Department for Transport

Carbon Policy Sensitivity Test
Supplementary Analysis

Moving Britain Ahead

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Summary

- The Airports Commission (AC) identified an indicative set of measures that could enable aviation emissions to be restricted to the Committee on Climate Change (CCC)'s planning assumption, based on their *assessment of need* demand scenario. The House of Commons Environmental Audit Committee recommended that this analysis be repeated under further demand scenarios. This analysis does so under the *global growth* demand scenario. More details on the *global growth* demand scenario are contained in Chapter 3 of *Strategic Fit: Forecasts*[1].

- In line with the Commission's carbon policy sensitivity test, we do not assume a higher carbon price. This means that more abatement needs to be delivered through technical measures. Specifically, the higher demand associated with the global growth scenario requires more intensive use of biofuels and further improvements in fuel efficiency. But such measures would enable the CCC planning assumption to be met.

- Alternative measures could be applied in practice to reduce the reliance on biofuels and operational measures, however, in order to maintain consistency with the AC's analysis, consideration of these measures has not been included. Notably, most of the abatement required is not because of airport expansion but would be needed in any case because of high background demand growth.

- Our analysis also shows that the level of measures required fall within the mid-range policy level scenario according to the DfT 2011 study[2] (see Appendix 1). This provides reassurance that abatement measures could be available to address unlikely, higher demand scenarios.

- This analysis shows that such abatement is technically feasible; but we recognise that further work would be required to identify how to deliver these measures in practice and in the context of the best use of future bio-energy in the economy.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/439687/strategic-fit-updated-forecasts.pdf
[2] A Marginal Abatement Cost Curve Model for the UK Aviation Sector (2011) http://www.icao.int/environmental-protection/Documents/ActionPlan/UK_AbatementModel_en.pdf

1. Introduction and purpose

1.1 This analysis was undertaken to complete evidence relating to the use of abatement measures under high demand scenarios.

1.2 Alongside the AC's Final Report, the AC published a carbon policy sensitivity test[3]. Their analysis identified an indicative set of measures that could enable carbon emissions attributable to the UK aviation sector to be restricted to a level consistent with the CCC planning assumption of 37.5MtCO_2 from UK aviation by 2050. This test was undertaken for the AC's *assessment of need* demand scenario only. Their work draws in part on a study commissioned by DfT in 2011 that examines the cost and abatement potential of measures to reduce carbon emission from aviation[4].

1.3 The Environmental Audit Committee (EAC), when examining the Government's willingness to address the environmental implications of the AC's recommendation, appeared to be referencing this test in paragraph 10 of their report.[5]

"***The Government, when making a decision, will need to consider its carbon emissions mitigation against the full range of demand scenarios modelled by the Commission."***

1.4 Within this context, this analysis sets out the supplementary work undertaken by DfT to consider the abatement measures under the AC's demand scenario that requires the most carbon abatement – *global growth* – as defined within the AC's *Strategic Fit: Forecasts.*[6] Other demand scenarios are not considered as they require less abatement effort to ensure emissions are kept to within the CCC's planning assumption.

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[3]Economy: Carbon Policy Sensitivity Test (2015) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/439679/economy-carbon-policy-sensitivity-test.pdf

[4] A Marginal Abatement Cost Curve Model for the UK Aviation Sector (2011) http://www.icao.int/environmental-protection/Documents/ActionPlan/UK_AbatementModel_en.pdf

[5]House of Commons Environmental Audit Committee: The Airports Commission Report: Carbon Emissions, Air Quality and Noise (2015) http://www.publications.parliament.uk/pa/cm201516/cmselect/cmenvaud/389/389.pdf

[6]Strategic Fit: Forecasts (2015) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374660/AC05-forecasts.pdf

2. Methodology

2.1 Where possible, the same methodology as that used by the AC has been followed to ensure consistency and to facilitate comparisons. So a two-step process has been applied:

- Demand has been forecast using the same version of the DfT aviation model as used by the AC. For demand purposes, carbon prices were based on those used in the AC's carbon policy sensitivity test analysis which were set at a level to ensure emissions hit 37.5MtCO_2 in 2050 in the *assessment of need* do minimum scenario (£334/tonne). Aside from this, all other demand inputs associated with the *global growth* scenario were maintained from the AC's analysis. The demand model produces an estimate of carbon emissions before any additional abatement activities.

- Only the same sets of abatement measures as those used by the AC (increased use of biofuels and airline operational measures) have been considered. Because the carbon reduction required is greater than in the *assessment of need* scenario, these measures need to be used more intensively.

2.2 Details of the abatement measures applied in the AC's *assessment of need* analysis is set out in the AC's publication. This new analysis builds on the existing work, by considering the following measures:

- Further increase in use of biofuels

- Additional airline operational measures

2.3 For this supplementary analysis, total biofuel penetration is a combination of any levels of biofuel mandated by policy and any biofuels produced as a result of Government support for demonstration plants together with the baseline level assumed by the model.

2.4 The AC decided that no further technological levers would be considered because of the considerable difficulty and uncertainty of costing the investment required to make these further efficiency gains.

