hydrogen-powered aircraft, we see a clear role for UK produced fuels. Spearheading this transition will allow our service sector to export the important know-how that this will generate. **We will use the transition to SAF to build a new UK SAF industry, providing £180 million of new funding between 2022-2025 to support the commercialisation of SAF plants and fuel testing in the UK.** This is in addition to £400m of funding through a government partnership with Breakthrough Energy Catalyst to drive investment into the next generation of green technologies. By 2035, the development of a domestic industry for the production of sustainable fuels could support up to 5,200 UK jobs, and a GVA of up to £2.7 billion from UK production and global exports.¹⁵
- 2.25 The investment community has a key role to play in making Jet Zero a reality. Therefore, alongside the Jet Zero Strategy, we have published the **Jet Zero Investment Flightpath (JZIF)**, which highlights opportunities for private investment in the UK's



Image courtesy of Rolls-Royce

aviation decarbonisation sector across System Efficiencies, SAF, and ZEF. The JZIF summarises the key government commitments as set out in this Strategy and sets out clear milestones for government and industry to catalyse on and offering rewarding investment opportunities in major growth markets. One of the ways we are supporting this investment is by setting out a range of sustainable aviation activities in the UK Green Taxonomy, to be consulted on shortly.

- 2.26 **We will work with the sector to develop the skills needed and encourage long-term diversity through our Reach for the Sky outreach programme.** Jet Zero will require a workforce with the skills to handle new systems and technologies. We will work together through the AGP to identify and articulate future skills requirements, including upskilling and reskilling existing workforce and commit to creating 25,000 total new apprenticeships starts in Aerospace

by 2030. We recognise the important role GA plays as the grassroots of the sector and the entry point into aviation and aviation careers. Supported by our outreach partners, Aviation Ambassadors will continue to promote awareness of aviation careers and opportunities in order to promote diversity, inclusion, accessibility and innovation in the sector, including in areas that support decarbonisation.

- 2.27 **We will also continue to support sustainable airport growth where it is justified.** Airports play a key role in supporting economic growth and UK trade. It is right that we support the sector to recover from COVID-19 whilst putting in place the framework to ensure the sector reduces its emissions over time. Our approach to sustainable growth is detailed further in the “Influencing consumers” section.

3 Our policy measures

3.1 Delivery of Jet Zero will require action across different market segments. We will focus our policies across six measures:

- **System efficiencies:** improving the efficiency of our existing aviation system, including our airports, airspace, and the aircraft we use.
- **Sustainable aviation fuels:** building a thriving UK sustainable aviation fuel industry, bringing UK innovations to the commercial market, supporting thousands of green jobs, and supporting the UK's fuel security.
- **Zero emission flight:** developing and bringing into commercial service novel forms of aircraft that offer the potential for zero carbon tailpipe emissions.
- **Markets and removals:** creating successful carbon markets and investing in greenhouse gas removals to compensate for residual emissions in 2050.
- **Influencing consumers:** preserving the ability for people to fly whilst supporting consumers to make sustainable aviation travel choices.
- **Addressing non-CO₂:** working closely with academia and industry to better understand the science and potential mitigations of non-CO₂ impacts.

3.2 The following sections outline the strategic objectives for each of these policy areas over the long-term, and the individual policies we will develop and implement over the next five years to maximise emissions reductions in the short and medium-term.

Our policy measures



System efficiencies

Improving the efficiency of our existing aviation system: **our aircraft, airports and airspace.**

Our ambition is for **all airport operations in England to be zero emission by 2040.**

We are providing a further **£3.7m funding** in the years 2022/23 to support airports to complete stage 2 of their airspace change proposals.



Sustainable aviation fuels

SAF are a key lever to accelerate the transition to Jet Zero, and represent an industrial leadership opportunity for the UK.

We will be supporting the development of the UK SAF industry with **£180m of new funding.**

By 2025 we are committing to having at least **five UK SAF plants** under construction and a SAF mandate in place with a target of at least **10% SAF in the UK aviation fuel mix by 2030.**



Zero emission flight

There is the potential for new, zero emission aircraft to play a role in the decarbonisation of aviation.

Our aspiration is to have **zero emission routes connecting different parts of the United Kingdom by 2030.**

We are supporting industrial R&D through the **ATI Programme** (£685m funding over the next 3 years) and have **invested £3m in the ZEFI project.**



Markets and removals

The implementation of carbon markets and greenhouse gas removal technologies is vital to achieving Jet Zero.

We aim to have legislation for the **Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)** in force no later than 2024, and are working with the UK ETS Authority to **enhance the effectiveness of the UK Emissions Trading Scheme (UK ETS).**



Influencing consumers

We want to **preserve the ability for people to fly** whilst supporting consumers to make sustainable aviation travel choices.

We will publish a Call for Evidence on our proposal to **provide consumers with environmental information at the time of booking in autumn 2022**, working with the Civil Aviation Authority.



Addressing non-CO₂

Tackling the climate impact of aviation is not just about reducing CO₂ emissions, there are other non-CO₂ impacts that also affect the climate and local air quality.

Our focus is to **increase our understanding** of non-CO₂ impacts as the exact scale of their effect remains uncertain.

System efficiencies

Overview

- 3.3 System efficiencies remain one of the key foundations of our Strategy, providing short- to medium-term solutions, which will result in a significant proportion of emission savings before 2050. System efficiencies are not only an important area for emissions reduction in itself, but they also provide a more efficient environment in which future fuels and technologies are enabled and most effectively used. Whilst these low and zero emissions solutions are developed, continued improvements in efficiencies of our airspace, aircraft and airports offer the best opportunity to reduce emissions, with many of the solutions being available today.
- 3.4 There has been significant progress in this area. Plans for airspace modernisation have been developing at pace, with ACOG releasing the second iteration of the Airspace Change Masterplan in January 2022¹⁶. NATS have also been implementing live airspace changes, the most notable of which is the introduction of Free Route Airspace (FRA) over Scottish airspace in December 2021, which gives airlines much more freedom to fly optimised routes. The Airport Operators Association (AOA) published their Decarbonisation Report¹⁷ in October 2021, which sets out what UK airports have done and plan to do on the road to net zero. There have also been several developments in improving aircraft efficiency, including progress on Rolls Royce's UltraFan engine demonstrator. The largest engine in the world is now being assembled in the UK and will be tested later in 2022, offering a step-change in sustainability, saving 25% compared with first-generation Rolls-Royce Trent engines, and co-benefits from a reduction in local air pollutants and noise.

The importance of system efficiencies:

Next generation aircraft, such as the **Airbus A320neo**, offer around **20% efficiency gains** on their predecessors¹⁸



CO₂ emissions per passenger in 2019 were **22% lower** than 1990 due to efficiency improvements



2/3 of major UK airports have **net zero targets** prior to **2040**¹⁹

Co-benefits of proposed efficiencies:

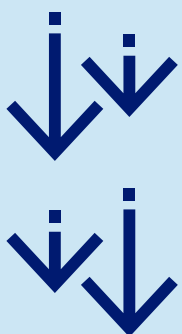
Moving to best-in-class aircraft, operations and airspace modernisation could deliver between **12-15% of CO₂ savings by 2050**²⁰



72,000 aerospace jobs on ultra-efficient aircraft by **2050**²¹



9.5% of annual CO₂ emissions from aviation avoided by ultra-efficient aircraft in **2050**²²



90% NOx reduction



65% reduced perceived noise per aircraft

by 2050 vs 2000 aircraft²³

Key actions:

All airport operations in England to be **zero emission by 2040**

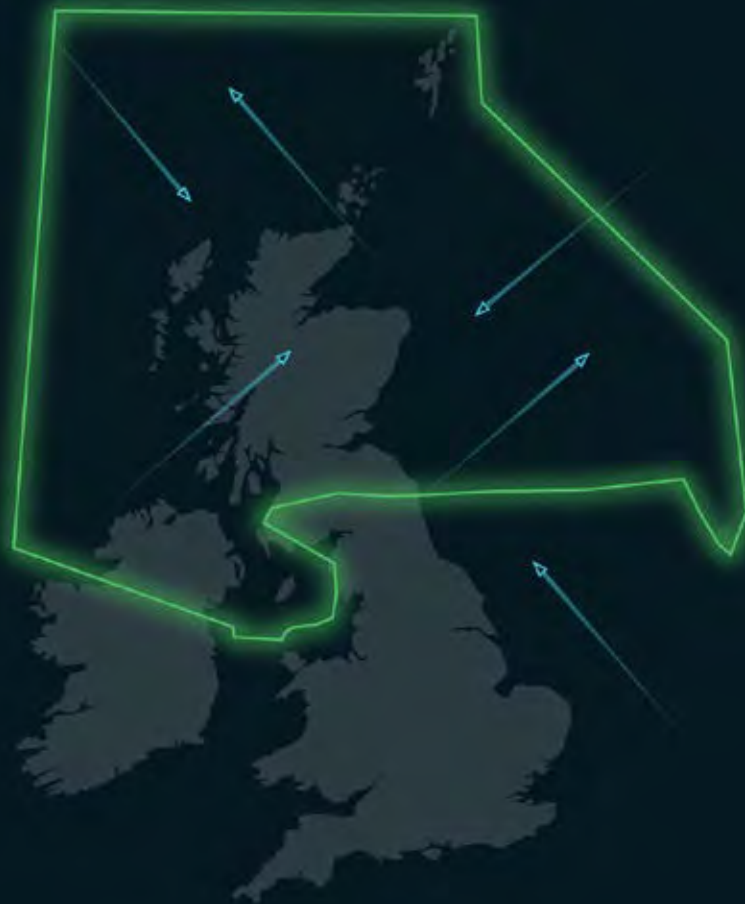
£9.2m funding between **2020-2023** to deliver airspace modernisation in the UK



NATS

FREE ROUTE AIRSPACE

DEPLOYMENT 1



Case study: NATS deployment of Free Route Airspace

In December 2021, NATS implemented the biggest airspace change ever undertaken in the UK, over Scotland and surrounding areas – a footprint twice the size of the UK and airspace that controls over 80% of transatlantic traffic. The introduction of Free Route Airspace (FRA) removes traditional air routes and allows airlines to flight plan and fly an optimal trajectory based on weather and wind speed between a defined entry and exit point.

It is estimated that the deployment of FRA in this area will enable a reduction of 500,000nm flown and up to 12,000 tonnes of CO₂ per year. Further benefits will be realised when FRA is extended across the rest of the UK in the coming years. FRA is also being implemented across Europe as part of a wider European plan to introduce cross-border FRA, which is estimated to result in a reduction in flying of one billion nautical miles and 20 million tonnes of CO₂.

Image courtesy of NATS

Strategic objectives

- Maximising and making efficient use of our existing airspace, aircraft and airports.
- All airport operations in England to be zero emission by 2040.
- Delivery of the Airspace Modernisation Strategy up to 2040.
- Grow UK share of the global aerospace manufacturing market as more efficient technology emerges.

Five year delivery plan policies

3.5 **Our ambition remains for all airport operations in England to be zero emission by 2040.** Whilst airport operations account for a relatively small percentage of total aviation emissions, it is right to place more ambitious targets on airports, reflecting that the aviation sector will face difficulties to reduce emissions overall. It is also an area where significant co-benefits, especially when combined with the introduction of new generation aircraft, can be realised by

reducing local air pollution and noise for local communities. The Mott MacDonald Feasibility of Zero Emissions Airport Operations in England by 2040 report²⁴ provides an early indication of the extent to which certain airport activities can be decarbonised by 2040 and highlights that our ambition can be achieved.

3.6 While many consultation respondents were supportive of this ambition, including in some cases recommending an earlier target, we recognise the views raised by some airports who have concerns about meeting the target. We are committed to working closely with the industry in both defining the details of our ambitions and looking at how best to overcome the challenges to delivery. **We will therefore publish a Call for Evidence in autumn 2022** to gather more information to support further development of the definitions and detailed implementation plans, as well as identify any specific areas that may be challenging to decarbonise.

Bristol Airport using zero emission battery powered ground handling equipment. Image courtesy of Bristol Airport.



- 3.7 **We will support airspace modernisation, providing £9.2m funding between 2020-2023 to drive forward progress in redesigning the UK's 'motorways in the sky' with the aim to deliver quicker, quieter, and cleaner journeys for those who use and are affected by UK airspace.** From 2020 we supported sponsors to continue through stage 2 of the airspace change process. In January 2022, we announced a further £3.7m to continue this support, helping airports develop more efficient flight routes that make use of modern technology, such as performance-based navigation.
- 3.8 **We will support ACOG, together with the CAA, to ensure carbon savings are realised as part of the wholesale changes to UK airspace being developed as part of the Airspace Change Masterplan²⁵, and plans for airspace modernisation account for the introduction of zero emission aircraft.** In January 2022, the CAA published ACOG's Airspace Change Masterplan Iteration 2²⁶. With the programme still in its relatively early stages, Iteration 2 of the Masterplan provides a system-wide view of when, where, and why changes are needed and the sequence of those changes. It describes how and where environmental inefficiency occurs in the current system (such as aircraft following longer flight paths and sub-optimal climb and descent profiles), which helps determine the four regional clusters for optimisation to ensure emissions savings are realised. It is estimated that the first two clusters of airspace changes will begin deployment in 2025, with the last, most complex cluster around London airspace estimated to begin deployment around 2027. Further iterations of the Masterplan will give more detail of the system wide impacts in terms of environmental goals, with the third iteration due towards the beginning of 2023.
- 3.9 **We will consider whether a mechanism is needed (voluntary or mandatory) for all airlines to avoid tankering where there is no practical reason to carry additional fuel, such as immovable turnaround times or fuel supply issues.** Initially, this will be assessed as part of the policy development for the UK SAF mandate. Analysis will be undertaken on the potential impact a SAF mandate may have on the likelihood of tankering, and whether a mandatory agreement will be required. This will determine whether we need to introduce a mechanism to restrict tankering separately from the mandate. Further details will be provided in the second SAF mandate consultation later this year.
- 3.10 **We are working with the ATI, industry and academia to establish a method for quantifying the potential emissions savings of future R&D projects for aircraft technology developments, to allow us to assess the sustainability benefits for the aviation sector and prioritise the funding of projects most likely to deliver clean growth.** The new ATI Technology Strategy, DestinATIon Net Zero²⁷, published in April 2022, focusses on technology developments for commercial aircraft and associated manufacturing industry with the potential to deliver the greatest sustainability and economic benefits.

