CAA INSIGHT NOTE: 02

AVIATION POLICY FOR THE ENVIRONMENT

Civil Aviation Authority

CAA INSIGHT NOTE:

AVIATION POLICY FOR THE ENVIRONMENT

KEY INSIGHTS

• The aviation sector will need to address and mitigate its environmental impacts in the areas of climate change, noise and local air quality if aviation consumers are to continue to enjoy current levels of choice and value.

• The development of the Sustainable Aviation Framework creates an opportunity to develop a policy framework based on a clearly defined set of desired outcomes in terms of each of the environmental challenges faced.

• Government should ensure that intervention to address environmental challenges takes place at the level where it is most effective and proportionate.

• Where policy intervention is appropriate, measures should be designed in a way which maximises their effectiveness and efficiency.

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KEY INSIGHTS

• The Framework should be based on robust information and recognise the trade-offs inherent in the formulation of policy to address environmental challenges.

CLIMATE CHANGE

• Further improvements in the CO_2 emissions performance of the sector remain a priority.

• The aviation sector faces strong commercial incentives to reduce CO_2 emissions, both through the cost of fuel and the internalisation of the environmental costs of carbon emissions through the inclusion of aviation in the EU Emissions Trading System (EU ETS). Nevertheless, more could be done to encourage further improvements in performance.

• The effectiveness of any policy measures will continue to be dictated by their design and the UK's success in building consensus on the desirability of action at the global level.

• The provision of trusted, reliable information to consumers and other stakeholders may have an important role to play in influencing consumer behaviour and incentivising improved performance.

• Climate change is a global challenge. The Government should continue to promote and pursue a coordinated global solution for the aviation sector;

• There is considerable debate about the merits of including aviation in EU ETS and an ongoing need to provide objective information to help inform these discussions.

• Despite the challenges to the inclusion of aviation in EU ETS, this offers the next-best solution.

KEY INSIGHTS

• Setting national carbon targets for aviation or mandatory targets for the uptake of biofuels in addition to UK participation in EU ETS would be likely to limit the efficacy of pan-sectoral incentives and could lead to a net increase in carbon as a consequence.

• However, technical and operational measures, in particular the modernisation of UK airspace, offer significant potential to improve the UK's performance on aviation emissions.

AVIATION NOISE

• Aviation noise is, in many ways, the converse of climate change. As the impacts are often concentrated on local populations, any policy measures should ideally address local conditions and seek to engage local decision-makers.

• Heathrow accounts for more than one quarter of people affected by aviation noise in Europe, based on the European standard measure of 55_{LDen}. There are issues related to aviation noise at a number of other UK airports.

• Recent decades have seen considerable progress in reducing noise generated by aircraft. This trend has been driven by technological improvements and controls on the expansion of aircraft operations at selected airports.

• The development of the aviation policy framework presents an opportunity to develop a new, twin-track approach to noise policy focused on two high-level outcomes:

- seeking continued reductions in the number of people affected by noise; and
- encouraging better engagement with communities in order to achieve greater consensus in support of sustainable development of the sector.

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KEY INSIGHTS

• Technological improvements are expected to contribute to further reductions in UK aviation's 'noise footprint' in the future.

• The complexity of the available information on aircraft noise and its impact is one of the significant barriers to better engagement on noise issues.

- o Measuring and modeling aviation noise in order to assess its impact is a challenging task but one that is essential to developing robust policy and sound decision-making.
- o Improvements in the information that is provided to the public about noise impacts may have an important part to play in facilitating more constructive debate between the aviation sector and communities affected by aviation noise, as well as incentivising progress in aircraft noise performance.

• It may be possible to define or set a 'noise envelope' within which aviation growth would be permitted, as technology and operations reduce noise from aircraft. It would be fundamental for clear outcomes to be established in order to ensure that the design of the 'noise envelope' sets appropriate incentives.

• Policy decisions on the approach to airspace regulation can have a significant impact on the way that noise is distributed. The decision on whether to favour dispersion or concentration of flight paths is of particular importance. The Government has an opportunity to clarify its policy in this area.

