Jet Zero
Department for Transport Consultation
Response from Richmond Heathrow Campaign
8 September 2021

INTRODUCTION

1. This Report is a written response from the Richmond Heathrow Campaign (RHC) to the DfT Consultation titled *'Jet Zero 14 July, 2021'*.

2. The DfT is seeking views on development of framework for its Jet Zero Strategy to support the aviation sector to decarbonise. The DfT says 'it is committing to the UK's share of aviation emissions reaching net zero by 2050 and proposing a suite of policies to support industry to make this happen. These policies span across five different measures:
   1. Improving the efficiency of our aviation system, (Q5 & Q6)
   2. Accelerating the deployment of SAF, (Q7 & Q8)
   3. Supporting the development of zero emission aircraft, (Q9 & Q10)
   4. Ensuring we use markets to drive down emissions in the most cost-effective way, (Q11)
   5. Working to influence the behaviour of consumers.' (Q13 & Q14)

6. We include the 6th Carbon Budget, demand management, airport expansion, APD and the DfT's appraisal approach in response to Q2 to Q4. In Q12 we outline RHC's proposal for an Airport Carbon Quota Scheme. In Q15 we respond on non-carbon emissions.

3. RHC represents three amenity groups in the London Borough of Richmond upon Thames: The Richmond Society, The Friends of Richmond Green, and the Kew Society, which together have over 2000 members. The members of our amenity groups are adversely affected by noise from Heathrow Airport's flight paths, poor air quality and road and rail congestion in west London. We acknowledge Heathrow's contribution to the UK economy and seek constructive engagement in pursuit of a better Heathrow. We are an active participant in the Heathrow Community Noise Forum.

4. Our premise is that it would be preferable to aim for a better Heathrow rather than bigger Heathrow and to capitalise on the world beating advantage of London's five airports, in particular by improving surface accessibility to all five airports, which would be a major benefit to users. We believe aviation growth should be shared across the UK and not concentrated at Heathrow and other South East airports. Our approach is to continue supporting the case for no new runways in the UK and we believe this is well supported by the evidence produced by the Airports Commission and the DfT in relation to the Airports National Policy Statement, 2017 and by the Climate Change Committee in its Sixth Carbon Budget, 2020. We seek aviation net zero carbon and now with electric propulsion on the horizon and a bit of wishful thinking, zero noise and zero air pollution - the three zeros.

5. Over recent years we have undertaken extensive research on Heathrow and submitted a large number of papers to the Airports Commission, the DfT, CAA and others, which can be found at www.richmondheathrowcampaign.org

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Q1. Do you agree or disagree that UK domestic aviation should be net zero by 2040? How do you propose this could be implemented?

Answer: Disagree

Comment:

1. RHC recommends no later than 2035 for all domestic flights to be carbon net zero and by 2040 to include all greenhouse gases. The DfT ambition is too weak, policy is lacking and action is too slow.
2. The strategy needs to incentivise hybrid and zero propulsion flight for all domestic flights so as to phase out fossil fuel propulsion faster than the DfT and industry seek. SAFs should not be considered for domestic flights until they have satisfied the needs of longer haul flights, which as discussed later, is impossible by 2035.
3. The targets need to minimise the increase between 2021 and 2035 in cumulative concentration of carbon in the atmosphere. Climate Change does not depend just on an end date and domestic aviation emissions of 4% of UK aviation emissions in a single year - the cumulative impact is significant.
4. Growth in domestic travel needs to be shared between surface travel and aviation so that between 2021 and 2035 the balance is adjusted to ensure aviation rapidly reduces to net zero by 2035 and that in the interim and to the extent the reduction fails, less polluting surface modes should be used.
5. In order to achieve the necessary balance between domestic surface travel and aviation, transport pricing must be competitive (i.e. lower surface transport costs and higher flying costs taking account of relative life cycle emissions and internalisation of the costs).
6. Aviation is substantially under-taxed compared to other sectors of the economy, meaning other sectors have to pick up the tab to satisfy the government's fiscal needs (see Q2 - 15/16). Also, demand is inflated. RHC estimates show full and fair APD on domestic aviation, based on the exemption from fuel duty and VAT, would have been around £1.5 bn in 2019 instead of actual £0.5 bn. APD needs to be raised to full and fair value. APD is a general tax needed to support the government's fiscal needs and the additional income could be used to fund, for example, social services for those less well off and for whom flying is un-affordable.
7. RHC is not in support of out-of-sector offsetting for UK domestic flights - the polluter (the passenger and freight owner) should take direct responsibility for emissions and their carbon mitigation for domestic flights.
8. Domestic transfers should be minimised and replaced by direct flights. Transfers double the fuel burned and hence emissions.
9. The CCC has included a ceiling on number of passengers of 365 mppa in order to achieve aviation net zero by 2050. This allows for 25% compound passenger growth (2018-2050). This can and should be accommodated by increased aircraft loads. There is ample UK airport capacity to meet demand constrained by greenhouse gases over the next 30 years. There should be no airport expansion for more ATMs and certainly should not include domestic traffic as justification since surface transport is a much more favourable alternative.
10. The CCC assessment report to parliament in June 2021 already shows the failures against target and on that form even 365 mppa ceiling is becoming too high and a ceiling of zero passenger growth is becoming likely.
11. RHC proposes an Airport Carbon Quota Scheme (see Q12) to be managed through airport Action Plans and directly linking the legal targets in the UK carbon budgets to action by the individual airlines and airports.

Q2. Do you agree or disagree with the range of illustrative scenarios that we have set out as possible trajectories to net zero in 2050? Are there any alternative evidence-based scenarios we should be considering?

Answer: Disagree

Comment:

1. The consultation admits to being about pathways rather than forecasts and targets, which are needed, and it is short on evidence and independent review and relies over-much on the aviation industry's self-interested approach and lack of urgency. Seemingly, the next ten years is about experimenting with different pathways with mitigation action being deferred until after 2030 or even 2035. This is far too late.

2. All the Jet Zero scenarios deliberately exclude managing demand growth, which is a major plank of the Climate Change Committee's legally established 6th Carbon Budget. The DfT should be considering alternative scenarios that include demand management, and not to do so is woefully inadequate, as we highlight below.

3. As explained later, RHC believes the efficiency mitigation assumptions and the SAF abatement costs are too optimistic and the out-of-sector greenhouse gas removals highly speculative.

6TH CARBON BUDGET, DECEMBER 2020

4. RHC relies on the 6th Carbon Budget and its Balanced Net Zero Pathway as the definitive basis for assessing the Jet Zero High Ambition and other pathways. It is a source of information and a legally based pathway to aviation net zero that converts ambition into policy, targets and action. The Budget demonstrates aviation net zero is achievable and financeable by 2050, and as such satisfies the Paris Agreement on Climate Change.

5. UK aviation demand in 2018 was 292 million passengers a year (mppa) resulting in the 12.6 Million tonnes (Mt) of kerosene jet fossil fuel and 39.6 Mt of carbon emissions.

6. The 6th Carbon Budget predicts unconstrained Baseline passenger growth averaging 1.6% a year or compound 64% (2018-2050) resulting in 64 Mt a year of carbon by 2050 or 51 Mt a year after Baseline efficiencies.