3.11 We will ensure maximum potential is made of all flights and avoid unnecessary emissions from "ghost flights" that are empty or near empty when departing the UK. During the pandemic, we saw a decrease in average load factors across flights reflecting international travel restrictions and changes to passenger confidence to travel. There are several reasons why flights may need to operate with lower loads, such as an imbalance in demand between countries, provision of repatriation flights, and flights carrying freight. The usual rules requiring airlines to operate flights to retain their historic slots rights were waived in March 2020. As such, we do not believe that low-volume flights were undertaken simply to retain slots during this time. As the sector recovers, we will seek further transparency on this issue, working with the CAA on increased monitoring data on flight loads.

3.12 We will ensure that operational improvements are made wherever possible and that the appropriate forums are used to consider these. There are a number of potential improvements in operations which may not be fully covered by other policies, such as formation flight, differential airspace charging for more efficient aircraft, and advanced airport operations, which will need collaboration between different parts of the sector to deliver. We will continue to track such developments and ensure they are being addressed by industry through ongoing engagement with industry working groups and the CAA. This will include continued support to the work of Sustainable Aviation and addressing issues around new operational requirements for zero emissions aircraft through the Jet Zero Council's Zero Emission Flight Delivery Group.

3.13 We will work through ICAO to ensure a global baseline for fuel efficiency, both through CO₂ certification standards and guidance to states on implementing operational efficiencies. ICAO's current CO₂ standard applies to new-type design aircraft, and from 2023, this standard will also apply to in-production aircraft that are modified or meet specific change criteria. Any aircraft designs which do not meet this standard cannot be produced after 2028. We will support the work of ICAO to review and update the CO₂ standard by 2025.

Key performance indicators

- Call for Evidence published in 2022 on Zero Emission Airport Target, and final policy design concluded.
- The ATI use their sustainability model to investigate the CO₂ impact of different technology scenarios to prioritise government investment in projects with the highest potential to reduce emissions while delivering economic growth. We will work with the ATI to update this model annually as technologies are progressed and new projects are funded.
- Iterations of the Airspace Modernisation Masterplan continue to be delivered in accordance with co-sponsor commissions.

Sustainable aviation fuels (SAF)

Overview

- 3.14 Sustainable aviation fuels (SAF) are one of the key technologies available to government and industry to achieve Jet Zero. SAF are drop-in fuels, meaning they can be blended into fossil-based aviation fuel and used in existing aircraft and infrastructure without modification and therefore could deliver both short- and long-term CO₂ emissions savings, and potentially reduce non-CO₂ impacts. These advanced fuels, obtained from sustainable feedstocks, can achieve lifecycle emissions savings of over 70% compared with conventional jet fuel, when fully replacing kerosene. Some experts view SAF as the only alternative to kerosene for long-haul flights up to 2050.
- 3.15 Our ambition is to build a thriving UK SAF production industry, bringing UK innovations to the commercial market, supporting thousands of green jobs, and the UK's fuel security. In parallel, we will work internationally through ICAO and initiatives like the World Economic Forum's SAF Ambassadors to facilitate greater global use of SAF.
- 3.16 SAF development and production is currently limited due to high capital costs, as well as its reliance on technology that is yet to be proven at scale. We are encouraged by the recent progress made by industry, such as Phillips 66 Limited Humber Refinery becoming the first in the UK to produce SAF at a commercial scale. The RAF also achieved a world record in late 2021 with the first ever flight using entirely synthetic fuel, with an Ikarus C42 microlight aircraft powered by synthetic gasoline. However, we recognise that to accelerate the domestic production of SAF and to achieve our mandate ambition, significant economic and technical barriers need to be overcome. We are working closely with industry to identify and overcome these, including through the Jet Zero Council SAF Delivery Group (SAF DG).

The importance of SAF:

Aviation fuel
usage reached

12.4Mt
in 2019²⁸



SAF are a 'drop in' option which can be used in existing aircraft without modification and are already available for commercial use²⁹

When fully replacing kerosene, SAF use achieves, on average,

over 70%

GHG emissions savings
on a lifecycle basis

SAF will be essential to achieve **net zero aviation** for medium and long-haul flights, which account for around

80% of the CO₂ emissions from aviation³⁰

Our "High Ambition" scenario projects approximately
5m tonnes of SAF are required by 2050
to meet our net zero target

Key actions:

We have committed to having **at least five commercial-scale UK plants under construction by 2025**

We will support the delivery of the first net zero transatlantic flight running on **100% SAF** with up to £1m of funding

Our previous advanced fuels competitions have supported the development and commercialisation of SAF pathways since 2014:

£25m Advanced Biofuels Demonstration Competition (ABDC) – launched in 2014

£22m Future Fuels for Flight and Freight Competition (F4C) – launched in 2017

£15m Green Fuels Green Skies Competition (GFGS) – launched in 2021

We will provide

→ **£180m**
new funding
between
2022-2025

to support the commercialisation of SAF plants and fuel testing in the UK

We will have a SAF mandate in place by 2025, **reducing greenhouse gas emissions through the uptake of aviation fuel by the equivalent of at least**

10% SAF use
by 2030



The co-benefits of a UK SAF industry:

By 2035, the development of a SAF industry could generate up to

£2.7bn GVA

for the UK from UK production and global exports



By 2035, the development of a domestic industry for the production of sustainable aviation fuels is expected to **support up to**

5,200
UK jobs³¹



Case study: Phillips 66 Limited

The Phillips 66 Limited Humber Refinery near Immingham is the first plant in the UK to produce SAF at scale. Phillips 66 Limited have leveraged the capabilities of their existing refinery to produce SAF from waste cooking oil and other waste derived oils. Currently the refinery has the capability of producing approximately 20,000 metric tonnes per year, with plans to increase to more than 53,000 metric tonnes per year by 2025. The SAF produced at the Humber Refinery has

already been supplied to several UK airports, including London Heathrow, via the existing pipeline structure. In March 2022, British Airways took its first delivery of SAF from the Humber Refinery as part of its multi-year supply agreement with Phillips 66 Limited.

Image courtesy of Phillips 66 Humber Refinery,
South Killingholme, North Lincolnshire

Strategic objectives

- We will have a SAF mandate in place by 2025, reducing greenhouse gas emissions of aviation fuel by the equivalent of at least 10% SAF use by 2030.
- Working with the private sector to build a thriving domestic SAF industry, with a commitment to have at least five commercial-scale UK plants under construction by 2025.
- Working in partnership with industry and investors to build long term supply.
- Establish world-class testing and certifying facilities for SAF in the UK.

Five year delivery plan policies

3.17 We will implement a SAF mandate which will come into force in 2025. The SAF mandate will set an obligation on fuel suppliers to reduce the greenhouse gas emissions of aviation fuel by the equivalent of at least 10% SAF use by 2030. In July 2021, we consulted on a UK SAF mandate³² which set out a variety of potential SAF uptake scenarios that would see at least 10% of liquid aviation fuel usage to be met by SAF by 2030 and up to 75% by 2050. As confirmed in the Government response to this consultation, the mandate will be a greenhouse gas (GHG) emissions scheme based on tradable credits, which will allow suppliers to meet their obligation in a flexible and cost-effective manner whilst also achieving significant GHG savings. We will publish a follow-up consultation in autumn 2022 to refine the practicalities of implementing a mandate, as well as the monitoring and reporting mechanisms the mandate will introduce. We will need to prepare secondary legislation to implement the mandate, and we expect to kick-start this process in mid-2023.

3.18 We will engage with stakeholders to build an evidence base for potential complementary support to build a UK SAF industry. We understand that industry feels that additional support should form a key part of any comprehensive policy framework to build a UK SAF sector. We acknowledge the investment risks of producing SAF compared to fossil jet fuel and the ask for additional support to develop a UK industry, including loans and guarantees. We must ensure that any support intervention has the potential to reduce the cost of finance for SAF developers as well as reduce overall costs to government and would need further careful consideration given the potential costs and unintended consequences.

3.19 Evidence is required on how to target any potential intervention by better understanding where the market failures are in the SAF investment lifecycle, what the best timing and form of intervention could be, and interactions with UK SAF policy. Over summer 2022, we will continue to work with industry on how to create the long-term conditions for investable projects in the UK through a series of workshops and bilateral meetings followed by a call for evidence this year if necessary. Through this engagement we will work with industry to gather evidence on the market failure, and the need for any complementary support options from industry or government to stimulate and accelerate the development of a UK SAF industry. **We would like to reach a preferred government position on how to further stimulate investment in a UK SAF industry by the end of the year.**

3.20 We will continue to support the development of SAF through advanced fuels funding competitions.

We have now launched the Advanced Fuels Fund, which will provide £165m of capital grant funding to support first-of-a-kind commercial and demonstration plants, helping leverage private investment and de-risk future investment. This funding will be available for three years and will build on the progress made in our previous advanced fuels grant competitions, such as the Green Fuel Green Skies (GFGS) competition and the Future Fuels for Flight and Freight Competition (F4C). In addition, £400m of funding is being made available through a government partnership with Breakthrough Energy Catalyst to drive private sector investment into the next generation of green technologies, through which advanced fuel production projects may seek additional capital. These competitions aim to aid in the development of first of a kind commercial SAF plants in the UK, helping to kick-start a UK SAF industry and, along with the introduction of the mandate, allow us to reach our commitment to see at least five commercial-scale UK SAF plants under construction by 2025.

3.21 We will establish a SAF clearing house to enable early stage aviation fuel testing as an essential capability to support our decarbonisation agenda.

Through the Net Zero Strategy, £12m of new funding was announced for a SAF clearing house. The clearing house will deliver early-stage aviation fuel testing, funding, and expert advice for producers of new fuels hoping to enter testing at all certification stages/pathways. We anticipate a domestic clearing house would build on and further develop existing UK expertise to help reduce uncertainty, cost, and time barriers to SAF development which in turn will broaden the scope of eligible fuels without sacrificing safety. It is our ambition to establish the UK clearing house by the end of 2022 and start providing funding for fuel testing thereafter.

3.22 We will work in partnership with the financial community including the UK Infrastructure Bank, industry and investors, as well as through our existing partnerships with the Jet Zero Council and Breakthrough Energy Catalyst

to understand the possible market failures and how any potential interventions – by industry or government – should be targeted. We need to work together to unlock the capital needed to scale up the UK SAF industry to ensure existing and future SAF policy remains effective at driving investment in the UK.

- 3.23 **We will support the delivery of the first net zero transatlantic flight running on 100% SAF with up to £1m of funding.** In May this year we launched a competition to support the delivery of a UK-US flight running on 100% SAF. We have run an expression of interest and are now moving to closed competition for airlines that were shortlisted at that stage. We aim to announce the winner of the competition by autumn 2022, and we will work with the winning airline and delivery partners to ensure this flight can take to the skies in 2023.
- 3.24 **Joint industry and government work will continue, including through the Jet Zero Council SAF Delivery Group.** The SAF DG and its subgroups have already had a direct and meaningful role in informing and accelerating SAF policy development – having driven progress on the development of a SAF mandate, the commercialisation of SAF and the technologies and feedstocks required for SAF production, and the provision of SAF at Scottish airports during COP26. Over the summer and autumn 2022 we will continue to engage with industry, including through the SAF DG and through our development of a Low Carbon Fuels Strategy, to inform the development of our SAF policy.
- 3.25 **All parts of government will work together to pioneer the accelerated procurement and use of SAF.** We recognise that collaborating across government promotes innovation and ensures relevant knowledge is disseminated to inform the development of policy for SAF production, commercialisation, and use. Work continues across government and across several policy areas, including carbon capture, utilisation, and storage (CCUS), biomass, gasification, nuclear, GGRs, direct air capture (DAC), feedstock availability and procurement.
- 3.26 **We intend to reward recycled carbon fuels (RCFs) under the Renewable Transport Fuel Obligation (RTFO). A focused consultation on the inclusion of RCFs in the RTFO** will be published shortly. Supporting RCFs under the RTFO will encourage fuel suppliers to exploit non-recyclable biogenic waste that is otherwise difficult and costly to separate from residual waste, as well as industrial gases, which will bring greater quantities of SAF to market. It will also stimulate investment into SAF as well as providing early revenue support for this emerging industry. In the SAF mandate government response, we confirm that RCFs will be eligible for support under the SAF mandate, subject to meeting the sustainability criteria, which will be finalised ahead of the launch of the scheme. We expect the SAF mandate will mirror the RCF provisions we are planning to introduce under the RTFO to ensure the two schemes interact smoothly once the mandate becomes operational.

3.27 **We will look at the desirability of using SAF on existing UK government funded Public Service Obligation (PSO) routes.** We are exploring options to introduce further environmental conditions for PSO routes, such as encouraging operators to use a certain portion of SAF.

3.28 **As part of the five year reviews of this Strategy, we will undertake regular assessments of the SAF trajectory to 2050.** As outlined in the SAF mandate consultation, there is currently variation in our projections of SAF uptake as a percentage of total aviation fuel demand by 2050. In the "High ambition" illustrative scenario set out in the "clear goal, multiple solutions" section, SAF uptake reaches 50% by 2050, which would require a rapid scale up of SAF and a range of barriers will need to be overcome. We will seek further views on how we can ensure the mandate can accelerate SAF use and development in the second mandate consultation and will review the overall trajectory in the five year reviews of the Jet Zero Strategy. This will allow our target to be reflective of the developments in this space and increase our interim SAF usage targets if the market and the technology develop quickly and SAF costs and carbon abatement costs come down significantly.

3.29 **We will continue to utilise the Clean Skies for Tomorrow (CST) SAF Ambassadors group, which develops, pilots, and promotes industry-led policy proposals for national SAF policies.** During COP26, we worked with CST and other states to launch a SAF policy toolkit, which provides practical advice to governments and industry to support the acceleration of SAF. The group currently includes official and ministerial representation from Costa Rica, Kenya, Netherlands, the UAE, Singapore, and the UK. We are working with the CST to develop plans for the future of the group, including regional workshops to promote the toolkit.

3.30 **We will negotiate in ICAO for comprehensive SAF sustainability standards and to work towards a future global SAF objective.** In November 2021, ICAO adopted a comprehensive set of sustainability criteria for SAF meaning that from 2024, SAF will need to meet social, economic, and environmental sustainability criteria to be eligible for use by airlines under CORSIA.

Key performance indicators

- SAF mandate introduced in 2025.
- Reducing greenhouse gas emissions of aviation fuel by the equivalent of at least 10% SAF use by 2030.
- At least five commercial-scale UK SAF plants under construction by 2025.
- Establishing a UK SAF clearing house by the end of 2022.
- Multiple UK SAF projects attracting private investment by 2025.



