SSE Briefing Note on Planning Application UTT/18/0460/FUL

Material Considerations: Carbon Emissions/Climate Change

1. There is no more material issue for today's decision makers than the existential threat of climate change. The past 12 months have (again) witnessed record global temperatures, a further increase in extreme weather events, and a growing realisation that climate change poses a threat not only to future generations but also to the present generation.

2. Carbon dioxide (CO_2) emissions are the main contributor to climate change and the largest single source of CO_2 emissions in the East of England is Stansted Airport. Using the figures provided by Stansted Airport Ltd ('STAL') in the Environmental Statement for Planning Application UTT/18/0460/FUL, if expansion to 43 million passengers per annum ('mppa') were to be approved, Stansted's CO_2 emissions would increase **by 60% to 2.50 million tonnes** ('Mt') in 2028[1] compared to the 2016 base year.

3. Officers have in the past advised the Planning Committee to disregard the increase in Stansted Airport CO_2 emissions on the basis that the Department for Transport ('DfT') has allowed for these and is satisfied that UK airports can expand to make best use of their existing runways without breaching the objective of keeping UK aviation emissions to 37.5Mt by 2050[2].

4. Since November 2018, however, a number of new material factors have emerged, including:

   4.1. In December 2018, the DfT published its long-awaited Green Paper: *'Aviation 2050: The future of UK aviation'* and, in February 2019, the Committee on Climate Change ('CCC')[3], formally responded to the DfT Green Paper (see Annex B), stating as follows:

   > *"The UK's currently legislated 2050 target is to reduce economy-wide greenhouse gas emissions by at least 80% from 1990 levels.* ***Since the Climate Change Act became law, the UK has ratified the Paris Agreement, implying even stronger action. You will be aware that my Committee has been asked by Ministers to offer advice on the implications of the Paris Agreement for the UK's statutory framework, including when 'net-zero' emissions can be achieved. A stronger UK target would require more effort from all sectors, including aviation. We intend to provide an updated view on the appropriate long-term ambition for aviation emissions within our advice on the UK's long-term targets. We will publish our report in spring. Following that, we will write to you directly to set out the implications for the Aviation Strategy.***
   >
   > *Our present planning assumption, which underpins the fifth carbon budget and the current 2050 target, is that UK aviation emissions in 2050 should be around their 2005 level (i.e. 37.5 MtCO_2e). Your acceptance of this planning assumption in the consultation is a very welcome step. The final white paper should further clarify that this will be met on the basis of actual emissions, rather than by relying on international offset credits.*
   >
   > *Aviation emissions in the UK have more than doubled since 1990, while emissions for the economy as a whole have fallen by around 40%. Achieving aviation emissions at or below 2005 levels in 2050 will require contributions*

[1] STAL Environmental Statement for Planning Application UTT/18/0460/FUL, Volume 1, Table 12.11.
[2] See Annex A: *'Beyond the Horizon: making best use of existing runways'*, Jun 2018, para 1.11 & Tables 1, 2, 3 & 4.
[3] The Climate Change Act 2008 established the CCC as an independent advisory body to the Government.

from all parts of the aviation sector, including from new technologies and aircraft designs, improved airspace management, airlines' operations, and use of sustainable fuels. ***It will also require steps to limit growth in demand. In the absence of a true zero-carbon plane, demand cannot continue to grow unfettered over the long-term."*** [4] [emphasis added]

4.2. In June 2019, in the light of the Paris Agreement[5] and the advice from the CCC, Section 1 of the Climate Change Act 2008 was amended to require the Government to reduce UK greenhouse gas ('GHG') emissions **by 100% by 2050**[6] compared to the original requirement to achieve an 80% reduction by 2050. The new target, known as "net zero", constitutes a **legally binding commitment** to end the UK's contribution to climate change by 2050.

4.3. In September 2019, in the light of the new "net zero" statutory target, the CCC provided further advice to the Government (see Annex C), including the following:

"– Aviation emissions could be reduced by around 20% from today to 2050 through improvements to fuel efficiency, some use of sustainable biofuels, ***and by limiting demand growth to at most 25% above current levels.*** *This is likely to be cost-saving. There is potential to reduce emissions further with lower levels of demand.*

– Novel fuels (e.g. synthetic carbon-neutral kerosene, algal biofuels) could allow greater reductions, but their development is highly speculative and should not be relied upon.

– ***The Government should assess its airport capacity strategy in this context****. Specifically, investments will need to be demonstrated to make economic sense in a net-zero world and the transition towards it."* [7] [emphasis added]

4.4. Also, in September 2019, the DfT announced that it would postpone publication of the new Aviation White Paper from late 2019 to early 2020 to allow time for the latest CCC advice to be addressed.

4.5. Over the past 12+ months, pursuant to its duty of candour in connection with SSE's Judicial Review ('JR') challenge, the Secretary of State for Transport has made a number of disclosures to SSE including the basis upon which the Department for Transport (DfT) concluded that UK aviation CO_2 emissions could be kept to 37.5MtCO_2 by 2050. The DfT's assumptions for Stansted are summarised in the table below and provided in more detail at Annex D.

Table 1: DfT Assumptions for Stansted

	2028	***2050***
Passengers (m)	22.3	35.5
ATMs	148,000	204,000
CO_2 emissions	1.37Mt	1.64Mt

Source: DfT Disclosures to SSE. The equivalent data for UK aviation as a whole is provided in Annex A, i.e. 'Beyond the Horizon: making best use of existing runways', DfT, Jun 2018, Tables 1, 2 and 3.

[4] The CCC letter of February 2019 is at Annex B.
[5] The aim of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2^0C and pursue efforts to limit the temperature increase even further to 1.5^0C. This goes beyond any previous international agreement aimed at tackling climate change and, as at August 2019, 196 nations plus the EU, have signed the Paris Agreement and 183 nations and the EU have ratified it.
[6] Compared to 1990 levels.
[7] The CCC letter of September 2019 is at Annex C.

5. By comparison with the DfT's assumptions, STAL has assumed that, if the application were to be approved, Stansted's CO_2 emissions would increase to 2.50Mt in 2028[8]. **This is 82% above the 1.37Mt allowed for by the DfT** (as shown in the above table). For 2050, the DfT has assumed that Stansted's CO_2 emissions will be 1.64Mt but this is based on Stansted handling 204,000 ATMs. Planning Application UTT/18/0460/FUL seeks approval for 274,000 ATMs and there is an emphasis on expanding Stansted's long haul routes which, obviously, are more carbon intensive per ATM. The likely out-turn is therefore that Stansted's CO_2 emissions in 2050 would be **at least 34% above the 1.64Mt allowed for by the DfT**[9].

6. The DfT's stated position is that it is unnecessary for a local planning authority ('LPA') to consider the increase in CO_2 emissions for individual airport planning applications because provision has already been made for these. That would be an entirely reasonable position in circumstances where the DfT had actually made adequate provision for the level of additional CO_2 emissions which would ensue from approval of Planning Application UTT/18/0460/FUL. However, it is clear beyond doubt that **the DfT has not made adequate provision**.

7. SSE's JR challenge, scheduled for a High Court hearing from 12th to 14th November, will seek a judgment on the above issue. In the meantime, the Court of Appeal is currently hearing a wider case relating to the Secretary of State's decision to support the development of a third runway at Heathrow. The main case is being brought by the London Boroughs of Hillingdon, Wandsworth, Richmond-Upon-Thames, Hammersmith & Fulham, the Royal Borough of Windsor & Maidenhead, and Greenpeace Ltd.

8. In the Heathrow case the Secretary of State faces a more fundamental challenge on the issue of climate change. The claimants argue that the need to tackle climate change is of such importance and of such urgency that it is irrational for the Secretary of State to sanction airport expansion at this time. The evidence being relied upon includes the latest IPCC[10] analysis of the growing existential threat of climate change, the resolutions of the September 2019 UN Climate Change Summit, the Paris Agreement and the recommendations of the CCC.

9. SSE's position is more focused and merely seeks a High Court ruling that the Secretary of State should take responsibility for determining UTT/18/0460/FUL using his powers under the Planning Act 2008. Part of SSE's case is that it is irrational for the Secretary of State to tell a LPA to take no account of the additional CO_2 emissions associated with the expansion of an airport <u>unless</u> adequate provision has been made for these emissions at national level. If UDC were to completely disregard the increase in CO_2 emissions arising from the proposed development and there has not been adequate provision at national level (as in this case) there would clearly be a failure to give proper consideration to the single most important issue facing today's decision makers, particularly those with responsibility for planning.

10. One option for UDC, as noted by Paul Stinchcombe QC, would be to support SSE's JR application. This support could be limited purely to the carbon emissions/climate change impacts of the proposed development and it would not require UDC to become a claimant alongside SSE. UDC is already registered as the 'Second Interested Party' to the case and as such receives copies of all the submissions and is entitled to make submissions of its own. We would urge UDC to give the most serious consideration to this option, noting that the London Boroughs of Hillingdon, Wandsworth, Richmond-Upon-Thames, Hammersmith & Fulham and others have had no qualms about leading a far more fundamental challenge to the Secretary of State's position on the issue of aviation carbon emissions/climate change.

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[8] STAL Environmental Statement for Planning Application UTT/18/0460/FUL, Volume 1, Table 12.11.
[9] (1.64Mt x 274,000/204,000) before adjusting upwards for long haul but offset by 'non-ATMs'.
[10] Intergovernmental Panel on Climate Change (a UN body).

11. If UDC proceeds to determine Planning Application UTT/18/0460/FUL, due consideration must be given to the Airports National Policy Statement ('ANPS') which states as follows:

> *"**Decision Making***
>
> *Any increase in carbon emissions alone is not a reason to refuse development consent, **unless the increase in carbon emissions resulting from the project is so significant that it would have a material impact on the ability of Government to meet its carbon reduction targets, including carbon budgets**."* [11] [emphasis added]

12. In the light of the disclosures made to SSE by the DfT it is clear that approval of Planning Application UTT/18/0460/FUL would have *"a material impact on the ability of Government to meet its carbon reduction targets, including carbon budgets"*. Moreover, this will be the case even if the UK aviation target remains at 37.5MtCO_2 but the CCC's September 2019 report suggests that, in order to meet the new "net zero" statutory objective, this should be reduced to around 30MtCO_2[12]. The CCC also recommends:

    - *"Measures should be put in place to limit growth in demand to at most 25% above current levels by 2050.* [The DfT's current forecast is for growth of 49% over the same period.] *These could include carbon pricing, a frequent flyer levy, fiscal measures to ensure aviation is not undertaxed compared to other transport sectors (e.g. fuel duty, VAT), reforms to Air Passenger Duty, or management of airport capacity.*
    - *The Government should assess its airport capacity strategy in the context of net zero."*

13. The Aviation White Paper, due in early 2020, will set out the DfT's updated policy for managing aviation CO_2 emissions consistent with the requirements of the Paris Agreement, the new "net zero" statutory objective and the above advice of the CCC.

