BAL/6/3
Matt Osund-Ireland
Climate Change

Bristol Airport

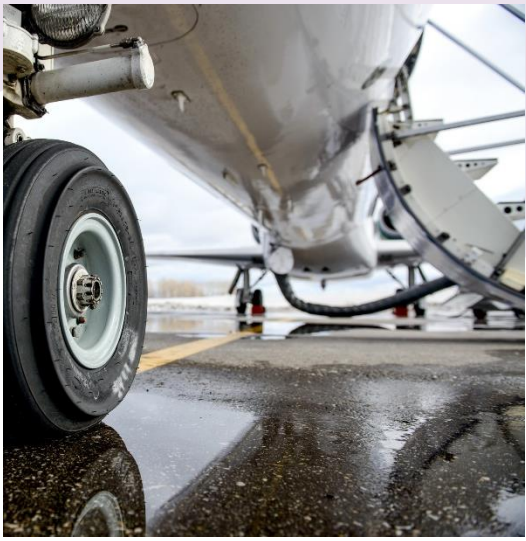
12 mppa Planning Appeal

Appeal Ref: APP/D0121/W/20/3259234

Rebuttal:

Carbon and Climate Change,

Matt Ösund-Ireland



Wood Group UK Limited – July 2021

Report for

Bristol Airport Limited

Main contributors

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Glossary of abbreviations

Table 0.1 Glossary of abbreviations

Abbreviation	Explanation
BAL	Bristol Airport Limited
CB6	Sixth Carbon Budget
CCCAP	Carbon and Climate Change Action Plan
CCC	Climate Change Committee
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)
EA	European Economic Area
ES	Environmental Statement
ESA	Environmental Statement Addendum
EU ETS	European Emissions Trading Scheme
GGR	Greenhouse Gas Removal
IAS	International Aviation and Shipping
ICAO	International Civil Aviation Organisation
IEMA	Institute of Environmental Management and Assessment
mppa	million passengers per annum
OR	Officer's Report
ppmv	parts per million by volume
UK ETS	UK Emissions Trading Scheme
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

1.1 Evidence from NSC and Rule 6 Parties

1.1.1 Following exchange of Proofs of Evidence on 15 June 2021 this Rebuttal has been prepared to address specific carbon and climate change issues raised by NSC and other Rule 6 parties, namely the evidence submitted by:

a. Dr Mark Hinnells: *Carbon* (NSC/W6/1);
b. Prof. Kevin Anderson: *Carbon and Climate Change* (BAAN/W1/1)
c. Finlay Asher: *Sustainable Aviation* (BAAN/W2/1);
d. Sam Hunter Jones: *Carbon* (BAAN/W3/1);
e. Tim Johnson: *Carbon and GHG impacts* (PCAA/W4/1);
f. Dr Alex Chapman: *Economic* Impacts (PCCA/W5/1); and
g. Liz Beth: *Planning* (XR/W4/1).

1.1.2 In addition, carbon and climate change are cited in the evidence submitted by a number of parish councillors (Ronnie Morley, Robin Jeacocke, Sarah Warren, Karen Warrington, Hilary Burn, Phil Haughton, Becky Heath and Jenny Heath, Jocelyn Ryder-Smith, Richard Osborne, Scarlett Vester and Rachel Middleton). I consider the issues raised by these councillors to be important but addressed in the evidence presented by those listed above. For the purposes of this Rebuttal, I have not provided individual responses to the issues raised by councillors.

1.2 Structure of Rebuttal

1.2.1 For the purposes of this Rebuttal, I have used the Proof of Evidence submitted by Dr Hinnells to provide the overall structure. Dr Hinnells highlights five areas in his summary and conclusions:

a. MBU;
b. Current policy;
c. Mitigations;
d. Significance; and
e. Prematurity.

1.2.2 Where Dr Hinnells has raised issues also addressed by other witnesses, I have cross referenced this evidence. Additional issues raised by other witnesses are also included in this Rebuttal:

a. Non-CO_2 emissions;
b. Aviation emissions from inbound flights; and
c. Planning Policy.

1.2.3 Where in this Rebuttal I have referred to paragraph numbering, it is either referring to the paragraph number of the witness' evidence, my evidence or this Rebuttal.

2. Making Best Use (MBU)

2.1 Dr Hinnells

2.1.1 In paragraphs 22, 68, 81, 86, 97, 100 and 109-111 of his evidence, Dr Hinnells develops an argument that the 37.5 $MtCO_2$ planning assumption for aviation is no longer valid as it was based on the UK target of reducing emissions in 2050 to 80% below 1990 levels with 'room' for sectors to trade emissions between them and, with the target now 100%, this 'room' is removed. In paragraph 193, Dr Hinnells reaches a conclusion that "*the significance of the development in carbon terms should be weighed against net zero, not against 37.5 $MtCO_2$ or 23 $MtCO_2$*".

2.1.2 As described in my evidence, the publication of *Beyond the horizon – making best use of existing runways* by the Department of Transport in 2018[1] (referred to as 'MBU') represents current UK Government policy on aviation and climate change, establishing the 'planning assumption' of 37.5 $MtCO_2$ for aviation, as previously recommended by the CCC, and as 'taken into account' in the First to Fifth Carbon Budgets. I note, however, the MBU in describing which abatement measures were included in the policy mix scenarios, states clearly that (para 1.20 with underlining added):

"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. <u>It should not be interpreted as a statement of future carbon policy</u> which will be considered through the development of the Aviation Strategy. <u>Other measures are likely to be available and may turn out to be more cost effective or have greater abatement potential</u>".

2.1.3 In the recent Appeal Decision for Stansted[2], the Planning Inspector noted:

"The in-principle support for making best use of existing runways provided by MBU is a recent expression of policy by the Government. It is given in full knowledge of UK commitments to combat climate change, having been published long after the Climate Change Act 2008 (CCA) and after the international Paris Agreement."

2.1.4 This is entirely consistent with my own understanding of the correct policy position. Government has not changed the MBU policy since the adoption on the 'net zero' target in June 2019, although it has clearly had the opportunity to do so if it thought this appropriate. Indeed, the Secretary of State for Transport made it quite clear in a Written Statement to Parliament on 27 February 2020 – long after the adoption of 'net zero' – that MBU remains Government policy. An extract from the Statement said (underlining added):

"We want Britain to be the best place in the world to do business and as a government we are committed to investing in transport and wider infrastructure as part of levelling up economic opportunities across the country, including investing in the strategic road network, proceeding with HS2, and committing £5bn of funding to improve bus and cycle services outside London.

[1] CD 6.4: Beyond the horizon - The future of UK aviation: Making best use of existing runways, Department for Transport, June 2018, *available at* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714069/making-best-use-of-existing-runways.pdf *accessed 21 April 2021*

[2] CD 9.107: Para 18

We fully recognise the importance of the aviation sector for the whole of the UK economy. The UK's airports support connections to over 370 overseas destinations in more than 100 countries facilitating trade, investment and tourism. It facilitates £95.2bn of UK's non-EU trade exports; contributes at least £14bn directly to GDP; supports over half a million jobs and underpins the competitiveness and global reach of our national and our regional economies. Under our wider "making best use" policy, airports across the UK are already coming forward with ambitious proposals to invest in their infrastructure.

We are committed to working closely with the sector to meet our climate change commitments. Our global aviation emissions offsetting scheme, sustainable aviation fuels, greenhouse gas removal technology and eventually, electric net-zero planes, will all help play their part in the aviation sector decarbonising. We also welcome Sustainable Aviation's industry led commitment to net zero carbon emissions by 2050 and the range of innovative action this will unlock to achieve this outcome. We are investing nearly £2 billion into aviation research and technology, and this year my department will publish an ambitious plan of actions setting out how we will decarbonise transport and support the UK achieving net zero emissions by 2050".[3]

2.1.5 There can be no proper suggestion that MBU does not remain current Government policy attracting full weight.

2.2 Mr Hunter Jones

2.2.1 In paragraphs 4.1 – 4.18 Mr Hunter Jones presents an argument that is centred on a criticism of the Planning Inspectorate (paragraph 4.6) stating that:

"These aspects of the 'making best use' policy do not appear to have been appreciated by the panel that recently determined the appeal made by Stansted Airport against the council's refusal of permission".

2.2.2 I do not presume to answer on behalf of the Planning Inspectorate.

2.2.3 In paragraphs 4.12 and 4.13 Mr Hunter Jones quotes from Aviation 2050 suggesting that:

"*Aviation 2050 does not take a position on the significance of aviation emissions related to this development or more generally, deferring the assessment of environmental impacts to the relevant planning decision-maker*".