7. The now legally adopted 6th Carbon Budget targets the following reductions in the 51 Mt of aviation carbon in 2050, along with interim targets:

   a. **12 Mt a year through demand management**,
   b. **8 Mt a year through efficiencies**,
   c. **8 Mt a year through replacement of kerosene jet fossil fuel with sustainable aviation fuels (SAFs) reaching 25% blend by 2050**,
   d. **23 Mt a year removal from the atmosphere**.

8. The full aviation carbon abatement scenario is shown on a temporal basis in Figure 1 and in 2050 in Figure 2, as interpreted by RHC from the 6th Carbon Budget.

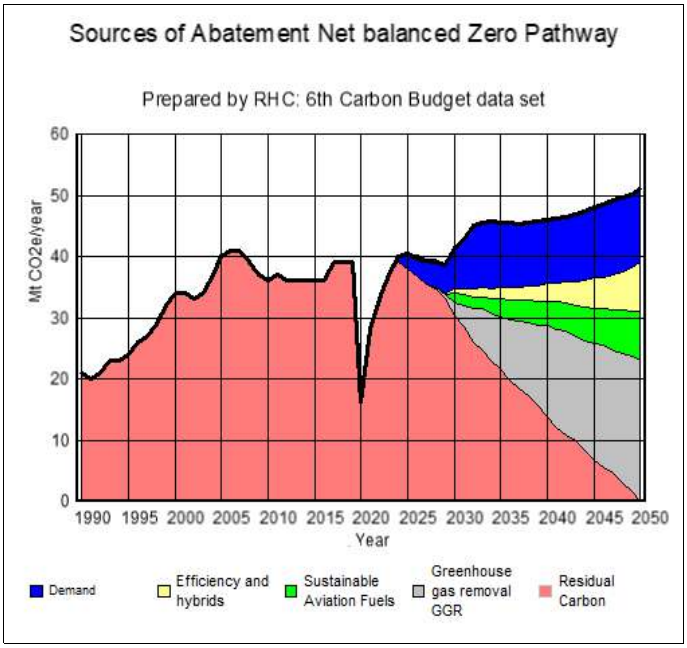


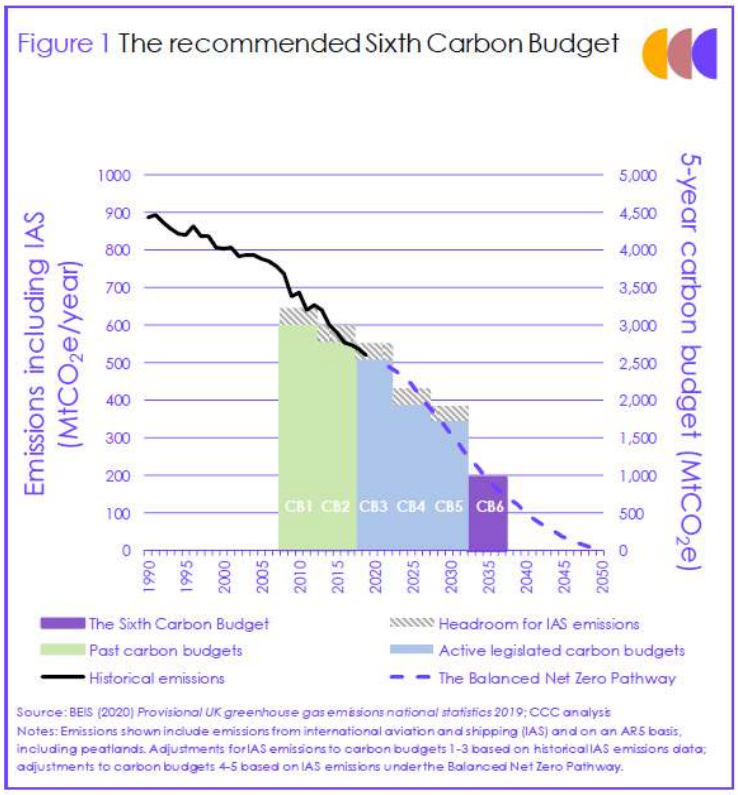
Figure 1

9. The Baseline scenario includes airport expansion (2029-2033), and Figure 1 shows the substantial reduction in carbon if this expansion were excluded, as is required by the 6th Carbon Budget.

UK Aviation Balanced Net Zero. No expansion Annual Carbon Abatement in 2050 Figure 2	**Demand**	**Kerosene/SAFs mass and energy**		**Carbon Emissions**
	mppa	Mt/yr	TWh/yr	Mt/yr
Base Year 2018	292	13	159	40
Unconstrained demand growth (avg1.6% pa, 64% 2018-2050)	**+186**	**+7**	**+98**	**+24**
Year 2050	478	20	257	64
Baseline Efficiencies (avg. 0.7 pa, 20% 2018-2050)		**-4**	**-52**	**-14**
Unconstrained Baseline scenario year 2050	478	16	205	51
Demand management	**-113**	**-4**	**-48**	**-12**
Balanced Net Zero demand (avg 0.7 pa, 25% 2018-2050)	365	12	157	39
Additional Efficiencies and hybrids (avg. 0.7% pa)		**-2**	**-31**	**-8**
Sub-total		10	126	31
Sustainable Aviation Fuels (SAFs) 25% replacement		**0**	**0**	**-8**
Sub-total		10	126	23
Removal of carbon from the atmosphere (GGR)			0	**-23**
Aviation Net Zero Carbon year 2050	365	10	126	0

Source: CCC 6th Carbon Budget Dec 2020 - RHC Interpretation. Note figures are rounded. Assumes one tonne of kerosene produces 3.15 tonnes of carbon and one kg of kerosene produces 12.0 kWh of energy. TWh is terawatt hours i.e. billion watt hours.

10. We show in Figure 3 the UK historical and targeted emissions reduction 1990-2050 as included in the 6th Carbon Budget.



Comparing the UK and aviation's historical performances in Figures 1 and 3 shows how aviation has failed in the 30 years since 1990 to address the developing crisis of climate change.

While the 6th Carbon Budget aviation Pathway does end in zero carbon, there are a great number of uncertainties, as highlighted by the CCC.

Figure 3 Source CCC 6th Carbon Budget

11. The DfT's High Ambition Pathway is replicated in Figure 4. A comparison with the CCC Balanced Net Zero Pathway shows the great divergence in demand management and in efficiency, hybrids and SAFs. RHC believes the DfT is over-optimistic, and given the historical under-performance, there is little confidence in the remaining 30 year performance.

We continue with the topic of demand management.

