



Department
for Transport



Jet Zero Consultation

A consultation on
our strategy for
net zero aviation

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- 1 ZEROe hydrogen-powered concept aircraft. Image courtesy of Airbus.
- 2 ZeroAvia world's first hydrogen fuel cell flight of a commercial-size aircraft. Image courtesy of the Aerospace Technology Institute and reproduced with permission of ZeroAvia. Copyright © 2020 ZeroAvia Ltd.
- 3 Rolls-Royce electric aircraft ACCEL. Image courtesy of Rolls Royce.
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- 5 Solar charged aircraft from NUNCATS. Image courtesy of NUNCATS.

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Foreword

Over the past 18 months the world has been grappling with a global pandemic from which we are only now – thanks to our world leading vaccine programme and the fortitude of the British people – beginning to emerge.

As we do, we must face another challenge no less daunting - climate change. The UK must be a leading voice in the search for solutions to this global threat. And, as host of the COP26 climate conference in Glasgow later this year, we have a unique opportunity to steer debate and address this climate emergency.

As a government we have shown our absolute commitment to reducing UK emissions in line with the Paris Agreement. We have legislated for net zero emissions by 2050 across the economy, and recently agreed with the Climate Change Committee to a 78% reduction in emissions in Carbon Budget Six by 2035 on 1990 levels.¹

Our ambition to decarbonise includes every sector of our economy. While aviation contributes only 2-3% of global greenhouse gas emissions today, it is forecast to become the second highest residual emitter in 2050 as other sectors reduce their emissions. Despite aviation being one of the most challenging sectors to decarbonise, we are clear that it will play its part in ensuring the UK reaches net zero.

So we have established the Jet Zero Council to accelerate action now, to deliver zero emission transatlantic flight within a generation, and for the first time our carbon budgets will now formally include emissions from both domestic and international aviation.

This consultation sets out our plans to take this even further through a strategy to deliver net zero aviation by 2050, or 'Jet Zero' as we call it.

The strategy will provide a clear 'Jet Zero' goal for the sector whilst allowing the different technological pathways to develop. It will ensure the UK is at the vanguard of progress on reducing aviation emissions and continues to drive international progress. And it will put partnerships at the heart of delivery – partnerships with industry, academia, NGOs and the public.

It is a strategy that will deliver the requirement to decarbonise aviation, and the benefits of doing so, whilst allowing the sector to thrive, and hardworking families to continue to enjoy their annual holiday abroad; we want Britons to continue to have access to affordable flights, allowing them to enjoy holidays, visit friends and family overseas and to travel for business.

Decarbonising, whilst retaining the connectivity we cherish and preserving our aviation sector means we must act quickly to revolutionise the technologies needed across the aviation industry: develop cleaner aircraft, produce and use more sustainable fuels, and make our airspace and airports more efficient.

This is your opportunity to help shape our strategy and give your perspective on how we decarbonise the aviation sector whilst continuing to benefit from the connectivity, jobs and economic benefits it provides.

We encourage you to respond.



Rt Hon Grant Shapps MP,
Transport Secretary



Robert Courts MP,
Minister for Aviation

How to respond

The consultation period began on 14 July 2021 and will run until 8 September 2021. Please ensure that your response reaches us before the closing date. If you would like further copies of this consultation document, it can be found at www.gov.uk/dft#consultations or you can contact NZaviationconsultation@dft.gov.uk if you need alternative formats (Braille, audio CD, etc.).

We strongly encourage responses via the online survey or by email to NZaviationconsultation@dft.gov.uk. If you are unable to respond by the online form or by email, we would invite you to please let us know by asking someone to email on your behalf. If none of the above is possible, then we invite you to provide responses to:

Aviation Decarbonisation Division,
Great Minster House, 33 Horseferry Road,
London SW1P 4DR.

When responding, please state whether you are responding as an individual or representing the views of an organisation. If responding on behalf of a larger organisation, please make it clear who the organisation represents and, where applicable, how the views of members were assembled.

There will be consultation events held during the consultation period. If you would be interested in attending these events, please contact NZaviationconsultation@dft.gov.uk.

If you have any suggestions of others who may wish to be involved in this process please contact us.

Freedom of information

Information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the Freedom of Information Act 2000 (FOIA) or the Environmental Information Regulations 2004.

If you want information that you provide to be treated as confidential, please be aware that, under the FOIA, there is a statutory Code of Practice with which public authorities must comply and which deals, amongst other things, with obligations of confidence.

In view of this it would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information, we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department.

The Department will process your personal data in accordance with the Data Protection Act (DPA) and in the majority of circumstances this will mean that your personal data will not be disclosed to third parties

Confidentiality and data protection

The Department for Transport (DfT) is carrying out this consultation to gather evidence on our approach to meet our target of net zero aviation by 2050. This consultation and the processing of personal data that it entails is necessary for the exercise of our functions as a government department. If your answers contain any information that allows you to be identified, DfT will, under data protection law, be the Controller for this information.

As part of this consultation we are asking for your name and email address. This is in case we need to ask you follow-up questions about any of your responses. You do not have to give us this personal information. If you do provide it, we will use it only for the purpose of asking follow-up questions.

DfT's privacy policy has more information about your rights in relation to your personal data, how to complain and how to contact the Data Protection Officer. You can view it at www.gov.uk/government/organisations/department-for-transport/about/personal-information-charter.

To receive this information by telephone or post, contact us on **0300 330 3000** or write to Data Protection Officer, Department for Transport, Ashdown House, Sedlescombe Road North, St Leonards-on-Sea, TN37 7GA.

Your information will be kept securely on the IT system within DfT and destroyed within 12 months after the consultation has been completed.

1 Introduction

- 1.1 Aviation and the UK go hand in hand. We were pioneers of early flight, and the sector has long been at the heart of our economic success. It is vital for trade and the distribution of goods, creates jobs, connects friends and family, and – crucially for an island nation – links us to the rest of the world. Flight is essential for our Global Britain ambitions of openness as a society and an economy.
- 1.2 The importance of aviation to the UK is why we are supporting the sector through the COVID-19 pandemic – by the end of September 2021, the air transport sector (airlines, airports, and related services) will have benefited from around £7bn of government support. But we know that the virus has had a devastating effect, and our airports, airlines and aircraft manufacturers are all feeling the financial impact of reduced demand.
- 1.3 As our aviation sector recovers, we must address the next global challenge. Climate change is one of the greatest and most pressing threats facing the modern world. This Government is committed to going further and faster to tackle it, as evidenced by our commitment to net zero emissions by 2050, and a 78% reduction in emissions by 2035.² By providing the right policy framework, we will support the UK aviation sector to build back greener and take the steps we need, to put the sector on the road to net zero.
- 1.4 Our success will not only preserve the benefits of aviation, but also unlock a significant prize. Decarbonising our aviation sector is a huge opportunity for the UK, leading a global transition to net zero aviation, which will see new technologies, new companies and new markets all emerge. It is an opportunity for our world-class manufacturing sector to develop new low and zero emission aircraft technology, to build a dynamic sustainable aviation fuels (SAF) industry, employ people the length and breadth of the UK, reduce our reliance on imported fuels, and have airports, aircraft and airspace that are cleaner and quieter.
- 1.5 We have already made great strides. We have established the Jet Zero Council to focus the sector on developing UK capabilities to deliver both net zero and zero emission technologies, announced new funding for the UK's emerging SAF sector and zero emission flight infrastructure in the Prime Minister's Ten Point Plan for a Green Industrial Revolution,³ invested significantly into aerospace R&D through the Aerospace Technology Institute (ATI), established a new UK Emission Trading Scheme (UK ETS) with greater ambitions than the EU system it replaces, begun to implement the Carbon Offsetting and Reduction Scheme for International Aviation (CORSI) in the UK, and most recently committed to formally including the UK's share of international aviation and shipping emissions in the Sixth Carbon Budget.⁴
- 1.6 But there is more to be done and we want to set an ambitious framework to support the aviation sector to decarbonise. This framework is what our Jet Zero Strategy will set out, and what we are seeking your views on through this consultation. We are committing to the UK's share of aviation emissions reaching net zero by 2050 and proposing a suite of policies to support industry to make this happen. These policies span across five different measures: improving the efficiency of our aviation system, accelerating the deployment of SAF, supporting the



Photo by Dima Berlin on Shutterstock

development of zero emission aircraft, ensuring we use markets to drive down emissions in the most cost-effective way, and working to influence the behaviour of consumers.

- 1.7 And we recognise that we cannot act in isolation – aviation emissions are an inherently global issue and therefore the UK will continue to take a leading role in the work of the International Civil Aviation Organization (ICAO), drawing also on our COP26 Presidency, to reduce emissions from international aviation.

- 1.8 The focus of this consultation, and the forthcoming strategy, is reducing CO₂ emissions; however delivery on this can provide other environmental benefits, such as reducing non-CO₂ impacts and noise, and improving air quality.

- 1.9 We welcome views from all parts of the UK and recognise the important role that will need to be played by the sector, wider industry, academia, innovators and the public in realising our ambitions and showcasing the UK's leading role in tackling this once in a generation issue.

2 Our Approach and Principles

2.1 The aim of our strategy is for aviation to decarbonise in a way that preserves the benefits of air travel and delivers clean growth of the UK sector by maximising the opportunities that decarbonisation can bring.

2.2 This will not be easy. Aviation is expected to be one of the few residual emitting sectors in 2050. Many of the technologies we need are in their infancy and will take time to develop. Aviation emissions are an inherently global issue so we must continue to show leadership and work closely with other countries to deliver global change. And decarbonisation will require transformation across all parts of the aviation system: our aircraft, our airspace, and our airports.

2.3 However, it also presents huge opportunities: the global transition to net zero aviation will see new technologies, new companies and new markets all emerge. Being at the forefront of this transition will allow the UK to maximise the benefits from the green industrial revolution.

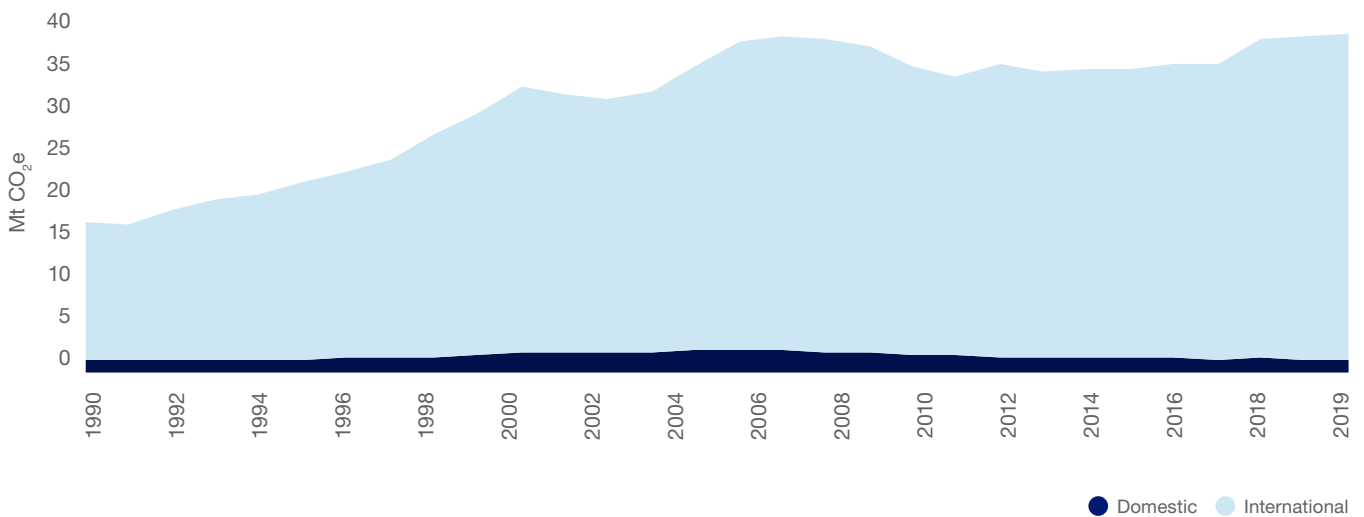
2.4 To ensure we achieve this, our delivery of Jet Zero will be underpinned by three principles:

- **Clear goal, multiple solutions:** we will focus on achieving net zero aviation by 2050 – or Jet Zero – whilst being flexible over the pathway to achieve it.
- **International leadership:** the vast majority of UK aviation emissions are from international flights; tackling these needs global agreement and UK leadership.
- **Delivered in partnership:** achieving Jet Zero requires all parts of the sector to work together to develop, test and implement the solutions we need.