• The operational procedures employed by airports and airlines can have a considerable influence on the level of noise created, the impact of the noise and the populations affected. A number of alternative practices could be employed to reduce noise emissions.

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• Economic instruments could play a greater part in dealing with noise, consistent with the 'polluter pays' principle.

• The aviation policy framework offers an opportunity to explore new ways of encouraging improved engagement between airports and their local communities.

• The policy framework should therefore look to generate a solution that offers more effective channels of recourse to those that remain affected by aircraft noise.

LOCAL AIR QUALITY

• The current legislative framework governing air quality is generally considered to be credible and robust. There does not appear to be any merit in proposing amendments to the existing arrangements.

• Indeed, there may be lessons learned from the outcome-based, non-sectoral approach to air quality that could be useful in addressing other environmental impacts, for example as part of an alternative approach to noise policy.

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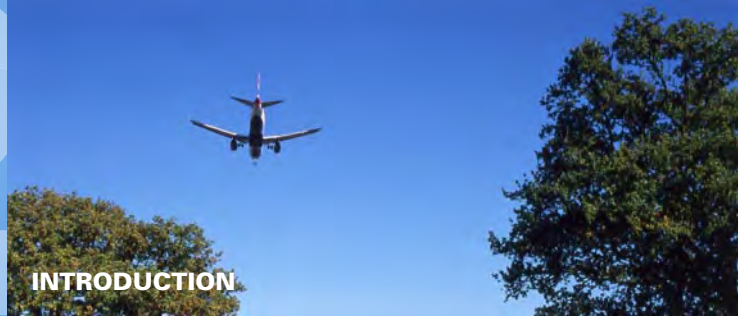
INTRODUCTION

Environmental concerns are central to the aviation policy debate. The Government has made it clear that aviation will only be allowed to grow further if the sector is successful in tackling its environmental impacts.

The CAA is committed to contributing fully to the development of a policy framework which meets the needs of current and future aviation consumers, tackles the environmental effects of aviation and provides a stable platform for the industry to deliver the investment that will meet these goals.

In the CAA's response to Government's scoping consultation[1] we set out how we



consider that clarity and durability can best be achieved by formulating the policy framework at two distinct levels:

The strategic level: the Government should set broad objectives and the outcomes it is seeking to achieve.

The implementation level: the Government should then set out steps that it intends to take to achieve the outcomes; ensuring the Government only intervenes where it has the ability to drive forward strategy.

The CAA committed to publish a series of three Insight Notes to build on its initial consultation response:

• *Aviation Policy for the Consumer* considers the issue of connectivity from the perspective of current and future consumers. In particular, it addresses the implications of forecast demand growth for the choice and value offered to UK consumers;

• *Aviation Policy for the Environment* is the second document in the series. It considers how UK aviation can grow without unacceptable environmental consequences, focusing on the key challenges of climate change, noise and local air quality:

Part 1 examines the environmental challenges facing the aviation sector and establishes some principles that should be considered in developing an outcome-based policy framework for addressing these challenges;

Part 2 focuses on climate change and considers the balance between the need for a global

framework to tackle a global challenge and the scope for operational and technical measures to be taken forward at a national level;

Part 3 highlights the potential for development of the Framework to establish a new approach to address aviation's noise impacts, based on pursuing the twin outcomes of further noise reduction and an improved relationship between the aviation sector and local communities;

Part 4 looks at local air quality and notes how the current outcome-based, non-sectoral approach to managing air quality issues may offer some useful insights for tackling other environmental challenges.

• *Aviation Policy for the Future: Creating a Sustainable Framework* considers a number of the challenges that will need to be addressed to ensure that the framework provides a robust strategic platform for successful delivery of the investment and improvements to the UK aviation system that will be needed to meet the needs of aviation consumers and the UK economy.

The Scoping Response and all three of the Insight Notes are available on the CAA website: www.caa.co.uk/sustainableaviationframework

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PART 1: THE ENVIRONMENTAL CHALLENGES

The aviation sector will need to address and mitigate its environmental impacts in the areas of climate change, noise and local air quality if aviation consumers are to continue to enjoy current levels of choice and value.