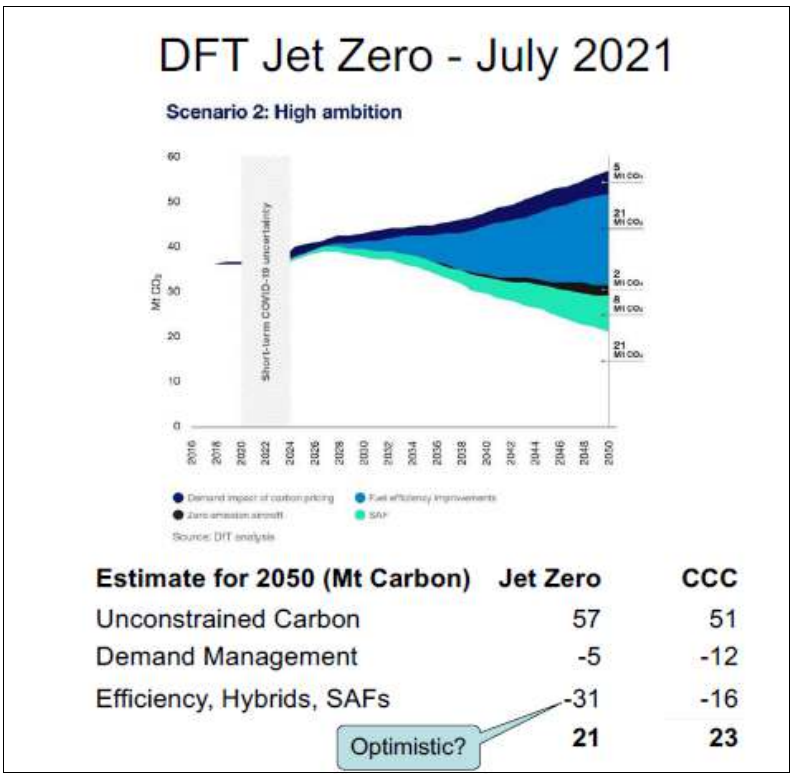


Figure 4

DEMAND MANAGEMENT

12. Demand management is ill defined and can involve an increase or decrease in growth or absolute demand. Figure 5 shows indicative demand sensitivity to abatement cost, prepared by RHC from recent CCC, DfT and Sustainable Aviation information.

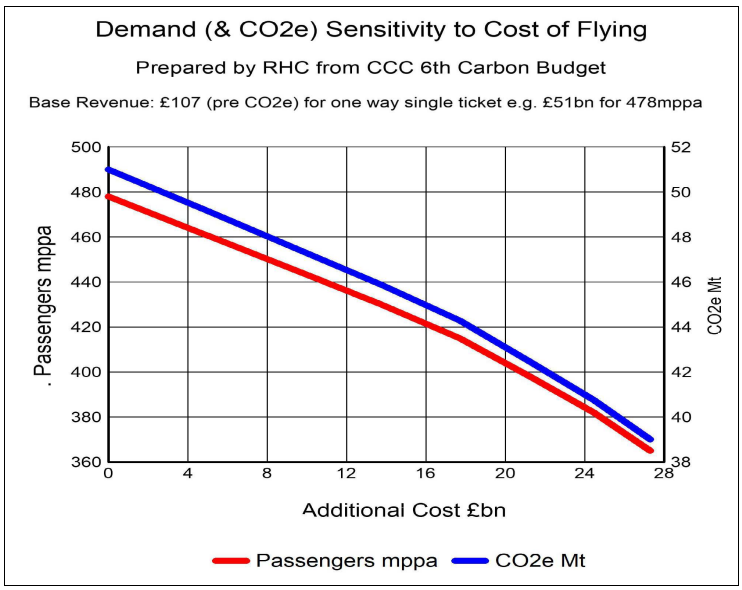


Figure 5

13. Figure 6 shows the components of the £16 bn a year of abatement costs needed to ensure demand does not exceed the ceiling of 365 mppa by 2050, assuming expansion has been ruled out but if not, another £12 bn a year of abatement costs would be needed (Q2-14b). **Slippage on the targets could require the 365 mppa ceiling to be reduced to 2019 levels of around 300 mppa.**

Figure 6 **Indicative Demand Management Components to achieve 365 mppa demand ceiling**	Pre- Demand Management Revenue	Demand Management Increment	Required Revenue
	£ bn/year	£b/year	£bn/year
Airline costs before fuel, carbon and APD (365 mppa)	29.0	0	29.0
Kerosene fuel cost (12.4 Mt at £450/tonne)	5.6	0	5.6
Fuel Efficiency, hybrids net of capex and opex costs (Q5, 3)	0	-2.2	-2.2
SAFs and carbon costs (Q7, 8)	0	7.0	7.0
Greenhouse gas removals of residual carbon (Q11, 4)	0	1.0	1.0
APD increased to Full and Fair level (Q2, 16)	2.9	9.7	12.6
Sub-total	37.5	15.5	53.0
Undefined revenue gap	0	0.5	0.5
Total UK Ticket Revenue	37.5	16.0	53.5

AIRPORT EXPANSION

14. UK airports continue to seek unsustainable expansion.

a. The DfT's Airports National Policy Statement (APNS), approved by the Secretary of State in 2018, estimated the impact of Heathrow's 3rd runway on the UK economy in a range of minus £2.2 bn to plus £3.3 bn (present value 60 years 2014 prices). Included was a cost of £1 bn for carbon, which given the evidence, RHC regards as ludicrously low and does not even cover the carbon cost of additional surface access.

b. Crucially, the DfT estimated that the 3rd runway would benefit passengers by £64.3 billion (60 yr present value), as a result of the increased capacity reducing scarcity rent and hence ticket prices. This works wholly against the UK passenger demand ceiling in the 6th Carbon Budget of 365 mppa, if aviation is to achieve net zero by 2050. RHC estimates current UK ticket prices will need to rise on average by 70% or £28 bn a year to constrain demand growth that includes airport expansion. Without expansion an additional 7 Mt a year of carbon emissions would be avoided and £12 bn a year of mitigation costs would be saved and ticket prices could be held to a 40% increase, as shown in Figure 6. The DfT's scarcity rent value included is wholly misplaced in RHC's opinion and without it the economic value of expansion is substantially negative and Heathrow expansion unjustified.

c. There are other carbon consequences of a 3rd runway. The APNS predicts that adding 43 mppa to Heathrow will take growth of 17 mppa from other UK airports, which surely contradicts the government's levelling-up policy and is a result of the regions having to bear part of the carbon cost of Heathrow's expansion. Of the net 26 mppa, 16 mppa would be international-to-international transfers resulting in only 10 mppa additional UK terminating passengers. The DfT is ignoring its own evidence in not taking these matters into account. The Airports Commission and RHC believe I-I transfers add no economic value to the UK. Instead, they add a substantial carbon cost to the UK and are exempt from APD.

d. Heathrow has ample capacity to handle terminating passengers for the foreseeable future and more so with reduction in I-I transfers and increased loads. According to the DfT, expansion does not increase the number of destinations. It does increase frequency but for the most part this is on already popular routes.

e. The 6th Carbon Budget says *'There should be no net expansion of UK airport capacity unless the sector is on track to sufficiently outperform its net emissions trajectory and can accommodate the additional demand.'* In effect we suggest this means no expansion until zero carbon flight is the norm, perhaps in 30 year's time.

AIR PASSENGER DUTY

15. **UK demand and carbon emissions inflated by under-taxation**. We referred to this matter in Q1 as it concerns domestic aviation. The following is based on all UK aviation. Aviation is substantially under-taxed compared to other sectors of the economy, meaning other sectors have to pick up the tab to satisfy the government's fiscal needs. RHC estimates passenger demand is inflated as a result of under-taxation by around 10% and therefore by 4 Mt out aviation's total carbon emissions of 40 Mt in 2019. Our estimates show full and fair tax on aviation, based on the exemption from fuel duty and VAT, would have been around £15.8bn in 2019 instead of actual £3.6bn. The shortfall, net of actual APD, was a substantial £12.2bn (£9.4bn from terminating passengers and £2.8bn from I-I

transfers' exemption from tax) [1]. APD is a general tax needed to support the government's fiscal needs and the additional income could be used to fund, for example, social services for those less well off and for whom flying is un-affordable.