UK Aviation Emissions 1990–2019⁵



Clear goal, multiple solutions

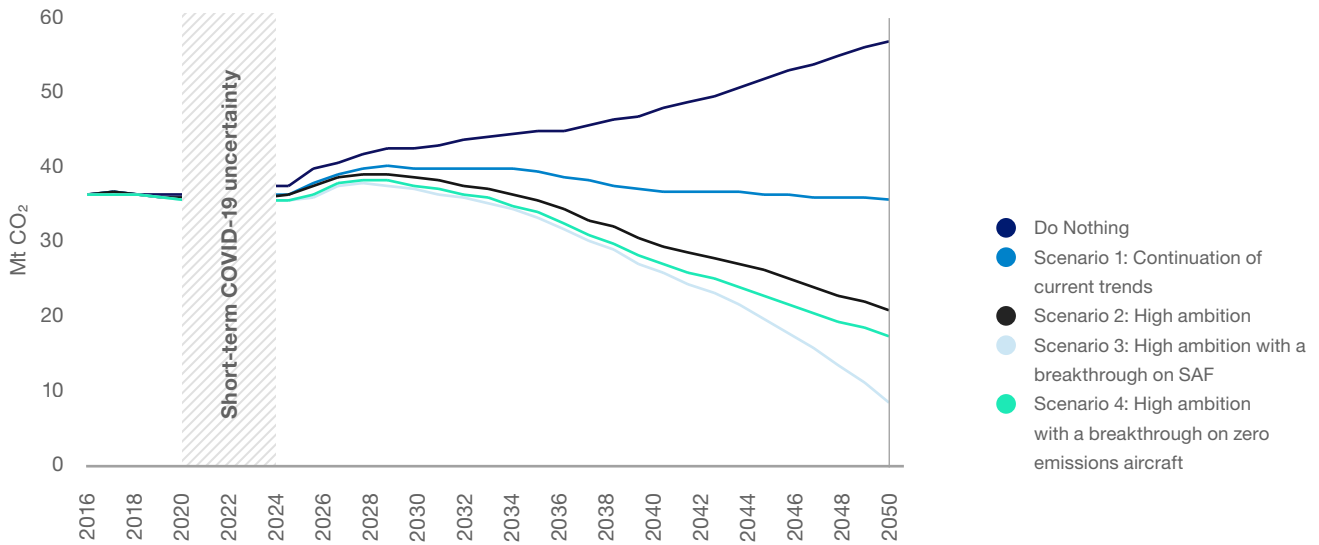
We will focus on achieving Jet Zero, whilst being flexible over the pathway to achieve it.

- 2.5 Many of the technologies we need to achieve Jet Zero are at an early stage of development or commercialisation. Sustainable aviation fuels, zero emission aircraft, and greenhouse gas removal technologies are hugely promising and exciting, and we expect a combination of these technologies will ensure the UK aviation sector reaches net zero by 2050.
- 2.6 It is too early to specify the optimal mix, so **our focus for the coming decade will be to accelerate the development of all these technologies**, such that by 2030 we have a clearer picture of what is needed to achieve Jet Zero.
- 2.7 Whilst there may be alternative pathways, the goal is clear. Through **our strategy, we will commit the UK aviation sector to reaching net zero by 2050 – or Jet Zero**. As staging posts, we have already committed to including international aviation (and shipping) emissions in the UK's Sixth Carbon Budget and **are consulting on an earlier target for UK domestic aviation to reach net zero by 2040**, following the Climate Change Committee's recommendation for an earlier target for domestic aviation in their Sixth Carbon Budget report.
- 2.8 And we need to make sure that, whichever mix of measures emerges, we remain on track to meet these goals. So, **we propose to set a CO₂ emissions reduction trajectory for aviation from 2025 to 2050** against which we will monitor progress. We propose to set this based on our 'high ambition' scenario (see page 14), whilst noting the uncertainty regarding the future technological mix.⁷ This would see in-sector CO₂ emissions of 39 Mt in 2030, 31 Mt in 2040 and 21 Mt in 2050 (any residual emissions in 2050 should be offset by greenhouse gas removal methods).
- 2.9 Alternatively, a trajectory based on net CO₂ emissions – where offsetting and removals are considered as part of the target – would see CO₂ emissions of 23-32 Mt in 2030, 12-19 Mt in 2040 and 0 Mt in 2050.
- 2.10 To ensure the strategy delivers the reductions needed, and reflects the emerging context as solutions develop, **we will review our strategy every five years and adapt our approach based on progress made**. The Government will also conduct a further assessment of the treatment of international aviation emissions in carbon budgets in 2025, reflecting on any significant developments in international or domestic policy.
- 2.11 Whilst the Jet Zero Strategy will be focussed on reducing CO₂ emissions, we will continue to work to increase our understanding of non-CO₂ impacts and their effects on the environment (see Chapter 4).

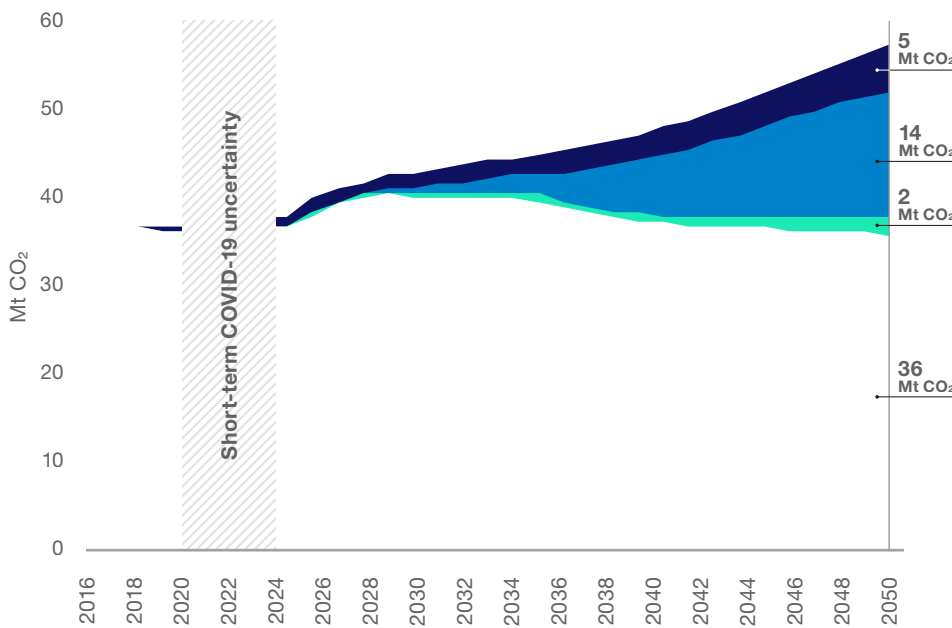
Illustrative pathways to UK net zero aviation by 2050

We have modelled four illustrative scenarios to reach UK net zero aviation by 2050 through different technological pathways. The proposed CO₂ emissions reduction trajectory for aviation from 2025 to 2050 is based on our 'High ambition' scenario shown in more detail on page 14. For further detail, see the supporting evidence and analysis document.

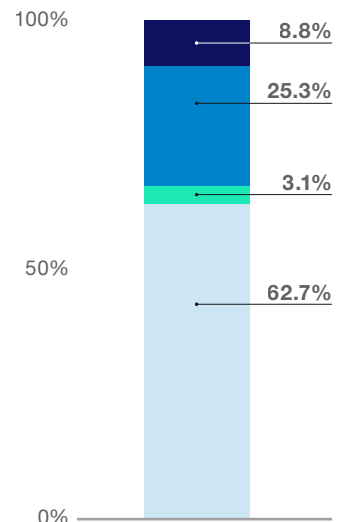
Aviation decarbonisation scenarios⁶



Scenario 1: Continuation of current trends



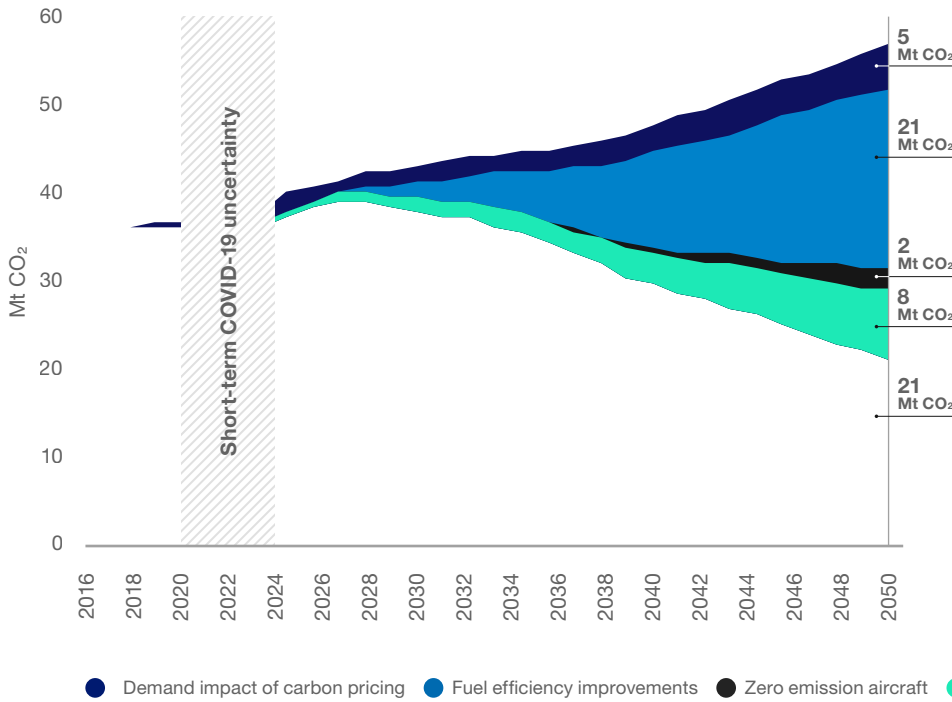
% abatement from each measure in 2050



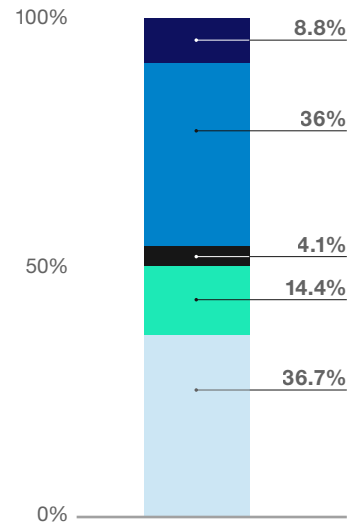
Legend for Scenario 1 breakdown:

