CONTRACTING UK CARBON EMISSIONS: IMPLICATIONS FOR UK AVIATION

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Abstract

Stabilising atmospheric carbon dioxide concentrations at or below 550ppmv is widely believed to be necessary to avoid 'dangerous climate change'. Achieving such levels demands industrialised nations make significant emissions cuts, whilst emerging economies adopt low-carbon pathways. This paper demonstrates the severe consequences for the UK in meeting its obligations to reduce carbon emissions under the apportionment rules informing both RCEP's 22nd report, Energy the Changing Climate, and the 2003 Energy White, if the UK Government continues to permit the current high levels of growth within its aviation sector.

The paper reveals the enormous disparity between the UK's position on carbon reduction and the Government's reluctance to recognise and adequately respond to the rapidly escalating emissions from aviation. A comparison of forecasts and scenarios reflecting growing aviation emissions with a contracting UK emissions profile clearly illustrates this point. Results show that at an annual growth rate of only half of that experienced by UK aviation emissions in 2004, this sector will account for over 90% of permissible emissions in 2050 under the 550ppmv level, and consume the entire carbon budget under the 450ppmv level. The paper goes on to highlight the serious and significant implications for other sectors of the UK's economy and addresses concerns regarding the effectiveness of including the aviation sector within the EU's emissions trading scheme. The paper concludes that aviation growth must be curbed until sufficient steps are taken to ensure fuel efficiency gains balance growth in activity, or until there is widespread use of alternative fuels that significantly reduce the industry's carbon emissions.

1. Introduction

European nations are in broad agreement that individual States, and the EU as a whole, must tackle the problem of ever-increasing carbon dioxide emissions arising from energy consumption. In response, a number of nations have set carbon reduction targets for particular future years. In theory at least, these targets are chosen to correspond with stabilising carbon dioxide concentrations at levels that are likely to avoid ‘dangerous climate change’. Although there is no scientific consensus for what is considered to be ‘dangerous’ in relation to climate change, it has been broadly accepted by the policy community that this relates to global mean surface temperatures not exceeding 2ºC above pre-industrial levels.

By choosing targets related to global carbon dioxide concentrations, governments have, often without due consideration or recognition, accepted that such targets must include all carbon dioxide-producing sectors. In this regard, the UK is a clear example. The UK Government has set a target of reducing carbon dioxide emissions by 60% by 2050 from 1990 levels. Its basis for choosing 60% was the Royal Commission on Environmental Pollution’s report, Energy The Changing Climate [1], which indicates that a 60% reduction in carbon dioxide emissions from 1990 levels corresponds to stabilising global carbon dioxide concentrations at 550ppmv using a Contraction and Convergence regime[2] to apportion emissions between nations. However, the UK Government has also stated that this target does not include the emissions generated by either international aviation or shipping. Furthermore, in the same year that it chose a carbon reduction target, it published an Aviation White Paper proposing how the UK could meet the rising demand for air travel.

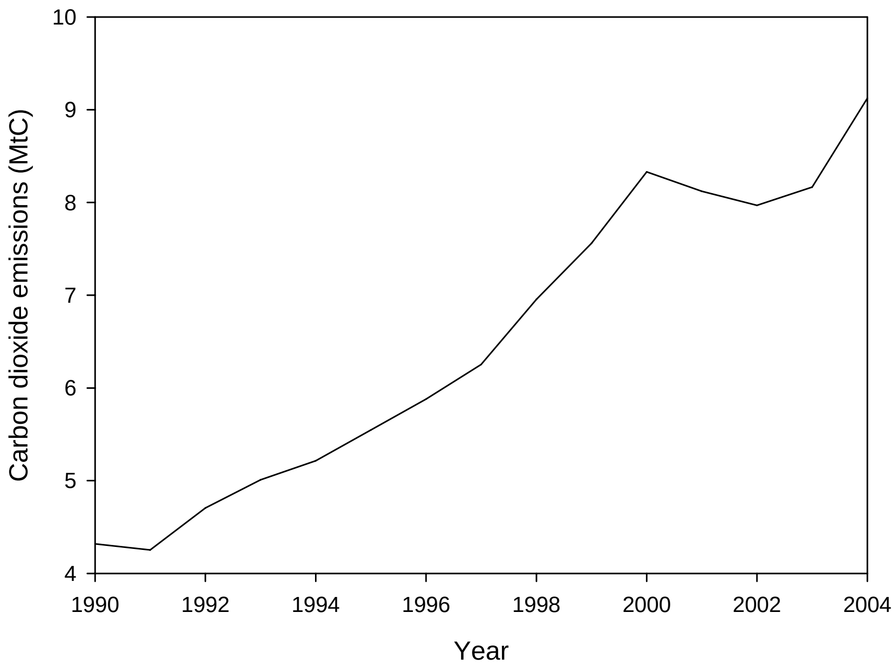
Selecting which sectors to include and which to omit under a carbon budget essentially negates the choice of a target based on global carbon dioxide concentrations, unless those sectors contribute negligible amounts of carbon dioxide. This paper clearly demonstrates that this is not the case for carbon dioxide emissions generated by the aviation sector, and illustrates that, contrary to UK Government forecasts, this sector’s emissions are growing so rapidly, that they are on course to exceed those generated by car transport within twelve years. The implications for such rapid growth in relation to the UK’s carbon reduction targets are highlighted using carbon reduction profiles for stabilising carbon dioxide concentrations at both 550ppmv and 450ppmv.