16. Extended to 2050 with demand growth of compound 25% mppa, full and fair APD would be £19.4 bn a year instead of a counterfactual £4.4 bn, i.e. an increase of £15.0 bn. However, arguably the growth between 2018 and 2050 should take account of fuel efficiencies of compound 35%, resulting in a net increase of £9.7 bn, as shown in Figure 6.

Q3. Do you agree or disagree that we should set a CO2 emissions reduction trajectory to 2050?
a . Should the trajectory be set on an in-sector CO2 emissions basis (without offsets and removals) or a net CO2 emissions basis (including offsets and removals)?
b. Do you agree or disagree with the possible trajectories we set out, which have in-sector CO2 emissions of 39 Mt in 2030, and 31 Mt in 2040 and 21 Mt in 2050, or net CO2 emissions of 23-32 Mt in 2030, 12.19 Mt in 2040 and 0 Mt in 2050?

Answer : Agree to setting a trajectory to 2050 net zero.
Answer to (a): see comment
Comment:

1. **Offsets are an excuse not to take direct in-sector action.** According to the 6th Carbon Budget, aviation net zero in 2050 will have to rely on abatement of a huge 23 Mt of carbon by out-of-sector removal of greenhouse gases from the atmosphere (GGR). We are in favour in principal of market based cap and trade schemes such as the UK ETS. Any additional out-of-sector offsetting would be ineffectual and wholly misguided in our view.

2. **International aviation is not taking carbon emissions seriously.** 60% of global passenger demand (but 96% of UK demand) is for international flights, which is the responsibility of the UN-ICAO and disjointedly outside the scope of COP 26 that covers domestic aviation. The ICAO offsetting scheme for international aviation (CORSIA) will be largely ineffective in our view, on account of the un-reliability of offsetting schemes, low carbon price of a few dollars per tonne of CO2e that lacks commercial incentive and the temporary life of the scheme - to 2035. CORSIA is a convenient excuse for the UK aviation industry and government not to take dedicated action.

Answer to (b): Disagree
Comment:

3. Figure 7 illustrates the abatement divergence of the DfT and aviation industry from the 6th Carbon Budge in 2050, for example. The DfT and Sustainable Aviation assume higher demand growth and hence carbon. In all three cases, expansion is included as unconstrained growth but the 6th Carbon Budget then removes the associated carbon by assuming no expansion. RHC estimates that around 7 Mt out of the 12 Mt of carbon a year is the result of airport expansion. In RHC's view the Jet Zero and aviation industry are far to optimistic on SAFs and Figure 7 illustrates the disparity with the 6th Carbon Budget.

[1] RHC response on 30 June 2021 to HM Treasury Consultation - Aviation Tax Reform.

Figure 7. Comparison of Carbon Abatement Pathways in 2050			
Mt CO2e	6th Carbon Budget Dec 2020(1)	DfT Jet Zero July 2021	SA(2) July 2021 Update
Unconstrained Carbon	51	57	66
Demand management	-12	-5	-4
Efficiencies, hybrids, SAFs	-16	-31	-37
Net before out-of-sector removal from atmosphere	23	21	25
1. Balanced Net Zero Pathway; (2)Sustainable Aviation (Industry Group)			

Q4. Do you agree or disagree that we should review progress every five years and adapt our strategy in response to progress?

Answer: Disagree

Comment:

1. While we support a feedback control loop, we are concerned that without demand management included, the control will be ineffective. There needs to be Plan B and C etc and demand management must be included. The Strategy is just too vague and procrastination is the thief of time. Progress in the next 10 years is crucial and reviews should be annual. The timing of airport expansion planning processes in the next 10 years will muddy the picture and RHC urges the government to take expansion off the table until zero carbon flights are the norm, in perhaps 30 years time. There is an emergency after all.

Q5. Do you agree or disagree with the overall approach to improve the efficiency of our existing aviation system?

EFFICIENCIES

Answer: Disagree

Comment:

1. The claim by the aviation industry that new generations of aircraft result in 20% efficiencies is hollow. 20% means an average 0.9% pa over the 25 year life of an aircraft and the introduction of more efficient aircraft is deferred by fleet turnover averaging only around 5% a year. The CCC assumes efficiencies averaging 1.4% pa 2018-2050, which seems not unreasonable but the aviation industry assumes average rates above 2%pa, which seems over-optimistic.

2. We believe efficiency gains from airspace modernisation are over-optimistic and we are concerned that re-design of flight paths to save carbon could worsen noise, NOx and particulate pollution. The claim of £29 bn of benefit from Airspace Modernisation is very substantially overstated and seemingly based on wholly out-of-date traffic forecasts. We have urged there be an up-to-date webTAG evaluation of Airspace Modernisation.

3. The 6th Carbon Budget assumes the value of efficiencies and operational improvements as £2.8 bn a year in 2050 but £2.2 bn a year net of investment, operating and financial costs.

4. The aviation industry is calling for the government and hence tax payer to financially support carbon abatement by funding efficiencies from aircraft and airspace modernisation and SAF refineries, etc. The industry is in denial of the polluter-should-pay principle (the polluter being the passenger and freight owner) by not managing demand and seeking support from the public purse.

5. Airport and surface access efficiencies are important but are not nearly as significant as in-flight efficiencies.

Q6. What more or differently could be done to ensure we maximise efficiency within the current aviation system?

Answer: see comment

Comment:

1. The use of Heathrow as a hub airport is inefficient. It concentrates traffic at a single location with resultant congestion and additional carbon emissions. But furthermore, as we say in Q2 15(c), a 3rd runway at Heathrow adds just 10 mppa terminating passengers but 16 mppa international-to-international transfer passengers. I-I transfers double the take-offs and lengthen the journey distances - both of which add to fuel burn and carbon. It would be far better for the industry to spend the development cost of say £20 bn plus on mitigating carbon. The Airports Commission said in its Report on Heathrow expansion that I-I transfers provide little economic value to the UK (a view supported by RHC and consultants Oxera and PWC). I-I transfers do not materially support otherwise unviable long-haul routes and the claim they do is fiction, and instead they use capacity on popular routes that could better be used by UK terminating passengers including people doing UK business.

2. Heathrow' holding stacks add to fuel burn and perhaps the bigger point is that aircraft carry extra fuel as a contingency in the face of uncertain congestion on arrival at Heathrow's airspace and the extra weight increases emissions. Better flight planning between departure airports and Heathrow could reduce a substantial carbon cost.

3. Tankering may be a problem and we realise it is difficult to account for. Better information on the topic and working with airlines to minimise it would be a help.

4. Increasing aircraft loads and airlines not having to fly empty planes to retain slots would reduce carbon. Airlines seek to add frequencies to their schedules but we believe this is at the expense of efficient loads.

5. In Figure 6 we assume the net £2.2 bn a year of efficiency gains are passed by the airlines to passengers as a cost reduction and hence a reduction in ticket prices. But there may be a case for the industry retaining the financial benefits of efficiency improvements on condition the savings are invested in further fuel savings and carbon mitigation.