Image courtesy of Rolls-Royce

Zero emission flight (ZEF)

Overview

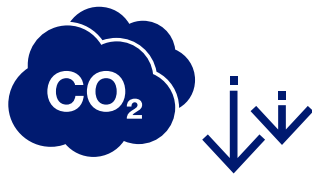
- 3.31 The UK is already showing leadership in the development of exciting, emerging forms of aircraft that offer the potential for zero carbon tailpipe emissions (zero emission flight). Small battery electric aircraft are already in use in the UK's General Aviation (GA) sector. There is also a range of development activity underway globally on the use of hydrogen in commercial aviation including by Airbus who have announced their intent to bring into commercial service hydrogen aircraft by 2035. To assess the feasibility of zero emission flight the Government funded an independent study, the FlyZero project. This project concluded that whilst continued research was needed there is a viable technical and commercial case for the use of liquid hydrogen as an aviation fuel in long-haul aviation.
- 3.32 We will maintain the successful government and industry AGP and continue to provide public co-investment into zero-carbon emission aircraft development through the ATI Programme. The ATI Programme has supported technology development of hydrogen aircraft such as GKN's H2Gear and ZeroAvia's HyFlyer. And with ATI programme backing, Rolls Royce broke the world all-electric air speed record with their 'Spirit of Innovation' aircraft in late 2021.
- 3.33 We acknowledge that the adoption of novel new technology, such as hydrogen aircraft, will require the production of low carbon hydrogen at scale, plus the establishment of ground infrastructure at airports to handle new types of aircraft and fuel. Our advisory body the Jet Zero Council, including its new Delivery Group on Zero Emission Flight, will continue to consider the above factors. With a wide membership across industry and academia the group will identify and recommend solutions to barriers to the commercial adoption of zero emission aircraft.

The importance of zero emission aircraft

Zero-carbon liquid hydrogen offers a

100% reduction

in lifetime CO₂ emissions and no tailpipe CO₂ emissions relative to kerosene.



Progress so far:

In 2021 Rolls Royce broke the world all-electric air speed record with their **Spirit of Innovation aircraft**³³

Airbus have announced plans to bring to market a **zero emission commercial aircraft by 2035**³⁴

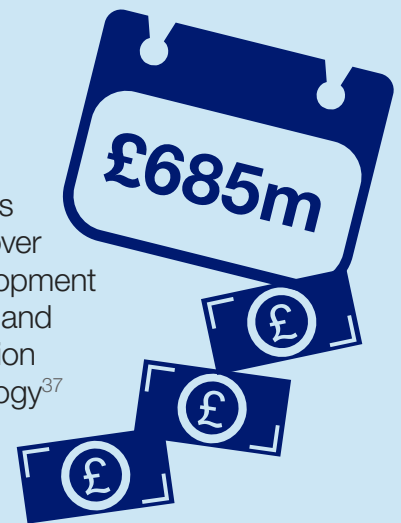
In May 2022 Cranfield University **installed a hydrogen re-fuelling station** which can serve its co-located airport³⁵

Key Actions:

We will **double** our UK ambition for hydrogen production to up to **10GW by 2030**, with at least half of this from electrolytic hydrogen³⁶



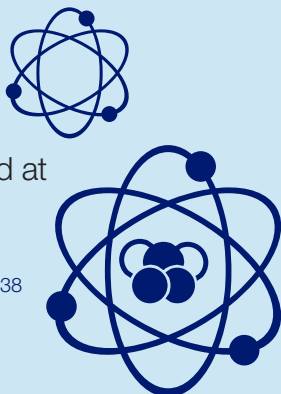
In March 2022, **£685m government R&D funding** was granted to the ATI Programme over 2022-2025 to support the development of zero-carbon and ultra-low emission aircraft technology³⁷



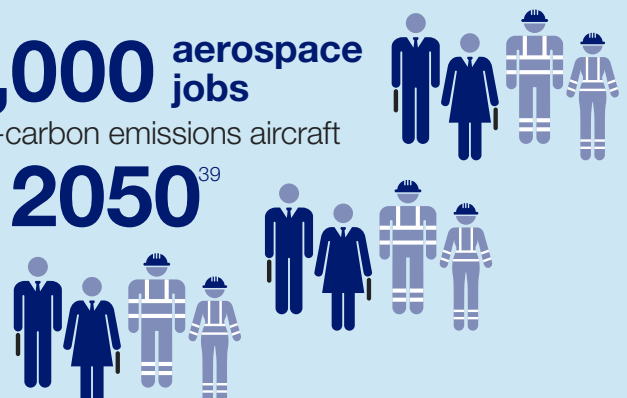
Co-benefits of ZEF industry:

Rapid investment in hydrogen aviation could see the UK securing:

Up to **19%** global aerospace industry share, valued at **£178bn** per annum in 2050³⁸



60,000 aerospace jobs on zero-carbon emissions aircraft **by 2050**³⁹





Case Study: Airbus ZEROe Demonstrator

Airbus aim to bring a zero emission commercial aircraft to market by 2035 and in April 2022 announced the launch of a Zero Emission Flight Development Centre in Filton, Bristol.

In 2022, Airbus launched their ZEROe Demonstrator with the aim to test hydrogen combustion propulsion technology on an A380 multimodal platform. Three concept hybrid-hydrogen aircraft have been designed to enable the exploration of a variety of configurations and hydrogen technologies that will shape the development of future

zero emission aircraft. They are powered by hydrogen combustion through modified gas turbine engines, where liquid hydrogen is used as a fuel for combustion with oxygen. In addition, the onboard hydrogen fuel cells create electrical power that complements the gas turbine, resulting in a highly efficient hybrid-electric propulsion system.

Airbus ZEROe concept aircraft powered using liquid hydrogen. Image courtesy of Airbus.

Strategic objectives

- Grow UK share of the global aerospace manufacturing market as new forms of aircraft emerge.
- Facilitate collaboration between aviation, other transport modes and sectors of the economy on the adoption of hydrogen.
- Ensure parallel development of aircraft with the energy and ground infrastructure required for their operation.
- Ensure the aviation sector workforce is prepared for the introduction of new aircraft.
- Stimulate future innovation by promoting diversity and accessibility in the sector.
- Put in place the policy and regulatory system to enable zero emission aircraft to enter commercial service and deliver our aspiration of zero emission routes connecting different parts of the United Kingdom to be realised by 2030.

Five year delivery plan policies

- 3.34 **As part of the Government's £22 billion annual investment in R&D⁴⁰ we will continue to support industrial R&D through the ATI Programme, informed by the UK Aerospace Technology Strategy.** In March the Government announced a funding uplift for the ATI programme of £685m over three years. This represents an increase of 50% on the previous 3 years. The ATI Technology Strategy notes zero emission aircraft technologies as one of three priority areas.
- 3.35 **The Government remains committed to UK association to Horizon Europe as agreed in the 2020 Trade and Cooperation Agreement with the EU.** In the event that the UK is unable to associate to Horizon Europe, the funding allocated to Horizon association will go to UK government R&D programmes, including those to support new international partnerships. Through any alternative programme, supporting our research community to continue collaborating with their European partners will remain a top priority.
- 3.36 **We will ensure the UK is at the forefront of deploying zero emission aircraft, with an aspiration to have zero emission routes connecting different parts of the United Kingdom by 2030.** We will work towards this aim by working with the CAA and ICAO to ensure the UK remains the best location in which to develop and deploy new zero emission aircraft. We will also look at the feasibility of using zero emission aircraft on existing UK government funded PSO routes, and review to what extent we can and should go further in pioneering zero emission requirements on publicly subsidised journeys. This will require consideration of the balance between reducing aviation emissions whilst ensuring value for money on PSO routes supported by public funding.
- 3.37 **We will maintain our evidence-based approach supporting industry and academia to innovate.** The FlyZero project⁴¹ provided valuable evidence on the technologies required to enable zero emission flight and the commercial and technical considerations of bringing such an aircraft to market. We are keen to see industry accelerate the development and testing of new zero emission aircraft keeping the UK at the forefront of an exciting new industry. The ATI will use a sustainability model they have developed to investigate the CO₂ impact of different technology scenarios to prioritise government investment in projects with the highest potential to reduce emissions while delivering economic growth. We will work with the ATI to update this model on a yearly basis as technologies are progressed and new projects are funded.
- 3.38 **We will convene and support industry to develop the ground infrastructure necessary to fuel and handle zero emission aircraft, including activities at GA airfields.** The Government funded the Zero Emission Flight Infrastructure (ZEFI) project in 2021/2022. To take forward this work a Zero Emission Flight Delivery Group (ZEF DG) of the Jet Zero Council has been established to convene activity across aviation, aerospace and the energy sector. Through award winning architects and engineers, the UK designs, and constructs world renowned airport infrastructure across the globe. The Government will support the sector to maintain this advantage as airports adapt to handling zero emission aircraft.

3.39 We will look to invest in apprenticeships and training programmes to up- and cross-skill talent in the UK to work in ZEF, and across the aviation sector. We will achieve this aim through aligning our skills ambition with the AGP strategy Destination Net Zero to ensure a consistent approach throughout government and industry. Additionally, we are working in partnership with the Connected Places Catapult to undertake a research project on future aviation skills. The Future Aviation Skills research project will look to determine what skills the aviation workforce will need in order to fully integrate emerging aviation technologies, including ZEF technologies, and will provide recommendations as to how industry and government can best ensure that these skills needs are met. This is especially important as a better understanding of the novel zero emission technologies will result in effective support during its rapid development and then into commercialisation. We are also building partnerships with colleges and universities to help build and upskill a future talent pipeline capable of taking forward long-term innovation work including in green skills and ZEF.

3.40 We will support the development of the Tees Valley Transport Hydrogen Hub, including through industry engagement, to generate demonstration activity at Teesside International Airport, supporting future demand and investment in the region. The Government published the British Energy Security Strategy⁴² in April 2022, which details our new ambition of achieving 1GW and 10GW of low carbon hydrogen production capacity by 2025 and 2030 respectively. This is supported by the UK Hydrogen Strategy⁴³ which provides the key steps needed in the 2020s to meet our targets and has set the context for further scale up on the way to net zero.

3.41 Government and industry will work jointly through the newly established Jet Zero Council ZEF Delivery Group. The Jet Zero Council provides a platform which will be used to consider the wider enabling framework for zero emission flight, including the infrastructure, regulatory and commercialisation requirements. It will consider how best to take forward the conclusions of the FlyZero and ZEFI projects, and support the delivery of our ambition for zero emissions routes in the UK this decade.

General Aviation

3.42 We will encourage the adoption of innovative zero emission aircraft and aviation technology in GA. GA is a diverse sector and includes activities such as business aviation, emergency services (e.g. Search and Rescue), pilot training, and recreational flying. Often referred to as the 'grass roots' of aviation, GA can be a critical enabler and testbed for the development and implementation of new, greener technologies across all forms of aviation. Now is the ideal window of opportunity for GA to support and accelerate this implementation both within GA but also within the commercial sector where large scale benefits can also be realised. We will engage closely with the sector on how it can adapt, support and engage with the opportunities that decarbonisation brings.

3.43 We will use newly commissioned research, which aims to provide an evidence baseline in carbon emissions emitted by GA operations. This new evidence base will support the development of ambitious new policies to enable government to support the implementation of new technologies, procedures and regulation in supporting the GA sector adopt and introduce new technologies and greener ground-based infrastructure.

Key performance indicators

- Zero emission routes in the UK by 2030
- Successful demonstration of zero emission technologies, including those funded through the ATI Programme.
- Increased public awareness of hydrogen aircraft by 2027 via the biannual public attitudes survey: 'Transport Technology Tracker'⁴⁴.
- Increased number of zero emission flight projects across aircraft technology and infrastructure support that have developed from R&D to pilot testing and initial stage small scale commercialisation.
- Diverse stakeholder representation within the Jet Zero Council ZEF DG and sub-group workstreams.



Rolls-Royce 'Spirit of Innovation' aircraft. UK government investment, through the ATI Programme, helped enable Rolls-Royce to achieve the world's fastest all-electric plane in 2021. Image courtesy of Rolls-Royce.

Markets and removals

Overview

- 3.44 Successful carbon markets and investment in Greenhouse Gas Removal (GGR) technologies are vital for the aviation sector to meet the UK's net zero target. Carbon markets, where airline operators can obtain and surrender allowances, are now well established and also have the potential to facilitate investment in GGR technologies through enabling the integration of negative emissions. Carbon markets can provide a mechanism for decarbonisation to occur where it is most cost-effective to do so and provide a useful price signal for investors. This will be especially beneficial for the aviation sector and other hard-to-abate sectors that are likely to have emissions by 2050.
- 3.45 But we know that there are also challenges in deploying and scaling up nascent GGR technologies as well as building industry-wide support for their use. An international approach to carbon markets, for example by working through organisations such as ICAO, is required to help maximise value for money, maintain competitiveness and attract investment. The Government is committed to showing leadership in setting standards and targets to reduce carbon emissions but will engage purposefully with the aviation sector to ensure that targets and standards established by a markets and removals framework are achievable and properly costed.
- 3.46 The UK Emissions Trading Scheme (UK ETS) covers all domestic flights in the UK as well as flights from the UK to the EEA, and to and from Gibraltar. This Strategy draws on UK ETS Authority proposals in the Developing the UK ETS consultation to increase the ambition of the scheme by aligning the cap with a clear net zero trajectory, and new carbon price assumptions which illustrate the potential costs faced by airline operators in future. This Strategy also reflects the need to expand the reach and impact of carbon markets by facilitating interaction between UK ETS and other international schemes such as CORSIA.

Case study: Carbon Engineering Direct Air Capture system

Since 2009, Carbon Engineering (CE) has pioneered a liquid sorbent-based Direct Air Capture (DAC). The DAC system is optimised for scale and can be used to support aviation decarbonisation in two complementary ways. Its AIR TO FUELS™ process produces highly scalable, low carbon intensity synthetic fuels. It also produces permanent, verifiable carbon removal that captures and stores atmospheric CO₂ underground. This provides a flexible tool that has the potential to address aviation's 'hard to abate' residual emissions at scale. CE's DAC platform can be built in one or more modules, each capable of capturing 500,000 tonnes of CO₂ annually. CE is now working with global partners to deploy at commercial scale. In cooperation with 1PointFive, CE is designing the first commercial-scale plant in the US Permian Basin. Operations are planned to begin in 2024. 1PointFive recently shared plans to deploy 70-135 such megatonne-scale plants by 2035. In the UK, CE is working with Storegga. The partners are currently engineering a DAC facility, targeted for North-East Scotland. The facility is expected to be operational in 2026 and capable of capturing between 500,000 and one million tonnes of CO₂ per year.

