Developing a Sustainable Framework for UK Aviation

Submission of

Birmingham Friends of the Earth

Friends of the Earth Birmingham

October 2011

Alaa Khourdajie

Alaa.khourdaji@gmail.com

Table of Contents

Executive Summary:

In response to the Department for Transport (DfT) scoping document *"Developing a Sustainable Framework for UK Aviation"* Birmingham Friends of the Earth conducted thorough research to provide its inputs to this consultation. This document is to present a set of progressive policy frameworks that will help the UK industry in meeting its obligation toward the international climate and development agendas, and strengthen its role in the face of the current economic difficulties.

The response is structured into three main sections: the Passenger Demand Forecast, Tourism Deficit and the Labour Market, and Aviation Emissions. The research was focused generally on the national trends, but particularly on Regional Connectivity and Regional Airports. In the interest of presenting a real case study, the investigation used Birmingham Airport runway extension as a benchmark for some of the figures. Each section was dealing with the assumptions and methodologies behind the DfT published Aviation Forecast, September 2011, as well as providing analysis of the negative economic, social and environmental implications of expanding the aviation industry and the regional airports, such as Birmingham.

In principle, the DfT 2011 forecasts on passenger demand, emissions and economic benefit were fundamentally based on aggressive assumptions, such as future low oil prices, high economic growth, and minimal impact of carbon taxes on fares. Moreover, there was no account of the impact of the increasing outbound tourism trends on local jobs, or the economic inefficiency of expanding airports. In addition to that, the emissions estimation methodologies were not in line with recent research that has been able to make better calculation of the emissions from aviation. Various studies have shown that the UK is not meeting its current carbon budget and will fall even further behind for future ones, notwithstanding the lack of admission of Radiative Forcing measurements in the assessments.

Given the strong evidence of the negative impacts of expanding the aviation sector in general and Birmingham Airport in particular, we propose a shift towards investments in more sustainable and local industries. The argument here is not to shut down Birmingham Airport assuming that this would generate economic growth. It is about shifting public subsidies from expanding airports to making the UK more attractive for tourists. We propose that the government should invest in creating favourable travelling conditions by public transport and other incentives so that more British tourists spend their holidays in the UK and more foreign visitors come here. Investments should be directed toward reducing inefficiencies in aircraft technologies, and better matching to aircraft type to mission (operational incentives). Also, policies should promote behavioural change in the leisure market through demand management measures that reflect the true social costs of taking air flights, and incentivise remote meeting technologies in the business market.

Passengers Demand Forecast:

The passenger demand forecasts are overestimated. Not only do they assume airport expansions are to continue happening, but they were also linked to high GDP figures, pre-crisis economic growth level, low oil prices, no increase in taxation, low climate tax/carbon price, minimal effect of the 80% carbon targets and following demand trends seen over the 90s. In our view and given the unfolding negative economic prospects, as we are writing this response, these estimates should be downgraded and reflect more pessimistic growth trends. We suspect that realistic figures would potentially be leaning toward the "Lowlow" forecast that is associated with low GDP and high oil prices; Table 3.9 page 88 of the UK Aviation Forecast document, DfT 2011.

The overestimated growth in demand will be trapped with the increasing fares after the inclusion of Aviation in the EU ETS. Point Carbon reported that the top 10 airlines will be faced with €360 million cost of CO_2 allowance, which will then be passed on to the consumers. John Hanlon ELFAA's (European Low fares Airline Association) secretary general said that in the low fare market this means charging the customer €12 more for a flight[1].

Based on the QinetiQ scenarios of oil prices and fuel efficiency improvements[2], we suggest that DfT should adopt the High Oil Price scenario with a projected price of $150 per barrel (in 2008 prices) in 2030 [Increase of 47% (an annual average of 1.8%)]. This also leads to the QinetiQ scenario of Upper Bound of Fuel Efficiency Improvements, which will be elaborated upon later in the Aviation Emissions section. The key element of bundling these scenarios is that the future oil price is predictably high and hence more likely to lead to acceleration in the development of new technology and the acquisition of it by the airlines.

Despite the fact that we consider the demand trends are overestimated, we will be relying on them throughout this document to generate figures related to the tourism economic deficit and job losses caused by such trends, if materialised. This, however, is not to suggest that the tourism deficit will not be associated with the "lowlow" forecast or QinetiQ's one. On the contrary, it is to press the point of the needed further investments in tourism-related services and aircrafts technologies.

1 http://www.euractiv.com/climate-environment/eu-hits-top-10-airlines-historic-carbon-benchmarks-news-507930

2 "Future Aircraft Fuel Efficiency" Gareth Horton, QinetiQ, March 2010

Tourism Deficit and the Labour Market:

Under the current economic conditions, the government is required to take responsible investment decisions. Reducing the current budget deficit should be supported with investments that maximise the economic and social benefits. We aim in this section to show that further investments in expanding the UK Aviation industry in general and Birmingham Airport in particular are going to yield dramatic economic deficits. The planned £25m expansion investment to the runway of Birmingham Airport will deepen the tourism deficit in the West Midlands area. If Birmingham airport were to need extra capacity, operational and procedural improvements should be the first priorities to meet any increase in demand. Furthermore, the government should focus its investments on the tourism industry to make it more attractive to both British and foreign visitors.