- Demand impact of carbon pricing
- Fuel efficiency improvements
- Zero emission aircraft
- SAF
- Abatement outside aviation sector

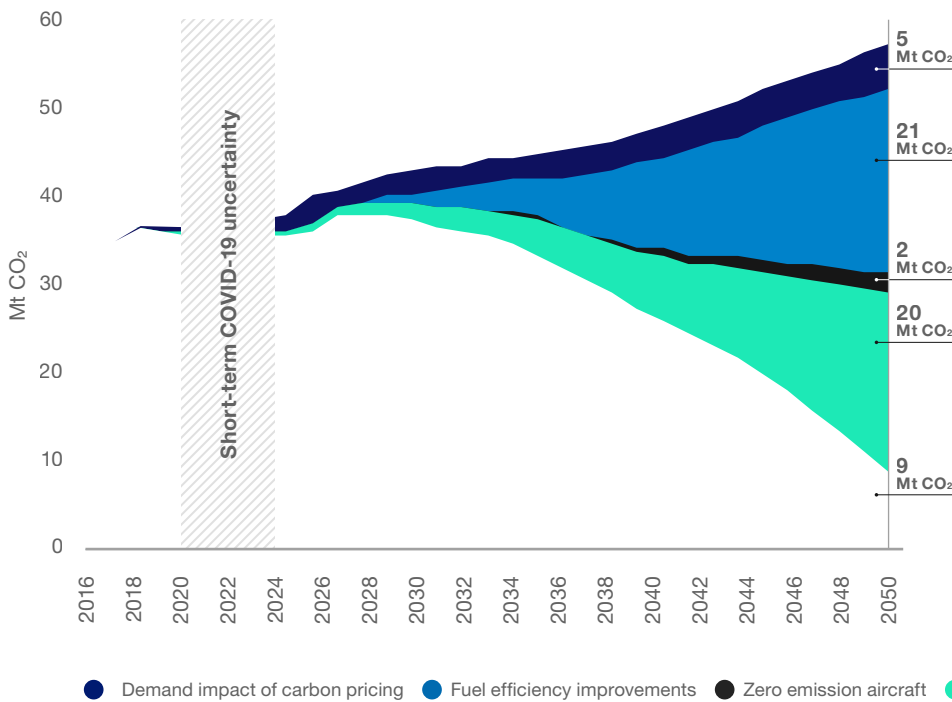
Scenario 2: High ambition



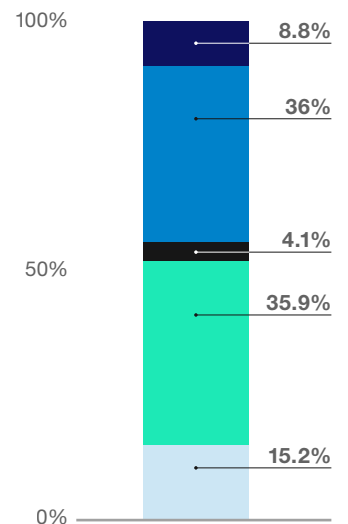
% abatement from each measure in 2050



Scenario 3: High ambition with a breakthrough on SAF

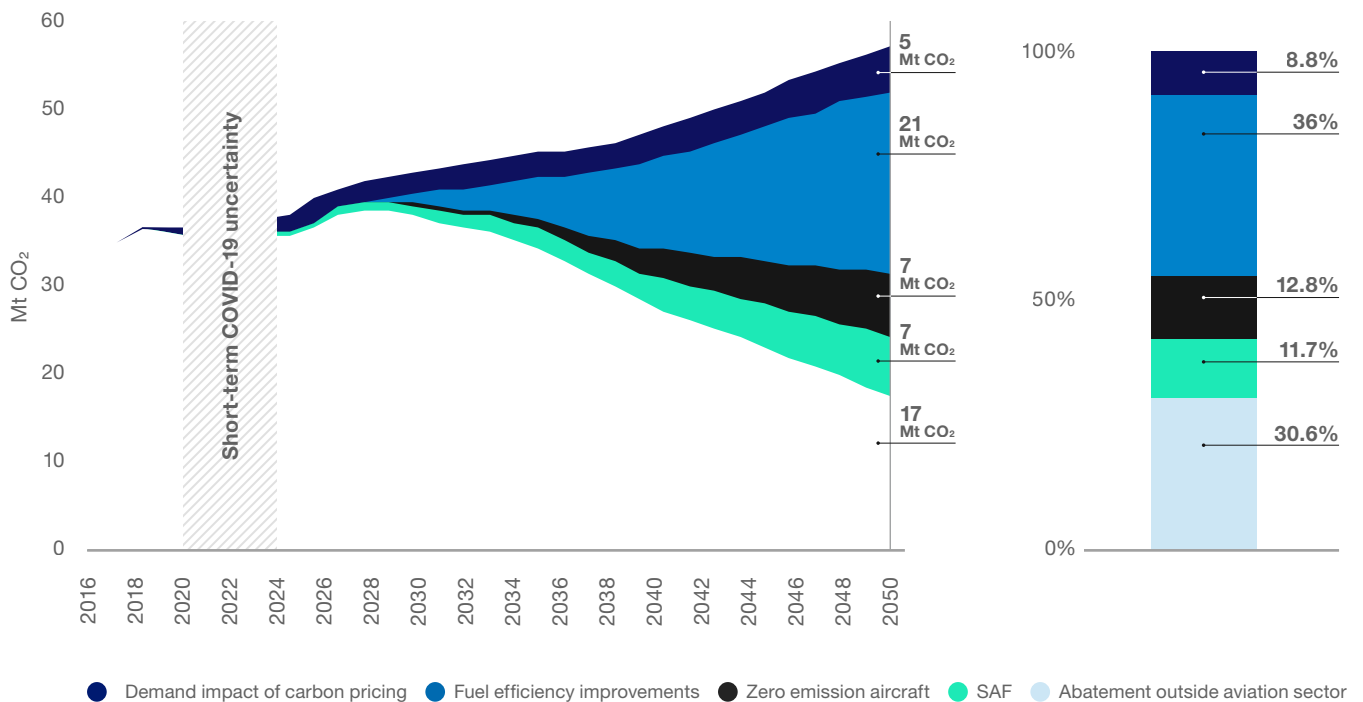


% abatement from each measure in 2050



Scenario 4: High ambition with a breakthrough on zero emission aircraft

% abatement from each measure in 2050



Questions...

1. Do you agree or disagree that UK *domestic* aviation should be net zero by 2040? How do you propose this could be implemented?

2. Do you agree or disagree with the range of illustrative scenarios that we have set out as possible trajectories to net zero in 2050? Are there any alternative evidence-based scenarios we should be considering?

3. Do you agree or disagree that we should set a CO₂ emissions reduction trajectory to 2050?
 - a. Should the trajectory be set on an in-sector CO₂ emissions basis (without offsets and removals) or a net CO₂ emissions basis (including offsets and removals)?

- b. Do you agree or disagree with the possible trajectories we have set out, based on our high ambition scenario, which have in-sector CO₂ emissions of 39 Mt in 2030, and 31 Mt in 2040 and 21 Mt in 2050, or net CO₂ emissions of 23-32 Mt in 2030, 12-19 Mt in 2040 and 0 Mt in 2050?

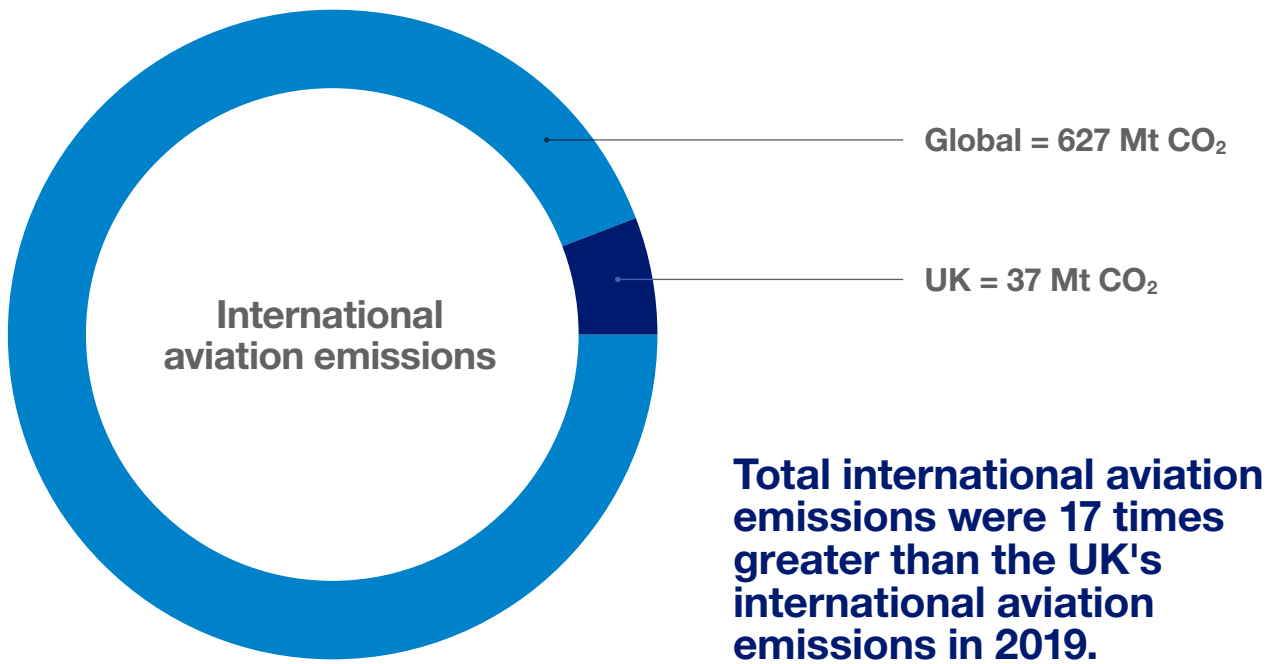
4. Do you agree or disagree that we should review progress every five years and adapt our strategy in response to progress?

International leadership

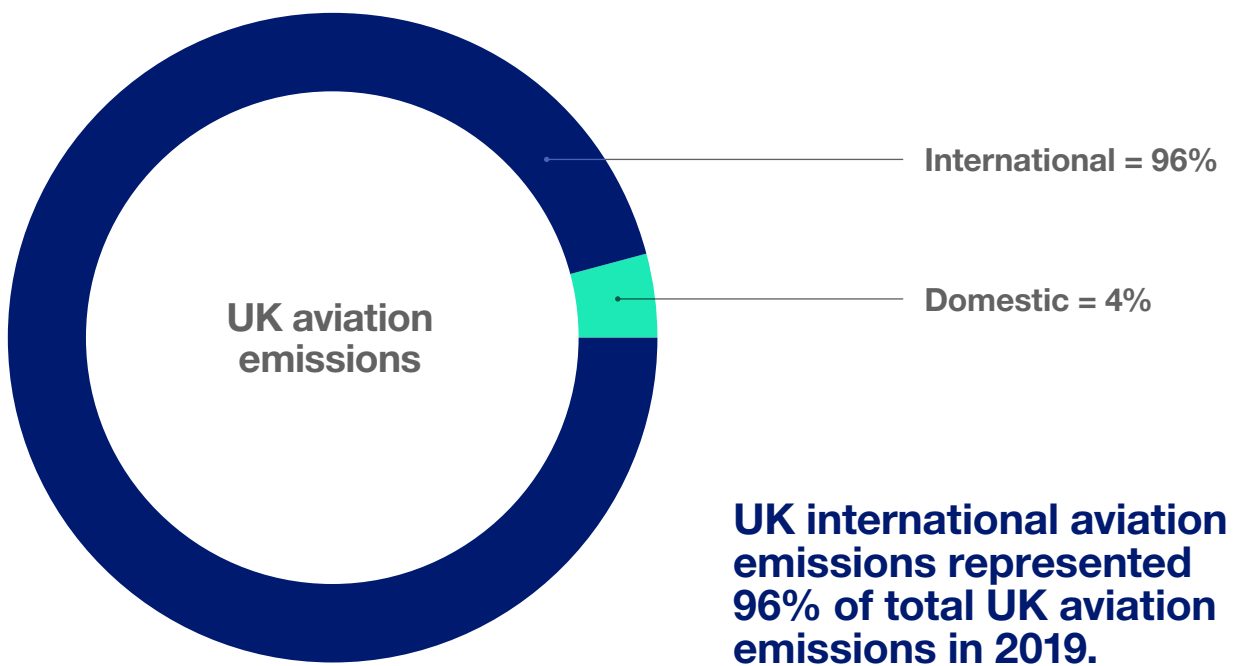
The vast majority of UK aviation emissions are from international flights; tackling these needs global agreement and UK leadership.

