House of Commons

Environmental Audit Committee

Net zero and the UK aviation sector

Third Report of Session 2023–24

Report, together with formal minutes relating to the report

Ordered by the House of Commons to be printed 18 December 2023

HC 404
Published on 21 December 2023
by authority of the House of Commons

Environmental Audit Committee

The Environmental Audit Committee is appointed by the House of Commons to consider to what extent the policies and programmes of government departments and non-departmental public bodies contribute to environmental protection and sustainable development; to audit their performance against such targets as may be set for them by His Majesty's Ministers; and to report thereon to the House.

Current membership

Philip Dunne MP (*Conservative, Ludlow*) (Chair)

Duncan Baker MP (*Conservative, North Norfolk*)

Sir Christopher Chope MP (*Conservative, Christchurch*)

Barry Gardiner MP (*Labour, Brent North*)

James Gray MP *(Conservative, North Wiltshire)*

Ian Levy MP (*Conservative, Blyth Valley*)

Clive Lewis MP *(Labour, Norwich South)*

Caroline Lucas MP (*Green Party, Brighton, Pavilion*)

Cherilyn Mackrory MP (*Conservative, Truro and Falmouth*)

Jerome Mayhew MP (*Conservative, Broadland*)

Anna McMorrin MP *(Labour, Cardiff North)*

John McNally MP (*Scottish National Party, Falkirk*)

Dr Matthew Offord MP (*Conservative, Hendon*)

Chris Skidmore MP *(Conservative, Kingswood)*

Cat Smith MP (*Labour, Lancaster and Fleetwood*)

Claudia Webbe MP (*Independent, Leicester East*)

Powers

The constitution and powers are set out in House of Commons Standing Orders, principally in SO No 152A. These are available on the internet via www.parliament.uk.

Publications

Committee reports are published on the Committee's website at www.parliament.uk/eacom/ and in print by Order of the House.

Committee Staff

Dawn Amey (Committee Specialist), Martyn Atkins (Clerk), Mahika Dixit (POST Fellow), Alexander Farnsworth (Committee Specialist), Chloe Jago (Senior Media and Communications Officer), Rebecca Lees (Second Clerk), Gary O'Key (Committee Specialist), Ben Smith (Committee Operations Officer) and Jonathan Wright (Committee Operations Manager).

During the course of the Committee's inquiry Nicholas Davies was the Senior Committee Specialist and Laura Grant was a Committee Specialist.

Contacts

All correspondence should be addressed to the Clerk of the Environmental Audit Committee, House of Commons, London SW1A 0AA. The telephone number for general enquiries is 020 7219 8890; the Committee's email address is eacom@parliament.uk.

You can follow the Committee on X (formerly Twitter) using @CommonsEAC.

Contents

1 Introduction

1. Powered flight is a significant contributor to national, continental and global connectivity and a substantial driver of economic growth. Passenger aviation enables national and international travel for business and for leisure; civil freight aviation enables rapid trade in goods with all parts of the globe.

2. These benefits come with acknowledged environmental costs. The effect of aviation on the climate, through the generation of greenhouse gases and other atmospheric effects, is widely acknowledged. Emissions from civil aviation represented 8 per cent of the UK's emissions in 2019, in the last year before the pandemic: in 2022 the corresponding figure was 7 per cent.[1] Emissions from the sector are considered to be one of the hardest to abate.

3. In March 2021 we launched an inquiry to examine how the Government was approaching the challenge of reducing emissions from the two transportation sectors considered to be the hardest to abate—civil aviation and shipping—in the light of the target of net zero emissions by 2050 which was given statutory effect in June 2019. We examined both sectors together in the course of the oral evidence we took, though we have chosen to report separately on each sector.

4. For civil aviation, we set out to examine the following issues:

- the contribution operational efficiencies could make to reduce emissions from aircraft and the timescale over which these might be expected to have an effect;
- the pathway to commercialisation for zero carbon aviation fuels; the role of the Government's Jet Zero Council in driving progress to commercialisation, and the potential role of transitional fuel technologies such as alternative hydrocarbons;
- the pathways to development of zero emission technology for civil aviation, and the likely timescale for commercialisation of zero emission aircraft;
- the role of the UK Government in supporting industry in the development and uptake of technologies, fuels and infrastructure to deliver net zero aviation;
- equitable ways to achieve reductions in passenger numbers using civil aviation originating in the UK;
- the further action needed by the International Civil Aviation Organization (ICAO) to drive emissions reductions, and the steps the UK Government ought to take to drive international action to reduce emissions;
- the effectiveness of the ICAO CORSIA global offsetting scheme for international airlines, and the UK and EU emissions trading schemes, in stimulating technology improvement, behaviour change, or both to reduce emissions from aviation, and
- how the UK should define its ownership of international aviation emissions in order to include them in future statutory carbon budgeting.[2]

1 Climate Change Committee, *Progress in reducing emissions: 2023 Report to Parliament*, June 2023

2 The call for evidence is available on the Committee's website at https://committees.parliament.uk/call-for-evidence/542/ .

5. In this report we examine the overall challenges that face the aviation sector as it moves to decarbonise. We make recommendations to Ministers on the steps that need to be taken to ensure that the UK Government can reliably meet its own targets for the contribution of the aviation sector to net zero.

The policy context

6. The UK Government, international aviation bodies and the aviation industry have proposed a number of initiatives to mitigate emissions from aviation, including:

- Market-based measures such as the United Nations CORSIA program, the EU Emissions Trading System (EU ETS) and the UK ETS;
- Measures to improve the fuel efficiency of conventional aviation such as through changes to aircraft, air traffic management, airspace modernisation and ground operations at airports; and
- Measures to promote the development and use of low carbon technologies such as zero carbon fuels (electricity and hydrogen), alternative hydrocarbon fuels (biofuels) and aircraft designs (wing, airframe and engine designs).[3]

7. In its Transport Decarbonisation Strategy, issued in 2021, the Government pledged that new technology would allow domestic flights to be emissions-free by 2040, and international aviation to be zero carbon by 2050. The UK has a large and mature aviation sector comprising aircraft manufacturers, fuel producers and air service providers, and thus appears well-placed to take a technological lead. The Government has established the Jet Zero Council—a partnership between industry and Government—with the aim of delivering zero-emission transatlantic flight "within a generation".[4]

8. The industry body Sustainable Aviation claims that without UK Government support, low carbon technologies are unlikely to develop fast enough to play a significant role in mitigating emissions before 2050.[5] The industry's plans to meet net zero by 2050 rely on industry funding for carbon removals, the technologies for which are not yet developed at scale.[6]

9. The technical and structural challenges to decarbonising the aviation sector should not be underestimated. The current fleets of aircraft used in international air travel are typically carbon-intensive in their manufacture and operation. They represent substantial investments by their owners and operators and are expected to have long lifetimes in service. While the pathways to decarbonising aviation are becoming clearer, progress to date has been slow. The technologies to achieve significant reductions in current emissions are in their infancy.

3 .*Aviation, decarbonisation and climate change*, House of Commons Library Briefing Paper CBP 8826, September 2021

4 Information on the Jet Zero Council's establishment and composition is available at https://www.gov.uk/government/groups/jet-zero-council

5 "UK's leadership in sustainable aviation technology accelerates industry's transition to net zero", Sustainable Aviation news release, 17 April 2023; Sustainable Aviation, *Net Zero Carbon Road-Map: summary report*, April 2023

6 Either through nature based solutions or through negative emissions technologies.

10. The international nature of the aviation sector has made effective regulation challenging, as it requires many states with diverse and often competing interests to agree to bring their regulatory approaches into alignment. The International Civil Aviation Organization (ICAO) has developed CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation), a global offsetting mechanism, which aims to stabilise net CO_2 emissions: it has been criticised for not requiring emission reductions.[7]

Background to the inquiry

11. Our objective in this inquiry has been to examine the scope for technological innovation, changes in fuelling and operational efficiencies to reduce the emissions from the aviation sector, and to establish the action required to be taken by the UK Government at national and international level so as to achieve the interim and overall emissions targets it has set. During the inquiry we considered several initiatives which could play a significant role in reducing emissions and the potential barriers to implementing these initiatives. We also considered the governance, coordination and delivery of policies to decarbonise aviation.

12. Shortly after we concluded taking oral evidence in the inquiry, the UK Government issued its Jet Zero Strategy, providing a more detailed policy framework for the Government's ambition to encourage the aviation sector to reduce its emissions to 2050.[8] In March 2023 the Government published for the first time its plan to achieve emissions reductions consistent with the statutory carbon budgets set for the period to 2033–2037. This plan provided more detail about the assumptions underpinning the Government's overall strategy for the contribution which the aviation and shipping sectors can make to achieving net zero. In June 2023 the Climate Change Committee issued its annual statutory report to Parliament on progress in reducing emissions, which contained several recommendations for Government policy on aviation: we have drawn on the CCC's findings, and the Government's response of October 2023, as we have finalised this report.

13. We received 72 written evidence submissions and held five public evidence sessions, hearing from 32 witnesses including academics, professional bodies, manufacturers, NGOs, representatives from the finance, aviation and shipping industries and Government advisers. To conclude the oral evidence, we heard from Robert Courts MP, the then Parliamentary Under-Secretary of State at the Department for Transport, and Lee Rowley MP, the then Parliamentary Under-Secretary of State at the then Department for Business, Energy and Industrial Strategy. During the course of the inquiry, we undertook a visit to ZeroAvia and to Air Salvage International, both based at Kemble in Gloucestershire. We are very grateful to everyone who submitted written evidence, who provided oral evidence and who otherwise assisted us in this inquiry.[9]

7 See, for example, "Corsia: The UN's plan to 'offset' growth in aviation emissions", *Carbon Brief*, 4 February 2019

8 Department for Transport, Jet Zero strategy: delivering net zero aviation by 2050, July 2022

9 The Chair of the Committee, Rt Hon Philip Dunne MP, declared his registered interest as a non-executive director of Reaction Engines at the opening session of oral evidence in the inquiry (Q1). Following the announcement on 5 November 2021 by Reaction Engines of a project involving partnership with the Science and Technology Facilities Council, which receives funding from the UK Government, he withdrew from the inquiry and has taken no further part in the Committee's proceedings in relation to the inquiry or this report.

2 The UK aviation sector and the environment

14. Aviation is generally recognised to be an economic sector which will be difficult to decarbonise fully in the timescale required under net zero policies. In the contribution of IPCC Working Group III to the IPCC's 6th Assessment Report, issued in April 2022, the aviation sector was recognised to be a key vulnerable economic sector that was only in the early stage of adaptation to climate change.[10]

15. In March 2022, the International Civil Aviation Organization (ICAO) published a report on the feasibility of a long-term aspirational goal for international aviation CO_2 emission reductions. The study looked at various integrated scenarios combining in-sector measures covering technology, operations and fuels from to 2050 and 2070. None of the scenarios in the study reached zero CO_2 emissions in 2050, although the most ambitious one led to residual CO_2 emissions of around 200 million tonnes, around 90% less than the baseline "do nothing" scenario.

16. Global aviation emissions have not increased in direct proportion to kilometres flown, as the sector has steadily made operational and fuel efficiencies. Since 1990, average efficiency improvements of 0.8% per annum (increasing to 2.1% per annum from 2010 to 2019) have led to significant reductions in CO_2 emissions per passenger. The Department for Transport reports that without these efficiency gains, UK aviation emissions in 2019 would have been more than 20% higher per passenger based on the same rate of growth in passenger numbers.[11]

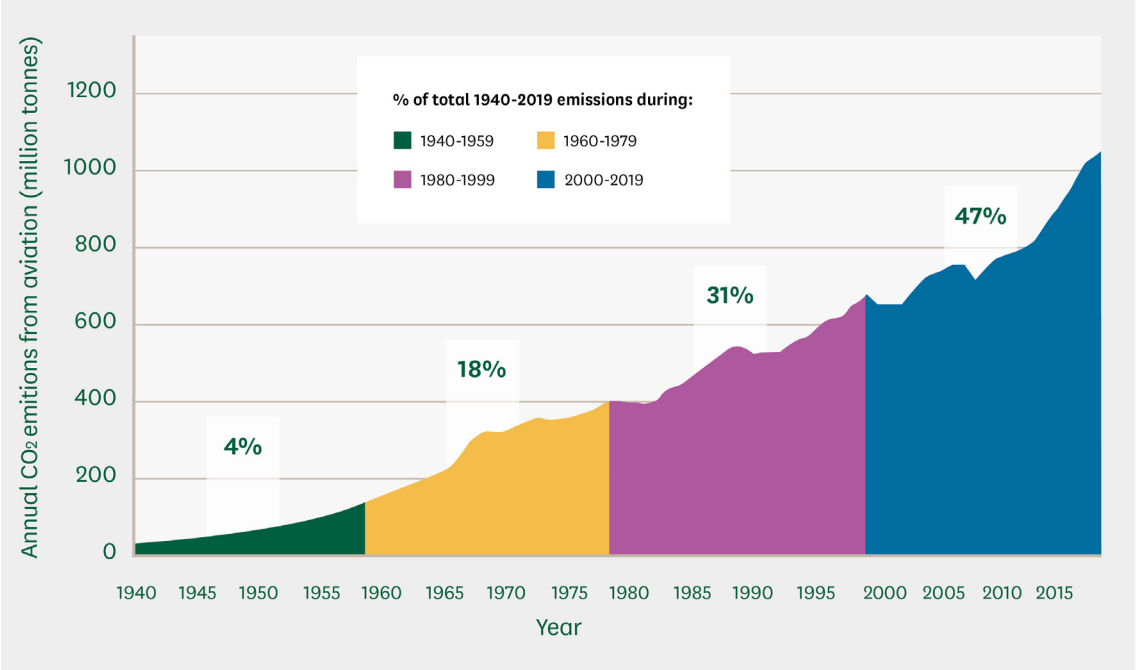
17. Aviation's path to decarbonisation is nevertheless substantially slower than that of many other sectors of the economy. The European Aviation Environmental Report for 2022, produced by the European Union Aviation Safety Agency, observed that 47% of all CO_2 emissions from the global aviation sector had been emitted after 2000: in contrast, emissions from the rest of the economy had fallen by around 40%.[12]

10 IPCC, Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)], Cambridge, 2022

11 Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021, para 3.5

12 European Union Aviation Safety Agency, *European Aviation Environmental Report 2022*, p. 47

Figure 1: Annual global CO_2 emissions from aviation (1940–2019) with percentage of total cumulative emissions broken down into 20 year periods



Source: European Union Aviation Safety Agency, *European Aviation Environmental Report 2022*, p. 47

The effect of UK aviation on greenhouse gases

18. UK greenhouse gas emissions (GHG) from aviation consist of emissions from domestic flights within the UK and emissions from international flights departing from the UK. Domestic emissions are included in national emissions targets under the Climate Change Act 2008, which sets the target of net zero by 2050 for the UK economy. Emissions from international flights are not yet formally included under statutory Climate Change Act targets, though the Government has undertaken to legislate to include international aviation in the Sixth Carbon Budget, the interim emissions target the UK is required to reach by 2037.

19. Sustainable Aviation, the trade body representing major UK airports, airlines and aerospace manufacturers which have made a commitment to achieving net zero, has calculated, on the basis of passenger kilometres flown from UK airports in 2018, that passenger flights account for 97% of civilian UK aviation CO_2 emissions. The other 3% is assumed to be accounted for by dedicated freight-only flights.[13]

20. UK aviation has grown significantly since 1990: passenger numbers increased threefold to reach a peak of 296 million in 2019.[14] In 2020 aviation was one of the sectors most severely impacted by the pandemic, as passenger travel almost came to a halt under restrictions curtailing much international travel. Emissions from UK international aviation fell by 61% in 2020, and domestic aviation fell by 60%, the largest proportional

13 Sustainable Aviation, *Decarbonisation Road-Map: a path to net zero*, February 2020, p. 15

14 *Aviation, decarbonisation and climate change*, House of Commons Library Briefing Paper CBP 8826, September 2021

reduction out of all domestic transport emissions.[15] Passenger numbers recovered gradually over 2021, and in 2022 passenger levels reached 60% of pre-pandemic levels. The Climate Change Committee estimates that UK aviation demand will recover to pre-pandemic levels by 2024.[16]

21. Before the pandemic, the direct annual contribution of aviation to the UK economy was estimated to be at least £22 billion, with around £14 billion from air transport and £8 billion from aerospace. According to Government figures in the Jet Zero Strategy, the UK aviation industry directly employs 230,000 people.[17] The hydrogen flight developer ZeroAvia, citing an Oxford Economics study commissioned by the Airport Operators Association in 2014, asserted that the sector supported over 960,000 UK jobs either directly or indirectly.[18]

CO_2 emissions from UK aviation

22. In 2019 CO_2 emissions from UK domestic flights (flights both originating and terminating in the UK) accounted for 1.4 $MtCO_2e$ (3.7% of the UK's aviation emissions), while emissions from the UK's international aviation activity, measured by fuel supplied from UK bunkers to international flights, accounted for 36.4 $MtCO_2e$ (96.3%). UK international and domestic emissions from aviation accounted for 8% of total UK greenhouse gas emissions.[19]

23. The pandemic had a substantial negative effect on air travel globally, and the UK was no exception to the trend. Overall emissions from UK aviation dropped to 16.4 $MtCO_2e$ in 2020 and 15.1 $MtCO_2e$ in 2021. Estimated emissions in 2022 were 29.3 $MtCO_2e$: while this figure represents 77% of UK aviation emissions in 2019, it also represents an increase of 95% on the 2021 figure. The UK aviation industry appears to be recovering from the effects of the pandemic, but at a corresponding cost to the UK's net carbon emissions.

Non-CO_2 emissions from aviation

24. Aviation activity affects the environment in ways which cannot be adequately captured simply by measuring greenhouse gas emissions. While conventional aircraft engines affect the concentration of carbon dioxide in the atmosphere through emissions from the combustion of kerosene, these engines have also been found to affect the concentration of other pollutants in the atmosphere, resulting in a short-term increase, but long-term decrease in atmospheric ozone (O_3); a decrease in atmospheric methane (CH_4); plus emissions of water vapour; soot; sulphur aerosols; and water contrails.[20] These non-CO_2 climate impacts increase the total impact aviation is reckoned to have on global climate change. There are known to be seasonal and regional variations from non-CO_2 effects,[21] but these appear as yet difficult to quantify empirically.