2.2.4 In fact, the discussion relates to a definition of the test for significance which in this case was:

"*demonstrating that their project will not have a material impact on the government's ability to meet its carbon reduction targets*".

2.2.5 This definition is included in the quote provided by Mr Hunter Jones in paragraph 4.12.

2.2.6 Further discussions on the points made by Mr Hunter Jones are addressed by Mr Melling in his Rebuttal.

[3] Written statement to Parliament from the Secretary of State for Transport - Aviation update: 27 February 2020 *available at* https://www.gov.uk/government/speeches/aviation-update-27-february-2020 *accessed 1 July 2021*

3. Current policy

3.1 Dr Hinnells

3.1.1 In paragraph 187 Dr Hinnells states:

"Whilst the Government has adopted net zero, the overall 6CB [Sixth Carbon Budget] and determined that international aviation should be included in the UK's targets, it has not yet identified how these targets will be achieved generally nor specifically within the aviation sector, though such policy may be announced shortly and I reserve the right to change my recommendation to the LPA".

3.1.2 As I have explained in Section 2 of this Rebuttal, MBU remains the current policy for aviation and climate change.

3.1.3 In paragraph 64, Dr Hinnells identifies the UK ETS and CORSIA as measures that support MBU. As explained in my evidence, the UK ETS is applicable from 1 January 2021 and effectively caps emissions from UK flights to other UK destinations and destinations within the European Economic Area (EEA). I have taken this opportunity to illustrate how this would affect emissions from flights operating out of Bristol Airport under a 12 mppa airport, in Table 3.1 below.

Table 3.1 UK ETS and flights from Bristol Airport (12 mppa)

	Aircraft emissions ($kTCO_2$)				
Destination	**2017**	**2024**	**2030**	**2040**	**2050**
UK	45.5	49.3 *(48.5 – 49.3)*	45.8 *(45.1 – 46.5)*	41.4 *(40.3 – 42.5)*	34.7 *(32.3 – 38.2)*
EEA	387.5	416.9 *(413.5 – 420.2)*	434.2 *(427.7 – 440.7)*	423.3 *(412.3 – 434.7)*	354.8 *(330.7 - 391.1)*
Outside the EEA	39.5	43.0 *(42.7 – 43.4)*	62.4 *(61.5 – 63.4)*	62.1 *(60.5 – 63.8)*	52.1 *(48.5 – 57.4)*
Total	472.5	508.8 *(504.7 – 512.9)*	542.4 *(534.3 – 550.6)*	526.9 *(513.1 – 541.0)*	441.6 *(411.6 – 486.8)*
% Total included within UK ETS	0%*	92%	88%	88%	88%

Central emission scenario (see ES Addendum for details) is shown as the main value in the future scenario years. The range shown in brackets represents the upper and lower emission scenario.
*Note the UK ETS replaced the UK's participation in the EU ETS on 1 January 2021. In 2017, flights to UK and EEA destinations would have been covered by the EU ETS. These flights represent 92% of flights from Bristol Airport in 2017.

3.1.4 As can be seen from Table 3.1, the UK Government has an existing measure in place to cap 88 - 92% of aviation emissions from Bristol. This leaves 8-12% of aviation emissions which would be covered currently by CORSIA.

3.1.5 Referring back to paragraph 4.4.9 of my evidence, including international aviation emissions within the Sixth Carbon Budget and using the UK ETS and CORSIA to control these emissions on an ongoing annual basis is an effective and flexible response to meeting the UK's net zero target. This view appears to be supported by the UK Government which made it clear in its press release of 20th April 2021 that:

"The government will look to meet this reduction target through investing and capitalising on new green technologies and innovation, whilst maintaining people's freedom of choice, including on their diet. That is why the government's sixth Carbon Budget of 78% is based on its own analysis and does not follow each of the Climate Change Committee's specific policy recommendations."

3.1.6 In paragraph 3.2.1(q) of my evidence I quoted from the 2015 Airport Commission Final Report which refers to CORSIA (para 2.67):

"If an international deal cannot be struck (whether EU or global), UK-specific measures may be needed to ensure that aviation makes an appropriate contribution to the UK's overall carbon reduction goals."

3.1.7 Further, in paragraph 3.4.9 of my evidence I quoted from the UK Government consultation on CORSIA:

"*The UK is therefore negotiating in ICAO for a long-term goal for international aviation emissions that, like our national targets under the Climate Change Act, is consistent with the Paris Agreement. The UK is also acutely aware of its responsibility as COP26 President to push for great ambition in tackling climate change across all sectors. The UK will use the platform of COP26 to push for progress in decarbonising all sectors including aviation*".

3.1.8 I am not aware of this policy position changing with international aviation now included in the Sixth Carbon Budget.

3.1.9 In conclusion, the MBU remains as the current UK Government policy on aviation and climate change, supported by the UK ETS and CORSIA. In terms of any update to this policy, the Government has clearly signalled a shift towards investment in new green technologies and innovation. The role of technological development is recognised by the CCC in its 2021 Progress Report[4] (p32):

"The overdue Net Zero Aviation Strategy must set out credible pathways and policies to encourage technological development in the sector but also recognise the potential need to manage aviation demand in future, should improvements in sustainable aviation fuels and low-carbon aircraft fall short of Government and industry ambitions. An assessment of the UK's airport capacity strategy and a mechanism for aviation demand management should be part of the aviation strategy."

3.1.10 My interpretation of this statement is that the CCC supports the potential for technological development ahead of implementing a mechanism for aviation demand management, with a mechanism being in place should technological development not achieve sufficient reductions in carbon emissions.

3.2 Prof Anderson

3.2.1 In paragraphs 4.1 – 4.6 Prof Anderson presents his own analysis of how the global carbon budgets should be apportioned to developing countries and downscaled further to provide a UK carbon budget. He then argues (paras 4.7 – 4.9) that the carbon budgets as defined by the Climate Change Act 2008 are insufficient to meet the Paris commitments. Prof Anderson then goes on to describe the sixth carbon budget, the inclusion of international aviation and shipping and, importantly, the need to "*take steps in the immediate short term to facilitate the almost 4/5th cut in emissions in the mid-2030s*" (para 4.11).

[4] 2021 Report to Parliament, CCC *available at* https://www.theccc.org.uk/publication/2021-progress-report-to-parliament/ *accessed 28 June 2021*

3.2.2 Although Prof Anderson may disagree with the UK Government's carbon budgets they are enshrined in UK law and provide regulatory limits that reflect and, indeed, drive UK Government policy. The UK carbon budgets provide five year interval targets on a pathway to achieving carbon net zero in 2050. The point made by Prof Anderson on the need for early action is noted and, as described in my evidence (e.g. Figure 5.1), BAL is already taking measures to reduce emissions and, with the CCCAP, is providing clear commitments to reduce emissions further and well before 2050.

3.2.3 In paragraphs 5.5 – 5.9 Prof Anderson describes the EU ETS, UK ETS and CORSIA. He incorrectly states that flights into or out of the EU area are not included in the EU ETS. In fact, there is a provision within the EU ETS legislation for such flights to be temporarily excluded only until 1 January 2024 unless CORSIA is deemed to be sufficiently equivalent in reducing net emissions. He points out that aviation emissions within the EU ETS have increased, perhaps missing the point that the aim of the EU ETS is to offer flexibility in where and in which sector emission reductions can be achieved and has proven "*to be an effective tool in driving emissions reductions cost-effectively. Installations covered by the ETS reduced emissions by about 35% between 2005 and 2019*"[5]. Prof Anderson then goes on to try to discredit CORSIA and I refer to paragraphs 3.1.6 – 3.1.9 above.

3.3 Mr Asher

3.3.1 In paragraphs 8.1 – 8.4 Mr Asher discusses carbon offsetting and emissions pricing.

3.3.2 In paragraph 8.1 Mr Asher states that "*the EU ETS has always been limited to intra-EU flights only*". This is not quite true. The EU ETS has a clause that temporarily excludes extra EU flights until 1 January 2024.

3.3.3 In paragraph 8.1 Mr Asher states that: "*In future, the CORSIA scheme will replace the ETS for international aviation emissions"*. Again, this is not quite true. The UK Government is due to consult on how the UK ETS and CORSIA will interface and has made it clear that CORSIA alone will not be used to meet the UK carbon net zero target.

3.3.4 Mr Asher goes on to describe some of the weaknesses of CORSIA. I do not disagree with some of the concerns Mr Asher raises and refer to paragraphs 3.1.8 – 3.1.10 above.