14. It will be important for the Planning Committee not to pre-empt either the decisions of the High Court in the current cases or the new Government policy due to be published in early 2020. The precautionary principle must apply, not least because the IPCC has estimated that CO_2 stays in the atmosphere for between 50 and 200 years.[13] Approval of the current Stansted Airport Planning Application would therefore have adverse irreversible effects upon the environment for generations to come.

<u>*Surface Access Impacts*</u>

15. The Planning Committee will also wish to be mindful that approval of UTT/18/0460/FUL would result in an additional 8mppa generating an additional 2.9m car journeys per annum[14] to/from the airport and an additional 0.5m staff car journeys per annum. Importantly, if the Planning Application is approved STAL expects to achieve a <u>lower</u> public transport mode share than is currently the case – a fact that emerged only after the publication of the Draft S.106 Agreement in March 2019, i.e. long after the former Planning Committee considered the Application. This is clearly inconsistent with the need to promote more sustainable transport options.

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[11] ANPS, DfT, June 2018, para 5.82.
[12] Annex C, page 9.
[13] The IPCC 1990 Report included in its *'Policymaker Summary'* a table showing the properties of various green-house gases, including an atmospheric lifetime of CO_2 listed as 50 to 200 years, with a footnote caveat *that "the way in which CO_2 is absorbed in the ocean and biosphere is not simple and a single value cannot be given*...".
[14] Transport Assessment, Appendix G1.

16. Finally, on 30th July 2019, UDC resolved to declare a climate and ecological emergency and committed to achieving net zero carbon status by 2030. The resolution was approved by an overwhelming majority of local councillors and the challenge now is to convert words into deeds.

17. Stansted Airport is already the largest single source of CO_2 emissions in the East of England and is currently seeking approval for a further substantial increase in its CO_2 emissions to 2.50Mt, which is 60% more than the 2016 base year and 82% more than provided for by the DfT. The Planning Committee has a responsibility to future generations to ensure that the damage to the global environment and ecology that would ensue from approving Planning Application UTT/18/0460/FUL can be justified by proven economic benefits.

Attachments

Annex A – *'Beyond the Horizon: making best use of existing runways'*, DfT, June 2018

Annex B - CCC Letter of February 2019

Annex C - CCC Letter of September 2019

Annex D – Summary of DfT CO2 Projections

Stop Stansted Expansion
22 October 2019

HM Government

Beyond the horizon
The future of UK aviation

Making best use of existing runways

June 2018

HM Government

Beyond the horizon
The future of UK aviation

Making best use of existing runways

June 2018

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1. Making best use of existing runways

1.1 The government's 2013 Aviation Policy Framework provided policy support for airports outside the South East of England to make best use of their existing airport capacity. Airports within the South East were to be considered by the newly established Airports Commission.

1.2 The Airports Commission's Final Report recognised the need for an additional runway in the South East by 2030 but also noted that there would be a need for other airports to make more intensive use of their existing infrastructure.

1.3 The government has since set out its preferred option for a new Northwest runway at Heathrow by 2030 through drafts of the Airports National Policy Statement (NPS), but has not yet responded on the recommendation for other airports to make more intensive utilisation of their existing infrastructure.

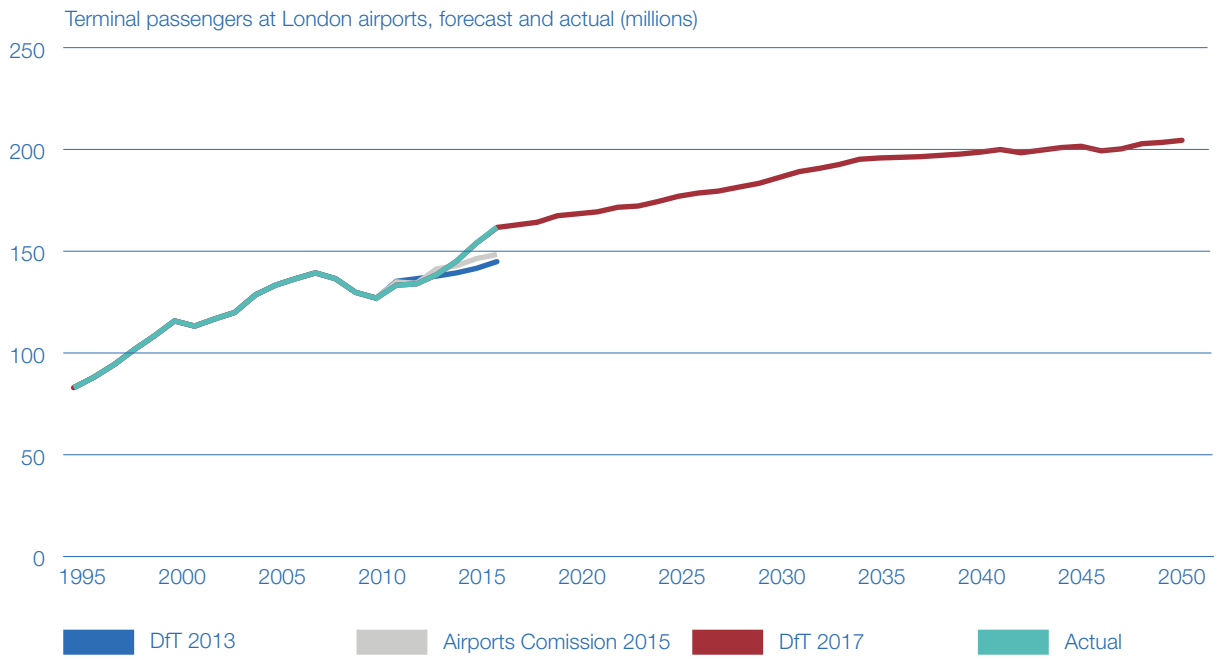
1.4 On 24th October 2017 the Department for Transport (DfT) released its latest aviation forecasts. These are the first DfT forecasts since 2013[1]. The updated forecasts reflect the accelerated growth experienced in recent years and that demand was 9% higher in London[2] in 2016 than the Airports Commission forecast[3]. This has put pressure on existing infrastructure, despite significant financial investments by airports over the past decade, and highlights that government has a clear issue to address.

1.5 The Aviation Strategy call for evidence set out that government agrees with the Airports Commission's recommendation and was minded to be supportive of all airports who wish to make best use of their existing runways, including those in the South East, subject to environmental issues being addressed. The position is different for Heathrow, where the government's proposed policy on expansion is set out in the proposed Airports NPS.

1 Additional aviation forecasts were published by the Airports Commission in 2015 to support their recommendations for an additional runway in the south east.

2 Heathrow, Gatwick, Stansted, Luton and London City

3 The difference is explained largely be the fact that oil prices were lower than expected



Call for evidence response summary

1.6 The Aviation Strategy call for evidence document asked specifically for views on the government's proposal to support airports throughout the UK making best use of their existing runways, subject to environmental issues being addressed.

1.7 We received 346 consultation responses. Excluding those who either did not respond or responded on a different topic, 60% were in favour, 17% against and 23% supportive provided certain issues were addressed.

1.8 The main issues raised included the need for environmental issues such as noise, air quality, and carbon to be fully addressed as part of any airport proposal; the need for improved surface access and airspace modernisation to handle the increased road / rail and air traffic; and clarification on the planning process through which airport expansion decisions will be made.

Role of local planning

1.9 Most of the concerns raised can be addressed through our existing policies as set out in the 2013 Aviation Policy Framework, or through more recent policy updates such as the new UK Airspace Policy or National Air Quality Plan. For the majority of environmental concerns, the government expects these to be taken into account as part of existing local planning application processes. It is right that decisions on the elements which impact local individuals such as noise and air quality should be considered through the appropriate planning process and CAA airspace change process.

1.10 Further, local authorities have a duty to consult before granting any permission, approval, or consent. This ensures that local stakeholders are given appropriate opportunity to input into potential changes which affect their local environment and have their say on airport applications.

Role of national policy

1.11 There are, however, some important environmental elements which should be considered at a national level. The government recognises that airports making the best use of their existing runways could lead to increased air traffic which could increase carbon emissions.

1.12 We shall be using the Aviation Strategy to progress our wider policy towards tackling aviation carbon. However, to ensure that our policy is compatible with the UK's climate change commitments we have used the DfT aviation model[4] to look at the impact of allowing all airports to make best use of their existing runway capacity[5]. We have tested this scenario against our published no expansion scenario and the Heathrow Airport North West Runway scheme (LHR NWR) option, under the central demand case.

1.13 The forecasts are performed using the DfT UK aviation model which has been extensively quality assured and peer reviewed and is considered fit for purpose and robust for producing forecasts of this nature. Tables 1-3 show the expected figures in passenger numbers, air traffic movements, and carbon at a national level for 2016, 2030, 2040, and 2050.

	Baseline	Baseline + best use	LHR NWR base	LHR NWR + best use
2016	266.6	266.6	266.6	266.6
2030	313.4	314.8	342.5	341.9
2040	359.8	365.9	387.4	388.8
2050	409.5	421.3	435.3	444.2

Table 1: Terminal Passengers at UK airports, million passengers per annum

	Baseline	Baseline + best use	LHR NWR base	LHR NWR + best use
2016	2,119	2,119	2,119	2,119
2030	2,330	2,358	2,459	2,460
2040	2,584	2,602	2,697	2,700
2050	2,901	2,958	3,013	3,043

Table 2: Air Transport Movements (ATMs) at UK airports, 000s

	Baseline	Baseline best use	LHR NWR base	LHR NWR best use
2016	37.3	37.3	37.3	37.3
2030	38.6	38.8	43.5	43.4
2040	38.1	38.7	42.3	42.4
2050	37.0	37.9	39.9	40.8

Table 3: CO_2 from flights departing UK airports, million tonnes

4 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/674749/uk-aviation-forecasts-2017.pdf

5 Modelled the impact of airports increasing their planning cap whenever they have become 95% full.

Implications for the UK's carbon commitments

1.14 As explained in Chapter 6 of the Aviation Strategy Next Steps document[6], we have made significant steps in developing international measures for addressing aviation carbon dioxide (CO_2) emissions, including reaching agreement at the International Civil Aviation Organisation (ICAO) in October 2016 on a global offsetting scheme for international aviation, known as the Carbon Offsetting and Reduction Scheme for International Aviation, or CORSIA. However, there remains uncertainty over future climate change policy and international arrangements to reduce CO2 and other greenhouse gases. The Airports Commission devised two scenarios which continue to be appropriate to reflect this uncertainty: carbon traded and carbon capped[7]. In this assessment the DfT has followed the same approach.