[1] (RCEP 2002)
[2] All nations aim for equal per-capita emissions by a particular year whilst the global emission total reduces in line with stabilising carbon dioxide concentrations at a particular level.

2. Background

Although the UK's national emissions inventory does not include emissions generated by the UK's international aviation or shipping industries, data for these sectors are collected and submitted separately as a memo to the United Nations Framework Conventional on Climate Change (UNFCCC). The sales of aviation bunker fuels recorded at airports could be used to estimate the emissions associated with international aviation. However, the National Environment Technology Centre (NETCEN), who estimate the emissions associated with the UK's aviation industry, employ a methodology that takes into account aircraft movements, distances travelled, deliveries of aviation spirit and turbine fuel and the consumption of aviation turbine fuel by the military[3]. This data includes both passenger and cargo aircraft. Figure 1 presents this data from 1990 to 2004[4].

Figure 1: Carbon dioxide emissions from the UK's International Aviation Industry



Clearly, the data indicates that carbon dioxide emissions from the UK's international aviation industry have increased rapidly since 1991, apart from during the two years following the events of September 11th 2001. On average, emissions increased at an annual average rate of 7% between 1990 and 2000, and, even including the events of September 11th, at 6% between 1990 and 2004[5]. Between 2003 and 2004, carbon dioxide emissions generated by international aviation increased by 11.7%, and those from domestic aviation increased by 3.8%.

3 (Watterson et al. 2004)
4 The uncertainties associated with this data are discussed in Watterson et al. 2004.
5 This is based on the mean value of the percentage change in emissions between one year and the next.

3. Method

To assess if emissions from the aviation industry are significant in relation to the UK Government's climate policy, it is necessary to analyse the UK's total current and historic carbon dioxide emissions, with and without the aviation sector. Once this data is collated, it is possible to relate the aviation industry's emissions to future carbon dioxide targets and consider the implications for other sectors.

To address the first challenge, the national carbon dioxide data compiled by NETCEN for the UNFCCC are plotted for 1990 to 2004[6]. This result is then compared with a profile that not only includes this national data, but also the international aviation contribution to carbon dioxide emissions and, in addition, the estimated contribution from international shipping. The carbon dioxide data for international aviation are again taken directly from the figures submitted to the UNFCCC. For international shipping, the data are estimated based on a crude method that relates total global marine bunker fuel sales to the UK's proportion of global GDP[7].

Relating the contribution from the aviation sector to climate change targets begins by plotting carbon reduction profiles for the UK's 60% target trajectory (~550ppmv), and for a concentration that relates more closely to the 2°C temperature threshold (~450ppmv). A combination of Government aviation forecasts, and 'what if' scenarios for the aviation industry, based on both current and historical trends, and assumptions about future trends, are then compared with these trajectories over a fifty year time period.

4. Results

Current and historical carbon dioxide emissions

Figure 2 illustrates the national carbon dioxide emissions as they are submitted to the UNFCCC[8]. According to the data, emissions in this profile have been reducing on average at 0.36% per year. However, the period between 1991 and 1995 was significantly affected by a switch from coal to gas, and a relocation of energy intensive industry overseas. Both contributed to the biggest reduction in carbon reduction emissions seen between 1990 and 2004, and are essentially one-off events that can not be repeated. Furthermore, carbon dioxide emissions have not been declining since 1995.

When the carbon dioxide emissions from international aviation and shipping are added to this profile, it is clear that carbon dioxide emissions have not shown the same level of reduction since 1990. Furthermore, the gap between emissions that do not include aviation and shipping, and those that do include these sectors, is widening. This indicates that international aviation and shipping emissions are becoming larger portions of the overall total as time progresses.

