Information on aviation’s environmental impact

CAP 1524

Published by the Civil Aviation Authority, 2017

Civil Aviation Authority,

Aviation House,

Gatwick Airport South,

West Sussex,

RH6 0YR.

First published 2017

The latest version of this document is available in electronic format at www.caa.co.uk, where you may also register for e-mail notification of amendments.

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Introduction

Purpose

The purpose of this document is to bring together environmental information and data published on the CAA website between 2011 and 2014.

This data was initially presented with the intention of providing a ‘one stop shop’ for publicly available information on the environmental impact of the UK’s civil aviation activity.

As the CAA no longer considers this the most effective way of providing the public with environmental information, this data is no longer published on the CAA’s environment web pages and exists here in archive form.

In addition to specific figures on the environmental impact of airports, airlines and other bodies, this document also contains some high level explanations of how aviation affects the environment. Additionally, it provides more detailed explanation of how to interpret the relevant metrics of environmental impact than can be found on the CAA’s environmental web pages. While this information represented the most up to date thinking at the time it was published on the CAA website, we cannot ensure its continued accuracy.

General

The most common concerns around the environmental impact of aviation are climate change and noise, but air quality and local environments are also directly impacted by aviation.

Airlines and airports are not obliged to produce the data below, and while there are standard protocols (particularly around emissions) there are no standardised requirements for reporting. This makes it extremely difficult to produce comparable data, and users should be wary of drawing comparisons from the material in this document. In many cases the methodologies and time periods between entries are inconsistent, and users are advised to refer to source material from the airline or airport in order to understand the specific conditions under which their data was produced. More recent data, subsequent to that below, can also be found from the relevant airline/airport website.

This document will not be updated and no responsibility can be taken for the continued accuracy of any part.

Chapter 1

Climate change

Introduction

Aircraft emit a range of greenhouse gases throughout different stages of flight. Aircraft are fairly unique in that they directly emit gases into the higher levels of the atmosphere. When emitted at this altitude, the same gases can have very different effects than when emitted at ground level.

Scientific evidence strongly indicates that these greenhouse gases contribute to climate change.

Greenhouse gases move throughout the atmosphere and so do not respect international boundaries. This means that they are an international issue regardless of where the emissions were released.

Types of greenhouse gases created by aviation

Many different gases contribute to climate change. CO2 is generally viewed as the most problematic greenhouse gas. It has a long life cycle and plays a key role in global warming. In aviation, it is primarily generated by burning carbon-rich ‘fossil fuels’ in engines. Other gases emitted by aircraft are:

- Oxides of nitrogen (NOx)
- Ozone (O3) – created by the reaction of NOx and sunlight
- Soot and aerosols
- Water vapour – causing contrail or man-made cirrus clouds

Less is known about the effects of these other gases. Some researchers predict that these gases have a far greater effect than CO2 when emitted in the higher levels of the atmosphere.

Aviation's contribution to CO2 generation

The following table shows direct emissions from a number of sectors in 2012, according to data from the Committee on Climate Change:

Industry	Emissions (million tonnes per annum)
Power generation	150
Road transport	108
Industry	105
Aviation	34
Waste	22
Shipping	11

Table 1: Emissions by sector in 2012. Source: Committee on Climate Change

The Energy Savings trust estimated that the average house produces 4.5t of CO2 per annum. CO2 generation from aviation was therefore equivalent to 7.7 million homes in 2012.

CO2 emissions are directly proportionate to the amount of fuel burned by an aircraft. In approximate terms, every tonne of aviation fuel burned produces between 3.15 and 3.18 tonnes of CO2.

Aviation accounts for approximately 6% of total UK emissions. Of this, around 90% of these emissions arise from international flights; and 10% from domestic flights. Aviation emissions have doubled since 1990. Over the same time period, aircraft have become substantially more energy-efficient, through improvements in engine and airframe technology: but these improvements have not kept pace with the growth in emissions from increased air traffic. Because of continued increases in forecast demand for aviation and a lack of low carbon alternative technologies, aviation will increase its relative share of UK's emissions if greater improvements are not made.

Government has produced a series of aviation growth forecasts that predicts at what level CO2 emissions could be in the future. The Government forecasts have been reproduced in the table below and relate to emissions on all flights departing UK airports. The figures assume the central range forecast of an aviation sector that is constrained by available capacity.

2010 (actual)	2030 (forecast)	2050 (forecast)
33.2	43.5	47.0

Table 2: DfT UK aviation forecasts for CO2 emissions from flights departing UK airports (million tonnes)

It should also be remembered that activities associated with flying also create CO2 emissions. These can be:

- From airport buildings;
- Onsite ground vehicles; and
- From those travelling to the airport in vehicles whether to work at the airport or take a flight.

These activities constitute a relatively small proportion of total aviation emissions: the majority originate directly from aircraft. For example, in 2010 the direct emissions from major airports were less than 1% of the total emissions emitted by aircraft using the airports.

Climate change policies

In the UK, the Department of Energy & Climate Change (DECC) is responsible for delivering the UK Government’s commitments under the Climate Change Act 2008. Under this Act, the UK is required to achieve an 80% cut in greenhouse gas emissions on 1990 levels by 2050. This applies to all sectors and is not specific to aviation.

The Government's target is to reduce UK aviation emissions so that by 2050 they are back to 2005 levels or lower. The Government has asked the Committee on Climate Change to suggest which emissions can be reduced and how. The Committee has also been asked to assess how further expansion in aviation beyond 2020 would affect the sector’s ability to meet the Government target. The full report by the CCC is available on its website.

In 2012 the CCC also recommended that emissions from international aviation should be included in the UK Carbon budget. However, due to the uncertainty over the international framework for reducing aviation emissions, this decision has been deferred by Government

Within the Aviation Policy Framework, the Government set out its expectation for aviation in relation to climate change – ‘to ensure that the aviation sector makes a significant and cost-effective contribution towards reducing global emissions.’ (2.4).

The policy framework goes on to say that ‘Our emphasis is on action at a global level as the best means of securing our objective, with action within Europe the next best option and a potential step towards wider international agreement.’ (2.5)

Within the European context, emissions from aviation are being tackled through the EU Emissions Trading System (ETS). The ETS regulates emissions in those sectors with the highest emissions such as power generation. The aviation sector became part of the scheme in 2012, and flight operators in the European Economic Area are required to submit data under the ETS.