Carbon traded scenario

1.15 Under the carbon-traded scenario, UK aviation emissions could continue to grow provided that compensatory reductions are made elsewhere in the global economy. This could be facilitated by a carbon trading mechanism in which aviation emissions could be traded with other sectors. In this case, provided a global trading scheme is place, higher UK aviation activity would have no impact on global emissions as any increase in emissions would be offset elsewhere and therefore there is nothing to indicate that this policy would prevent the UK meeting its carbon obligations.

Carbon capped scenario

1.16 The carbon-capped scenario was developed to explore the case for expansion even in a future where aviation emissions were limited to the Committee on Climate Change's (CCC) planning assumption of 37.5Mt of CO_2 in 2050. Under DfT's carbon-capped scenario the cap is met using a combination of carbon pricing and specific measures. For the central demand case we determined that the most appropriate specific measures to use, based on cost effectiveness and practicality of implementation, were more efficient aircraft ground movements (using single engine taxiing) and higher uptake of renewable fuels[8].

6 https://www.gov.uk/government/consultations/a-new-aviation-strategy-for-the-uk-call-for-evidence

7 For background to the Carbon Policy scenarios used by DfT both in this document and in its airport expansion analysis see pages 9 and 33-38 of: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/653879/updated-appraisal-report-airport-capacity-in-the-south-east.pdf

8 These would be implemented alongside the carbon price.

1.17 The more efficient ground movement policy involves government action to incentivise the use of single-engine taxiing at UK airports. It is assumed that the policy would lead to a 95% take-up rate by 2030 and beyond and it is estimated that this measure would reduce fuel consumption by around 1% per flight on average[9].

1.18 The renewable fuels policy involves government regulations to mandate specific renewable fuel percentages in aviation fuel supply. Any measures deployed would be designed to ensure that the renewable feedstock is sustainable and delivers substantial lifecycle CO_2 savings, such as municipal waste, which on this basis could deliver savings of over 70%. Such a scheme would be consistent with the future aims of the Renewable Transport Fuel Obligation to include aviation and focus on advanced fuels, as set out in the government's response to its recent consultation[10]. The levels of carbon reduction delivered by the policy measures are presented in Table 4.

	No expansion base	No expansion + best use	LHR NWR base	LHR NWR + best use
Carbon reduction required, $MtCO_2$	-0.5	0.4	2.4	3.3
Abatement from single engine taxiing, $MtCO_2$*	0	0.3	0.3	0.3
Renewable fuel uptake required	0	0**	12%	16%

*Figure does not vary due to rounding
**Zero due to rounding

Table 4: Policies to meet CCC cap (37.5 $MtCO_2$), levels in 2050

1.19 The level of renewable fuels required is higher under the making best use sensitivity but these are still at the conservative end of the range of forecast future biofuel supply[11].

1.20 There is significant uncertainty over the likely future cost of these measures and their impact on carbon so this policy mix is presented to illustrate the type of abatement action that could be taken. It should not be interpreted as a statement of future carbon policy which will be considered through the development of the Aviation Strategy. Other measures are likely to be available and may turn out to be more cost effective or have greater abatement potential.

1.21 On balance, therefore, it is likely that these or other measures would be available to meet the planning assumption under this policy.

9 Ricardo Energy & Environment, 2017. *Carbon Abatement in UK Aviation* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/653776/carbon-abatement-in-uk-aviation.pdf

10 DfT, 2017. *Renewable transport fuel obligations order: government response.* https://www.gov.uk/government/publications/renewable-transport-fuel-obligations-order-government-response

11 See Increased use of biofuels chapter in Carbon Abatement in UK Aviation Report prepared by Ricardo Energy & Environment for discussion https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/653776/carbon-abatement-in-uk-aviation.pdf

Local environmental impacts

1.22 The government recognises the impact on communities living near airports and understands their concerns over local environmental issues, particularly noise, air quality and surface access. As airports look to make the best use of their existing runways, it is important that communities surrounding those airports share in the economic benefits of this, and that adverse impacts such as noise are mitigated where possible.

1.23 For the majority of local environmental concerns, the government expects these to be taken into account as part of existing local planning application processes.

1.24 As part their planning applications airports will need to demonstrate how they will mitigate local environmental issues, which can then be presented to, and considered by, communities as part of the planning consultation process. This ensures that local stakeholders are given appropriate opportunity to input into potential changes which affect their environment and have their say on airport applications.

Policy statement

1.25 As a result of the consultation and further analysis to ensure future carbon emissions can be managed, government believes there is a case for airports making best of their existing runways across the whole of the UK. The position is different for Heathrow Airport where the government's policy on increasing capacity is set out in the proposed Airports NPS.

1.26 Airports that wish to increase either the passenger or air traffic movement caps to allow them to make best use of their existing runways will need to submit applications to the relevant planning authority. We expect that applications to increase existing planning caps by fewer than 10 million passengers per annum (mppa) can be taken forward through local planning authorities under the Town and Country Planning Act 1990. As part of any planning application airports will need to demonstrate how they will mitigate against local environmental issues, taking account of relevant national policies, including any new environmental policies emerging from the Aviation Strategy. This policy statement does not prejudge the decision of those authorities who will be required to give proper consideration to such applications. It instead leaves it up to local, rather than national government, to consider each case on its merits.

1.27 Applications to increase caps by 10mppa or more or deemed nationally significant would be considered as Nationally Significant Infrastructure Projects (NSIPs) under the Planning Act 2008 and as such would be considered on a case by case basis by the Secretary of State.

1.28 Given the likely increase in ATMs that could be achieved through making best use of existing runways is relatively small (2% increase in ATMs "without Heathrow expansion" scenario; 1% "with Heathrow"), we do not expect that the policy will have significant implications for our overall airspace capacity. However it is important to note that any flightpath changes required as a result of a development at an airport will need to follow the CAA's airspace change process. This includes full assessment of the likely environmental impacts, consideration of options to mitigate these impacts, and the need to consult with stakeholders who may be affected. Approval for the proposed airspace change will only be granted once the CAA has been satisfied that all aspects, including safety, have been addressed. In addition, government has committed to establish an Independent Commission on Civil Aviation Noise (ICCAN) to help ensure that the noise impacts of airspace changes are properly considered and give communities a greater stake in noise management.

1.29 **Therefore the government is supportive of airports beyond Heathrow making best use of their existing runways. However, we recognise that the development of airports can have negative as well as positive local impacts, including on noise levels. We therefore consider that any proposals should be judged by the relevant planning authority, taking careful account of all relevant considerations, particularly economic and environmental impacts and proposed mitigations. This policy statement does not prejudge the decision of those authorities who will be required to give proper consideration to such applications. It instead leaves it up to local, rather than national government, to consider each case on its merits.**

Committee on Climate Change

Independent advice to government on building a low-carbon economy and preparing for climate change

The Rt Hon Chris Grayling MP
Secretary of State for Transport
Great Minster House
33 Horseferry Road
London SW1P 4DR

12 February 2019

Aviation 2050 – The future of UK aviation

Dear Secretary of State,

I am writing to you to provide my Committee's views on your recently published consultation, *Aviation 2050 – The future of UK aviation*.

The UK's currently legislated 2050 target is to reduce economy-wide greenhouse gas emissions by at least 80% from 1990 levels. Since the Climate Change Act became law, the UK has ratified the Paris Agreement, implying even stronger action. You will be aware that my Committee has been asked by Ministers to offer advice on the implications of the Paris Agreement for the UK's statutory framework, including when 'net-zero' emissions can be achieved. A stronger UK target would require more effort from all sectors, including aviation. We intend to provide an updated view on the appropriate long-term ambition for aviation emissions within our advice on the UK's long-term targets. We will publish our report in spring. Following that, we will write to you directly to set out the implications for the Aviation Strategy.

Our present planning assumption, which underpins the fifth carbon budget and the current 2050 target, is that UK aviation emissions in 2050 should be around their 2005 level (i.e. 37.5 $MtCO_2e$). Your acceptance of this planning assumption in the consultation is a very welcome step. The final white paper should further clarify that this will be met on the basis of actual emissions, rather than by relying on international offset credits.

Aviation emissions in the UK have more than doubled since 1990, while emissions for the economy as a whole have fallen by around 40%. Achieving aviation emissions at or below 2005 levels in 2050 will require contributions from all parts of the aviation sector, including from new technologies and aircraft designs, improved airspace management, airlines' operations, and use of sustainable fuels. It will also require steps to limit growth in demand. In the absence of a true zero-carbon plane, demand cannot continue to grow unfettered over the long-term.

Our analysis, and that of industry, suggests the largest contribution to reducing aviation emissions will come from new technologies and aircraft designs. Research we have commissioned jointly with your department, which was published alongside the

consultation, indicates that many of these developments are likely to be cost-effective, given their potential fuel savings. The final white paper should build on the approach set out in the Aerospace Sector Deal and Future Flight Challenge, and set out a clear strategy to ensure these technology solutions are developed and brought to market in a timely fashion.

In our recent Biomass review[1] we advised that government should not plan for high levels of biofuel use in aviation in the long-term, given uncertainty about sustainable biomass supply and cost-effectiveness. Production of aviation biofuel will likely need to be in conjunction with carbon capture and storage (CCS) to be competitive with competing uses for biomass (e.g. in industry, electricity generation, or hydrogen production). A pragmatic planning assumption would be to aim for up to 10% biofuel use in aviation in 2050. In the period to 2030 government policy should aim to develop a market for aviation biofuels produced in genuinely CCS-ready facilities, and should facilitate this by achieving more of the 2030 Renewable Transport Fuel Obligation through aviation fuels.

We welcome your proposal to ask the National Infrastructure Commission (NIC) to scrutinise the needs case for further airport expansion. The consultation paper also states other conditions must be met prior to further expansion. The work of the NIC is already consistent with the requirements of the Climate Change Act and the government's climate change commitments; the final white paper should clarify that this will continue to be the case.

We also welcome the commitment to negotiate in the ICAO a long-term goal for global international aviation emissions that is consistent with the Paris Agreement. The ICAO's current carbon policy, CORSIA, has an end date of 2035 and will need to be based on robust rules that deliver genuine emission reductions. A new long-term objective would provide a strong and early signal to incentivise the investment in new, cleaner, technologies that will be required for the sector to play its role in meeting long-term targets. This is particularly important in aviation given the long lifetimes of assets. A similar approach has been agreed for global shipping emissions in the IMO, which has set a target for greenhouse gas emissions to be at least 50% below 2008 levels by 2050.

I note that your consultation commits to regular updates of the Aviation Strategy. These regular reviews will provide an opportunity to respond to a future decision by Parliament to meet the UK's commitments under the Paris Agreement. I hope the final white paper will set more specific time-points for these reviews, and align them to developments in government climate strategy overall.