3.4 Mr Hunter Jones

3.4.1 In paragraph 3.16 Mr Hunter Jones states that:

"The CCC does not view the ETS and other market mechanisms as being sufficient on their own in achieving necessary emissions reductions for the sectors and activities that they cover. Indeed, the CCC advises against placing sole reliance on carbon pricing".

3.4.2 The inclusion of international aviation within the Sixth Carbon Budget means that the UK Government is not wholly reliant on carbon pricing within the UK ETS and CORSIA to achieve the emission

[5]https://ec.europa.eu/clima/policies/ets_en#:~:text=The%20EU%20ETS%20has%20proven%20to%20be%20an,emissions%20by%20about%2035%25%20between%202005%20and%202019.

reductions required. What the UK ETS provides is a market mechanism to enable the aviation sector and, indeed, any participating sector, to realise the most cost effective means of reducing emissions (see paragraph 5.12 of Mr Hunter Jones' evidence).

3.5 Mr Johnson

3.5.1 In paragraph 5.11 Mr Johnson acknowledges that the UK Government and the CCC are aligned in not using CORSIA to meet UK climate obligations and there is no intent to use international offsets for compliance with the Climate Change Act.

3.5.2 In paragraphs 3.8 – 3.22 Mr Johnson provides an overview of aviation policy, referring to the Airports National Policy Statement, MBU, Aviation 2050 and various CCC reports.

3.5.3 In paragraph 3.10 Mr Johnson states that "*the scope of the EU ETS was subsequently reduced to intra-EU flights only, initially for twelve months, and then as a permanent amendment*". This is not quite true. The EU ETS has a clause that temporarily excludes extra EU flights until 1 January 2024.

4. Mitigations

4.1 BAL Target Commitments

4.1.1 With reference to paragraph 162 of his evidence I would like to highlight the omission made by Dr Hinnell and note that the draft CCCAP states clearly:

"*By 2021 all our operations and activities will be carbon neutral. This means all of BAL's Scope 1 and 2 emissions will be offset by the end of 2021*".

I do not accept that the targets have been set later compared to other proposals. In fact, quite the opposite, BAL has built on its existing commitments and is going further than other airport operators already by being carbon neutral in 2021 and, through the CCCAP, being carbon net zero itself by 2030 and aiming for the airport as a whole (i.e. including aviation emissions) by 2050. The CCCAP states clearly BAL's commitment to reaching the highest level set by the Airports Carbon Accreditation scheme.

Dr Hinnells acknowledges that the CCCAP is in draft form and is to be agreed with NSC and yet he criticises the CCCAP for not being complete.

4.1.2 Dr Hinnells concludes:

"In my view the draft CCCAP is a step in the right direction but it does not go far enough to set out ambitious targets and how they will be achieved. The position adopted in relation to sustainable aviation fuel is particularly disappointing given that such fuel is an essential part of the CCC and Sustainable Aviation paths to net zero. My understanding is that the Council will continue to discuss this document however with a view to securing further improvement and clear reductions in carbon emissions should permission be granted for the proposed development" (para 168).

And:

"*Whilst the CCCAP is welcome, it does nothing to guarantee an emissions trajectory that is consistent with sixth carbon budget (2033-37) and net zero in 2050 including aviation*" (para 188).

And

"*It is no answer to suggest that there are mitigations such as Sustainable Aviation Fuel, or other technologies, since these are in their technical and commercial infancy and no guarantee can be placed on them, and thus little weight should be placed on them in the planning balance*" (para 189).

4.1.3 My position is that BAL has set ambitious targets that are wholly in line with carbon net zero, namely for BAL to be carbon net zero by 2030 and for the airport as a whole to be carbon net zero by 2050. However, I do agree with Dr Hinnells that the CCCAP does not 'guarantee' an emissions trajectory to 'net zero' by 2050; instead it sets out a series of detailed measures to achieve that objective. Neither the law nor policy requires BAL to 'guarantee' a trajectory to 'net zero' by 2050.

4.1.4 At the national level, the UK Government is also committed to the UK being carbon net zero, including aviation, whilst also being very aware of the increasing proportion of total emissions that aviation will make to the net UK carbon account as we move towards net zero. Indeed, this is highlighted by Dr Hinnells (para 73):

"Aviation 2050 (CD9.29) explains that as at December 2018 UK aviation accounted for around 7% of the UK's total greenhouse gas emissions (excluding non warming impacts of aviation) but its share of emissions is likely to continue to increase as other sectors, such as energy and manufacturing, decarbonise more quickly. Thus the Government recognised that this means that carbon emissions aviation could represent a 25% share of the UK's greenhouse gas emissions by 2050 (Aviation 20250 paragraph 1.24)."

4.1.5 Dr Hinnells refers to recent consultation on decarbonising transport[6] and highlights the upcoming UK Government consultation and "*proposed plan for aviation to play its part in delivering our carbon net zero ambitions*", following the green paper (*Aviation 2050)*, the 2050 net zero target and further CCC advice on international aviation and shipping.

4.1.6 *Decarbonising transport* reiterates the UK Government commitment to:

"*negotiating in ICAO for a long-term emissions reduction goal for international aviation that is consistent with the temperature goals of the Paris Agreement*" (para 2.57).

And goes further, to state that:

"As a responsible national government, we need a contingency measure in case international progress does not go far enough or fast enough. That is why in the Government's response to the latest CCC Progress Report, we made it clear that we would be minded to include international aviation and shipping emissions in our carbon budgets if there is insufficient progress at an international level" (para 2.58).

4.1.7 Dr Hinnells acknowledges BAL is a member of the Sustainable Aviation Group that has published a road map for the UK aviation industry to achieve carbon net zero. He also identifies Destination 2050 which represents Europe's aviation sector and provides a similar roadmap albeit with more emphasis on electric and hydrogen aircraft (paras 85-87).

4.1.8 Dr Hinnells goes further (paras 126 – 130) to compare the CCC and Sustainable Aviation projections to 2050. The CCC 'balanced pathway' projection assumes UK passenger growth is limited to 25% with a range of technical mitigations which result in aviation emissions being 23 $MtCO_2$ in 2050. The Appeal Development, increasing passenger numbers by 2 mppa would represent 2.7 % of the UK's 25 % growth anticipated by the CCC[7] . Sustainable Aviation forecasts passenger numbers grow by 70%, but with a range of technical mitigations which result in aviation emissions being only 25 $MtCO_2$ in 2050. Dr Hinnells acknowledges that these forecasts of residual emissions exhibit a "*good degree of consistency about potential outcomes but not pathways*".

4.1.9 Table 4.1 of my evidence describes all five aviation growth scenarios developed by CCC, including the 'widespread innovation' scenario which includes for 50% growth in passengers and results in aviation emissions being as low as 15 $MtCO_2$ in 2050. A great many more scenarios could be developed, taking into account passenger growth, technological innovation and residual emissions. For example, a 'widespread +' scenario could be developed with a greater growth in passengers with resultant higher aviation emissions in 2050, which may be more in line with the Sustainable Aviation scenario.

[6] Decarbonising Transport: Setting the Challenge, Department of Transport, March 2020 *available at* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932122/decarbonising-transport-setting-the-challenge.pdf *accessed 28 June 2021*

[7] Total number of passengers in 2018 was 292, 245,000 at UK airports. 25% growth = 365,306,250. Difference is 73.061.250. 2,000,000/ 73.061.250 = 2.7%.

4.1.10 In the round, I agree with Dr Hinnells that the forecasts of the CCC and Sustainable Aviation exhibit a good degree of consistency about potential outcomes. Both the CCC and Sustainable Aviation agree there is a clear potential for technological innovation to reduce emissions, and they also both agree there is a need for greenhouse gas removal (GGR) technologies to 'net zero' residual emissions. The CCC has presented five different pathways, Sustainable Aviation has presented one pathway (with several iterations) and many more could be developed. The pathway that is realised, however, will depend in large measure on Government mechanisms.

4.1.11 On 22 June 2021, Sustainable Aviation issued a Press Release[8] announcing new interim decarbonisation targets of at least 15% by 2030 and 40% by 2040, having reaffirmed its commitment to net-zero by 2050:

"Today the UK's leading airlines, airports, aerospace manufacturers and air service navigation providers have reaffirmed their joint commitment to a net-zero future for UK aviation, setting out a first set of interim decarbonisation targets that will act as milestones on the path to net-zero aviation by 2050.

Industry 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 game-changing sustainable aviation fuels (SAF), permanent carbon removal, and new low and zero-carbon technologies – such as electric and hydrogen-powered aircraft – become mainstream in the 2030s".