The EU Commission publishes annual lists of emissions for those in the scheme.

At the international level, ICAO has agreed to targets for delivering carbon neutral growth from aviation from 2020 and delivering 2% annual emission improvements up to 2050. This will be achieved using a combination of improvements in technology, operational procedures, use of alternative fuels and the introduction of a global market based measure.

The ICAO General Assembly, through Resolution A38-18, agreed to develop this global market-based measure scheme for international aviation. The scheme that is being developed would be implemented from 2020. The design of this measure will require the agreement of the ICAO member states at the next ICAO General Assembly in September 2016.

More information can be found on this by visiting:

- The policy owner – The European Commission
- Responsibility for delivering EU-ETS policy within the UK – Department of Energy & Climate Change

- The regulator for the EU-ETS – the Environment Agency

Factors contributing to aviation's CO2 emissions

There are many factors that affect the amount of CO2 emissions from a flight. Some of these are in the control of airlines; some can be controlled or influenced by airports and regulators; some are to do with the weather.

The main factors are:

- Aircraft type
- Flight profile and distance
- Weight of the aircraft
- Operational procedures
- Use of next generation biofuels
- The weather
- Efficiency improvements

Aircraft type

Each aircraft will burn fuel at a different rate. There can be variances between models: air frame design and modifications will affect drag and weight; different engines will operate at varying levels of efficiency depending upon the range that they are designed to fly. Between aircraft families the variances can be even greater.

Aircraft and engine manufacturers have significantly improved the efficiency of aircraft and engines since the early 1960s. Newer aircraft are in general more fuel-efficient and produce fewer emissions. While airlines obviously can control the age of their fleet, there is often a long lead time between order and delivery - meaning investments they make in fuel-efficient aircraft can take some time to make a difference to emissions performance.

Flight profile and distance

Aircraft burn fuel and emit emissions at differing rates during the different stages of a flight. These can be broadly categorised as:

Take-off and climb to cruise altitude

There is a higher fuel burn rate at this stage because of the power needed to get the aircraft to climb to its cruise altitude. Air at a lower altitude is denser, creating more drag on the aircraft: at this stage the aircraft is at its heaviest because it holds all the fuel needed for the journey.

At cruise altitude

This is the most fuel-efficient stage of the flight because the air is less dense and the aircraft is flying at its most efficient operating speed.

Landing

At this stage the aircraft is at its lightest because it will have consumed most of its fuel load. The aircraft is also descending, requiring less power to be in operation, emitting proportionally lower emissions than at the start of the flight.

Efficiency and distance

Because of the high emissions at the start of a journey, short-haul flights are deemed the most inefficient because they spend a greater proportion of their total journey in the high emissions phase. These aircraft are also likely to do more short flights during a day, spending more time in the take-off and climb phase than longer haul aircraft.

Long-haul journeys are broadly speaking the next most inefficient type of flight. Although the aircraft spends a long time at its most efficient cruise altitude, the aircraft has to carry more fuel to cover the long distance and this extra weight makes it burn more fuel.

Medium distance flights of between 2,000 and 5,000 km are therefore the most fuel-efficient flights and tend to emit the lowest emissions per km travelled.

External factors

There are factors outside of an airline operator’s control in relation to duration of flight. Very few flights can fly the most direct ‘as the crow flies’ route because of the need to safely manage aircraft traffic. In more congested airspace – such as above London and the South East of England – aircraft are often held in holding patterns or stacks before they are allowed to land. Airspace is also controlled for military purposes; and some airspace in the world is deemed not safe to fly over due to conflict on the ground which means greater distances have to be flown to avoid such areas.

Weather can also influence flight profiles – see below for further details.

Weight of the aircraft

The lighter an aircraft is, the less fuel it will burn. Reducing unnecessary weight on an aircraft can therefore reduce CO2 emissions (as well as fuel costs). Airlines are always looking for ways to reduce the weight of their aircraft, and have taken a wide range of steps to do so. These include:

- using lighter types of paint
- taking fewer and lighter catering trolleys on board
- removing in-flight magazines
- reducing the baggage allowance rates

Per flight, the level of emission saving is negligible. However, a Project Omega study found that if all these measures were taken on a single Boeing 747 (Jumbo Jet) that operated a daily return from the UK to the US, it would save 456.2 tonnes of CO2 per year. That's roughly equivalent to the average domestic carbon footprint of 45 UK residents.

Operational procedures

Changes to aircraft operational procedures both in the air and on the ground can reduce the amount of fuel they burn and hence the volume of CO2 they emit.

Continuous Climb Operations and Continuous Descent Operations aim to make the climb to or descent from cruising altitude more efficient. Just as in a car, smoother acceleration and deceleration burns less fuel, so a smoother, steadier climb with fewer changes of speed will require less aircraft fuel. A similar principle applies to descent, where a smoother descent, perhaps begun earlier, reduces the need for braking and re-acceleration.

Clearly, this requires detailed flight planning and assistance from air traffic control. However, the aviation industry is looking to increase its use: industry body Sustainable Aviation has launched a campaign to increase the use of Continuous Descent Operations in the UK by 5%, which could reduce CO2 emissions by 10,000 tonnes a year. On the ground reduced engine taxiing and the use of Fixed Electrical Ground Power can also reduce the amount of fuel used. Further information can be found in relation to air quality in subsequent chapters.

Use of next generation biofuels

Conventional jet fuel, in common with other road transport fuels such as diesel and petrol, is based on fossil fuels and has a high carbon content - creating high levels of CO2 emissions. The aviation industry has looked at alternatives, such as biofuels (fuels derived from organic matter such as plants) which enable overall CO2 emissions to be reduced by taking account of the carbon absorbed during plant growth.

Early development of biofuels typically involved growing crops solely for fuel. However, it's now recognised that this approach can be environmentally counterproductive, because of the effects of land use change, competition with food crops and water supplies. Instead, there is a concerted effort to produce biofuels from waste sources.

Industry body Sustainable Aviation has published a roadmap outlining where the industry believes growth in biofuels can come from and what the barriers are to this growth.

The weather

The weather can worsen or improve the environmental impact on the environment from flight to flight:

- Headwinds will require more fuel to be burnt so increases emissions, although a tailwind will help reduce emissions.
- Bad weather such as snow, high winds or fog can cause delays with take-off and landing which see aircraft idling on the ground or being held in stacks which increases the emissions of the aircraft.