- 2.12 As an island nation, we rely heavily on overseas air travel, with 93% of our passengers flying internationally in 2019. As a result, in 2019 international flights accounted for 96% of total UK aviation emissions.⁸
- 2.13 The UK is at the forefront of global change, and the Government will continue to demonstrate global leadership in decarbonising aviation, both in the actions we take domestically and in our ambitious work with other countries on global decarbonisation measures. However, we recognise that the best way to reach our aviation net zero goal is by working with other countries, to reduce any risks of adding regulation or cost to *only* the UK's international aviation sector that could be challenging to implement, damage the UK's competitiveness, or risk carbon leakage.
- 2.14 Our best path to tackling all aviation emissions is by using our international leadership and influence. We will continue to work with other states through the International Civil Aviation Organization (ICAO), drawing also on our COP26 Presidency, to agree ambitious emissions goals and effective mitigation measures for the entire global sector. This includes **securing agreement to a global long-term goal for international aviation CO₂ emissions that is consistent with the Paris Agreement**, negotiating for the strengthening of the CORSIA offsetting scheme, and the adoption of policies that support the use of truly sustainable aviation fuels.
- 2.15 We will continue to work closely with our partners and allies to understand different perspectives, encourage greater ambition and coordinate national approaches. We will also support countries with less experience or resources with their aviation decarbonisation efforts.
- 2.16 Whilst these steps will be crucial in addressing UK aviation emissions, such an approach also puts an even bigger prize within our grasp: the opportunity to achieve significant reductions in **all international aviation CO₂ emissions**, which were around 600 Mt in 2019 – 17 times greater than the UK's contribution.¹¹ Given the global nature of both the aviation sector and of climate change, and with global demand for aviation expected to continue to grow, the UK's leadership in tackling aviation emissions can play a crucial role in the race to net zero.

UK share of international aviation emissions in 2019⁹



Proportion of UK international and domestic aviation emissions in 2019¹⁰



Delivered in partnership

Achieving Jet Zero requires all parts of the sector to work together to develop, test and implement the solutions we need.

- 2.17 Governments cannot achieve Jet Zero alone; success is dependent on all parts of the sector and the public working together, across the globe.
- 2.18 In the UK this collaborative approach is already well under way through the **Jet Zero Council, the Aerospace Technology Institute (ATI)** and through the **Aerospace Growth Partnership (AGP)**. We have also established the **Airspace Change Organising Group (ACOG)** to lead on modernising UK airspace, which engages and collaborates with a range of stakeholders in its delivery.
- 2.19 We will work closely with **Sustainable Aviation** as a key industry forum for reducing emissions. Launched in 2005, it is a world first, bringing together UK airlines, airports, manufacturers, and other sector partners to address climate change, noise and local air quality in the aviation industry. In 2020 it set out its plan for getting the UK aviation industry to net zero by 2050¹² and recently published interim targets for the sector.¹³
- 2.20 We will continue to collaborate with foreign governments, bilaterally, and through **ICAO, the European Civil Aviation Conference (ECAC)** and other multilateral forums, to share best practice, promote the UK's interests, and coordinate action.
- 2.21 Partnership will be embedded throughout our strategy, though we will also acknowledge where it is right for the Government to lead; whether through supporting R&D funding, or putting in place the policy and investment framework that will see the technologies we need deployed at scale.

Jet Zero Council

Established in 2020, the Jet Zero Council brings together government and industry, with the ambitious aim to deliver zero emission transatlantic flight within a generation.

To achieve this, it will consider how to develop and industrialise clean aviation and aerospace technologies, establish UK production facilities for sustainable aviation fuels and develop a coordinated approach to the policy and regulatory framework needed to deliver net zero aviation by 2050.

To accelerate progress on the objectives of the Council, two focused Delivery Groups have been established which reflect the priorities of the Council: zero emission flight and sustainable aviation fuels.



Aerospace Technology Institute (ATI) and Aerospace Growth Partnership (AGP)

The Aerospace Technology Institute (ATI) promotes transformative technology in air transport and developed the UK's Aerospace Technology Strategy.¹⁴ This strategy aims to maintain UK's competitive advantage in civil aerospace manufacturing as the sector accelerates the environmental performance of aircraft while developing emerging, and potentially transformative, zero emission technologies.

It complements the broader strategy for the sector created by the Aerospace Growth Partnership (AGP) – a joint government industry partnership to tackle barriers to growth, boost exports and grow high value aerospace jobs in the UK.

Through the AGP and guided by the ATI's technology strategy, government is investing £1.95bn, matched by industry, in mid-stage aerospace R&D through the ATI Programme.

Rolls-Royce UltraFan engine.
Image courtesy of Rolls-Royce.

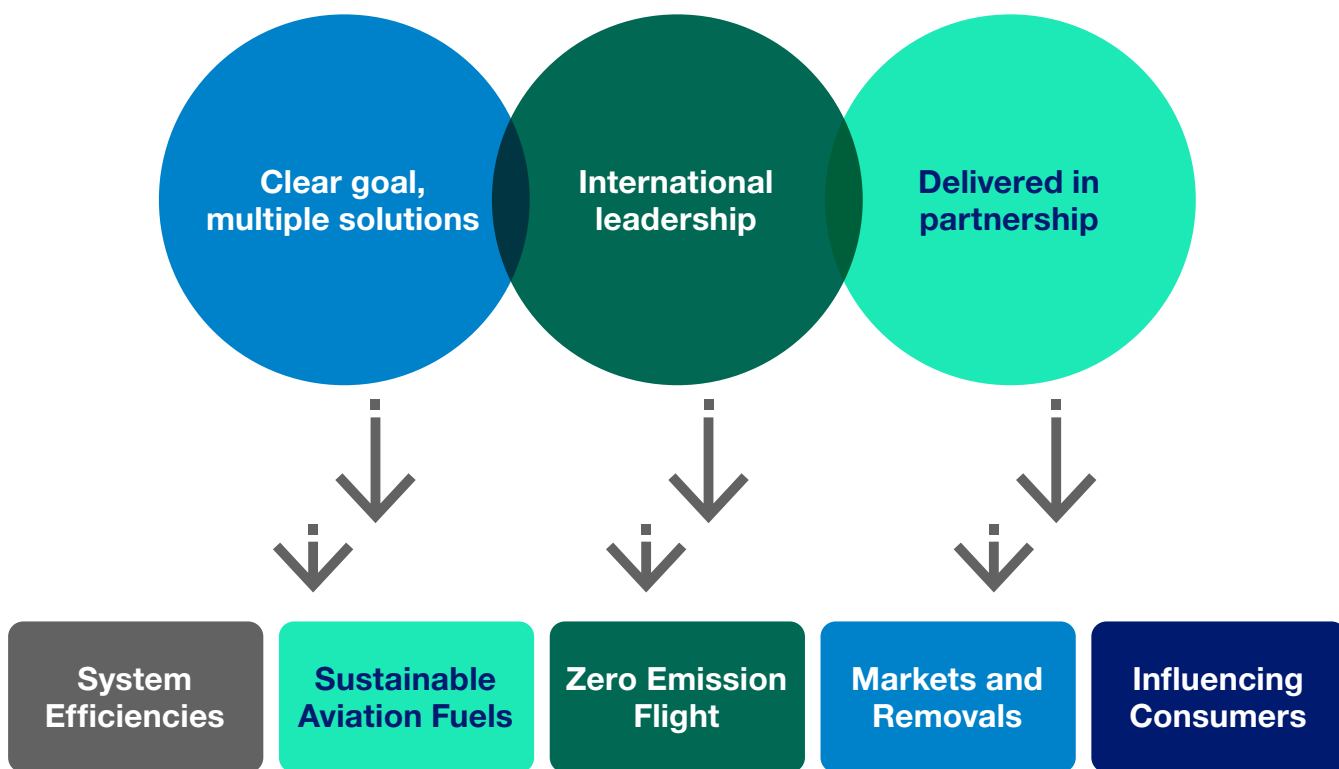
3 Measures

- 3.1 Our Jet Zero principles – clear goal, multiple solutions; international leadership; delivered in partnership – are the foundations of our strategy to decarbonise aviation, and of the steps we will take to reduce and, where possible, eliminate CO₂ emissions from aviation.
- 3.2 Our consultation sets out planned action across five different measures. The first three – system efficiencies, SAF, and zero emission flight – are all focussed on our priority of maximising in-sector emissions reductions through different technological and operational approaches. The fourth – markets and removals – gives a further driver for in-sector reductions by pricing emissions, whilst also providing a route for the sector to offset or remove any residual emissions. The final measure – influencing consumers – explores options for encouraging consumers to choose the most sustainable routes and travel providers when planning and undertaking their journeys.
- 3.3 This chapter sets out our approach across each of these five measures, including the policies we will look to implement, and asks for feedback.

Beluga super transporter being fuelled with SAF for the first time in Broughton in May 2021.

Image courtesy of Airbus.





System Efficiencies

A significant proportion of our emissions reductions will come from improving the efficiency of our existing aviation system: our aircraft, airports and airspace.

- 3.4 We can reduce CO₂ emissions by increasing the efficiency of our existing aviation system, through improving the efficiency of our aircraft, changing how our airports operate, and optimising the use of our airspace.
- 3.5 This is not wishful thinking. The aviation sector has shown significant improvement in efficiency over recent decades, investing in greener technologies, improving operations, and phasing out older aircraft. Since 1990, average efficiency improvements of 0.8% per annum (increasing to 2.1% per annum from 2010-2019) have led to significant CO₂ emissions reductions per passenger. Without these efficiency gains, in 2019 UK aviation emissions would have been more than 20% higher per passenger based on the same rate of growth in passenger numbers.^{16,17}
- 3.6 Given the lead-in times of other technological measures, **improving the efficiency of our current aviation system offers the best opportunities for short- to medium-term reductions in CO₂ emissions** and could also deliver immediate improvements in noise and air quality.
- 3.7 In our illustrative scenarios to 2050, improvements in the efficiency of our current aviation system deliver 25%-36% of the CO₂ savings, with fuel efficiency improvements of 1.5%-2% per annum. Indeed, failing to make improvements here will increase the likelihood that additional and more expensive interventions are needed.



Moving to **best-in-class aircraft, operations and airspace modernisation** could deliver

25-36%
of CO₂ savings
by 2050¹⁸

The icon consists of a dark blue cloud with 'CO₂' written in white inside. Two white arrows point downwards from the top of the cloud.