15 Department for Business, Energy and Industrial Strategy, *2020 UK Greenhouse Gas Emissions, Final Figures*, February 2022

16 Climate Change Committee, *The Sixth Carbon Budget: Aviation*, December 2020, p. 5

17 Department for Transport, *Jet Zero strategy: delivering net zero aviation by 2050*, July 2022

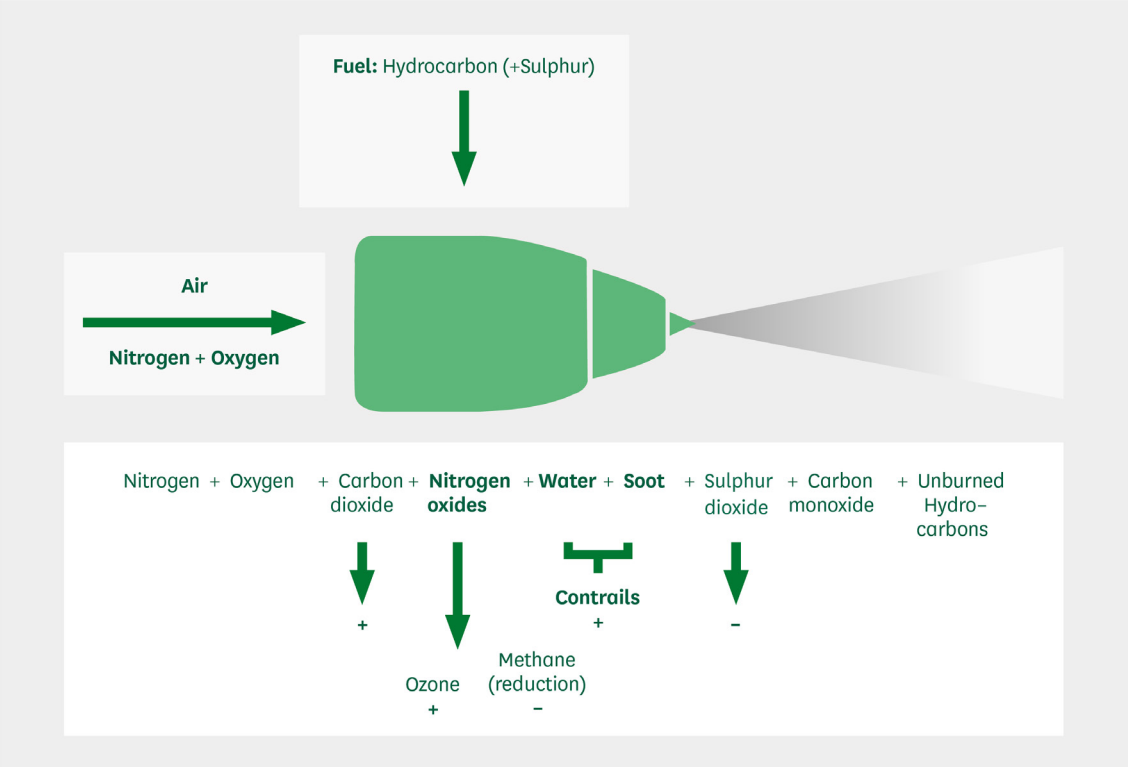
18 ZeroAvia (ZAS0040), citing *Economic Benefits from Air Transport in the UK*, Oxford Economics, November 2014

19 Department for Business, Energy and Industrial Strategy, *Final UK greenhouse gas emissions national statistics: 1990 to 2019*, February 2021. Due to the impact of Covid-19 on the aviation industry, 2019 represents the last full year of emissions reporting. The figures include emissions from military aviation, which we have not considered in this report.

20 Hannah Ritchie, "Climate change and flying: what share of global CO_2 emissions come from aviation?", published online at OurWorldInData.org, 22 October 2022

21 Climate Change Committee, *Progress in reducing emissions: 2023 Report to Parliament*, June 2023, p. 268

Figure 2: Typical emissions from a conventional aviation jet turbine



Source: Department for Transport: *Jet Zero strategy: delivering net zero aviation by 2050*, July 2022, p. 56

25. The air traffic control services provider NATS told us that the non-CO_2 impacts of aviation were not a well understood aspect of the overall environmental footprint of aviation.[22] Green Alliance observed that when additional non-CO_2 effects were included, aviation's total contribution to climate warming was two to three times higher than the contribution associated with its CO_2 emissions alone.[23] The Aviation Environment Federation told us that 'some of these impacts arise only in certain atmospheric and meteorological conditions… and have variable lifetimes in the atmosphere (most are short-lived compared to CO_2)' and that 'no policy or accounting measures have yet been devised to tackle them'.[24] The CCC has stated that best estimates suggest that aviation non-CO_2 emissions account for the majority of global aviation's warming impact on the planet to date.[25]

26. Research commissioned by the Department for Transport in 2018 found that despite progress in understanding the overall effects of non-CO_2 emissions from aviation, several uncertainties remained and new effects had been identified with potentially large yet unestimable impacts.[26] The impacts of soot emissions impacts on high altitude cirrus cloud formation are uncertain; and while aviation sulphur compound emissions are known to cool low-level clouds, the magnitude of the impact is uncertain. Uncertainties also remain

22 NATS (ZAS0058)
23 Green Alliance (ZAS0022)
24 Aviation Environment Federation (AEF) (ZAS0043)
25 Climate Change Committee, *Progress in reducing emissions: 2023 Report to Parliament*, June 2023
26 David S. Lee, *The current state of scientific understanding of the non-CO2 effects of aviation on climate*, Department for Transport, 2018

as to whether contrails and contrail-cirrus warm the Earth's surface as much as other aviation effects. Mitigation strategies might reduce non-CO_2 impacts at the expense of additional CO_2 emissions.

27. In its Jet Zero Strategy the Government states that

> Recent scientific evidence suggests the best estimate is that roughly two thirds of aviation's historical climate impacts are due to non-CO_2, and that, whilst non-CO_2 emissions can have both warming and cooling effects, the net warming rate is likely to be around three times that of CO_2.[27]

28. The Climate Change Committee, in its 2022 progress report, recommended that the Government, when designing a mandate for the introduction of aviation fuels to replace conventional aviation kerosene, ensure that such fuels would not have a harmful non-CO_2 impact relative to regular jet fuel.[28] The CCC also developed an initial methodology for estimating the potential warming effect of such emissions. In its 2023 report the CCC recommended that the Government commit to a minimum goal of no further additional warming from non- CO_2 effects after 2050.[29]

29. Responding to the 2022 report, the Government has undertaken to 'consider the emerging evidence' on the non-CO_2 impacts of aviation: it is scoping a research programme to examine these impacts, and is considering the CCC methodology 'in further detail'.[30] In its response to the 2023 report, the Government indicated that expressions of interest had been launched for two research projects on non-CO_2 impacts, funded by the Department for Transport, which are to feed into a wider multi-year research programme to be undertaken in collaboration with academia and industry partners. Ministers have committed to exploring the "feasibility and appropriateness" of incorporating measures to address the non-CO_2 impacts of aviation in the UK ETS, and are open to pursuing international measures to address non-CO_2 impacts as the research evidence develops.[31]

30. **The impact of conventional aviation activity on climate is still not fully quantifiable. While the contribution of aviation to levels of atmospheric CO_2 and other greenhouse gases is quantifiable and substantial, the climate impact of other emissions from aviation is currently not well understood and difficult to quantify. Measures to decarbonise the sector are vital: but removing carbon dioxide from aviation activity is unlikely to eliminate its overall impact on the environment. The Government has acknowledged the contribution of non-CO_2 effects from aviation in the development of its strategy for decarbonising aviation, and is examining methods of mitigating non-CO_2 effects from aviation which uses fuels which have a reduced carbon footprint.**

31. ***We consider that any strategy designed to reduce the impact of UK aviation activity on global warming ought to encompass the environmental effects of aviation in their entirety. We therefore recommend that the Government actively commission, promote***

27 Department for Transport, Jet Zero strategy: delivering net zero aviation by 2050, July 2022, para 3.64
28 Climate Change Committee, *Progress in reducing emissions: 2022 Report to Parliament*, June 2022, recommendation 205 (p. 573)
29 Climate Change Committee, *Progress in reducing emissions: 2023 Report to Parliament*, June 2023, p. 268
30 HM Government, Responding to the Climate Change Committee's Annual Progress Report 2022 Recommendations, HC 1270, March 2023, p. 117; Department for Transport, Jet Zero strategy: delivering net zero aviation by 2050, July 2022, para 3.71
31 HM Government, Responding to the Climate Change Committee's Annual Progress Report 2023 Recommendations, HC 1919, October 2023, p. 81

and support research into the total environmental effects of aviation, with a view to incorporating the emerging consensus into all future iterations of its strategy for net zero aviation.

3 Aviation emissions in the UK's carbon budgets

32. The Climate Change Committee's latest modelling of the likely pathway for the UK economy to reach net zero by 2050 is contained in its advice to Government on the Sixth Carbon Budget, published in November 2020 and setting an overall carbon budget for the UK economy to reach by the end of the budgetary period in 2037.[32]

33. The Climate Change Act 2008 provided that emissions of greenhouse gases from international aviation or international shipping were not to count as emissions from sources in the United Kingdom, and therefore were not to be included in carbon budgets set under the Act. This was an interim position, and the Act required Ministers either to make provision for including international aviation and shipping emissions in carbon budgets by the end of 2012 or to issue a statement explaining why not.[33]

34. In its advice to Government the CCC recommended that legislation be brought forward to include international aviation and shipping emissions within the scope of the Sixth Carbon Budget, rather than leaving 'headroom' for these emissions in carbon budget calculations as had been done in previous statutory carbon budgets.

35. In October 2018 the UK Government commissioned advice from the CCC on the measures required for the UK to reach net zero emissions by 2050. That advice was provided in May 2019, and included specific advice on the measures required to be taken in respect of aviation. The Government then introduced secondary legislation to amend the Climate Change Act 2008 so as to establish a net zero target.[34] The legislation did not, however, amend the 2008 Act so as to include international aviation and shipping within the UK's net zero target. The Government set out its intentions in the explanatory memorandum to the instrument:

> The Government recognises that international aviation and shipping have a crucial role to play in reaching net zero emissions globally. However, there is a need for further analysis and international engagement through the appropriate frameworks. For now, therefore, we will continue to leave headroom for emissions from international aviation and shipping in carbon budgets to ensure that emissions reduction strategies for international aviation and shipping can be developed within International Maritime Organisation and International Civil Aviation Organisation frameworks at the appropriate pace, and so that the UK can remain on the right trajectory for net zero greenhouse gas emissions across the whole economy.[35]

32 Climate Change Committee, *The Sixth Carbon Budget: The UK's path to Net Zero*, December 2020

33 The Secretary of State has the power under section 30 of the Climate Change Act 2008 to make regulations in effect amending the Act to establish "the circumstances in which, and the extent to which, emissions from international aviation or international shipping are to be regarded for the purposes of [the Act] as emissions from sources in the United Kingdom." The statutory Government statement indicating why aviation and shipping emissions were not to be included in carbon budgets was issued in December 2012: Department for Energy and Climate Change, *International aviation and shipping emissions and the UK's carbon budgets and 2050 target*, 19 December 2012

34 HC Deb, 12 June 2019, cols 661–64; see also The Climate Change Act 2008 (2050 Target Amendment) Order 2019, SI 2019/1056

35 Explanatory Memorandum to the Climate Change Act 2008 (2050 Target Amendment) Order 2019

36. Despite an undertaking given by Ministers in June 2021 to legislate within 12 months, the relevant secondary legislation has not yet been presented to Parliament for approval.[36]

The Climate Change Committee's scenario for net zero aviation

37. In 2019 Ministers commissioned specific advice from the CCC on how best to bring international aviation and shipping emissions within the UK's net zero target. In response the CCC indicated that zero-carbon aviation was 'highly unlikely to be feasible' by 2050, and that reaching net zero emissions would require greenhouse gas removals in order to offset any remaining emissions.[37] At that point the CCC predicted that, unless abated, aviation was likely to be the largest emitting sector in the UK by 2050, consuming 36% of the available carbon budget.[38]

38. The Sixth Carbon Budget, enacted in 2021 following approval by both Houses of Parliament, set an economy-wide target to reduce greenhouse gas emissions by 78% by 2037 compared to 1990 levels.[39] Reaching net zero greenhouse gas emissions will require extensive changes across all sectors of the economy and most sectors will need to reduce emissions close to zero. Those sectors that are difficult to decarbonise completely are expected to use offsetting and negative emissions technologies to mitigate their continuing emissions.

39. Under the 'balanced pathway' model adopted by the Climate Change Committee for the Sixth Carbon Budget, aviation will continue to be a net contributor to the UK's CO_2 emissions by 2050.

- By the start of the Sixth Carbon Budget period (in 2032), the sector is expected to emit 12.7 $MtCO_2e$ less than the estimated baseline of 45 $MtCO_2e$, representing an economy with no aviation abatement measures. Of this 12.7 $MtCO_2e$ saving, measures to reduce demand for aviation are expected to contribute 9.59 $MtCO_2e$, sustainable aviation fuels (SAF) 1.59 $MtCO_2e$ and efficiency measures and hybrid fuels a further 1.52 $MtCO_2e$.
- By the end of the 6th CB period in 2037, CCC modelling anticipates that the sector will emit 16 $MtCO_2e$ less than the estimated baseline of 46 $MtCO_2e$. Demand reduction measures are expected to contribute 11 $MtCO_2e$, SAF 2 $MtCO_2e$ and efficiency measures and hybrid fuels a further 3 $MtCO_2e$.
- The CCC's projections for 2050 under the balanced pathway still envisage aviation contributing 23 $MtCO_2e$ to the UK's emissions, set against a baseline of 51 $MtCO_2e$. The reduction of 28 $MtCO_2e$ comprises a contribution of 12 $MtCO_2e$ from demand management, 8 $MtCO_2e$ from SAF and 8 $MtCO_2e$ from efficiency measures and hybrid fuels.

The overall modelling of this pathway is illustrated in Figure 3 below.

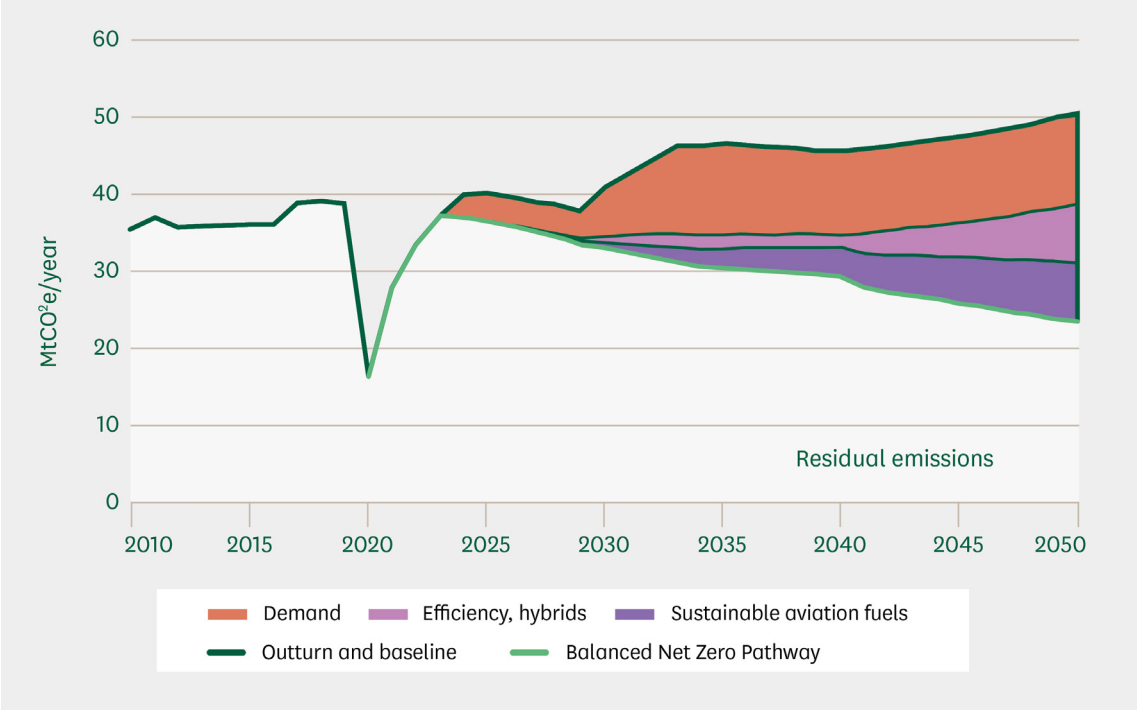
36 Department for Transport (ZAS0053); Climate Change Committee, *Progress in reducing emissions: 2023 Report to Parliament*, June 2023, p. 282

37 Climate Change Committee, Letter from the CCC Chairman, Lord Deben, to the Secretary of State for Transport, Rt Hon Grant Shapps MP, about net-zero and the approach to international aviation and shipping (IAS) emissions, 24 September 2019

38 *Ibid.*

39 Climate Change Committee, *The Sixth Carbon Budget: The UK's path to Net Zero*, December 2020

Figure 3: sources of abatement in the CCC's Balanced Net Zero Pathway for the aviation sector



Source: Climate Change Committee advice report on the Sixth Carbon Budget, figure 3.7.a., based on CCC analysis and BEIS provisional release of UK greenhouse gas emissions statistics for 1990–2019 (2020)

40. The CCC based its 'balanced pathway' model on a number of assumptions as to the development of aviation on the pathway to net zero:

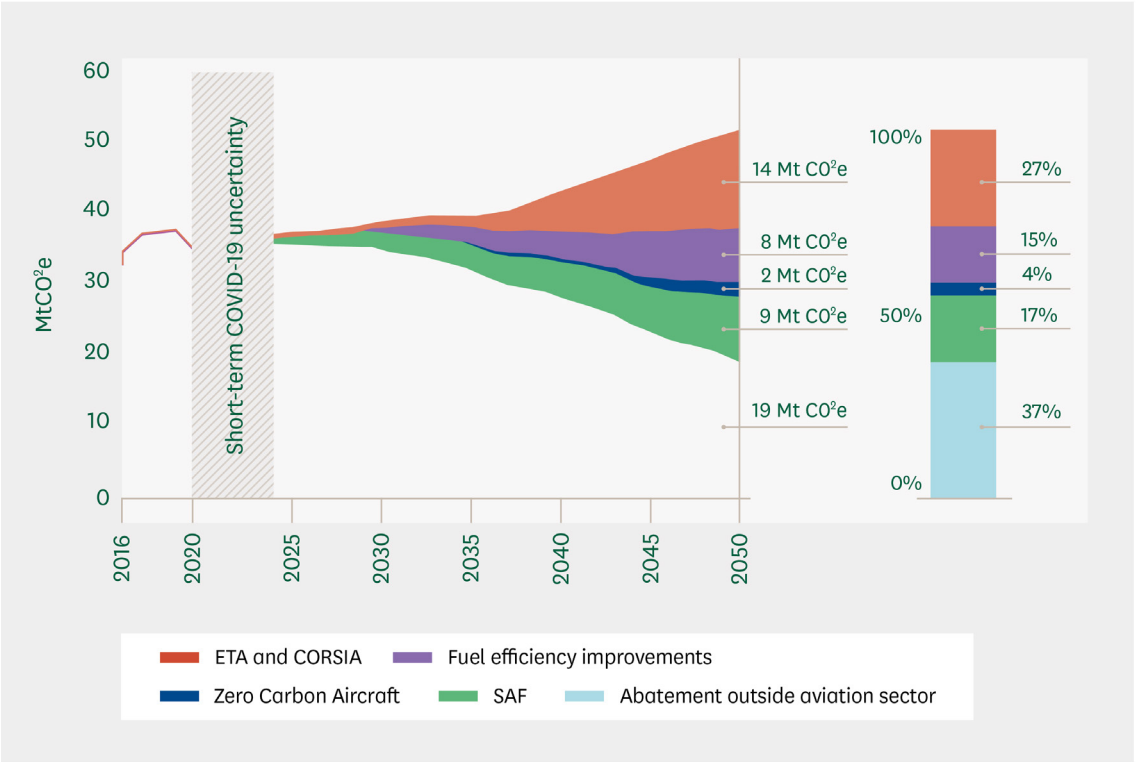
- By 2050 demand would have grown by no more than 25 per cent relative to a 2018 baseline;
- The sector would improve its efficiency by 1.40 per cent annually to 2050, and
- By 2050 17 per cent of the fuel for UK aviation would be from biofuel and 8 per cent would be from synthetic jet fuel.