Yours,

Lord Deben

Chairman, Committee on Climate Change

[1] CCC (2018) *Biomass in a low-carbon economy*

Committee on Climate Change

Independent advice to government on building a low-carbon economy and preparing for climate change

Rt Hon Grant Shapps MP
Secretary of State for Transport
Great Minster House
33 Horseferry Road
London SW1P 4DR

24 September 2019

Net-zero and the approach to international aviation and shipping emissions

Dear Secretary of State,

The Government has legislated for the UK to reach net-zero greenhouse gas emissions by 2050. I am pleased the Government clarified to Parliament that the target must cover the whole economy, including international aviation and shipping (IAS) emissions. This letter responds to the Government's request on how to bring IAS emissions formally within the UK's net-zero target, setting out the rationale and the implications for the UK's climate strategy.

Our advice that 2050 is an appropriate date for net-zero is based on formal inclusion of IAS emissions within the target. Without this a more ambitious target is likely to be required.

The rationale for inclusion of IAS emissions in the UK carbon targets

The primary policy approach to reducing IAS emissions should be international. Through the efforts of your Department, the UK has played a key role in progress by both the International Civil Aviation Organisation (to agree a global offsetting scheme for aviation emissions to 2035) and the International Maritime Organisation (to agree to reduce shipping emissions by at least 50% by 2050 compared to 2008 levels and pursue efforts to phase emissions out entirely).

This international framing should not prevent the inclusion of IAS emissions in UK carbon targets, as is already the case for other sectors that are covered by international agreements and potentially exposed to competitiveness pressures (e.g. energy-intensive industry).

Addressing IAS emissions is strategically important. Formal inclusion of IAS emissions in the net-zero target would complement agreed international policies and should not be interpreted as a unilateral UK approach to reducing emissions in these sectors.

- Aviation is likely to be the largest emitting sector in the UK by 2050, even with strong progress on technology and limiting demand. Aviation also has climate warming effects beyond CO_2, which it will be important to monitor and consider within future policies.
- Including IAS emissions in UK carbon targets increases confidence that the Government is appropriately prioritising their reduction. That should include pushing for suitably strong international levers, as well as using supplementary UK measures where these do not impact on the competitiveness of the IAS sectors.
- Inclusion of IAS emissions clarifies the requirements for policy development in other sectors (e.g. the scale of deployment needed for options to offset remaining emissions).
- There are no practical barriers to inclusion. Emissions are already estimated and reported to the UN and should be included in UK emissions targets on the same basis. The uncertainty attached to these estimates is no higher than for other sectors covered by carbon budgets.

- Inclusion can be managed through secondary legislation and without any additional costs for achieving net-zero beyond those already agreed by Parliament.

Formal inclusion of IAS emissions would help to guide long-term policy approaches and infrastructure investment decisions.

Achieving net-zero IAS emissions in the UK

The planning assumption for IAS should be to achieve net-zero emissions by 2050. This should be reflected in your forthcoming Aviation Strategy and as the Clean Maritime Plan is taken forward. It means reducing actual emissions in these sectors and is likely to require some use of greenhouse gas removals (GGRs) to offset remaining emissions:

- **Aviation.** Zero-carbon aviation is highly unlikely to be feasible by 2050.
  - Aviation emissions could be reduced by around 20% from today to 2050 through improvements to fuel efficiency, some use of sustainable biofuels, and by limiting demand growth to at most 25% above current levels. This is likely to be cost-saving. There is potential to reduce emissions further with lower levels of demand.
  - Novel fuels (e.g. synthetic carbon-neutral kerosene, algal biofuels) could allow greater reductions, but their development is highly speculative and should not be relied upon.
  - The Government should assess its airport capacity strategy in this context. Specifically, investments will need to be demonstrated to make economic sense in a net-zero world and the transition towards it.
- **Shipping.** Achieving zero-carbon or near zero-carbon shipping by 2050 is likely to be feasible and cost-effective through use of alternative fuels (e.g. zero-carbon hydrogen or ammonia). A transition to these fuels will need to be well underway globally before 2050, with refuelling infrastructure established and a substantial fraction of the fleet already switched, in order to meet the IMO's current 2050 objective.
- **Greenhouse gas removals (GGRs).** For aviation, and to the extent that shipping emissions cannot be eliminated, measures to remove CO_2 from the atmosphere will be required to offset remaining emissions. They cannot be a substitute for genuine emissions reductions.
  - In the long term offsets can only be based on verifiable emissions removal from the atmosphere. These would ideally be delivered through the international framework (e.g. CORSIA), but may need additional UK policies.
  - However, there will not be unlimited access to GGR offsets since their potential is constrained by global land and other resources. The focus should therefore be on highly scalable GGR options rather than those limited in scope (e.g. afforestation).

The Government can take steps towards enabling IAS to reach net-zero emissions in the UK and internationally by establishing a new market for GGRs. Such a strategy could create a significant new global export opportunity for the UK in GGR technology and expertise.

Further detail on the issues covered in this letter is set out in the accompanying annex.

Yours,

Lord Deben

Chairman, Committee on Climate Change

Annex

Net-zero and the approach to international aviation and shipping emissions

Introduction

In June 2019 the Government legislated for the UK to reach net-zero emissions by 2050, but this formally excluded emissions from international aviation and shipping (IAS).

The Government clarified to Parliament that their plans for net-zero cover the whole economy, including IAS emissions, and that they await the Committee's advice on formal inclusion of these sectors within the target.[1]

Our advice is set out in the accompanying letter, which summarises the rationale for formal inclusion of IAS sectors within the net-zero target and sets out how this could be achieved. It reflects the advice in our net-zero report, which incorporated the UK's share of IAS emissions. If these emissions are not formally included then a more ambitious net-zero target is likely to be required.

This annex presents the evidence base underpinning our advice. It explains how and why IAS emissions should be brought formally within the net-zero target, and the implications for the UK's climate strategy.

We set out our assessment in the following four sections:

(i) Recap of net-zero advice
(ii) How to include IAS emissions within the net-zero target
(iii) How to get to net-zero IAS emissions
(iv) Implications for aviation and shipping policy

(i) Recap of net-zero advice

The Paris Agreement set a long-term goal to hold the increase in global average temperature to well-below 2°C and to pursue efforts to limit the increase to 1.5°C (compared to pre-industrial levels). In order to achieve this long-term temperature goal it also aims to balance 'anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century' (which is widely interpreted as implying net-zero greenhouse gas (GHG) emissions globally).

Global emission pathways consistent with delivering this temperature goal require reducing global CO_2 emissions to net-zero by around 2050, and global GHG emissions to net-zero by around 2070 (Figure A1). This includes all sources of emissions globally, including those from aviation and shipping.

The Paris Agreement also requires that parties pursue their 'highest possible ambition'. At the UK level our analysis currently suggests that 2050 is the earliest credible date for reaching net-zero including IAS emissions, based on capability, equity, and responsibility to lead.

Reducing UK emissions to net-zero will require action across all sectors of the economy (Figure A2). Getting to very-low emissions (e.g. a few million tonnes of CO_2-equivalent - CO_2e) is feasible in most sectors. The greatest challenges are in reducing agriculture and aviation emissions, where there are limited zero-carbon options. These sectors are likely to be a significant source of emissions even in the long-term.

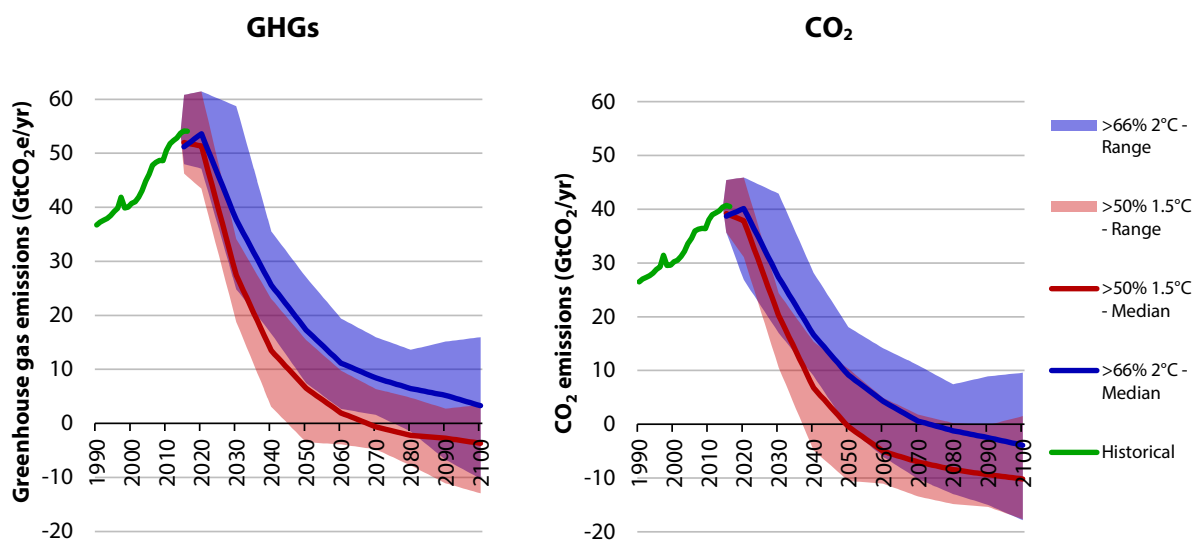
Getting to net-zero emissions overall will therefore require greenhouse gas removals (GGRs) (e.g. bioenergy with carbon capture and storage - BECCS, direct air capture of CO_2 with storage

[1] Hansard HC (12 June 2019) Volume 661 Column 682 *Net Zero Emissions Target*.

– DACCS) in order to offset remaining emissions. We identify sufficient potential for these to be delivered domestically to reach net-zero emissions for the economy as a whole, including IAS.