Photo by Jose Lebron on Unsplash

The benefits of system efficiencies

Aerospace R&D delivers significant spillover benefits

to the rest of the economy and high paid manufacturing jobs that boost productivity



Airspace modernisation will allow the aviation industry to deliver a further

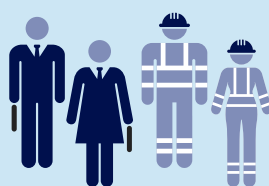
£29 billion

to the UK economy

and create nearly

116,000

more jobs by 2035.²¹



Many of the measures to improve efficiencies also result in noise reductions – new aircraft technology alone could reduce perceived noise from aircraft by

65% by 2050²².

65% by 2050²².



- 3.8 There is huge potential to increase the efficiency of conventional **aircraft** (those powered by fossil fuel or SAF) through improvements to jet engines, wings, structures, and other systems. Next generation models of aircraft, such as the Airbus A320neo, offer around 20% efficiency gains on their predecessors.¹⁹ Replacing older aircraft still in operation with the latest models could save approximately 20 Mt CO₂ by 2050.²⁰ The UK is working through ICAO to ensure stringent international standards for aircraft emissions as technology improves.
- 3.9 There are also significant savings to be made at **airports**, where changes to operations – such as the use of a single engine for taxiing, and eventual use of an electric motor – could cut CO₂ emissions by 60% in this phase of flight.²³ Connected and autonomous vehicles (CAVs) will also have a role to play in increasing the efficiency of airside vehicles, such as Aurrigo's automatic baggage dolly, and Oxbotica's autonomous cargo pod and driverless shuttles, which have already been trialled at Heathrow and Gatwick airports. Six UK airports²⁴ currently hold Airports Council International (ACI) Europe Carbon Neutrality accreditation and many are setting more ambitious net zero targets. For example, Bristol Airport has announced that it intends to be the UK's first net zero airport (including its building, airfield and fleet) by 2030.
- 3.10 CO₂ can be cut by reducing aircraft weight by precisely matching fuel and water requirements with passenger loads, through maintenance procedures that can improve engine performance, and by optimisation of speed, route

and altitude in flight planning. Ground handlers also have a role to play, with a transition to electric tugs (such as those used at Heathrow and other airports) further reducing CO₂ emissions.

- 3.11 Finally, improvements in our **airspace** will lead to more direct flights at more efficient altitudes and speeds. Holding in stacks for aircraft waiting to land at busy airports is a particular inefficiency that needs to be addressed through the Airspace Modernisation Programme.²⁵ Increased CO₂ emissions associated with fuel tankering, a practice whereby aircraft carry more fuel than required in order to reduce the need to refuel at their destination, should also be addressed, a practice estimated to produce an additional 0.9 Mt of unnecessary CO₂ emissions per year.²⁶
- 3.12 COVID-19 has significantly impacted the extent the sector is able to invest in new, more efficient technologies, systems or programmes. However, the pandemic presents opportunities too. As aviation demand has reduced, airlines have accelerated the phasing-out of older, more polluting aircraft. Lower traffic levels have enabled the testing of new procedures which would have otherwise been very difficult to do (see box).
- 3.13 Our approach to improving system efficiencies is guided by this current context: **we will ensure the aviation system has the right policy framework** to encourage continued investment in efficiency gains, and **we will take the learning opportunity of these past 16 months** to ensure that as traffic returns, it will be in a system making the best use of technology and procedures for optimised efficiency.



Removal of North Atlantic Track system case study

For decades, a lack of radar surveillance has meant aircraft flying across the North Atlantic have done so using an organised track structure, with fixed speeds and altitudes – essentially invisible high-altitude motorways.

As COVID-19 reduced traffic levels from around 1,300 flights to around 500 flights per day, this allowed NATS and NAV CANADA – who jointly operate the North Atlantic flight region – to test removal of the organised track structure. Instead, they used real time satellite-based surveillance, allowing aircraft to change their speed and altitude across the Atlantic in response to conditions, saving carbon by allowing all aircraft to fly their optimum route. A decision will be made day-to-day whether to remove the tracks with the ambition that this eventually will lead to their permanent removal.

Image courtesy of NATS.

Our existing policy commitments:

- We will support airspace modernisation, providing up to £5.5m funding in the years 2020/21 and 2021/22 to support sponsors to continue through Stage 2 of the airspace change process.
- We will work with the Civil Aviation Authority as co-sponsors of the Airspace Modernisation Programme to support Airspace Change Organising Group (ACOG) in ensuring carbon savings are realised and plans for airspace modernisation account for the introduction of zero emission aircraft.
- We will continue to work through ICAO to ensure a global baseline for fuel efficiency, both through CO₂ certification standards and guidance to states on implementing operational efficiencies.

Our new policy proposals:

- We propose that all airport operations in England should be zero emission by 2040 (scope 1 and scope 2 emissions).
- We will seek a voluntary agreement from all airlines to avoid tankering where there is no practical reason to carry additional fuel, such as immovable turnaround times or fuel supply issues.
- We welcome thoughts on whether there are wider changes to policy that might incentivise improved efficiencies, including:
 - Airport charges / slot allocation – the possible use of landing fees to charge for CO₂ (in addition to NO_x and noise) and/or consideration of environmental performance when allocating slots at constrained airports where new slots become available.
 - Making provision for Air Navigation Service Providers (ANSPs) to implement differential charging based on environmental performance within their controlled airspace.
 - Identifying where changes to regulations may be needed to implement new CO₂ emission saving operations e.g. formation flight.
 - Whether there are other ways to stimulate investment in greater operational efficiencies across the aviation system.

Questions...

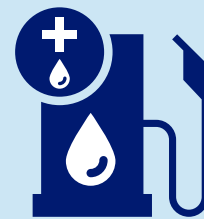
5. Do you agree or disagree with the overall approach to improve the efficiency of our existing aviation system?
6. What more or differently could be done to ensure we maximise efficiency within the current aviation system?

Sustainable Aviation Fuels (SAF)

Sustainable aviation fuels could play a key role in decarbonising aviation, whilst also representing an industrial leadership opportunity for the UK.

- 3.13 As well as improving the efficiency of aircraft, we need to reduce the climate impact of the fuels that they use.
- 3.14 SAF are a ‘drop in’ option, meaning they can be blended into fossil-based aviation fuel and used in existing aircraft without modification and therefore could deliver both medium- and long-term CO₂ emissions savings. Many experts view SAF as the only alternative for long-haul flights up to 2050, which are the flights with the biggest climate impact; **it is estimated that flights greater than 5,000km (equivalent to a flight from London to Bahrain), which make up just 10% of overall flights, are responsible for over 60% of UK aviation emissions.**²⁷
- 3.15 When compared to conventional fossil aviation fuel, SAF produced from feedstocks with strong sustainability credentials can result in over 70% CO₂ emissions saving on a lifecycle basis²⁸ and could deliver net zero emissions with the addition of greenhouse gas removal technologies. Most SAF also emit less soot and particulate matter compared with conventional fossil jet fuel which is expected to reduce non-CO₂ climate impacts.

The benefits of sustainable aviation fuel²⁹



A UK SAF industry could generate between **£700m–£1.6bn** in Gross Value Added (GVA) per year.

Creating between **5,000–11,000** green jobs.

Helping the UK to ‘level up’ and not rely on oil imports, with production facilities across the whole of the UK.

What are SAF?

“SAF” are low carbon alternatives to conventional, fossil-derived, aviation fuel – ‘drop in equivalents’ that present similar characteristics to conventional jet fuel. Generally, SAF can be produced from three types of feedstock:

- **Biomass:** this includes biogenic waste, e.g. used cooking oil.
- **Non-biogenic waste:** e.g. unrecyclable plastics or waste fossil gases from industry.
- **CO₂ + green hydrogen:** zero-carbon electricity is used to produce hydrogen through water electrolysis; hydrogen then reacts with CO₂ captured from the air or waste industrial exhaust streams to produce a synthetic fuel. This process is known as Power-to-liquid (PtL).

- 3.16 However, currently the costs of SAF are high and uncertain, ranging from 2-3 times compared to the price of the fossil counterfactual, and potentially up to 8 times more for certain technology pathways.³⁰ Development and production do however present an industrial leadership opportunity for the UK: a thriving domestic SAF industry will provide highly skilled jobs and support economic growth.
- 3.17 SAF supply is already rewarded through the Renewable Transport Fuel Obligation (RTFO) which provides tradeable certificates for every litre of certain sustainable fuels used for aviation. The Government has also provided grant funding to businesses through our Advanced Biofuel Demonstration Competition (2014) and Future Fuels for Flight and Freight Competition (2017), putting the UK in a strong position to develop advanced fuels capable of decarbonising harder-to-decarbonise sectors. We are now building on this ambition through the Green Fuels, Green Skies competition which is providing £15m in 2021-22 to support the early development of first-of-a-kind commercial SAF plants in the UK.
- 3.18 Our strategy will build on this commitment. We are continuing to develop plans for a SAF clearing house and will shortly consult on a UK SAF blending mandate to kick-start the market which could enable greater SAF uptake than is within the CCC's Balanced Pathway. We are keen to maximise the environmental and industrial opportunities that SAF offer and, in the upcoming months, we will also consider whether further innovative policy mechanisms are needed to provide greater confidence to UK SAF producers.
- 3.19 At the time of writing there is currently no comprehensive global regulatory standard for SAF sustainability. The UK is therefore active at ICAO in negotiating for a full set of sustainability criteria for SAF that will underpin its global deployment. At the same time, we recognise that a global ambition for future SAF deployment may help to give certainty to the global industry and avoid some of the challenges associated with states acting alone. Any such goal would need to be underpinned by strong sustainability criteria.
- 3.20 Our vision is to scale up SAF over the coming years, such that out to 2050 they are primarily used on flights that may be more challenging to conduct by zero emission aircraft – most likely the long-haul flights that are responsible for the bulk of emissions – whilst ensuring that the UK secures the huge economic prize on offer: reducing dependence on imported oil and creating new green jobs across the UK.

The **Jet Zero Council SAF Delivery Group** has been set up for government and industry to work together to establish UK SAF production facilities and accelerate the delivery of the fuel to market. It is focused on the development of a UK SAF mandate, the commercialisation of the sector, and the technologies and feedstocks that the UK should prioritise.



Rolls-Royce case study

As part of their ATI Programme project 'SIRUS', supported with a £16m government grant, Rolls-Royce have undertaken engine ground tests using 100% SAF. Covering emissions, efficiency, noise and operability, Rolls-Royce aim to make all their civil aero-engines in production compatible with 100% SAF by 2023, double the current maximum blend of 50%. This will allow SAF to contribute further to our net zero commitment and places Rolls-Royce and the UK at the forefront of this increasingly important field.

Image courtesy of Rolls Royce.

Our existing policy commitments:

- We will shortly consult on a UK SAF mandate setting out our level of ambition for future SAF uptake and defining the scope, technology, compliance and reporting implications underpinned by it.
- We have formed the Clean Skies for Tomorrow SAF Ambassadors group, which will develop, pilot and promote industry-led policy proposals for national SAF policies, ahead of COP26.
- We will continue to engage SAF stakeholders through the Jet Zero Council SAF Delivery Group, to ensure future SAF policy is robust.
- We have consulted on the possibility of expanding the RTFO to reward recycled carbon fuels (RCF) which are produced from fossil wastes that cannot be avoided, reused or recycled.
- We are supporting the development of SAF through the Green Fuel, Green Skies competition, through which companies will be able to bid for a share of £15 million in 2021-22 to kickstart the development of first-of-a-kind production plants in the UK. Successful projects are expected to be announced in summer 2021.
- We will establish a SAF clearing house to enable early stage aviation fuel testing as an essential capability to support our decarbonisation agenda.