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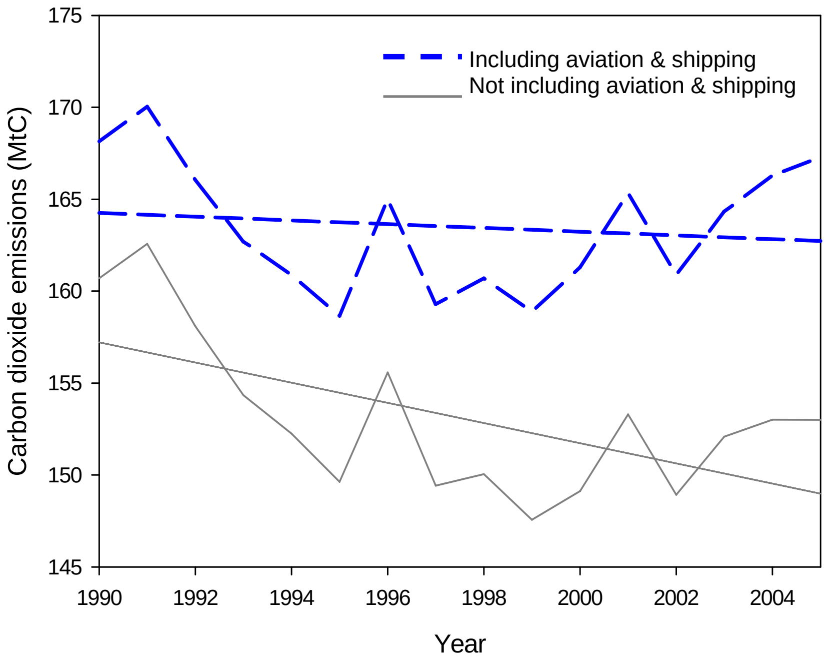
[6] Uncertainty analysis associated with this data can be found at (Eggleston et al. 1998)

[7] Emissions for shipping are currently based on UK marine bunker sales. However, unlike aviation, the tax on shipping fuel allows for large discrepancies in price from nation to nation, resulting in a significant amount of 'bunkering'. Assuming that the proportion of total marine bunker fuel is related to a nation's GDP is a crude but more realistic method of apportioning shipping emissions and is employed here. This method will be refined in the future. The uncertainty associated with this method has not been quantified, but will be affected by uncertainty in the global marine bunker fuels sold, for which no figure could be obtained. Assuming this figure, provided by the International Energy Agency, to be appropriate, the fact that the UK is an island state suggests that any apportionment of shipping emissions based on national GDP is more likely to be an underestimate than an overestimate.

[8] http://www.defra.gov.uk/environment/statistics/globatmos/download/xls/gafg06int.xls

Figure 2: UK carbon dioxide emissions



Carbon emission trajectories

To produce total economy emission trajectories for the UK, the Global Commons Institute (GCI) Contraction and Convergence model was used to reproduce the results of the RCEP report[1], in line with the UK Government's 60% carbon reduction target[9]. The GCI model, *CCOptions*, essentially calculates a global carbon trajectory based on stabilising atmospheric carbon dioxide concentrations at a particularly level. This global carbon budget is then apportioned between nations as they move towards equal per capita emissions. However, the *CCOptions* model does not include emissions from international aviation and shipping. To estimate the impact of including these emissions, the model was modified to incorporate global bunker fuel data available from the CDIAC database[10]. The UK's national carbon emission total in the start year then reflects an estimate of the true carbon dioxide emission total for the UK in the year 2000 (149.1MtC + 8.3MtC from international aviation + 3.8MtC from shipping = 161.2MtC).

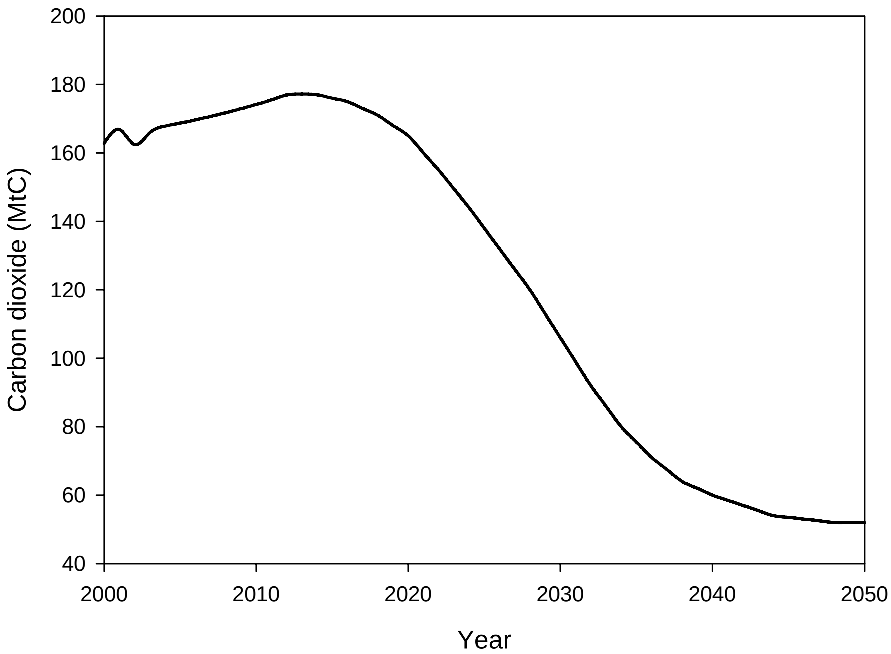
Within *CCOptions*, it is the global cumulative emissions released between the start date and the end date that are of importance when aiming for a particular carbon dioxide stabilisation level. Therefore, both the global and national trajectories that are followed from today are of crucial importance. The standard output of *CCOptions* relating to the UK's emissions produces a curve that begins with a stabilisation of carbon dioxide emissions from the start date until around 2010, followed by a decline. However, the fact that the model begins its trajectory scenario in the year 2000, immediately renders the initial period to be out of date. Therefore, a more realistic trajectory for UK emissions is presented