4.1.12 In Table 4.1 of my evidence I compared the five CCC projections, including 'balanced pathway' with the projections in the ES and ESA, concluding that the assumptions made in the ES / ESA about future reductions in emissions from aviation can be described as a 'reasonable worst case' when compared to the CCC assumptions which themselves are not considered to be optimistic.

4.1.13 It is important to note here that the CCC projections are all based on the UK being carbon net zero in 2050; they are consistent with the Sixth Carbon Budget. The CCC and SA projections all assume a mix of passenger growth and technical mitigation, and all result in residual emissions that would need to be removed to achieve carbon net zero.

4.1.14 Dr Hinnells highlights the CCC acknowledgement in September 2019 that (para 83):

"The planning assumption for IAS should be to achieve net-zero emissions by 2050. This should be reflected in the 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".

4.1.15 In its 2021 Report to Parliament[4] the CCC states that (p159):

"*The overdue Net Zero Aviation Strategy must set out credible pathways and policies to encourage technological development in the sector but also recognise the potential need to manage aviation demand in future, should improvements in sustainable aviation fuels and low-carbon aircraft fall short of Government and industry ambitions. An assessment of the UK's airport capacity strategy and a mechanism for aviation demand management should be part of the aviation strategy*".

4.1.16 In the remainder of this section I will respond to this statement in three steps:

a. Technologies to reduce emissions;

[8] Sustainable Aviation Press Release, 22 June 2021 *available at* https://www.sustainableaviation.co.uk/news/uk-aviation-industry-strengthens-commitment-to-achieving-net-zero-and-launches-first-interim-decarbonisation-targets/ *accessed 29 June 2021*

b. Technologies to remove emissions; and

c. Aviation demand management.

4.2 Technologies to reduce emissions

Dr Hinnells

4.2.1 Dr Hinnells highlights some of the carbon reduction measures that could be applied (para 69):

"It is instructive see within the ANPS (CD6.9) the sorts of measures that Government sees as relevant for an airport operator to consider in order to reduce carbon emissions. These include paragraph 5.78):

a. Zero or low-emission hybrid or electric vehicle use (ultra-low emission vehicles), charging and fuel facilities;

b. Reduced engine taxiing (improved taxiing efficiency);

c. Reducing emissions from aircraft at the gate;

d. Reduced emissions from airport buildings (for example from lower carbon heating);

e. Changes to the layout of surface access arrangements; and

f. Encouraging increased use of public transport by staff and passengers".

4.2.2 *Aviation 2050*[9] includes a whole section on the role of innovation in the industry and Annex C, which provides a description of potential carbon abatement measures. Many of these measures are included in the CCCAP.

4.2.3 Dr Hinnells refers to research by his own company on behalf of the Department of Transport[10] and highlights the potential barriers to the development and use of advanced biofuels for aviation. However, it is worth noting that the same report concludes in the Executive Summary that:

"*Although substantial Government intervention is needed, the development of a SAF industry in the UK could support substantial UK low carbon growth. A high level analysis indicates that this could generate between £700m and £1,660m in GVA, with potentially half of this being generated from the export of IP and the provision of engineering services. This industry could create between 5,000 and 11,000 green jobs, and furthermore, replacing imported kerosene with domestically produced SAF would increase fuel security and have a net positive impact on the UK's balance of payments*".

4.2.4 Dr Hinnells also refers to the GFGS Green Fuels, Green Skies Competition and Renewable Transport Fuels Obligation (paragraphs 119 – 124) highlighting that these are important policy mechanisms albeit would benefit from further financial support.

4.2.5 Although not directly referring to aviation, I consider the following statement from the CCC 2021 Progress Report[4] to be insightful (p41):

[9] Aviation 2050: The future of UK aviation - A consultation, HM Government CM9714, December 2018 *available at* aviation-2050-print.pdf (publishing.service.gov.uk) *accessed 28 June 2021*

[10] Targeted Aviation Advanced Biofuels Demonstration Competition – Feasibility Study Final Report for Department for Transport, UK *available at* https://ee.ricardo.com/downloads/transport/targeted-aviation-advanced-biofuelsdemonstration-competition-%E2%80%93-feasibility-study *accessed 28 June 2021*

"Electric Vehicles. Analysis from Bloomberg New Energy Finance indicates that the cost of batteries (the most expensive part of an EV) has fallen by nearly 90% over the last decade and EVs are expected to be cheaper than fossil fuel vehicles by the mid-2020s across a range of different vehicle types."

4.2.6 Table 4.1 provides an overview of technologies already identified to improve aircraft design, provide alternative fuels, change air space and enhance ground based support. All these technologies exist and are receiving significant financial investment to bring them to commercial fruition.

Table 4.1 Technologies to reduce aviation emissions

Technology		Description of potential to reduce aviation emissions	Key barriers to implementation	Potential for improvements	Reference
Aircraft design	Fuel-efficiency improvements	Increased fuel efficiency on flights can be achieved in a number of ways including the use of lighter materials within the aircraft (including the seats, trolleys, paints and entertainment material) to reduce the weight of the aircraft. Behaviour changes have also been shown to reduce emissions though encouraging pilots to use efficient flight procedures including taxiing and assessing fuel load.	Low barriers to implementation as some options are relatively low cost. The operational lifetime of an aircraft is around 25-30 years and therefore fleet renewal is slow.	It is anticipated that such reductions could reduce emissions by 20-30% compared to a do-nothing alternative.	McKinsey & Company, 2020[11]
	Improved aerodynamics of aircraft	Improved aerodynamics results in reduced fuel-burn. Technological developments include the introduction of non-planar wings, laminar flow wing profiles and active wings.	Design evolution of jets typically takes ~15 years and is extremely expensive. Therefore there will be lag times associated with introduction of new technologies.	Fuel consumption has been shown to be reduced by between 1% - 4% for B737-800 and A320ceo.	Hasan et al., 2021[12]
	Higher efficiency aircraft	Newer generation aircraft have improved design of engines which reduce GHG emission.	The operational lifetime of an aircraft is around 25-30 years and therefore fleet renewal is slow.	Emission reductions are anticipated to be on the order of magnitude of ~1.5% per year. New technology aircraft are, on average, around 15-20% more fuel-efficient than the models they replace.	Hasan et al., 2021 IATA, 2020[13]
Alternative fuel types	Sustainable aviation fuels (biofuels and synthetic fuels)	Biofuels and synthetic sustainable aviation fuels have been found to reduce the lifecycle emissions of fuel production. The CO_2 produced in the burn stage is equivalent to the conventional jet fuel, however they result in a net reduction in emissions since the production stage absorbs CO_2. The technical feasibility of SAF is proven.	There are issues around the supply since production facilities and refineries are costly, transportation can be substantial and there is concerns of other environmental risks such as deforestation.	SAF can be blended with conventional kerosene meaning that infrastructure does not need to be changed. SAF fuels could contribute a lifecycle saving of ~80% relative to conventional fuels.	McKinsey & Company, 2020

[11] McKinsey & Company (2020). How airlines can chart a path to zero-carbon flying [online] *available at*: How airlines can chart a path to zero-carbon flying | McKinsey *accessed 5th July 2021.*

[12] Hasan, M.A., Mamun, A.A., Rahman, S.M., Malik, K., Al Amran, M., Uddin, I., Khondaker, A.N., Reshi, O., Tiwari, S.P. and Alismail, F.S., (2021). Climate Change Mitigation Pathways for the Aviation Sector. Sustainability, 13(7), p.3656 accessed 5th July 2021.