PART 1: THE ENVIRONMENTAL CHALLENGES

AVIATION AND ITS CONTRIBUTION TO CLIMATE CHANGE:

• **Global aviation** accounts for around 2 per cent of global CO_2 emissions[II]. As other sectors decarbonise and as more and more people want to travel, aviation's share of emissions will grow proportionately unless significant action is taken.

• **UK aviation CO_2** emissions account for around 6 per cent of UK CO_2 emissions. This share could rise to up to 25 per cent[III], even if aviation emissions return to 2005 levels by 2050 and UK carbon budgets are met[IV]. Aviation is due to enter the EU Emissions Trading System (EU ETS) from January 2012. With emissions capped at 95 per cent of 2004-06 levels from 2013 to 2020, the sector is forecast to rely on allowances to meet this target – as a consequence of expected demand growth in the latter part of the decade. Reducing emissions is, therefore, a matter of priority for the sector.

• **Non-CO_2** There are potentially significant non-CO_2 effects from aviation which arise from the emissions of gases and particles including contrails and induced cloudiness. Considerable work has been undertaken in the past decade to attempt to quantify these effects and to assess potential policy options for reducing non-CO_2 impacts, for example through a multiplier or a flanking instrument. Notwithstanding these efforts, further work is required to develop scientific understanding in order to improve the accuracy of quantification of effects and better judge the most appropriate policy measures.

NOISE AND ITS IMPACT:

• The noise generated by aviation activity can have a significant impact on the quality of life of those living close to airports or under flight paths. As many as 725,000 people around Heathrow and under its flight paths are affected by aircraft noise, based on the European standard measure of 55_{LDen}.

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PART 1: THE ENVIRONMENTAL CHALLENGES

The development of the Sustainable Aviation Framework creates an opportunity to develop a policy framework based on a clearly defined set of desired outcomes in terms of each of the environmental challenges faced.

• Within the range of noise impacts, night noise is generally considered to be the most contentious issue.

LOCAL AIR QUALITY AND AVIATION:

• Many specific locations across the country, most frequently at roadsides, have been assessed as having levels of nitrogen dioxide that exceed European limits. Road transport is the major source of air pollution at most hotspots. Aviation contributes to local air pollution near airports through a combination aircraft engine emissions, ground operations, and surface access road transport.

AN OUTCOME BASED FRAMEWORK

The Framework should set out the outcomes that will guide the actions of the aviation sector, as well as those to be taken by Government and other regulatory bodies. Outcomes should be capable of standing the test of time, in order to provide clear and robust investment signals to key actors in the sector such as infrastructure operators, service providers and private investors.

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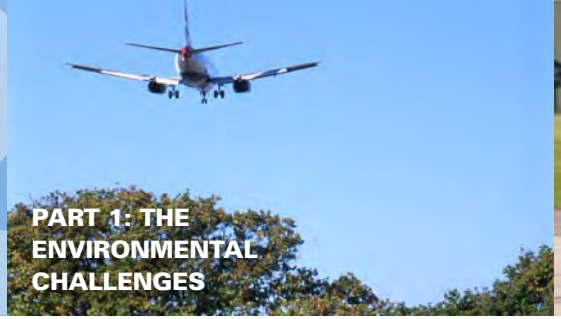

PART 1: THE ENVIRONMENTAL CHALLENGES

Government should ensure that intervention to address environmental challenges takes place at the level where it is most effective and proportionate.

One of the key challenges for Government will be to determine the appropriate level for intervention, recognising that, in many cases, action may be more effective if taken by others.

In developing a strategic national level framework, the Government will need to ensure that the framework encompasses environmental impacts which are either global, in the case of climate change, or highly localised in the case of aviation noise and air quality. The challenge is compounded by the need to balance these impacts against economic benefits for which governance is primarily national.

The appropriate level of intervention to achieve the desired outcomes will be a function of where it is most effective and proportionate. The Framework has, as its starting point, the current, layered regulatory structures (local, national and international) for tackling the main environmental challenges faced by aviation.