According to the EuroStat report on Domestic Tourism Sept 2011, 77% of Europeans are spending their holidays in their own countries[3]. However, Britain was below this average and in 2010 was 9th highest in the proportion of residents who spend most of their holidays abroad, see Figure 1 below. 57% of the residents took long-stay holidays, 22% out of which were domestic, while 28% were abroad. The report shows that residents in member states with high domestic long-stay holiday figures spend more than half of the holiday budget inside their country. This, however, doesn't apply to the UK.

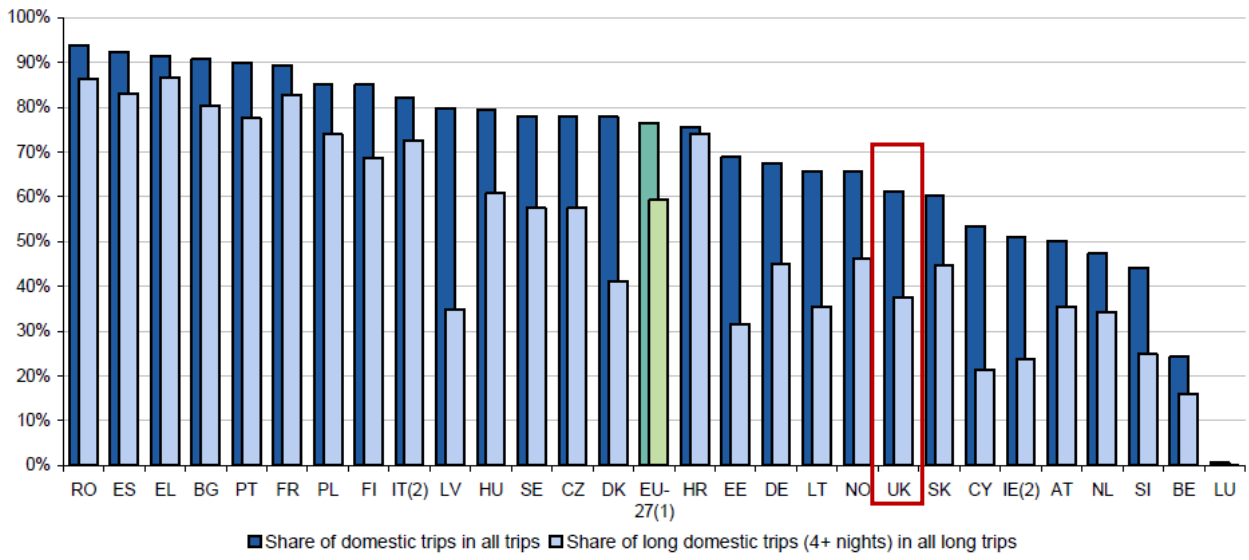

Figure 1 - Share of domestic holiday trips in all holiday trips (only trips of 4 or more nights), 2010

3 Eurostat Statistics in Focus 49/2011 "Domestic Tourism" Authors: Christophe Demunter, Chryssanthi Dimitrakopoulou

Looking at the figures that combine both short and long stay holidays, the table below shows that the UK surpasses the European average of outbound trips, and it is below the European average of domestic trips. This reflects how British residents spend the majority of their holiday budgets outside the country.

Table 3: Holiday trips of EU residents (aged 15 and over), 2010 by destination and duration

	Number of holiday trips (in thousands)			Share by type of trip					
				Domestic			Outbound		
	All holiday trips	Domestic holiday trips	Outbound holiday trips	Total	Short	Long	Total	Short	Long
EU-27([1])	*1 046 804*	*801 575*	*245 229*	*77%*	*51%*	*26%*	*23%*	*5%*	*18%*
UK	111 515	68 370	43 145	61%	41%	20%	39%	6%	33%

The report goes further to state that the British outbound tourists spend 50% more than domestic ones, whereas across the EU the domestic is slightly more than the outbound. When it comes to average expenditure per trip, European tourists spend on average more than three times less in their domestic trips than in the outbound trips, knowing that domestic trips are generally shorter than outbound ones. However, the British tourist's average expenditure on domestic trip (249 euro) is higher than that of European average (234 euro).

Moreover, the British tourist expenditure per domestic night (72 euro) in the UK is 38% higher than the European tourists average expenditure (52 euro per domestic night in their own countries) and even higher by 33% than the expenditure per night abroad in Europe (54 euro) for a British tourist. This reflects the lack of the governmental support to the tourism sector in the UK and thus the incentives to British residents to take holidays abroad.