The UK Government's modelling for net zero aviation

41. The Government's own model, which underpins the assumptions of the Jet Zero Strategy, rests on a separate set of projections:

- By 2050, demand (measured in terms of airline passengers at UK terminals) would have increased by 70% from a 2018 baseline
- Airline fuel efficiency would increase by 2 per cent annually between 2017 and 2050
- Sustainable aviation fuels would be providing 10 per cent of aviation fuel for flights within and departing the UK by 2030, 22 per cent by 2040 and 50 per cent by 2050
- No UK air traffic movements (ATMs) would be made by zero emission aircraft in 2030, but 5 per cent of UK ATMs would be made by zero emission aircraft by 2040, and 27 per cent would be made by 2050.

Figure 4: The Jet Zero Strategy 'high ambition' scenario



Source: HM Government, *Jet Zero illustrative scenarios and sensitivities*, July 2022

42. Under this model, a baseline of 52 $MtCO_2e$ in 2050 would be abated to residual emissions of 15 Mt CO_2e. The Government estimates that by 2050 14 $MtCO_2e$ will be abated by the effect on demand of carbon pricing; 8 $MtCO_2e$ will be found from improvements in fuel efficiency; 13 $MtCO_2e$ will be found from the use of sustainable aviation fuels; and a further 2 $MtCO_2e$ of abatement will derive from the use of zero emission aircraft.

Proposals from the UK aviation industry

43. Sustainable Aviation is the trade body representing major UK airports, airlines and aerospace manufacturers which have made a commitment to achieving net zero. In 2020 it set a net zero 2050 target and in 2021 set interim targets: in April 2023 it issued an updated forecast for the UK aviation industry's contribution to net zero aviation by 2050, stressing that the achievement of the industry's goals was reliant on adequate policy support from the Government.[40]

40 "UK's leadership in sustainable aviation technology accelerates industry's transition to net zero", Sustainable Aviation news release, 17 April 2023; Sustainable Aviation, *Net Zero Carbon Road-Map: summary report*, April 2023

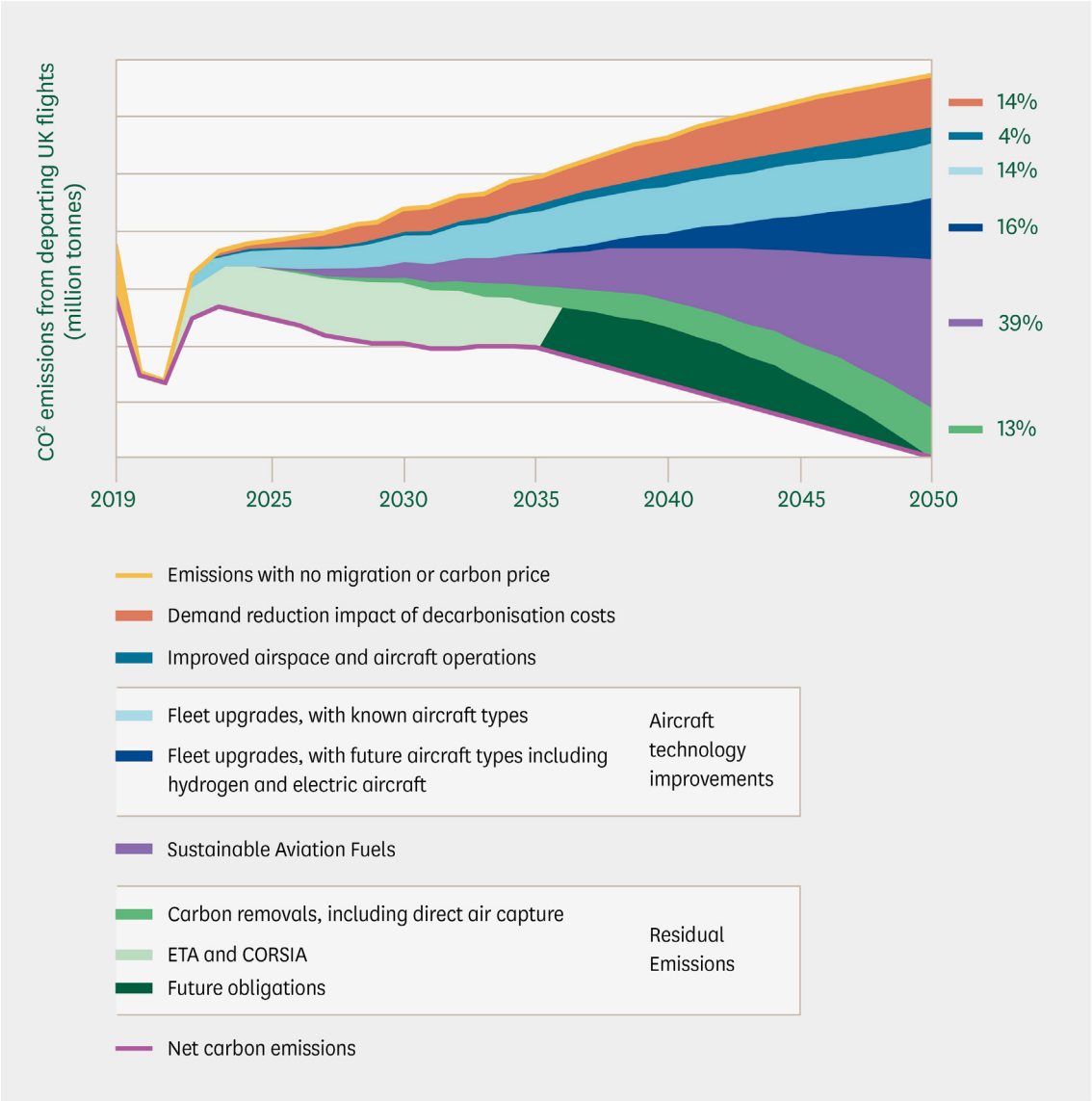
44. Sustainable Aviation told us that "UK aviation remains committed to achieving net zero emissions by 2050", suggesting that

> the best option for the UK, both in terms of allowing it to meet its decarbonisation goals, support international aviation towards net zero and to protect and deliver good jobs to the UK economy is to support the growth of UK aviation within a net carbon ceiling determined by the science.[41]

45. Sustainable Aviation is targeting at least an overall 15% reduction in net emissions relative to 2019 by 2030, and a 40% net reduction by 2040, with the pace of decarbonisation ramping up as replacement aviation fuels, permanent carbon removals, and new low and zero-carbon technologies—such as electric and hydrogen-powered aircraft—become mainstream in the 2030s.[42] Under its Net Zero Carbon Road-Map, a baseline of 67.4 $MtCO_2e$ in 2050 would be abated to residual emissions of 8.8 Mt CO_2e, to be removed from the atmosphere by negative emissions technologies. Sustainable Aviation estimates that by 2050 9.6 $MtCO_2e$ will be abated by the effect on demand of carbon pricing; 2.6 $MtCO_2e$ will be found from improvements in airspace and aircraft operations; 26.4 $MtCO_2e$ will be found from the use of sustainable aviation fuels; and a further 20.1 $MtCO_2e$ of abatement will derive from the use of zero emission aircraft.

41 Sustainable Aviation (ZAS0024)
42 Sustainable Aviation (ZAS0024)

Figure 5: Sustainable Aviation projections for net zero UK in the UK aviation sector



Source: Sustainable Aviation, *Sustainable Aviation Net Zero Carbon Road-Map*, April 2023

Comparing the modelling of aviation decarbonisation measures

46. The datasets and assumptions behind all three models evidently vary. A broad comparison of the three models is set out in Table 1 below.

Table 1: Comparison of CCC Balanced Pathway, Jet Zero Strategy High Ambition Scenario and Sustainable Aviation Net Zero Carbon Road-Map abatements of emissions from UK aviation by 2050

	CCC Balanced Pathway	Jet Zero Strategy High Ambition Scenario	Sustainable Aviation NZ Carbon Road-Map
Unabated aviation emissions (baseline) $MtCO_2e$	51	52	67.5
Demand measures	12	14	9.5
Sustainable aviation fuels	8	9	26.3
Efficiencies[a]	8	8	12.2[b]
Zero emission aircraft	0	2	10.8[c]
Residual emissions	23	19	8.8

Source: CCC Sixth Carbon Budget; Jet Zero illustrative scenarios and sensitivities; Sustainable Aviation Net Zero Carbon Road-Map

[a] In the CCC and Jet Zero Strategy modelling this primarily refers to efficiencies from fuel use

[b] Of which 9.5 $MtCO_2e$ is attributable to fleet upgrades of known aircraft types

[c] Including fleet upgrades with future aircraft types including hydrogen and electric aircraft

47. The industry's April 2023 projections of unabated emissions from UK aviation are substantially higher than those of the CCC or the Government, and its projections of the contribution to carbon abatement from new aviation fuels and from technological efficiencies in aircraft fleets, including zero emission aircraft, are also markedly more optimistic. As a result the industry's projection of the 2050 'emissions gap'—residual emissions unable to be mitigated by action within the aviation sector—appears far lower than the CCC and Government estimates.

The UK's progress towards its carbon budget targets for aviation

48. In preparing its 2023 progress report on emissions reductions the Climate Change Committee had the benefit of analysis of the Government's March 2023 Carbon Budget Delivery Plan. While recognising the greater certainty provided by the Government's July 2022 Jet Zero Strategy the CCC found that there were significant risks to the achievement of the aviation emissions reductions required by 2027, 2032 and 2037 under the Fourth, Fifth and Sixth Carbon Budgets respectively, across almost all of the policy areas covered by the Strategy.[43]

43 Climate Change Committee, *Progress in reducing emissions: 2023 Report to Parliament*, June 2023, p. 278. Note that the Fourth and Fifth Carbon Budgets apply to UK domestic aviation only (with headroom provided for international aviation): the Sixth Carbon Budget will formally include aviation once the Government has enacted the appropriate secondary legislation.

Our view on aviation emissions in the UK's carbon budgets

49. **The Government's decision to include international aviation emissions in the UK's budgets with effect from the Sixth Carbon Budget has sent a very positive signal about the UK's resolve to address carbon emissions from UK aviation by the use of policy instruments. Establishing a requirement to bring aviation emissions within the Sixth Carbon Budget target by 2037, rather than leaving budgetary headroom for them as in previous budgets, removes ambiguities around the issue and obliges the Government to address the complexities around accounting for the UK's share of international aviation emissions.**

50. **We are nevertheless concerned that legislation to give effect to this commitment has not been brought forward for approval by Parliament, over two and a half years since the commitment was originally made and over two years since the Government promised to legislate "within twelve months".**

51. ***We recommend that the Government lay before Parliament for approval, without further delay, a draft statutory instrument under section 30 of the Climate Change Act 2008 to define the emissions from international aviation and international shipping which are to be reckoned as emissions from sources in the United Kingdom.***

52. **The outputs from the modelling undertaken by the Climate Change Committee, the Government and Sustainable Aviation vary as to the projections of likely emissions reductions from UK aviation by 2050. In some instances these variations are substantial, and tend to reduce overall confidence in the reliability of the projections from each source.**

53. ***We recommend that the Government work with the Climate Change Committee and Sustainable Aviation on a comparative analysis of the models underpinning the projections for UK aircraft emissions, so as to reach consensus, as far as possible, on the likely impact of measures to be taken by industry and by Government on levels of emissions from UK aviation out to 2050.***

We examine below the Government's overall strategy to achieve its net zero aviation targets against the evidence we have taken, recent developments in policy and the CCC's assessments of progress.

4 'Jet Zero'—the UK Government's strategy for net zero aviation

54. Having consulted on a strategy for decarbonising aviation—the Jet Zero Strategy—in 2021, the Government issued its strategy in July 2022. Several consultations on the implementation of elements of the overall strategy are ongoing.[44]

55. The strategy comprises action across six measures. The first three—system efficiencies, aviation fuel, and zero emission flight—are focused on in-sector emissions reductions through technological and operational approaches. Market and removal-based measures are seen as a further driver for in-sector reductions by pricing emissions and allowing the aviation sector to offset any residual emissions. We examine the Government's approach to each measure in more detail below, against the evidence we received in the inquiry before the strategy was issued and against subsequent commentary.

56. The strategy also includes provision for the revision of measures in the light of emerging evidence about the effect of non-CO_2 aviation emissions: we addressed these issues in Chapter 1 above.

57. While it contains measures to influence consumer demand, the strategy does not include any provision for policy interventions which will actively dampen or reduce overall UK passenger demand for flying. In its response to the Committee's initial call for evidence, the Department for Transport indicated that it did not consider explicit demand management to have any role in reducing aviation emissions:

> We want to preserve the benefits of flying for everyone, to enjoy holidays, visit friends and family overseas and to support our businesses. Our assessment is that the aviation sector can achieve net zero through efficiency improvements, cleaner fuels and new technologies. We recognise that we will need to keep our approach under review and intend to assess progress on the sector's CO2 emission reduction pathway and update our strategy through five-year reviews.
>
> Where people want to fly, we can do more to help them make the most sustainable choices. We are currently working 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, helping to recognise airlines that do more to reduce emissions.[45]

This position was most recently reflected in the Prime Minister's remarks on net zero delivered at a Downing Street news conference in September 2023, when he said he had "scrapped" proposals for "new taxes to discourage flying or going on holiday".[46] We consider the exclusion of active demand management measures from the Government's strategy in greater detail in the following chapter.

44 Department for Transport, Jet Zero strategy: delivering net zero aviation by 2050, July 2022
45 Department for Transport (ZAS0053)
46 HM Government, PM speech on Net Zero, 20 September 2023

System efficiencies

58. Emergent technologies such as sustainable aviation fuels and novel electric and hybrid-electric flight provide opportunities to reduce aviation emissions: but their potential for net emissions reductions, and when they are likely to be commercially available, remain the subject of debate, as we examine below.[47] The Jet Zero Strategy relies heavily on system efficiencies in aviation operations reducing emissions in the short to medium-term while future fuel and propulsion technologies are developed.[48]

59. The Government indicates that the aviation sector has shown improved efficiency over recent decades, investing in greener technologies, improving operations, and phasing out older aircraft.

60. The Jet Zero Strategy expects improvements in system efficiency to deliver between 25 and 36% of overall CO_2 savings from aviation by 2050, with overall efficiency improvements, including fuel efficiency, of 1.5% to 2% per year (continuing the current trend).[49] The CCC's balanced pathway envisages annual efficiency improvements of 1.4% to 2050. Sustainable Aviation estimates annual savings from improved airspace and aircraft operations of 0.54 $MtCO_2e$ in 2030, rising to 1.41 in 2040 and 2.5 in 2050.

61. Efficiency gains can be made from changes to aircraft, airports and airspace:

- **Aircraft design**: consulting on its strategy, the Government stated that "there is huge potential to increase the efficiency of conventional aircraft through improvements to jet engines, wings, structures, and other systems".
- **Airports**: Savings can be made at airports from the use of a single engine for taxiing, and the eventual use of an electric motor could cut CO_2 emissions by 60% in this phase of flight.[50] Emissions 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.[51]
- **Airspace:** Improvements in airspace can lead to more direct flights at more efficient altitudes and speeds: for example, removing stacks for aircraft waiting to land at busy airports and removing the track structure over the North Atlantic.[52]

Aircraft

62. Depending on the market, an aircraft can remain in service for about 30 years. While an aircraft follows a specific maintenance cycle, its performance can degrade over time due to engine and aerodynamic deterioration, leading to additional CO_2 emissions. Fleet

47 *Aviation, decarbonisation and climate change*, House of Commons Library Briefing Paper CBP 8826, September 2021
48 Department for Transport, Jet Zero strategy: delivering net zero aviation by 2050, July 2022, para 3.3
49 Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021
50 Air Transport Action Group, Waypoint 2050; cited in Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021
51 Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021
52 *Ibid.*

renewal helps reduce aviation's environmental impact, as newer aircraft tend to be more fuel efficient. The COVID-19 pandemic had some impact on the fleets utilised by the airlines at UK airports, as airlines chose to retire their least fuel-efficient aircraft.[53]

63. Manufacturers are demonstrating incremental efficiencies into the lifecycle of their aircraft: for instance, Airbus claims, on the basis of its scope 3 disclosures, that the average scope 3 emissions of the 566 commercial aircraft it delivered in 2020 were estimated to be 63.5gCO_2e per passenger kilometre, in comparison to the 66.6gCO_2e per passenger kilometre of the 863 aircraft it delivered in 2019.[54]

64. The Government states that "there is huge potential to increase the efficiency of conventional aircraft through improvements to jet engines, wings, structures, and other systems". Next generation models of aircraft, such as the Airbus A320neo, are said to offer around 20% efficiency gains on their predecessors.[55] Rolls Royce has developed more efficient engines, such as its UltraFan, from composite materials: these can reduce the weight of aircraft and therefore increase fuel efficiency.[56]

65. The CCC found that up to 2020 fuel intensity in aviation was improving. During the COVID-19 pandemic it worsened due to lower demand and seat occupancy. The likely driver for increased fuel intensity during the pandemic was that seat occupancy fell and the number of 'ghost' flights increased.[57] While the Government's strategy includes a commitment to ensure the "maximum potential" of all flights departing the UK, it challenges the assumption that low-volume flights during the pandemic were operated simply to retain rights to landing slots, as the relevant rules were waived in March 2020.[58]

66. To improve fuel efficiency the Government is considering whether a mechanism will be required to ensure that airlines using UK airports avoid the practice of 'tankering'—carrying surplus fuel—when there is no practical reason for it, apart from to avoid refuelling at airports where fuel prices are high.[59] A question on measures to avoid tankering has been included as part of the Government's second consultation on reducing GHG from aviation fuel, issued in March 2023.[60] We consider the broader issue of new aviation fuels further below.

Airports

67. When consulting on the strategy, the Government set an ambition that all airport operations in England should be zero emission by 2040. This ambition was reaffirmed when the strategy was issued.[61] The Government cited in support of its ambition a

53 Department for Transport, Jet Zero: modelling framework, March 2022
54 Airbus, "Scope 3 disclosure: Reducing emissions from our products in-service and our supply chain" [undated]
55 Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021, para 3.8
56 Rolls-Royce (ZAS0056)
57 Climate Change Committee, *Progress in reducing emissions: 2022 Report to Parliament*, June 2022
58 Department for Transport, Jet Zero strategy: delivering net zero aviation by 2050, July 2022, para 3.11, p. 32
59 Jet Zero strategy: delivering net zero aviation by 2050, para 3.9, p. 31
60 Department for Transport, *Pathway to net zero aviation: developing the UK sustainable aviation fuel mandate*, March 2023
61 Jet Zero strategy: delivering net zero aviation by 2050, para 3.5, p. 30

feasibility study which indicated the potential for decarbonisation in airports in England.[62] Nevertheless, a number of airport operators have expressed concerns about meeting any targets which might be set.