- Temperature can result in higher and lower emission rates; with aircraft requiring less fuel to take off in colder temperatures due to the air being denser which enables the engine to run more efficiently.
- Indirect environmental effects can also occur from bad weather such as an increase in the amount of de-icing fluid needed to be used in prolonged spells of cold weather.

Efficiency improvements

In addition to reducing emissions levels overall, the aviation industry seeks to increase its efficiency. In environmental terms, this means reducing the level of emissions per passenger or tonne of freight carried.

Passengers make up a relatively small proportion of the total weight of an aircraft, but an aircraft is more ‘efficient’ when more passengers are carried as the total emissions are shared between larger numbers of people.

Consumer ability to reduce CO2 emissions

The easiest way to reduce CO2 emissions from flying is to reduce the amount you fly. This is not always practical: aviation is an important and convenient form of transport for millions of people.

Some steps can be taken to reduce emissions without ceasing to fly:

- Select airlines with modern (i.e. more efficient) aircraft
- Consider flying economy rather than business or first class
- Fly with airlines with lower CO2 performance figures
- Use public transport to get to the airport
- Make a carbon offset payment when you fly. This involves the payment of a sum to compensate for the emissions produced by a flight. Money from these schemes goes to projects working to reduce emissions. Some airlines offer a carbon offset charge when booking a flight, but specialist carbon offsetting companies are another option. Research your options. Information is available from the International Carbon Reduction and Offsetting Alliance.

Data

Issues with CO2 emissions reporting and forecasts

Emissions calculations are difficult and in the absence of solid data, must often use assumptions. There are a number of factors to be aware of when studying and comparing emissions data. These include:

- **Differences in calculation methods**. The UK Government calculates emissions based on fuel usage. It tracks sales of bunker fuel (the fuel used by airlines), then uses a conversion factor to generate the CO2 figure. Airlines typically calculate emissions using fuel burn data and a conversion factor. Each method will lead to a different figure, so when comparing emissions data, it is important to ensure the calculation method used is the same.
- **Risk of double counting.** Different organisations report the same emissions – for example airports and airlines. So, there is a danger that emissions can be double counted.

The difficulty of emissions reporting and forecasting is demonstrated by the difference in the forecasts for 2050 between the Government and industry body Sustainable Aviation. They have used different assumptions about air traffic control efficiency improvements, the speed of introduction of sustainable fuels, the relative efficiency of new aircraft and the degree of carbon trading that may occur.

Observations on emissions reporting

Airports are not required to publish data about their greenhouse gas emissions. There are no official standards, and while most organisations report emissions using standard greenhouse gas reporting protocols, there are often slight variants in their calculations. Users are advised to visit organisations' websites to determine the details of exact methodologies and to be wary of making comparisons. In general, data is published in terms of CO2 equivalent (CO2e) which includes greenhouse gases besides carbon dioxide.

It should be noted that although airports generate direct CO2 emissions, the majority of airport emissions are from the arrival and departure of aircraft.

The most appropriate method of comparison for the performance of airlines is to use efficiency metrics. In order to compare operators, the same efficiency metric must be used, but the lack of common reporting practice used across airlines makes it difficult for consumers to make these comparisons. Efficiency metrics in the tables below will have been calculated using different methodologies. The CAA is encouraging airlines to report in a more standardised format to increase the availability of more comparative environmental performance data.

CO2 emissions by airline

This table shows publicly available reported emissions for the fifteen largest airlines that operate out of the UK based on passenger numbers.

NOTE: Many of these airlines operate internationally – figures given for emissions represent global operations, not only flights from UK airports.

NOTE: No common reporting practice has been used in the production of these figures. No 'like for like' comparison can be made from the table below. Some figures may include total greenhouse gas emissions; others CO2 only, and some combine aircraft emissions with operational infrastructure emissions (e.g. office buildings).

Airline	Total global emissions (million tonnes)	Global passengers carried (millions)	Efficiency	Source
Aer Lingus	-	11.9	-	-
American Airlines	26.8 (2011 data)	86.8 (2013 data)	-	Environmental data, 2011
British Airways	18.1 (CO2e)	39.9	101.7g CO2 per pax-km	Corporate Responsibility Report 2013
EasyJet	6.1	69.8	81.05g CO2 per pax-km	Corporate Responsibility Report 2013
Emirates	25.6	44.5	100.3g CO2 per pax-km	Environment Report 2013/14
Flybe Ltd	-	7.7	-	-
Jet2.com	-	5.5	-	-
Lufthansa	27.7	102	9.84kg CO2 per 100 pax-km	Sustainability Report 2014
Monarch	-	7.0	-	-

Airline	Total global emissions (million tonnes)	Global passengers carried (millions)	Efficiency	Source
Ryanair	-	81.3	-	-
Thomas Cook	3.9 (CO_2e)	6.1	71.5g CO_2 per pax-km	Sustainability Report 2014
Thompson*	5.1	10.3	70.7g CO_2 per revenue pax-km	Sustainable Holidays Report 2013
United Airlines	31.3 (CO_2e)	90.1	1.56 CO_2e tonnes/1,000 revenue tonne miles	Corporate Responsibility Report 2013
Virgin Atlantic	4.8 (CO_2e)	6	0.799kg CO_2 per revenue tonne-km	Change is in the Air Sustainability Report 2014
Wizz Air	-	-	-	-

Table 3: CO_2 emissions by airline

NOTE: 'CO_2e' means 'carbon dioxide equivalent' – where total greenhouse gases have been accounted for

NOTE: No attempt has been made to standardise the metrics in this table

Sustainable Aviation members' absolute CO2 emissions and efficiency between 2003 and 2012

Sustainable Aviation member airlines are: British Airways, Flybe, Monarch, Thomas Cook Airlines, TUI Group and Virgin Atlantic.

The following table is reproduced from Sustainable Aviation's Progress Report 2013:

Year	Total CO2 emissions (million tonnes/year)	Fuel efficiency (litres of fuel per revenue tonne km)
2003	27.14	0.414
2004	28.3	0.4
2005	29.61	0.399
2006	31.56	0.399
2007	32.33	0.406
2008	32.15	0.403
2009	30.52	0.396
2010	30.65	0.376
2011	32.17	0.381
2012	32.24	0.374

Table 4: Sustainable Aviation members' total CO2 emissions and fuel efficiency

CO2 emissions and efficiency by airline

This table shows the three airlines operating in the UK with the highest CO2 emissions based on the most recent data published by airlines themselves.