2.5 Alternative measures could be applied in practice to reduce the reliance on those identified above. In order to maintain consistency with the AC analysis, however, consideration of these measures have not been included.

2.6 As the issue at hand is the availability of abatement potential, we have focussed on this aspect and have not provided updated cost estimates.

2.7 The AC used the “Low” policy measures as defined in **Tables 2.1** through to **2.5**. The higher demand associated with the policy test reported here requires greater abatement, and the use of the “Medium” measures as defined in the same tables.

2.8 The low, medium and high policy lever thresholds should be considered largely indicative given the uncertainty around the policy picture over the forecast period. There therefore remains considerable uncertainty around the ease with which these policy levers could be applied.

Table 2.1: Biofuel uptake assumptions

	2030	2050
Baseline	**0.50%**	**2.50%**
Low policy test inherited from baseline	0.50%	2.50%
Low policy test demonstration	1.00%	1.00%
Low policy test mandatory	0.50%	6.50%
Low policy test total	**2.00%**	**10.00%**
Medium policy test inherited from baseline	0.50%	2.50%
Medium policy test demonstration	2.00%	2.00%
Medium policy test mandatory	0.50%	15.00%
Medium policy test total	**3.00%**	**20.00%**

2.9 For this test three operational measures have been defined:

- *Fuel efficient cruising speeds*
- *Powering of airfield taxiing (such as electric)*
- *Reductions in contingency fuel*

2.10 The medium policy test relies on more optimistic assumptions than the low policy test.

Table 2.2: Assumptions on fuel efficiency gains through reductions in aircraft cruising speeds, cumulative overall efficiency gain

	2020	2030	2040
Baseline	0.00%	0.00%	0.00%
Low policy test	0.00%	0.90%	1.70%
Medium policy test	1.00%	3.50%	5.00%

Table 2.3: Assumptions on fuel efficiency gains through change of airfield taxiing practice, cumulative overall efficiency gain

	2020	2030	2040
Baseline	0.00%	0.00%	0.00%
Low policy test	0.00%	0.50%	1.00%
Medium policy test	0.50%	1.00%	1.50%

Table 2.4: Assumptions on fuel efficiency gains through less contingency fuel, cumulative overall efficiency gain

	2020	2030	2040
Baseline	0.00%	0.00%	0.00%
Low policy test	0.00%	0.20%	0.40%
Medium policy test	0.20%	0.40%	0.60%

2.11 The three airline operational measures identified above (speed, airfield taxiing and contingency fuel) can be reasonably added as their interactions would be minimal.[7] The overall operational gains shown in **Table 2.5** are adopted for the baseline and the sensitivity tests.

Table 2.5: Combined airline operational measure settings – cumulative overall efficiency gain

	2020	2030	2040
Baseline	0.00%	0.00%	0.00%
Low policy test	0.00%	1.60%	3.10%
Medium policy test	1.70%	4.90%	7.10%

[7] E.g. in the high measure case, a 1% reduction in fuel carried is not going to materially affect the gains which could be derived from speed optimisation etc..

3. Passenger demand and CO2 forecasts

3.1 This section is split into two. First, outputs from the demand model before consideration of further carbon measures are presented for all capacity options, including the do minimum. And then the impact of the assessed carbon measures are shown.

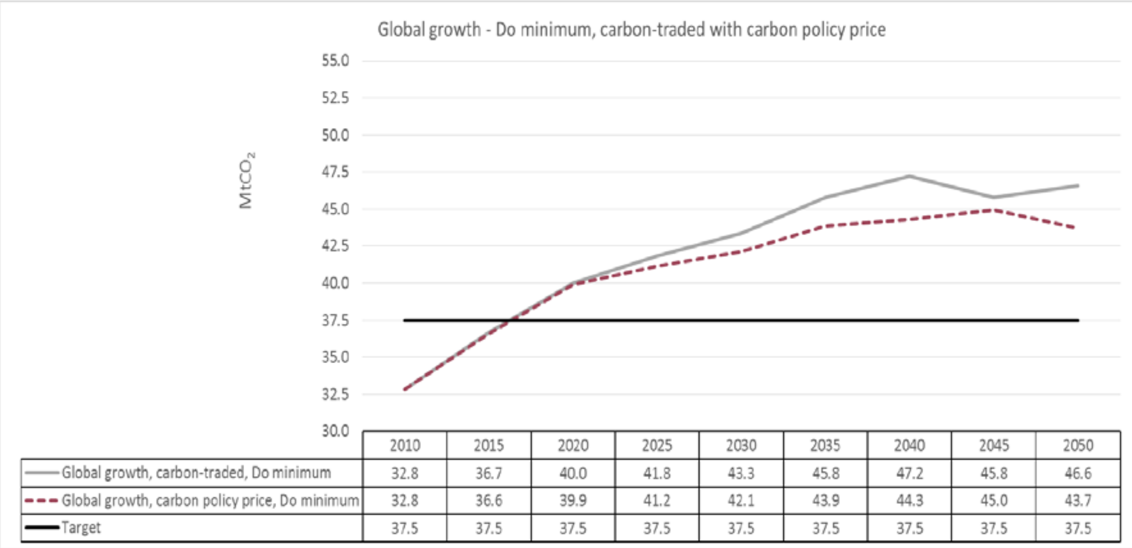
3.2 Passenger and emission forecasts for the baseline carbon-traded and carbon policy price test for the do minimum of no added capacity are shown in **Table 3.1** and the profiles of CO_2 emissions in **Figure 3.1**. Details of the carbon traded case are provided in the AC publications. Carbon traded results were published by the AC and included here only for reference purposes.