68. In February 2023 the Government issued a further consultation on measures to meet the overall 2040 ambition, recognising that airport operations were "fertile ground for nurturing existing solutions and boosting the industry's commitment to net zero by 2050".[63] The consultation closed in May 2023 and a Government response is awaited.

Airspace

69. There is potential to reduce aircraft fuel consumption and therefore emissions by improving the efficiency of airspace use and air traffic management. The industry body Sustainable Aviation told us that an immediate industry priority was to systematically progress airspace modernisation and ensure it is fully completed by 2033: in the short term, modernising UK airspace and enabling more efficient flight profiles offered the greatest opportunity to reduce UK aviation emissions.[64]

70. Dr Andy Jefferson, of Sustainable Aviation, told us that the use of aircraft systems and air traffic control data analysis and capability had enormous potential to reducing aviation emissions, indicating, for example, the benefits from introducing free route airspace over most of Scotland from December 2021:

> That means that effectively airlines will be able to fly their most efficient path through Scotland along their flight. NATS is estimating that that will reduce emissions to the equivalent of 3,500 homes worth of emissions every year.[65]

Free route airspace, which allows airlines to plan an optimal trajectory for aircraft between defined entry and exit points in airspace based on weather and wind speed, is eventually to be extended across UK airspace: when implemented together with cross-border free routing across European airspaces, the Government claims that it will result in an annual reduction of one billion nautical miles flown and 20 million tonnes of CO_2 emitted.[66]

71. In the strategy the Government pledges support for the Civil Aviation Authority and the Airspace Change Organising Group (ACOG) to ensure that overall plans to modernise UK airspace—an Airspace Change Masterplan—deliver carbon savings.

The CCC's current assessment

72. In its 2023 progress report the Climate Change Committee indicated that there were significant overall risks to achieving the 23% of CO2 emissions abatement required from system efficiencies by 2037.

73. Progress identified by the CCC includes the inclusion of a question on measures to avoid tankering in the March 2023 consultation on sustainable aviation fuels; the

62 Jet Zero strategy: delivering net zero aviation by 2050, para 3.5: Connected Places Catapult and Mott MacDonald, Feasibility of Zero Emissions Airport Operations in England by 2040, April 2022
63 Department for Transport, Call for evidence: 2040 zero emissions airport target, May 2023
64 Sustainable Aviation (ZAS0024)
65 Q11
66 Jet Zero strategy: delivering net zero aviation by 2050, p.29

commitment in the Strategy to avoid unnecessary emissions from 'ghost flights' departing the UK; and the goal for all English airport operations to be net zero by 2040, supported by a call for evidence.

74. The CCC has identified that the Strategy's pathway to achieving fuel efficiency improvements entails 2% growth year on year, where historic growth has been at 1.5%. As in 2022, it recommends continued innovation and funding for aircraft efficiency measures and airspace modernisation. In its response to the corresponding recommendation in 2022, the Government indicated that it had provided up to £9.2 million of funding for the airspace modernisation programme: the Civil Aviation Authority's refreshed Aviation Modernisation Strategy, issued in January 2023, introduced the overarching principle of environmental sustainability.[67] In its response to the 2023 report, Ministers stressed that Government support to the Airspace Modernisation Programme had been provided on an exceptional basis "to aid pandemic recovery": the airport sponsors of the programme were expected to resume responsibility for funding the programme.[68]

75. Sustainable Aviation, in its refreshed Road-Map for net zero carbon, makes an ambitious case for efficiency improvements from the current aircraft fleet and conventional aircraft models in development, from airspace modernisation and from reducing emissions from airport operations.[69] The structure of the Sustainable Aviation projections mean that they do not map neatly onto the projections from the net zero models produced by the CCC and the Government: however, the body's overall claims are for efficiencies which outstrip the core projections made by the CCC and the Government. In a statement released in response to the CCC's June 2023 report, Sustainable Aviation called for a package of policy measures from Government, including "more decisive" action to quicken the pace of airspace modernisation, "enhanced co-investment" in research and development for low carbon aircraft, and a strategy to support the availability of sufficient renewable energy "to power aviation's transition": this will presumably include the decarbonisation and electrification of operations at UK airports.[70]

Our view on system efficiencies

76. **There is evidently significant potential for increased efficiencies across all aviation's operations which can lead to incremental reductions in CO_2 emissions across the UK aviation sector. Efficiencies from fuel use in the current and emergent fleet of aircraft, better use of airspace and reductions in emissions from airport and aviation operations will all have a significant part to play in aviation's contribution to reaching net zero.**

77. **We agree with the Climate Change Committee that the 0.5% year-on-year improvement in fuel efficiency from the aircraft fleet requires considerable effort both in research and development activity and in incentivising the industry to renew existing aircraft fleets.**

67 HM Government, Responding to the Climate Change Committee's Annual Progress Report 2022 Recommendations, HC 1270, March 2023, p. 114; Civil Aviation Authority, Airspace Modernisation Strategy, January 2023

68 HM Government, Responding to the Climate Change Committee's Annual Progress Report 2023 Recommendations, HC 1919, October 2023, pp. 79–80

69 Sustainable Aviation, *Net Zero Carbon Road-Map: summary report*, April 2023

70 Sustainable Aviation briefing note, " Sustainable Aviation response to the Committee on Climate Change 2023 Progress Report to Parliament", July 2023.

78. ***We recommend that the Government sustain and enhance its engagement with the aviation industry on the delivery of operational efficiencies from current and future fleets of aircraft operating through the UK, to maintain the ambition to secure 2% year-on-year CO_2 emissions reductions from fuel and operational efficiencies. The delivery of these reductions must be rigorously monitored against an established baseline: should the rate of progress in reductions fall behind 2%, the potential contribution of system efficiencies to meeting the 2050 net zero target must be urgently reassessed.***

79. ***We recommend that the Department for Transport and the Civil Aviation Authority intensify their work on airspace modernisation, bearing in mind the overarching principle of environmental sustainability.***

80. **We support the Government's aim to secure net zero in UK airport operations by 2040. Detailed policy measures to achieve this aim have not yet been implemented, and we look forward to publication of the Government's findings following the call for evidence. Decarbonisation of UK airports will require a substantial increase in electrification. We plan to examine broader issues about sustainable electricity supply to major elements of the UK's infrastructure, such as airports, in our current inquiry into *Enabling sustainable electrification of the UK economy.***

Aviation fuels

81. The aviation industry has been developing a range of lower carbon alternatives to conventional aviation fuel. These biofuels and electro-chemical fuels are described by the industry as 'sustainable aviation fuels' (SAFs). SAFs are a 'drop in' fuel: they can be blended into fossil-based aviation fuels and can be used in existing aircraft without modification.

82. Three classes of feedstock are currently being used to develop SAFs:

- **Biomass**: including biogenic waste (for instance, used cooking oil);
- **Non-biogenic waste**: for instance, unrecyclable plastics or waste fossil gases from industry, and
- **E-kerosene**: a synthetic fuel generated through a reaction between hydrogen derived from electrolysed water and CO_2 captured either from the air or from waste industrial exhaust streams.[71]

83. The claims made for greater sustainability from SAFs derive from the methods used in their production and the contribution they make to reducing aviation's reliance on the extraction of fossil fuels. The International Air Transport Association (IATA) has estimated that emissions from SAFs are between 70 and 80 per cent lower than those from conventional aviation kerosene over the course of the fuel's life cycle, since the fuel is either made from waste products—where the carbon has already been accounted for—or from plants that absorb carbon dioxide as they grow.[72] When burned, however, SAFs emit at least as much CO_2 as the kerosene currently used to fuel airliners.

84. SAF production processes are at different levels of technical and commercial maturity, with technology readiness levels typically ranging between 5 (early demonstration pilots)

71 Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021
72 See for example, IATA Sustainable Aviation Fuels fact sheet, May 2019

and 8 (pre-production).[73] Many projects face significant challenges when trying to bridge the gap from demonstration rigs to large-scale commercialisation plants, due to the high capital costs of first-of-a-kind commercial plants, which could go beyond even £1 billion. This has typically resulted in high prices for the product: they are often two to three times more expensive than conventional aviation fuels, while the reported cost of some technology pathways is up to eight times dearer.[74] Consequently there is limited demand for SAFs, at present, and limited revenues.[75]

85. The majority of the UK's aviation carbon emissions are from long-haul flight. The industry body Sustainable Aviation argue that there is currently "no realistic, 'in-sector' technology pathway that delivers net zero flight for long haul other than through sustainable aviation fuels". It says they should not be considered as 'transitional' fuels, as they will be needed in 2050.[76]

86. Manufacturers have begun to prepare their aircraft for the introduction of SAF to commercial aviation. All Airbus aircraft are currently certified to operate on up to a 50% blend of SAF mixed with kerosene, and Airbus has the ambition to achieve certification of 100% unblended SAF by the end of this decade.[77] On 28 November 2023 the first transatlantic commercial flight powered entirely by SAF took place.

Commercial maturity

87. The current level of SAF usage in the UK is less than 1% of UK demand. Sustainable Aviation's aim is for at least 32% of UK fuel supply to be provided by SAF by 2050.[78]

88. The first SAF facility in the UK, Altalto Immingham—a project led by the fuel manufacturer Velocys in collaboration with British Airways—is planned to be constructed in North East Lincolnshire.[79] Velocys claims that Altalto expects to produce waste-to-fuel SAFs from the mid-2020s in enough volumes to 'fuel the equivalent of over 1000 transatlantic flights'.[80]

89. Sustainable Aviation has established a roadmap for the development of a SAF industry to commercial maturity, depending on appropriate Government support for the establishment of SAF supply chains. If appropriate support were available, the roadmap envisages "a world leading sustainable aviation fuel industry" in the UK, with "up to 14 UK-based SAF plants by 2035" in seven clusters, promising "tens of thousands of jobs and £billions in G[ross] V[alue] A[dded] to former industrial regions of the country".[81]

90. The initial industry roadmap entailed a lead time for policy implementation and operationalisation of at least five years. In April 2023 Sustainable Aviation published a

73 Technological readiness levels (TRLs) are typically on a scale of 1 (basic principles established) to 9 (successful deployment). They originated in NASA technical assessments.
74 The International Council on Clean Transportation, The cost of supporting alternative jet fuels in the European Union, 2019; cited in Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021
75 Department for Transport, Sustainable aviation fuels mandate: consultation on reducing the greenhouse gas emissions of aviation fuels in the UK, July 2021
76 Sustainable Aviation (ZAS0024)
77 Rolls-Royce Powers Toward 'Net Zero' Target with Airbus and Shell.
78 Sustainable Aviation (ZAS0024)
79 Sustainable Aviation, *Decarbonisation Road-Map: a path to net zero*, February 2020
80 Velocys (ZAS0021)
81 Sustainable Aviation, *Decarbonisation Road-Map: a path to net zero*, February 2020

revised and augmented roadmap which identified substantially greater potential for a SAF industry in the UK, but which demanded "urgent action" from Government to "remove barriers to realising this potential": namely the establishment of a price support mechanism for SAF.[82]

A SAF testing and certification clearing house

91. In order to be used in commercial aircraft, drop-in SAFs have to go through an approval process to fulfil strict certification criteria and prove that their physical and chemical characteristics are almost identical to fossil-based jet fuel and can therefore be safely blended together. This allows SAF to be used by existing aircraft and does not require any adaptation to the aircraft or fuel supply infrastructure.

92. The Government has provided funding to support fuel testing, research and innovation. This includes £3 million support for a new SAF testing and certification clearing house, which was established in the Energy Institute at the University of Sheffield in the summer of 2023.[83] In November 2023 the clearing house announced the availability of grant funding of up to £5.35 million, provided by the Department for Transport, to support the cost of pre-screening SAF testing. The Government's funding supported Rolls-Royce to undertake a large civil aero-engine ground test with 100% SAF blends to confirm the capability of their engines to use future lower and zero-carbon aviation fuels.

93. The Jet Zero Strategy included further proposals to accelerate the procurement and use of SAF across Government and on UK public service obligation (PSO) routes.

A Sustainable Aviation Fuels mandate

94. 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.

95. In its Jet Zero Strategy the Government announced that it would mandate that 10% of the "UK fuel mix" should consist of SAFs by 2030. In July 2021 the Government launched a consultation on the introduction of an SAF mandate from 2025, examining how the measure could be used to "blend greener fuels into kerosene, which will create a market-led demand for these alternative fuels". A second consultation, setting out the long-term trajectory for the mandate, indicating how more advanced production pathways will be developed, and seeking to clarify to industry how the mandate is to be administered and complied with, was launched in March 2023.[84]

96. Green Alliance welcomed the Government's consultation on a SAF mandate, as it would "encourage industry to invest more heavily in green hydrogen and direct air capture, as well as e-kerosene plants, consequently making e-kerosene more competitive and widely available.".[85] However, Green Alliance expressed concerns over the ability to scale up sustainable fuel production and create market incentives for their adoption.

82 Sustainable Aviation, *Net Zero Carbon Road-Map: summary report*, April 2023

83 University of Sheffield news release, "First UK Clearing House for certifying new sustainable aviation fuels to launch at University of Sheffield", 31 March 2023

84 Department for Transport, *Pathway to net zero aviation: developing the UK sustainable aviation fuel mandate*, March 2023

85 Green Alliance (ZAS0022)

97. The Climate Change Committee has warned that SAFs might not deliver sufficient abatement if airlines were not to take up SAF to the level required in the Government's pathway for aviation, and/or those fuels that were procured did not have a sufficient CO_2 and non-CO_2 saving. While the Government has partially mitigated this risk by mandating a 10% use of SAF by 2030, the CCC considers that this mandate represents a 'very high level of ambition'.[86]

Contracts for difference–a price support mechanism for SAF

98. Several aviation companies have suggested that a Contracts for Difference (CfD) model be introduced to support the commercialisation of SAF and create price certainty. The Government already uses the CfD model as its main mechanism for supporting low-carbon electricity generation.[87]

99. CfDs have the potential to incentivise investment in different energy sources by providing developers of projects with high upfront costs and long lifetimes with direct protection from volatile wholesale prices, and they protect consumers from paying increased support costs when electricity prices are high.

100. Velocys pointed out to us that "a mandate does not give any guarantee of SAF prices [and] finance experts have consistently delivered the message to the Government that investment in SAF plants in the UK will only occur when there is price certainty"[88]. A price support mechanism, or Contract for Difference for SAF was "essential if the UK is to establish its own production and become a leader in the market in the 2020's."[89]

101. Jonathan Counsell, from the International Airlines Group, told the Committee that

> a mandate will not be enough. We need to de-risk the investment. I have spent a lot of my time in the last few years talking to investors and a lot of them have had difficult times with early-stage renewables. This is why our view is that you need a mandate coupled with a price stability mechanism, such as contracts for difference. If you get those two—and we have spoken to investors—they will invest in these plants in the UK.[90]

102. The Energy Act 2023 makes legislative provision to establish a revenue certainty mechanism for the production of SAF.[91] The Department for Transport has issued a delivery plan for designing and implementing a revenue certainty mechanism for SAF by 2026, and is to launch a consultation on the design and delivery of the scheme to bolster the development of SAF and drive further investment.[92]

86 Climate Change Committee, *Progress in reducing emissions: 2022 Report to Parliament*, June 2022

87 A Contract for Difference (CfD) model is a contract between an energy producer and the Government. The producer is paid the difference between the 'strike price' – "a price for electricity reflecting the cost of investing in a particular low-carbon technology" – and the 'reference price' – "a measure of the average market price for electricity in the UK market". The benefit to that model is that producers are provided with long-term price security, "allowing investment to come forward at a lower cost of capital and therefore at a lower cost to consumers". See Department for Energy Security and Net Zero (then Department for Business, Energy and Industrial Strategy), Electricity Market Reform: Contracts for Difference, February 2017

88 Velocys (ZAS0021)

89 Velocys (ZAS0021)

90 Q329

91 Energy Act 2023, s. 158

92 Department for Transport, Revenue certainty mechanism for SAF: delivery plan, September 2023

How sustainable are SAFs?

103. As the emissions from the combustion of drop-in SAF are comparable to kerosene, the majority of the reductions in carbon emissions originate from the production process. In order to assess the overall climate benefit from using SAF, a lifecycle analysis is performed to account for all the stages in the lifecycle of aviation fuels. It includes feedstock recovery and transportation, fuel production and transportation, and fuel consumption by aircraft. According to the industry body Sustainable Aviation, SAFs produced from feedstocks with strong sustainability credentials can result in over 70% CO_2 emissions saving on a lifecycle basis compared to conventional fossil aviation fuels.[93]

104. Despite being lower-carbon alternatives, biofuels also result in GHG emissions across their lifecycle. The emissions saved by using aviation biofuels varies widely depending on the raw material and production process Analyses of emissions from the whole production and consumption chain of biofuel technologies (so-called "well-to-wake" analyses) have identified reductions in lifecycle emissions of between 18 and 95 per cent: the lowest CO_2e reductions on the use of conventional jet fuels have been shown to result from the use of sugar cane feedstock in a direct sugar to hydrocarbons (DHSC) process and the highest from the use of forestry residues in a gasification and Fischer-Tropsch process.[94]

105. There is currently no comprehensive global regulatory standard for SAF sustainability. Biomass could come from sources associated with deforestation and land degradation, including products derived from palm and coconut. Tyndall Manchester recommended the development of sustainable biomass supply chains that could balance the potential demands for SAF production, and called for research into ways of optimising each stage of the biofuel process so as to minimise environmental impacts while continuing to ensure the industry's commercial potential. Tyndall warned of the potential negative implications for the UK's national and international commitments on biodiversity if the sourcing of biofuels were to have a disproportionate focus on decarbonisation, energy security and affordability.[95]

106. Green Alliance pointed out that as measures to eliminate waste were implemented in the UK, the availability of waste products as a SAF feedstock would diminish.[96] The Aviation Environment Federation echoed this saying that "waste must be reduced, and methane release must be minimised in addition to achieving net zero. The use of waste as a fuel for aircraft offers limited real emissions reduction and will not be a scalable solution"[97].

107. The Government has indicated that it is active at the ICAO in negotiating for a full set of sustainability criteria for SAFs that will underpin their global deployment.[98] In its initial sustainable aviation fuels mandate consultation, the Government proposed mandatory sustainability criteria, expecting that these criteria would allow the restriction of SAF production to feedstock and process inputs that deliver emissions savings, taking into account supply chains and sustainability and land use:

93 Sustainable Aviation, *Decarbonisation Road-Map: a path to net zero*, February 2020
94 Imperial College London, Aviation Biofuels: Strategically important, technically achievable, tough to deliver, Grantham Institute Briefing paper No. 23, November 2017
95 Tyndall Manchester (ZAS0041)
96 Green Alliance (ZAS0022)
97 Aviation Environment Federation (AEF) (ZAS0043)
98 Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021

- Fuels must achieve a minimum GHG emissions saving on a lifecycle basis
- Fuels must be made from sustainable wastes or residues (SAF produced from food or feed crops will not be allowed)
- Feedstocks, including residues, should not be obtained from land with high biodiversity value or land with high carbon stocks
- SAF production must not direct renewable electricity away from existing applications
- Where hydrogen is used as a process input, the hydrogen must be low carbon.[99]

The CCC's current assessment

108. In its 2023 progress report the Climate Change Committee recognised the progress which had been made by the Government in achieving the target of SAF to contribute 10% of aviation fuel to UK aviation by 2030. Policy commitments after 2030 appear less certain: the CCC has made recommendations about:

- the minimum rate for greenhouse gas savings to be made from SAF deployment relative to jet fuel, while upholding stringent fuel eligibility standards;
- the current high levels of uncertainty about global and domestic SAF feedstock availability to 2050, and the need to mitigate against supply risks when developing SAF policy, and
- the potential for high-quality greenhouse gas emissions removals to reduce emissions overall (including aviation emissions) to 2030.