The importance of markets and removals

We are aiming to have all legislation for **CORSIA in place by 2024**, covering the majority of international flights departing the UK

Carbon Offsetting Reduction Scheme for International Aviation (CORSIA):

CORSIA is the first worldwide offsetting scheme of its kind to address **CO₂ emissions** in any single sector

From 2023, a total of **114 States** have volunteered to participate in CORSIA, representing nearly **80% of international aviation activity**⁴⁵



UK Emissions Trading Scheme (UK ETS):

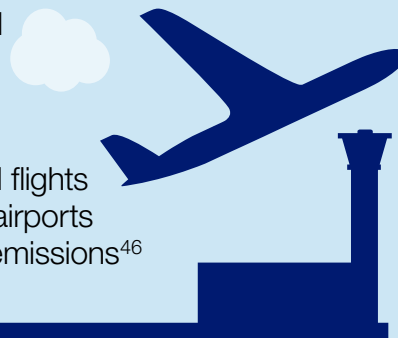
The UK ETS promotes **cost-effective decarbonisation**, allowing businesses to cut carbon where it is cheapest to do so



UK ETS-covered flights made

44%

of all commercial flights to and from UK airports based on 2019 emissions⁴⁶



Approximately, **27%**

of emissions from UK departing flights were covered by the UK ETS based on 2019 emissions⁴⁷

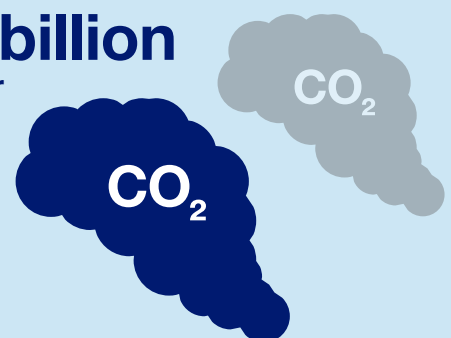
We have consulted on amending the UK ETS cap to align with net zero, and to seek views on the future of free allowances, SAF uptake and non-CO₂ impacts

Greenhouse gas removals (GGRs):

We are providing **£100m** in research and innovation funding for Direct Air Capture and other GGRs



We have committed to £1 billion in investment to develop four Carbon Capture, Usage and Storage clusters aiming to capture and store between **20-30 MtCO₂ a year by 2030**⁴⁸



We are exploring the potential of UK ETS as a long term market for both nature-based and engineered GGRs, and the preferred business models to incentivise investment in engineered GGRs

Strategic objectives

- Develop carbon markets that set a sustainable pathway towards decarbonisation and cover all aviation emissions.
- Continue to explore options to develop robust negative emissions markets as mechanisms to allow hard-to-abate sectors such as aviation to balance residual emissions.

Five year delivery plan policies

- 3.47 **We aim to have all legislation for CORSIA and any consequential amendments that may be required in force by 1 January 2024, enforce it robustly and encourage other states to do the same.** Sustained reductions in aviation emissions can only be achieved on an international basis. We recognise that, due to the structure of the aviation sector, many aircraft operators will have obligations under both the UK ETS and other emissions trading schemes, such as the EU Emissions Trading Scheme (EU ETS) and CORSIA. We continue to gather and assess evidence regarding compliance with multiple schemes, which will help to inform international engagement and potential co-operation on operational features of the scheme.
- 3.48 **We will enhance the effectiveness of the UK ETS, in collaboration with the devolved administrations through the UK ETS Authority.** A consultation on the proposed developments to the UK ETS closed in June 2022. It covered a range of aviation policy elements for which the Authority proposed different implementation approaches based on evidence from previous stakeholder engagement, industry readiness and broader ambitions for net zero policy. This includes the level of ambition for the UK ETS and the future of free allocation of allowances, as well as the role that the UK ETS can play in the future incentivisation of SAF.
- 3.49 **We are committed to maintaining the integrity of the UK ETS for aviation in supporting decarbonisation activities.** We are exploring the potential for the UK ETS to go further in supporting the decarbonisation of aviation, including gathering evidence of the feasibility and appropriateness of expanding the scope of the UK ETS to incorporate non-CO₂ impacts, and the potential for further international cooperation with other emissions schemes such as the EU ETS and CORSIA.
- 3.50 **We will continue to invest in the development of GGR technology.** The Government is already investing £100 million in research and innovation for Direct Air Capture and other GGRs and committed up to £1 billion in investment to develop four Carbon Capture, Usage and Storage clusters by 2030. We will continue to work with industry bodies and organisations on a range of policy initiatives that support our ambition to achieve net zero in the most cost-effective way.
- 3.51 **We are exploring the role that the UK ETS could play as a long-term market for GGRs and are considering this issue through the Developing ETS consultation.**⁴⁹ The UK ETS Authority is evaluating if the UK ETS has the potential to send a market signal for investment and accelerate the development and deployment of both engineered and nature-based solutions. The Authority is also assessing if including GGRs in the UK ETS could encourage competitiveness and increased efficiency of GGRs; if it could support ETS market liquidity and satisfy demand from sectors like aviation that are hard to decarbonise completely or; if a different approach would be better suited to facilitate a market for GGRs.
- 3.52 There are considerations that need to be made in respect of GGR inclusion. These include the establishment of robust monitoring, reporting and verification frameworks, avoidance of double counting with other schemes, and ensuring that

inclusion of GGRs into the UK ETS does not remove or weaken the incentive for sectors to decarbonise. It is also acknowledged that engineered GGRs are a relatively nascent technology which may require additional policy support to enable deployment at scale. The UK ETS Authority is collecting evidence on the potential interaction between the ETS and GGRs as one long-term approach. However, we remain open to the possibility that other steps, or a mixture of methods, may be better suited to supporting GGRs in future.

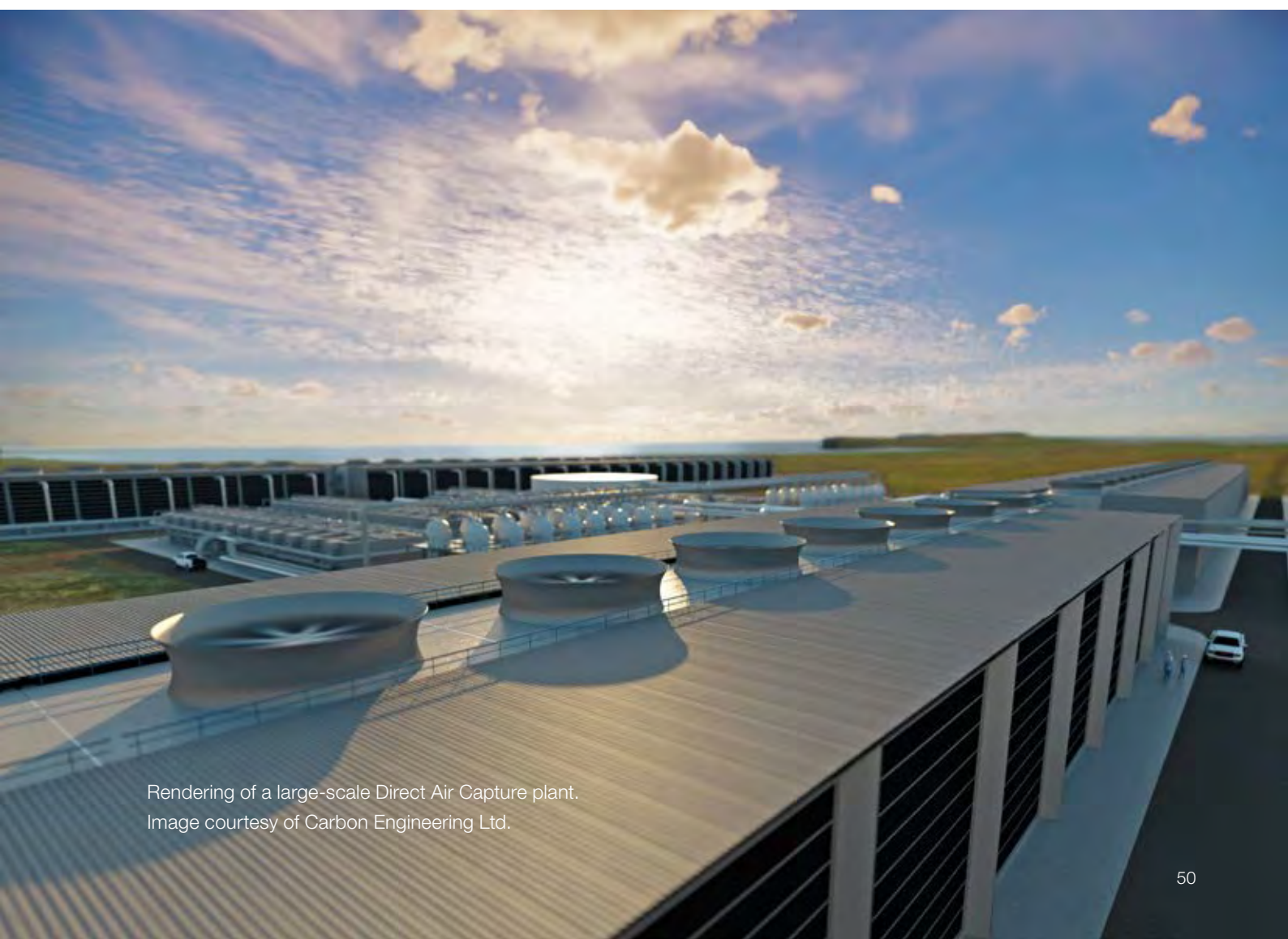
3.53 **We are exploring business models to incentivise investment in GGRs.**

Building on the Call for Evidence published in 2020⁵⁰ the Government is consulting on business models to incentivise early investment in engineered GGRs to enable deployment from the mid-to-late 2020s. The consultation

considers options for building a market for engineered removals, and outlines the Government's approach to monitoring, reporting and verification for initial GGR deployment to ensure that these projects provide permanent and verifiable removal of CO₂ from the atmosphere.

Key performance indicators

- Implement a net-zero consistent UK ETS cap and any decisions on aviation free allocation policy and interaction with the future SAF mandate by 2025.
- CORSIA fully implemented in the UK by 2024.
- Finalise business models and markets to support growth of GGRs and negative emissions by 2024.



Rendering of a large-scale Direct Air Capture plant.
Image courtesy of Carbon Engineering Ltd.

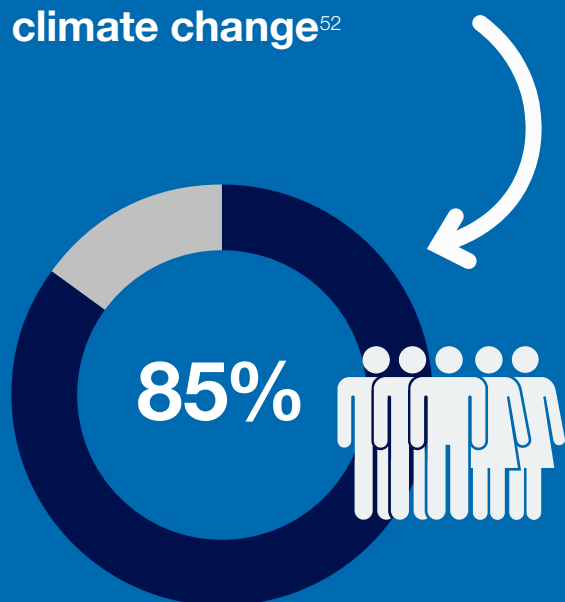
Influencing consumers

Overview

3.54 **Our aim is to preserve the ability for people to fly whilst supporting consumers to make sustainable aviation travel choices.** Our focus on influencing and informing consumers is an important part of our overall approach to Jet Zero. We want to empower consumers and businesses to make the greenest choices when flying, and by doing so, reward those parts of the sector who move quickly to decarbonise.

3.55 **We welcome the work the aviation industry is doing to encourage accurate and transparent reporting of CO₂ emissions per passenger, including IATA's recently launched Recommended Practice Per-Passenger CO₂ Calculation Methodology⁵¹.** This methodology takes into account various factors, including an emissions factor for the conversion of jet fuel consumption to CO₂, guidance on non-CO₂ related emissions and Radiative Forcing Index, and guidance on SAF and carbon offsets as part of the calculation.

Our public attitudes tracker shows that 85% of people are concerned about climate change⁵²



2/5
(39%)

of respondents **agree or strongly agree** that they would pay more for flight tickets to reduce the environmental and/or noise impact of flying⁵³



43% of UK adults surveyed said they are **willing to limit flying**, in order to reduce their contribution to climate change⁵⁴

Through our influencing consumers policies, we are aiming to increase the number of consumers making greener choices by:



1. **Providing environmental information to consumers at the point of booking a flight**
2. **Ensuring consumers have access to sustainable modes of transport to and from the airport**



- 3.56 **The Government remains committed to growth in the aviation sector and working with industry to ensure a sustainable recovery from the pandemic.** In our recently published strategic framework for the future of aviation – 'Flightpath to the Future'⁵⁵ – we recognise that airport expansion has a role to play in realising benefits for the UK through boosting our global connectivity and levelling up. The framework is clear that we continue to be supportive of airport growth where it is justified, and our existing policy frameworks for airport planning⁵⁶ provide a robust and balanced framework for airports to grow sustainably within our strict environmental criteria. We have also been clear expansion of any airport in England must meet our climate change obligations to be able to proceed.
- 3.57 Our approach to sustainable growth is supported by our analysis (set out in the supporting analytical document) which shows that **we can achieve Jet Zero without the Government needing to intervene directly to limit aviation growth.** The analysis uses updated airport capacity assumptions consistent with the latest known expansion plans at airports in the UK. The analysis indicates that it is possible for the potential carbon emissions resulting from these expansion schemes to be accommodated within the planned trajectory for achieving net zero emissions by 2050, and consequently that our planning policy frameworks remain compatible with the UK's climate change obligations.

Case study: Travalyst's shared framework to display flight emissions data

Travalyst, a non-for-profit sustainable travel organisation, and its coalition of seven top travel brands – Skyscanner, Google, Booking.com, Trip.com Group, TripAdvisor, Expedia Group and Visa – recently announced that they have aligned on a shared framework to collect and display flight emissions data. The framework consists of a set of shared principles and preferred methodology for estimating carbon emissions from air travel, which have been agreed and committed to by the coalition. This means that whether consumers are booking a flight on Skyscanner or Google (and in the near future, the rest of the distribution platforms in the coalition), they will be shown the same information.

Currently, the following factors are taken into account: origin and destination; aircraft types; cabin class and seat configuration; load factor (estimate); CO₂ emissions for cruise, climb and descent (estimate) and CO₂e (including contrails). Travalyst is working closely with IATA and other key stakeholders to align approaches to CO₂ calculations, and expect the model will be developed and improved over time with a goal of assessing a broader view of sustainability, beyond emissions.