[13] IATA (2020). Carbon offsetting for international aviation *available at:* https://www.iata.org/contentassets/fb745460050c48089597a3ef1b9fe7a8/paper-offsetting-for-aviation.pdf *accessed 5th July 2021.*

Technology		Description of potential to reduce aviation emissions	Key barriers to implementation	Potential for improvements	Reference
	Hydrogen	There are several processes to generate hydrogen; significant interest exists for Power-to-Liquids 'electrofuels'. This pathway allows the production of a synthetic alternative to fossil kerosene through the use of renewable electricity to produce hydrogen from water by electrolysis and a combination with carbon from CO2 (ideally captured from the air).	The current aviation technology roadmap suggests that battery- and hydrogen-powered commercial passenger aircraft (known also as zero-emissions and zero-carbon aircraft, respectively), will enter into service by 2040, allowing them then to compete in the short-haul market segment.	The Power to-Liquid process can present greenhouse gas balances with close to zero emissions.	Schmidt et al., 2017[14] Deloitte, 2021[15]
	Electric or hybrid aircraft	Alternative propulsion (including electricity, hydrogen or hybrid systems) could replace conventional turbine-powered planes.	Use of fully electric aircraft on commercial aircraft with more than 100 passengers appears unlikely within the next 30 years. Battery weight remains an issue. Hydrogen is more commercially competitive relative to conventional fuels.	Hybrid- propulsion on smaller, lighter or short-haul flights may be viable in the medium-term resulting in less fuel use. Commercial passenger aircraft are expected to enter into service by 2040 and are designated s zero-emission (battery) / zero-carbon (hydrogen-fuelled) aircraft.	McKinsey & Company, 2020 Deloitte, 2021 Hasan et al., 2021
	Fourth-generation biofuels (FGB)	FGB are mostly derived from genetically modified algae meaning that there is n[16]o competition with conventional crops for land use. This could lead to large scale production of FGBs.	Large scale production has not yet occurred and is not sufficient to meet demand.	Costs of SAF are expected to reduce over time but currently remain high.	McKinsey & Company, 2020
	Electrofuels	Power-to-Liquid (PtL) electrofuels are associated with the production of a synthetic alternative fuel to fossil kerosene through the use of renewable electricity to produce hydrogen from water by electrolysis. PtL requires minimal or no modification to existing aircrafts, engines and ground refuelling infrastructure.	Electofuels are 3-6 times more expensive than kerosene and are therefore not produced at scale, despite being commercially viable. Production requires a large	Emissions are close to zero.	EASA, 2019[17]

[14] Schmidt, P., Batteiger, V., Roth, A., Weindorf, W. and Raksha, T., 2018. Power-to-Liquids as Renewable Fuel Option for Aviation: A Review. Chemie Ingenieur Technik, 90(1-2), pp.127-140 *accessed 5th July 2021.*

[15] Deloitte (2021). Europe's future aviation landscape: The potential of zero-carbon and zero-emissions aircraft on intra-European routes by 2040 *available at:* deloitte-nl-future-of-mobility-europe-future-aviation-landscape-2040.pdf *accessed 5th July 2021.*

[17] EASA (2019). European Aviation Environmental Report *available at:* Sustainable Aviation Fuels | European Aviation Environmental Report (europa.eu) *accessed 5th July 2021.*

Technology		Description of potential to reduce aviation emissions	Key barriers to implementation	Potential for improvements	Reference
			amount of renewable energy which may limit supply.		
	Other fuel sources	Other non-traditional fuel sources such as municipal household waste are under investigation as potential fuel sources.	The technology is still unproven at scale and further research and development is needed.	Emission savings are not sufficiently understood at this stage, although likely to be substantial relative to conventional jet fuel.	McKinsey & Company, 2020
	Solar	Solar energy can be used as a zero-emission driving force for the aviation. Thus far, the feasibility has been demonstrated only for small aircraft. Currently, solar energy can provide the required electrical power to operate various services within the plane including loading and unloading, internal heating, ventilation, air conditioning of aircraft obtained through the auxiliary power unit (APU), or receiving power and pre-conditioned air either from a ground power unit or directly from the gate.	There are currently limitations to the technology pertaining to generation and storage procedures.	More research is underway to determine the feasibility of using it for the larger commercial airliners. Though in March 2015, Solar Impulse 2, a just solar-powered airplane with 17,000 solar cells on its wings, began a circumnavigation journey around-the-world spending 23 days in the air.	Hasan et al., 2021
Air space change	Airspace modernisation	Airspace modernisation relates to navigational improvements to make better use of airspace and streamline the routes taken by aircraft to cut down on flight time and therefore minimise fuel burn and emissions.	Airspace modernisation requires planning consultation and approval and can therefore take time to implement.		IATA, 2020
	Flight optimisation	Optimisation of flight schedules, aircraft speed, aircraft type and appropriate fuel loads will lead to efficiencies.			IATA, 2020
Ground based solutions	Optimising airport layout	Optimising airport layouts could improve the throughput, minimise the taxiing time between runways and gates and prevent unnecessary holding of aircraft.	Reducing these inefficiencies requires collaboration from a large group of stakeholders including regulators, airlines and airport operators.		IATA, 2020 Hasan et al., 2021

Mr Asher

4.2.7 In paragraphs 4.1 - 4.8 Mr Asher argues that increasing the fuel efficiency of aviation does not necessarily reduce emissions. Mr Asher states (paragraph 4.5):

"*The key metric for the earth's atmosphere is not emissions per passenger mile, but rather total emissions produced by aviation*".

4.2.8 I agree with this statement and note that UK aviation emissions are reported as total emissions, as are emissions from Bristol Airport.

4.2.9 Mr Asher goes on to state (paragraph 4.6):

"It would be a reasonable assumption to project that aviation emissions will continue to grow on a similar trajectory if air traffic growth remains unregulated, even if efficiency improvements continue".

4.2.10 Again, I agree with this statement and note that UK aviation emissions are regulated as total emissions.

4.2.11 In paragraphs 5.1 – 7.7 Mr Asher provides an overview of the potential for electric flight, hydrogen, and sustainable aviation fuels to reduce aviation emissions. He identifies the technologies listed in Table 4.1 above and provides a more cautious view on whether such technologies would, in practice, succeed.

4.2.12 I do not intend to support or dismiss any one or more of these technologies but note that the UK Government has made it clear that the UK aviation sector is included within the carbon net zero target, has set the framework for regulation and reporting, and the UK aviation sector has responded and confirmed its commitment to being carbon net zero by 2050. These technologies represent some of the solutions available to the aviation sector to meet its carbon net zero commitment.

Mr Johnson

4.2.13 In paragraphs 5.1 – 5.16 Mr Johnson provides an overview of technical measures to reduce aviation emissions, including the barriers to their implementation, how carbon pricing may act in managing demand and CORSIA. In paragraph 5.13 Mr Johnson refers to the same report as Dr Hinnells and also misses the same concluding statement, which I have included in paragraph 4.2.3 above for clarification.

4.2.14 I have discussed CORSIA in Section 3 of this Rebuttal and refer to the evidence of Mr Brass regarding carbon pricing.

4.3 Technologies to remove emissions

4.3.1 Greenhouse gas removals (GGRs)[18]:

"'is the name given to a group of methods that actively remove greenhouse gases from the atmosphere. There are a range of methods which may be counted as GGRs – from nature-based solutions such as afforestation, to engineered solutions such as Direct Air Carbon Capture and Storage (DACCS), which separates a stream of CO_2 from the air that can then be captured and stored".

Dr Hinnells

4.3.2 Dr Hinnells states (para 136):

"*Where a net addition to UK carbon emissions will arise then the question arises whether there is evidence that GGR measures will be available in 2050 to enable an increase in capacity whilst still achieving net zero*".

4.3.3 This statement appears to mirror the recommendations for the next steps toward GGR delivery outlined by the CCC[5] (p44):

"Greenhouse Gas Removals (GGR). There is growing international research and development into engineered GGRs, with a small number of test facilities in operation globally. Additionally, several major global companies have recently made commitments to purchase GGRs to compliment the use of renewables and improved resource efficiency to meet their Net Zero targets. Although small at present, corporate commitments such as these, if replicated more widely, could provide an early market for dedicated GGR credits – helping to facilitate the development and cost discovery needed for engineered removals to play a role in reaching Net Zero."

And pp186-187:

"The Net Zero Strategy should set out expected amounts and timings of land-based and engineered removals (i.e. bioenergy with CCS (BECCS) and direct air carbon capture and storage (DACCS)) in contributing to meeting the Sixth Carbon Budget and the Net Zero target. These should avoid over-reliance on these solutions".

"Building on the results of the BEIS GGR consultation, policy on governance and support mechanisms should be developed over the next year in order to enable GGR scale-up during the mid-late 2020s. This should include enabling domestic engineered removals to contribute to UK carbon budgets and Net Zero, establishing GGR monitoring, verification and reporting structures that ensure that GGR is sustainable and verifiable, and setting out support mechanisms that align with the expectations for the role and timing of GGR contribution to UK emissions reductions".

"More generally, as GGR by BECCS and DACCS is reliant on CCS infrastructures for the storage of the removed CO_2, it is critical that CCS is established in a consistent timeframe and in a manner that allows for the usage of CO_2 pipeline and storage for removals".

4.3.4 The definition of GGR quoted above was provided by the Greenhouse Gas Removals Team of the UK Department of Business, Energy and Industrial Strategy in the recent call for evidence on GGRs, as referred to by the CCC above. It is clear from the call for evidence that the UK Government recognises the current constraints in the GGR market due to a number of barriers but provides a strong statement of policy intent (p4):

[18] Greenhouse Gas Removals - Call for Evidence, HM Government, December 2020 *available at* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/941191/greenhouse-gas-removals-call-for-evidence.pdf *accessed 1 July 2021*

"*The government intends to position the UK at the forefront of new markets for low carbon technologies and services in the transition to net zero, and there will likely be substantial economic opportunities for the UK to lead the way in developing and adopting cutting-edge GGR approaches*".