Our view on sustainable aviation fuels

109. **Sustainable aviation fuels may offer a means of reducing the carbon emissions attributable to the lifecycle of aviation kerosene from its production to its combustion, and the Government envisions a substantial role for SAFs. There is nevertheless potential for wide variability in lifecycle emissions across the general class of fuels which the industry currently terms 'sustainable aviation fuels'. We note that the Climate Change Committee warned in its 2023 Progress Report to Parliament that the Jet Zero Strategy approach is "high risk due to its reliance on nascent technology", such as the rapid uptake of these fuels.**

110. **We welcome the initiatives taken by the Government to date to establish a domestic industry for the manufacture of sustainable aviation fuels, and the steps it is taking to build long-term supply chains for domestic and international aviation. We note the measures announced to date on the establishment in 2025 of a mandate for SAF use. We will monitor the outcome of the Government's second consultation on the issue and the drafting of the secondary legislation required to implement the mandate.**

111. **We are concerned that the broad definition of what is currently considered a sustainable fuel, and the absence of a global standard for SAFs, may lead to the**

99 Department for Transport, Sustainable aviation fuels mandate: consultation on reducing the greenhouse gas emissions of aviation fuels in the UK, July 2021

development of aviation fuels which cannot credibly be described as sustainable. *We recommend that the Government take every opportunity to establish in its policy instruments for a UK SAF industry the strongest safeguards to ensure significant lifecycle emissions savings from the use of SAFs developed in the UK.*

112. **We note with approval the Government's criteria restricting the feedstocks to be used in UK-manufactured SAF and specifying that feedstocks are not to be obtained from land with high biodiversity value or land with high carbon stocks. *We recommend that in its forthcoming Land Use Strategy the Government establish clear and unambiguous criteria as to the type of land which is to be allocated to growing feedstocks for SAF. The Government must also take every opportunity in international forums to press for the highest standards of sustainability in the production of SAF feedstocks.***

113. ***We further recommend that Ministers and officials work vigorously at the ICAO and in all other relevant international bodies for the establishment of a global regulatory standard for SAFs which is comprehensive and rigorous.***

114. **We welcome the establishment of an UK SAF Clearing House at the University of Sheffield to support SAF producers through the process of certification and approval of their products for commercial use.**

115. **The Government must match its ambition for the development of a domestic SAF industry with an appropriate appetite for risk and innovation in order to ensure that commercial production of truly sustainable fuels develops at pace. The introduction of a revenue certainty mechanism, via provision in the Energy Act 2023, represents a welcome initial step in this process. To this end, *we recommend that the Government make swift progress on the implementation of a price support mechanism to incentivise investment for SAF production pathways.***

Zero-carbon emission flight technologies

116. Two technological pathways currently appear to offer the potential of truly zero-carbon emission flight: hydrogen-electric and battery-electric. The industry body, Sustainable Aviation, considers that aircraft using these emergent technologies will in future be able to operate short-haul and some medium-haul flights. Most medium-haul and all long-haul flights will be in conventional aircraft powered by sustainable aviation fuels instead of fossil kerosene.[100]

Government support for technological research and development

117. Substantial support has been provided to research and development of zero emission flight through continued Government support of the Aviation Technology Institute (ATI). Zero-emission flight is now one of ATI's three priority areas for development: its Destination Zero technology roadmap issued in 2022 sets out a roadmap for the development of zero-emission flight technologies to 2050.[101]

118. ATI was established in 2013 by the UK Government, in partnership with the commercial aerospace sector: each side initially committed £150m each per year to fund aerospace research and development.[102] In March 2022 the Government increased its funding to the ATI by £685m over the three years to March 2025, an increase of 50% on the previous three-year period.[103] In the Autumn Statement delivered on 22 November 2023 the Chancellor of the Exchequer announced an additional £975 million of funding for ATI for the period from 2026 to 2030 as part of a £4.5bn funding package for UK manufacturing.[104] Government funding is to be matched with industry co-funding, resulting in provision of an overall funding uplift to the ATI of almost £2bn for 2026 to 2030.[105]

Prospects for commercial deployment of zero-emission flight

119. Rolls Royce told us that domestic aviation presented a readily addressable near-term market for new disruptive aerospace technologies including electrification and hybrid-electric propulsion, which had the benefit of being deployable without significant infrastructure development.[106]

120. The Government considered, when consulting on its Jet Zero policy, that a range of hydrogen-electric and battery-electric aircraft could enter the sub-regional and general aviation markets this decade, while other forms of propulsion such as hydrogen or ammonia combustion might also have a role.[107]

121. The challenge is to scale up these technologies to larger commercial passenger usage. There are doubts that large-scale pure electric flights will be feasible because of the size and weight of batteries required to generate the necessary thrust. In the Climate Change

100 Sustainable Aviation (ZAS0024)
101 Aviation Technology Institute, Destination Zero: the technology journey to 2050, April 2022
102 Aviation Technology Institute news release, "ATI response to UK Gov R&D roadmap", 23 August 2020
103 Jet Zero strategy: delivering net zero aviation by 2050, para 3.34, p. 44
104 HM Treasury, Autumn Statement 2023, November 2023, para 4.71
105 Airspace Technology Institute, 'A new 5-year funding settlement for the Aerospace Technology Institute', 22 November 2023.
106 Rolls-Royce (ZAS0056)
107 Department for Transport, Jet Zero consultation. A consultation on our strategy for net zero aviation, July 2021

Committee's 2019 projections, hybrid-electric planes would make up less than 10% of km flown in 2050 and full-electric aircraft were unlikely to be feasible by 2050, particularly for long-haul flight.[108]

122. In May 2022 Sophie Lane, Chief Relationships Officer of the Aerospace Technology Institute (ATI), told us that in her view the market for zero emissions aircraft was "very immature": papers produced for the ATI's FlyZero project, which aimed to realise zero-carbon emission commercial aviation by 2030, had shown the feasibility of what could be achieved, but the work needed validation and further research.[109]

Battery electric aircraft

123. Cranfield Aerospace Solutions Ltd, in collaboration with Denis Ferranti Meters Limited and Rolls-Royce plc, are converting a Britten-Norman Islander 9-seat aircraft to all-electric propulsion.[110] The project received a £9 million UK Government grant in 2019 through the Aerospace Technology Institute (ATI).

124. In November 2017, the E-Fan X demonstrator programme was launched at the Royal Aeronautical Society in London as an innovation project to develop and demonstrate technologies related to hybrid-electric propulsion. It was initially proposed to be jointly developed by Airbus, Rolls-Royce and Siemens. In June 2019, Siemens decided to leave the project. The E-Fan X hybrid electric aircraft was due to fly for the first time in 2021. However, in April 2020, Airbus and Rolls Royce announced they were ending the project early to "refocus their efforts".

Hydrogen aircraft and hydrogen powered flight

125. The focus in technological development has therefore increasingly switched to hydrogen. Hydrogen has three times the energy density of kerosene and more than 100 times that of lithium-ion batteries. Hydrogen gas is compressed and fed into a fuel cell. The fuel cell and surrounding components are complex and heavy, and the hydrogen requires bulky storage tanks.

126. Hydrogen propulsion eliminates CO_2 emissions in flight and can be produced carbon free as 'green hydrogen'. Estimates show that hydrogen combustion could reduce the climate impact of a flight by 50–75% and fuel propulsion by 75–90%. Hydrogen could also result in a significant reduction in non-CO_2 emissions from aviation.

127. ATI's 'FlyZero' research programme identified liquid hydrogen as the most viable route to achieving zero carbon flight, but warned that given the slow rate of fleet turnover, even if new hydrogen aircraft are available in the 2030s it will take decades for them to roll through the fleet. Sophie Lane, of ATI, told us that the technology for low emission hydrogen aircraft is at an early stage, such aircraft were unlikely to be commercially viable

108 Climate Change Committee, Letter from the CCC Chairman, Lord Deben, to the Secretary of State for Transport, Rt Hon Grant Shapps MP, about net-zero and the approach to international aviation and shipping (IAS) emissions, 24 September 2019

109 Q349

110 Project Fresson: 9-seat aircraft electric propulsion conversion (Britten Norman), UKRI, cited in *Aviation, decarbonisation and climate change*, House of Commons Library Briefing Paper CBP 8826, September 2021

for decades, telling us about a concept for a longer range aircraft capable of flying 279 passengers halfway around the world without a stop or anywhere in the world with just one stop to refuel.[111]

> "The hydrogen pathway is viable. We believe it is feasible, but it needs a lot more work and a lot more investigation into what it will take to be able to do that. We have recently modelled, potentially, a mid-size aircraft in the late 2040s that could be hydrogen based. You can see that there is a pathway there but there needs to be a lot more investigation."[112]

128. Sustainable Aviation foresees that hydrogen will be used on mainly short to medium length air journeys.[113]

129. ZeroAvia told us that they are aiming to scale-up their technology quickly to offer zero emission hydrogen power to increasingly larger aircraft with longer potential ranges—targeting 50-80 seat aircraft with 1,000 nautical mile (nm) range by 2026, right through to 200+ seats with a 5,000nm range by 2040.[114] Val Miftakov told us that he believed that hydrogen could power about 25% of flight by 2050.

130. In September 2020, ZeroAvia tested its hydrogen fuel cell system by powering an adapted six-seat Piper M350 light aircraft on a 19-mile demonstration flight from Cranfield airport in Bedfordshire.[115] The company is now building a 19 seat commercial aircraft that took a test flight in November 2021 before being commercially available by 2024: Committee members viewed this aircraft on their visit to ZeroAvia at Kemble airfield.

131. ZeroAvia received a £12.3 million grant through the ATI and has secured further ATI funding to scale up and demonstrate its hydrogen-electric powertrain on a 19-seater aircraft, with the aim to achieve commercialisation in 2023. ZeroAvia's technology retrofits existing airframe models simplifying regulatory issues and reducing time to market. It plans to take on routes between UK islands for 20-minute journeys.[116]

132. Airbus announced in 2020 that hydrogen fuelled propulsion would be a key element of its ZeroE project, which would see it produce a new generation of zero emissions aircraft.[117] They told us that they believe that hydrogen will play its part in all sectors of aviation with hydrogen fuel cells for commuter and regional flights, and hydrogen burn for short to medium range and in power to liquid fuels (e-fuels) for long distance travel.[118]

133. 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. The company hopes to build and operate a 50-seat aircraft by 2026, which would be only marginally smaller than the aircraft used by British Airways on routes out of London

111 Department for BEIS and Department for Transport news release, "Government backed liquid hydrogen plane paves way for zero emission flight", December 2021
112 Q341
113 Sustainable Aviation (ZAS0024)
114 ZeroAvia (ZAS0040)
115 The British American company is backed by a £12.3 million UK Government grant.
116 ZeroAvia (ZAS0040)
117 Airbus (ZAS0052)
118 Airbus (ZAS0052)

City airport across the UK and Europe. Within a decade, ZeroAvia says it plans to scale up operations, building hydrogen aircraft capable of carrying 100–200 passengers across Europe.[119]

134. easyJet told us that they saw hydrogen as "a very credible fuel" for a short haul airline. David Morgan, Director of Flight Operations at the airline, told us that the area needed development, pointing out that a hydrogen economy would be necessary to support hydrogen flight:

> The one area that we will all need to keep an eye on is the infrastructure needed to be able to supply these aircraft with a sufficient amount of green hydrogen needed to be able to operate these fleets. That is a whole different challenge again but one that we are starting to address in terms of collaboration with other hard-to-abate sectors that will also use hydrogen.[120]

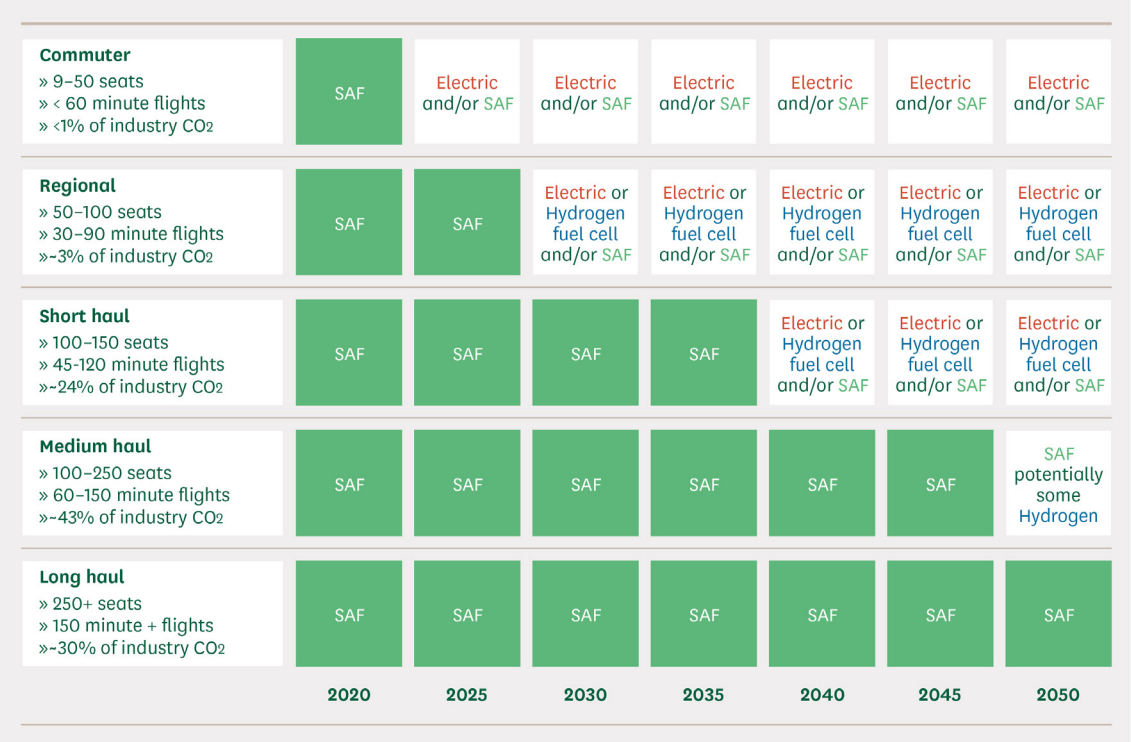
135. Airbus echoed this: in their view it was imperative that the Government consider both the scaling up of production of low carbon hydrogen, and the development of the infrastructure to deliver hydrogen to aviation facilities.[121]

Scaling up the development of zero emission flight

136. The UK aviation industry (through the Air Transport Action Group) has provided an indicative overview of where low- and zero-carbon energy could be deployed in commercial aviation to 2050. It is more optimistic on the use of SAF than on zero emission flight technologies. Sustainable Aviation agrees with the analysis that hydrogen and electric aircraft will address short and some medium length air journeys with sustainable aviation fuels (SAF) being used to replace fossil kerosene on most medium to all long haul flights. It said since the majority of the UK's aviation carbon emissions are from long-haul flight, there is currently "no realistic, 'in-sector' technology pathway that delivers net zero flight for long haul other than through sustainable aviation fuels".[122]

119 Airbus (ZAS0052)
120 Q307
121 Airbus (ZAS0052)
122 Sustainable Aviation (ZAS0024)

Table 2: Projected availability of lower carbon fuels and aircraft between 2020 and 2050, by type of route



Source: Sustainable Aviation

137. ZeroAvia asserts that hydrogen-electric powertrains are the only viable, scalable solution for zero-emission aviation. It says hydrogen-electric power trains have up to 30 times higher specific energy and lower cycling costs than lithium-ion batteries, and numerous advantages over all other decarbonisation solutions. It says the weight of the powerplant is a short-term issue.[123]

138. The Connected Places Catapult sees a role for zero emission flight to connect cities and places between regions in the UK to deliver greater levels of connectivity, driving new services, productivity gains and prosperity. The Jet Zero Strategy suggests 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.[124]

Zero emission flight in the Jet Zero Strategy

139. The Government's modelling in the Jet Zero Strategy high ambition scenario—its core model—envisages zero emission flight accounting for 2MtCO$_2$e of the emissions reductions attributable to aviation by 2050. In its high ambition scenario which envisages a technological breakthrough in zero-emission flight, the Government envisages that 7MtCO$_2$e of emissions reductions will be attributable to ZEF by 2050, accounting for 12.8% of the total emissions reductions to be achieved from UK aviation.

123 ZeroAvia (ZAS0040)
124 Connected Places Catapult (ZAS0069)

140. The Government has established an aspiration to introduce zero-emission aircraft on short-haul routes connecting different parts of the UK by 2050.[125] To achieve this it intends to work with the Civil Aviation Authority and the ICAO to maintain the UK as an optimal location for the development and deployment of new zero-emission aircraft. The Government will examine whether it is feasible to use zero-emission aircraft, when developed to the standard when they can be certified for passenger flight, on public service obligation (PSO) routes connecting parts of the UK, seeking to strike a balance between promoting the reduction of emissions and securing value for money from the Government's expenditure on PSO routes.

The CCC's current assessment

141. In its 2023 progress report the Climate Change Committee identified some risks to the delivery and funding mechanisms supporting the contribution of zero-emission flight to reaching Sixth Carbon Budget targets. Overall, it identified significant risks to ZEF's contribution to achieving the target: although it credits the Government with investment in development of the technology required, the CCC indicates that the Jet Zero Strategy lacks plans for how the roll-out of ZEF will be supported beyond the initial aspiration to use zero-emission aircraft on some public service obligation routes by 2030. In response, the Government has indicated the priorities for the Jet Zero Council's Zero-Emission Flight Delivery Group to 2024: the Group will be focusing on addressing barriers to commercialisation of zero-emission flight, supporting the Aerospace Technology Institute's work considering UK hydrogen supply for domestic aerospace manufacturing.[126]

Our view on zero emission aircraft

142. **Zero-emission flight represents a very promising long-term prospect for achieving reductions in the CO_2 emissions from UK aviation. Unlike the use of SAF, zero-emission flight technologies hold out the promise of eliminating the carbon emissions entailed in aircraft movements. We are encouraged by the significant contributions to research and development in this sector which are being undertaken by UK-based firms supported by the Government and industry through the Aviation Technology Institute.**

143. **While zero-emission flight technologies offer a route to significant reductions in aviation's CO_2 emissions, their deployment is realistically likely to be limited to short-haul flights for the foreseeable future. ZEF can play a significant role in promoting aviation as a means of connecting the UK, particularly on public service obligation routes between the UK mainland and island communities.** ***We recommend that the Government establish a target under the Jet Zero Strategy for the full roll-out of zero-emission aircraft on a minimum number of routes essential to UK connectivity by 2040, with a view to encouraging the greater takeup of ZEF aircraft on commercially-operated short haul routes within the UK.***

144. **Zero-emission flight is sometimes described as providing 'guilt-free' flying. While it is the case that ZEF technologies remove the CO_2 emissions from conventional aircraft movements which are aviation's most damaging effect on the environment, the**

125 Department for Transport, *Jet Zero strategy: delivering net zero aviation by 2050*, July 2022, para 3.35, p. 44

126 HM Government, Responding to the Climate Change Committee's Annual Progress Report 2023 Recommendations, HC 1919, October 2023

potential effects on the atmosphere from both hydrogen and battery-electric flight are not fully known. ***We recommend that the Government, when promoting research into the non-CO2 effects of aviation, include in its strategy the funding of research into the effects on the atmosphere and climate of aircraft using zero-emission flight technologies.***

Market-based measures and carbon removals

145. Market-based measures are policy instruments designed to mitigate the climate impact of aviation beyond the reductions in emissions which operational and technological measures or changes to aviation fuel can currently achieve. They rely on the operation of national and transnational carbon markets to deliver net reductions in a country's overall emissions inventory.