Table 3.1: Passenger forecasts and CO_2 emissions, *global growth*

Do minimum Global growth mppa	2011	carbon-traded 2030	 2040	 2050	carbon policy price 2030	 2040	 2050
Heathrow	70	87	96	91	86	93	91
Gatwick	34	44	47	45	43	47	49
Stansted	18	35	35	35	35	35	35
Luton	10	18	18	18	16	18	18
London City	3	7	7	8	8	7	8
London	135	191	204	197	188	200	201
Other modelled UK	83	141	198	260	133	177	230
UK Total	**218**	**332**	**401**	**457**	**321**	**377**	**431**

UK	2011	carbon-traded 2030	 2040	 2050	carbon policy price 2030	 2040	 2050
$MtCO_2$	34.4	43.3	47.2	46.6	42.1	44.3	43.7
Aircraft kms (millions)	3270.9	4575.5	5447.0	6259.4	4429.4	5114.0	5904.0

Figure 3.1: Do minimum carbon-traded and carbon policy price CO_2, *global growth*



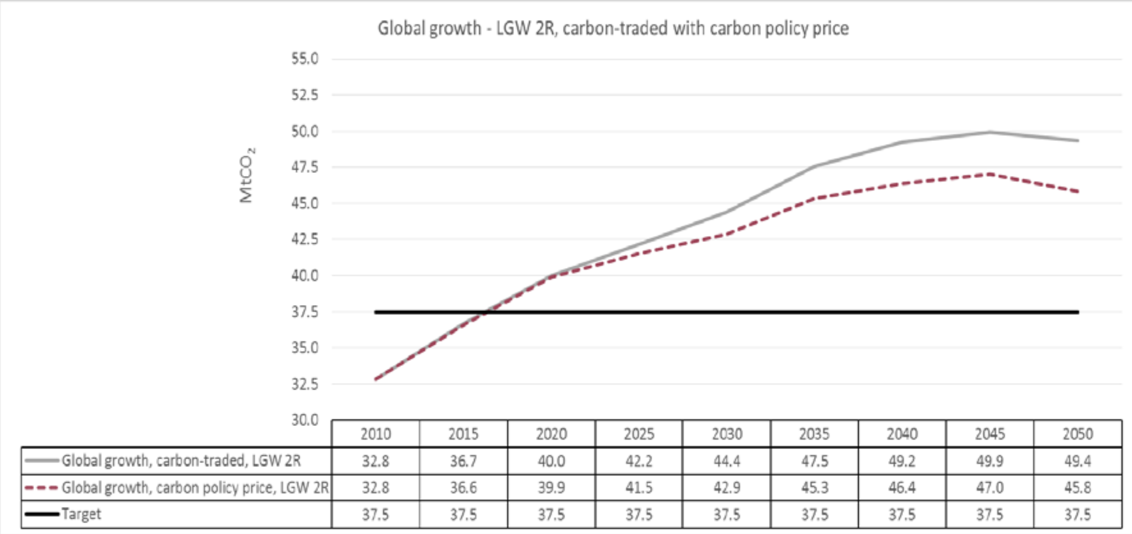
3.3 Forecasts have then been made for London Heathrow Northwest Runway (LHR-NWR), London Heathrow Extended Northern Runway (LHR-ENR) and London Gatwick Second Runway (LGW-2R) using the carbon price which limits the emissions to 37.5MtCO_2 in the do minimum for the *assessment of need* scenario. Since this analysis uses a higher demand growth scenario and because adding capacity increases demand, it follows that in these options' emissions outputs will exceed 37.5MtCO_2.

Table 3.2: LGW-2R carbon-traded and carbon policy price passenger forecasts and CO_2 emissions, *global growth*

LGW 2R Global growth mppa	2011	carbon-traded 2030	carbon-traded 2040	carbon-traded 2050	carbon policy price 2030	carbon policy price 2040	carbon policy price 2050
Heathrow	70	86	93	91	86	92	90
Gatwick	34	58	86	96	54	75	92
Stansted	18	35	35	35	35	35	35
Luton	10	15	18	18	14	18	18
London City	3	7	8	9	7	7	8
London	135	201	240	249	195	227	242
Other modelled UK	83	138	179	239	131	164	212
UK Total	**218**	**339**	**420**	**488**	**326**	**391**	**454**