Airline	Year	Total CO2 emissions	Efficiency	Source
United Airlines	2010	33.2 million tonnes	0.179 (emissions / 1000 RPM)	United Airlines Eco-Skies Report
Lufthansa	2013	27.7 million tonnes	9.84 kg CO2 per 100 passenger km	Lufthansa Sustainability Report 2014
American Airlines	2011	26.8 million tonnes	Not available	American Airlines Environmental Data

Table 5: Table of CO2 emissions and efficiency by airline

NOTE: This data is not comparable due to the different years and efficiency metrics used.

Greenhouse gas emissions by airport

The following table contains data for all UK airports with more than 50,000 air transport movements a year (excluding training, aero club and military movements). Three levels ('scopes') of reporting are included, alongside DfT forecasts made in 2013. The DfT's forecasts assume a capacity restrained aviation environment, based on the central forecast in the range.

As a general rule, the three scopes of reporting are:

- **Scope 1:** direct emissions – emissions that the airport can control (from sources owned or controlled by them
- **Scope 2:** indirect emissions – emissions that an airport generated from the purchase of electricity, heat or steam
- **Scope 3:** indirect emissions – emissions outside the control of the airport but those generated due to the activities of the organisation and that they may have influence over (e.g. emissions from aircraft in landing and take-off cycles, or passenger travel to the airport). This figure will be lower than forecast emissions from departing aircraft because it only includes the emissions from the aircraft as they take off and land (not the entire flight).

Airport	Pax No.	Scope 1 (tonnes)	Scope 2 (tonnes)	Scope 3 (tonnes)	Emissions 2010 (tonnes)	Forecast 2030 (tonnes)	Forecast 2050 (tonnes)
Aberdeen	3,440,000	-	-	-	200,000	200,000	200,000
Birmingham	9,114,000	-	-	-	800,000	1,700,000	4,600,000
Bristol	6,125,000	-	-	-	400,000	700,000	1,000,000
East Midlands Intl	4,328,000	1,829	5,972	-	300,000	300,000	1,100,000
Edinburgh	9,775,000	-	-	-	600,000	700,000	1,000,000
Gatwick	35,429,000	13,589	45,791	641,182	3,900,000	4,700,000	4,300,000
Glasgow	7,358,000	2,973	15,788	112,548	500,000	700,000	800,000

Airport	Pax No.	Scope 1 (tonnes)	Scope 2 (tonnes)	Scope 3 (tonnes)	Emissions 2010 (tonnes)	Forecast 2030 (tonnes)	Forecast 2050 (tonnes)
Heathrow	72,332,000	43,000	241,000	1,987,000	18,800,000	21,400,000	18,200,000
London City	3,380,000	-	-	-	200,000	500,000	500,000
Luton	9,693,000	-	-	-	700,000	1,300,000	900,000
Manchester	20,680,000	13,415	46,361	-	2,200,000	3,200,000	5,300,000
Newcastle	4,415,000	-	-	-	300,000	300,000	500,000
Stansted	17,849,000	9,940	29,684	-	1,100,000	3,500,000	1,900,000

Table 6: Passenger numbers, emissions by scope and DfT forecast emissions by airport

NOTE: Passenger numbers (Pax No.) are CAA statistics from 2013.

NOTE: Scopes 1, 2 and 3 are airports’ own data.

NOTE: Emissions from departing aircraft (2010) are DfT data from DfT Aviation Forecasts 2013.

NOTE: Scope 2 for Glasgow Airport is 2012 data.

NOTE: Bristol Airport and Edinburgh Airport collect CO2 data but this is not presented using GHG protocol reporting.

NOTE: Fields for which data is absent represent a lack of publicly reported data.

CO2 emissions by airport in 2012

This table shows the three UK airports with the highest CO2 emissions, based on data published by the airports themselves.

The three ‘scopes’ in the table are explained above. Emissions are shown in tonnes CO2.

Airport	Scope 1	Scope 2	Scope 3	Total emissions	Source
Heathrow	91,000	225,000	1,923,000	2,248,000	Heathrow Airport 2012 Sustainability Performance Summary
Gatwick	13,202	48,867	705,146	705,146	Gatwick Airport – Our Decade of Change 2013 Performance
Stansted	46,826	-	361,240	408,066	Stansted Airport Sustainability Report 2013-14

Table 7: 2012 CO2 emissions by airport

Aircraft age by airline

This table shows the average age of the fleet of Europe's busiest airlines by passenger number, based on Buchair/JP Fleets database for September 2013, and European rank based on 2013 European Passenger numbers.

Company	Average aircraft age	European rank
Air France-KML	12	3
UTair	24	20
Aegean Airlines	5	24
Aeroflot Russian Airlines	6	9
Air Berlin	5	8
Air Europa	6	23
Alitalia	9	11
British Airways	21	4
Brussels Airlines	23	28
eastJet	6	5
Finnair	10	22
Flybe	10	25
Iberia	9	14
Jet2	22	29
Lufthansa Group	22	1
Monarch Airlines	13	27
Norwegian	9	13
Pegasus Airlines	4	15
Ryanair	5	2
S7 Airlines	13	21
SAS	13	10
SunExpress	9	26

Company	Average aircraft age	European rank
TAP Portugal	12	18
Thomas Cook	12	12
Transaero Airlines	15	17
TUIfly	8	7
Turkish Airlines	8	6
Virgin Atlantic	11	30
Wizz Air	4	16

Table 8: Aircraft age and European rank by airline. Source: Buchair/JP Fleets 2013

Use of next generation biofuels

This table shows which of the 15 airlines carrying the most passengers in the UK have a stated policy on the use of biofuels.

Airline	Commitment to biofuel development	Proposed feedstock source	Source
Aer Lingus	None stated		
American Airlines	None stated		
British Airways	Yes	Domestic waste	British Airways Corporate Responsibility Report 2012
EasyJet	None stated		
Emirates	None stated		
Flybe	None stated		
Jet2.com	None stated		
Lufthansa	Yes	A number of trials operated	Lufthansa Sustainability Report 2014
Monarch	None stated		
Ryanair	None stated		
Thomas Cook	None stated		
Thomson	Yes	Used cooking oil	Thomson Airways press release, Oct 2011
United Airlines	None stated		
Virgin Atlantic	Yes	Waste gases	Airline website
Wizz Air	None stated		

Table 9: publicly stated policies on use of biofuels by airline. Source: airline websites

Passenger load factors by airline in 2013

Passenger load factors are the percentage of actual passengers carried relative to the number of seats available. This is a good indicator of efficiency. This table shows 2013 passenger load factors for the ten largest UK airlines by passenger number.