146. For aviation, the main market-based measures currently in place are the European Union Emission Trading Scheme (the EU ETS), the UK Emission Trading Scheme (the UK ETS) and the ICAO's CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation).

147. Carbon markets support international climate change efforts by acting as a source of finance and allowing access to cost-efficient abatement mechanisms. Two types of carbon market have been developed:

- **Emissions trading systems** (cap-and-trade schemes): companies purchase and trade emissions allowances which allow them to emit units of CO_2 equivalent. Governments economically incentivise firms, corporations, and other entities to cut emissions by setting a limit (a 'cap') on emissions and issuing permits within the limit. Both the UK and EU ETS take this approach.
- **Offsetting mechanisms:** governments and companies trade offsets, i.e. emission reduction units, which typically represent one tonne of CO_2 equivalent extracted from the atmosphere by mitigation measures. CORSIA takes this approach.

The European Union Emission Trading Scheme (EU ETS)

148. The EU ETS sets an EU-wide cap on the total amount of greenhouse gas emissions from energy intensive sectors including power stations and industrial plants. The cap decreases over time (1.74% each year) to reduce overall emissions. Airlines operating between the 31 countries subject to the scheme are covered within the EU ETS but via a separate cap. Approximately 140 UK-administered aircraft operators take part in the EU ETS.

The UK Emission Trading Scheme (UK ETS)

149. The UK ETS replaced the EU ETS in the UK from 1 January 2021. 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. Emissions from covered sectors will reduce in line with the cap: in July 2023 the UK Government and the devolved administrations confirmed that the cap would be set so as

to achieve net zero by 2050. Having assessed that the risk of carbon leakage from aviation ETS participation was low, the Government has given notice that the free allocation of emissions permits to aviation will end in the 2026–2030 allocation period.

Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

150. CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation), is a global market-based measure to address CO_2 emissions organised through ICAO, the UN aviation agency. Airlines offset the growth in international aviation emissions covered by the scheme above 2019 levels. The UK is among 88 states that have volunteered to participate from 2021 and the Government is now implementing the scheme in UK law. There are some notable non-participants in the scheme—China, Russia and India.

151. An airline can reduce its carbon offsetting requirements by using CORSIA-eligible fuel (CEF), although these need only reduce the carbon emissions by 10% compared to fossil fuel-derived kerosene. Any remaining CO_2 offsetting requirements must be purchased as emission units through carbon markets and recorded within a central CORSIA registry.

152. Sustainable Aviation told us that it has consistently advocated carbon pricing and effective carbon market-based measures. It supports CORSIA and the EU ETS over unilateral national taxes and has built in a rising carbon price into its roadmaps.[127]

153. The Climate Change Committee has been critical of CORSIA and wants to see international measures that incentivise GGRs for *all* emissions from aviation, not just emissions above a 2019–2020 baseline.

154. The climate charity Possible told us that the CORSIA scheme would "do more harm than good" and was not "an effective strategy to reduce aviation emissions or promote technological improvements or behaviour change". It said the offsets are priced far too low to provide any real disincentive to flying, and the existence of the scheme provides a disincentive to the difficult and expensive work of developing lower-emissions forms of aviation.

> The existence of offsets, particularly a "standard" scheme such as CORSIA, is also liable to create a misleading impression among travellers that the problem of their flight's climate impacts has been addressed and it is therefore fine for people to keep on flying.[128]

155. In Possible's view, similar problems affected the ETS: charges incurred under the scheme were too low to provide a genuine disincentive to kerosene-powered flight. To be effective, emissions needed to be priced at a high enough rate to make them prohibitive, and to genuinely incentivise a modal shift to other forms of transport.

156. The Aviation Environment Federation was concerned that getting political agreement amongst 193 states would be very challenging and could result in either a significantly

127 Sustainable Aviation (ZAS0024)
128 Possible (ZAS0012)

lower level of ambition or a delay to the decision. International measures to limit aviation emissions would be insufficient without strong domestic and regional measures delivered in parallel.[129]

The CCC's current assessment

157. In its 2023 progress report the Climate Change Committee indicated that there had been no progress on offsets and removals policies specific to the aviation sector since the 2022 progress report. The CCC observed that the Government had not yet responded to its consultation on the UK ETS issued in 2022, where it indicated it was considering the scope of free allocation allowances in the aviation sector: the response from all four UK administrations was in fact published in July 2023, and indicated that free allocations to aviation would cease in the 2026–2030 allocations period.[130] It warned airlines which have established carbon offsetting schemes to ensure that the schemes offered to consumers invest only in high-quality, long-lived offset schemes with regular monitoring, reporting and verification. The CCC envisages, and recommends, that offsetting schemes be replaced by airline investment in high-quality and permanent greenhouse gas removals.

Our view on market based measures and carbon removals

158. **Requiring airlines to set a price on their emissions, and purchase credits for these emissions through a trading scheme, can be a constructive mechanism to ensure that the carbon cost of aviation is more adequately reflected in the cost to the consumer. This in itself may influence consumer demand for flights, depending on the availability and cost of the necessary carbon credits. Sustainable Aviation has categorised market-based measures as demand management mechanisms.**

159. **We welcome the decision of the UK Government and devolved administrations to end the issuing of free ETS allocations to aviation with effect from the 2026–2030 allocation period. We note that the use of SAF in aviation is currently zero-rated for ETS, even though the emissions from burning SAF in flight are currently equivalent to those from burning aviation kerosene: as the SAF market matures, consideration must be given to pricing SAF in the ETS at a level which genuinely reflects its carbon impact.**

160. ***We recommend that the Government implement its proposed changes to the UK ETS so as to remove conventional aviation fuel from free allocations, and that it consult on a methodology to include SAF in the ETS in a way which does not inhibit the development and use of SAF in UK aviation.***

161. **Offsetting mechanisms, such as CORSIA, may provide an interim step towards contributing to the removal from the atmosphere of the emissions attributable to UK aviation. We commend the Government on the work it has already undertaken at international level to secure an agreement on an international offsetting mechanism. More remains to be done, and the use of offsets to address aviation emissions is at best a stopgap measure until more effective and high-quality technologies to achieve permanent greenhouse gas removals are available.**

129 Aviation Environment Federation (AEF) (ZAS0043)

130 UK Government, Scottish Government, Welsh Government and Department of Agriculture, Environment and Rural Affairs for Northern Ireland, Developing the UK Emissions Trading Scheme: Main Response, July 2023

5 Closing the aviation emissions gap

162. It is widely recognised that aviation, as a 'difficult to decarbonise' sector, is not capable of reducing its emissions to net zero by 2050 by virtue of decarbonisation initiatives undertaken within the sector. This observation applies to the UK aviation sector as much as any other. The separate scenarios modelled by the Climate Change Committee and by the Government all result in an 'emissions gap' of residual emissions from UK aviation which cannot be offset by decarbonisation from technological innovation, efficiency savings or the use of synthetic fuels.

163. The existence of this 'emissions gap' was widely acknowledged in the evidence we received. Dr Andy Jefferson, Programme Director at the industry body Sustainable Aviation, told us that reducing emissions from aviation to the extent required would represent a challenge for the UK carbon budget that should not be underestimated:

> It is a significant challenge, and it requires dramatic investment in the new technology opportunities going forward. We set out in our plan that we believe that is deliverable through investment in modernising airspace and flying aircraft more efficiently, investing in the current generation aircraft that are available… we think the switching of fuel from oil fossil fuel to true sustainable aviation fuels will reduce carbon footprints currently by 70%. In future, we think we can have sustainable aviation fuels that are completely zero carbon emitting.[131]

164. He agreed with the Climate Change Committee's analysis that residual emissions from aviation would have to be addressed in order to reach the goal of net zero aviation by 2050:

> We think there will still be the need for some residual emission management, which we are looking at currently through carbon trading schemes, both UK ETS and CORSIA for flights outside of the UK, but increasingly, moving forward, how those schemes can move more into the carbon removal space, so carbon capture and storage and true carbon removal.[132]

165. Ministers are confident that these residual emissions can be managed by technological means alone. In its response to the Climate Change Committee's 2023 emissions reduction report the Government cited Department for Transport analysis which showed that the UK "could achieve its net zero targets by focusing on new fuels and technology".[133]

166. Others have been less confident. Green Alliance's assessment of Government policies and current trajectories for aviation growth led them to conclude that "the UK's aviation sector is not on track to meet net zero CO_2 emissions by 2050" as "technological, efficiency and offset options alone" were insufficient to reduce aviation emissions to the extent required: the proposed sustainable aviation fuels mandate and emerging technology for zero-emission aircraft "rely on technologies which are not yet commercially scalable, and which do not deliver emissions savings in the short term".[134]

131 Q2
132 Q2
133 HM Government, Responding to the Climate Change Committee's Annual Progress Report 2023 Recommendations, HC 1919, October 2023, pp. 82 and 83
134 Green Alliance (ZAS0022)

167. The Aviation Environment Federation (AEF) stated that

> almost all proposed pathways for the aviation sector achieving net zero, whether from the Climate Change Committee, the Department for Transport, or the industry coalition Sustainable Aviation, assume the sector will still be emitting large amounts of CO_2 in 2050—in excess of 20MtCO_2 annually—that will need to be removed and permanently stored every year in order to meet the net zero target.[135]

Risks to current strategies to close the emissions gap

168. The CCC says that the Government's pathway for aviation relies heavily on very nascent technologies being scalable and deployed relatively quickly for commercial use. There is no policy framework ready to implement that would mitigate demand growth if these technologies are not deployed as planned.[136]

169. As we have indicated above, there is an emerging industry in SAF, and the Government has set an ambitious target for SAF implementation. In its 2023 progress report the CCC indicated that the process to implement the Government's SAF mandate had been delayed and was dependent on an uncertain domestic and global feedstock supply.[137] In response, the Government has indicated that it is "on track to deliver" the SAF mandate legislation by 2025.[138] Despite the Government's declared commitment to a SAF industry in the UK, elements of its policy remain to be fully developed pending further consultation. Until the SAF mandate legislation is fully operational and all the policy instruments to support it are in place, there must remain a doubt over whether the Government's ambition to deliver SAF usage in flights departing the UK by 2030 will be realised to the extent envisaged in the Jet Zero Strategy.

170. System efficiencies are best placed to deliver short- to medium-term emissions reductions. The projections of the CCC and of the Government as to the contributions such efficiencies can make vary: over the 14 years to the end of the Sixth Carbon Budget period, failure to realise the Government's more ambitious projections, representing 0.5% year on year, will leave a hole in the budget which will be difficult to replace.

171. Reliable, high-quality greenhouse gas removals are not yet in operation. While the current state of development and availability of carbon capture and storage technologies is beyond the scope of our inquiry, it is impossible to state with any certainty that the aviation industry will be able to purchase greenhouse gas removals to the extent envisaged by the Government or by the industry to ensure that aviation falls within the Sixth Carbon Budget target by 2037 and achieves net zero by 2050.

135 Aviation Environment Federation (AEF) (ZAS0043)
136 Climate Change Committee, *Progress in reducing emissions: 2022 Report to Parliament*, June 2022
137 Climate Change Committee, *Progress in reducing emissions: 2023 Report to Parliament*, June 2023
138 HM Government, Responding to the Climate Change Committee's Annual Progress Report 2023 Recommendations, HC 1919, October 2023, table 2, pp 26–27

Demand-side measures to close the emissions gap

172. We received a number of submissions which highlighted concern that the Jet Zero Strategy, as consulted on by Ministers, would not be sufficiently robust to deliver the emissions reductions envisaged without including measures to manage the UK's current and projected demand for aviation services. Several proposals indicated the benefits of active policy measures to limit current trends in passenger kilometres flown and in overall aviation emissions.

173. Witnesses observed that 96% of the UK's aviation emissions came from international, mainly long-haul, flights, and approximately 15% of the UK's population generated over 70% of the UK's international air travel. It was put to us that targeted efforts aimed at convincing the 15% of the population that fly frequently to adopt new behaviour could result in significant emissions reductions.

174. Green Alliance told us that that the best way to lower aviation emissions was for policies to be put in place "to encourage consumers to make more sustainable choices and to reduce flying". Instead of relying on emissions reduction technologies, Green Alliance recommended that measures be taken "to ensure passenger numbers do not exceed 2019 levels in the short term, while there are no ways to reduce emissions from flights at the scale necessary".[139]

Fuel taxation

175. The aviation sector is exempt from both VAT and fuel duty. Possible said this gives the industry little motivation to move away from its cheapest and easiest source of power.[140] Prior to the October 2021 Budget, the Aviation Environment Federation, Tax Justice, Green Alliance and Greenpeace called for excise duties on kerosene and VAT to be applied to airline tickets to accurately reflect aviation's environmental costs. AEF explained to us that the post-Brexit UK-EU air services agreement now permits the UK to tax fuel on routes to EEA countries.[141]

Passenger taxation

176. Airlines pay air passenger duty for each passenger on flights departing from the UK. These costs are usually passed onto passengers. There are currently two bands for APD: one short-haul rate for trips under 2,000 miles, and a long-haul rate for longer trips.

177. In the October 2021 Budget, the Chancellor of the Exchequer announced that the Government was introducing a package of Air Passenger Duty (APD) reforms that are intended to "bolster UK air connectivity" through a 50% reduction in domestic APD and "further align with UK environmental objectives" by adding a new ultra-long-haul distance band.[142] The Government argued that its proposals aligned the tax more closely with its environmental objectives: "[a]irlines ordinarily pass the cost of APD onto the passenger and therefore those passengers who fly more will pay more tax". The reforms were legislated for in the Finance Act 2022 and took effect in April 2023.

139 Green Alliance (ZAS0022)
140 Possible (ZAS0012)
141 Aviation Environment Federation (AEF) (ZAS0043)
142 HM Treasury, *Autumn Budget and Spending Review 2021*, October 2021

A frequent flyer levy

178. Possible had developed a proposal for a frequent flyer levy—a progressive tax which increases per flight someone takes or per mile that they fly. The purpose of the levy, which Possible envisages would replace air passenger duty, is to discourage the frequent flying which, Possible contends, makes up most aviation emissions, and to achieve a more equitable distribution of remaining air miles.

179. Possible told the Committee that a frequent flyer levy was the only fiscal policy measure which was capable of reducing aviation demand in a way which decreased rather than exacerbated existing high levels of inequality in access to flights.[143] Increases to Air Passenger Duty or caps on air traffic movements could disproportionately affect the UK's poorer residents and impact jobs at regional airports. Polling results which Possible presented to us appeared to suggest that the UK public preferred a frequent flyer levy to other policy measures to tackle the climate impacts of air travel.

180. The Aviation Environment Federation proposed further demand management measures that would reduce the carbon impact of aviation:

- Measures to **internalise the carbon cost of flying** into ticket prices, by requiring airlines to invest in the new technology, fuels or carbon removals necessary to achieve annual carbon targets
- **Information** for the public and for aviation consumers about the carbon impact of their fight compared with other transport choices
- Development of a **sustainable tourism policy** that creatively promotes domestic tourism, and that focuses on locations to which the UK can connect using sustainable overload travel when promoting both inbound and outbound tourism.
- An **end to giving rewards for flights such as air miles**. This would require action from the private sector, although the Government could consider additional taxes on the use of air miles to act as a disincentive.
- **Stopping UK airport expansion** to limit environmental harm. The CCC now recommends no 'net' increase in airport capacity: it is of the view that existing aggregate airport capacity can accommodate the limited growth in aviation demand that it foresees, and recommends that there should be no net expansion of UK airport capacity until an airport capacity management framework is in place. In its 2023 annual report the CCC observed that the planned expansion of multiple airports across the UK was in contradiction to this recommendation[144]

181. Other organisations have also called for demand management measures to encourage less flying:

- Research commissioned by WWF in the run up to COP26 showed that of its 22,000 people polled, 89% supported raising flying costs, particularly on frequent fliers.