Table 4: Tourist expenditure on holiday trips of EU residents (aged 15 and over), 2010, by destination

	Tourist expenditure on holiday trips with overnight stays (in million euro)			Tourist expenditure per trip (in euro)			Tourist expenditure per night spent (in euro)		
	All holiday trips	Domestic holiday trips	Outbound holiday trips	All holiday trips	Domestic holiday trips	Outbound holiday trips	All holiday trips	Domestic holiday trips	Outbound holiday trips
EU-27 ([1])	*373 107*	*192 291*	*180 815*	*350*	*234*	*737*	*63*	*52*	*81*
United Kingdom ([2])	45 999	18 073	27 926	388	249	610	60	72	54

In August 2011, the DfT published its latest forecast for the number of passengers. These figures show that there will be a deficit in the number of Leisure passengers, if we compare the numbers of British people travelling abroad with foreign visitors coming into the UK. Figure 2 illustrates how this deficit is evident across all the various forecasting scenarios:

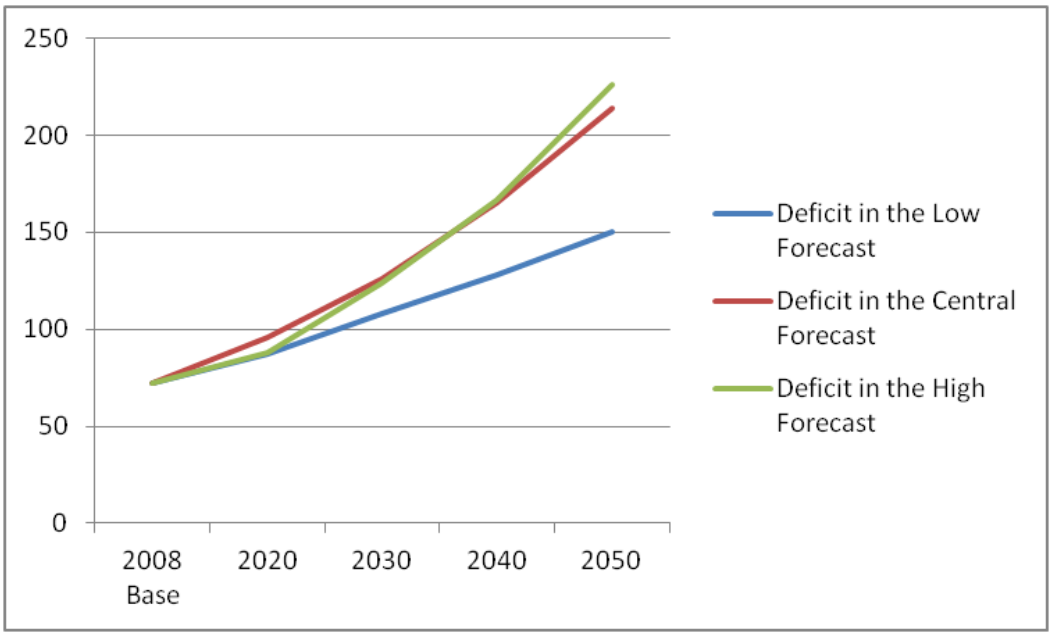

Figure 2 – mppa Leisure Passenger Deficit

The figure below published by the ONS in July 2011 shows the overseas earnings and expenditure of air transport's inbound and outbound visitors. The negative gap in expenditure was £3,540m in July 2010 and £3,400m in July 2011. Ddespite the fact that the British tourists' overseas expediture declined in July 2011 by 3.43% and the foreign visitors' expenditure in the UK declined in July 2011 by 3.03%, yet this is triggered by the economic situation and far from closing the gap.

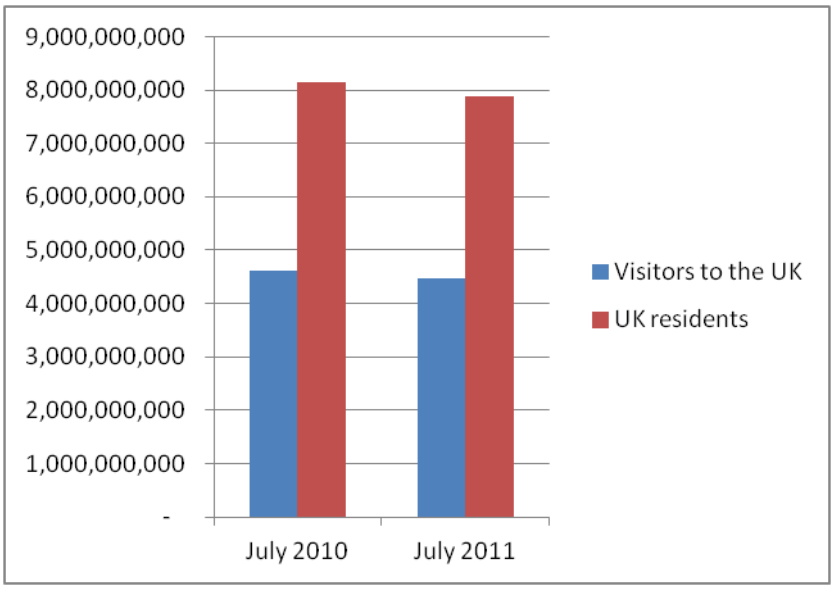

Figure 3 - Past tourism expenditure deficit – ONS Data

Following the DfT national forecast of the number of inbound and outbound Leisure passengers and the ONS expenditure figures for 2008 and July 2011 (as the most recent representative sample to be multiplied with 2020 and onwards figures), Figure 4 below shows the increasing aviation tourism deficit in the UK across all the forecasts (low, central, and high):