Image courtesy of REDPIXEL.PL on Shutterstock

3.58 Our economy-wide Net Zero Strategy considers that, even if there was no step-up in ambition on aviation decarbonisation (e.g. through our "continuation of current trends" scenario), we would still be able to achieve net zero by 2050. However, this is not the approach we are taking: instead we are committing to ambitious action to reduce in-sector aviation emissions. Our "High ambition" scenario, which we will use to monitor the sector's progress, has 19.3 MtCO₂e residual emissions in 2050, compared to 23 MtCO₂e in the Climate Change Committee's (CCC) Balanced Net Zero Pathway.⁵⁷

Strategic objectives

- Consumers to have access to environmental information at the time of booking a flight.
- Consumers to have access to sustainable modes of transport to and from airports in England.
- Support growth in airport capacity where it is justified.

Five year delivery plan policies

3.59 **We will publish a Call for Evidence on our proposal to provide consumers with environmental information at the time of booking a flight in autumn 2022, working with the CAA.** The CAA published their Environmental Sustainability Strategy⁵⁸ in May 2022, which set out their overall strategic intent to improve total environmental performance in the aviation and aerospace system. Through their Strategy, the CAA have committed to consulting on their policy design and implementation proposal for sharing environmental information with consumers, and as a first step will be publishing a Call for Evidence in autumn 2022, with a consultation in 2023. They are aiming to have the policy in place by the end of 2023.

3.60 **We will work with airports, other government departments, local authorities, and other interested bodies to help airports in England improve their surface access through developing Master Plans and Surface Access Strategies.** An aviation passenger's journey includes more than the flight itself, and we want to ensure we have the right policies in place to encourage passengers and employees to travel on sustainable modes of transport to and from the airport where possible. As part of this, we will encourage airports to work with airlines, local authorities and local transport providers to consider how they can develop integrated service offerings with surface transport providers.

3.61 **We will support airport growth where it can be delivered within our environmental obligations.** The aviation sector is important for the whole of the UK economy in terms of connectivity, direct economic activity, trade, investment, and jobs. Before COVID-19, it facilitated £95.2 billion of UK's non-EU trade exports; contributed at least £22 billion directly to GDP; directly provided at least 230,000 jobs across all regions of the country and underpins the competitiveness and global reach of our national and our regional economies. We are committed to enabling a green recovery of the sector, as well as sustainable growth in the coming years. The Government's existing planning policy frameworks, along with the Jet Zero Strategy and the Flightpath to the Future strategic framework for aviation, have full effect and are material considerations in the statutory planning process for proposed airport development.⁵⁹

3.62 It is vital that local communities and the wider public have confidence that the impacts of airport expansion have been properly considered. Applicants should therefore provide sufficient detail regarding the likely environmental and other effects of airport development to enable communities and planning decision-makers to give these impacts proper consideration. **Applicants should engage with the relevant planning authority at an early stage of the planning process to agree an appropriate approach.**

3.63 Planning authorities and applicants should consider all relevant policy, guidance and other material considerations that may assist appraisal for airport development proposals and decision-making. Applicants should clearly set out their approach and findings in an accessible way that can be easily understood by the general public and decision-makers. The Government recognises the importance of a clear and consistent approach in relation to the assessment of a development's impacts in the process, and **will keep under review whether further guidance is needed to assist airport planning decision-making, with particular reference to environmental impacts.**

Key performance indicators

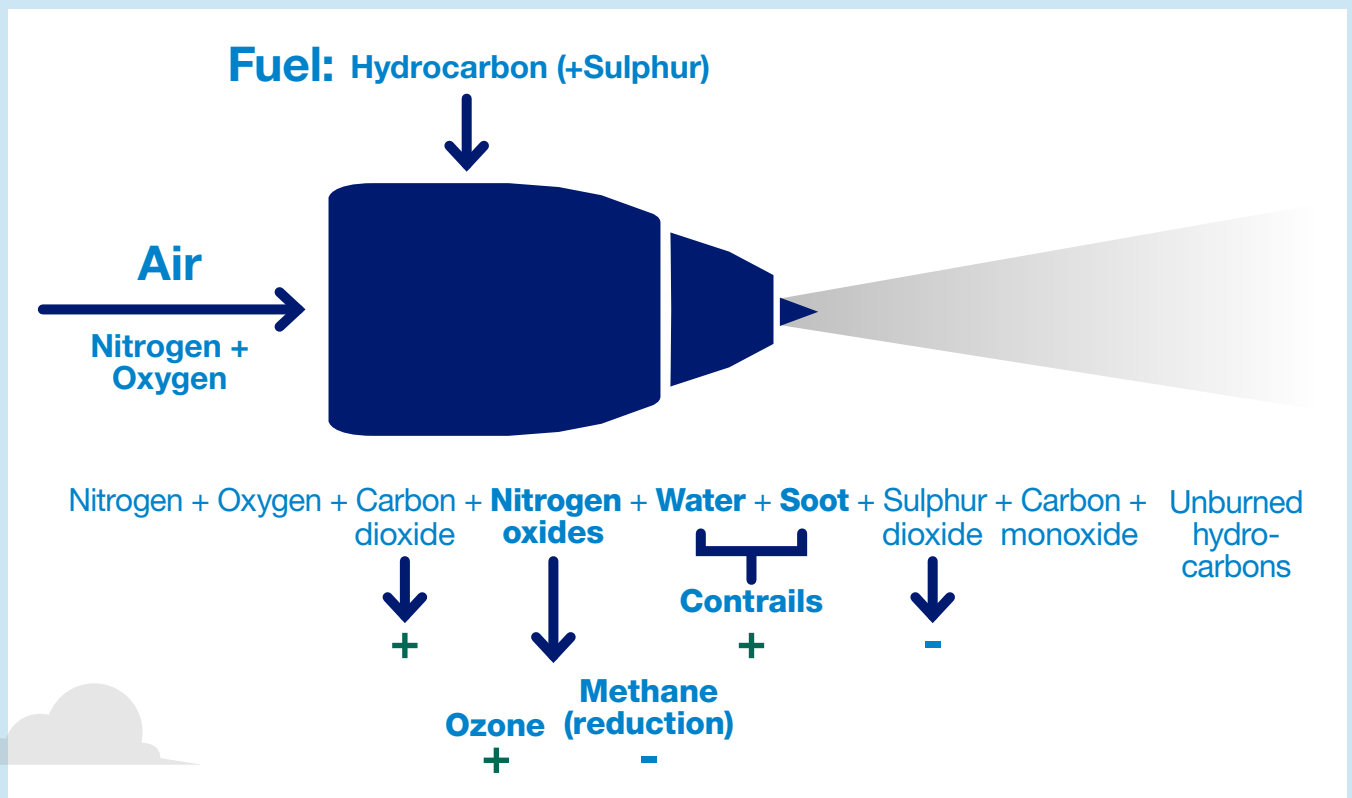
- Policy in place to provide standardised environmental information to consumers at the point of booking a flight.
- A continued increase in the proportion of UK adults who consider the impact of flying on the environment, as monitored through public attitude research.
- We will monitor passengers travelling to airports in England by public transport (e.g. bus, train, or tube, compared to car or private hire) covering airports reported within the CAA Departing Passenger Survey. We encourage airports to improve their surface access strategies to ensure easy and reliable access for staff and passengers, increase the use of public transport and minimise congestion, emissions, and other local impacts.

Addressing non-CO₂

Overview

- 3.64 Much of our Strategy focusses on how we reduce the CO₂ emissions from aviation, however, we also recognise that aviation has non-CO₂ climate impacts, which need to be addressed. There are large uncertainties over the magnitude of non-CO₂ impacts on climate. Recent scientific evidence suggests the best estimate is that roughly two thirds of aviation's historical climate impacts are due to non-CO₂, and that, whilst non-CO₂ emissions can have both warming and cooling effects⁶⁰, the net warming rate is likely to be around three times that of CO₂.⁶¹ The uncertainties are real however: the non-CO₂ impacts of aviation on climate are eight times more uncertain than those resulting from CO₂.⁶²
- 3.65 Research conducted by the National Aeronautics and Space Administration (NASA) and the German Aerospace Centre (DLR)⁶³ showed that SAF can produce 50%-70% fewer soot particles, which could reduce the warming impact of contrails. Increasing the understanding of the impact of SAF has also been a recent priority for the Jet Zero Council SAF Delivery Group. Moreover, the FlyZero project considered the merits of using hydrogen-powered aircraft on reducing non-CO₂ emissions. It concluded that further academic research is needed into the climate impacts of hydrogen-powered aircraft due to the potential of additional water vapour being emitted into the atmosphere.
- 3.66 The research and analysis carried out thus far suggests that many of the measures to improve efficiencies, rollout of SAF, and the acceleration of zero emission flight are expected to also have a positive impact on reducing non-CO₂ impacts. Where there is evidence to the contrary, we will carefully consider the overall impact on the climate and adjust our policies as required.

Addressing non-CO₂



What are non-CO₂ impacts?

CO₂ is the principal greenhouse gas emitted by aviation but important non-CO₂ effects can cause additional warming

Major forcings from aviation come from **contrail cirrus clouds, CO₂ and the 'net NOx' effect**, with minor contributions from water vapour, soot and sulphur aerosol-radiation interactions



What effect do non-CO₂ impacts have?

Non-CO₂ impacts currently represent around **66%** of the net effective radiative forcing (ERF): **this is not a fixed number** and is scenario dependent. Cumulative CO₂ emissions currently represent around **34%** of the net ERF⁶⁴

Non-CO₂ effects contributed **8x more than CO₂ to the uncertainties in 2018**⁶⁵

Non-CO₂ emissions can have both **warming cooling effects**



What can we do to tackle non-CO₂ impacts?

Research indicates SAF can produce **50%–70% fewer** soot particles, which could reduce the overall warming effect of contrails⁶⁶

We will carefully consider any need for **additional research and development activity on non-CO₂ effects, including working with UK Research and Innovation (UKRI)**



Strategic objectives

- Work closely with academia and industry, and monitor global developments in this area, to better develop our understanding of non-CO₂ impacts and potential mitigations.
- Develop and implement policies to address and reduce non-CO₂ impacts.
- Work with industry and academia, including the CCC, to explore a means of estimating and tracking non-CO₂ emissions from the UK aviation industry.

Five year delivery plan policies

3.67 We will continue to work with the scientific community and industry, including through the Jet Zero Council SAF Delivery Group, to increase our understanding and evidence of the non-CO₂ impacts of using SAF blend flights. Scientific evidence currently suggests that SAF could have a positive impact in reducing non-CO₂ impacts – specifically persistent contrail formation. There is good evidence through observations that SAF blends reduce soot, and therefore the amount of ice crystal formation. Airbus, DLR, Rolls-Royce, Neste, Manchester University and National Research Centre (NRC) Canada have partnered together on the

ECLIF3 project investigating the effects of 100% SAF on aircraft emissions and performance. The first in-flight trial has shown that combusting SAF releases fewer particulates than kerosene⁶⁷ and we will consider the outcome of this trial when the project publishes its results, expected to be in late 2022 to 2023. However, the degree to which this reduces the climate effect of persistent contrails is not well quantified, due to limited evidence and modelling and therefore we will continue working with the scientific community and industry to increase our understanding and evidence base.

3.68 We will work closely with atmospheric scientists, other researchers, industry and internationally to better understand the science and potential mitigations of non-CO₂ impacts from aviation. Furthermore, we will carefully consider any need for additional research and development activity on non-CO₂, including working with UK Research and Innovation (UKRI). We are also committed to working through ICAO to lead research into the non-CO₂ impacts of international aviation and their mitigation. As the evidence base develops we will support the consideration of appropriate international measures to address non-CO₂ impacts alongside reducing CO₂ emissions.

Case study:

Since first approved in UK Defence Standard 91-91, semi-synthetic fuels and the subsequent families of SAF, usually bio-based, have been studied by UK Universities. The relationship between the fuel chemical composition and engine exhaust emissions is of key interest. Recent studies by UK universities, including Manchester Metropolitan University, Sheffield University, Cardiff University, and Birmingham University, have contributed significantly to understanding the potential co-benefit that SAF would have in terms of reducing some non-CO₂ emissions (non-volatile and volatile particulate

matter), the non-volatile (soot) fraction of which, influences contrail formation processes.

In-flight measurements, such as the ECLIF3 study between Airbus, Rolls-Royce, the German Aerospace Centre (DLR), Neste, Manchester University and NRC Canada have shown, that indeed, the number of ice crystals are reduced when SAF is used, and current limited modelling suggests this may well reduce contrail forcing. Research to better characterise the impact of fuel composition on non-CO₂ related emissions is ongoing.

3.69 We will consider the scientific and practical underpinning work needed to determine at what point contrail avoidance trials in the UK may be beneficial. There are a number of ongoing trials exploring this issue including through EUROCONTROL and DLR who have conducted the first live operational trial on contrail prevention aimed at mitigating non-CO₂ impacts. The 10-month trial ran from the beginning of 2021, during which time 209 aircraft trajectories were altered to avoid contrail formation. As yet, the results have not been published, nor has it been demonstrated that the altered trajectories led to a reduction in the total (CO₂ and non-CO₂) climate effect, however we will consider the final outcome of the trial once it becomes available.

3.70 We are exploring whether and how non-CO₂ impacts could be included in the scope of the UK ETS. The Developing the UK ETS consultation (published in March 2022) sought to gather evidence on the feasibility and appropriateness of expanding the scope of the UK ETS to incorporate the non-CO₂ impacts of aviation, where these impacts could be monitored and priced in a similar way to CO₂. Responses are being carefully considered and will help to inform future long-term policy development in this area. We recognise there are a number of challenges that would need to be overcome to facilitate the full inclusion of non-CO₂ impacts in the UK ETS, and so we also sought views on any near term measures, such as charges within the UK ETS, that could account for non-CO₂ impacts in the interim⁶⁸.

3.71 We will work with the CCC to explore their recommendation for no additional non-CO₂ warming from aviation after 2050 and to develop a methodology to monitor the non-CO₂ impacts from aviation on a regular basis. The CCC recommends that non-CO₂ effects are tackled alongside UK climate targets without increasing CO₂ emissions. We will work with industry and academia to explore a means of estimating and tracking the non-CO₂ emissions from the UK aviation industry. In their June 2022 Progress Report⁶⁹, the CCC shared an initial methodology to estimate the potential warming impact of these emissions relative to a baseline. We are currently considering this methodology in further detail.

Key performance indicators

- To increase our evidence and modelling base, we will consider conducting trial flights looking into the benefits of different SAF pathways on contrail formation and other non-CO₂ impacts. This could be captured through the competition we are running with Innovate UK to deliver the first ever transatlantic flight fuelled on 100% SAF⁷⁰, where we have asked airlines to highlight how they intend to collect data and information to assess the impact of SAF on reducing contrail cirrus, and potentially other non-CO₂ impacts.

Image courtesy of Keith P Shine, University of Reading



4 Five year delivery plan

Clear goal, multiple solutions: Our strategic framework & trajectory

Policy commitment

We are committing the UK aviation sector to reaching net zero, or Jet Zero, by 2050.