143 Possible (ZAS0012)
144 Aviation Environment Federation (AEF) (ZAS0043)

- The Campaign for Better Transport has proposed the banning of internal UK flights where an equivalent train journey would take less than five hours. It also wants to see mandatory emissions labels on tickets and a frequent flyer levy.[145]

- Climate Assembly UK members resoundingly rejected a future in which air passenger numbers would rise by as much as 65% between 2018 and 2050, labelling it "counterproductive". 80% 'strongly agreed' or 'agreed' that taxes that increase as people fly more often and as they fly further should be part of how the UK gets to net zero.[146]

Criticism of demand management measures

182. Industry representatives disagreed with the premise that reducing demand for air travel represents the most cost-effective method available for maintaining current emission levels. Sustainable Aviation said:

> What we do in the UK is important but, as demand for aviation grows particularly in new and emerging markets overseas, our efforts have to work in concert with a global push towards a common net zero goal.[147]

183. It noted the importance of aviation for trade:

> It is easy to forget that aviation is not just about enabling holidays - it enables international education and family/ friends to meet, and is a key economic driver for the UK, not least enabling trade with over 40% of the value of our trade outside the EU being flown.[148]

184. Logistics UK said air freight currently accounts for 40% of UK imports and exports by value and is vital for the UK economy. Air freight will always be needed for time-sensitive express deliveries for higher-value products such as car parts and pharmaceuticals.[149] Sustainable Aviation told us that in their view the best option for the UK was "to support the growth of UK aviation within a net carbon ceiling determined by the science".[150]

185. When asked about demand management measures, Chris Young, Chief Engineer at Rolls Royce told the Committee:

> Some of the carbon offsetting schemes and things like that and pricing mechanisms may inevitably have an impact on demand, but I don't think there is any need for additional means.[151]

186. Andy Jefferson, programme director at Sustainable Aviation, said that APD was not "hypothecated to manage the impacts around environment, net zero or anything else".[152] He was wary of raising prices through taxation as he thought that

145 Campaign for Better Transport news release, "Make trains cheaper and ban domestic flights to help tackle climate change", 11 October 2021
146 Climate Assembly UK, *The path to net zero: Climate Assembly UK full report*, September 2020
147 Sustainable Aviation (ZAS0024)
148 *Ibid.*
149 Logistics UK (ZAS0064)
150 Sustainable Aviation (ZAS0024)
151 Q37
152 Q43

> [it is] not fair and equitable. It is not solving the problem and it is probably not helping industry invest in innovation, so it is a triple negative in some regards.[153]

187. On a frequent flyer levy, he said that policymakers must understand the consequences for business and trade in the UK" and cautioned that if only the UK applied it, it would only constrain people's ability to travel in and from the UK.[154]

Advice from the Climate Change Committee

188. The Climate Change Committee has advised that "demand management is the most effective way of reducing aviation CO_2 and non-CO_2 emissions", and has pointed to the options available to Government to manage demand, including promotion of the use of digital technologies, addressing current use of private flying and provision of lower-cost domestic rail travel.[155]

189. In its 'balanced pathway' the CCC envisaged aviation passenger growth by 2037 to be limited to 25% over the level recorded in 2018. Its baseline scenario reflected an assumption of unconstrained growth of around 65% over the same period.[156] Chris Stark, the CCC's chief executive, told us in July 2023 that the Government now expected a 70% growth in passenger numbers by 2050, which was beyond what the CCC had modelled:

> [w]e will have an aviation sector that is too big for the remaining carbon budget that we have in the future if we do not act on the demand side now. We would like to see technology, in similar terms, come through and save the day on aviation, but until it shows signs of doing so, we think it is important to bear down on the growth in demand. We are not suggesting that demand should shrink; we are saying that it should grow by less than the Department and the industry expect it to.[157]

Appearing before the Committee in November 2023 he described aviation as "an undertaxed sector".[158]

The Government's position on demand management measures

190. In the Jet Zero Strategy itself the Government acknowledged arguments in favour of demand management:

> 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

153 Q41
154 Q42
155 Climate Change Committee, *Progress in reducing emissions: 2023 Report to Parliament*, June 2023
156 Climate Change Committee, *The Sixth Carbon Budget: Aviation*, December 2020
157 Q409
158 Oral evidence taken before the Environmental Audit Committee on *Mapping the path to net zero*, HC 276, 22 November 2023, Q473

> 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.[159]

Ministers set out their opposition to the direct use of demand management measures in the Government's response to the Jet Zero consultation. The Government stated that it "remains committed to growth in the aviation sector where it is justified", and argued that

> Our analysis set out in the Jet Zero Strategy shows that the aviation sector can achieve Jet Zero without government needing to intervene directly to limit aviation growth, with scenarios that can achieve our net zero targets by focusing on new fuels and technology, with knock-on economic and social benefits, without limiting demand.[160]

191. The Government has indicated that, under the 'high ambition' scenario which is the basis for the Jet Zero Strategy, residual emissions from UK aviation by 2050 are estimated to be 19.3 MtCO2e, compared to 23 MtCO2e residual emissions in the scenario for aviation presented in the CCC's 'balanced pathway' for the Sixth Carbon Budget. The Government recognises that "to achieve this trajectory we will need to see significant investment in, and uptake of, new technologies and operational processes […] Government is committed to working with the sector to ensure we achieve our aims'.[161]

192. The Government's response to advice from the Climate Change Committee on demand management was in effect given by the Prime Minister on 20 September 2023. In a speech in Downing Street he appeared to set the Government's policy on this issue definitively against the use of the tax system to manage demand for aviation, saying:

> The proposal […] to create new taxes to discourage flying or going on holiday. I've scrapped [that] too.[162]

This position was reiterated in the Government response to the Committee's 2023 progress report:

> [W]e are anti-aviation emissions, not flying, and want to deliver sustainable flying for everyone to enjoy holidays, visit friends and family overseas and to travel for business.[163]

Our view on demand management

193. **Aviation is a sector of the economy where emissions are recognised to be some of the hardest to abate. Under all the scenarios presented for the reduction in emissions from UK domestic and international aviation, it is recognised that there will be residual emissions which will have to be addressed by other means in order for the UK economy to reach net zero by 2050.**

159 Department for Transport, Jet Zero Consultation: Summary of responses and government response, July 2022
160 *Ibid.*
161 *Ibid.*
162 HM Government, PM speech on Net Zero, 20 September 2023
163 HM Government, Responding to the Climate Change Committee's Annual Progress Report 2023 Recommendations, HC 1919, October 2023, para n4.3

194. **There is considerable dispute over the desirability of policy measures which would reduce UK aviation emissions by reducing the demand for aviation services. The Climate Change Committee has been clear that demand management is the most effective way of reducing aviation CO_2 and non-CO_2 emissions, and whilst there are a number of different approaches available for consideration, they have not been subject to formal modelling in the Jet Zero Strategy policy framework.**

195. **We note that UK Ministers have so far ruled out the inclusion of active demand management measures in the Jet Zero Strategy in preference for a policy which promotes the growth of the airline industry following the pandemic. This is beyond the approach proposed by the Climate Change Committee. Although the Jet Zero Strategy commits to 70% passenger demand growth by 2050 on 2018 levels, the CCC's Balanced Pathway for the Sixth Carbon Budget recommends a 25% demand increase over the same period.**

196. **While the Jet Zero Strategy contains measures to influence consumers towards more sustainable choices, and includes carbon pricing measures which will have an indirect effect on demand, it does not include any policy instruments designed to discourage flying in favour of other modes of travel or of communication. Ministers appear confident that the package of measures in the Strategy can achieve the reductions in emissions required from UK aviation, with the residual emissions accounted for by negative emissions technologies.**

197. **While we note the ambition shown by the Government and by the aviation industry in proposing technological methods to reduce aviation emissions, we recognise the very significant challenges for the industry in delivering the required reductions, and note that any additional costs associated with carbon reduction, such as carbon pricing through ETS and Corsia schemes, unless fully absorbed by the sector, could reflected in ticket prices and may have further impacts on overall demand. Further such costs on the sector which limit demand may run the risk of stifling the innovation that the Government and industry strategies rely on, and may skew the international aviation market in favour of more polluting airlines in a way that the multilateral ETS and Corsia schemes are designed to avoid.**

198. **We recognise that the Government's decision, while consistent with a policy of promoting the UK aviation industry, carries a degree of risk. In order to deliver the emissions reductions foreseen, the high ambition scenario in the Jet Zero Strategy needs to be followed through with vigour and conviction and needs to be given the appropriate priority for delivery. Failure to follow through on the ambitions expressed will result in the UK falling behind in its delivery of emissions reductions, leaving other sectors to pick up the slack. Even if the Government maintains its high ambition, there is a risk that the aviation sector will not fulfil the confident predictions it has made for emissions reductions.**

199. **The Climate Change Committee has argued that demand-side measures have an important role to play in ensuring that the aviation sector delivers the necessary emissions reductions and that risks in the current approach are mitigated. That Committee has therefore urged the Government to "develop a suite of policy and technology options" to address aviation demand.**

200. **Ministers have committed to five-yearly reviews of progress against the Jet Zero Strategy's targets, and have undertaken to take action to amend policy if it appears to be necessary. On the current timetable the first such review is to take place in 2027. This appears to us to be a relaxed timetable for policy review at what is a critical stage for an incipient policy. If a review in 2027 concludes that targets are unlikely to be met, the ensuing policy changes will only bear fruit in the early 2030s—arguably too late for the emissions reductions initially envisaged to be achieved.**

201. ***We recommend that an initial review of the Jet Zero Strategy and the modelling underlying its 'high ambition' scenario be undertaken no later than the end of 2025, with a view to determining whether the Strategy remains on track to meet the interim emissions reductions projected for 2030 and 2040 as well as the overall reductions projected for 2050.***

202. ***The review should be undertaken with the active engagement of the UK aviation sector, which is principally responsible for delivering the reductions in emissions it has claimed are possible: any shortfalls in delivery ought to be reviewed and urgently remedied.***

203. ***Should the evidence of the review indicate that technological measures alone will not deliver the emissions reductions predicted, we recommend that Ministers reconsider the role of demand management measures in aviation emissions policy. In preparation for the outcome of that review, we recommend that the Government develop policy proposals on demand reduction, including consideration of greater use of digital technologies, reducing the cost of rail travel, and a frequent flyer levy, should these then be required.***

Conclusions and recommendations

The UK aviation sector and the environment

1. The impact of conventional aviation activity on climate is still not fully quantifiable. While the contribution of aviation to levels of atmospheric CO_2 and other greenhouse gases is quantifiable and substantial, the climate impact of other emissions from aviation is currently not well understood and difficult to quantify. Measures to decarbonise the sector are vital: but removing carbon dioxide from aviation activity is unlikely to eliminate its overall impact on the environment. The Government has acknowledged the contribution of non-CO2 effects from aviation in the development of its strategy for decarbonising aviation, and is examining methods of mitigating non-CO2 effects from aviation which uses fuels which have a reduced carbon footprint. (Paragraph 30)

2. *We consider that any strategy designed to reduce the impact of UK aviation activity on global warming ought to encompass the environmental effects of aviation in their entirety. We therefore recommend that the Government actively commission, promote and support research into the total environmental effects of aviation, with a view to incorporating the emerging consensus into all future iterations of its strategy for net zero aviation.* (Paragraph 31)

Aviation emissions in the UK's carbon budgets

3. The Government's decision to include international aviation emissions in the UK's budgets with effect from the Sixth Carbon Budget has sent a very positive signal about the UK's resolve to address carbon emissions from UK aviation by the use of policy instruments. Establishing a requirement to bring aviation emissions within the Sixth Carbon Budget target by 2037, rather than leaving budgetary headroom for them as in previous budgets, removes ambiguities around the issue and obliges the Government to address the complexities around accounting for the UK's share of international aviation emissions. (Paragraph 49)

4. We are nevertheless concerned that legislation to give effect to this commitment has not been brought forward for approval by Parliament, over two and a half years since the commitment was originally made and over two years since the Government promised to legislate "within twelve months". (Paragraph 50)

5. *We recommend that the Government lay before Parliament for approval, without further delay, a draft statutory instrument under section 30 of the Climate Change Act 2008 to define the emissions from international aviation and international shipping which are to be reckoned as emissions from sources in the United Kingdom.* (Paragraph 51)

6. The outputs from the modelling undertaken by the Climate Change Committee, the Government and Sustainable Aviation vary as to the projections of likely emissions reductions from UK aviation by 2050. In some instances these variations are substantial, and tend to reduce overall confidence in the reliability of the projections from each source. (Paragraph 52)

7. *We recommend that the Government work with the Climate Change Committee and Sustainable Aviation on a comparative analysis of the models underpinning the projections for UK aircraft emissions, so as to reach consensus, as far as possible, on the likely impact of measures to be taken by industry and by Government on levels of emissions from UK aviation out to 2050.* (Paragraph 53)

'Jet Zero'—the UK Government's strategy for net zero aviation

8. There is evidently significant potential for increased efficiencies across all aviation's operations which can lead to incremental reductions in CO2 emissions across the UK aviation sector. Efficiencies from fuel use in the current and emergent fleet of aircraft, better use of airspace and reductions in emissions from airport and aviation operations will all have a significant part to play in aviation's contribution to reaching net zero. (Paragraph 76)

9. We agree with the Climate Change Committee that the 0.5% year-on-year improvement in fuel efficiency from the aircraft fleet requires considerable effort both in research and development activity and in incentivising the industry to renew existing aircraft fleets. (Paragraph 77)

10. *We recommend that the Government sustain and enhance its engagement with the aviation industry on the delivery of operational efficiencies from current and future fleets of aircraft operating through the UK, to maintain the ambition to secure 2% year-on-year CO2 emissions reductions from fuel and operational efficiencies. The delivery of these reductions must be rigorously monitored against an established baseline: should the rate of progress in reductions fall behind 2%, the potential contribution of system efficiencies to meeting the 2050 net zero target must be urgently reassessed.* (Paragraph 78)

11. *We recommend that the Department for Transport and the Civil Aviation Authority intensify their work on airspace modernisation, bearing in mind the overarching principle of environmental sustainability.* (Paragraph 79)

12. We support the Government's aim to secure net zero in UK airport operations by 2040. Detailed policy measures to achieve this aim have not yet been implemented, and we look forward to publication of the Government's findings following the call for evidence. Decarbonisation of UK airports will require a substantial increase in electrification. We plan to examine broader issues about sustainable electricity supply to major elements of the UK's infrastructure, such as airports, in our current inquiry into *Enabling sustainable electrification of the UK economy.* (Paragraph 80)

13. Sustainable aviation fuels may offer a means of reducing the carbon emissions attributable to the lifecycle of aviation kerosene from its production to its combustion, and the Government envisions a substantial role for SAFs. There is nevertheless potential for wide variability in lifecycle emissions across the general class of fuels which the industry currently terms 'sustainable aviation fuels'. We note that the Climate Change Committee warned in its 2023 Progress Report to Parliament that the Jet Zero Strategy approach is "high risk due to its reliance on nascent technology", such as the rapid uptake of these fuels. (Paragraph 109)

14. We welcome the initiatives taken by the Government to date to establish a domestic industry for the manufacture of sustainable aviation fuels, and the steps it is taking to build long-term supply chains for domestic and international aviation. We note the measures announced to date on the establishment in 2025 of a mandate for SAF use. We will monitor the outcome of the Government's second consultation on the issue and the drafting of the secondary legislation required to implement the mandate. (Paragraph 110)

15. We are concerned that the broad definition of what is currently considered a sustainable fuel, and the absence of a global standard for SAFs, may lead to the development of aviation fuels which cannot credibly be described as sustainable. *We recommend that the Government take every opportunity to establish in its policy instruments for a UK SAF industry the strongest safeguards to ensure significant lifecycle emissions savings from the use of SAFs developed in the UK.* (Paragraph 111)

16. We note with approval the Government's criteria restricting the feedstocks to be used in UK-manufactured SAF and specifying that feedstocks are not to be obtained from land with high biodiversity value or land with high carbon stocks. *We recommend that in its forthcoming Land Use Strategy the Government establish clear and unambiguous criteria as to the type of land which is to be allocated to growing feedstocks for SAF. The Government must also take every opportunity in international forums to press for the highest standards of sustainability in the production of SAF feedstocks.* (Paragraph 112)

17. *We further recommend that Ministers and officials work vigorously at the ICAO and in all other relevant international bodies for the establishment of a global regulatory standard for SAFs which is comprehensive and rigorous.* (Paragraph 113)

18. We welcome the establishment of an UK SAF Clearing House at the University of Sheffield to support SAF producers through the process of certification and approval of their products for commercial use. (Paragraph 114)

19. The Government must match its ambition for the development of a domestic SAF industry with an appropriate appetite for risk and innovation in order to ensure that commercial production of truly sustainable fuels develops at pace. The introduction of a revenue certainty mechanism, via provision in the Energy Act 2023, represents a welcome initial step in this process. To this end, *we recommend that the Government make swift progress on the implementation of a price support mechanism to incentivise investment for SAF production pathways.* (Paragraph 115)

20. Zero-emission flight represents a very promising long-term prospect for achieving reductions in the CO2 emissions from UK aviation. Unlike the use of SAF, zero-emission flight technologies hold out the promise of eliminating the carbon emissions entailed in aircraft movements. We are encouraged by the significant contributions to research and development in this sector which are being undertaken by UK-based firms supported by the Government and industry through the Aviation Technology Institute. (Paragraph 142)

21. While zero-emission flight technologies offer a route to significant reductions in aviation's CO2 emissions, their deployment is realistically likely to be limited to short-haul flights for the foreseeable future. ZEF can play a significant role in

promoting aviation as a means of connecting the UK, particularly on public service obligation routes between the UK mainland and island communities. *We recommend that the Government establish a target under the Jet Zero Strategy for the full roll-out of zero-emission aircraft on a minimum number of routes essential to UK connectivity by 2040, with a view to encouraging the greater takeup of ZEF aircraft on commercially-operated short haul routes within the UK.* (Paragraph 143)

22. Zero-emission flight is sometimes described as providing 'guilt-free' flying. While it is the case that ZEF technologies remove the CO2 emissions from conventional aircraft movements which are aviation's most damaging effect on the environment, the potential effects on the atmosphere from both hydrogen and battery-electric flight are not fully known. *We recommend that the Government, when promoting research into the non-CO2 effects of aviation, include in its strategy the funding of research into the effects on the atmosphere and climate of aircraft using zero-emission flight technologies.* (Paragraph 144)

23. Requiring airlines to set a price on their emissions, and purchase credits for these emissions through a trading scheme, can be a constructive mechanism to ensure that the carbon cost of aviation is more adequately reflected in the cost to the consumer. This in itself may influence consumer demand for flights, depending on the availability and cost of the necessary carbon credits. Sustainable Aviation has categorised market-based measures as demand management mechanisms. (Paragraph 158)

24. We welcome the decision of the UK Government and devolved administrations to end the issuing of free ETS allocations to aviation with effect from the 2026–2030 allocation period. We note that the use of SAF in aviation is currently zero-rated for ETS, even though the emissions from burning SAF in flight are currently equivalent to those from burning aviation kerosene: as the SAF market matures, consideration must be given to pricing SAF in the ETS at a level which genuinely reflects its carbon impact. (Paragraph 159)

25. *We recommend that the Government implement its proposed changes to the UK ETS so as to remove conventional aviation fuel from free allocations, and that it consult on a methodology to include SAF in the ETS in a way which does not inhibit the development and use of SAF in UK aviation.* (Paragraph 160)

26. Offsetting mechanisms, such as CORSIA, may provide an interim step towards contributing to the removal from the atmosphere of the emissions attributable to UK aviation. We commend the Government on the work it has already undertaken at international level to secure an agreement on an international offsetting mechanism. More remains to be done, and the use of offsets to address aviation emissions is at best a stopgap measure until more effective and high-quality technologies to achieve permanent greenhouse gas removals are available. (Paragraph 161)

Closing the aviation emissions gap

27. Aviation is a sector of the economy where emissions are recognised to be some of the hardest to abate. Under all the scenarios presented for the reduction in emissions from UK domestic and international aviation, it is recognised that there will be residual emissions which will have to be addressed by other means in order for the UK economy to reach net zero by 2050. (Paragraph 193)

28. There is considerable dispute over the desirability of policy measures which would reduce UK aviation emissions by reducing the demand for aviation services. The Climate Change Committee has been clear that demand management is the most effective way of reducing aviation CO2 and non-CO2 emissions, and whilst there are a number of different approaches available for consideration, they have not been subject to formal modelling in the Jet Zero Strategy policy framework. (Paragraph 194)

29. We note that UK Ministers have so far ruled out the inclusion of active demand management measures in the Jet Zero Strategy in preference for a policy which promotes the growth of the airline industry following the pandemic. This is beyond the approach proposed by the Climate Change Committee. Although the Jet Zero Strategy commits to 70% passenger demand growth by 2050 on 2018 levels, the CCC's Balanced Pathway for the Sixth Carbon Budget recommends a 25% demand increase over the same period. (Paragraph 195)

30. While the Jet Zero Strategy contains measures to influence consumers towards more sustainable choices, and includes carbon pricing measures which will have an indirect effect on demand, it does not include any policy instruments designed to discourage flying in favour of other modes of travel or of communication. Ministers appear confident that the package of measures in the Strategy can achieve the reductions in emissions required from UK aviation, with the residual emissions accounted for by negative emissions technologies. (Paragraph 196)