Airline	Passenger load as % available
British Airways	81.5
eastJet	87.9
Virgin Atlantic	78.6
Thomson	92.4
Thomas Cook	93.1
Monarch	85.1
Jet2.com	89.8
Flybe	63.5
BA Cityflyer	69.3
Titan Airways	73.9
Other	54.2
Total	83.9

Table 10: Passenger load factors by airline in 2013 Source: CAA statistics

Chapter 2

Air quality

Introduction

Poor air quality is known to have a damaging effect on health. Depending on the level and type of pollution, symptoms can range from minor irritation to severe effects (particularly amongst those suffering from respiratory illnesses). Air pollution can also damage vegetation and ecosystems.

Pollutants are emitted from aircraft engines, particularly affecting those working and living near an airport. Ground vehicles operating at airports, passenger transport, employee transport and delivery vehicles also contribute to aviation's pollutant emissions.

Types of pollutant created by aviation

The main pollutants that are monitored are:

- Nitrogen dioxide (NO2)
- Nitrogen oxides (NOx)
- Particulate matter (PM)

Carbon monoxide, polycyclic aromatic hydrocarbons, benzene and 1,3-Butadiene are also amongst pollutants of concern.

Aviation's contribution to protecting from air pollutants

The aviation industry is working to reduce the level of pollutants emitted through improvements to aircraft and engine design, operational procedures and fuels.

Changes made by airlines

Airlines can help to improve air quality by:

- Switching off main engines on arrival and, where possible, limiting the use of aircraft auxiliary power units by using fixed electrical ground power, ground power units and pre-conditioned air.
- Delaying the switching on of main engines until absolutely necessary on departure.
- Whilst parked at aircraft stands, operating aircraft on the lowest possible energy draw (e.g. turning off unnecessary electrical systems such as In Flight Entertainment).
- Reducing the number of engines used when taxiing.
- Applying reduced-thrust take-off.

Changes made by airports

Airports can help to improve air quality by:

- Providing fixed electrical ground power and pre-conditioned air for aircraft.
- Optimising the most efficient flow of aircraft when moving between runways and stands.
- Investing in lower emission ground vehicles for use at the airport.
- Considering charging higher landing charges for aircraft with higher NOx emissions.
- Developing surface access strategies that encourage the use of public transport.

In 2013, one monitoring station at Heathrow showed that local air quality annual mean limits for NO2 had been exceeded. All other airports were within legal limits. Heathrow has developed a dedicated website, Heathrow Airwatch, to allow data to be closely monitored and presented in order to tackle this issue.

Air quality policies

EU Member States are set air quality targets through European legislation. Some of these targets are reflected as UK-wide objectives whilst others are devolved objectives with separate targets for England, Scotland, Wales and Northern Ireland.

Defra is the Government department with responsibility for setting national policy on air quality to meet these targets. At a local level, local authorities are required to assess air quality and Air Quality Management Areas (AQMAs) are declared if national air quality objectives are not being met.

Two of these targets are for average mean levels of $40\mu gm^{-3}$ for NO2 and PM10 in the UK. Data is available below for a number of UK airports in relation to both targets.

There are no specific air quality targets for the UK aviation industry. Instead, air quality at airports is measured as part of a local authority's duties around air quality and any issues are dealt with between the airport and local authority.

Different airports have different obligations for monitoring and reporting air quality, with some reporting requirements necessary by law through planning obligations.

Consumer ability to reduce pollutant emissions

Passengers can influence air quality in their travel choices to and from airports. Public transport and car park use impact air quality less than being dropped off and collected from airports.

Data

Issues with air quality reporting

Monitoring stations capture air pollution from all sources in a particular area and it is therefore impossible to isolate the pollution arising from aviation activity in these measurements.

Contextual data from other parts of the UK

Monitoring location	NO2 2014 annual average mean	PM10 2014 annual average mean
Manchester, Oxford Road	68	28
Cambridge, Parker Street	45	22
Hounslow, Brentford (M4)	53	36
London, Euston Road	98	-

Table11: Air quality readings for parts of the UK. Source: All but London, Euston Road from Air Quality England (London, Euston Road from London Air Quality Network)

Nitrogen dioxide (NO2) at UK airports

This table shows the mean level of NO2 in µgm^{-3} at UK airports with more than 50,000 air transport movements per year.

Airport	2005	2006	2007	2008	2009	2010	2011	2012	2013
Aberdeen	-	-	-	-	-	-	-	-	-
Birmingham	-	27	28	25	21	28	24	24	24
Bristol	-	-	-	-	-	-	-	19	20
East Midlands	-	-	-	-	-	-	27	29	23
Edinburgh	-	-	-	-	-	-	-	-	-
Gatwick	-	-	-	-	-	37	32	33	32
Glasgow	-	-	-	-	-	-	-	-	-
Heathrow LHR2	53	52	54	53	50	50	50	48	48
Heathrow Harlington	38	37	37	35	36	34	34	33	38
Heathrow Green Gates	36	37	38	38	38	41	35	33	33
Heathrow Oaks Road	38	33	38	35	33	37	30	30	34
London City	-	-	-	-	-	35	33	35	32
Luton	-	-	-	-	-	-	-	-	-
Manchester	-	-	-	-	-	-	23	24	22
Newcastle	-	-	-	-	-	-	-	-	-
Stansted Location 3	-	-	-	-	-	-	22	26	24
Stansted Location 4	-	-	-	-	-	-	19	19	19

Table 12: Annual average mean NO2 levels at UK airports. Source: Airport websites. Figures not publicly available are marked with ‘-‘

Particulate matter (PM) at UK airports

This table shows the mean level of PM10 in µgm^{-3} at UK airports with more than 50,000 air transport movements per year.