UK	2011	carbon-traded 2030	carbon-traded 2040	carbon-traded 2050	carbon policy price 2030	carbon policy price 2040	carbon policy price 2050
MtCO_2	34.4	44.4	49.2	49.4	42.9	46.4	45.8
Aircraft kms (millions)	3270.9	4664.4	5658.9	6726.5	4487.5	5289.5	6244.0

Figure 3.2: LGW-2R carbon-traded and carbon policy price CO2 emissions, *global growth*



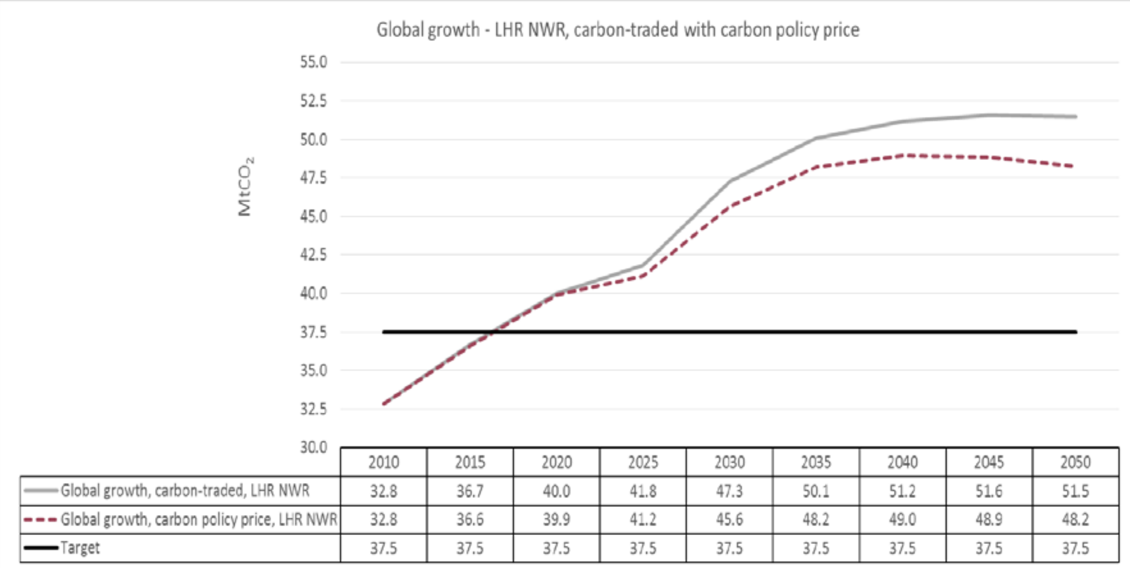
3.4 **Table 3.2** shows that when the 2050 carbon price is raised from £196/tonne to £334/tonne, forecast passenger demand at LGW-2R drops from 96 million to 92 million passengers. National demand drops by 34 million passengers. Further, national carbon emissions drop by 3.6$MtCO_2$ to 45.8$MtCO_2$ with the new capacity. Therefore a further 8.3$MtCO_2$ is required to be abated by further policy measures. Most of the abatement required is not because of airport expansion but would be needed in any case because of high background demand growth.

Table 3.3: LHR-NWR carbon-traded and carbon policy price passenger forecasts and CO2 emissions, *global growth*

LHR NWR Global growth		carbon-traded			carbon policy price		
mppa	2011	2030	2040	2050	2030	2040	2050
Heathrow	70	125	138	148	122	136	146
Gatwick	34	42	47	45	41	46	48
Stansted	18	35	35	35	33	35	35
Luton	10	13	18	18	12	17	18
London City	3	5	7	9	5	8	8
London	135	220	246	254	213	241	255
Other modelled UK	83	135	181	241	129	162	211
UK Total	**218**	**355**	**427**	**496**	**342**	**404**	**466**

		carbon-traded			carbon policy price		
UK	2011	2030	2040	2050	2030	2040	2050
$MtCO_2$	34.4	47.3	51.2	51.5	45.6	49.0	48.2
Aircraft kms (millions)	3270.9	4878.0	5750.3	6752.0	4695.8	5454.4	6323.0

Figure 3.3: Heathrow North West Runway carbon-traded and carbon policy price CO2 emissions, ***global growth***



	2010	2015	2020	2025	2030	2035	2040	2045	2050
Global growth, carbon-traded, LHR NWR	32.8	36.7	40.0	41.8	47.3	50.1	51.2	51.6	51.5
Global growth, carbon policy price, LHR NWR	32.8	36.6	39.9	41.2	45.6	48.2	49.0	48.9	48.2
Target	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5