4.3.5 Tables 4.2 and 4.3 have been compiled to provide a summary of GGR technologies, in terms of carbon capture and carbon storage, largely based on reports either published or commissioned by the UK Government or CCC. All these technologies exist and are receiving significant financial investment to bring to commercial fruition.

Table 4.2 Technologies to capture carbon emissions

Technology		Description of potential to reduce aviation emissions	Key barriers to implementation	Reference
BECCS	Bioenergy with carbon capture and storage.	These technologies convert biomass, biogas and biogenic wastes into another energy vector (power, heat, hydrogen, fuels or methane), while at the same time capturing 90%+ of the biogenic CO_2 produced and sending it for geological sequestration. Storage can be completed via either direct air capture (DAC-CCS route) or via point-source capture (PSC-CCS route). BECCS can result in negative greenhouse gas emissions by the aviation industry.	Though the aviation sector has experience with biofuels and CCS is relatively well understood, BECCS has struggled to move beyond demonstration projects for saline sequestration and there are limited commercial projects that use CO_2 in enhanced oil recovery. Efforts to combine the two technologies further remain limited due to costs.	(CCC, 2020)[19]
CCS	Post-combustion carbon capture	This is the primary method used in existing power plants. Here the CO_2 is separated from the exhaust following the combustion process. The efficiency of carbon dioxide capture depends on the concentration of carbon dioxide within the flue gases of a power plant. Post-combustion carbon capture is thus the least efficient as the process depends on dilute CO_2 concentrations.	Commercially available post-combustion capture technologies increase the cost of energy generation whilst also reducing a plant's efficiency. Additionally, the technologies necessary to reduce the cost of capture, have not been demonstrated at scales large enough for power plant applications.	(RRF, 2020)[20]
	Pre-combustion carbon capture	Commercially available pre-combustion capture technologies are used by industrial facilities. For power plants, pre-combustion capture is still in early stages. This technology involves gasifying fuel and separating out the CO_2. Due to the more concentrated CO_2, pre-combustion capture typically is more efficient, but the capital costs of the base gasification process are often more expensive	For the time being, this can only be built into new facilities as costs of retrofitting an existing facility for pre-combustion capture is too costly.	(RRF, 2020) (US DOE, 2021)[21]
	Oxy-fuel combustion systems	The fuel is burned in a nearly pure-oxygen environment, rather than regular air, resulting in a concentrated stream of CO_2 emissions, which is easier to capture.	Using oxy-fuel combustion requires more capex (oxygen plant, flue gas recirculation), and can produce a lower power output as the oxygen plant and gas compressor demand power.	(RRF, 2020)

[19] CCC (2020). Climate Change Committee. The Sixth Carbon Budget Aviation *available at:* https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf *accessed 5th July 2021*

[20] RRF (2020). Resources for the future. Carbon Capture and Storage 101 *available at:* CCS_101.pdf (rff.org) *accessed 5th July 2021*

[21] US DOE (2021). US Department of Energy. Pre-combustion Carbon Capture Research *available at:* https://www.energy.gov/fe/science-innovation/carbon-capture-and-storage-research/carbon-capture-rd/pre-combustion-carbon *accessed: 5th July 2021*

Technology		Description of potential to reduce aviation emissions	Key barriers to implementation	Reference
DAC	Direct air capture	Direct air capture technologies extract CO_2 directly from the atmosphere. There are mainly two technologies available for this approach; liquid systems that pass air through chemical solutions (e.g. a hydroxide solution), removing the CO_2 and returning the rest of the air to the environment, and solid direct air capture technology which makes use of solid sorbent filters that chemically bind with CO_2. When the filters are heated, they release the concentrated CO_2, which can be captured for storage or use.	The CO_2 in the atmosphere is more dilute than the flue gas from a power station or a cement plant. This contributes to higher energy needs and costs for direct air capture relative to other CO_2 capturing technologies and applications. Additionally, as the technology has yet to be demonstrated at large scale, the future cost of direct air capture is uncertain.	(IEA, 2020)[22]

[22] IEA (2020). Direct Air Capture *available at:* Direct Air Capture – Analysis - IEA *accessed: 5th July 2021*

Table 4.3 Technologies to store captured carbon

Technology	Description of potential to reduce aviation emissions	Key barriers to implementation	Reference
Geological storage	Once the CO_2 is captured, for geological storage it is compressed into a fluid and transported to an appropriate storage site. This is usually by pipelines and/or ships, and occasionally by trains or other vehicles. The CO_2 is injected into deep, underground geological formations, where it is stored long term, rather than being released into the atmosphere. Storage sites used for CO_2 include former oil and gas reservoirs, deep saline formations, and coal beds.	There are challenges and high costs associated with transporting CO_2 once it is captured. Significant energy is required to compress CO_2 and maintain high pressure throughout pipelines, and the pipelines themselves are expensive. Additionally, each source of CO_2 must be connected to an appropriate storage site via pipeline, which can make CCS more difficult and expensive to implement in areas without geological formations that are appropriate to use for storage.	(RRF, 2020)
Storage in plastic	This process involves cleaning and compressing the captured CO_2 before it is converted by chemical reactions into a form of plastic. Producing plastics in this way, for example polyurethane, could provide an immediate short-term reduction in greenhouse gas (GHG) emissions.	There is often a trade-off between an encouraging emissions balance (i.e., decreased emissions) and difficulties with establishing the necessary technology and infrastructure. Furthermore, for some products, there may currently be an insufficient global market to ensure economic viability. However, the production of polyurethane does appear to be the most promising for the UK and could provide an immediate short-term mitigation solution for GHG emissions.	(Hankin et al., 2019)[23]
Storage in building materials	The sequestered carbon can be used to create construction materials, utilising chemical reactions that then ensure the CO_2 remains stored within the material.	For some materials the volume of stored carbon dioxide must be increased significantly. There are in addition issues related to scale as a whole.	(Xi et al., 2016)[24]
Storage in food (micro algae, etc)	Bio-sequestration of CO_2 using microalgal cell factories has emerged as a promising way of recycling CO_2 into biomass via photosynthesis. This in of itself can then be used for the production of bioenergy and other value-added products.	There are difficulties associated with scaling this process due the overall costs of production in relation to the value of the by-products produced.	(Singh and Dhar, 2019)[25]

[23] Hankin, A., Guillén Gosálbez, G., Kelsall, G., Dowell, N., Shah, N., Weider, S. and Brophy, K. (2019). Assessing the economic and environmental value of carbon capture and utilisation in the UK. *available at*: https://spiral.imperial.ac.uk/bitstream/10044/1/70818/7/IMSJ7227-Briefing-Paper-190625-WEB.pdf *accessed 5 July 2021*

[24] Xi, F., Davis, S.J., Ciais, P., Crawford-Brown, D., Guan, D., Pade, C., Shi, T., Syddall, M., Lv, J., Ji, L. and Bing, L., (2016). Substantial global carbon uptake by cement carbonation. Nature Geoscience, 9(12), pp.880-883.

[25] Singh and Dhar (2019). Overview of Carbon Capture Technology: Microalgal Biorefinery Concept and State-of-the-Art available at: Frontiers | Overview of Carbon Capture Technology: Microalgal Biorefinery Concept and State-of-the-Art | Marine Science (frontiersin.org) *accessed 5 July 2021*

4.3.6 In summary, the aviation sector needs GGRs to achieve carbon net zero. This is agreed by Dr Hinnells, the UK Government, the CCC, Sustainable Aviation and BAL. The Government and the CCC have identified a number of GGR technologies that could be developed and utilised, and both recognise the need for a clear strategy of investment. The UK Government has provided a strong statement of policy intent to capitalise on the economic opportunities for the UK to lead the way in developing and adopting cutting-edge GGR approaches.

Prof Anderson

4.3.7 In paragraphs 4.12 – 4.15 Prof Anderson appears to dismiss the potential of GGR technologies, even considering the CCC's expectations to be "*enormously optimistic*". This appears to be in contradiction with Dr Hinnell's view of GGR and, indeed, the UK Government's stated position (see paragraph 4.3.4 above).

4.4 Aviation demand management

4.4.1 The CCC has long advocated restricting future airport expansion as an approach to limiting aviation demand.

4.4.2 The UK ETS and CORSIA provides a market based approach to demand management that does not require UK Government to make arbitrary decisions on which airports can expand, which cannot expand and, potentially, which need to contract. This market based approach places the responsibility to manage emissions on the airlines, using a combination of investment in reduction and removal technologies and, if required, purchase of emission allowances from the UK ETS or verified offsets from CORSIA.