The net-zero target should therefore be met by reducing UK emissions as far as possible (i.e. not by offshoring them), and by using GGRs to offset the emissions that remain (Figure A3). Given potential to achieve this domestically, the aim should be to meet the target without relying on use of international offset credits. The Government confirmed to Parliament that this is its approach.[2]

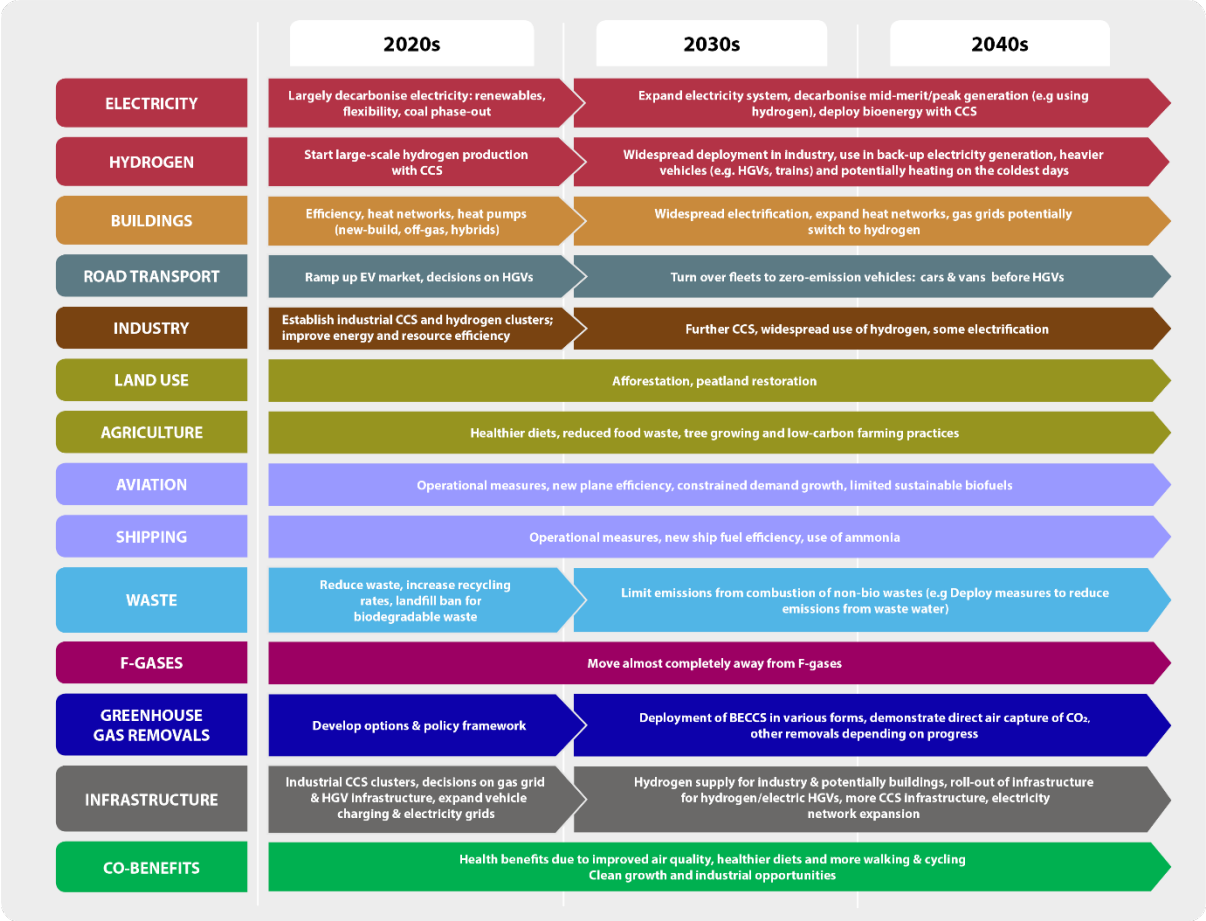
Figure A1. Global emissions pathways for CO_2 and GHGs consistent with the Paris Agreement



Source: Huppmann, D. et al. (2018) *A new scenario resource for integrated 1.5°C research*. Nature Climate Change, 8 (12), 1027.
Notes: Shading indicates maximum and minimum across the scenario grouping at any point in time. The solid coloured lines are the 'median' scenario (at each point in time) in each scenario group. GHG emissions in the bottom panel are aggregated across all GHGs using the GWP100 values from the IPCC 4th Assessment Report.

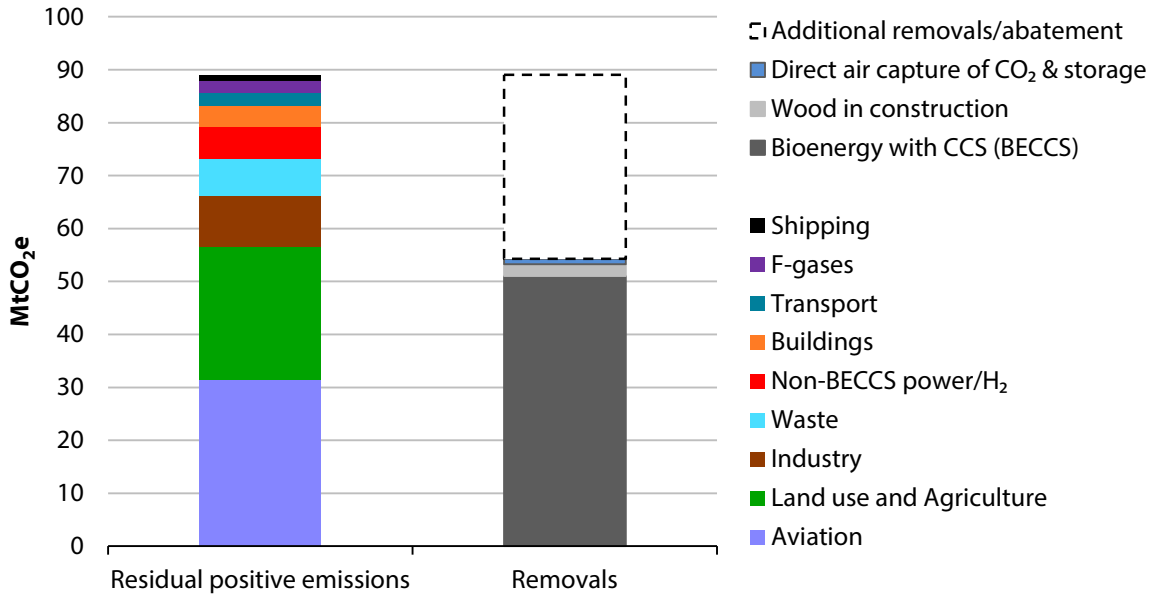
[2] Hansard HC (12 June 2019) Volume 661 Column 663 *Net Zero Emissions Target*.

Figure A2. Sectoral transitions required over the period to 2050 to reach net-zero



Source: CCC (2019) *Reducing UK emissions – 2019 Progress Report to Parliament*.

Figure A3. Greenhouse gas removals required to balance positive emissions in 2050



Source: CCC (2019) *Net zero – The UK's contribution to stopping global warming*.
Notes: Sectoral emissions and contributions from removals presented for the Further Ambition scenario in our net-zero report. The contribution from 'additional removals/abatement' refers to the options to go beyond the Further Ambition scenario and achieve net-zero emissions, which can be done with additional removals and/or further reductions of positive emissions.

(ii) How to include IAS emissions within the net-zero target

The primary policy approach to reducing IAS emissions should be at the international level, given the global nature of these sectors and the risk of carbon leakage from a unilateral UK approach.

The UK has played a key role in progress by both the International Civil Aviation Organisation (ICAO) and International Maritime Organisation (IMO):

- **Global aviation policy.** The ICAO has agreed a global offsetting scheme for international aviation emissions (the Carbon Offsetting and Reduction Scheme for International Aviation - CORSIA). Airlines flying on routes between countries covered by the scheme are required to offset growth in emissions above 2020 levels. The scheme starts in 2021 and is mandatory from 2027. The policy currently stops in 2035.
- **Global shipping policy.** The IMO has agreed to peak GHG emissions from global international shipping as soon as possible, to reduce them by at least 50% below 2008 levels by 2050, and to pursue efforts to phase them out entirely.

Other voluntary industry initiatives have also been agreed:

- **Aviation.** The International Air Transport Association (IATA), which represents the global airline industry, has adopted a target to reduce net aviation CO_2 emissions by 50% below 2005 levels by 2050. The European airport industry has committed to net-zero CO_2 emissions by 2050 at the latest, covering emissions at airports but not from flights.

- **Shipping.** Maersk, the world's largest shipping company, has announced a goal to reach carbon neutrality by 2050.

At the UK level, addressing IAS emissions is strategically important for the robustness of the net-zero target:

- IAS emissions cause climate change and should therefore be included within the UK's targets and strategies.
- Aviation is likely to be the largest emitting sector in 2050, even after strong progress on technology and measures to limit demand.
- Aviation's true climate impact is likely to be understated, given the existence of short-term non-CO_2 effects (e.g. from contrails) which are not covered in the basket of gases reported to the UN or by the Climate Change Act.

An international framing should not prevent the inclusion of IAS emissions in UK carbon targets, as is already the case for other sectors that are covered by international agreements and potentially exposed to competitiveness pressures (e.g. energy-intensive industry).

Formal inclusion of IAS emissions in the net-zero target would complement agreed international policies and should not be interpreted as a unilateral UK approach to reducing emissions in these sectors:

- **Inclusion increases confidence that the Government is sufficiently prioritising reduction of IAS emissions.** That should include pushing for suitably strong international levers, as well as using supplementary UK measures where these do not impact on the competitiveness of the IAS sectors.
  - At the international level this includes the need for a long-term objective for the aviation sector in line with the Paris Agreement, and future CORSIA caps consistent with this that incentivise GGRs for all emissions, not just emissions growth above 2020 levels.
  - At the UK level, supplementary policies that have limited competitiveness risks include support for developing alternative fuels, managing growth in demand, and kick-starting a market for GGRs.
- **Inclusion clarifies the requirements for policy development in other sectors.** That includes the scale of deployment needed for GGR options, and the need for low-carbon fuel infrastructure to extend to ports.

There are no practical barriers to formal inclusion of IAS emissions. Emissions are already estimated and reported to the UN and should be included in UK emissions targets on the same basis. The uncertainty attached to these estimates is no higher than for other sectors covered by carbon budgets.

- The Climate Change Act requires that inclusion be on the basis of international carbon reporting practice. Bunker fuel sales are the currently agreed methodology by which countries report IAS emissions to the UN.
- While a range of alternative methodologies have been proposed, uncertainty in IAS emissions is no higher than for other sectors already covered by carbon budgets and the net-zero target (Figure A4).
  - Domestic aviation and shipping emissions are already formally included within the net-zero target on the basis of bunker fuel sales.
  - For international aviation, bunker fuel sales are an accurate reflection of aviation activity as airlines do not tend to carry more fuel than needed for a

given flight (UK departing-flight emissions modelled by DfT are within 4% of the bunker fuel sales estimate).