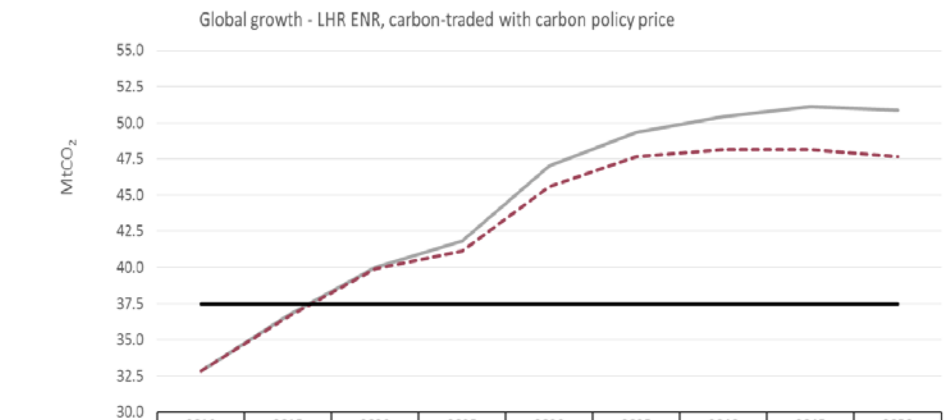
3.5 **Table 3.3** shows that when the 2050 carbon price is raised from £196/tonne to £334/tonne, passenger demand at LHR-NWR drops from 148 million to 146 million passengers. National demand drops by 30 million passengers. Further, national carbon emissions drop by 3.3MtCO_2 to 48.2MtCO_2 with the new capacity. Therefore a further 10.7MtCO_2 is required to be abated by further policy measures. Most of the abatement required is not because of airport expansion but would be needed in any case because of high background demand growth.

Table 3.4: LHR-ENR carbon-traded and carbon policy price passenger forecasts and CO2 emissions, *global growth*

LHR ENR Global growth mppa	2011	carbon-traded 2030	carbon-traded 2040	carbon-traded 2050	carbon policy price 2030	carbon policy price 2040	carbon policy price 2050
Heathrow	70	123	131	142	121	130	139
Gatwick	34	42	47	46	41	45	49
Stansted	18	35	35	35	33	35	35
Luton	10	13	18	18	12	18	18
London City	3	6	7	8	5	8	8
London	135	219	239	248	213	235	249
Other modelled UK	83	135	183	243	129	164	214
UK Total	**218**	**354**	**422**	**491**	**341**	**399**	**462**

UK	2011	carbon-traded 2030	carbon-traded 2040	carbon-traded 2050	carbon policy price 2030	carbon policy price 2040	carbon policy price 2050
MtCO_2	34.4	47.0	50.4	50.9	45.6	48.2	47.7
Aircraft kms (millions)	3270.9	4859.0	5699.4	6664.3	4692.7	5386.8	6282.5

Figure 3.4: LHR-ENR carbon-traded and carbon policy price CO2 emissions, *global growth*



	2010	2015	2020	2025	2030	2035	2040	2045	2050
Global growth, carbon-traded, LHR ENR	32.8	36.7	40.0	41.8	47.0	49.4	50.4	51.1	50.9
Global growth, carbon policy price, LHR ENR	32.8	36.6	39.9	41.2	45.6	47.7	48.2	48.1	47.7
Target	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5

3.6 **Table 3.4** shows that when the 2050 carbon price is raised from £196/tonne to £334/tonne, passenger demand at LHR-ENR drops from 142 million to 139 million passengers. National demand drops by 29 million passengers. Further, national carbon emissions drop by 3.2MtCO_2 to 47.7MtCO_2.with the new capacity. Therefore a further 10.2MtCO_2 is required to be abated by further policy measures. Most of the abatement required is not because of airport expansion but would be needed in any case because of high background demand growth.

3.7 Having first reduced carbon emissions through higher carbon prices, these next set of results focus on the further policy measures that are required in order to bring emissions down to reach 37.5MtCO_2 by 2050 in each capacity option.

3.8 The resulting modelled improvement in fuel efficiency over time is also reported, with efficiency being defined as the improvement in seat-kms produced per tonne of fuel. Improvements in fuel efficiency reflect not only the operational measures referred to in section 3, but also changes that occur without such additional measures. The most significant of these relate to fleet turnover with existing aircraft being replaced by those with greater efficiency throughout the modelled period.

3.9 The metric of fuel efficiency does not reflect the cut in carbon emissions delivered by an increased proportion of biofuels in total aviation fuel consumption. The effects of carbon policy measures are shown relative to the do minimum capacity option with baseline carbon policy assumptions.

3.10 In LGW-2R option, a further 8.3MtCO_2 of abatement is required in addition to that delivered by higher carbon prices. **Table 3.5** shows that the medium operational efficiency measures combined with the partial adoption of biofuels (14.7% including 2.5% within the baseline) is required to complete the abatement down to 37.5MtCO_2 in 2050 (In this and other tables, “AoN” refers to assessment of need and “GG” for global growth).