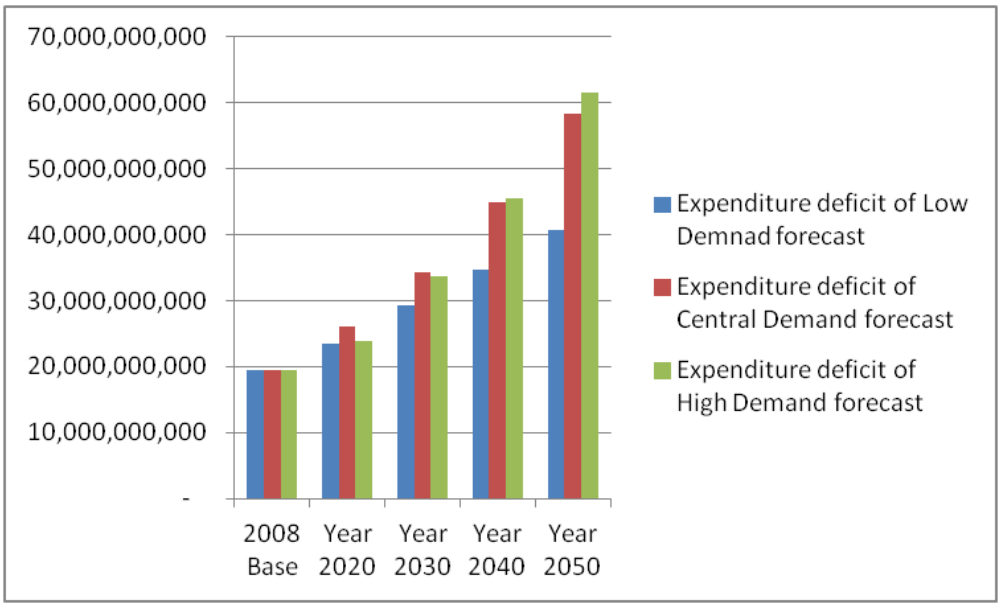

Figure 4 - Forecasted expenditure deficit

Furthermore, Professor John Whitelegg in his paper "Aviation: the social, economic, and environmental impact of flying" suggested that data for the UK as a whole show that the amounts of money invested by UK companies abroad is higher than that invested by overseas businesses in the UK. If there is a link between the enhanced accessibility provided by international air services (as the aviation industry claim) then it works to the disadvantage of the UK and supports a net outflow of resources. This is confirmed by recent figures in the IMF 2009 data: Inward Direct Investment from top five sources (US, Netherlands, France, Germany, and Luxemburg) is £657,642m, while the Outward Direct Investment to the same countries as destinations is £1.05bn. If these figures are partially facilitated by the aviation industry, then they show substantial net deficit of £406,213m, which will generate high benefits if it is invested domesitcally.

One would argue that jobs in the aviation industry are mitigating such outflow. According to Berkeley Hanover Consulting "more jobs in aviation will mean fewer jobs in other industries. This is fine and good economics if it reflects real consumer preferences and if the prices of the relevant various services reflect their true costs and are not subsidised. However, most of these jobs are subsidised; Aviation pays no fuel tax and no VAT. It benefits from duty-free sales at airports and from artificially low landing fees. Although it pays air passenger duty, this is comparatively low compared to the fuel tax and VAT relief. This means that, on average, the tax subsidy per (direct) job in the aviation industry is £50,000 a year; or £1,000 a week; or £25 an hour. Moreover, adding more jobs is contradicting a positively efficient economic model of reducing the number of jobs for a given output."

As Jeremy Birch stated in his paper "Airports, tourism and regional economies", the taxation of car travel in the UK is around 5p per passenger kilometre and most of this is made up of duty and VAT on petrol. The only significant tax on air travel is Air Passenger Duty and for typical European short-haul trips this works out as between 0.3p and 1.2p per passenger kilometre. This means that taxation is working currently to make domestic tourism less attractive, and this is especially so for the South West where car travel is the only practical way to reach many destinations.

Focusing on Birmingham Airport in particular, the DfT forecast of the UK outgoing leisure travellers (excluding domestic) and foreign incoming leisure arrivals below shows the increasing deficit up until 2050. In 2010 alone, the number of British citizens travelling abroad for tourism from Birmingham Airport was 6 times the number of foreign leisure travellers coming to the UK through Birmingham Airport. These figures include both Long Haul and Short Haul flights.

Year	Birmingham Airport – DfT Central Forecast	
	UK Leisure	Foreign Leisure
2010	6,000,000	1,000,000
2030	17,000,000	4,000,000
2050	15,000,000	5,000,000

Multiplying the 2010 figures with the ONS average monthly tourism expenditure figures of 2010, we can state that Birmingham Airport contributed £2,072,991,437.5 to the expenditure deficit. Furthermore, multiplying the above 2030 and 2050 forecast figures with the ONS expenditure figures of July 2011 implies that for Birmingham Airport the aviation tourism deficit will peak in 2030 at £ 7,094,238,458.7 and maintain a high rate in 2050 of £ 5,423,295,272.3. These two figures are roughly estimated and need to be tested against the increasing expenditure patterns in the future and matched with the assumed expenditure rates in the DfT demand forecast.. Figure 5 below shows the different expenditure patterns.