We are setting an earlier target for UK domestic flights to reach net zero by 2040.

We will review our Strategy every five years and adapt our approach based on progress made.

Implementation approach and delivery milestones

We will achieve net zero aviation through the implementation of the Jet Zero Strategy. We will review progress against our emissions reduction trajectory annually (**first annual review in 2025** due to the current uncertain impacts of COVID-19), and against the KPIs and our overall approach every five years (**first five year review in 2027**).

In addition, we will continue to consider and respond to the CCC's annual reports which cover aviation and will continue to use this reporting cycle to monitor our progress towards meeting the UK's carbon budgets, Nationally Determined Contribution under the Paris Agreement and our overall net zero target.

We are considering a number of options to achieve this target, including through the UK ETS to deliver UK-wide carbon savings equivalent to domestic aviation; requiring airlines to buy GGR credits to account for any emissions from domestic flights from 2040; or through requirements to use zero emission or low carbon fuels and technologies. **A further consultation will be required, to fully explore the most effective and appropriate approach for implementation, which we will carry out in 2023.**

The Government will carry out a review of its overall strategic approach to decarbonising aviation in line with the latest technological developments, progress against our emissions reduction trajectory, and our KPIs for each policy measure every five years. We will use these review points to take stock of how emerging technologies are developing, and if we consider that our strategy is not achieving the intended emissions reductions, or decarbonisation technologies are not developing at the pace required, further action will be considered including amending our existing policies or developing new ones. **The first review will be published in 2027.**

Policy commitment

Implementation approach and delivery milestones

We are committing to our “High ambition” scenario, which sees aviation CO₂ emissions peak in 2019.

We are setting an emissions reduction trajectory and will aim to ensure that emissions do not go above 2019 levels. We will **monitor the sector's emissions on an annual basis from 2025.**

We are setting a CO₂ emissions reduction trajectory for aviation, based on our “High ambition” scenario, from 2025 to 2050.

We are setting the trajectory on an in-sector basis, using our 'High ambition' scenario which will **include interim targets of 35.4 MtCO₂e in 2030, 28.4 MtCO₂e in 2040, and 19.3 MtCO₂e in 2050.**

We will review progress against the emissions reduction trajectory annually (first annual review in 2025) and our overall approach every five years. We will work with the CAA to explore how we can use the emissions reduction trajectory most effectively to monitor progress.

We are aiming for more timely annual reporting of aviation emissions data from 2023.

We will work with the CAA and other partners to report the sectors emissions on a timelier basis annually and **will aim to have a new reporting cycle in place by 2023.**

We also note the CAA's new environmental performance reporting requirements (inherited from the European Union Aviation Safety Agency) and will work with them to increase transparency of reporting of the sector's overall progress towards meeting our net zero goals.

International leadership

Policy commitment

We will negotiate for agreement on a long-term aspirational goal for the CO₂ emissions of international aviation that is aligned with the temperature goal of the Paris Agreement.

We will work closely with other states at the 41st ICAO Assembly and beyond to maintain and strengthen CORSIA.

Implementation approach and delivery milestones

We will use our position and influence within ICAO, and our relationships with other member states, to promote the message that an ambitious, Paris-consistent, goal for international aviation is both feasible and necessary to give clear direction for sustainable growth and draw investment.

At the 41st ICAO Assembly (27 September to 7 October 2022) we will coordinate with like-minded states and negotiate strongly in favour of such a goal. Once a goal is agreed, we will provide technical expertise to support monitoring and evaluation, and consideration of measures to implement the goal.

Ahead of the 41st ICAO Assembly, we will use our position and influence within ICAO, and our relationships with other member states, to promote the message that CORSIA remains an effective measure for meeting the medium-term goal of carbon-neutral growth from 2020 and that it is too early to consider substantive changes to its design.

At the Assembly, we will coordinate with like-minded states and seek a conclusion to the first Periodic Review that acknowledges the success of implementing the monitoring, reporting and verification component of CORSIA; does not make substantive changes to the design that was agreed by member states in 2016; and leaves scope for further improvements to be considered in future.

Beyond the Assembly, we will continue to work through ICAO to ensure CORSIA is maintained and, as more experience is gained through implementation, later improved and strengthened.

Policy commitment

Implementation approach and delivery milestones

We will begin providing direct support to other states that may need help implementing CORSIA effectively, drawing on the UK's own experience and using the expertise of the UK CAA and Environment Agency.

Starting with a pilot in 2022-23, we will begin to offer capacity building support to a small number of states to help them implement CORSIA effectively. The continuation of the programme in subsequent years depends on the success of the pilot and availability of funding.

We will continue to grow the International Aviation Climate Ambition Coalition to build wider global support for ambitious action on aviation emissions.

We will continue to encourage states from across the globe to join the Coalition, and hold further meetings in the run up to the 41st ICAO Assembly to coordinate and set direction for achieving our shared objectives, particularly on CORSIA and the long-term aspirational goal. Following the Assembly, we will continue to lead the Coalition as a forum for international collaboration.

We will set higher expectations for ambitious environmental provisions in negotiating air services agreements.

We will continue to use opportunities in our bilateral air services agreements to advance our decarbonisation objectives. **We have updated our model Air Services Agreement with an ambitious article on Environmental Protection;** we will endeavour to include this in new air services agreements and where we are seeking to update existing arrangements. This recognises that participation in the UK aviation market must come with a responsibility to minimise environmental impacts.

Delivered in partnership

Policy commitment

We will strengthen the work of the Jet Zero Council.

Implementation approach and delivery milestones

We will regularly review the objectives and membership of the Jet Zero Council, to ensure it remains effective at driving forward the decarbonisation agenda. We reviewed the JZC membership and asked members to sign a Members' Charter in July 2022, two years after the Council was first established and will continue to review the Council's membership every two years to maintain the most appropriate and engaged membership.

We will publish by the end of 2022 and regularly update two-year delivery plans for the Jet Zero Council Delivery Groups, which will set out the action needed in the coming years to support the delivery of Jet Zero by 2050. We will consider establishing an overarching Trade and Investment Delivery Group to span the work on SAF and ZEF, showcasing UK expertise internationally and maximising inward investment into Jet Zero.

We will also use the newly established Jet Zero Communications and Engagement Network to engage wider industry and communicate the work happening across government and industry to achieve Jet Zero. The network will identify and map the existing communications activity on Jet Zero and determine how best to generate the maximum momentum around the Jet Zero agenda. The network will also aim to host webinars for the Jet Zero community at least yearly to keep up to date with Jet Zero progress and discuss key topics of interest.

In addition to the Jet Zero Council, we will continue to work with industry through key partnerships, including Sustainable Aviation, AGP, ACOG and the ATI.

We will continue to work closely with Airspace Change Organising Group as they develop iteration 3 of their Masterplan, due later in 2022, to ensure emissions saving potentials are capitalised on.

We will continue to work closely with ACOG. **We will review the draft of Iteration 3 of their Masterplan in late 2022 along with the CAA, for adoption into the Airspace Modernisation Strategy.** The third iteration of the Masterplan is due to be published towards the beginning of 2023.

Maximising opportunities

Policy commitment

Implementation approach and delivery milestones

We will continue to invest in our world-leading aerospace sector through the ATI programme where the Government has committed an additional £685m in funding for the programme over the next three years.

We have extended government support for the ATI programme to 2031 and further funding beyond 2025 will be decided in future spending reviews. The ATI estimate that joint industry and government commitments to 2031 will enable: UK attributable abatement of global aviation CO₂ emissions of 125 MtCO₂ by 2050.

The AGP's strategy - Destination Net Zero - for UK Aerospace sets out a joint industry and government commitment to co-invest at least £1.37 billion in R&D to 2025 for development of ultra-low and zero emission technologies.

The AGP will launch a new supplier development programme with the equivalent of up to £15 million in improvement activities to suppliers in the first three years, with strong commitment from major industry players, and a commitment to create 25,000 new apprenticeship starts in aerospace by 2030. **The AGP aim to double aerospace's estimated contribution to the UK economy to at least £17 billion GVA per annum by 2035** from circa £8 billion contribution per annum today (cumulative £191 billion to 2035 or £526 billion to 2050).

We will use the transition to SAF to build a new UK SAF industry, providing £180 million new funding between 2022-2025 to support the commercialisation of SAF plants and fuel testing in the UK.

We have launched the £165m industry competition to accelerate the development of advanced fuel production plants and strengthen and broaden the pipeline of future projects. There will be a second application window in autumn 2023 and by March 2025, the funded projects will conclude. By 2025, we committed to seeing at least five commercial-scale UK SAF plants under construction.

We will work with the sector to develop the skills needed and encourage long-term diversity through our Reach for the Sky outreach programme.

Supported by our outreach partners, **Aviation Ambassadors will continue to promote awareness of aviation careers and opportunities**; in order to promote diversity, inclusion, accessibility and innovation in the sector, including in areas that support decarbonisation.

System efficiencies

Policy commitment

Our ambition remains for all airport operations in England to be zero emission by 2040.

Implementation approach and delivery milestones

We will work collaboratively with airports to develop the requirements to meet this target over the coming months. **To aid in this we will be publishing a Call for Evidence on the best approach to implementing the target in Autumn 2022.**

This target relates to airports in England as elements of relevant policy are devolved to the Scottish and Welsh Governments plus the Northern Ireland Executive. We will however engage with the Devolved Administrations in developing the target to share knowledge and support all airports in the UK to decarbonise.

We will support airspace modernisation, providing £9.2m funding between 2020-2023 to drive forward progress in redesigning the UK's 'motorways in the sky' with the aim to deliver quicker, quieter and cleaner journeys for those who use and are affected by UK airspace.

In January 2022, the CAA published a refresh of their Airspace Modernisation Strategy (AMS) for consultation. **The refreshed AMS extends the existing strategy out to 2040 and introduces sustainability as an overarching principle** to be applied through all modernisation activities, including both better managing noise and contributing to achieving net zero emissions.

The consultation closed on 4 April 2022 and responses are being considered by the CAA, with publication of the strategy due later in 2022.

We will support ACOG, together with the CAA, to ensure carbon savings are realised as part of the wholesale changes to UK airspace being developed as part of the Airspace Change Masterplan, and plans for airspace modernisation account for the introduction of zero emission aircraft.

We will continue to work with ACOG and the CAA to ensure development of airspace change proposals support our net zero aviation ambitions. **The third iteration of the ACOG Masterplan is expected to be delivered towards the beginning of 2023,** which the Government will review alongside the CAA. The first stage of airspace changes will be implemented from 2025.

Policy commitment

Implementation approach and delivery milestones

We will consider whether a mechanism is needed (voluntary or mandatory) for all airlines to avoid tankering where there is no practical reason to carry additional fuel, such as immovable turnaround times or fuel supply issues.

Initially, this will be assessed as part of the policy development for the UK SAF mandate. **Analysis will be undertaken on the potential impact that a SAF mandate may have on the likelihood of tankering, and whether a mandatory agreement will be required.** This will determine whether we need to introduce a mechanism to restrict tankering separately from the mandate; further details will be provided in the second SAF mandate consultation later this year.

We are working with the ATI, industry and academia to establish a method for quantifying the potential emissions savings of future R&D projects for aircraft technology improvements, to allow us to assess the sustainability benefits for the aviation sector and prioritise the funding of projects most likely to deliver clean growth.

The ATI will use a sustainability model they have developed to investigate the CO₂ impact of different technology scenarios to prioritise government investment in new technologies most likely to deliver clean growth. We will work with the ATI to update this model annually as technologies are progressed and new projects are funded.

We will aim to ensure maximum potential is made of all flights and avoid unnecessary emissions from "ghost flights" that are empty or near empty when departing the UK.

We will work with the CAA this year to monitor aircraft load factors to seek transparency on this issue.

We will ensure that operational improvements are made wherever possible and the appropriate forums are used to consider these.

We will continue to track developments and progress for flight operations that improve efficiencies from the latest research and feedback from industry, working with industry through fora such as Sustainable Aviation, ACOG and CAA to ensure these are pursued.

We will work through ICAO to improve global fuel efficiency, both through CO₂ certification standards and guidance to states on implementing operational efficiencies.

We will provide expertise to support the work of ICAO's environment committee in developing new standards and guidance, including the planned work on the first ever integrated review of the standards for CO₂ emissions and aircraft noise in the next three-year cycle.

Sustainable aviation fuels

Policy commitment

Implementation approach and delivery milestones

We will implement a SAF mandate which will come into force in 2025. The SAF mandate will set an obligation on fuel suppliers to reduce the greenhouse gas emissions of aviation fuel by the equivalent of at least 10% SAF use by 2030.

We are aiming to publish a second SAF mandate consultation in autumn 2022 to refine the practicalities of implementing a mandate, as well as monitoring and reporting mechanisms the mandate will introduce. We expect to kick-start the legislative process in mid-2023.

We will engage with stakeholders to build an evidence base for potential complementary support to build a UK SAF industry.

This summer, we will continue to work with key stakeholders on how to further stimulate investment in a UK SAF industry through a series of workshops and bilateral meetings. **This autumn, we will provide an update, and any formal call for evidence needed to help us build the evidence base on the market failure, the need for any complementary support options from industry or government to stimulate and accelerate the development of a UK SAF industry.**

We will continue to support the development of SAF through advanced fuel funding competitions.

We have launched the Advanced Fuels Fund, which will provide £165m of capital grant funding to support first-of-a-kind commercial and demonstration plants, helping leverage private investment and de-risk future investment. There will be a second application window in autumn 2023 and by March 2025, the funded projects will conclude. **By 2025, we committed to seeing at least five commercial-scale UK SAF plants under construction.**

We will establish a SAF clearing house to enable early stage aviation fuel testing as an essential capability to support our decarbonisation agenda.

The clearing house will deliver early-stage aviation fuel testing, funding, and expert advice for producers of new fuels hoping to enter testing at all certification stages/pathways. **It is our ambition to establish the UK clearing house by the end of 2022** and start providing funding for fuel testing thereafter.

We will work in partnership with the financial community, including the UK Infrastructure Bank, industry and investors, as well as through our existing partnerships with the Jet Zero Council and Breakthrough Energy Catalyst to unlock the capital needed to scale up the UK SAF industry.

We continue to engage with industry and investors to understand potential market failures and how any potential additional interventions should be targeted.

Policy commitment

Implementation approach and delivery milestones

We will support the delivery of the first net zero transatlantic flight running on 100% SAF with up to £1m of funding.

In May 2022 we launched a competition to support the delivery of a UK-US flight running on 100% SAF. **We will announce the winner of the competition by autumn 2022** and we will work with the winning airline and delivery partners to ensure this flight can take to the skies in 2023.