Table 3.5: LGW-2R, effect of CO2 abatement measures

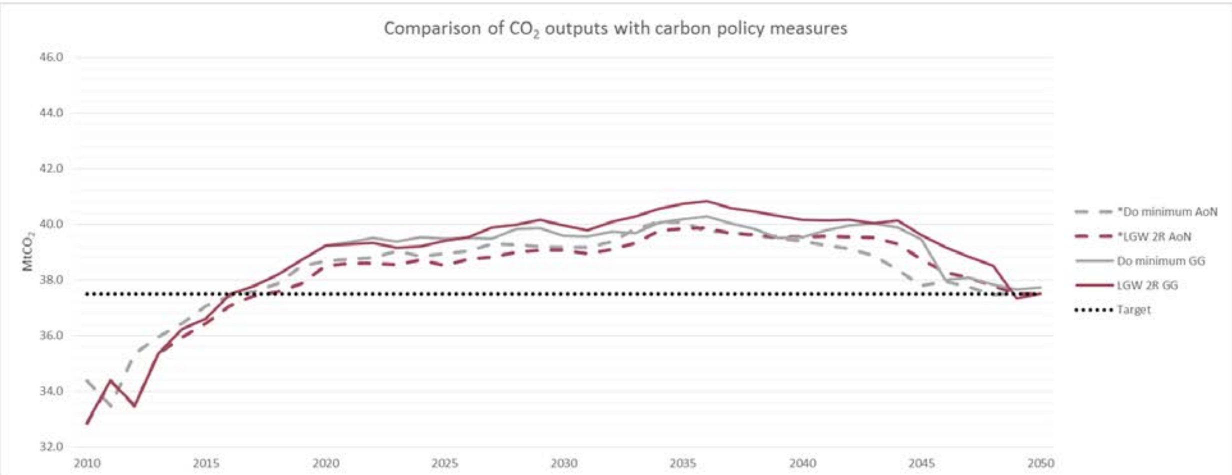
Effect of carbon measures on CO_2 levels in 2050				
Option	***Do minimum AoN**	***LGW 2R AoN**	**Do minimum GG**	**LGW 2R GG**
2050 carbon-traded base (Mt)	39.9	40.8	46.6	49.4
2050 carbon price policy (Mt)	37.5	38.2	43.7	45.8
Operational efficiency measures	None	None	Medium	Medium
Biofuel measures	None	CCC	Low	Medium
2050 Operational efficiency %	0.0%	0.0%	7.1%	7.1%
**2050 Biofuel measures total %	2.5%	4.2%	10.0%	14.7%
2050 Operational efficiency abatement (Mt)	0.0	0.0	2.7	2.8
2050 Biofuel total abatement (Mt)	0.0	0.7	3.3	5.5
2050 Total abatement (Mt)	0.0	0.7	6.0	8.3
2050 Final CO2 level after carbon policy measures (Mt)	37.5	37.5	37.7	37.5

*Presented within the AC's Economy: Carbon Policy Sensitivity Test (2015)

**Includes 2.5% baseline biofuel level. Demonstration and mandatory measures are additionally presented for this supplementary test into one biofuel measure

3.11 **Figure 3.5** shows the profile of total modelled emissions through throughout the modelled period for the do minimum and LGW-2R with the abatement measures required to meet the CCC planning assumption.

Figure 3.5: LGW-2R CO2 emissions 2010-2050 with abatement measures



*Presented within the Airport Commission's Economy: Carbon Policy Sensitivity Test (2015)

3.12 **Table 3.6** shows the change in fuel efficiency required to accommodate LGW-2R within the CCC planning assumption. Biofuels do not contribute to the fuel efficiency metric and carbon price policy has only a very indirect effect through reducing passenger demand. An increase from 1.06% to 1.23%pa fuel efficiency is required to limit emissions to 37.5MtCO_2 in 2050 within the *global growth* scenario.

Table 3.6: LGW-2R CO2 annual rate of improvement in fuel efficiency to meet planning assumption

Fuel efficiency improvement per annum after carbon policy measures			
Option	**Baseline (no extra policy measures)**	**Carbon price policy**	**Operational efficiency policy**
***Do minimum AoN**	1.07%	1.08%	
***LGW 2R AoN**	1.10%	1.10%	
Do minimum GG	1.04%	1.07%	1.24%
LGW 2R GG	1.05%	1.06%	1.23%

*Presented within the AC's Economy: Carbon Policy Sensitivity Test (2015)

3.13 **Table 3.6** shows that the fuel efficiency improvements do not play much of a role in reducing expansion-related emissions. Instead, greater use of biofuels – which do not affect fuel efficiency – delivers the additional abatement over and above that needed in the baseline.

3.14 In LHR-NWR, a further 10.7MtCO_2 of abatement is required in addition to that delivered through higher carbon prices. **Table 3.7** shows that the medium operational efficiency measures combined with the partial adoption (19.0% including 2.5% within the baseline) is required to complete the abatement down to 37.5MtCO_2 in 2050.