Our new policy proposals:

- We will consider whether further policies are needed to provide SAF producers with greater confidence and encourage UK production.
- We will continue to negotiate in ICAO for comprehensive SAF sustainability standards and to work towards a future global SAF objective. We will also work with smaller groups of states to coordinate on SAF policies where this can be complementary to ICAO's work.
- We will look at the feasibility of using SAF on UK Public Service Obligation (PSO) routes.
- Alongside the five-year reviews of this strategy, we will undertake a SAF-specific review by 2030, once the supportive policy framework is in place, and SAF production is being scaled up, and use this to confirm a SAF trajectory to 2050.
- We will work across government to pioneer the accelerated procurement and use of SAF.

Questions...

7. Do you agree or disagree with the overall approach for the development and uptake of SAF in the UK?
8. What further measures are needed to support the development of a globally competitive UK SAF industry and increase SAF usage?



Fulcrum Sierra BioFuels is currently in the commissioning phase and expected on line in 2021.

The facility is capable of producing over 30 kt per year of SAF from 175 kt of processed residual household waste. Similar plants of various capacities are currently under development in the UK.

Image courtesy of Fulcrum BioEnergy Limited.

Zero Emission Flight (ZEF)

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

3.21 Zero emission flight technologies such as hydrogen-electric and battery-electric aircraft have already been demonstrated in the UK. Continued investment in these technologies could support a significant reduction in global aviation emissions.

3.22 A key role for the Jet Zero Council is to act as a catalyst for zero emission flight across the Atlantic. This is an exciting but challenging technological endeavour. Given our existing global position in aerospace and aviation, the UK is well placed to be at the forefront of developing and deploying new, potentially transformative, technologies.

3.23 Government and industry are investing in the development of emerging aircraft

technology through the ATI programme, including through FlyZero – a research project taking an in-depth look into the potential for a zero emission aircraft by 2030. The Government is also supporting wider programmes such as the Industrial Strategy Challenge Fund Future Flight, Faraday Battery and Driving the Electric Revolution challenges. The UK has a proud history of leading innovation in aviation and this will continue into a new era of low and zero emission flight.

3.24 Small scale electric aircraft have already been demonstrated in the UK. A range of hydrogen-electric and battery-electric aircraft could enter the sub-regional and General Aviation markets this decade, and other forms of propulsion such as

The benefits of zero emission flight

No tailpipe CO₂ emissions, and potential for reduced non-CO₂ impacts.



Funding through the ATI programme **could benefit the UK economy by £114 billion up to 2035** and **create and safeguard 95,000** direct and supply chain jobs.³¹

H2GEAR, a liquid hydrogen propulsion project supported by the ATI, **is expected to create over 3,000 jobs** alone over the next decade.³²



FlyZero Project

FlyZero is a 12-month research project, which is being delivered by the ATI and supported with a £15m grant from BEIS. The project brings together over 80 experts from across industry and academia to explore the design challenges and market opportunity of potential zero emission aircraft concepts. The work is aimed at preparing the UK for zero emission commercial flight. The UK is the first nation to invest in such a broad collaboration with industry.



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ZeroAvia case study

Supported by the ATI Programme, last year, ZeroAvia achieved the world's first hydrogen fuel-cell powered flight of a commercial-grade aircraft. The flight also showcased a full zero emission ecosystem, with onsite hydrogen production via electrolysis. ZeroAvia have secured further ATI funding to scale-

up and demonstrate their hydrogen-electric powertrain on a 19-seater aircraft, with the aim to achieve commercialisation in 2023. In March 2021, British Airways, Bill Gates's Breakthrough Energy Ventures and others invested over £17m to accelerate the development of a larger hydrogen engine.

hydrogen or ammonia combustion may also have a role. We are keen to accelerate the development of these aircraft, and welcome industry ambition to scale up the technology to larger commercial passenger usage, which currently account for the majority of carbon emissions from aviation.

- 3.25 We welcome views on our **aspiration, to have zero emission routes across the United Kingdom by the end of the decade** as part of our wider ambitions to improve connectivity across the UK. We would also welcome views on the potential **use of Public Service Obligation (PSO) routes – air routes which are vital for the economic and social development of a region – for early roll-out of such aircraft**. This is our starting point, but we aim to scale up these technologies to

achieve zero emission transatlantic flight within a generation.

- 3.26 We are providing support for the development of hydrogen technology, which we expect to play a key role in fuelling zero emission aircraft. The UK's first hydrogen transport hub, being developed in the Tees Valley, will support research, testing and trials as part of its cross-transport mode work to improve our understanding of hydrogen's role in reaching net zero by 2050. The UK Hydrogen Strategy will set out actions needed to decarbonise and expand hydrogen production, alongside speculative demand from aviation through to 2050. The Regulatory Horizons Council⁹³ has selected hydrogen regulation as an area that it will conduct a deep dive report into this year, and initially indicated a strong

interest in the transport aspects and aviation in particular.

- 3.27 We have an opportunity to utilise our world class manufacturing sector to build a leading position in the design and production of zero emission aircraft. Continued investment in technology development could unlock long-term economic benefits, and lead to UK-developed technology significantly contributing to the reduction of global aviation emissions.
- 3.28 For zero emission aircraft to be able to operate in the UK, we need to ensure that our airports and airfields have the infrastructure to fuel, take-off and land those planes, that pilots and staff have the skills to operate and maintain them safely, and that they are developed within a regulatory environment which enables their demonstration, certification and quick scale-up to safe deployment. As such, we are investing £3m into R&D this year to better understand the infrastructure needs at airports to ensure these aircraft can operate safely and efficiently.
- 3.29 We recognise that there are specific challenges for the General Aviation sector, such as transitioning from AvGas to affordable alternatives. There is however significant opportunity for the sector to lead on the introduction of zero emission aircraft. As set out in our General Aviation Roadmap³⁴ we will continue to encourage an innovative, environmentally sustainable sector, including the use of new technology.
- 3.30 Our approach to accelerating the development of future zero emission flight is therefore: to consider the recommendations of the FlyZero project and ongoing R&D programmes, work to ensure our airports have the infrastructure they need to manage these new technologies, and collaborate with the Civil Aviation Authority (CAA) to support the enabling of demonstration activity that supports these aircraft in a safe way.

Our existing policy commitments:

- We will continue to support industrial R&D through the ATI Programme, informed by the UK Aerospace Technology Strategy, with the objective of securing clean growth.
- We will continue to work with the ATI, industry and academia to establish a method for quantifying the potential emissions savings of future R&D projects in advance of publication of the Jet Zero Strategy, to allow us to quantify the sustainability benefits for the aviation sector the Programme seeks to achieve and prioritise the funding of projects most likely to deliver clean growth.
- We will support the FlyZero project, which will set out a plan by early 2022 for how the UK might best contribute to a zero emission aircraft by 2030.
- We are investing £3m into R&D funding in 2021/22 to understand the infrastructure needed by airports to handle new forms of zero emission aircraft.
- The Government will publish a UK Hydrogen Strategy which will detail the key steps needed in the 2020s to deliver our 5GW of low carbon hydrogen production capacity ambition and set the context for further scale up on the way to net zero.
- We will support the development of the Tees Valley Hydrogen Hub, including through industry engagement to generate demonstration activity at Teesside International Airport.
- We will work with the CAA and ICAO to ensure the UK remains the best location in which to develop and deploy new zero emission aircraft.



Rolls-Royce ACCEL electric aircraft.
Image courtesy of Rolls-Royce.

Our new policy proposals:

- We will ensure the UK is at the forefront of deploying zero emission aircraft. Our aspiration is to have zero emission routes connecting the United Kingdom by 2030.
- We will look at the feasibility of using zero emission aircraft on UK PSO routes.
- We will work with industry to encourage the adoption of innovative zero emission aircraft and aviation technology in General Aviation.
- We will work through the Jet Zero Council to consider the wider enabling framework for zero emission flight, including the infrastructure, regulatory and commercialisation requirements.

Questions...



- 9 Do you agree or disagree with the overall approach for developing zero emission flight in the UK?
- 10 What further measures are needed to support the transition towards zero emission aviation?

Markets and Removals

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

- 3.31 The UK remains a leading voice in the establishment and development of carbon markets and views carbon pricing as an essential lever for reaching net zero. We launched Europe's first emissions trading scheme in 2002, which served as a pilot for the EU Emissions Trading System (EU ETS) within which aviation was included from 2012.
- 3.32 At the start of this year, jointly with the devolved administrations, we introduced the UK Emissions Trading Scheme (UK ETS), replacing the UK's participation in the EU ETS. The UK ETS currently covers around a third of all UK emissions, including all domestic flights, flights from the UK to the European Economic Area and flights between the UK and Gibraltar. In 2019, these flights made up 44% of all commercial flights to and from UK airports.³⁵ Our UK ETS is also more ambitious than the EU system UK aviation was previously subject to. The cap on total emissions has already been reduced

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.

The UK ETS works on the 'cap and trade' principle, where a cap is set on the total amount of certain greenhouse gases that can be emitted by sectors covered by the scheme and which decreases over time.

Under CORSIA, aeroplane operators offset the growth in international aviation CO₂ emissions covered by the scheme above 2019 levels*.

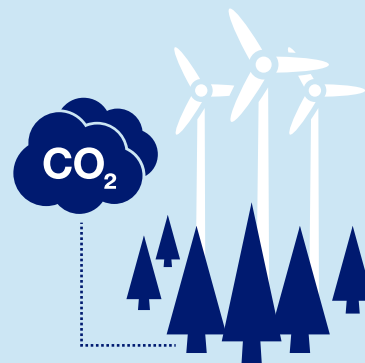
*The baseline is currently defined as an average of 2019 and 2020 emissions, however due to the COVID-19 pandemic, the ICAO Council agreed in June 2020 to change this to 2019 emissions only for the Pilot Phase. The CORSIA periodic review in 2022 will consider whether to extend the baseline change to the subsequent phases.

The benefit of markets and removals

Market-based measures, such as **the UK ETS and CORSIA, promote cost-effective decarbonisation**, allowing businesses to cut carbon where it is cheapest to do so.

Market-based measures **incentivise businesses to invest in green technologies**.

It is estimated that **14% of global emissions come under an ETS** in 2021.³⁶



Under the UK ETS, emissions from covered sectors will reduce in line with the cap, which will be set to an appropriate net zero trajectory.

by 5%, and **the Government will consult on how to align the cap with a net zero trajectory later this year.**

We also welcome views on whether the scheme could be expanded to cover other non-CO₂ gases from aviation.

- 3.33 The UK is particularly influential in the work of ICAO, the UN agency responsible for tackling international aviation emissions. It is a member of the Committee on Aviation Environmental Protection and was instrumental in the agreement and development of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). CORSIA is the first global market-based measure to address CO₂ emissions in any single sector. The UK is among 88 states that have volunteered to participate from the start of this year and we are now implementing the scheme in UK law.
- 3.34 To support countries with less experience in aviation decarbonisation policy and help secure the widest possible participation in CORSIA, we will explore how the UK can help to develop the capacity of other governments to implement ICAO's climate policies.
- 3.35 By pricing CO₂ emissions, market-based measures can drive cost-effective and technology-agnostic emissions reductions, making system efficiencies,
- SAF and zero emission flight more economically attractive, and influencing the travel choices of consumers. They also implement the 'polluter pays' principle – that those who engage in activity that has an environmental impact should bear the cost of that impact.
- 3.36 They also play a second role: whilst our priority is to deliver in-sector CO₂ emissions reductions, **most projections suggest there will be residual CO₂ emissions from aviation in 2050.** Markets can facilitate the offsetting of aviation's CO₂ emissions through investments in robust schemes that remove or avoid an equivalent volume of these emissions elsewhere.
- 3.37 Over time, as easier carbon reduction opportunities become scarce and the need for negative emissions becomes greater, we expect schemes that rely on offsetting through avoided emissions to shift to employing greenhouse gas removal methods. These take an equivalent amount of CO₂ out of the atmosphere in a verifiable and additional manner.
- 3.38 We will continue to review the opportunities for offset markets, so they can contribute to delivering the emissions reductions consistent with net zero by 2050, and further explore the potential role of greenhouse gas removal methods in addressing residual emissions from hard-to-abate sectors.