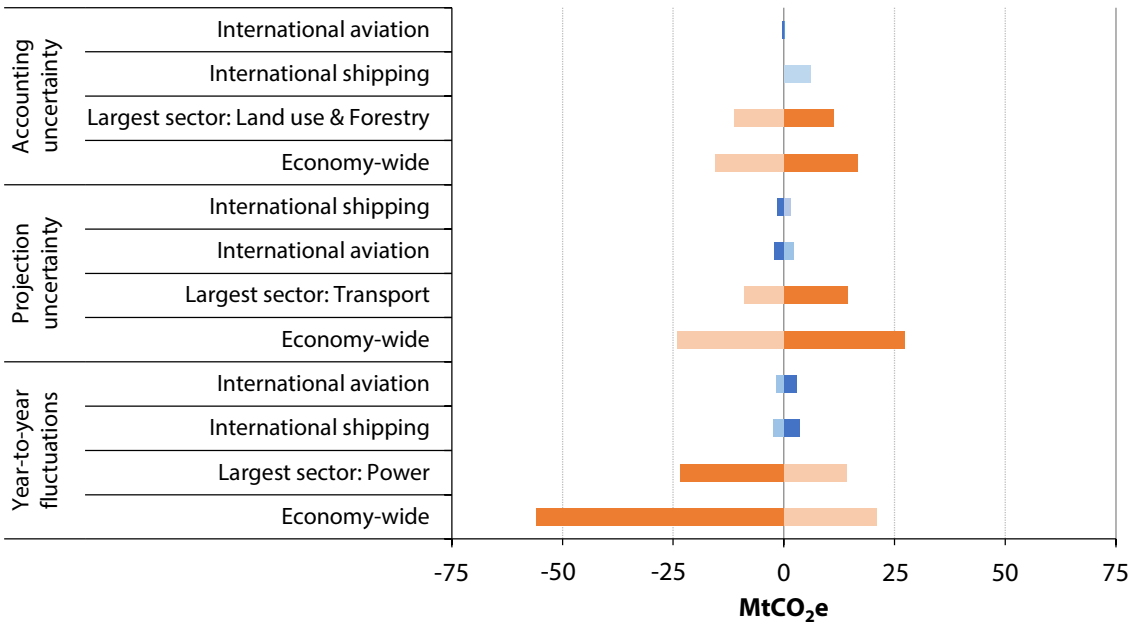
  - For international shipping, bunker fuels *may* not accurately reflect country-level shipping activity and emissions, given the potential for ships to refuel at multiple ports on routes. However, while imperfect, the difference between this approach and alternative methodologies is unlikely to be material.
  - Were alternative methodologies for measuring IAS emissions to be developed and agreed internationally for annual reporting (e.g. by the ICAO, IMO, or UNFCCC) then this could be managed through adjustments to carbon budgets, as allowed under the Climate Change Act.

- Inclusion can be managed through secondary legislation under section 30 of the Climate Change Act, and without any additional costs for achieving net-zero beyond those already agreed by Parliament.

Other countries have already decided to include IAS emissions in their net-zero targets and/or strategies (e.g. in Scotland[3] on the basis of bunker fuel sales, and in France[4]).

In the context of international negotiations at ICAO and IMO, inclusion of IAS emissions in the net-zero target should not be interpreted as a rejection of multi-lateral approaches or as prejudicing discussions on burden sharing.

Figure A4. Uncertainty in IAS emissions compared to wider uncertainties in carbon budgets



Source: CCC calculations, BEIS (2019) *2017 UK Greenhouse Gas Emissions, Final Figures*, Lee et al (2005) *Study on the Allocation of Emissions from International Aviation to the UK inventory*, CCC (2011) *Review of UK Shipping Emissions*, CCC (2015) *Sectoral scenarios for the Fifth Carbon Budget – Technical report*, DfT (2017) *UK Aviation Forecasts*, BEIS (2019) *Updated energy and emissions projections 2018*.
Notes: Chart shows uncertainty across three main categories for IAS compared to other sectors already included in carbon budgets and for the economy as a whole. Projection uncertainty is for 2030. Year-to-year fluctuations show the largest annual increase and decrease since 1990.

[3] See www.climate.scot

[4] See http://www.assemblee-nationale.fr/dyn/15/dossiers/energie_climat

Aviation and shipping both emit very small amounts of regulated non-CO_2 greenhouse gases (methane and nitrous oxide) but also have additional warming and cooling effects that are not included in the basket of gases covered by the Paris Agreement and the Climate Change Act (Figure A5):

- **Aviation** produces a range of different pollutants that affect the climate in different ways. The most significant effect is from creation of contrails and high clouds, although the impact of these are short-lived as these clouds are high in the atmosphere. Measuring these effects on an annual basis is challenging, given their short-term nature and dependence on localised conditions. Overall, non-CO_2 effects from aviation warm the climate and approximately double the historic warming effect of CO_2 alone.
- **Shipping** has non-CO_2 effects that come from the emission of sulphur dioxide, which has an overall cooling effect on the climate but causes local air pollution.

In both aviation and shipping these non-CO_2 effects are mainly short-lived, meaning that if they were stopped their effects on the climate would rapidly disappear.

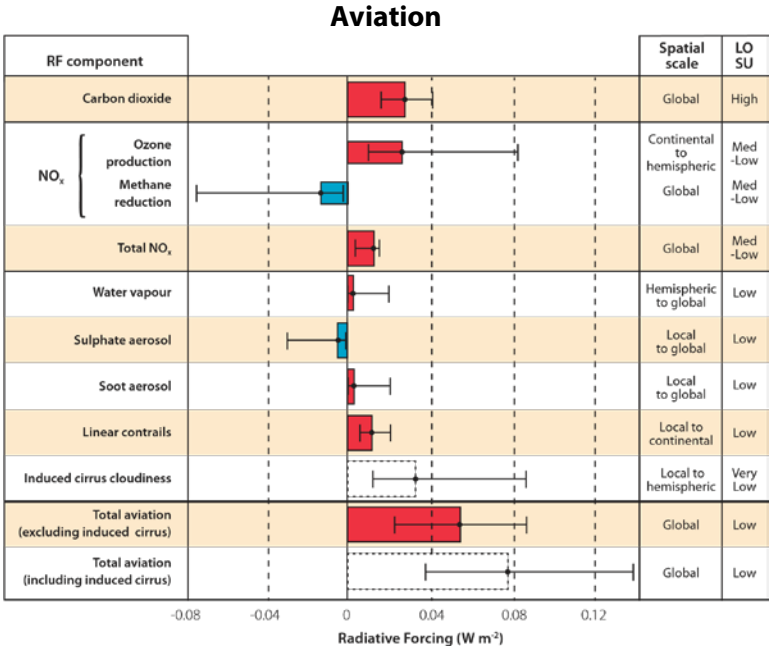
The appropriate approach to policy at this stage is not to include these effects within the net-zero target, but to improve scientific understanding (e.g. for annual reporting) and develop options to markedly reduce them over the coming decades that are not at the expense of GHG emissions.

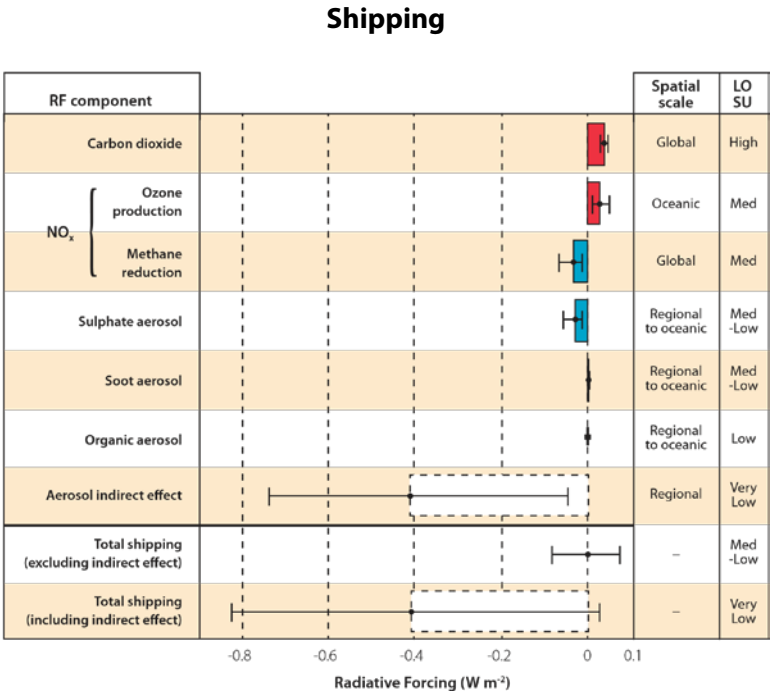
In aviation, policies are already in place to limit some non-CO_2 effects due to their impact on air quality. In shipping, sulphate emissions are likely to be significantly reduced in future due to global regulations to reduce the sulphur content of shipping fuels. These are expected to come into force in 2020.

While addressing non-CO_2 effects is important, this does not change the need to reduce CO_2 emissions which are the dominant factor contributing to IAS' impact on the climate.

We will continue to monitor progress to reduce the non-CO_2 effects of IAS in our annual progress reports to Parliament and in our advice on setting carbon budgets.

Figure A5. Non-CO_2 effects from aviation and shipping





Source: Lee et al (2010) *Transport impacts on atmosphere and climate: aviation,* Atmospheric Environment; Eyring et al (2010) *Transport impacts on atmosphere and climate: shipping,* Atmospheric Environment.
Notes: Each component of aviation and shipping's effect on climate is shown in terms of radiative forcing, which measures the current atmospheric imbalance (in Watts per square metre, Wm-2) due to aviation and shipping activity up until now. Note that it does not give a measure of future effects from current activity - for instance, emitted CO_2 will reside in the atmosphere for many decades, whereas today's contrails and aerosols will only last up to a few hours or days. Whiskers denote 90% confidence intervals (aviation) and range of estimates in the literature (shipping). LOSU indicates the Level of Scientific Understanding regarding each effect. Induced cirrus and aerosol indirect effects are shown as a dotted bar due to high uncertainty.

(iii) How to get to net-zero IAS emissions

The planning assumption for the IAS sectors should be to achieve net-zero emissions by 2050. This reflects the strategic importance of these sectors, and their international nature.

Getting to net-zero emissions will require reducing IAS emissions as far as possible and using scalable GGRs (e.g. BECCS or DACCS) to offset remaining emissions.