Joint industry and government work will continue through the Jet Zero Council SAF Delivery Group (SAF DG).

Over summer and autumn 2022 **we will continue to engage with industry, including through the Jet Zero Council SAF DG** and our work on a Low Carbon Fuels Strategy, to inform the development of our SAF policy.

All parts of government will work together to pioneer the accelerated procurement and use of SAF.

We will continue to work across government over several policy areas to inform the development of UK SAF policy and ensure it complements existing government policies.

We intend to reward recycled carbon fuels (RCFs) under the Renewable Transport Fuel Obligation (RTFO).

A consultation on the inclusion of RCFs in the RTFO is due to be published shortly. We will continue to work to ensure that the RCF provisions we are planning to introduce under the RTFO are mirrored under the SAF mandate.

We will look at the desirability of using SAF on existing UK government funded Public Service Obligation (PSO) routes.

We continue to explore options to introduce further environmental conditions for PSO routes, such as encouraging operators to use a certain portion of SAF.

As part of the five year reviews of this Strategy, we will confirm and undertake regular assessments of the SAF trajectory to 2050.

We will confirm a SAF trajectory to 2050 in our first five-year review of the Jet Zero Strategy (2027).

We will continue to utilise the Clean Skies for Tomorrow (CST) SAF Ambassadors group to develop, pilot, and promote industry-led policy proposals for national SAF policies.

We continue to work with CST and the SAF Ambassadors group to promote the SAF policy toolkit and support more states to implement SAF policies. We are currently working with the CST to develop plans for the future of the group, including regional workshops to promote the toolkit.

We will negotiate in ICAO for comprehensive SAF sustainability standards and to work towards a future global SAF objective.

In November 2021, ICAO adopted a comprehensive set of sustainability criteria for SAF meaning that **from 2024, SAF will need to meet social, economic, and environmental sustainability criteria to be eligible for use by airlines under CORSIA.**

Zero emission flight

Policy commitment

As part of the government's £22 billion annual investment in R&D, we will continue to support industrial R&D through the ATI Programme, informed by the UK Aerospace Technology Strategy.

The Government remains committed to UK association to Horizon Europe as agreed in the 2020 Trade and Cooperation Agreement with the EU.

We will ensure the UK is at the forefront of deploying zero emission aircraft, with an aspiration to have zero emission routes connecting different parts of the United Kingdom by 2030.

We will maintain our evidence-based approach supporting industry and academia to innovate.

We will convene and support industry to develop the ground infrastructure necessary to fuel and handle zero emission aircraft.

Implementation approach and delivery milestones

The Government has committed to match funding of industry projects through the ATI programme to 2031.

We will continue to seek and support opportunities for collaboration with international partners.

We will work through the Jet Zero Council's Zero Emission Flight Delivery Group to accelerate the adoption of zero emission routes.

Building on the FlyZero and Zero Emission Flight Infrastructure projects, we will use their evidence-based outcomes and recommendations to inform discussions through the Jet Zero Council's Zero Emission Flight Delivery Group (ZEF DG).

The ZEF DG Infrastructure subgroup will be established in 2022. The Government will work with the subgroup chair, core members and affiliate members to set advisory workstreams and deliverables. These will be used to create policies to facilitate the development of necessary zero emission ground infrastructure.

Policy commitment

Implementation approach and delivery milestones

We will look to invest in apprenticeships and training programmes to up- and cross-skill talent in the UK to work in ZEF.

We will work with the AGP to align our skills ambitions with their strategy Destination Net Zero to ensure a consistent approach throughout government and industry.

We are working in partnership with the Connected Places Catapult to undertake a research project on future aviation skills which will provide recommendations as to how industry and government can best ensure that these skills needs are met.

We are building partnerships with colleges and universities to help build and upskill a future talent pipeline capable of taking forward long-term innovation work including in green skills and ZEF.

We will support development of the Tees Valley Hydrogen Transport Hub, engaging closely with industry and other transport stakeholders to generate demonstration activity at Teesside International Airport, supporting future demand and investment in the region.

We will publish further information on the Tees-Valley Hydrogen Hub in due course.

Government and industry will work jointly through the newly established Jet Zero Council ZEF DG.

The Government will work with the Chair and members of the Delivery Group to set work packages and deliverables to tackle the main challenge areas to zero emission aviation.

We will encourage the adoption of innovative zero emission aircraft and aviation technology in General Aviation (GA).

We will use newly commissioned research, which aims to provide an evidence baseline in carbon emissions emitted by GA operations, to develop ambitious new policies for the sector. This **research will be published following the conclusion of the project in July 2022.**

We will use newly commissioned research, which aims to provide an evidence baseline in carbon emissions emitted by GA operations.

Through industry and local private operator collaboration, **an effective database will be developed against which a baseline in carbon emissions can be ascertained.**

Markets and removals

Policy commitment

We aim to have all legislation for CORSIA and any consequential amendments that may be required in force by 1 January 2024, enforce it robustly and encourage other states to do the same.

Implementation approach and delivery milestones

The Government conducted a consultation on implementing CORSIA in 2021, which included six high-level options for how CORSIA could interact with the UK ETS on flights in the scope of both schemes. We received 23 responses and are currently considering how it could be implemented. **We will make a final decision on interaction of CORSIA with UK ETS prior to airlines having to comply with their CORSIA offsetting requirements.**

In June 2022, the Government published a Statement of Intent which announced the introduction of legislation to implement CORSIA's offsetting requirements for the 2021 scheme year only by November 2022. Recent estimates indicate that operators will not accrue CORSIA offsetting obligations during the pilot phase, however, the CORSIA Standards and Recommended Practices require States to calculate and inform operators of their CORSIA offsetting obligations in respect of 2021 emissions by 30 November 2022. Therefore, we intend to amend the Air Navigation (CORSIA) Order 2021, to introduce a legal obligation for this while we give further consideration to interaction between CORSIA and the UK ETS.

We will enhance the effectiveness of the UK ETS, in collaboration with the devolved administrations through the UK ETS Authority.

We are carefully considering responses to the Developing the UK ETS consultation and will respond in due course.

Any changes to the future trajectory of the UK ETS cap and aviation free allocation policy are expected to take effect from 2024.

Policy commitment

Implementation approach and delivery milestones

We will continue to invest in the development of GGR technology.

The Government has committed **£1 billion in investment to develop four Carbon Capture, Usage and Storage clusters by 2030 capturing 20-30MtCO₂** per year across the economy by 2030 to help meet the UK's 2050 net zero target.

We are exploring the role that the UK ETS could play as a long-term market for GGRs and are considering this issue through the Developing ETS consultation.

The Developing the ETS consultation looked at the role the UK ETS could play as a potential market for GGRs and closed in June 2022. Further **options for developing a UK market for negative emissions are being explored through the consultation on GGR business models, published in July 2022**. Following these consultations, the Government will set out recommendations on how Government can put in place a framework that will encourage investment and use of GGR technology in due course. The Developing the ETS consultation also sought evidence on Monitoring Reporting and Verification (MRV) of GGRs. The UK will use this and other available research to contribute to initiatives like the Integrity Council for Voluntary Carbon Markets (IC-VCM). IC-VCM are engaged in the development of Core Carbon Principles and an Assessment Framework that will provide a global definition for carbon crediting programmes. Threshold standards which can cut across borders could bring considerable benefits to the aviation sector by protecting the integrity of GGRs.

We are exploring business models to incentivise investment in GGRs.

This will be set out in the Government response to the Business Models for Engineered Greenhouse Gas Removals consultation.

Influencing consumers

Policy commitment

We will publish a Call for Evidence on our proposal to provide consumers with environmental information at the time of booking a flight in autumn 2022, working with the CAA.

We will work with airports, other government departments, local authorities, and other interested bodies to help airports in England improve their surface access through developing Master Plans and Surface Access Strategies.

Implementation approach and delivery milestones

We will determine our approach and set out further detail following a **CAA-led Call for Evidence in autumn 2022, and a consultation in 2023**. This will build on previous research carried out by the CAA and BritainThinks.

A number of airports have brought forward schemes that reduce emissions from surface access traffic. **We will work closely with the airports and other interested parties to learn from their schemes to encourage the uptake of best practice.**

Policy commitment

We will support airport growth where it can be delivered within our environmental obligations.

We will keep under review whether further guidance is needed to assist airport planning decision-making, with particular reference to environmental impacts.

Implementation approach and delivery milestones

The Government's existing policy framework for airport planning in England – the Airports National Policy Statement (ANPS) and Beyond the horizon, the future of UK aviation: Making best use of existing runways (MBU) – have full effect, as a material consideration in decision making on applications for planning permission. Our analysis shows that it is possible to achieve our goals without the need to restrict people's freedom to fly.

Applicants should engage with the relevant planning authority at an early stage of the planning process to agree an appropriate approach.

Applicants should provide sufficient detail regarding the likely environmental and other effects of airport development to enable communities and planning decision-makers to give these impacts proper consideration.

Planning authorities and applicants should consider all relevant policy, guidance and other material considerations that may assist appraisal for airport development proposals and decision-making. Applicants should clearly set out their approach and findings in an accessible way that can be easily understood by the general public and decision-makers. **We will keep under review whether further guidance is needed to assist airport planning decision-making.**

Addressing non-CO₂

Policy commitment

We will continue to work with the scientific community and industry, including through the Jet Zero Council SAF Delivery Group, to increase our understanding and evidence of the non-CO₂ impacts of using SAF blend flights.

We will work closely with atmospheric scientists, other researchers, industry and internationally to better understand the science and potential mitigations of non-CO₂ impacts from aviation.

Implementation approach and delivery milestones

Through the competition we are running with Innovate UK to deliver **the first ever transatlantic flight fuelled on 100% SAF, we have asked airlines to highlight how they intend to collect data and information to assess the impact of SAF on reducing contrail cirrus, and potentially other non-CO₂ impacts.**

Alongside the data gathered from this flight, we will continue to explore and support further research and policy development in this area. The pioneering flight, on an aircraft powered by 100% sustainable aviation fuel, is expected to take off in 2023.

We will also consider the outcome of the Airbus, DLR, Rolls-Royce, Neste Manchester University and NRC Canada partnership project – ECLIF3 – which is investigating the effects of 100% SAF on aircraft emissions and performance.

We will carefully consider any need for additional research and development activity on non-CO₂ emissions and their effects, including working with UK Research and Innovation (UKRI).

We are also committed to working through ICAO to encourage research into the non-CO₂ impacts of international aviation and their mitigation. As the evidence base develops we will support the consideration of appropriate international measures to address non-CO₂ impacts alongside reducing CO₂ emissions.

Policy commitment

Implementation approach and delivery milestones

We will consider the scientific and practical underpinning work needed to determine at what point contrail avoidance trials in the UK may be beneficial.

We will review the outcomes of ongoing contrail avoidance trials, particularly the EUROCONTROL and the DLR trial and **consider whether or not it will be beneficial for the Government to support similar trials in the UK.**

We are exploring whether and how non-CO₂ impacts could be included in the scope of the UK ETS.

We will consider responses from the Developing the UK ETS consultation, which will inform further consideration of the potential future inclusion of non-CO₂ impacts in the UK ETS or simpler measures to price non-CO₂ impacts.

We will work with the CCC to explore their recommendation for no additional non-CO₂ warming from aviation after 2050 and to develop a methodology to monitor the non-CO₂ impacts from aviation on a regular basis.

We will work with industry and academia to explore a means of estimating and tracking the non-CO₂ emissions from the UK aviation industry. In their June 2022 Progress Report, the CCC shared an initial methodology to estimate the potential warming impact of these emissions relative to a baseline. We are currently considering this methodology in further detail.

5 Glossary of terms

Airspace modernisation – improving the UK's airspace structure by updating systems and using new technology to improve how air traffic is managed, which will help to deliver quicker, quieter and cleaner journeys.

Aviation Ambassadors – a Group that helps the Department for Transport (DfT) and local educational organisations to raise the profile of aviation, create new and improved career pathways, develop enhanced outreach activities and make training more financially accessible.

Carbon budgets – under the Climate Change Act 2008, the Government must set five-yearly carbon budgets, 12 years in advance, from 2008 to 2050, which restrict the total amount of greenhouse gases that the UK can emit over that period. The UK is the first country to set legally binding carbon budgets.

Carbon markets – a carbon market, such as the UK ETS or CORSIA, puts a price on each tonne of emissions included in the market, generating an incentive for participants to reduce their emissions.

Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

– CORSIA is a carbon market developed by the ICAO to address CO₂ emissions for international flights, adopted in October 2016.

Climate Change Committee (CCC) – an independent, statutory body established under the Climate Change Act 2008 to advise the UK government and devolved administrations on tackling climate change.

Contrail – a type of ice cloud, formed by aircraft, as water vapour condenses around small soot particles produced during the combustion process. They can also form when water vapour from the aircraft's engines collides with water vapour in the air.

Free allowances – carbon market credits allocated to aircraft operators to reduce the risk of carbon leakage.

Greenhouse Gas Removals (GGRs) – a range of approaches that directly remove greenhouse gases from the atmosphere and fall broadly into 2 categories:

- nature-based approaches, such as afforestation, forest management and soil carbon sequestration
- engineering-based approaches, such as direct air carbon capture and storage (DACCS), bioenergy with carbon capture and storage (BECCS), wood in construction, biochar and enhanced weathering.

Illustrative scenarios – the 4 potential pathways set out in the Jet Zero consultation, the further technical consultation, and now the Jet Zero Strategy to model different scenarios with a different mix of technologies to illustrate potential pathways for reaching net zero aviation by 2050.

In-sector emissions – emissions produced by the aviation sector before consideration of offsets, avoided emissions in other sectors, or greenhouse gas removal methods.

International Civil Aviation Organization (ICAO)

– a specialised agency of the United Nations that supports the planning and development of international air transport across 193 nations, providing an internationally accepted set of standards.

Jet Zero – collective term used across government and industry for our ambition to achieve net zero CO₂ aviation by 2050.

Jet Zero Council – a partnership between industry and government to bring together ministers and chief executive officer-level stakeholders, with the aim of delivering zero emission transatlantic flight within a generation.

Load factor – percentage of available seats an airline must sell to break even, beyond which they make a profit. Each airline's break-even load factor depends on their costs and expenditure, but is usually around 70% on average.

Net zero – the Government target that the UK's total greenhouse gas emissions should be equal to or less than the emissions the UK removed from the environment. This can be achieved by a combination of emission reduction and emission removal.

Non-CO₂ impacts – impacts other than CO₂ that also affect the climate and local air quality, in particular contrails and NOx emissions.

NOx – nitrogen oxides, a source of air pollution.

Offsets/Offsetting – the process of compensating for carbon emissions arising from human activity by participating in schemes designed to make equivalent reductions of carbon dioxide in the atmosphere.