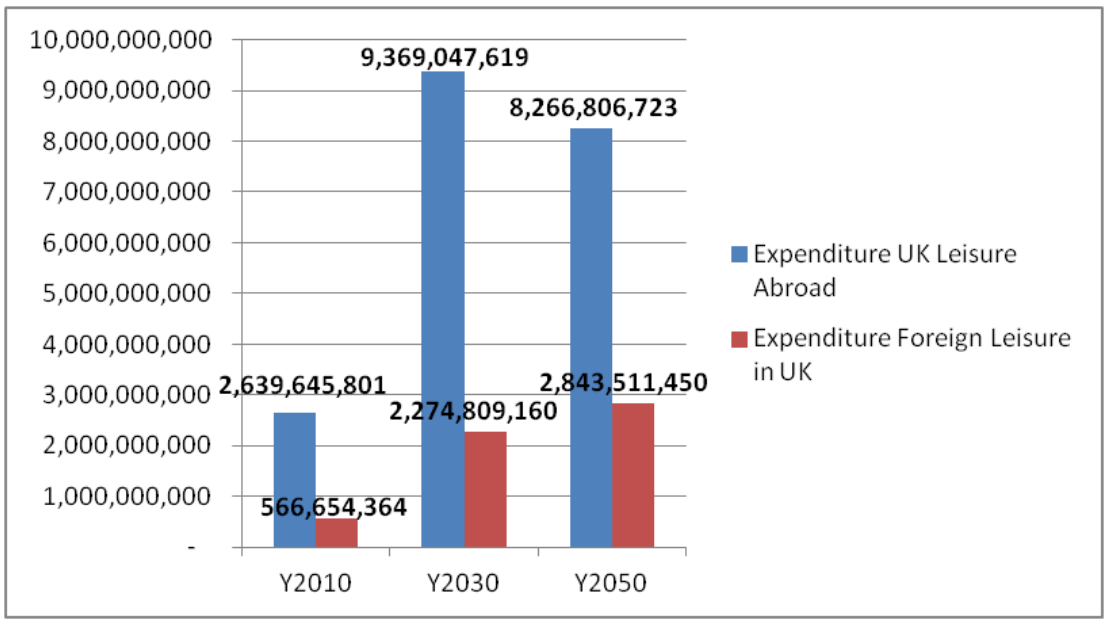

Figure 5 - Tourism expenditure deficit through Birmingham Airport only

These figures could be hypothetically translated in terms of number of jobs generated/maintained from the tourism expenditure deficit. Based on the ONS 2010 Annual Survey of Hours and Earnings (ASHE) the average annual income in the West Midland is £24,265. Therefore, assuming a simple multiplier that the expenditure from the inbound visitors arriving through Birmingham Airport is generating jobs in the West Midlands, we can say that 23,352 jobs were generated/maintained in 2010 only (these figures could mitigate the direct, indirect, induced and catalysed jobs). On the other hand, applying the same multiplier to the expenditure of the UK travellers abroad through Birmingham Airport implies an opportunity cost of 108,784 jobs would have been generated/maintained locally. This would amount to a deficit of 85,431 jobs.

Figure 6 below shows the jobs deficit from 2010 to 2050 corresponding to the DfT leisure passengers forecast for Birmingham Airport. It is vital to note that this figure is based on July 2011 passenger expenditure figures and ASHE 2010 figures.

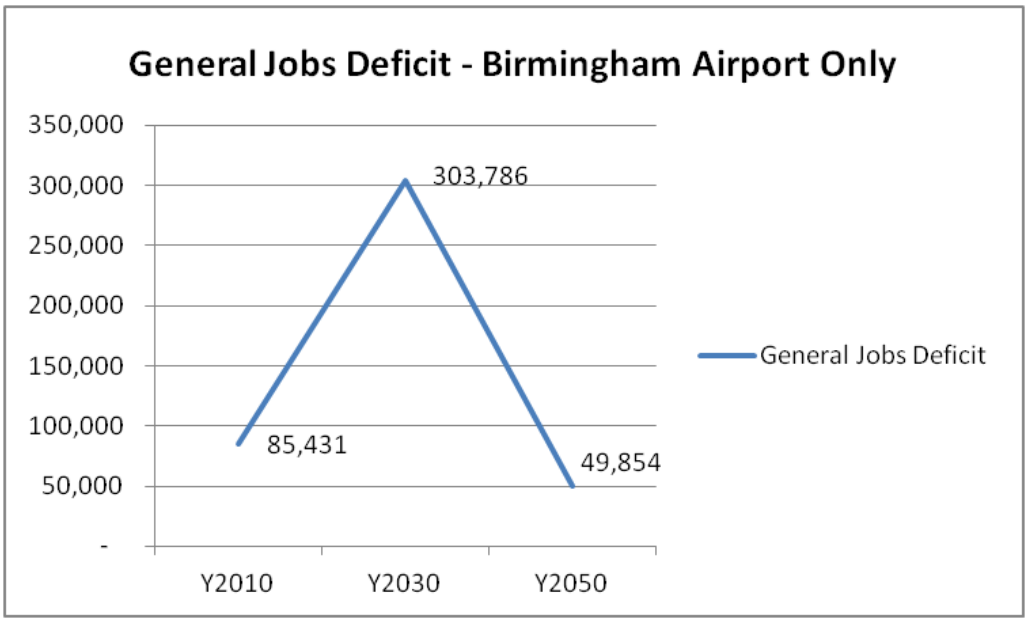

Figure 6 - Jobs Deficit caused by Birmingham Airport only

Aviation Emissions:

In response to the emissions forecast provided by DfT and the claim of stabilizing and balancing the aviation emissions through their inclusion in the ETS, we have reviewed various research papers that provide rigorous modelling techniques and robust forecasts for the carbon emissions from the aviation sector. Moreover, the Marginal Abatement Cost (MAC) Curve presented by DfT illustrates the availability of more sustainable mitigation measures than imposing biofuels. The expansion of regional airports such as Birmingham Airport requires rethinking in the light of these new methodologies for emissions estimation and mitigation.

A recent report by Cambridge Econometrics[4] (CE) states that the 2010 UK emission targets of a 20% reduction between 1990 and 2010 were missed. The official data indicated a 16.5% reduction by 2010. Moreover, the report shows that based on the existing policies, both the inherited and newly introduced targets (carbon budget up to 2027), the UK will narrowly miss its target in the first budget period and widely in the subsequent ones.

Air transport emissions are expected to rise 4% pa over the period of 2010-2015 (excluding the net purchases of EU ETS allowance). This will be higher than energy-intensive industries (2.75%), other industries (1.5%) and household (0.75%). Moreover, it [aviation] will also sustain its emission growth trends by 3% pa in 2015-2020 and 3.5% pa in 2020-2025.

The trend in the (CE) forecast shows that the increasing reliance on net purchases of EUAs (ETS Emission Unit Allowance) to meet the targets as a purely domestic effort will prove inadequate. Professor Paul Ekins of the UCL Energy Institute at University College London argued that the new policies are not yet firm or clear and the time needed for them to be implemented will be long. Therefore the coalition government need to bring further policies into force, especially for the non-EU ETS heating and transport sectors. “This response will be needed if the achievement of the still large further required reductions for the fourth carbon budget is to be proof against the kind of policy optimism that has so far been evident in this area.” He said.

CE assumed an increase in nominal terms to €23/tCO_2 by the end of Phase 2 in 2012 as the economy recovers; a rise of around 2% pa to €28, on the same basis has been assumed in the period thereafter to 2020. However, the recent reports by the IMF and World Bank have ruled out any recovery in the near term and they have downgraded UK economic growth from 1.7% to 1.1% in 2011 and to 1.6% in 2012. Therefore, the EU ETS will not introduce a carbon price that represents the actual social cost.

4 http://www.camecon.com/UK/UKEnergy/PressRelease-UKEnergy.aspx

Another research paper by Dr. Jardine of Oxford University[5] presented a sophisticated emissions forecasting methodology developed by Sabre Holdings. The fuel burn is attributed to different sections of the flight (Figure 7), which each use fuel at different rates. Emissions occur during: The Landing and Take Off cycle (LTO) which includes all activities near the airport that take place below the altitude of 3000 feet (1000 m). This is the fuel required to get the aircraft into the air (and down again) and are constant irrespective of flight length, yet it accounts for the weight of the loaded fuel. Ascents require a much more intense fuel burn than cruising at constant altitude. The Climb, Cruise and Descent cycle (CCD) is defined as all activities that take place at altitudes above 3000 feet (1000 m). This fuel use accounts for the bulk of the flight distance, and naturally varies with flight length.