Q7. Do you agree or disagree with the overall approach for the development and uptake of SAF in the UK?

SUSTAINABLE AVIATION FUELS SAFS

Answer: Disagree

Comment:

1. Figure 8 shows the 6th Carbon Budget fuel mix on a temporal basis 2018-2050 and in 2050 in Figure 9.

2. It is not clear from the Jet Zero evidence exactly how the DfT estimates compare at this level of detail, other than that the SAFs are double the 6th Carbon Budget estimates in the Balanced Net Zero Pathway.

3. We agree with the DfT on taking account of the energy density of fuels but we understand that SAFs, as drop-in fuels, are similar in performance and character to fossil kerosene jet fuel and that it is not unreasonable to assume 12.0 kWh/kg for both.

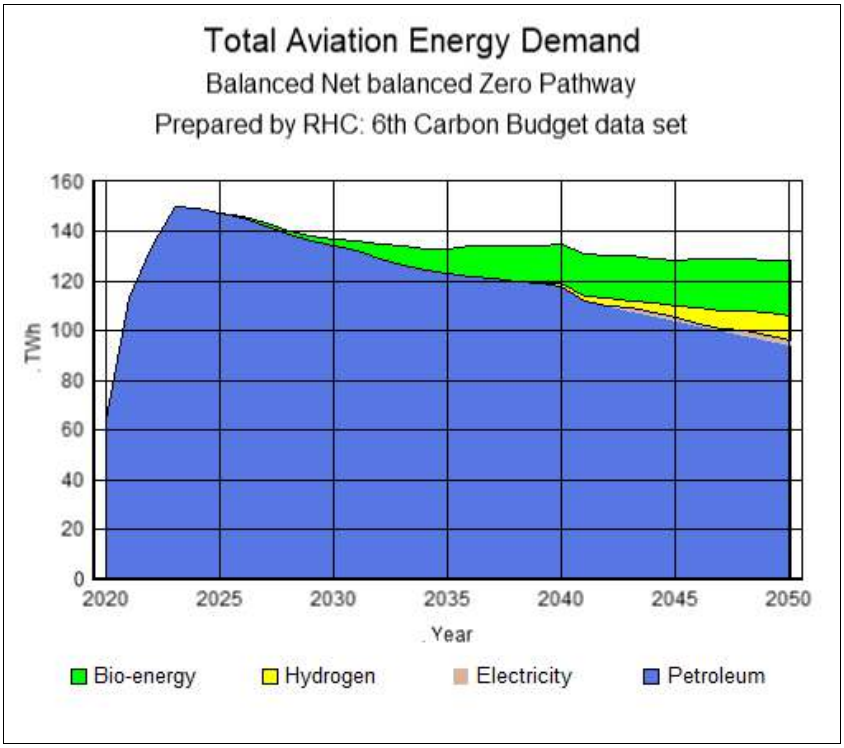


Figure 8

	Aviation Fuels - Power		
	2018	2050	2050
TWh	Actual	Baseline	**Balanced Net Zero**
Biomass FT jet		0	**14**
HEFA biojet		0	**8**
Biowaste FT jet		0	**0**
Synthetic jet		0	**10**
	0	0	**32**
Fossil jet	159	205	**94**
Aviation Fuels TWh	159	205	**126**
Efficiency improvement pa		0.7%	**1.4%**
Passengers mppa	292	478	**365**
Pax Increase 2018 to 2050		64%	**25%**
Net airport expansion		Yes	**No**
Carbon MTCO2	39	51	**23**

Figure 9 Prepared by RHC from 6th Carbon Budget data.

4. Generally, we assume one tonne of kerosene produces 3.15 tonnes of CO2. The Life cycle CO2 from SAF we assume is required to be below 40% but seems unlikely to be below 20%.

5. We have not seen much information on the life cycle energy efficiency of different propulsion systems including the fuels. Energy is lost as heat as well as kinetic energy required to

transport the fuels on the ground and in the air. Arguably, if the source is the sun or wind, it does not matter but otherwise the kinetic energy used in flight is far from 100% efficiently produced and used and will vary with fuel type and associated propulsion system. Further information on energy efficiency would be welcome.

6. A major question is whether SAFs can be supplied at competitive prices to kerosene. Figure 10 shows the RHC model for airline decisions on whether to purchase kerosene or SAFs with a cap and trade scheme, based on one tonne of fuel.

Fuel Cost per tonne		SAF Option		Kerosene Option	
	Price/tonne	Tonnes	Cost £	Tonnes	Cost £
Kerosene	500	0.75	375.0	1.00	500.0
Kerosene CO2e	£111.0	2.36	262.2	3.15	349.7
SAF 25%	£780	0.25	195.0		
SAF CO2e LCA 20%	111.00	0.16	17.5		
Total fuel and carbon costs			849.7		849.7

Figure 10

7. Figure 11 illustrates Figure 10 graphically for one million tonnes of fuel. The left hand columns are SAF options and the right hand columns kerosene options. The breakeven is at a price of £780 per tonne of SAF and the total fuel and carbon cost is £0.85 bn. The limited availability of SAFs means the current price is not indicative of the longer term price but prices are as much as three of four times the current kerosene price of around £500/t.

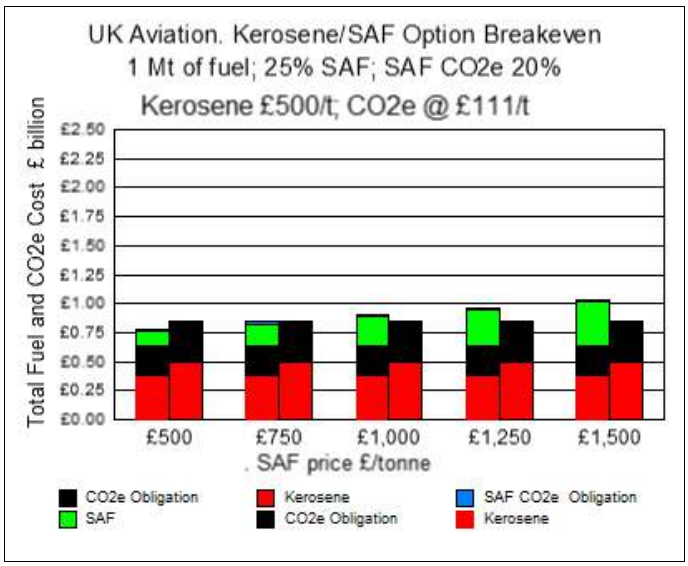


Figure 11

8. If CO2 traded prices were £221/t in 2050, for example, the fuel cost (kerosene, SAF and carbon) would be £1.2 bn per Mt of fuel and based on 10 Mt of fuel needed for 365 mppa in 2050, the total fuel cost would be £12 bn a year which is an increase of £7 bn compared to the counterfactual £5 bn without SAFs and CO2e costs. This is shown in Figure 6, as it effects demand.