Airport	2005	2006	2007	2008	2009	2010	2011	2012	2013
Aberdeen	-	-	-	-	-	-	-	-	-
Birmingham	-	22	21	16	18	19	21	18	19
Bristol	-	-	-	-	-	-	-	18	19
East Midlands	-	-	-	-	-	-	19	18	18
Edinburgh	-	-	-	-	-	-	-	-	-
Gatwick	-	-	-	-	-	22	22	22	24
Glasgow	-	-	-	-	-	-	-	-	-
Heathrow LHR2	28	28	25	23	23	24	25	25	25
Heathrow Harlington	25	23	21	21	16	14	-	18	20
Heathrow Green Gates	24	24	22	17	17	19	21	21	21
Heathrow Oaks Road	24	24	22	20	20	21	24	22	22
London City	-	-	-	-	-	22	24	21	23
Luton	-	-	-	-	-	-	17	15	21
Manchester	-	-	-	-	-	-	15	13	15
Newcastle	-	-	-	-	-	-	-	-	-
Stansted Location 3	-	-	-	-	-	-	15	20	15
Stansted Location 4	-	-	-	-	-	-	-	-	-

Table 13: Annual average mean PM10 levels at UK airports. Source: Airports' websites. Figures not publicly available are marked with '-'

Chapter 3

Local environment

Introduction

Aviation can affect a number of features in local environments. Biodiversity and landscape can be affected by habitat loss and fragmentation; light pollution can be visually intrusive; wildlife can be disturbed by increased noise and vibration levels; and measures taken to reduce the risk of planes colliding with birds can have their own disruptive effects.

Types of local environment impact by aviation

Different local environmental impacts of aviation include:

- Biodiversity
- Water
- Waste
- Surface access
- Air quality – this is dealt with above

Aviation's contribution to local environment

Biodiversity

Airports manage large sites which are not accessible by the general public and can therefore provide good opportunities to increase biodiversity. Many airports are proactive in encouraging biodiversity on their sites and further information on a specific airport's activities can found from the airport itself.

Wildlife

Wildlife – particularly birds and large mammals such as deer and foxes – can pose a hazard to aircraft. Airports have wildlife management strategies to reduce the incidence of these species in and around airports. Airports must report birdstrikes by aircraft to the CAA.

Aircraft flying over protected sites have the potential to cause disturbance (particularly during breeding seasons) and bird congregations cause a particularly high risk.

There are also a limited number of areas around the UK that, for civil aviation purposes, are officially designated as bird sanctuaries. Civilian pilots are asked to avoid flying over these areas below a specified altitude, but this is not mandatory and these areas are not 'no-fly' zones. The UK Aeronautical Information Publication (UK AIP) provides a list of designated sites.

Surface access

Thousands of people travel to airports each day. The transport choices they make can have a significant effect on the environmental impact of the airport as a whole.

Where airports are located near busy roads, for example, extra traffic can create significant congestion and have an impact on air quality.

There are many ways to improve airport surface access. The best options depends on location and existing infrastructure. Many airports have published surface access strategies, and measures taken have included:

- Invest in new or improved infrastructure to enhance traffic flow and ease congestion
- Encourage more public transport use
- Develop staff car sharing schemes
- Actively discourage the number of car journeys to and from the airport

Waste – airports

Waste is generated both at the terminal and when constructing new airport infrastructures. Waste is managed locally by airports and involves a mixture of waste disposal methods. As with any other organisation, airports are being challenged to recycle and re-use waste wherever possible. Waste performance data is available below.

Waste – airlines

Waste is generated during flight. Some airlines have waste policies in place to reduce the amount of waste as well as to encourage the re-use and recycling of generated waste.

Catering waste originating outside of the EU must be carefully treated for bio security reasons and must either be sent to deep landfill or incinerated.

A number of airlines publish information on waste management approaches and performance. Visit an airline’s website to find this information.

Water quality

Aviation fuel leaks and spillages can damage water quality. There are strict rules in place around the storage and handling of fuels. More information is available in CAP 784: Aircraft fuelling and fuel installations management, published by the CAA.

During winter months, aircraft sometimes have to be de-iced to allow their safe departure. De-icing fluid can impact water quality if not handled correctly. The Environment Agency has produced a report on the possible environmental impacts of de-icing chemicals used in the UK which also contains priorities for environmental quality standards development.

Water consumption

Some larger airports consume as much water as small towns. It is therefore important that measures are put in place to manage water consumption and reduce the amount of water used.

Tranquillity

Tranquillity is often linked to engagement with the natural environment and aviation activity can disturb this. Refer to our publications around noise for further information. Tranquillity maps are also available from the Campaign to Protect Rural England.

Local environment policies

To minimise the impact on wildlife, airports are required to meet a range of legislation and carry out environmental impact assessments for any new construction. They are also expected to be involved in local planning processes that affect areas close to airports. There is Government guidance on safeguarding airports which covers planning issues, but please contact your local authority or airport for further information.

Wildlife

Across the UK, there are dozens of protected wildlife sites. The level of protection is set out in legislation and details of such sites in England can be found on the Natural England website.

New sites would only be added to this list where there is an existing and quantifiable problem, supported with evidence. Any proposal for a new bird sanctuary would be considered by the CAA and we would take account of the potential impact on both aviation and wildlife.

National Parks and Areas of Outstanding Natural Beauty

The UK has 15 National Parks and 49 Areas of Outstanding Natural Beauty (AONBs). These span a large area of the country and it would be impractical to ban flight over them.

The CAA is required by law to ‘have regard to the effects’ of flying over these areas. This must be balanced with the established Government policy of minimising flights over densely populated areas. The CAA’s general principle is therefore to encourage planes to avoid flying over national parks and AONBs below 7,000 ft wherever possible while balancing this requirement with other environmental and safety considerations.

As a public authority, the CAA also has a duty under the Natural Environment and Rural Communities Act 2006 to conserve and enhance biodiversity.