9 Although the UK Government does not explicitly state that it used the Contraction and Convergence regime to calculate its 60% carbon reduction target, the RCEP (2000) report does indicate that this was the method used to produce this emissions target.

10 http://cdiac.esd.ornl.gov/trends/emis/annex.htm

in Figure 4. This scenario firstly includes the actual recorded emissions for the UK for the years 2000 to 2005 as illustrated in Figure 1, and secondly, emissions from all non-international sectors which are assumed to be stable between 2006 and 2010, while those from international transport increase at 2% lower than 2004 levels over the same period. This results in a larger amount of cumulative carbon dioxide emitted by the UK between 2000 and 2050 than the standard output from the model. Consequently, to maintain the cumulative emissions total required to stabilise carbon dioxide concentrations at 550ppmv, compensation is required in the later years to ensure that the cumulative emissions between 2000 and 2050 remain the same. The resultant trajectory is illustrated in Figure 3.

Figure 3: 550ppmv profile for UK carbon emissions

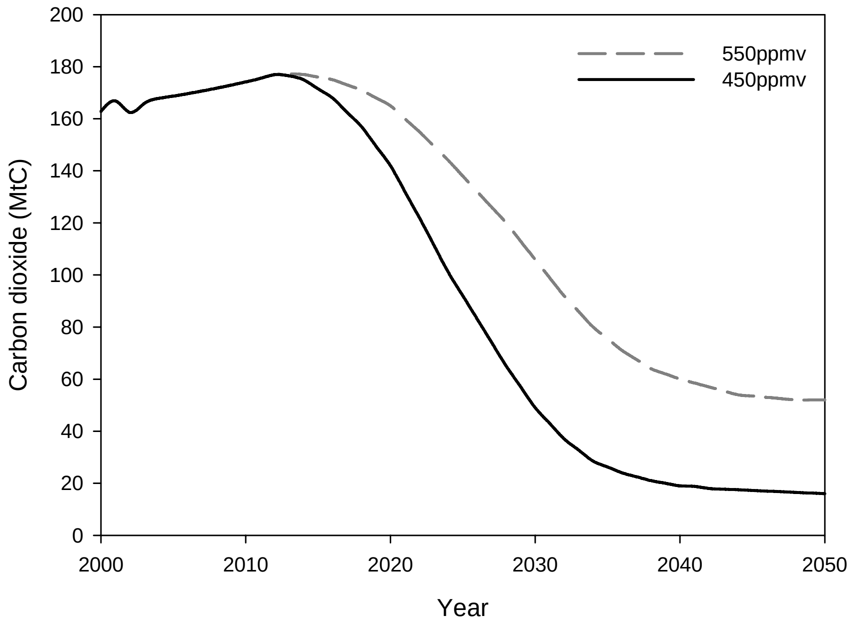


If a similar method is applied to the lower 450ppmv level, a level that is more likely to avoid global mean surface temperatures exceeding the 2°C threshold[11], the resulting profile, which is illustrated in Figure 4, is produced. Under both regimes, significant action is required in the short- and medium-term to ensure that carbon dioxide emissions generated by the UK begin to decline by 2013.

To investigate the implications of these trajectories for the aviation sector, UK Government forecasts and Tyndall scenarios are compared with the emissions profiles illustrated in figures 3 and 4.