Where policy intervention is appropriate, measures should be designed in a way which maximises their effectiveness and efficiency.

In line with the outcome-based approach that we recommend for the framework, we have identified a series of principles for effective policy intervention. Policy measures should:

- Set clear policy outcomes;
- Create a 'level playing-field';
- Use a mix of incentives and penalties – in order to create appropriate incentives for innovation and over-delivery;
- Be set within a credible, robust and sustainable framework which creates a platform for potential aviation growth, subject to the sector being successful in mitigating its environmental impacts.

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PART 1: THE ENVIRONMENTAL CHALLENGES

The Framework should be based on robust information and recognise the trade-offs inherent in the formulation of policy to address environmental challenges.

In addition to the challenge of developing a framework which takes account of the appropriateness of interventions at multiple governance levels, the Government continues to face the problem of how to measure the net costs and benefits of different policy options, particularly given the broad range of results generated by different ways of estimating environmental impact such as public survey data, estimates of health or economic productivity impacts or hedonic pricing approaches[v].

Robust, credible and impartial information may also be desirable in areas where there are disputes over the seriousness or nature of the impacts or where there are concerns over the impartiality of the information source, such as in the case of noise.

Linked to the desirability of a better understanding of environmental impacts, the Government should recognise, and where possible, factor into its decision-making, the potential for unintended consequences. For example, where the effect of adhering to a policy measure aimed at reducing aviation noise would lead to an increase in CO_2 emissions.

At the same time, such trade-offs are only relevant to UK aviation policy to the extent that national level intervention can influence behaviour. For example, while decisions on airframe and engine development are likely to be driven by global trends, national policy may have some impact on the uptake of these technologies.

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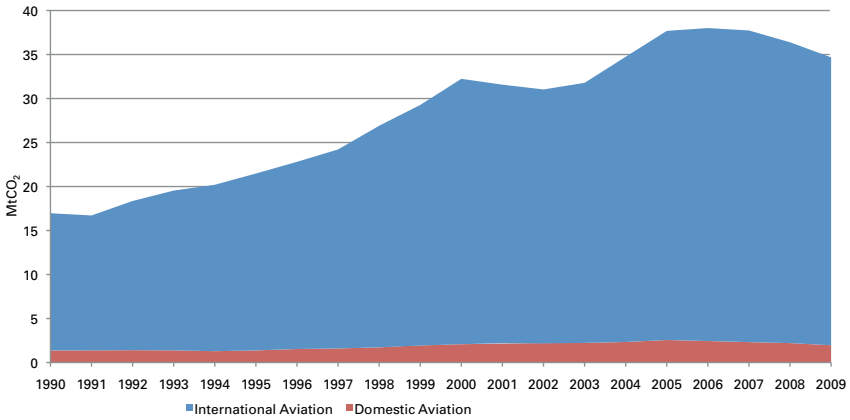
PART 2: CLIMATE CHANGE

PART 2: CLIMATE CHANGE

FURTHER IMPROVEMENTS IN THE CARBON PERFORMANCE OF THE SECTOR REMAIN A PRIORITY

UK aviation emissions of CO_2 have doubled since 1990 to 35 $MtCO_2$, reflecting increasing demand for aviation driven by income growth and industry deregulation. UK aviation CO_2 emissions now account for around 6 per cent of UK CO_2 emissions.

Figure 1: UK Aviation Emissions have doubled since 1990



Source: CCC, Progress Report, 2011.Emissions calculated on bunker fuels basis.

The aviation sector faces strong commercial incentives to reduce CO_2 emissions, both through the cost of fuel and the internalisation of the environmental costs of carbon emissions through the inclusion of aviation in the EU Emissions Trading System (ETS). Nevertheless, more could be done to encourage further improvements in performance

The aviation sector continues to make progress in terms of improvements in the efficiency of its aircraft, for example through purchase of more efficient aircraft that harness improvements in both airframe and engine technology; new aircraft are typically 15-20 per cent more fuel efficient than the previous generation. In addition, more efficient operational procedures have an important role to play in improving overall industry performance.