Data

Modes of transport used to access airports, 2014

This table and the graph below show the modes of transport used by passengers departing UK airports in 2014 (percentage)

Airport	Bus	Car (drop)	Car (park)	Car (rent)	Rail	Taxi	Tube / DLR	Other
Aberdeen	8	29	17	4	1	40	-	1
London City	-	10	1	-	-	42	46	1
East Midlands	8	35	36	2	-	19	-	-
Bristol	17	24	37	6	1	10	-	5
Glasgow	14	36	19	1	-	29	-	1
Birmingham	3	25	29	5	19	18	-	1
Luton	16	28	21	2	16	17	-	-
Edinburgh	29	25	16	6	-	24	-	-
Stansted	29	21	15	3	22	10	-	-
Manchester	2	29	26	3	14	26	-	-
Gatwick	7	16	25	2	36	14	-	-
Heathrow	13	15	12	3	10	29	18	-

Table 14: Modes of transport by airport. Source: CAA statistics 2014

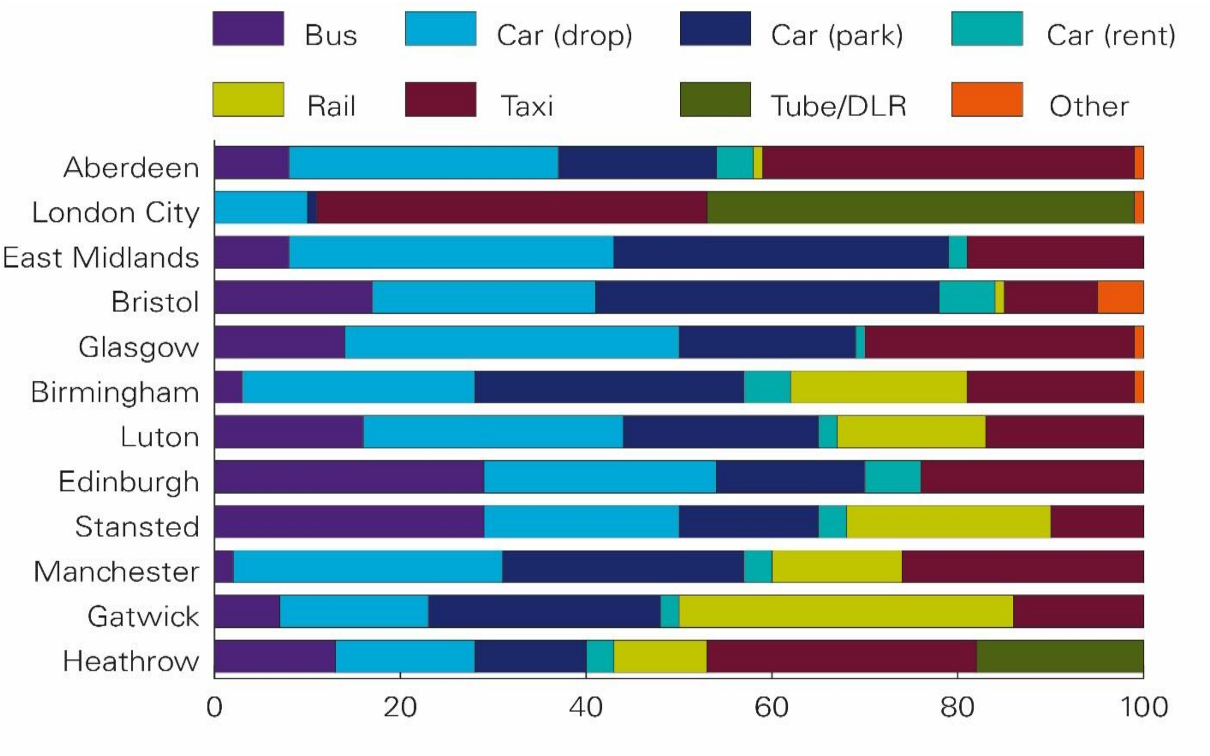

Figure 1: Modes of transport used by passengers departing UK airports, 2014 (percentage)

Waste and recycling/diversion performance by airport

This table shows waste and recycling performance for all UK airports with more than 50,000 air transport movements per year (excluding training, aero club and military movements).

Airport	Total waste	Recycling and diversion performance	Source
Heathrow	26,693 tonnes 0.37kg per pax	5.9% waste to landfill 94% of hazardous waste recycled 99% of construction waste recycled	Heathrow Airport Sustainability Summary 2013
Gatwick	9,315 tonnes 0.26kg per pax	38.7% waste re-used and recycled	-
Manchester	7,698 tonnes	71% waste diverted from landfill	-
Stansted	5,809 tonnes 0.27kg per pax	93% waste diverted from landfill	-
Luton	-	-	-
Edinburgh	1,392 tonnes	98% waste diverted from landfill	Edinburgh Airport Corporate Responsibility Report 2014
Birmingham	-	-	-
Glasgow	1,925 tonnes	84% waste diverted from landfill	Glasgow Airport Sustainability Report 2014
Bristol	0.21kg per pax	93.9% waste recycled or diverted	Bristol Airport Operations Monitoring Report 2013
Newcastle	-	-	-
East Midlands	508 tonnes	69% waste diverted from	-

Airport	Total waste	Recycling and diversion performance	Source
		landfill	
Aberdeen	-	-	-
London City	-	35-40% recycling rate	London City Airport Annual Performance Report 2013

Table 15: Waste and recycling by airport. Source: Airports' websites

Water consumption by airport

This table shows water consumption at all UK airports with more than 50,000 air transport movements per year (excluding training, aero club and military movements).

Airport	Water consumption	Source
Heathrow	2,220,772 m^3 in total 0.032 m^3 (32 litres) per pax	Heathrow Airport Sustainability Summary 2013
Gatwick	700,902 m^3 in total	-
Manchester	556,341 m^3 in total	-
Stansted	669,978 m^3 in total	-
Luton	-	-
Edinburgh	151,348 m^3 in total	Edinburgh Airport Corporate Social Responsibility Report 2013/14
Birmingham	-	-
Glasgow	140,960 m^3 in total 0.02 m^3 (19.7 litres) per pax	Glasgow Airport Sustainability Report 2014
Bristol	61,390 m^3 in total 0.01 m^3 (10 litres) per pax	Bristol Airport Operations Monitoring Report 2013
Newcastle	-	-
East Midlands	121,502 m^3 in total	-
Aberdeen	-	-
London City	-	-

Table 16: Water consumption at UK airports

Chapter 4

Noise

Introduction

Noise is an issue at almost every airport. The laws around noise make it clear that sound only becomes noise when it exists in the wrong place or at the wrong time, causing annoyance, sleep disturbance or other effects. Airports in more densely populated areas will have a greater noise impact as more people are likely to be affected.