[11] (Meinshausen 2006)

Figure 4: 450ppmv & 550ppmv profiles for UK carbon emissions



Future aviation emissions

In 2003, the UK Government published its Aviation White Paper[12], which included forecasts for carbon dioxide emissions from the aviation industry between 2000 and 2050. In total, they produced three growth forecasts within the accompanying documentation[13], one low, one medium and one high. The 'worst case' forecast assumes limited fuel efficiency improvements, limited fleet renewal, and no economic instruments. This forecast is based on the 'high capacity' case developed within the Economic Instruments paper[14], but with three, rather than two, additional runways built in the South East of England, as well as, so-called, unconstrained capacity in the regions[15]. The 'central case' figures are again based on the 'high capacity' scenario, but incorporating fleet fuel efficiency improvements envisaged by the IPCC[16] and by the Advisory Council for Aeronautics Research in Europe (ACARE)[17]. Finally, the 'best case' estimates use economic instruments to produce an additional 10% fleet fuel efficiency saving from 2020 onwards, with a 5% fleet fuel efficiency saving in 2010. These forecasts are for both domestic and international aviation and include freight transport[18]. The results are detailed in Table 1.

[12] (DfT 2004b)
[13] (DfT 2004a)
[14] (DfT 2003)
[15] Capacity is inherently constrained in such forecasts by, for example, by existing landing charges, car park fees etc.
[16] (IPCC 1999)
[17] (DfT 2004a)
[18] See paragraph 3.53 within the DfT Aviation and Global Warming paper (DfT 2003a)

Table 1: UK Government aviation emission forecasts

Year	DEFRA Worst Case	DEFRA Central Case	DEFRA Best Case
		MtC	
2000	8.8	8.8	8.8
2010	11.4	10.8	10.3
2020	16.5	14.9	13.4
2030	20.9	17.7	15.9
2040	25.1	18.2	16.4
2050	29.1	17.4	15.7

The data for these forecasts begin in the year 2000, but data for 2004 is now available[19]. Furthermore, the methodology used by the NETCEN to calculate the data has been revised recently and historical figures re-evaluated[3]. Comparing the actual data for 2000 to 2004 shown in Table 2 with these figures illustrates that firstly, the starting figure for 2000 has now been shown to be 0.2MtC higher. Secondly, that the figure for 2004 is already close to the forecasted values for 2010. For example, emissions would have to grow at just 0.83% per year between 2004 and 2010 if they are to remain within the upper bound of the Worst Case estimate by 2010. This comparison highlights that the Department for Transport must update these figures as a matter of urgency.

Table 2: NETCEN aviation emissions data as submitted to the UNFCCC

Year	NETCEN data
	MtC
2000	9.0
2001	8.8
2002	8.6
2003	8.8
2004	9.8

Aviation emission scenarios

The very high growth rates experienced by the aviation industry during the past few years have already rendered the UK Government's forecasts out-of-date. This is a significant limitation when attempting to assess this industry's impact on the climate. To illustrate how emissions are more likely to evolve if growth rates continue at close to current rates in the short term, three simple scenarios are presented here.

[19] A provisional figure for 2005 can also be estimated from the bunker fuel sales data recorded in the DTI's Digest of UK Energy Statistics (DTI 2006).

The first assumes that the average annual rate of growth in emissions of 7% per year, seen between 1993 and 2001, continues from a baseline 2004 figure of 9.8MtC, until the year 2012. This growth rate is somewhat lower than the latest confirmed rate available that indicates that emissions from international aviation increased by ~12% between 2003 and 2004. Between 2013 and 2050, emissions are assumed to grow at a much lower rate of 3% per year – similar to the figure suggested by the UK Government forecasts.

The reasoning behind the choice of emission growth is firstly based upon the fact that there are no new policies to address growth within the aviation sector, therefore, aside from the impact of terrorist attacks or some other unexpected event, there is currently no policy driver that will significantly reduce growth rates. Secondly, whilst oil prices have risen substantially in recent years, the aviation industry has continued to grow at very high rates, indicating that fuel price currently has a limited impact on growth rates. Thirdly, the success of the low-cost airlines, and the fact that they are making in-roads into some of the medium to longer-haul flights, is further driving the current very high growth rates. Within this scenario, all of these trends are assumed to continue over the short-term. For the period post-2012, it is assumed that radical policies either in the form of a quota system on flights, or fiscal measures, are introduced to significant curb growth rates. In terms of technology, in the period between 2004 and 2012, fuel efficiency is assumed to improve at around 1% per year across the fleet. From 2013 onwards, improvements are more significant, with the more rapid introduction of lighter aircraft, such as the Boeing Dreamliner, improved air traffic management and more directed R&D by the aircraft manufacturers.

This scenario results in 14.7MtC being emitted by the aviation sector by 2010, 16.8MtC by 2012 and 28.6MtC by 2030. If this trend continues post-2030, emissions will be 51.7MtC by 2050 (Table 3).