Loganair case study

Loganair, the UK's largest regional airline, has recently announced its "GreenSkies" environmental programme which includes mandatory carbon offsets to remove the same amount of carbon from the environment as that generated from every Loganair flight.

A £1 Carbon Offset charge will be included in the ticket price for every customer's flight from summer 2021. The mandatory carbon offset programme is the first such initiative by a UK regional airline to directly reflect the cost of offsetting emissions in ticket prices.

Greenhouse gas removal (GGR) and aviation

To achieve net zero by 2050, analysis from the CCC shows that a mix of engineered and nature-based GGRs will be required to balance residual emissions from aviation and other difficult-to-decarbonise sectors, such as agriculture and certain heavy industries.

GGRs are not yet implemented at commercial scale, either in the UK or globally, and forecasts of costs and scale-up potential

are highly uncertain. Demonstration of early-stage GGR solutions in the coming years will help to refine the Government's current assessment of GGR costs and the role they will play in achieving net zero. Work is ongoing to assess how the aviation sector could interact with GGRs, for example through bilateral agreements with GGR producers or through markets.



Image by Dmitry Kovalchuk on Shutterstock

Our existing policy commitments:

- We will have all legislation for CORSIA in force no later than the start of UK ETS Phase I(b) in 2024, enforce it robustly and encourage other states to do the same.
- We will, in collaboration with the devolved administrations through the UK ETS Authority, work to enhance the effectiveness of the UK ETS; ensuring that aviation is appropriately considered as we consult on amending the cap to align with net zero, reviewing the sector's free allocation, exploring expanding the pollutants covered, and making any changes that may be required to account for CORSIA.
- We will set out further details on the Government's approach to the development and deployment of greenhouse gas removal methods, following the Government's recent Call for Evidence.³⁷
- We will consider how the UK ETS could incentivise the deployment of greenhouse gas removal methods, in line with the Government's commitment in the Energy White Paper.
- We will negotiate for carbon pricing to be maintained and strengthened in the international aviation sector, including aligning the ambition of measures such as CORSIA with any long-term goal adopted by ICAO.
- We will be firm advocates within ICAO to improve the environmental ambition of CORSIA through ICAO's periodic reviews.

Our new policy proposals:

- We will strengthen carbon pricing for aviation to ensure we continue to apply the 'polluter pays' principle and consider incentives for greenhouse gas removal methods.
- We will explore how we can support other states that may need help implementing CORSIA effectively.

Questions...

- 11 Do you agree or disagree with the overall approach for using carbon markets and greenhouse gas removal methods to drive down CO₂ emissions?
- 12 What could be done further or differently to ensure carbon markets and greenhouse gas removal methods are used most effectively?

Influencing Consumers

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

3.39 Flying is a social and economic good, and one that we wholeheartedly support as a key part of building a Global Britain; our strategy will focus on decarbonising aviation and delivering sustainable flying for everyone. This Government is committed to tackling the CO₂ emissions from flights, whilst preserving the ability for people to fly.

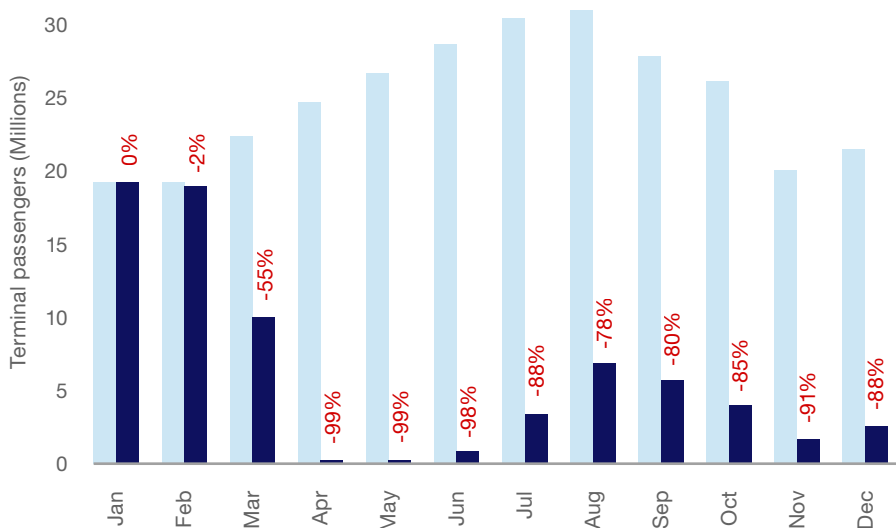
3.40 COVID-19 has devastated passenger numbers over the short-term, and we do not yet know what the longer-term effects on demand might be. Only as the pandemic continues to come under control and consumer confidence returns, will we begin to understand how it will affect the sector over the longer-term.

3.41 Nonetheless, even if the sector returns to a pre-COVID-19 demand trajectory, as we have assumed in our analysis, we currently believe the sector can achieve Jet Zero without the Government needing to intervene directly to limit aviation growth. The industry's need to rebuild from a lower base is likely to mean that plans for airport expansion will be slower to come forward.³⁹ Our analysis shows that there are scenarios that can achieve similar or greater CO₂ reductions to those in the CCC's Balanced Pathway⁴⁰ (which limits growth to 25% by 2050 compared to 2018 levels compared to a baseline of 65% growth) by focussing on new fuels and technology, with the knock-on

The impact of the pandemic on terminal passengers at UK airports³⁸

The coronavirus pandemic has led to an unprecedented decline in the number of terminal passengers at UK airports. **In April 2020, passenger numbers dropped by 99%** compared to April 2019, and remained low throughout the year.

Terminal passengers at UK airports – Change 2020 vs 2019



● 2019 ● 2020

economic and social benefit, rather than capping demand.

- 3.42 We recognise that net zero 2050 must be achieved and we must ensure that any growth in aviation is compatible with our emissions reduction commitments. The approach we intend to set out in our Strategy will prioritise in-sector reductions through technological and operational improvements, then seek to address residual carbon emissions through robust, verifiable offsets and additional greenhouse gas removals. It relies on the rapid scale-up and deployment of technologies that are currently at a relatively early stage of development and requires collaboration and commitment across all parts of the sector if it is to succeed.
- 3.43 We also recognise that as a responsible government, we will need to keep our Strategy under review. As such **we intend to assess progress on the sector's CO₂ emission reduction pathway and our strategy for delivering through our five-year reviews.**
- 3.44 We expect the approach set out in this draft strategy could impact demand for aviation indirectly. Where new fuels and technologies are more expensive than their fossil-fuel equivalents, and where the cost of CO₂ emissions are correctly priced into business models, we expect, as with any price rise, a moderation of demand growth.
- 3.45 We have recently consulted as a government on changes to Air Passenger Duty (APD), including seeking views on a potential increase to the number of distance bands, in order to align the tax more closely with our environmental objectives. Airlines ordinarily pass the cost of APD onto the passenger and therefore those passengers who fly more will pay more tax.
- 3.46 And there are ways in which we can provide consumers with greater opportunities to make sustainable, informed choices on their travel plans, and in turn incentivise industry to decarbonise. For example, by providing better information on the climate impacts of travelling on different routes, or on different airlines. A study by the International Council on Clean Transportation (ICCT) suggests that emissions per passenger can differ by up to 63% on the same transatlantic route.⁴¹
- 3.47 The Civil Aviation Authority (CAA) are planning to consult on environmental information provisions later this year and we intend to work with them to explore whether mandating the provision of such information to passengers at the time of booking could enable better progress in this area. We will also work with the CAA to ensure that that any future requirements for environmental information provision does not have any unintended consequences such as distorting competition.



CAA environmental information provision case study

The CAA, in partnership with BritainThinks, recently launched a research project to explore the feasibility and utility of sharing carbon information with consumers, to enable better decision-making.

The most significant findings were:

- Most participants thought that emissions information should be universally provided across all sectors.
- Participants thought that information provision should both inform the public about the relative impacts of flying and encourage airlines to reduce emissions.

- Participants thought that information design should be standardised, easily accessible, and have third-party vetting to encourage trust and reliability.

The research indicated there is a broad spectrum of how responsive consumers would be to this information and concluded that better information provision could provide an opportunity for consumers to pick more sustainable flight options.

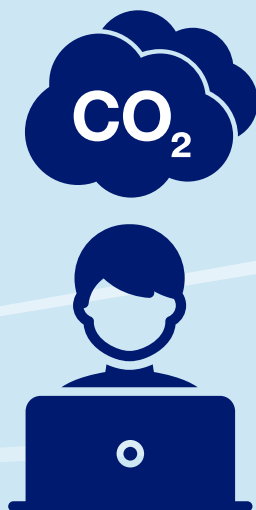
Photo by Rawpixel.com on Shutterstock

The benefits of influencing consumers

Work by the ICCT suggests that there can be **a difference of up to 63%** in emissions between different transatlantic flights.⁴²

Information provision could help:

- Passengers make informed decisions at the time of booking a flight.
- Increase public awareness of carbon emissions and climate change.
- Support aviation growth in a sustainable manner.



Our new policy proposals:

- We will work with the CAA to explore whether mandating the provision of environmental information to customers at the time of booking flights could influence consumer decision-making when presented with standard, reliable and accurate flight comparisons.
- We will look at other ways to support consumers to make sustainable choices when booking flights and reward those parts of the aviation sector that move more quickly to decarbonise.

Questions...

- 13 Do you agree or disagree with the overall focus on influencing consumers?
- 14 What more can government do to support consumers to make informed, sustainable aviation travel choices?

4 Non-CO₂ impacts

- 4.1 Tackling the climate impact of aviation is not just about reducing CO₂ emissions. Whilst the long-life span of CO₂ in the atmosphere makes tackling it of critical importance, there are other non-CO₂ impacts that also affect the climate and local air quality: in particular contrails and NO_x emissions.
- 4.2 Contrails – or condensation trails – form from the initial emission of water vapour and soot particles in the exhaust of aircraft. In high humidity regions of the atmosphere these contrails can persist and create cirrus clouds. This is understood to create a net warming effect in addition to any CO₂ emissions, though the exact scale of the effect has a large degree of uncertainty. The contribution from any individual flight also depends on factors such as the time of day, as well as the atmospheric conditions.
- 4.3 NO_x emissions increase the levels of ozone (leading to warming) and decrease ambient methane in the atmosphere (leading to cooling), which is understood to contribute to a net warming effect. Again, confidence in the magnitude of the effect is low.
- 4.4 Local air quality impacts from aviation occur in areas around airports, accounting for a small proportion of emissions e.g. 1% of nitrogen oxide emissions and 0.1% of particulate emissions⁴³. Aircraft NO_x emissions have therefore long been regulated for air quality purposes, which is also understood to have climate benefits. The UK played a leading role in the recent adoption by ICAO of the first scientifically based certification standards for aircraft non-volatile particulate emissions, which will again have local air quality and climate benefits.
- 4.5 We are working to address non-CO₂ impacts in the following ways:
- Many of the measures to improve efficiencies, rollout SAF, and accelerate zero emission flight are expected to 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.
 - We are improving our understanding of non-CO₂ impacts and will ensure that the latest scientific understanding of aviation non-CO₂ impacts is used to inform our policy.
 - ICAO now has standards in place to regulate all aircraft emissions with significant climate effects. We will continue to negotiate for these to be improved over time as well as consideration of other measures such as operational guidance and regulation of fuel composition.
 - We will consider the outcomes of EUROCONTROL's Contrail Prevention Trial and whether it would be beneficial to undertake similar trials in the UK in the future.