9. The CCC assumes 25% blend by 2050 but the DfT and Sustainable Aviation assume 50% blend.
    a. Seemingly, the 6th Carbon Budget assumes only sufficient supply of feedstock for 25% blend (given other demand uses). The feedstock has to be sustainable and not for example to use land, food crops or water. We clearly should not be producing waste feedstock so people can go on holiday!
    b. The CCC and industry assume no life cycle carbon emitted by the supply and use of SAFs, which seems over-optimistic.
    c. We question whether municipal waste and other feedstocks should be concentrated on providing aviation fuels. For example, diverting bio-fuel from a refinery producing bio-diesel merely transfers the carbon saving from road transport to aviation and probably with lost refinery yield.
    d. There are considerable uncertainties in scaling up SAF supply. Scaling up is not just about individual refineries but a whole infrastructure of pipelines for transporting SAF's and captured CO2 and at considerable cost.
    e. Current UK plans concentrate on bio refineries in the north of the UK, resulting in high freight costs of municipal waste feedstock across the UK and transport of fuel to the south to Heathrow and Gatwick, which use around 70% of UK aviation fuel.

10. As discussed in Question 5 (para 4) the polluter should pay and not the tax payer but the aviation industry does seem to be relying on government financial support for developing SAFs.

Q8. What further measures are needed to support the development of a globally competitive UK SAF industry and increase SAF usage?

Answer: see comment
Comment:

1. An efficient cap and trade scheme is essential to the internalisation of carbon abatement and so enable SAFs to have a chance of competing with Kerosene on price. We note the DfT has launched a consultation on a fuel mandate and in principal we support a fuel mandate. Carbon prices will be very important and how quickly these rise and SAF prices fall. It may not be until the mid 2030s that SAFs begin to compete on price and it is high risk relying on this point in time..

2. Future oil prices are very relevant in determining the competitiveness of SAFs. Clearly, the major oil companies have much to loose in stranded assets but there is an opportunity for them to transition to SAFs production and especially hydrogen supply and CO2 storage. The companies might be allowed to defer their very substantial field abandonment costs so as to provide for ongoing CO2 storage.

3. Oil and hence kerosene prices may become even more volatile than in the past, as supply and demand seek to keep in balance but it is nowhere near certain that oil prices will decline as demand declines. It will be important to maintain orderly markets if SAFs are to compete with kerosene.

Q9. Do you agree or disagree with the overall approach for the development of zero emission flight in the UK?

ZERO EMISSION AIRCRAFT

Answer: Broadly Agree; Comment:

1. The penetration of zero carbon propulsion into the UK fleet will inevitably start at the domestic and short haul end. But the important metric is how quickly can carbon be reduced. We believe demand management should be a priority and not just a fall back.

2. The Jet Zero consultation seemingly is short on details on the markets for zero carbon propulsion. While carbon emissions per passenger tend to rise in line with distance travelled, this statistic needs to be combined with the number of passengers in each distance band.

3. Airbus' 'Powertrain Timeline' introduction of net-zero carbon aircraft is in Figure 12.

Year introduced commercially	2023	2026	2030	2035	2040
Seats	10-20 seats	50-100 seats	100-200 seats	200+ seats	200+ seats
Max Range	500 nm	1,000 nm	2,000 nm	3,000 nm	5,000 nm

Figure 12. Airbus Powertrain Timeline for net-zero or hybrid aircraft commercialisation

4. Figure 13, prepared by RHC, shows the number of international ATMs and passengers on a cumulative basis versus destination distance for Heathrow in 2016. Around 60% of the of ATMs are under 2,000 nautical miles and mostly under loads of 200 passengers. These conditions suit emerging aircraft propulsion and design requirements up to 2030. But fleet change will take time and we have significant reservations that zero carbon planes can make much impact on carbon emissions before 2040, other than in the domestic market. We commented in Q1 on the domestic market.

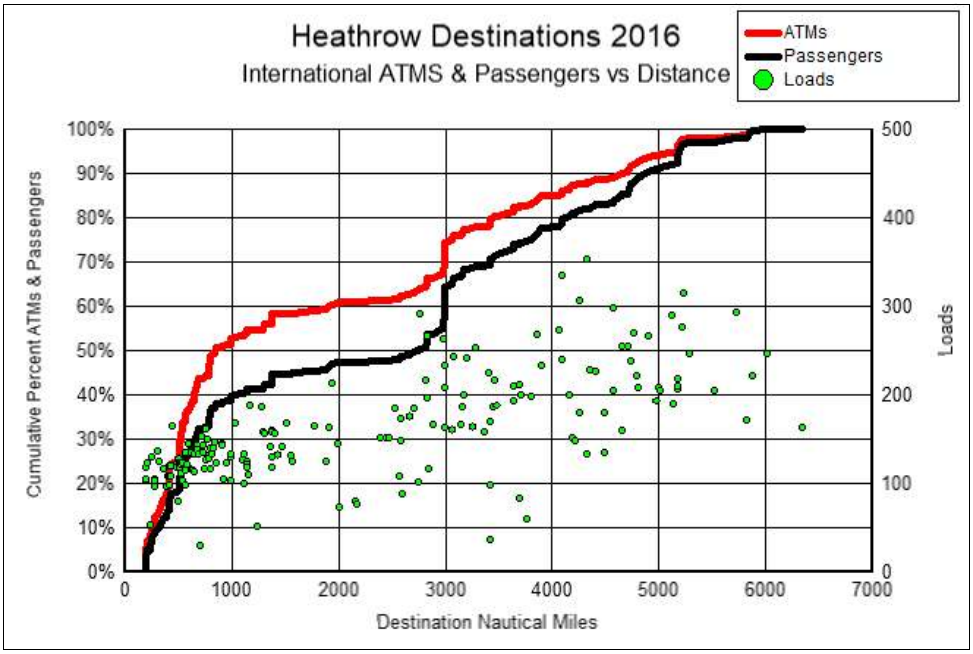


Figure 13

5. Figure 14 illustrates the CO2 per economy passenger and distance (km) one-way. The destinations chosen at random range from Paris at 346 km, New York 5,536 km Los Angeles 8,856 km and Aukland 19,280 km. Premium class (with more leg room) doubles these emissions and other GHGs double the numbers again.

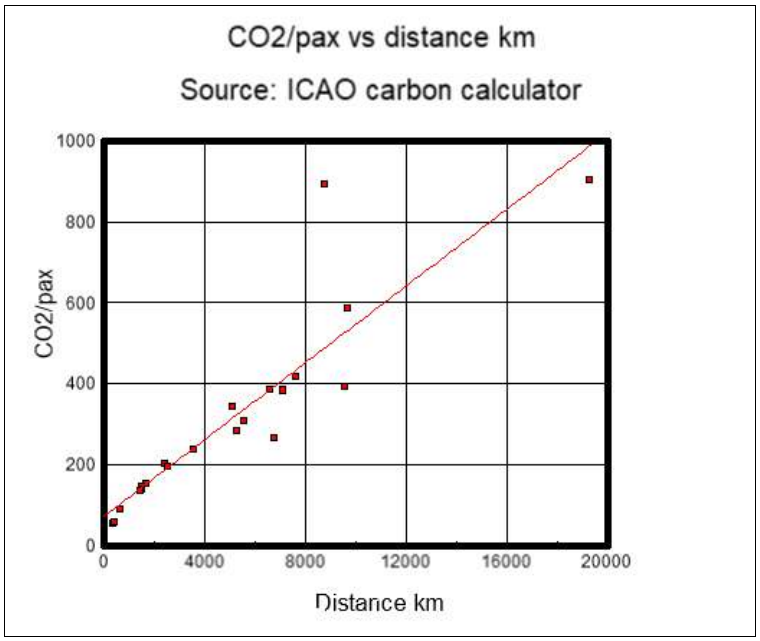


Figure 14

Q10. What further measures are needed to support the transition towards zero emission aviation?