The second scenario, assumes that rates of growth in emissions seen historically, and described within scenario 1, continue until 2030 due to an absence of any policy effective in significantly curbing growth. This therefore assumes that fares remain affordable and that there is little to no tax on kerosene. It also assumes that airport capacity is increased to adapt to this growth. Technological improvements are assumed to increase the fuel efficiency of the fleet by ~1% per year, and the 30-year lifetime of aircraft limits, to some degree, new technology impacting fuel efficiency improvements across the fleet.

This scenario results in the same amount of carbon emitted by 2010 and 2012 as the first scenario, but 56.9MtC being emitted by the aviation industry by 2030. Within this scenario, the carbon emissions from the aviation sector exceed the current level of emissions from the private car sector[20] by 2018.

[20] (Anderson et al. 2005)

The third scenario assumes that emissions growth is significantly reduced immediately to 4% per year, and that this rate continues until 2050. This scenario illustrates simply the levels of emissions that would be reached if immediate action to curb growth were to be taken.

Within scenario 3, 12.7MtC are being emitted by 2010, 13.4MtC by 2012 and 27.7MtC emitted by 2030. This illustrates that, even at much lower rates of growth, the aviation sector will be emitting nearly 30MtC by 2030. If total UK carbon emissions in 2030 were the same as they are today, this would result in the aviation industry being responsible for around 18% of emissions compared with 7% in 2004[20]. However, as illustrated in the next section, total UK emissions will need to be much lower by 2030 than they are today, if the UK is to play its part in alleviating climate change. The figures for these three scenarios are presented in Table 3.

Table 3: Aviation emission scenarios

Year	Scenario 1	Scenario 2	Scenario 3
		MtC	
2000	9.0	9.0	9.0
2010	14.7	14.7	12.7
2020	21.4	29.0	18.7
2030	28.7	57.0	27.8
2040	38.6	76.7	41.1
2050	51.9	103.0	60.8

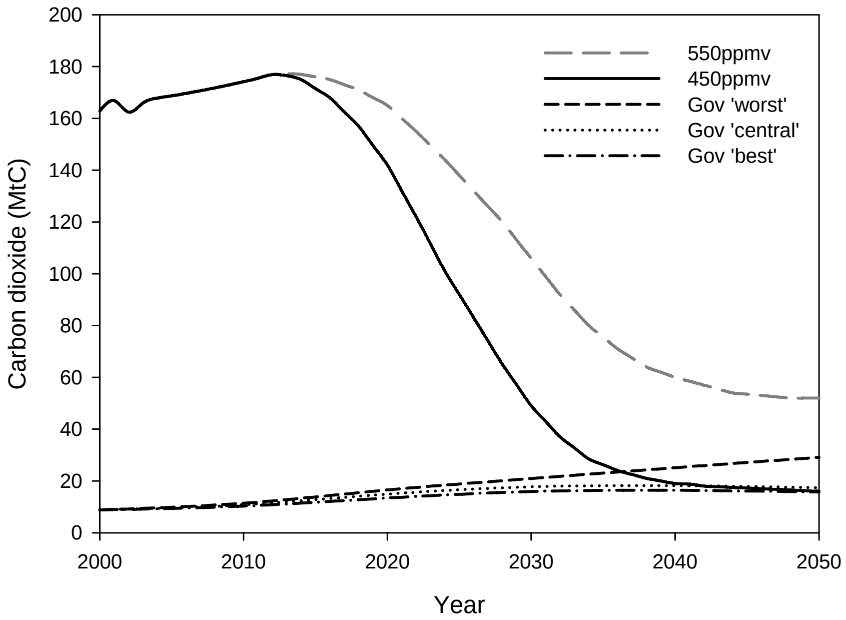
Implications of growing aviation for UK climate policy

To assess the implications of our growing aviation industry within a UK economy striving to drive down emissions, the UK Government aviation forecasts and the Tyndall aviation scenarios are compared with the Contraction and Convergence profiles illustrated in figure 4. The results are presented in figures 6 and 7.

Figure 6 presents the comparison between the UK Government's aviation forecasts and the UK carbon budget. Despite the fact that these forecasts are, as illustrated in Tables 1 and 2, unrepresentative of the true scale of aviation emissions, the results show that for all of the DfT's forecasts, carbon emissions from the aviation industry are accounting for more than the total carbon budget for the 450ppmv profiles by 2050. Furthermore, the UK Government's 'worst' case scenario exceeds the 450ppmv profile during the 2030s. This is particularly worrying as recent scientific research[21] indicates that stabilising carbon dioxide concentrations at levels lower than 450ppmv, will be necessary if there is to be a reasonable likelihood of avoiding so-called 'dangerous climate change'.