Image courtesy of Vertical Aerospace.

Questions...



- 15** What could be done further or differently to ensure we tackle non-CO₂ impacts from aviation?
-



Image courtesy of Rolls-Royce.

5 Conclusion

5.1 This document sets out our proposed approach and principles to deliver the ambition of decarbonising aviation in a way that preserves the benefits of air travel and maximises the opportunities that decarbonisation can bring. To achieve this, we have set out proposed action across five different categories of measures to reduce and where possible, eliminate CO₂ emissions.

5.2 The purpose of this document is to consult widely on our proposed approach, principles, and measures, recognising the important role that will need to be played by the sector, wider industry, academia, innovators and the public in realising our ambitions and showcasing the UK as the leading voice in tackling this once in a generation issue.

5.3 We welcome views on the questions raised throughout this document, which are repeated below. We will develop a final Jet Zero Strategy later this year. It will be informed by the responses received, and build on previous public engagement around aviation decarbonisation, including the Climate Assembly UK's report on air travel and the path to net zero,⁴⁴ the Department for Transport's National Travel Attitudes Study⁴⁵ and the findings of a deliberative research project on decarbonising transport, commissioned by the Department of Transport and carried out by BritainThinks⁴⁶.

Consultation questions...



- 1 Do you agree or disagree that UK *domestic* aviation should be net zero by 2040? How do you propose this could be implemented?

- 2 Do you agree or disagree with the range of illustrative scenarios that we have set out as possible trajectories to net zero in 2050? Are there any alternative evidence-based scenarios we should be considering?

- 3 Do you agree or disagree that we should set a CO₂ emissions reduction trajectory to 2050?
 - a. Should the trajectory be set on an in-sector CO₂ emissions basis (without offsets and removals) or a net CO₂ emissions basis (including offsets and removals)?

 - b. Do you agree or disagree with the possible trajectories we set out, which have in-sector CO₂ emissions of 39 Mt in 2030, and 31 Mt in 2040 and 21 Mt in 2050, or net CO₂ emissions of 23-32 Mt in 2030, 12-19 Mt in 2040 and 0 Mt in 2050?

- 4 Do you agree or disagree that we should review progress every five years and adapt our strategy in response to progress?

- 5 Do you agree or disagree with the overall approach to improve the efficiency of our existing aviation system?

- 6 What more or differently could be done to ensure we maximise efficiency within the current aviation system?

- 7 Do you agree or disagree with the overall approach for the development and uptake of SAF in the UK?

- 8 What further measures are needed to support the development of a globally competitive UK SAF industry and increase SAF usage?

- 9 Do you agree or disagree with the overall approach for the development of zero emission flight in the UK?

- 10 What further measures are needed to support the transition towards zero emission aviation?

- 11 Do you agree or disagree with the overall approach for using carbon markets and greenhouse gas removal methods to drive down CO₂ emissions?

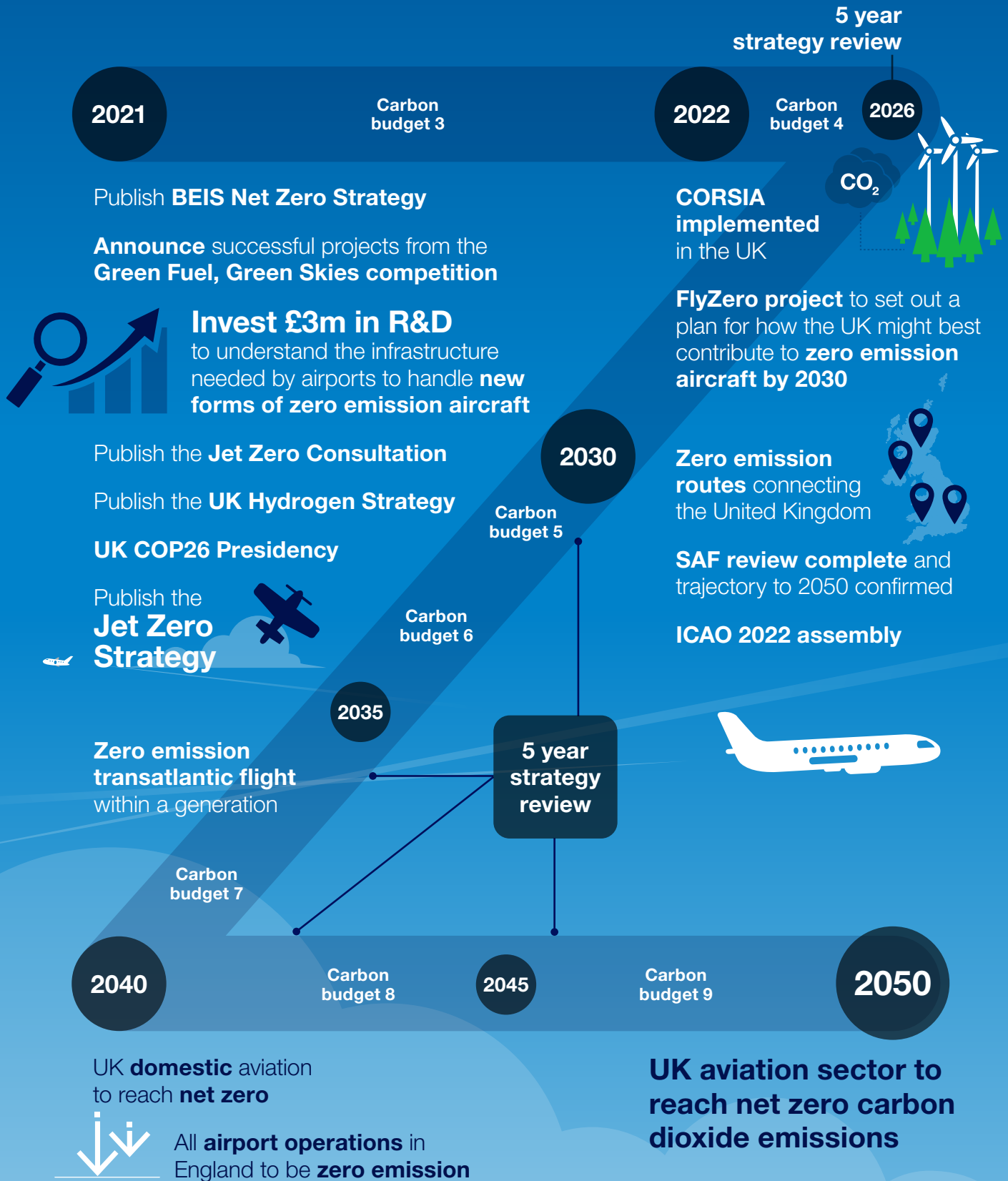
- 12 What could be done further or differently to ensure carbon markets and greenhouse gas removal methods are used most effectively?

- 13 Do you agree or disagree with the overall focus on influencing consumers?

- 14 What more can the Government do to support consumers to make informed, sustainable aviation travel choices?

- 15 What could be done further or differently to ensure we tackle non-CO₂ impacts from aviation?

Key milestones on our path to net zero aviation by 2050



Glossary of Terms

Airport operations – for the purposes of this document, airport operations refer to scope 1 and scope 2 emissions.

Greenhouse gases – greenhouse gases per the Kyoto protocol are: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydro-fluorocarbons (HFC), perfluorocarbons (PFC), nitrogen trifluoride (NF₃) and sulphur hexafluoride (SF₆).⁴⁷

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

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

Jet Zero Council – the Jet Zero Council (JZC) is 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.

Jet Zero Strategy – the Jet Zero Strategy will be published in response to this consultation.

Net emissions – emissions produced by aviation **after** consideration of offsets, avoided emissions in other sectors, and greenhouse gas removal technologies.

Net zero – refers to the Government target that the UK's total greenhouse gas (GHG) 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.

As this consultation is focussed on reducing carbon dioxide (CO₂) emissions specifically, net zero is used throughout the document to refer to net zero CO₂.

Net zero [CO₂] emission flight – can be achieved by deploying zero emission technologies or by reducing emissions and balancing out any remaining CO₂ emissions

produced by the aircraft by an equal share of negative emissions elsewhere. This could be achieved through zero emission aircraft, or through low emission aircraft in combination with sustainable aviation fuels with at least 100% lifecycle emission savings or off setting against greenhouse gas removals.

Public service obligations – public service obligations (PSOs) are a route-support measure that allow government to provide funding for the operation of air services on routes (to London or within a Devolved Administration) which are vital for the economic and social development of a region but are not viable on a wholly commercial basis.⁴⁸

Scope 1 emissions – emissions owned and controlled by the airport operator, such as energy generation and airport vehicles.⁴⁹

Scope 2 emissions – emissions from the off-site generation of energy purchased by the airport operator.⁵⁰

UK aviation emissions – defined as the CO₂ emissions arising from all flights (domestic, international, passenger and freighter) departing from UK airports, including during the taxiing and landing and take-off stages. This does not include General Aviation (non-commercial flights), international flights arriving into the UK, surface access emissions, non-aircraft airport emissions, or UK registered aircraft flying from non-UK airports.⁵¹

UK domestic aviation – for the purpose of this document is defined as flights which originate and terminate within the UK.

Zero emission aircraft – aircraft that do not emit any tailpipe CO₂ emissions. This could be achieved through a range of electric- or hydrogen-based propulsion technologies. This definition does not account for CO₂ emissions during manufacturing or aircraft maintenance.⁵²

Zero emission flight – the ecosystem supporting zero emission aircraft.

What will happen next

A summary of responses, including the next steps, will be published within three months of the consultation closing on www.gov.uk.

If you have questions about this consultation please contact:

NZaviationconsultation@dft.gov.uk

Consultation principles

The consultation is being conducted in line with the Government's key consultation principles which are listed below. Further information is available at www.gov.uk/government/publications/consultation-principles-guidance.

If you have any comments about the consultation process please contact: Consultation Co-ordinator, Department for Transport, Zone 1/29 Great Minster House, London SW1P 4DR
Email consultation@dft.gsi.gov.uk.

Public Sector Equality Duty

The Public sector equality duty came in to force in April 2011 (s.149 of the Equality Act 2010) and public authorities are now required, in carrying out their functions, to have due regard to the need to achieve the objectives set out under s149 of the Equality Act 2010.

The Department of Transport has assessed the strategic approach set out in this consultation with regard to Public Sector Equality Duty, and found that overall, climate change mitigation policies could advance equality of opportunity. Work will continue as individual policies are implemented.

We invite comment on how the Jet Zero Strategy could further achieve the objectives as set out under s149 of the Equality Act 2010 to:

- eliminate discrimination, harassment, victimisation and any other conduct that is prohibited by or under the Equality Act 2010;
- advance equality of opportunity between persons who share a relevant protected characteristic and persons who do not share it;
- foster good relations between persons who share a relevant protected characteristic and persons who do not share it.

Endnotes

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