Table 3.7: LHR-NWR, effect of CO2 abatement measures

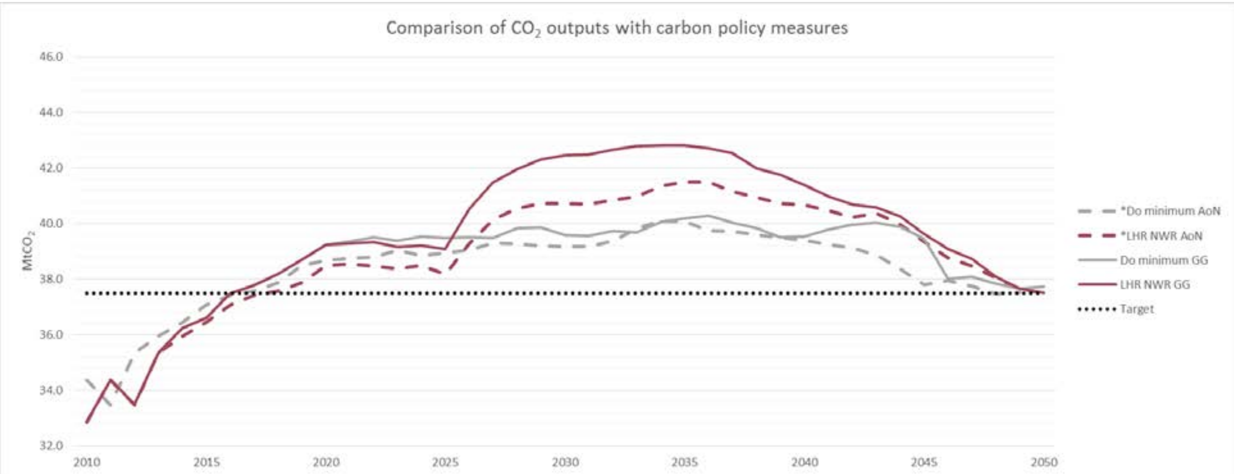
Effect of carbon measures on CO_2 levels in 2050				
Option	***Do minimum AoN**	***LHR NWR AoN**	**Do minimum GG**	**LHR NWR GG**
2050 carbon-traded base (Mt)	39.9	43.3	46.6	51.5
2050 carbon price policy (Mt)	37.5	41.0	43.7	48.2
Operational efficiency measures	None	Low	Medium	Medium
Biofuel measures	None	Low	Low	Medium
2050 Operational efficiency %	0.0%	3.1%	7.1%	7.1%
**2050 Biofuel measures total %	2.5%	8.1%	10.0%	19.0%
2050 Operational efficiency abatement (Mt)	0.0	1.2	2.7	3.0
2050 Biofuel total abatement (Mt)	0.0	2.3	3.3	7.8
2050 Total abatement (Mt)	0.0	3.5	6.0	10.7
2050 Final CO2 level after carbon policy measures (Mt)	37.5	37.5	37.7	37.5

*Presented within the AC's Economy: Carbon Policy Sensitivity Test (2015)

**Includes 2.5% baseline biofuel level. Demonstration and mandatory measures are additionally presented for this supplementary test into one biofuel measure

3.15 **Figure 3.6** shows the profile of total modelled emissions throughout the modelled period for the do minimum and LHR-NWR with the abatement measures required to meet the CCC planning assumption.

Figure 3.6: LHR-NWR CO2 emissions 2010-2050 with abatement measures



*Presented within the Airport Commission's Economy: Carbon Policy Sensitivity Test (2015)

3.16 **Table 3.8** shows the change in fuel efficiency required to accommodate LHR-NWR within the CCC planning assumption. Biofuels do not contribute to the fuel efficiency metric and carbon price policy has only a very indirect effect through reducing passenger demand. An increase from 1.07% to 1.25%pa fuel efficiency is required to limit emissions to 37.5$MtCO_2$ in 2050 within the *global growth* scenario.

Table 3.8: LHR-NWR CO2 annual rate of improvement in fuel efficiency to meet planning assumption

Fuel efficiency improvement per annum after carbon policy measures			
Option	**Baseline (no extra policy measures)**	**Carbon price policy**	**Operational efficiency policy**
***Do minimum AoN**	1.07%	1.08%	
***LHR NWR AoN**	1.06%	1.07%	1.15%
Do minimum GG	1.04%	1.07%	1.24%
LHR NWR GG	1.05%	1.07%	1.25%

*Presented within the Airport Commission's Economy: Carbon Policy Sensitivity Test (2015)

3.17 In the LHR-ENR option a further 10.2MtCO_2 of abatement is required in addition to that delivered through higher carbon prices. **Table 3.9** shows that the medium operational efficiency measures combined with the partial adoption (18.0% including 2.5% within the baseline) is required to complete the abatement down to 37.5MtCO_2 in 2050.