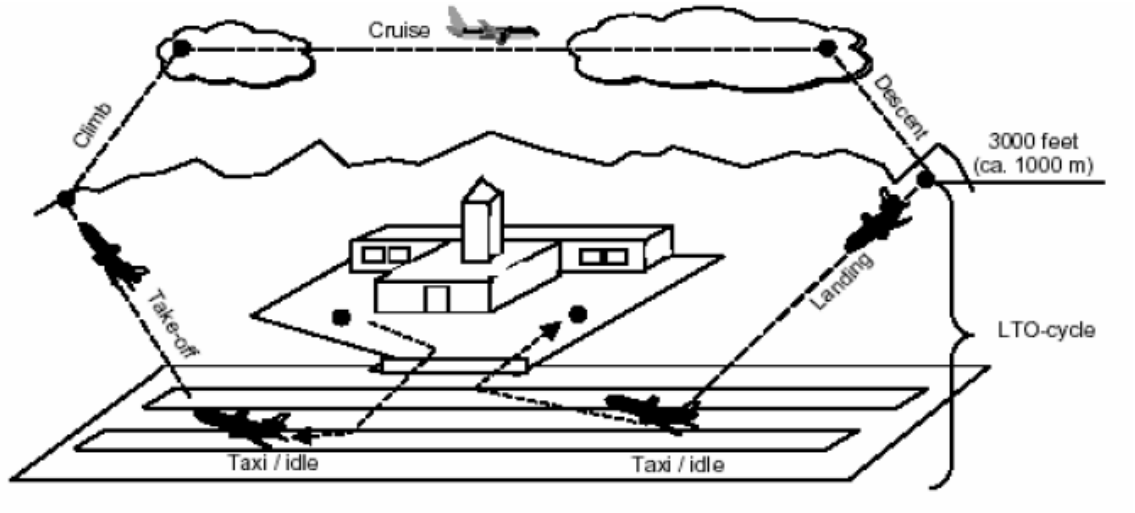

Figure 7 – Phases of flight of Aircraft

The paper argued how a conventional aviation emissions calculator is constructed, and the sensitivities to the input parameters. It then goes on to outline how the Sabre Holdings model can remove some of these assumptions and improve the accuracy of the overall model.

The DfT emissions forecast is based on total distance flown compromising the volume and average distance of flight from the UK, in turn driven by passenger and freight demand after accounting for airport capacity constraints. This simplest methodology uses solely an emissions factor per km. It neglects the impact of the take off section of flight and doesn't represent increased fuel load on long flights. A more sophisticated methodology should incorporate a constant term, which provides a much more accurate estimation of emissions as a function of distance flown, especially for short flights.

In the underlying assumptions of the fuel burn estimate, the burning rates are taken from the European Environment Agency's 'CORINAIR' Emission Inventory Guidebook. It is well known that CORINAIR doesn't include all new aircraft types. However, it is appreciated that

5 Christian N. Jardine "Calculating the Carbon Dioxide Emissions of Flights" Oxford University Centre for the Environment, 2009.

DfT has commissioned QinetiQ[6] to assess the suitability of CORINAIR and used PIANO aircraft design and performance model to deal with this shortcoming.

Given the impacts of introducing Biofuels on world food prices and deforestation, we recommend ruling out their introduction. Increasing efficiency should be dependent on proven technological improvement, which is the sustainable option that matches the international climate and food security agendas. The reliance on Biofuels presents worrying figures, such as over 2800 million barrels of aviation biofuel used per year by 2030. Estimates of the amount of land needed to produce jatropha to produce the amount of oil needed by aviation are remarkable - something like over 30% of the world's arable land by 2050. Even using algae to produce oil would use immense areas of land[7]. That said, and in reference to the section of Carbon Intensity of Fuel in the Scoping Document, we recommend to reconsider the emissions factor of 3.15 $kgCO_2/kgFuel$ in 2050 instead of 3.07 $kgCO_2/kgFuel$ that followed the Biofuels introduction assumption.

The MAC Model published by the DfT for the UK aviation sector shows that some emissions mitigation measures are more sustainable. It showed that the levers associated most consistently with the largest emission reductions over the full period considered are operational incentives and mandatory use of biofuels. A second tier of levers covers constraints on airport capacity, the achievement of Committee on Aviation Environmental Protection (CAEP) goals[8], ATM efficiency and biofuel demonstration plant. The weakest measures are regulatory CO2 standards, retrofitting and the promotion of video conferencing. Check the table below for details.

Table (ii) Estimated emission savings over the period 2010 to 2050 from "UK aviation" by policy lever ($MtCO_2$).

Demand baseline	Low			Central			High		
Policy	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
Regulatory CO_2 Standards	0	9	10	-ve	9	11	-ve	11	13
Early fleet retirement	0	1	33	1	19	59	20	41	84
Achieve CAEP goals	4	25	44	7	40	66	8	53	84
Retrofitting	1	2	4	1	3	4	1	3	5
Airport capacity	13	14	18	37	37	13	159	77	88
ATM efficiency	12	23	33	15	27	38	16	30	41
Operational incentives	59	92	139	69	108	162	77	120	180
Biofuel demonstration plant	11	20	44	13	23	51	14	26	58
Mandatory biofuels	39	66	108	34	68	118	23	64	125
Behavioural change	0*	11	19	0*	37	43	0*	12	27
Videoconferencing	0*	0	5	0*	-ve	7	0*	17	1
Total savings	**139**	**263**	**457**	**177**	**371**	**572**	**318**	**454**	**706**

Key: * lever defined as having no impact for the demand/policy case. –ve: model reports increase in emissions for the lever in question over the period. For explanation of shading, see text.

6 "Future Aircraft Fuel Efficiencies – Review of Forecast Method" QinetiQ on behalf of the DfT, March 2010

7 "Aviation and Climate Change: Thoughts on UK Policy" Peter Lockley

8 http://www.icao.int/env/caep.htm

However, as we mentioned earlier there are dangerous consequences with the biofuels penetration and based on the figures above there must be a shift of investments toward the operational incentives, something that is not fairly dealt with in the Scoping Document.

On the cost effectiveness side, two levers are consistently in the category of most cost-effective: Improvements in ATM efficiency and Support for biofuel demonstration plants. Also amongst the most cost-effective levers in some cases are: behavioural change, constraints on airport capacity, and mandatory use of biofuels. Operational incentives also appear to be relatively cost-effective in comparison to the others considered. See the table below.