Aviation's contribution to noise management

With noise best managed locally, different airports offer different types of information and assistance depending upon both local circumstances and legal requirements. Information available from airports may include:

- Details of operational information such as runway use and direction of take-off and landing to assess when aircraft will be flying overhead
- Flight tracking tools to allow individual flights to be tracked. A number of airports have online tools for this
- More detailed information on what generates noise and how the airport is attempting to reduce this impact
- Performance reports of how an airport is performing in relation to noise
- Explanation of airspace change proposals or trials being operated

Some airports also offer schemes to help local residents insulate homes and community buildings such as schools against noise. A few also provide direct financial assistance to help severely affected residents relocate to quieter areas.

Noise complaints should be made to the airport in question.

Noise can still be an issue at smaller airports. The CAA provides guidance on noise management at these sites.

Other actions that can be taken by different sectors of the aviation industry include:

- Aircraft and engine manufacturers can design quieter aircraft
- Air navigation service providers (ANSPs) can design airspace, air traffic routes and operational procedures that aim to reduce the number of people affected by noise
- Airlines can use their quietest aircraft at airports where noise impacts more people
- Research organisations can undertake research into methods for reducing aviation noise

Noise policies

European legislation

Under the EU Environmental Noise Directive, any airport with more than 50,000 aircraft movements a year or that has a significant noise impact on a densely populated urban area must produce a noise action plan and strategic noise plans. These must be updated every five years.

This EU Directive was transposed into the UK's Environmental Noise Regulations 2006, and the UK Government publishes guidance to help airports in England to develop noise action plans.

Local regulation

As noise is a local issue, some local authorities have placed additional obligations on airports through their planning frameworks. These can include caps on the total number of aircraft movements or restrictions on night flights. Currently, some form of restriction exists on night flights at nineteen UK airports.

An airport or the relevant local authority should be contacted about the obligations affecting that particular airport.

National regulation – designated airports

Under section 78-80 of the Civil Aviation Act 1982, Government has the power to decide to regulate certain airports directly in relation to noise. Currently, Heathrow, Gatwick and Stansted are regulated in this manner. At these airports, the Government:

- Sets noise preferential routes (NPRs) and any associated swathes
- Sets limits and quotas on night flights
- Produces noise contour maps

Data

Measuring noise

Two basic measures are used for assessing the impact of noise:

- L_{eq} is the 'equivalent continuous sound level'. The UK Government considers a L_{eq} of over 57dBA to represent the noise level for the onset of significant community annoyance.
- L_{den} uses an annual average of L_{eq} but also takes into account the additional disturbance of noise generated in the evening and at night.

Noise in the following tables is measured in dBA. 'A-weighted decibels' (dBA) reduce the decibel value of sounds at low and high frequencies to account for the human ear being less sensitive to these.

Aircraft movements by airport

This table shows the number of aircraft movements at all UK airports with more than 50,000 air transport movements per year (excluding training, aero club and military movements).

Airport	Aircraft movements 2013
Heathrow	472,000
Gatwick	250,000
Manchester	169,000
Stansted	146,000
Aberdeen	112,000
Edinburgh	111,000
Birmingham	95,000
Luton	95,000
Glasgow	78,000
East Midlands	76,000
London City	74,000
Bristol	62,000
Newcastle	57,000

Table 17: Aircraft movements in 2013 by UK airport. Source: CAA statistics 2013

L_{eq} sound level at UK airports

This table shows the equivalent continuous sound levels at airports in the UK.

Airport	Area within 57dBA L_{eq} day time contour (km²)	Population within 57dBA L_{eq} day time contour (thousands)	Year	Period
Heathrow	107.3	264.2	2013	Summer
Gatwick	40.9	3.2	2013	Summer
Manchester	26.3	24.6	2011	Annual
Stansted	20.0	1.2	2013	
Luton	13.8	7.1	2013	
Edinburgh	13.0	3.3	2011	
Birmingham	12.6	17.45	2013	
Glasgow	8.9	5.7	2011	
Bristol	8.3	-	2013	
Newcastle	6.5	0.5	2011	
East Midlands	7.2	1.1	2011	
Aberdeen	8.4	5.1	2011	
London City	-	13.6	2011	

Table 18: Sound levels at UK airports. Source: Airports' websites

NOTE: Some values for area in the table above are based on a 55dBA contours due to the presentation of data in five decibel intervals, rendering 57dBA contours unavailable.

L_{den} sound level at UK airports

This table shows the L_{den} at airports in the UK.

Airport	Area within 55dBA L_{den} day time contour (km^2)	Population within 55dBA L_{den} day time contour (thousands)	Year	Period
Heathrow	221.9	766.1	2011	Annual
Gatwick	85.6	11.3	2011	Annual
Manchester	57.5	73.4	2011	Annual
Stansted	57.5	7.4	2011	Annual
Luton	33.3	14.3	2011	Annual
Edinburgh	37.0	16.9	2011	Annual
Birmingham	27.9	44.3	2011	Annual
Glasgow	20.7	29.8	2011	Annual
Bristol	19.1	2.2	2011	Annual
Newcastle	16.1	4.1	2011	Annual
East Midlands	37.1	12.8	2011	Annual
Aberdeen	17.1	12.3	2011	Annual
London City	12.2	26.1	2011	Annual

Table 19: Sound levels at UK airports. Source: Airports' websites

Appendix A

Sources of further information

Climate change

- The Omega Project, run by the Manchester Metropolitan University between 2007 and 2009, investigated factors associated with the sustainable development of the UK air transport sector. The project involved many leading individuals and organisations in the world of sustainable aviation and led to a wealth of resources and knowledge being created on the subject, including greenhouse gases.
- The UK Government's Non-CO2 greenhouse gas emissions projections report: Autumn 2013
- The Climate Change Act 2008
- The Committee on Climate Change (CCC), an independent body set up under the Climate Change Act, has assessed the evidence behind climate change and has extensive information on climate effects.
- The CCC's Meeting the UK Aviation target – options for reducing emissions to 2050
- The Carbon Disclosure Project

Air quality

- UK Air provides comprehensive information on types of pollutants, their sources and their effects
- Aviation-specific information on local air quality can be found from the Centre for Aviation Transport and Environment at Manchester Metropolitan University, and the Laboratory for Aviation and the Environment at MIT.
- You can find out if you live in an AQMA (air quality management area) online.

- You can check the local air quality in your area using UK Air's Daily Air Quality Index.
- ICAO air quality pages
- Sustainable Aviation's Industry Code of Practice for Reducing the Environmental Impacts of Ground Operations and Departing Aircraft (technical information).