Reducing IAS emissions

Reducing aviation emissions will be more challenging than for shipping, given the lack of zero-carbon options in aviation (Figure A7):

- **Aviation.** Our scenarios from our net-zero advice suggest aviation emissions could be reduced from 36.5 $MtCO_2$ in 2017 to around 30 $MtCO_2$ in 2050 through a combination of fuel efficiency improvements, limited use of sustainable biofuels, and by managing demand growth. Major technological breakthroughs in commercial aviation are unlikely to make a significant difference to emissions by 2050 given long development and certification lead times, and slow turnover of the fleet.
  - **Fuel efficiency.** Our scenarios reflect a 1.4% annual improvement in fuel efficiency, which is in line with the historical average since 2000 for UK departing flights on a seat-km basis. This rate of improvement could be achieved through:
    - More efficient engines, including both advanced conventional jet designs, and some deployment of hybrid-electric aircraft in the 2040s (e.g. hybrids make up less than 10% of kilometres flown in 2050). There are no full-electric aircraft in the scenario which, particularly for long-haul flights, are unlikely to be feasible by 2050.
    - Improvements in aircraft design including through reductions in design speeds, and use of design elements such as high aspect ratio wings and composite materials.
    - Efficiency improvements in airlines' operations and in airspace management.
  - **Sustainable fuels.** Our scenario has a 10% uptake of sustainable fuels in 2050. It is not appropriate to plan for higher levels of uptake at this stage, given the range of competing potential uses for biomass across the economy (Figure A8) and uncertainty over which use will be most cost-effective. Our scenarios are based around supply of sustainable biomass with strong governance to ensure they reflect genuine emissions savings. We therefore assume high emissions saving from these biofuels. Emissions relating to cultivation, processing and transportation are relatively small and, where relevant, are included elsewhere in our economy-wide scenario.
  - **Demand.** In the absence of a true zero-carbon plane, demand cannot continue to grow unfettered over the long-term. Our scenario reflects a 25% growth in demand by 2050 compared to 2018 levels. This compares to current Government projections which are for up to a 49% increase in demand over the same period.[5]

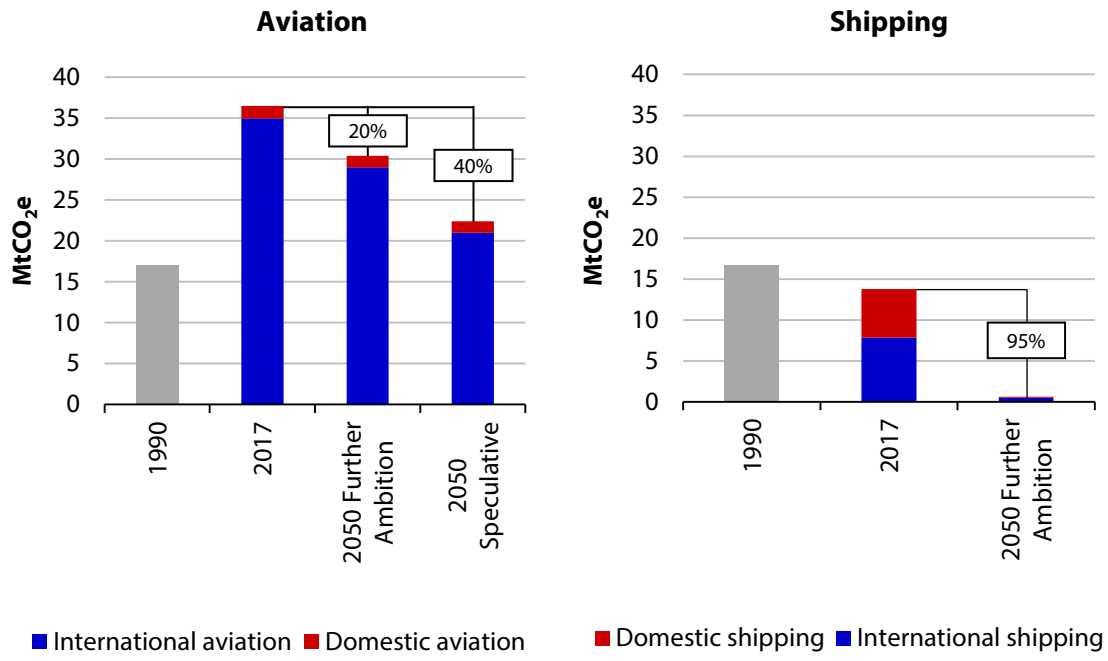
[5] DfT (2017) *UK Aviation Forecasts*.

- **Speculative aviation options.** We have identified 'Speculative' options in aviation on demand and alternative fuels which could reduce emissions below 30 $MtCO_2$ in 2050, though these have greater challenges:
  - **Further demand constraint** is possible in order to limit growth to less than 25% above current levels by 2050. We illustrate the potential emission savings from additional demand constraint through a scenario where demand is broadly at 2018 levels in 2050. This could save up to 8 $MtCO_2e$ in 2050, and could, for example, reflect future changes in consumer preferences and social norms, or more ambitious policy.
  - **Alternative fuels.** It is possible that synthetic carbon-neutral fuels ('power-to-liquid') could be used to reduce aviation emissions. Production of such fuels would entail recycling captured CO_2 (e.g. via direct air capture, DAC) in conjunction with zero-carbon hydrogen into a drop-in replacement for kerosene. However, costs for DAC are expected to be high (e.g. in our net-zero advice we estimated that it might be around £300/tCO_2 by 2050). On top of this, production of synthetic fuels is likely to have substantial further costs given low thermodynamic efficiency and multiple processing stages, even if the input electricity comes from low-cost renewables. CO_2 captured through DAC is therefore likely to provide emissions reductions at lower cost when combined with CCS rather than it being inefficiently recycled into a fuel:
    - Once CO_2 has been captured, sequestering it geologically can provide abatement at a further cost of up to £20 per tonne of CO_2. By contrast, the cost of recycling it into a carbon-neutral fuel to displace fossil kerosene is estimated to have a further net cost of around £100 per tonne of CO_2 in 2050 (Figure A9).
    - Paying this premium to reduce aviation emissions to net-zero via synthetic fuels rather than sequestering the CO_2 would have an additional cost to the UK of £2-4 billion annually in 2050 under the level of aviation emissions in our net-zero scenario.
- **Shipping.** A range of options exist to reduce shipping emissions, some of which may allow shipping to get to near-zero GHG emissions. These include more fuel-efficient ship and engine designs, improved ship operations, and use of alternative fuels:
  - **Improvements to fuel efficiency** include measures to reduce water resistance (e.g. more efficient hull coatings), measures to improve energy efficiency (e.g. recovery of waste heat), and use of alternative sources of propulsion (e.g. kites, sails and Flettner rotors).
  - **Ship operations.** Reducing speeds at which ships travel can significantly reduce fuel use. Other operational measures include use of software to plan the most efficient routes and to optimise ballast and trim.
  - **Alternative fuels.** Use of hydrogen or ammonia could allow for zero-carbon shipping, but widespread use of biofuels or electrification is unlikely.
    - There is potential for fuel switching in shipping to hydrogen or ammonia, both of which would need to be produced in a low- or zero-carbon way (i.e. from zero-carbon electricity or with CCS). These options can be applied to new ships and retrofitted to existing ships. The potential development of an international market in hydrogen (e.g. as ammonia) shipped from countries with low costs of low-carbon hydrogen production, does raise

the possibility of this being the primary way of supplying low-carbon fuel for refuelling at ports.

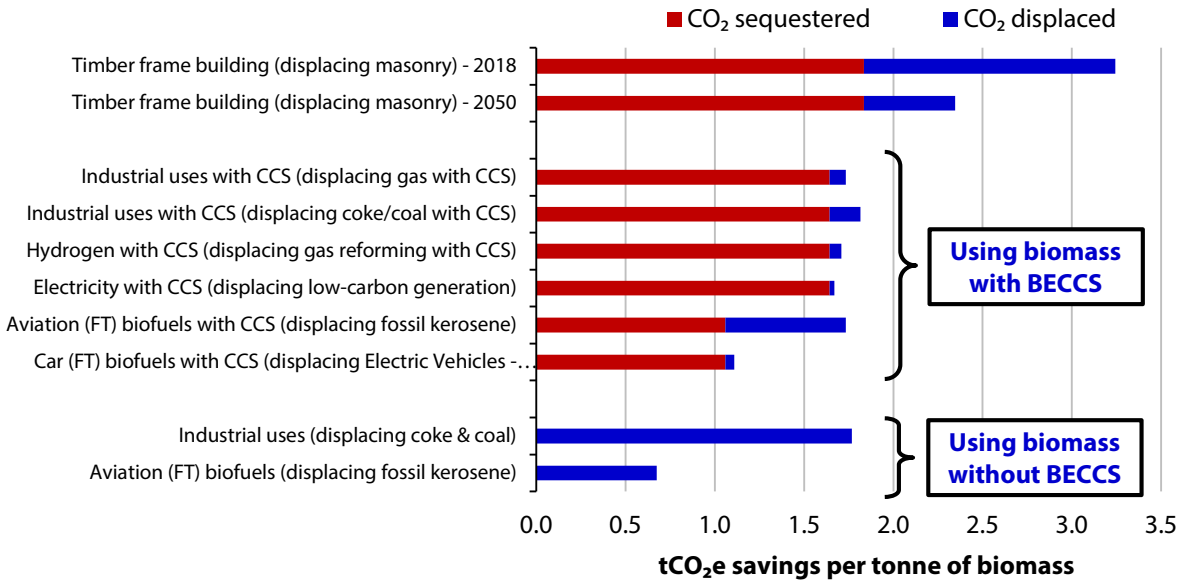
- Biofuels are technically feasible in shipping but not likely to be a priority or cost-effective given other competing uses for this resource.
- Electrification is possible for ships, but is likely to be limited to relatively short routes given energy and therefore battery requirements.

Figure A7. Aviation and shipping emission scenarios to 2050



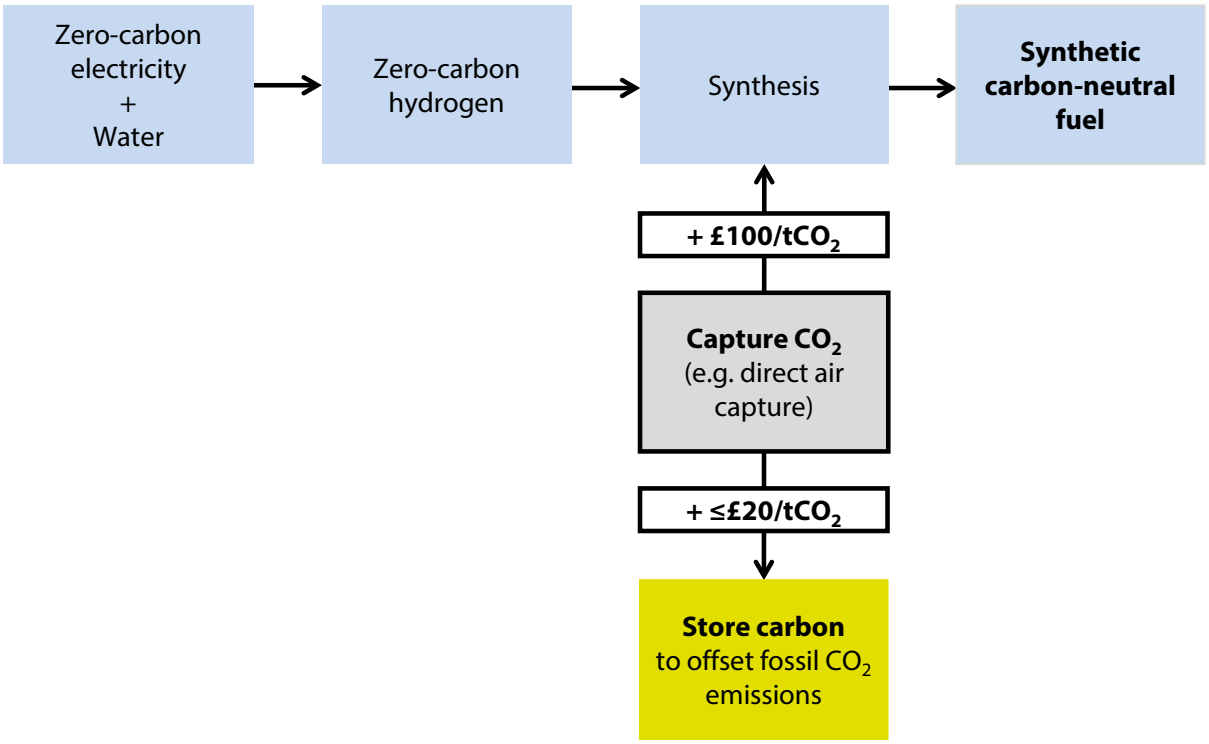
Source: CCC (2019) *Net Zero – The UK's contribution to stopping global warming (Technical Report)*.