[21] (Elzen and Meinshausen 2005)

Figure 6: UK carbon trajectories vs UK Government aviation forecasts



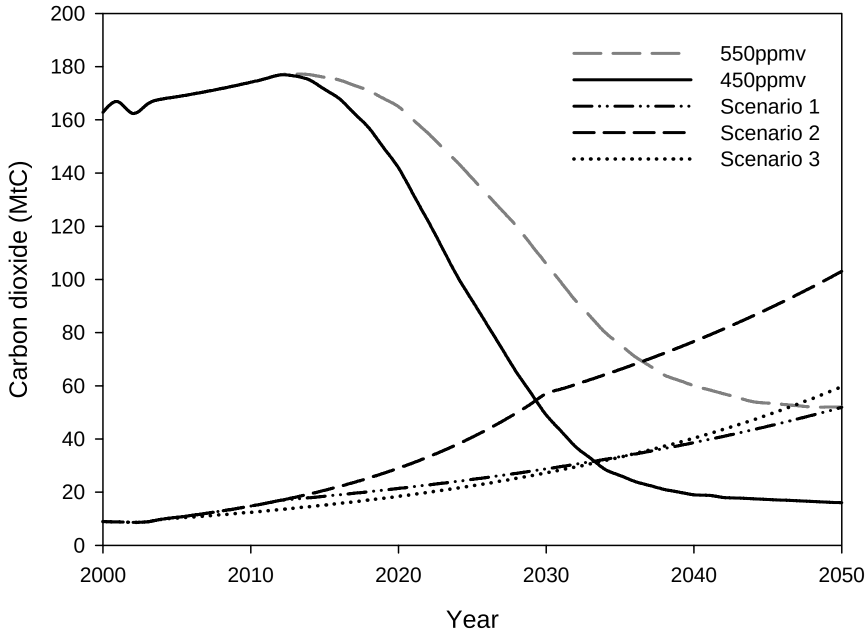
In other words, it will be virtually impossible to reconcile the levels of aviation growth forecast by the UK Government with a 450ppmv stabilisation level, unless dramatic changes are made to the way aircraft consume fuel or indeed the nature of the fuel source itself. Unfortunately, with current aircraft design locking the sector into using kerosene for 30-50 years, such changes are difficult to envisage. Such a disproportionate allocation of emissions to one sector will inevitably have significant consequences for all other carbon-emitting sectors of the economy[20].

Considering now the 550ppmv profiles, the DfT's forecasts show aviation emissions representing between 15% and 20% of the contracting carbon budget by 2030, and between 30% and 56% by 2050. For comparison, in 2004, aviation accounted for 7% of the UK's carbon budget[20]. The likely shift from a 7% share to these much higher proportions would indicate that other sectors need to decarbonise substantially to compensate for air travel, either through significant reductions in demand or the large-scale adaptation of low-carbon energy supply.

Consequently, the UK Government's forecasts predict the aviation industry accounting for over 50% of the UK's total carbon budget by 2050 if 550ppmv is the stabilisation target, and exceeding the UK's total 2050 carbon budget for 450ppmv. Whilst it may be argued that the Hadley Centre model, upon which the Contraction and Convergence profiles are based, generates slightly larger carbon-cycle feedbacks than other similar models[22], the forecasts nevertheless clearly highlight the substantial contradictions between the UK Government's Energy White Paper targets for carbon emissions and the same government's Aviation White Paper's airport expansion proposals.

[22] (Zeng et al. 2004)

Figure 7: UK carbon trajectories vs aviation scenarios



The aviation scenarios presented in table 3[23], and in graphical form in figure 7 clearly illustrate the outcome of the arguably more realistic growth scenarios for the aviation industry, and what this means for the UK's total carbon budget. Scenarios 1 and 3 exceed the UK's carbon budget under the 450ppmv regime by the early 2030s, with scenario 2 exceeding it prior to 2030. If 550ppmv is the chosen trajectory, only scenario 1 remains within budget by 2050. The rapidly increasing emissions being generated by the aviation industry will likely leave the industry with extremely difficult choices in the future. If the current high rates of growth continue, even for a short period, then emissions growth will need to be curbed to less than 3% per year within the next 6 years, if the UK is to remain within the budget necessary to meet 550ppmv. However, the latest science is suggesting that to have a reasonable chance of avoiding 'dangerous climate change', a 450ppmv target is more appropriate. The corresponding budget would require growth in passenger-kilometres to closely match fuel efficiency per passenger-kilometre over the short to medium-term. In other words, growth in the region of 1 to 2% per year.

[23] These scenarios still demand significant reductions in the growth rate from current and historical trends and hence either a major policy programme to reduce growth or a drastic sequence of events to discourage flying.