Table 3.9: LHR-ENR, effect of CO2 abatement measures

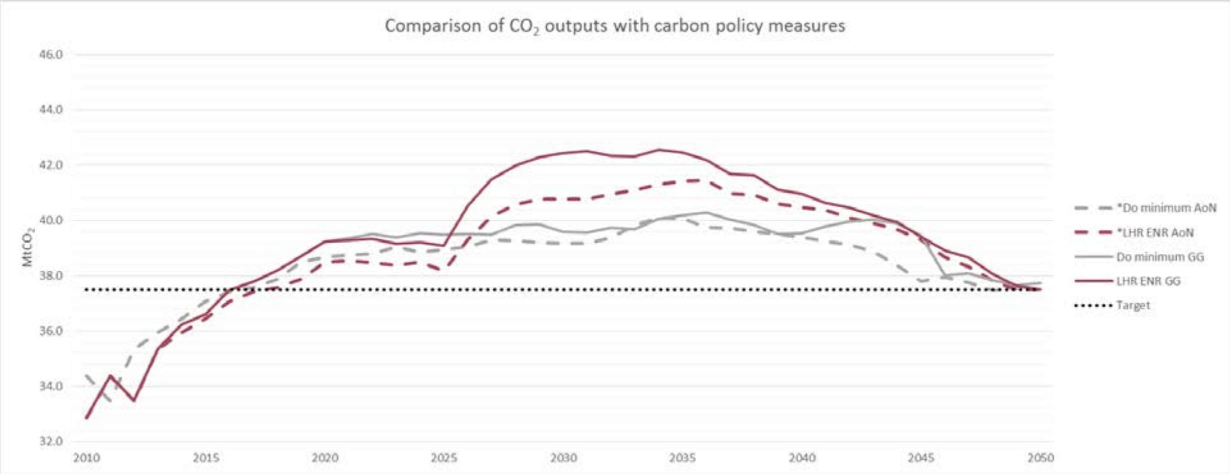
Effect of carbon measures on CO_2 levels in 2050				
Option	***Do minimum AoN**	***LHR ENR AoN**	**Do minimum GG**	**LHR ENR GG**
2050 carbon-traded base (Mt)	39.9	42.6	46.6	50.9
2050 carbon price policy (Mt)	37.5	40.4	43.7	47.7
Operational efficiency measures	None	Low	Medium	Medium
Biofuel measures	None	Low	Low	Medium
2050 Operational efficiency %	0.0%	3.1%	7.1%	7.1%
**2050 Biofuel measures total %	2.5%	6.9%	10.0%	18.0%
2050 Operational efficiency abatement (Mt)	0.0	1.2	2.7	2.9
2050 Biofuel total abatement (Mt)	0.0	1.8	3.3	7.2
2050 Total abatement (Mt)	0.0	2.9	6.0	10.2
2050 Final CO2 level after carbon policy measures (Mt)	37.5	37.5	37.7	37.5

*Presented within the AC's Economy: Carbon Policy Sensitivity Test (2015)

**Includes 2.5% baseline biofuel level. Demonstration and mandatory measures are additionally presented for this supplementary test into one biofuel measure

3.18 **Figure 3.7** shows the profile of total modelled emissions throughout the modelled period for the do minimum and LHR-ENR with the abatement measures required to meet the CCC's planning assumption.

Figure 3.7: LHR-ENR CO2 emissions 2010-2050 with abatement measures



*Presented within the AC's Economy: Carbon Policy Sensitivity Test (2015)

3.19 **Table 3.10** shows the change in fuel efficiency required to accommodate LHR-ENR within the CCC planning assumption. Biofuels do not contribute to the fuel efficiency metric and carbon price policy has only a very indirect effect through reducing passenger demand. An increase from 1.08% to 1.25%pa fuel efficiency is required to limit emissions to 37.5$MtCO_2$ in 2050 within the *global growth* scenario.

Table 3.10: LHR-ENR CO2 annual rate of improvement in fuel efficiency to meet planning assumption

Fuel efficiency improvement per annum after carbon policy measures			
Option	**Baseline (no extra policy measures)**	**Carbon price policy**	**Operational efficiency policy**
***Do minimum AoN**	1.07%	1.08%	
***LHR ENR AoN**	1.05%	1.07%	1.15%
Do minimum GG	1.04%	1.07%	1.24%
LHR ENR GG	1.05%	1.08%	1.25%

*Presented within the AC's Economy: Carbon Policy Sensitivity Test (2015)

Appendix 1: DfT (2011) Carbon Abatement Measure Settings

	Baseline (central)	*Lowpolicy lever*	*Medium Policy Lever*	*High Policy Lever*
Mandatory CO2 standard	No	Yes	Yes	Yes
Fleet retirement	22 years +	22 years	21 years	19 years
Improvement in fuel burn/fleet efficiency				
2020 future generation (compared to 2000 tech)	17.5-21.5%	21.5%	27.0%	27.0%
2030 future generation (compared to 2000 tech)	24.5-27.5%	26.0%	31.5%	36.0%
2040 future generation (compared to 2000 tech)	29.5-31.5%	36.0%	41.0%	43.2%
Biofuels				
2020-2030	0.5%	2.0%	3.0%	6.0%
2030-2040	1.5%	6.0%	11.5%	23.0%
2040-2050	2.5%	10.0%	20.0%	40.0%
Retrofitting of engines (fleet fuel eff)	0.00%	0.06%	0.22%	0.47%
Airline operational efficiency	0%	6.4%	11.1%	17.6%
Air Traffic Management (ATM) 2010-2050	0%	2.0%	4.0%	6.0%
Video conferencing	0%	0%	2% reduction in business demand	5% reduction in business demand
Modal shift ' behavioural change	0%	0%	2% reduction in leisure demand & 5% of long haul switches to short-haul	5% reduction in leisure demand & 10% of long haul switches to short-haul