Answer: See Comments

Comment:

1. Zero carbon propulsion will require infrastructure for batteries or hydrogen and it is not clear how this will be implemented. If domestic markets are early users of zero carbon propulsion then their use will need to be spread across twenty or more UK airports to make their use commercially viable.

2. We believe the uncertainties and risks are sufficiently great not to reject demand management in the intervening 20 or 30 years.

3. Zero-carbon aircraft could also result in noise and NOX pollution being decreased. But airframes will continue to produce a significant proportion of the noise. Estimates for airframe noise as distinct from propulsion noise is needed.

Q11. Do you agree or disagree with the overall approach for using carbon markets and greenhouse gas removal methods to drive down CO2 emissions?

REMOVAL OF RESIDUAL GREENHOUSE GASES FROM THE ATMOSPHERE

Answer: Disagree

Comment:

1. We commented on offsetting in Q3a and expressed our substantial reservations to offsetting

and for example the CORSIA scheme. We also said that in principal cap and trade schemes can be useful. We calculated in Figure 6 the impact of SAFs and carbon on demand as £7 bn a year in 2050. But this still leaves a substantial gap of £9 bn a year in demand management abatement costs needed to operate within the 365 mppa a ceiling.

2. Engineered greenhouse gas removals include bioenergy with carbon capture and storage (BECCS) and Direct Air capture of CO2 with storage (DACCS).The 6th Carbon Budget assumes out-of-sector removal of 23 Mt a year by 2050 - paid for by aviation. The Budget assumes engineered emission removals of 58 Mt CO2/year and 39 MT CO2/year of nature based sinks are needed by 2050 for aviation and other hard-to-abate sectors. In RHC's view carbon removal remains highly speculative. This report's author was involved in the north sea potential for storage and 30 years later there is little progress.

3. The removals capacity will need to be shared with other hard-to-abate sectors and cater for failures to reduce carbon emissions in a timely manner by other sectors.

4. RHC's interpretation of the 6th Carbon Budget is that the cost might be around £50/t of CO2 adding little over £1 bn to ticket prices (Figure 6). However, there is great uncertainty on the abatement costs and they are likely to vary widely depending on whether they are engineered or land sink based.

5. As said before, the removal of aviation's 23 Mt (6th Carbon Budget) or 21 Mt (DfT) a year by 2050 is highly speculative and it is essential demand management be introduced in the meantime and probably for all time until zero carbon aircraft are the norm.

Q12. What could be done further or differently to ensure carbon markets and greenhouse gas removal methods are used most effectively?

Answer: see comment

Comment:

RHC PROPOSED AIRPORT CARBON QUOTA SCHEME

1. There are considerable uncertainties in achieving net zero and other mechanisms must be developed and introduced soon, otherwise achieving net zero carbon is at great risk. RHC proposes that instead of a carbon tax or a frequent flyer levy (rejected by the HM Treasury), there be introduced an airport carbon (or greenhouse gas) quota system over five year cycles (or less), which is driven by UK Carbon Budgets and airport Action Plans. Airports are best placed, as with the night noise quota system, to work with airlines on aircraft fleets, routes and operations to meet noise and carbon targets. A quota system focussed on three airports would cover 80% of aviation carbon emissions - Heathrow 55%, Gatwick 15%, and Manchester 10%.

2. There are criticisms of the night time quota system that suggest the ceiling has not been reduced in a timely manner and that it has exerted insufficient pressure on airlines to reduce noise. However, a carbon quota system would flow directly from the CCC's carbon budgets approved by parliament and little if any scope to avoid meeting targets in a timely basis and ultimately net zero by 2050. The quotas should be included in each airport's Action Plans.

3. Figure 15 shows the carbon footprints from flights in 2018 for the UK's main airports. We have increased the Baseline footprints to the 51 Mt in 2050 in the 6th Carbon Budget and then allocated the Budget abatement totals to each airport according to their individual footprints in 2018. This is of course an approximation but serves the purpose of showing that three airports-Heathrow, Gatwick and Manchester together emit 80% of the UK carbon.

RHC Proposed Airport Quota Scheme

	Carbon CO2e '000 tonnes					
	2018	2050				
	Actual	Base Case	Demand	Efficiency	Fuels	Net Zero
Gatwick	**5,111**	**6,684**	**-1,573**	**-1,048**	**-1,048**	**3,014**
Heathrow	**22,022**	**28,798**	**-6,776**	**-4,517**	**-4,517**	**12,987**
London City	180	236	-56	-37	-37	106
Luton	1,095	1,432	-337	-225	-225	646
Stansted	1,498	1,959	-461	-307	-307	884
Aberdeen	136	178	-42	-28	-28	80
Belfast International	263	344	-81	-54	-54	155
Belfast City	90	118	-28	-18	-18	53
Birmingham	1,392	1,820	-428	-285	-285	821
Blackpool	0	0	0	0	0	0
Bournemouth	39	51	-12	-8	-8	23
Bristol	475	621	-146	-97	-97	280
Cardiff	92	120	-28	-19	-19	54
Durham Tees Valley	7	10	-2	-1	-1	4
Doncaster Sheffield	91	120	-28	-19	-19	54
East Midlands	335	438	-103	-69	-69	198
Edinburgh	772	1,009	-237	-158	-158	455
Exeter	51	67	-16	-10	-10	30
Glasgow	660	864	-203	-135	-135	389
Humberside	7	9	-2	-1	-1	4
Inverness	30	40	-9	-6	-6	18
Leeds-Bradford	209	273	-64	-43	-43	123
Liverpool	268	350	-82	-55	-55	158
Manchester	**3,589**	**4,693**	**-1,104**	**-736**	**-736**	**2,116**
Newcastle	356	466	-110	-73	-73	210
Newquay	10	13	-3	-2	-2	6
Norwich	38	50	-12	-8	-8	22
Prestwick	61	79	-19	-12	-12	36
Southampton	79	104	-24	-16	-16	47
Southend	42	55	-13	-9	-9	25
CCC 6th Carbon Budget	39,000	**51,000**	**-12,000**	**-8,000**	**-8,000**	**23,000**