Pan-industry initiatives, such as Sustainable Aviation, have made some progress in this area. Sustainable Aviation's work on 'The Perfect Flight' and its 'Aircraft on the Ground CO_2 Reduction Programme' are positive examples of industry-led initiatives. Increasing fuel costs and entry into the EU ETS mean that the incentives to improve technology and the operational environment further are likely to be even greater in the future.

Given the scale of the sector's challenges, it is likely that further, faster progress will need to be made over the coming decades. Figures published by Sustainable Aviation[VI] suggest that

its member airlines achieved a fuel efficiency improvement per route tonne-kilometre (a standard unit of aviation productivity), of approximately 5 per cent since 2000, equating to an annual efficiency improvement of approximately 0.6 per cent per annum. To put this in perspective, ICAO adopted a resolution at its 37th Assembly to work with States to achieve a global annual average fuel efficiency improvement of two per cent until 2020 and an aspirational global fuel efficiency improvement rate of two per cent per annum from 2021 to 2050.

The effectiveness of policy measures will continue to be dictated by their design and the UK's success in building consensus on the desirability of action at the global level.

At the strategic level, the CAA believes that the Framework should seek to ensure that the UK approach to addressing aviation's climate change impacts is consistent with the following principles:

• **Overall CO_2 emissions are reduced.** Measures which result in carbon leakage by shifting aviation activity from the UK to other countries will not lead to an overall reduction in CO_2 emissions;

• **The approach to non-CO_2 emissions is adapted as scientific understanding improves.** There remains a high level of uncertainty on the impact of non-CO_2 emissions such as contrails. The Framework should recognise the evolving nature of the debate in this area, by continuing to support international work to understand non-CO_2 effects.

• **Choice and value are maintained as far as possible.** It is appropriate that consumers should bear the costs of the environmental impacts that their travel choices generate. However, unilateral measures which place a greater burden on the UK than on our international partners risk affecting UK competitiveness and imposing a disproportionate cost on UK consumers;

• **The potential for future aviation growth is incentivised.** Measures which are consistent with potential growth in aviation activity – either as a result of reduction in aviation's CO_2 emissions, trading with other sectors or a combination of these – create positive incentives for the sector to improve its performance and are likely to be more successful than measures that focus entirely on restricting activity.

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The provision of trusted, reliable information to consumers and other stakeholders may have an important role to play in influencing consumer behaviour and incentivising improved performance.

There may be more that could be done to monitor industry performance and facilitate informed consumer decisions through the provision of information. Research undertaken by the CAA[VII] found that almost two fifths (38 per cent) of consumers thought that having access to information about the environmental impact of the flight they were booking, including carbon emissions, is 'very or quite important'. Making environmental information available to consumers may result in better informed passengers choosing better performing airlines and airports.

Although some parts of industry already provide environmental information, it is not standardised, leading to difficulties in assessing the overall progress made by the sector as well as the relative performance of different companies. Furthermore, the absence of external validation can lead to a lack of trust in the data. There is therefore a strong case for better provision of objective information; the measures in the draft Civil Aviation Bill[VIII] would provide the means for a comprehensive approach to the collection and publication of objective information on environmental performance.

Climate change is a global challenge. The Government should continue to promote and pursue a coordinated global solution for the aviation sector.

There is greatest potential for overall emissions reduction if policy action is taken at the global level. An appropriately designed multilateral solution would minimise competitive distortions and should mitigate carbon leakage between countries.

The CAA considers that the UK should continue to push for a global solution. The current debate around the implementation of the EU ETS potentially creates a window of opportunity to move the global debate forward as non-EU countries make their positions clear, for the first time in some cases. Progress towards a global solution is likely to require a combination of both political and technical approaches.

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There is considerable debate about the merits of including aviation in EU ETS and an ongoing need to provide objective information to help inform these discussions.

There is considerable international opposition to the inclusion of aviation in the EU ETS. This is largely centred on a legal debate as to whether international agreements, including the Chicago Convention, permit EU-led action to cover emissions generated beyond European territory.