31. While we note the ambition shown by the Government and by the aviation industry in proposing technological methods to reduce aviation emissions, we recognise the very significant challenges for the industry in delivering the required reductions, and note that any additional costs associated with carbon reduction, such as carbon pricing through ETS and Corsia schemes, unless fully absorbed by the sector, could reflected in ticket prices and may have further impacts on overall demand. Further such costs on the sector which limit demand may run the risk of stifling the innovation that the Government and industry strategies rely on, and may skew the international aviation market in favour of more polluting airlines in a way that the multilateral ETS and Corsia schemes are designed to avoid. (Paragraph 197)

32. We recognise that the Government's decision, while consistent with a policy of promoting the UK aviation industry, carries a degree of risk. In order to deliver the emissions reductions foreseen, the high ambition scenario in the Jet Zero Strategy needs to be followed through with vigour and conviction and needs to be given the appropriate priority for delivery. Failure to follow through on the ambitions expressed will result in the UK falling behind in its delivery of emissions reductions,

leaving other sectors to pick up the slack. Even if the Government maintains its high ambition, there is a risk that the aviation sector will not fulfil the confident predictions it has made for emissions reductions. (Paragraph 198)

33. The Climate Change Committee has argued that demand-side measures have an important role to play in ensuring that the aviation sector delivers the necessary emissions reductions and that risks in the current approach are mitigated. That Committee has therefore urged the Government to "develop a suite of policy and technology options" to address aviation demand. (Paragraph 199)

34. Ministers have committed to five-yearly reviews of progress against the Jet Zero Strategy's targets, and have undertaken to take action to amend policy if it appears to be necessary. On the current timetable the first such review is to take place in 2027. This appears to us to be a relaxed timetable for policy review at what is a critical stage for an incipient policy. If a review in 2027 concludes that targets are unlikely to be met, the ensuing policy changes will only bear fruit in the early 2030s—arguably too late for the emissions reductions initially envisaged to be achieved. (Paragraph 200)

35. *We recommend that an initial review of the Jet Zero Strategy and the modelling underlying its 'high ambition' scenario be undertaken no later than the end of 2025, with a view to determining whether the Strategy remains on track to meet the interim emissions reductions projected for 2030 and 2040 as well as the overall reductions projected for 2050.* (Paragraph 201)

36. *The review should be undertaken with the active engagement of the UK aviation sector, which is principally responsible for delivering the reductions in emissions it has claimed are possible: any shortfalls in delivery ought to be reviewed and urgently remedied.* (Paragraph 202)

37. *Should the evidence of the review indicate that technological measures alone will not deliver the emissions reductions predicted, we recommend that Ministers reconsider the role of demand management measures in aviation emissions policy. In preparation for the outcome of that review, we recommend that the Government develop policy proposals on demand reduction, including consideration of greater use of digital technologies, reducing the cost of rail travel, and a frequent flyer levy, should these then be required.* (Paragraph 203)

Formal minutes

The following declarations of interest relating to the inquiry were made:

27 October 2021

Philip Dunne declared the following pecuniary interest: Non-Executive Director of Reaction Engines Ltd (engineering technology developer), Building F5, Culham Science Centre, Abingdon OX14 3DB. From 24 July 2021 until further notice, I receive £3,400 a month.

James Gray declared the following non-pecuniary interests: honorary life member of the Baltic Exchange, and a Younger Brother in the Fraternity of Trinity House.

17 November 2021

Philip Dunne declared the following pecuniary interest: Non-Executive Director of Reaction Engines Ltd (engineering technology developer), Building F5, Culham Science Centre, Abingdon OX14 3DB, which, since his declaration of 27 October 2021, had formed a joint venture technology company with partners including the Science and Technology Facilities Council to develop ammonia technologies for use in hard to decarbonise sectors; and declared that he would take no further part in the inquiry.

Monday 18 December 2023

Members present

Duncan Baker

Barry Gardiner

Ian Levy

Caroline Lucas

Jerome Mayhew

Cherilyn Mackrory

[…]

In the absence of the Chair, Jerome Mayhew was called to the chair.

The Committee deliberated.

Draft Report (*Net zero and the UK aviation sector*), proposed by Jerome Mayhew, brought up and read.

Paragraphs 1 to 194 read and agreed to.

Paragraph 195 read.

Amendment proposed, in line 1, to leave out from "UK Ministers" to "the pandemic" in line 3 and insert "It is extremely concerning that UK Ministers have ruled out the inclusion of active demand management measures in the Jet Zero Strategy in preference for a policy which promotes the growth of the airline industry following the pandemic, which is far beyond that proposed by the Climate Change Committee. Although the Jet Zero Strategy commits to 70% passenger demand growth by 2050 on 2018 levels, the CCC's Balanced Pathway for the Sixth Carbon Budget recommends a 25% demand increase over the same period. The Climate Change Committee are also clear that existing aggregate airport capacity can accommodate the limited growth in aviation demand they foresee, and that there should be no net expansion of UK airport capacity until an airport capacity management framework is in place. The planned expansion of multiple airports across the UK is in contradiction to this recommendation." —(Caroline Lucas.)

Question put, That the Amendment be made.

The Committee divided.

Ayes, 1	**Noes, 3**
Caroline Lucas	Duncan Baker Ian Levy Cherilyn Mackrory

Question accordingly negatived.

Paragraph amended, divided and agreed to (now paragraphs 195 and 196).

Paragraph 196 (now paragraph 197) read, as follows:

"While we appreciate the ambition shown by the Government and by the aviation industry in proposing technological methods to reduce aviation emissions, we recognise the very significant challenges for the industry in delivering the required reductions. The additional costs associated with carbon reduction, such as carbon pricing through ETS and Corsia schemes, will, unless fully absorbed by the sector, be reflected in ticket prices and will have further impacts on overall demand. Imposing further costs on the sector by limiting demand may run the risk of stifling the innovation that the Government and industry strategies rely on, and may skew the international aviation market in favour of more polluting airlines in a way that the multilateral ETS and Corsia schemes are designed to avoid."

Motion made and Question put, to leave out paragraph 196 (now paragraph 197).—(Caroline Lucas.)

The Committee divided.

Ayes, 1	Noes, 3
Caroline Lucas	Duncan Baker Ian Levy Cherilyn Mackrory

Question accordingly negatived.

Motion made, to leave out paragraph 196 (now paragraph 197) and insert the following new paragraph:

"While we note the ambition shown by the Government and by the aviation industry in proposing technological methods to reduce aviation emissions, we recognise the very significant challenges for the industry in delivering the required reductions, and note that any additional costs associated with carbon reduction, such as carbon pricing through ETS and Corsia schemes, unless fully absorbed by the sector, could be reflected in ticket prices and may have further impacts on overall demand. Further such costs on the sector which limit demand may run the risk of stifling the innovation that the Government and industry strategies rely on, and may skew the international aviation market in favour of more polluting airlines in a way that the multilateral ETS and Corsia schemes are designed to avoid."—(Cherilyn Mackrory.)

Question put, That the new paragraph be read a second time.

The Committee divided.

Ayes, 3	Noes, 1
Duncan Baker Ian Levy Cherilyn Mackrory	Caroline Lucas

Question accordingly agreed to.

Paragraph agreed to.

Paragraph 197 (now paragraph 198) read.

Amendment proposed, in line 2, to leave out from "carries" to end and add "carries "considerable risks in relation to the aviation sector's contribution to emissions abatement for the Sixth Carbon Budget" according to the Climate Change Committee. Demand-side measures have an important role to play in ensuring that the aviation sector delivers the necessary emissions reductions and that risks in the current approach are mitigated. The Climate Change Committee has therefore urged the Government to "develop a suite of policy and technology options" to address aviation demand.".—(Caroline Lucas.)

Question put, That the Amendment be made.

The Committee divided.

Ayes, 1	Noes, 3
Caroline Lucas	Duncan Baker Ian Levy Cherilyn Mackrory

Question accordingly negatived.

Paragraph agreed to.

Paragraph—(Caroline Lucas)—brought up, read the first and second time, and inserted (now paragraph 199).

Paragraphs 198 to 200 (now paragraphs 200 to 202) read and agreed to.

Paragraph 201 (now paragraph 203) read, amended and agreed to.

Paragraph—(Caroline Lucas)—brought up and read, as follows:

"We recommend that the Government heeds the advice of the Climate Change Committee and urgently produces an airport capacity management framework and halts any airport expansion until this is in place. As the Climate Change Committee make clear, expansion should only continue if the carbon-intensity of the aviation sector is outperforming the Government's aviation emissions trajectory."

Question put, That the paragraph be read a second time.

The Committee divided.

Ayes, 1	Noes, 3
Caroline Lucas	Duncan Baker Ian Levy Cherilyn Mackrory

Question accordingly negatived.

Motion made and Question put, That the Report be the Third Report of the Committee to the House.

The Committee divided.

Ayes, 4	Noes, 1
Duncan Baker Barry Gardiner Ian Levy Cherilyn Mackrory	Caroline Lucas

Question accordingly agreed to.

Resolved, That the Report be the Third Report of the Committee to the House.

Ordered, That Jerome Mayhew make the Report to the House.

[…]

Adjournment

Adjourned till Wednesday 10 January 2024 at 2.00 pm.

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website.

Wednesday 27 October 2021

Dr Andy Jefferson, Programme Director, Sustainable Aviation; **Dr Chika Miyoshi**, Reader in Environmental Systems for Aerospace, Cranfield University; **Chris Young**, Group Chief Engineer, Rolls-Royce — Q1–45

Simon Bullock, Research Associate, Tyndall Centre for Climate Change Research, University of Manchester; **Sarah Kenny**, Chair, Maritime UK; **Anna Ziou**, Policy Director, UK Chamber of Shipping — Q46–80

Wednesday 1 December 2021

Matt Gorman, Director of Carbon Strategy, Heathrow Airport; **Glenn Llewellyn**, Vice President, Zero Emission Aircraft, Airbus; **Val Miftakhov**, Founder & CEO, ZeroAvia; **Hannah Tew**, Director of Air Mobility, Connected Places Catapult — Q81–129

Leo Murray, Director of Innovation, Possible; **Tim Johnson**, Director, Aviation Environment Federation — Q130–169

Wednesday 26 January 2022

Mike McCartain, Group Director of Safety, Marine and Engineering, Associated British Ports; **Guy Platten**, Secretary General, International Chamber of Shipping; **Dr Tristan Smith**, Reader in Energy and Shipping, UCL Energy Institute — Q170–215

Alex Clark, Researcher, Smith School of Enterprise and Environment, University of Oxford; **Katharine Palmer**, Global Head of Sustainability, Lloyd's Register, High-Level Climate Champion's Shipping Lead, United Nations; **Michael Parker**, Chairman, Global Shipping, Logistics & Offshore, Citi — Q216–253

Wednesday 30 March 2022

Helena Bennett, Senior Policy Adviser, Green Alliance; **Andy Cornell**, Representative, Renewable Transport Fuel Association, CEO, Advanced Biofuel Solutions; **Dr Neville Hargreaves**, Vice President, Waste to Fuels, Velocys; **Paddy Lowe**, Founder and CEO, Zero Petroleum — Q254–293

Jonathon Counsell, Group Head of Sustainability, International Airlines Group; **Mr Jonathan Hinkles**, Chief Executive, Loganair; **Hemant Mistry**, Director of Energy Transition, International Air Transport Association; **David Morgan**, Director of Flight Operations, easyJet — Q294–336

Wednesday 18 May 2022

Emma Gilthorpe, CEO, Jet Zero Council; **Sophie Lane**, Chief Relationships Officer, Aerospace Technology Institute — Q337–360

Robert Courts MP, Parliamentary Under-Secretary of State, Department for Transport; **Eamonn Beirne**, Deputy Director: Maritime Environment, Technology and International, Department for Transport; **Holly Greig**, Deputy Director: Aviation Decarbonisation Division, Department for Transport; **Lee Rowley MP**, Parliamentary Under-Secretary of State (Minister for Industry), Department for Business, Energy and Industrial Strategy; **Paul Griffiths**, Head of Aerospace Team, Department for Business, Energy and Industrial Strategy Q361–429

Published written evidence

The following written evidence was received and can be viewed on the inquiry publications page of the Committee's website.

ZAS numbers are generated by the evidence processing system and so may not be complete.

1 ADS Group Ltd (ZAS0018)
2 Aerospace Technology Institute (ZAS0044)
3 Airbus (ZAS0052)
4 Airlines UK (ZAS0017)
5 Airport Operators Association (ZAS0055)
6 Associated British Ports (ZAS0061)
7 Aviation Environment Federation (AEF) (ZAS0043)
8 BRULIC Ltd (ZAS0003)
9 Ballard Power Systems Europe A/S (ZAS0020)
10 Blakey, Dr Simon (Senior Lecturer, University of Birmingham) (ZAS0027)
11 Bristol Airport (ZAS0054)
12 Buss, Dr Grahame (ZAS0019)
13 Carbon Capture and Storage Association (ZAS0034)
14 Carbon Engineering (ZAS0026)
15 Connected Places Catapult (ZAS0069)
16 Cranfield University (ZAS0065)
17 Department for Transport (ZAS0073)
18 Department for Transport (supplementary memorandum) (ZAS0053)
19 E.A. Gibson Shipbrokers Ltd (ZAS0008)
20 GKN Aerospace Services Ltd (ZAS0062)
21 Green Alliance (ZAS0022)
22 HACAN (Heathrow Association for the Control of Aircraft Noise) (ZAS0004)
23 Heathrow Airport Limited (ZAS0048)
24 HyPulJet Ltd (ZAS0001)
25 International Air Transport Association (ZAS0051)
26 International Chamber of Shipping (ZAS0068)
27 International Consolidated Airlines Group (IAG) (ZAS0035)
28 Liquid Gas UK (ZAS0005)
29 Loganair Limited (ZAS0072)
30 Logistics UK (ZAS0064)
31 London Luton Airport (ZAS0057)
32 Magway Limited (ZAS0029)
33 Manchester Airport Group (ZAS0010)

34 Met Office (ZAS0030)

35 NATS (ZAS0058)

36 No 3rd Runway Coalition (ZAS0013)

37 Nuclear Industry Association (ZAS0028)

38 Pinks, Captain Melbourne (ZAS0002)

39 Possible (ZAS0012)

40 Prospect (ZAS0033)

41 Rae, Mr Anthony (ZAS0046)

42 Reaction Engines (ZAS0036)

43 Richmond Heathrow Campaign (ZAS0049)

44 Rolls-Royce (ZAS0056)

45 Royal Aeronautical Society (ZAS0023)

46 Royal Institution of Naval Architects (ZAS0059)

47 Safe Landing (ZAS0039)

48 Shell UK Ltd (ZAS0015)

49 Society of Maritime Industries (ZAS0050)

50 Southampton Marine and Maritime Institute, University of Southampton (ZAS0063)

51 Stansted Airport Watch (ZAS0047)

52 Stephenson Harwood LLP; and Napa Oy (ZAS0070)

53 Straightline Aviation (ZAS0071)

54 Sustainable Aviation (ZAS0024)

55 The European Marine Energy Centre Ltd (EMEC); Orcades Marine; Highlands and Islands Airports Limited (HIAL) – Kirkwall Airport; Loganair; Northlink Ferries; and Orkney Islands Council (ZAS0006)

56 The Manufacturing Technology Centre (ZAS0009)

57 The National Oceanography Centre (ZAS0007)

58 The Tyndall Centre for Climate Change Research (ZAS0066)

59 Transport & Environment (ZAS0038)

60 Tyndall Manchester (ZAS0041)

61 UCL Energy Institute; Decarbonising UK Freight Transport; Centre for Research into Energy Demand Solutions; and UMAS (ZAS0042)

62 UK Chamber of Shipping (ZAS0032)

63 UK Civil Aviation Authority (ZAS0060)

64 UK2070 Commission (ZAS0011)

65 University of Oxford (ZAS0037)

66 Velocys (ZAS0021)

67 Victor (ZAS0067)

68 West London Friends of the Earth (ZAS0045)

69 Wrexham Glyndwr University (ZAS0014)

70 Wärtsilä Voyage (ZAS0025)

71 ZeroAvia (ZAS0040)

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website.

Session 2023–24

Number	Title	Reference
1st	The financial sector and the UK's net zero transition	HC 277
2nd	Environmental change and food security	HC 312
1st Special Report	Seeing the wood for the trees: the contribution of the forestry and timber sectors to biodiversity and net zero goals: Government Response to the Committee's Fifth Report of Session 2022–23	HC 406

Session 2022–23

Number	Title	Reference
1st	Building to net zero: costing carbon in construction	HC 103
2nd	Pre-appointment hearing: Chair of the Environment Agency (Pre-appointment hearing)	HC 546
3rd	Recommendations on the Government's draft environmental principles policy statement	HC 380
4th	Accelerating the transition from fossil fuels and securing energy supplies	HC 109
5th	Seeing the wood for the trees: the contribution of the forestry and timber sectors to biodiversity and net zero goals	HC 637
6th	The UK and the Arctic Environment	HC 1141
1st Special Report	Water quality in rivers: Government Response to the Committee's Fourth Report of Session 2021–22	HC 164
2nd Special Report	Greening imports: a UK carbon border approach: Government Response to the Committee's Fifth Report of Session 2021–22	HC 371
3rd Special Report	Building to net zero: costing carbon in construction: Government Response to the Committee's First Report	HC 643
4th Special Report	Accelerating the transition from fossil fuels and securing energy supplies: Government and Regulator Response to the Committee's Fourth Report	HC 1221

Session 2021–22

Number	Title	Reference
1st	Biodiversity in the UK: bloom or bust?	HC 136
2nd	The UK's footprint on global biodiversity	HC 674
3rd	Green Jobs	HC 75
4th	Water quality in rivers	HC 74
5th	Greening imports: a UK carbon border approach	HC 737
1st Special Report	Energy efficiency of existing homes: Government Response to the Committee's Fourth Report of Session 2019–21	HC 135
2nd Special Report	Growing back better: putting nature and net zero at the heart of the economic recovery: Government and Bank of England Responses to the Committee's Third Report of Session 2019–21	HC 327
3rd Special Report	Biodiversity in the UK: bloom or bust?: Government Response to the Committee's First Report	HC 727
4th Special Report	Green Jobs: Government Response to the Committee's Third Report	HC 1010
5th Special Report	The UK's footprint on global biodiversity: Government Response to the Committee's Second Report	HC 1060

Session 2019–21

Number	Title	Reference
1st	Electronic Waste and the Circular Economy	HC 220
2nd	Pre-appointment hearing for the Chair-Designate of the Office for Environmental Protection (OEP)	HC 1042
3rd	Growing back better: putting nature and net zero at the heart of the economic recovery	HC 347
4th	Energy Efficiency of Existing Homes	HC 346
1st Special Report	Invasive species: Government Response to the Committee's First report of Session 2019	HC 332
2nd Special Report	Our Planet, Our Health: Government Response to the Committee's Twenty-First Report of Session 2017–19	HC 467
3rd Special Report	Electronic Waste and the Circular Economy: Government Response to the Committee's First Report	HC 1268