Prepared by RHC: CCC totals allocated to airports pro-rata to 2018

Figure 15

4. Figure 16 illustrates Figure 15 graphically

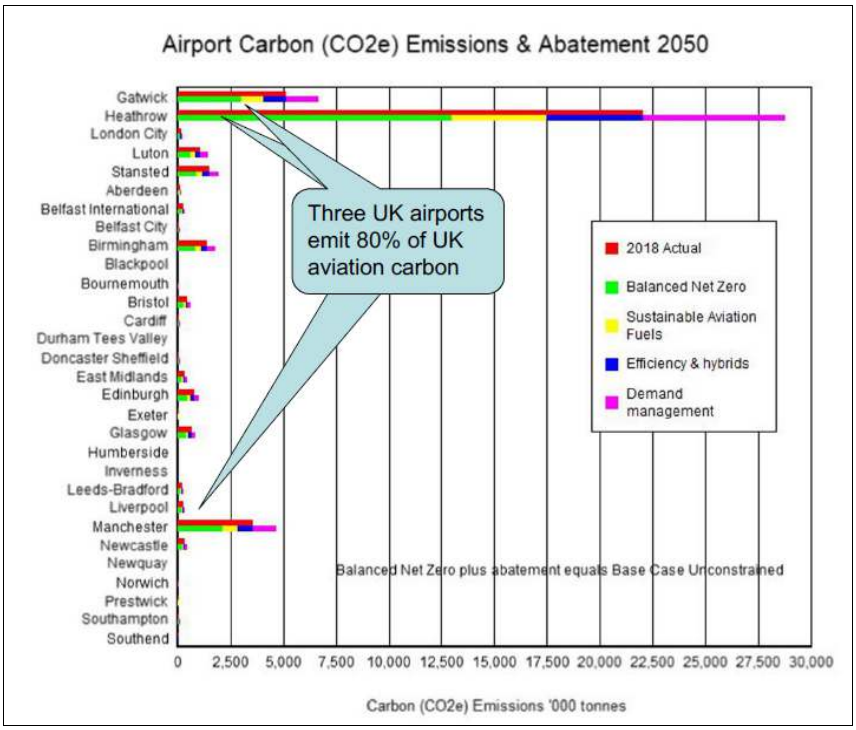


Figure 16

5. Figure 17 shows the level of demand management needed for each airport to reduce the unconstrained UK Baseline growth in demand to the target 365 mppa by 2050.

	Passenger Demand mmpa			
	2018	2050		
		Base Case	Net Zero	Reduction
Gatwick	47.2	77.2	59.0	-18.3
Heathrow	82.7	135.4	103.4	-32.0
London City	5.0	8.1	6.2	-1.9
Luton	16.0	26.2	20.0	-6.2
Stansted	26.6	43.5	33.2	-10.3
Aberdeen	3.2	5.3	4.0	-1.3
Belfast International	5.6	9.2	7.0	-2.2
Belfast City	2.9	4.8	3.6	-1.1
Birmingham	12.7	20.8	15.9	-4.9
Blackpool	0.0	0.1	0.0	-0.0
Bournemouth	0.7	1.2	0.9	-0.3
Bristol	8.3	13.6	10.4	-3.2
Cardiff	1.5	2.4	1.8	-0.6
Durham Tees Valley	0.1	0.2	0.2	-0.1
Doncaster Sheffield	1.4	2.2	1.7	-0.5
East Midlands	5.1	8.3	6.4	-2.0
Edinburgh	13.5	22.1	16.9	-5.2
Exeter	0.9	1.5	1.2	-0.4
Glasgow	10.2	16.7	12.7	-3.9
Humberside	0.2	0.4	0.3	-0.1
Inverness	0.9	1.4	1.1	-0.3
Leeds-Bradford	3.9	6.5	4.9	-1.5
Liverpool	5.2	8.5	6.5	-2.0
Manchester	28.0	45.8	35.0	-10.8
Newcastle	5.3	8.6	6.6	-2.0
Newquay	0.4	0.7	0.5	-0.2
Norwich	0.6	0.9	0.7	-0.2
Prestwick	0.7	1.2	0.9	-0.3
Southampton	2.1	3.5	2.7	-0.8
Southend	1.0	1.6	1.2	-0.4
Total	292.0	478.0	365.0	-113.0
Prepared by RHC: CCC totals allocated to airports pro-rata to 2018				

Figure 17

Q13. Do you agree or disagree with the overall focus on influencing consumers?

CONSUMER BEHAVIOUR

Answer: Disagree

Comment:

1. **Fair allocation of abatement costs**. The majority of people around the world do not fly (50% in the UK). In the UK, 15% of people take 70% of all flights.

   Purpose of travel. In pre-covid terms, 60% of UK passengers were UK resident leisure passengers (including friends and family), 20% foreign resident leisure passengers (tourists to the UK) and 20% business. International-to-international (I-I) passengers comprised 10% of passengers.

   Distance travelled. Emissions per passenger depend on distance travelled, class of travel and other factors. Broadly, individual flights vary substantially from the average of 0.13 tonnes of CO2 per passenger based on the UK's 39.6 MT and 292 mppa in 2018. Approximately 0.05kg of CO2 is emitted per 1000km in economy class. But a one way premium class journey from London to Auckland (20,000 km) emits a substantial 1.8 tonnes of CO2 per passenger, compared to an average UK carbon footprint of 6 tonnes of CO2 per person per year. Long-haul, short-haul and domestic comprise around 21%, 67% and 12% of UK air travel, respectively.

RHC proposes an increase in air passenger duty (APD) (see Q2 para 15 & 16) for fiscal and not pollution control reasons but it would have the effect of constraining demand and the long-established format of APD, based on distance and class of travel, seems a reasonable approach to allocating the cost of carbon mitigation. Furthermore, the substantial increase in HM Treasury income could support the less well off, social care, etc.

2. **Cheap UK air fares**. Airlines continue to race to the bottom on air fares (e.g. recent BA Gatwick plans and a new JetBlue Atlantic service) and demand is inflated with increased carbon emissions.

3. **Carbon implications from the high propensity of the British to fly**. More Britons travel abroad than any other nationality, according to official data from the international trade body for aviation. In 2018, 8.6% of all international travellers were British followed by the US with 7.6% and China 6.6 per cent. The global aviation industry emitted 915 Mt of carbon in 2019 or 2% of total global carbon emissions of 42 Gt. UK aviation emitted 39.6 Mt or 8% of total UK emissions of 522 Mt; as such the UK aviation carbon footprint is relatively high. 70% of passengers on UK international flights are UK resident but carbon accounting allocates 50% to the UK, based on departures alone, and therefore the UK bears less than its fair share of global aviation carbon costs. Surely, the UK is under moral obligation not to be the highest aviation polluter.

Q14. What more can the Government do to support consumers to make informed, sustainable aviation travel choices?

Answer: see comment

Comment:

1. Increase APD to full and fair levels and ensure ticket prices internalise the cost of carbon which could mean prices rising by 70%. We propose that APD be increased in steps in the years 2026 to 2030, once the aviation industry has had time to recover from covid.

Q15. What could be done further or differently to ensure we tackle non-CO2 impacts from aviation?

Answer: see comment

Comment:

1. **International aviation is predicted to grow at environmentally unsustainable rates.** The ICAO forecast substantial global aviation growth of over 4% pa through to 2045 compared to the CCC's unconstrained forecast of 1.6% pa or carbon constrained 0.7%pa for the UK. These differences create pressure on UK aviation to downplay the climate issues in the face of competition.

2. **International fault lines on who should pay**. Developing nations seek financial assistance from reluctant developed nations in mitigating a relatively high growth rate for carbon emissions. Bridging the major financial divide will be essential at COP 26 if there is to be co-operation in achieving aviation net zero.

3. **While claiming leadership, the UK is beholden to passenger and fuel markets.** There are practical issues of carbon leakage and competition between nations and tankering of fuels and international laws governing aviation such as the Chicago Convention. These are real problems but risk the UK not taking bold unilateral action on carbon.