Figure A8. Estimated GHG abatement across different biomass applications



Source: CCC (2018) *Biomass in a low-carbon economy*.
Notes: Shows estimates of GHG abatement provided by an oven dried tonne of biomass used in various sectors, considering an appropriate counterfactual (i.e. what we would expect it to be displacing, long-term).

Figure A9. Cost of storing captured CO_2 compared to cost of using it to produce synthetic fuels



Source: CCC analysis based on Royal Society (2019) *Sustainable synthetic carbon based fuels for transport*.

Getting IAS emissions to net-zero

Achieving net-zero IAS emissions will require limited use of scalable GGR offsets (e.g. BECCS or DACCS), given likely significant remaining IAS emissions in 2050 (primarily from aviation).

- GGR offsets could be funded through a requirement on IAS sectors to pay for removals, or Governments could generate revenues (e.g. through an emissions trading system or carbon tax) that can be used to pay for Government-procured removals.
- GGR offsets could in principle be delivered through international (e.g. CORSIA) or domestic policies, but must demonstrate genuinely additional removals within a robust governance framework. For CCS-based removals it would make sense for a substantial proportion of these to occur domestically, given the UK's advantages relating to availability of CO_2 storage capacity, offshore engineering expertise, and market regulation and design.
- There will not be unlimited access to GGR offsets. The potential for deploying these is limited by global constraints on land and resources. As some GGR options (e.g. afforestation) have relatively low costs but are limited in scope, it should be assumed that these opportunities will be taken in any case and will not provide additional scope to offset positive emissions elsewhere. The GGR options appropriate to offset 'hard to reduce' emissions will therefore generally be those that are highly scalable and towards the higher end of GGR costs (e.g. BECCS or DACCS).
- Offsets that do not offer potential for genuine GGR should not be pursued in the long term.

It may also be possible to deploy synthetic fuels to fully replace fossil fuel use, particularly in aviation. This could reduce emissions to gross (i.e. actual) zero. However, this is likely to be significantly more expensive than a GGR-based approach.

(iv) Implications for aviation and shipping policy

The approach to reducing IAS emissions should be through a combination of international and domestic policies. It will require a co-ordinated cross-government approach to join up the Government's clean growth, industrial strategy, and aviation and shipping objectives.

At the international level, global policies consistent with the ambition in the Paris Agreement are required to provide a level-playing field for airlines and shipping operators, and to guard against the risk of competitive distortions.

But international policies are unlikely to overcome all barriers to decarbonising the IAS sectors. Domestic policies should also be pursued where these can help overcome UK-specific market barriers, and where these do not lead to risk of carbon leakage.

Specific international and domestic policy approaches that should be considered for aviation, shipping, and GGRs include:

- **Aviation.** A package of international and domestic policy measures should be put in place that includes carbon pricing, support for research, innovation and deployment, and measures to manage growth in demand.
    - **A long-term goal for global international aviation emissions.** The ICAO's current carbon policy, CORSIA, has an end date of 2035 and will need to be based on robust rules that deliver genuine emission reductions. A new long-term goal for global international aviation emissions consistent with the Paris Agreement would provide a strong and early signal to incentivise the investment in new, cleaner, technologies that will be required for the sector to

play its role in meeting long-term targets. This is particularly important in aviation given the long lifetimes of assets. A similar approach has been agreed for global shipping emissions in the IMO, which has set a target for greenhouse gas emissions to be at least 50% below 2008 levels by 2050 (although this may need to be tightened further).

- **Support for research, innovation, and deployment in technology and alternative fuels.**
  - **Technology.** Our analysis, and that of industry, suggests the largest contribution to reducing aviation emissions will come from new technologies and aircraft designs. Many of these developments are likely to be cost-effective, given their potential fuel savings. The Government should build on the approach set out in the Aerospace Sector Deal and Future Flight Challenge, and set out a clear strategy to ensure these technology solutions are developed and brought to market in a timely fashion.
  - **Sustainable biofuels.** Some deployment of sustainable biofuels is likely to be appropriate in aviation (e.g. up to 10% of fuel use in 2050), but higher levels of uptake should be not planned for given competing alternative uses. Development of a UK market for aviation biofuels could be supported by achieving more of the 2030 Renewable Transport Fuel Obligation target through aviation fuels, subject to strong sustainability criteria being put in place. Aviation biofuels will need to be produced with CCS to be competitive against alternative uses of biomass.
  - **Synthetic fuels.** Synthetic fuels should not be a priority for government policy, but if the aviation industry wants to pursue them it should focus on demonstrating that these fuels, used in aviation, would be genuinely low-carbon, and could become cost-competitive and scalable in a global market.
- **Managing demand.** Measures should be put in place to limit growth in demand to at most 25% above current levels by 2050. These could include carbon pricing, a frequent flyer levy, fiscal measures to ensure aviation is not undertaxed compared to other transport sectors (e.g. fuel duty, VAT), reforms to Air Passenger Duty, or management of airport capacity. Research commissioned by the Department for Transport concludes that UK demand management policies in aviation are unlikely to lead to carbon leakage in aggregate.[6]
- **Airport capacity**. The Government should assess its airport capacity strategy in the context of net zero. Specifically, investments will need to be demonstrated to make economic sense in a net-zero world and the transition towards it. Current planned additional airport capacity in London, including the third runway at Heathrow, is likely to leave at most very limited room for growth at non-London airports.

[6] ATA and Clarity (2018) *The carbon leakage and competitiveness impacts of carbon abatement policy in aviation*.

- **Shipping.** The Government's Clean Maritime Plan[7] sets out many of the steps needed to decarbonise the shipping sector, and commits the UK to 'moving faster than other countries and faster than international standards'. A globally co-ordinated approach will be needed for the transition towards zero-carbon shipping, supported by domestic policies.
  - **Global policy to deliver the IMO 2050 target.** The IMO has agreed to reduce global international shipping emissions by at least 50% by 2050 compared to 2008 levels, and to pursue efforts to phase them out entirely. It must now put in a place a package of policies to deliver that target. That should include carbon pricing, support for research, innovation, and deployment, and a co-ordinated approach to provision of refuelling infrastructure for alternative fuels. Consideration should also be given to increasing the IMO's 2050 ambition, given the potential for much deeper reductions in global shipping emissions (e.g. to nearly zero through use of ammonia or other hydrogen-based fuels).
  - **Domestic policy to support the transition to zero-carbon shipping.** The main focus for domestic shipping policy should be on developing supply chains for zero-carbon fuels (e.g. hydrogen or ammonia), and the refuelling and other port infrastructure required to support this. That should include ensuring availability of key input technologies, including CCS, which will require a co-ordinated cross-government approach. It could also include support for developing and deploying these vessels (e.g. to demonstrate safety standards).
- **Greenhouse gas removal.** The Government can take steps towards enabling IAS to reach net-zero emissions in the UK and internationally by establishing a market for scalable GGR solutions (e.g. BECCS, DACCS). Such a strategy could create a significant new global export opportunity for the UK in GGR technology and expertise. This will require an effective cross-government approach across IAS and GGR policy. It highlights the importance of developing a UK CCS industry, which will be required for production of biofuels in aviation, and hydrogen and ammonia in shipping, as well as for GGRs.

These policy approaches should be reflected in the forthcoming Aviation Strategy and as the Clean Maritime Plan is taken forward.

The Committee will continue to monitor progress in decarbonising aviation and shipping as part of our annual reports to Parliament and as part of our advice on carbon budgets.

[7] Department for Transport (2019) *Clean Maritime Plan*.

Summary of projections extracted from the statistical spreadsheets disclosed by DfT to the Claimants

	- - - UK CO_2 - - -		Stansted CO_2		Stansted Passengers		Stansted ATMs	
	Departing flights (tonnes)		Departing flights (tonnes)		Scenario Modelled		Scenario Modelled	
YEAR								
	LHR NWR Base	**LHR NWR + Best Use**	**LHR NWR Base**	**LHR NWR + Best Use**	**LHR NWR Base**	**LHR NWR + Best Use**	**LHR NWR Base**	**LHR NWR + Best Use**
2020	38,874,109	38,874,109	1,460,686	1,460,686	22,137,512	22,137,512	157,037	157,037
2021	38,808,572	38,808,572	1,451,513	1,451,513	21,734,936	21,734,936	153,798	153,798
2022	39,104,343	39,104,343	1,458,974	1,458,974	21,659,296	21,659,296	152,940	152,940
2023	39,057,663	39,060,150	1,495,987	1,451,712	22,130,804	21,380,932	154,441	149,969
2024	39,134,849	39,087,646	1,543,644	1,476,895	22,978,798	21,843,462	159,436	152,670
2025	39,079,119	39,027,739	1,573,978	1,502,640	23,743,752	22,518,808	163,735	156,533
2026	42,096,425	42,060,523	1,508,445	1,452,629	22,954,938	21,948,974	156,437	150,694
2027	43,062,412	43,057,765	1,468,539	1,417,344	22,715,332	21,794,028	153,416	148,303
2028	43,601,058	43,603,079	1,424,675	1,372,281	22,251,156	21,297,632	148,386	143,144
2029	43,581,359	43,364,830	1,406,208	1,334,749	22,403,256	21,059,896	147,340	139,808
2030	43,468,312	43,378,937	1,375,866	1,324,730	22,275,988	21,270,018	145,042	138,737
2040	42,317,872	42,428,522	1,598,299	1,321,785	31,927,004	26,419,752	184,182	155,316
2050	39,945,335	40,786,072	1,668,288	1,643,223	35,491,040	36,074,640	203,835	204,800

Notes:

1) LHR NWR is the abbreviation used to denote the Heathrow third runway based on the 'North West Runway' option, which is the option that was recommeded by the Airports Commission and supported by both the Government and Heathrow Airport Ltd. It is scheduled to be built by 2026 and the above DfT forecasts are based on that assumption.

2) 'Best Use' relates to the policy of supporting expansion plans at UK airports other than Heathrow based on making best use of their existing runways. The DfT modelled this scenario to assess the impact of the policy on UK aviation CO_2 emissions. As can be seen above, it is projected to increase 2050 CO_2 emissions from 39.945Mt to 40.786Mt.

3) Under the 'Best Use' Scenario, Stansted is assumed to have a planning cap of 35mppa until 2031 and of 44.5mppa thereafter.

4) The conventional way to account for aircraft CO_2 emissions (so as to avoid double counting) is to include departing flights only, as above.