Public Service Obligation (PSO) routes – a route-support measure that allows government to provide funding for the operation of air services on routes (to London or within a devolved administration) that are vital for the economic and social development of a region but are not viable on a wholly commercial basis.

Renewable Transport Fuel Obligation (RTFO) – one of the Government's policies for reducing greenhouse gas emissions from road transport in the UK by encouraging the supply of renewable fuels.

SAF mandate – proposed tradeable credit, greenhouse gas emissions scheme to encourage the supply of, and generate demand for, SAF with the lowest possible emissions, and support the development of the SAF industry.

Slots – permission to use the airport infrastructure to operate an air service on a specific date and time for the purpose of landing or take-off. The allocation of slots between air carriers is a planning tool to ensure,

where airport capacity is scarce, that available landing and take-off slots are used efficiently.

Surface access – surface access refers to all the ways in which passengers, visitors, employees and commercial traffic travel to and from an airport when they are not in an aircraft.

Sustainable aviation fuel (SAF) – renewable or waste-derived aviation fuels that meet specific sustainability criteria and can be used in existing aircraft without significant engine modifications.

Systems efficiencies – encompasses both improvements in existing engine and airframe design (such as more efficient engines and lighter materials), and also operational improvements (such as air traffic control improvements and efficiencies at airports).

Tankering – the practice of carrying excess fuel in order to reduce or eliminate refuelling at the aircraft's destination.

UK Emissions Trading Scheme (ETS) – cap and trade scheme involving the allocation and trading of greenhouse gas emission allowances overseen by the UK government and devolved administrations.

UK Green Taxonomy – detailed in Greening Finance: A Roadmap to Sustainable Investment, the new UK Green Taxonomy is a classification system that sets out the criteria that specific economic activities must meet to be considered environmentally sustainable. It is intended to become a benchmark for investors increasingly looking to adhere to strict sustainability requirements. The Green Taxonomy aims to tackle 'greenwashing' in financial markets, support consumer protection and transparency, and help firms transition to net zero.

Zero emission – no GHG emissions are attributable to an actors operations. Under this definition, no offsets or balancing of residual emissions with removals are used.

Zero emission flight (ZEF) – the ecosystem supporting zero emission aircraft.

6 Abbreviations list

ACOG	Airspace Change Organising Group	JZC	Jet Zero Council
AGP	Aerospace Growth Partnership	KPI	Key Performance Indicators
AOA	Airport Operators Association	MRV	monitoring, reporting and verification
ATI	Aerospace Technology Institute	NASA	National Aeronautics and Space Administration
ATMs	Air Traffic Movements	NO_x	Nitrogen Oxides
CAA	Civil Aviation Authority	NRC	National Research Centre [Canada]
CCC	Climate Change Committee	NZS	Net Zero Strategy
CCUS	Carbon Capture, Utilisation and Storage	PSO	Public Service Obligation
CO₂	Carbon Dioxide	RAF	Royal Air Force
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation	R&D	Research and Development
CST	Clean Skies for Tomorrow	RCF	Recycled Carbon Fuels
DAC	Direct Air Capture	RTFO	Renewable Transport Fuel Obligation
DLR	German Aerospace Centre	SA	Sustainable Aviation
EEA	European Economic Area	SAF	Sustainable Aviation Fuel
EU ETS	European Union Emissions Trading Scheme	SAF DG	[Jet Zero Council] Sustainable Aviation Fuel Delivery Group
F4C	Future Fuels for Flight and Freight Competition	TIST	The International Small Group and Tree Planting Program
FRA	Free Route Airspace	TDP	Transport Decarbonisation Plan
GA	General Aviation	UK ETS	United Kingdom Emissions Trading Scheme
GFGS	Green Fuels, Green Skies	UKRI	United Kingdom Research and Innovation
GGR	Greenhouse Gas Removals	ZEF	Zero Emission Flight
GHG	Greenhouse Gas	ZEF DG	[Jet Zero Council] Zero Emission Flight Delivery Group
GVA	Gross Value Added	ZEFI	Zero Emission Flight Infrastructure
IATA	International Air Transport Association		
ICAO	International Civil Aviation Organization		

7 Endnotes

1. International Aviation Climate Ambition Coalition Declaration: <https://www.gov.uk/government/publications/cop-26-declaration-international-aviation-climate-ambition-coalition>
2. DestinATlon Zero: ATI Technology Strategy 2022: <https://www.ati.org.uk/wp-content/uploads/2022/04/ATI-Tech-Strategy-2022-Destination-Zero.pdf>
3. Sustainable Aviation fuels road-map: https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_FuelReport_20200205.pdf
4. Sustainable Aviation fuels road-map: https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_FuelReport_20200205.pdf
5. Energy and environment data tables: <https://www.gov.uk/government/statistical-data-sets/energy-and-environment-data-tables-env#fuel-consumption-env01>
6. RAF Net Zero Ambitions: <https://www.gov.uk/government/speeches/cas-raf-netzero-ambition>
7. CORSIA Information: <https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx>
8. Final UK greenhouse gas emissions national statistics: 1990 – 2020: <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2020>
9. International Aviation Climate Ambition Coalition Declaration: <https://www.gov.uk/government/publications/cop-26-declaration-international-aviation-climate-ambition-coalition>
10. Information on Jet Zero Council: <https://www.gov.uk/government/groups/jet-zero-council>
11. Sustainable Aviation interim decarbonisation targets: <https://www.sustainableaviation.co.uk/news/uk-aviation-industry-strengthens-commitment-to-achieving-net-zero-and-launches-first-interim-decarbonisation-targets/>
12. ACOG Airspace Masterplan: <https://www.acog.aero/airspace-masterplan/masterplan/>
13. Aerospace Growth Partnership Destination Net Zero: <https://theagp.aero/Destination-Net-Zero>
14. DestinATlon Zero: ATI Technology Strategy 2022: <https://www.ati.org.uk/wp-content/uploads/2022/04/ATI-Tech-Strategy-2022-Destination-Zero.pdf>
15. Sustainable Aviation fuels road-map: https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_FuelReport_20200205.pdf
16. ACOG – Airspace Change Masterplan: <https://www.acog.aero/airspace-masterplan/masterplan/>
17. AOA Decarbonisation Report: <https://www.aoa.org.uk/wp-content/uploads/2021/10/AOA-Decarbonisation-Report.pdf>
18. Airbus-A320 Family-Facts-and-Figures-June-2022: <https://www.airbus.com/sites/g/files/jlcbta136/files/2022-02/Airbus-A320-Facts-and-Figures-February-2022.pdf>
19. AOA Decarbonisation Report: <https://www.aoa.org.uk/wp-content/uploads/2021/10/AOA-Decarbonisation-Report.pdf>
20. DfT analysis
21. DestinATlon Zero: ATI Technology Strategy 2022: <https://www.ati.org.uk/wp-content/uploads/2022/04/ATI-Tech-Strategy-2022-Destination-Zero.pdf>
22. DestinATlon Zero: ATI Technology Strategy 2022: <https://www.ati.org.uk/wp-content/uploads/2022/04/ATI-Tech-Strategy-2022-Destination-Zero.pdf>
23. DestinATlon Zero: ATI Technology Strategy 2022: <https://www.ati.org.uk/wp-content/uploads/2022/04/ATI-Tech-Strategy-2022-Destination-Zero.pdf>
24. Mott MacDonald 'Feasibility of Zero Emissions Airport Operations in England by 2040': <https://cp.catapult.org.uk/report/feasibility-of-zero-emissions-airport-operations-in-england-by-2040/>
25. ACOG – Airspace Change Masterplan: <https://www.acog.aero/airspace-masterplan/masterplan/#:~:text=The%20purpose%20of%20the%20Masterplan,of%20our%20skies%20for%20aviation>
26. ACOG – Airspace Change Masterplan: <https://www.acog.aero/airspace-masterplan/masterplan/>
27. DestinATlon Zero: ATI Technology Strategy 2022: <https://www.ati.org.uk/wp-content/uploads/2022/04/ATI-Tech-Strategy-2022-Destination-Zero.pdf>
28. Energy and environment data tables: <https://www.gov.uk/government/statistical-data-sets/energy-and-environment-data-tables-env#fuel-consumption-env01>
29. Sustainable aviation fuels mandate 2021: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005382/sustainable-aviation-fuels-mandate-consultation-on-reducing-the-greenhouse-gas-emissions-of-aviation-fuels-in-the-uk.pdf
30. Air Transport Action Group: facts and figures: <https://www.atag.org/facts-figures.html>
31. Sustainable Aviation fuels road-map: https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_FuelReport_20200205.pdf
32. UK SAF Mandate Consultation: <https://www.gov.uk/government/consultations/mandating-the-use-of-sustainable-aviation-fuels-in-the-uk>
33. Rolls Royce press release: <https://www.rolls-royce.com/media/press-releases/2022/20-01-2022-the-spirit-of-innovation-officially-breaks-speed-record.aspx>
34. Airbus ZEROe Demonstrator: <https://www.airbus.com/en/innovation/zero-emission/hydrogen/zeroe>
35. Cranfield University press release: <https://www.cranfield.ac.uk/press/news-2022/major-boost-for-sustainable-aviation-research>
36. British Energy Security Strategy: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1069973/british-energy-security-strategy-print-ready.pdf
37. ATI Funding Uplift announcement: <https://www.gov.uk/government/news/green-aerospace-tech-to-receive-record-government-funding>
38. Destination Zero: ATI Technology Strategy 2022: <https://www.ati.org.uk/wp-content/uploads/2022/04/ATI-Tech-Strategy-2022-Destination-Zero.pdf>
39. FlyZero reports: <https://www.ati.org.uk/flyzero-reports/>

40. UK Innovation Strategy: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1009577/uk-innovation-strategy.pdf
41. FlyZero reports: <https://www.ati.org.uk/flyzero-reports/>
42. British Energy Security Strategy: <https://www.gov.uk/government/publications/british-energy-security-strategy>
43. UK Hydrogen Strategy: <https://www.gov.uk/government/publications/uk-hydrogen-strategy>
44. Transport Technology Tracker: <https://www.gov.uk/government/news/green-aerospace-tech-to-receive-record-government-funding>
45. ICAO: CORSIA News: https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_Newsletter_June_2022_v4.pdf
46. DfT analysis of CAA airports data: <https://www.caa.co.uk/data-and-analysis/uk-aviationmarket/airports/uk-airport-data/>
47. Data drawn from Eurocontrol and Final UK greenhouse gas emissions national statistics: 1990 – 2020: <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2020>
48. Carbon Capture, Usage and Storage (CCUS) investor roadmap: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1068444/ccus-roadmap.pdf
49. Developing UK ETS Consultation: <https://www.gov.uk/government/consultations/developing-the-uk-emissions-trading-scheme-uk-ets>
50. GGR Call for Evidence: <https://www.gov.uk/government/consultations/greenhouse-gas-removals-call-for-evidence>
51. IATA Recommended Practice Per-Passenger CO₂ Calculation Methodology: <https://www.iata.org/globalassets/iata/you--iata/travelers-covid/qa-iata-rp-per-passenger-co2-calculation-methodology.pdf>
52. BEIS Public Attitudes Tracker (Winter 2021, UK): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1064031/BEIS_PAT_Winter_2021_Net_Zero_and_Climate_Change.pdf
53. Civil Aviation Authority: UK Aviation Consumer Survey Wave 10 (Autumn 2021) Environmental Findings: <https://publicapps.caa.co.uk/docs/33/CAA%20Consumer%20Survey%20Wave%2010%20Autumn%202021%20Environment%20Report.pdf>
54. Ipsos Mori/DfT Longitudinal Survey – Wave 6: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1080053/all-change-travel-tracker-wave-6-report.pdf
55. Flightpath To The Future: <https://www.gov.uk/government/publications/flightpath-to-the-future-a-strategic-framework-for-the-aviation-sector#:~:text=Flightpath%20to%20the%20future'%20is,over%20the%20next%2010%20years.>
56. Airports National Policy Statement: new runway capacity and infrastructure at airports in the South East of England (2018): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/858533/airports-nps-new-runway-capacity-and-infrastructure-at-airports-in-the-south-east-of-england-web-version.pdf and Beyond The Horizon – Making Best Use Of Existing Runways and https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714069/making-best-use-of-existing-runways.pdf
57. Climate Change Committee's (CCC) Balanced Net Zero Pathway: <https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf>
58. CAA Environmental Sustainability Strategy: <https://www.caa.co.uk/consumers/environment/environmental-sustainability-strategy/>
59. Airports National Policy Statement: new runway capacity and infrastructure at airports in the South East of England (2018): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/858533/airports-nps-new-runway-capacity-and-infrastructure-at-airports-in-the-south-east-of-england-web-version.pdf and Beyond The Horizon – Making Best Use Of Existing Runways and https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714069/making-best-use-of-existing-runways.pdf
60. Manchester Metropolitan University: The current state of scientific understanding of the non-CO₂ effects of aviation on climate: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/813342/non-CO2-effects-report.pdf
61. Science Direct: The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018: <https://www.sciencedirect.com/science/article/pii/S1352231020305689>
62. Science Direct: The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018: <https://www.sciencedirect.com/science/article/pii/S1352231020305689>
63. NASA Press Release: NASA-DLR Study Finds Sustainable Aviation Fuel Can Reduce Contrails: <https://www.nasa.gov/press-release/nasa-dlr-study-finds-sustainable-aviation-fuel-can-reduce-contrails>
64. Manchester Metropolitan University: The current state of scientific understanding of the non-CO₂ effects of aviation on climate: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/813342/non-CO2-effects-report.pdf
65. Science Direct: The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018: <https://www.sciencedirect.com/science/article/pii/S1352231020305689>
66. NASA Press Release: NASA-DLR Study Finds Sustainable Aviation Fuel Can Reduce Contrails: <https://www.nasa.gov/press-release/nasa-dlr-study-finds-sustainable-aviation-fuel-can-reduce-contrails>
67. University of Manchester: First in-flight 100% sustainable fuels emissions study of passenger jet shows early promise: <https://www.manchester.ac.uk/discover/news/first-in-flight-100-sustainable-fuels-emissions-study-of-passenger-jet-shows-early-promise/>
68. Developing UK ETS Consultation: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1067125/developing-the-uk-ets-english.pdf
69. Climate Change Committee's (CCC) 2022 Progress Report to Parliament: <https://www.theccc.org.uk/publication/2022-progress-report-to-parliament/>
70. Net zero transatlantic flight fund: expression of interest guidance for applicants: <https://www.gov.uk/government/publications/net-zero-transatlantic-flight-fund/net-zero-transatlantic-flight-fund-expression-of-interest-guidance-for-applicants>