Discussion and conclusions

This paper illustrates a number of key points in relation to the aviation industry in the UK and the UK's climate change targets. Firstly, Government forecasts for aviation emissions have quickly become outdated due to the very high rates of growth being seen within the industry. Consequently, these forecasts must be revisited as a matter of urgency. Secondly, that even using these outdated forecasts, this paper illustrates the conflict between the UK Government's Aviation White Paper, which lays out measures to meet the demand for flights, and the UK's Energy White Paper of the same year. Thirdly, that using aviation emission scenarios that reflect the recent emission data, and the current rates of growth, the conflict between the UK Government's target and this growing industry has serious consequences for other sectors of the economy.

If the aviation sector is to be given a larger quota of emissions compared with other sectors, then these other sectors will need to decarbonise to compensate. This could be a reasonable solution to the limitations on technology and alternative fuels unique to the aviation sector, if the room for manoeuvre for other sectors were significant. However, these aviation scenarios suggest that if 450ppmv becomes the new climate target stabilisation level, then aviation emission can not be sustained at current levels, even with significant compensation from other sectors. If 550ppmv is chosen, then it is still likely that the total carbon budget will be exceeded by this one industry by 2050. Furthermore, if the industry were to take up 90% of the carbon budget, the pressure on other industries to decarbonise to 10% of their current levels would likely be too great[20].

The EU Emissions Trading Scheme

The silver bullet for the aviation industry is often cited as its swift incorporation into the EU Emissions Trading Scheme (EU ETS). However, as all of the EU nations are industrialised, they too will be looking to significantly reduce their carbon emissions from all of their sectors year-on-year. The EU Commission intends to include international aviation in the EU ETS by or before 2012[24]. The Commission is also intending for the scheme to include all flights taking off from EU nations, as opposed to a scheme incorporating just intra-EU flights in the first instance; the latter being preferred generally by the aviation industry[25]. However, given the logistics of incorporating this international sector within the current EU ETS, it is highly unlikely that trading between the aviation industry and other sectors will begin prior to 2010-12.

In the meantime, it is likely the EU member states will broadly follow the UK example and also significantly increase their emissions from aviation[26]. As illustrated in table 2, carbon dioxide emissions attributable to the UK's aviation industry rose by 11% between 2003 and 2004, equating to the aviation industry emitting 9.8MtC in 2004. Table 3 illustrates that growing this 9.8MtC figure at rates similar to the annual average experienced between 1993 and 2000, results in a near doubling of

[24] (COMM 2005)
[25] (Bows et al. 2006)
[26] (Bows et al. 2005); (ACARE 2002)

emissions from the UK's aviation industry by 2012. Although the aviation industry within the UK is the largest in Europe, and therefore emissions from this sector are a larger proportion of the nation's total than many other EU nations, the picture in Europe, in terms of rapidly growing emissions within the aviation industry and a reducing carbon cap, is not dissimilar[26]. Further analysis of the proposed emissions caps, the likely impacts on aviation growth and carbon costs for other sectors, are required to assess whether or not including aviation within the EU ETS will have the desired impact.

Conclusion

The aviation industry is a successful, well-established and technically-mature sector, contributing to both the development and culture of the UK specifically and the EU more generally. However, whilst the aviation industry continually pursues technical and operational improvements, there is little evidence to suggest that such improvements will offer more than relatively small incremental reductions in fuel burn. Similarly, industry stakeholders have indicated that the use of alternative low-carbon fuels appears unlikely prior to 2030[25]. Consequently, the aviation industry is in the position of seeing the demand for its services grow at unprecedented rates, whilst at the same time being unable to achieve substantial levels of decarbonisation in the short- to medium-term. Furthermore, a combination of both long design runs (already 35 years for the Boeing 747) and operating lives (typically 30 years), locks the industry into a kerosene-fuelled future. Therefore, the decisions we make now in relation to purchasing new aircraft and providing the infrastructure to facilitate their operation have highly significant implications for the UK's and EU's carbon emissions profile from now through until 2070.

The analysis presented within this paper reveals the enormous disparity between the UK's position on carbon reduction and the UK Government's singular inability to seriously recognise and adequately respond to the rapidly escalating emissions from aviation. Indeed, the UK typifies the EU in actively planning and thereby encouraging continued high levels of growth in aviation, whilst simultaneously asserting that they are committed to a policy of substantially reducing carbon emissions. This research quantifies the contradictory nature of these twin goals. Clearly, aviation growth must be curbed until sufficient steps are taken to ensure fuel efficiency gains balance growth in activity, or until there is widespread use of alternative fuels that significantly reduce the industry's carbon emissions. Ultimately, the UK and the EU face a stark choice: to permit high levels of aviation growth whilst continuing with their climate change rhetoric; or to convert the rhetoric into reality and substantially curtail aviation growth.

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