4.4.3 I have described the UK ETS and CORSIA in my main evidence and note, from Table 3.1 presented earlier, 88 % of aviation emissions from Bristol Airport would fall within the UK ETS cap and the remaining 12 % would fall under CORSIA.

4.4.4 In summary, I consider the most appropriate means of achieving carbon net zero in the aviation sector is to manage emissions *directly* rather than manage emissions *indirectly* by trying to restricting passenger numbers.

Prof Anderson

4.4.5 In paragraph 7.2 Prof Anderson implies that the CCCAP is:

"*substantially misrepresenting the CCC's suggestion that 25% passenger growth could be compatible with the UK achieving its climate goals, since it fails to point out that the CCC makes this suggestion with the crucial caveat that this should only be achieved with* ***no net expansion of UK airport capacity***" (Prof Anderson's emphasis).

4.4.6 In Table 4.1 of my evidence I provide the detail of the five scenarios developed by the CCC. The 'widespread innovation' scenario allows for twice the level of growth assumed in the 'balanced

pathway' scenario. As previously stated, the most appropriate means of achieving carbon net zero in the aviation sector is to manage emissions directly.

4.5 Summary

4.5.1 The UK is committed to being carbon net zero and that includes aviation. This could be achieved through a combination of emissions reduction and GGR technologies and innovation, driven by existing market measures such as Government incentives, the UK ETS and CORSIA. Notwithstanding that, the CCC recommends limiting growth in airport capacity should these be insufficient. Whereas the UK Government is clearly supporting technologies and innovation, and has included aviation in the carbon budgets towards being carbon net zero in 2050, it is not Government policy to limit growth in airport capacity:

"The government will look to meet this reduction target through investing and capitalising on new green technologies and innovation, whilst maintaining people's freedom of choice, including on their diet. That is why the government's sixth Carbon Budget of 78% is based on its own analysis and does not follow each of the Climate Change Committee's specific policy recommendations."

(UK Government press release of 20th April 2021).

4.5.2 In responding to the Sustainable Aviation press Release of 22 June 2021, Secretary of State for Transport Grant Shapps MP said:

"As the first major economy in the world to commit to net-zero by 2050, we are leading the charge to cut aviation emissions through the Jet Zero Council.

"The commitment shown here by industry today builds on that work, embodying the forward-thinking attitude we need to decarbonise the sector and put the UK at the forefront of green aviation."

4.5.3 Commenting on the launch of the Sustainable Aviation targets, Secretary of State for Business, Energy, and Industry Strategy Kwasi Kwarteng MP said:

"These targets are an important milestone for the British aviation industry and show that airports, aerospace manufacturers and airlines share in our ambition to adopt the new and emerging technologies necessary to fight climate change.

"Working with industry through our Jet Zero Council, we are putting the decarbonisation of the aviation sector at the centre of our plans to build back greener from the pandemic and this industry roadmap complements our vision perfectly."

5. Significance

5.1 Dr Hinnells

5.1.1 Dr Hinnells argues that the inclusion of aviation within the Carbon Sixth Budget and the shift in the 2050 policy target from 80% to 100% reduction below 1990 levels means the 37.5 $MtCO_2$ planning assumption is no longer valid. He goes on to argue that:

"The significance of the development in carbon terms should be weighed against net zero, not against 37.5 $MtCO_2$ or 23 $MtCO_2$".

5.1.2 Whilst the 37.5 $MtCO_2$ 'planning assumption' was taken into account in setting the First to Fifth Carbon Budgets, I agree that this is no longer relevant for the Sixth Carbon Budget (and beyond) and stated as such in my evidence (para 2.2):

"The inclusion of international aviation within the Sixth Carbon Budget would negate the need for a 'planning assumption' but not change the pathway to carbon net zero".

5.1.3 It is worth reiterating that the UK aviation industry, as represented by Sustainable Aviation, is committed to being carbon net zero by 2050 and this is supported by UK Government.

5.1.4 In my evidence I presented two approaches to assessing significance. The second approach was based on a determination of whether the change in carbon emissions would prevent UK Government achieving net zero GHG emissions by 2050. I addressed this by considering in turn: aviation emissions; emissions from the airport buildings and ground operations; and emissions from surface access.

5.1.5 In my evidence I reported aviation emissions would reduce with the Appeal Proposal compared to 2017 with 'reasonable worst case' assumptions of future aviation technologies. I also highlighted the UK ETS, CORSIA and the investment being made in new technologies. My conclusion was that the Government is providing clear mechanisms for capping aviation emissions within UK carbon budgets and encouraging the industry to drive emission reductions through innovation to make best use of existing runways.

5.1.6 I note that BAL is a member of Sustainable Aviation, has a track record in reducing emissions, is committed to being carbon net zero by 2030 and is targeting the airport as a whole to be carbon net zero by 2050 and is supporting one of the technologies investments made by UK Government.

5.1.7 My conclusion from this is that BAL is working in the same direction as the aviation industry and the UK Government in being carbon net zero by 2050 and that the Appeal Proposal does not prevent UK Government achieving net zero GHG emissions by 2050.

5.1.8 The issue of how Government is seeking to ensure that aviation emissions will be carbon net zero by 2050 is addressed in Section 4 of this evidence.

5.2 Prof Anderson

5.2.1 In paragraphs 6.3.1 – 6.3.3 Prof Anderson refers to the planning assumption of 37.5 $MtCO_2$ as outdated and suggests there is an error in not using the CCC recommendation of 23 $MtCO_2$. It is difficult to understand the logic of his point, however, as 23 $MtCO_2$ is not the 'planning assumption' that was actually used in setting the First to Fifth Carbon Budgets (set in secondary legislation) and there is no need for a 'planning assumption' in the context of the Sixth Carbon Budget (also set in secondary legislation) as no 'headroom' allowance needs to be 'taken into account' under section 10 of the Climate Change Act 2008.

5.2.2 Prof Anderson also suggests some mathematical illiteracy in the assessment of the project when compared to a much larger whole. Notwithstanding the discussion above regarding the use of carbon net zero as the reference for significance, I note that Prof Anderson goes on to suggest a 1.9 factor is applied, despite acknowledging that *"the CCC has advised that non-CO_2 effects should not be accounted for in the UK's carbon budgets, because it is challenging to aggregate their effects accurately"* (para 6.1.3). He then goes further, suggesting that the emissions calculations should include both inbound and outbound flights (paragraph 6.5.1) which would appear to only result in global aviation emissions being double counted (see paragraph 8.2.1 below). Prof Anderson goes even further (paragraphs 6.7.1 - 6.7.7), referring to research from his university and, in Table 3, suggests the allocation of annual aviation emissions from Bristol Airport to North Somerset Council. This is in clear contradiction of UK Government policy advice which requires aviation emissions to be assessed at a national level (see paragraphs 3.2.1.v of my evidence which refers to MBU) and inevitably results in the assessment of the project when compared to a much smaller whole.

5.3 Mr Johnson

5.3.1 In paragraph 3.14 Mr Johnson refers to the planning assumption of 37.5 $MtCO_2$ being "*not compatible with the UK's new trajectory to net zero by 2050*" and, in paragraph 3.22 summarises:

"*while existing aviation policy references keeping UK aviation emissions at or below 37.5MtCO2 by 2050, following the introduction of net zero legislation and the subsequent commitment to include IAS in carbon budgets any assessment of greenhouse gas emissions should also take account of the likely increase in Government ambition for the sector in the near future*".

5.3.2 I refer to paragraphs 5.1.1 – 5.1.3 above.

6. Conditions

6.1.1 Dr Hinnell sets out four requirements which I have summarised in Table 6.1 below with BAL's responses.

6.1.2 I do not consider any of these proposed conditions to be onerous although some clarification in the detail is required.

Table 6.1 Proposed NSC Conditions and BAL Response

	Proposed NSC Condition	BAL Response
a	A carbon roadmap updated every 5 years, in line with carbon budget periods (or as significant changes in policy require)	Agreed and already included in the CCCAP
b	The roadmap would need to show how BAL intended to implement national policy locally. This includes showing how BAL is taking its share of national policy targets, including specific carbon budget periods.	Agreed that the roadmap will show how BAL intends to implement national policy locally. Describing how BAL shows it is taking its share of national policy targets, including specific carbon budget periods to be defined.
c	The roadmap would need to cover carbon emissions from surface access; carbon emissions from ground based assets; how the airport will work with airlines to deliver aviation emissions reductions including provision of alternative fuels; and if national policy requires it, to manage non-carbon warming impacts	Agreed with additional detail to be added to the CCCAP as appropriate
d	If the CCCAP objectives were not met (i.e. projected carbon emissions were not met) there would need to be a mechanism for enforcement, just as there might be for a development which breaches air quality or noise policy. This may include asking for revised carbon plans to bring emissions within an agreed limit. But ultimately a breach of the plan should be considered a breach of the consent with the usual remedies.	Agreed subject to the mechanism for enforcement meeting national regulations and policy.