Table (iii) Cost-effectiveness of measures, net cost (£) per tonne of CO_2 saved.

Demand baseline	Low			Central			High		
Policy	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
Regulatory CO_2 Standard	n/a	1702	1430	n/a	1080	1553	n/a	927	1390
Early fleet retirement	1257	9999	1443	6667	1645	1044	1187	1385	1226
Achieve CAEP goals	968	338	401	500	150	197	355	11	58
Retrofitting	394	470	2319	274	377	2056	135	239	1770
Airport capacity	-53	-45	-27	39	79	196	53	148	155
ATM efficiency	-25	-14	1	-79	-69	-56	-159	-150	-138
Operational incentives	31	44	45	31	45	46	30	43	44
Biofuel demonstration plant	5	4	5	4	5	4	6	4	4
Mandatory biofuels	67	65	65	8	8	7	0.1	0.1	0.1
Behavioural change	n/a	18	20	n/a	-10	-12	n/a	-16	-28
Videoconferencing	n/a	n/a	50	n/a	n/a	31	n/a	12	544

Key: n/a: lever does not produce emissions savings in 2050 and therefore the cost-effectiveness has not been estimated. For explanation of shading, see text.

Looking at the two tables, we propose that there is a sustainable bundle of measures that achieves a sustainable reduction in the emissions at a reasonable cost. Furthermore, as stated earlier in this document, we consider that the lower bounds of the forecast are realistic ones. Therefore, such bundle could include: 1) Achieve CAEP goals 2) ATM efficiency 3) Operational Incentives and 4) Behavioural Change. Moreover, it is vital to note that in the underlying assumptions of the Behavioural Change measure in the MAC document, there was no account for the use of taxation (increasing APD). Therefore, Behavioural Change would achieve higher emissions savings if proper application of demand management measure (like increasing tax) was in place.

Furthermore, there was no accounting for the non-CO_2 emissions (Radiative Forcing Index - RFI). Despite the uncertainty of such calculations, there are various multipliers that can increase the accuracy of the figures, such as the multiplier introduced by IPCC. We suggest the inclusion of such RFI multiplier to reflect on the real social cost of aviation emissions.

An example of accurate emissions estimates is the SABRE holding model, which is based on a database that contains information about all flights including the date of travel, airline,

departure point and destination, fuel burn at individual flight level, as well as technical details about the plane used for the flight (model and seating configuration). It can immediately be seen that many of the unknown parameters are known in the Sabre database, and that more detailed and accurate estimations of emissions can be achieved. This is possible because of the availability of two high quality and detailed data sources: the SAGE model (The System for assessing Aviation's Global Emissions) and the Passenger Name Record. Moreover it allows comparison with the lowest carbon carrier to use for the flight and the CO_2 emissions of other transport modes, such as rail. We recommend initiating a review to analyse the SABRE Model and the possibility of increasing the current DfT forecasting accuracy to such level, or cooperating with Sabre holding for better results.

Coming to the aircraft fleet technological improvements argument, QinetiQ presented a scenario of Upper Bound of Fuel Efficiency Improvements, which is derived by high fuel prices and/or high costs of carbon credits, a commitment to significant reductions in CO_2 emissions together with a prosperous global economy to enable the funding to be available both for aircraft development and acquisition of the new aircraft by the airlines. QinetiQ stated that it would be reasonable to assume that under such scenario new aircraft types would be available two years earlier than under the Central Case of the DfT forecast. They would then enter the supply pool more rapidly, achieving 100% of their market share after 10 years of production. This implies that the retirement ages of aircraft types should be reduced by four years compared to the Central Case. That said and given the uncertain future economic prospects, it is vital to start shifting the unneeded investments of expanding airports toward such technological investments, and incentivising the airlines for earlier adoption of new aircraft types and rewarding them for retirement of old inefficient ones.

Following the forecasting range assumptions, we consider that these ones would present a more realistic and sustainable forecast projections:

1. Imposing regulatory CO_2 Standards.
2. Reducing the retirement ages below the DfT standards.
3. Imposing retro-fitting standards.
4. Imposing higher fuel burn improvements that follow the lower forecasts rates in the DfT forecast.
5. 1% (or more) per annum of net air traffic management system gain by 2050.
6. 0.25% (or more) per annum of extra efficiency each year through airline operational efficiency practices.
7. No Biofuels use.

Such assumptions, if followed, will produce a genuinely sustainable policy that takes the environmental risks into consideration.

References:

John Whitelegg “Aviation: the social, economic, and environmental impact of flying”

Gareth Horton “Future Aircraft Fuel Efficiency” QinetiQ, March 2010

Christophe Demunter, and Chryssanthi Dimitrakopoulou Eurostat Statistics in Focus 49/2011 “Domestic Tourism”

QinetiQ “Future Aircraft Fuel Efficiencies – Review of Forecast Method” on behalf of the DfT, March 2010

Peter Lockley “Aviation and Climate Change: Thoughts on UK Policy”

Christian N. Jardine “Calculating the Carbon Dioxide Emissions of Flights” Oxford University Centre for the Environment, 2009.