7. Prematurity

7.1.1 In paragraphs 196 to 200, Dr Hinnells presents an argument that approval should not be given for any airport expansion. He argues:

a. *"BAL has not demonstrated that all of the expansion plans of all of the airports in the UK can be accommodated with the available mitigation measures in the sixth carbon budget period and forward to 2050. Indeed, BAL has not carried out any kind of cumulative impact assessment.*

b. *It is no answer to contend that airport expansion schemes should be permitted since their use can be subsequently regulated by central Government introducing controls to inhibit the use of any increase in capacity.*

c. *If in reality a proportion of the benefits of a scheme will not be capable of coming forward, or there is a substantial risk that it will not, then that proportion of the benefits must not be taken into account by a planning decision maker or it should be given limited, if any, weight in the planning balance.*

d. *A choice has to be made as to which airport expansion plans should come forward and which should not. That choice can only be made at a national level by Government via a comparative exercise which examines all of the competing potential airport expansion proposals against a wide range of considerations relevant to the achievement of sustainable development (i.e. the economic social and environmental objectives of sustainable development). In such an exercise, all of the competing expansion proposals, including the Proposed Development, would need to be considered and compared, with only the highest ranked being selected to come forward and to utilise the carbon budget available and which can be offset. The decision as to which airports can expand and which cannot is a matter of central Government and not for determination in a Section 78 appeal. That comparative exercise has not been undertaken.*

e. *Since the grant of planning permission would prejudge the outcome of that exercise, to grant planning permission for appeal scheme now would be premature."*

7.1.2 My response to these arguments are as follows:

a. It is not for BAL to demonstrate that all expansion plans of all airports in the UK can be accommodated.

b. There are existing controls used by the UK Government to control carbon emissions from aviation, namely the UK ETS and CORSIA. The UK Government has included domestic and international aviation within the Sixth Carbon Budget and aviation emissions are limited within that budget, subject to the UK ETS cap and trade mechanism and CORSIA offsets.

c. If the benefits of the scheme cannot come forward then corresponding costs will also not come forward. I note that the air traffic forecasts for the Appeal Proposal envisage Bristol Airport reaching 12 mppa between 2027 and 2034. This is not disputed by NSC. I will refer to Mr James Brass for further discussion on this point.

d. There is no Government policy that the location of future airport expansion has to be determined at a national level. Government has put in place measures to control aviation emissions at a national level and the merits of such measures and policy are not matters for debate at a planning inquiry.

e. This is plainly wrong.

8. Other Issues

8.1 Non-CO_2 emissions

8.1.1 In paragraphs 6.1.1 – 6.1.3 Prof Anderson refers to non-CO_2 emissions as does Mr Asher in paragraph 3.4 of his evidence, Mr Johnson in paragraphs 4.1 – 4.3 of his evidence and Dr Chapman in paragraphs 9.2.8 – 9.2.12 of his evidence.

8.1.2 In my evidence I also refer to non-CO_2 emissions (e.g. section 3.7) concluding that:

"non-CO_2 emissions cannot be ignored and need to be acknowledged today so choices made in the technologies used to reduce aircraft emissions do not result in non-CO_2 impacts increasing; as the scientific understanding increases, the choices of technology will become better informed. This is fully acknowledged by UK Government and by the CCC. BAL also acknowledges this in its Carbon and Climate Change Action Plan (CCCAP – see Section 5 of my evidence) and I consider this the most appropriate approach to address this issue".

8.1.3 I note that this approach and its inclusion in the CCCAP is agreed with NSC and will form part of the planning conditions.

8.2 Aviation emissions from inbound flights

8.2.1 In paragraphs 9.3.2 – 9.3.3 Dr Chapman argues that aviation emissions from inbound flights should be included in the calculation. Dr Chapman applies a simple calculation and doubles the aviation emissions. I consider this approach to be flawed in at least two ways. Firstly, if Dr Chapman is applying this to all UK airports then this would result in double counting of emissions from flights that originate and end at UK airports. Secondly, if Dr Chapman is applying this to all airports globally then he would need all airports to apply this approach, otherwise emissions will be double counted.

8.3 Planning Policy

8.3.1 In paragraphs 6.1 – 6.2 Liz Beth highlights paragraph 148 of the National Planning Policy Framework, Policy CS23 of NSC's Core Strategy and Policy DM50 of NSC's Sites and Policies Plan. These are also identified in my evidence (paragraphs 3.5.1 - 3.5.10) and addressed accordingly in paragraphs 4.4.13 – 4.4.22.

9. Summary and Conclusions

9.1.1 My rebuttal to the evidence provided by NSC and Rule 6 parties can be summarised as follows:

a. The MBU remains as the current UK Government policy on aviation and climate change, supported by the UK ETS and CORSIA. In terms of any update to this policy, the Government has clearly signalled a shift towards investment in new green technologies and innovation.

b. 88% of aviation emissions associated with Bristol Airport will be capped within the UK ETS. The remaining 12% would be covered by CORSIA and, in any event, would be capped as international aviation is included in the Sixth Carbon Budget.

c. BAL has built on its existing commitments and is going further than other airport operators already by being carbon neutral in 2021 and, through the CCCAP, being carbon net zero itself by 2030 and aiming for the airport as a whole (i.e. including aviation emissions) by 2050. The CCCAP states clearly BAL's commitment to reaching the highest level set by the Aviation Carbon Accreditation scheme.

d. The UK Government has made it clear that the UK aviation sector is included within the carbon net zero target, has set the framework for regulation and reporting, and the UK aviation sector has responded and confirmed its commitment to being carbon net zero by 2050 with interim targets to be achieved by 2030 and 2040 with the full support of the UK Government[8]:

> *"These targets are an important milestone for the British aviation industry and show that airports, aerospace manufacturers and airlines share in our ambition to adopt the new and emerging technologies necessary to fight climate change.*
>
> *"Working with industry through our Jet Zero Council, we are putting the decarbonisation of the aviation sector at the centre of our plans to build back greener from the pandemic and this industry roadmap complements our vision perfectly."*

e. A number of technologies exist to *reduce* emissions (with improved aircraft design, alternative fuels, air space changes and enhance ground based support) and to *remove* emissions (utilising GGR technologies). All these technologies are receiving significant financial investment to bring to commercial fruition with the full support of the UK Government[18]:

> *"The government intends to position the UK at the forefront of new markets for low carbon technologies and services in the transition to net zero, and there will likely be substantial economic opportunities for the UK to lead the way in developing and adopting cutting-edge GGR approaches".*

f. The most appropriate means of achieving carbon net zero in the aviation sector is to manage emissions directly rather than manage emissions indirectly by restricting passenger numbers. The UK ETS and CORSIA provides a market based approach to demand management that does not require UK Government to make arbitrary decisions on which airports can expand, which cannot expand and, potentially, which need to contract.

g. The inclusion of international aviation within the Sixth Carbon Budget would negate the need for a 'planning assumption' but not change the pathway to carbon net zero. The emissions from the Appeal Proposal do not prevent the Government achieving its climate change objectives.

h. Non-CO_2 emissions need to be acknowledged so that choices can be made in the technologies used to reduce aircraft emissions do not result in net CO_2 and non-CO_2 impacts increasing, *"the CCC has advised that non-CO_2 effects should not be accounted for in the UK's carbon budgets, because it is challenging to aggregate their effects accurately"*[26].

i. Meeting local planning policies does not require assessment of aviation emissions as these are a matter of national policy. BAL is committed to being carbon net zero by 2030 and as such, all local planning policies relating to carbon would be met.

9.1.2 In summary, BAL is working in the same direction as the aviation industry and the UK Government in seeking to become carbon net zero by 2050 and the Appeal Proposal does not prevent the UK Government achieving net zero GHG emissions by 2050. Moreover, the planning conditions proposed by NSC's witness, Dr Hinnells, are considered acceptable subject to clarification. The conditions will require approval of the CCCAP that will enable BAL to become carbon net zero by 2030 and for the airport as a whole to become carbon net zero by 2050.

[26] The Climate Change Committee, Sixth Carbon Budget: The UK's path to Net Zero, December 2020, p374 *available at* The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero (4).pdf *accessed 6 July 2021*