The opposition to EU ETS appears to be unfortunate when considered alongside the lack of progress on a meaningful global alternative at the ICAO level.

In addition, many stakeholders are concerned around the potential for competitive distortions and carbon leakage as a result of implementation of the EU ETS. The absence of objective data contributes to these concerns. Further work is needed to ensure that the policy debate is based on reliable evidence.

Despite the challenges to the inclusion of aviation in EU ETS, the European Union Emissions Trading System (EU ETS) offers the next-best solution.

Co-ordinated action by all of the present and future major generators of CO_2 emissions offers the best approach to tackling aviation's contribution to climate change. However, progress on a universal accord of this kind has been limited and the medium-term prospects for a binding agreement that incentivises the kind of improvements needed appear limited.

In light of the strong case for immediate action to tackle aviation's CO_2 emissions and the challenge of achieving multilateral consensus, the EU ETS, which will cover approximately 25 per cent of global aviation emissions when it comes into force, offers a next-best solution. The CAA, therefore, continues to believe that the EU ETS remains worth pursuing as a medium-term solution to reducing aviation's carbon emissions. However, EU ETS is, and was always envisaged as, an interim solution and should not be seen as an alternative to a full global agreement.

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PART 2: CLIMATE CHANGE

Setting national carbon targets for aviation or mandatory targets for the uptake of biofuels in addition to aviation's participation in EU ETS would be likely to limit the efficacy of pan-sectoral incentives and could lead to a net increase in carbon as a consequence.

However, technical and operational measures, in particular the modernisation of UK airspace, offer significant potential to improve the UK's performance on aviation emissions.

The options for intervening at the national level in response to a global challenge such as climate change are extremely limited. Where multilateral measures are in place, for example through the EU ETS or the development of a global solution, it is not necessary to set a national target. Moreover, a national target is likely to distort behaviours, leading to more limited emissions reductions than a cross-sectoral approach that optimises reductions across the economy as a whole.

However, there are a number of technical and operational improvements that can be taken forward at a national level or on which the UK can take a leading role.

Airspace modernisation has particular potential to improve the efficiency with which UK airspace is utilised. The CAA is driving the implementation of airspace modernisation through the Future Airspace Strategy as well as taking a leading role in implementation of the European Single European Sky (SES) and Single European Sky ATM Research (SESAR) programmes.

As part of this modernisation programme, it may be necessary to re-design existing departure procedures, some of which have been in place since the 1960s and which are predicated on terrestrial navigation aids. Modern Flight Management Systems are able to deliver a navigation

solution that meets the requirements of Performance Based Navigation and this provides some flexibility in the design; however, this may result in a change to some existing routes to deliver the anticipated benefits.

These airspace initiatives, which are highlighted in the case study overleaf, have the potential to deliver significant environmental benefits, as well as improvements in safety and increased capacity. This reinforces the importance of policy makers taking a holistic approach to aviation policy that encompasses measures in the air as well as on the ground.

International co-operation in these areas is still relatively under-developed. There is even greater scope for the UK and the CAA to cooperate with international partners in the future, for example through the SES project and associated platforms such as Functional Airspace Blocks (FABs). The scale and scope of the benefits that could be delivered by the major international initiatives demonstrate the need to fully understand the interface between UK policy and actions taken forward in conjunction with our international partners.

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PART 2: CLIMATE CHANGE

CASE STUDY: **Airspace Modernisation is crucial to reducing the industry's carbon footprint and fuel burn.**

The airspace system encompasses all aspects of the airspace operation including: overall airspace design; the route structure linking the major airports; the ability to manage the flow of air traffic; the communication between all participants in the system; and the systems that increase awareness of all the participants.

Modernisation of the UK, and European, airspace system will reduce the negative environmental impacts of aviation through enabling more efficient use of the airspace and enable aircraft to operate in more environmentally efficient ways, as well as reducing overall fuel costs.

- **Future Airspace Strategy for the UK 2011 - 2030:** The CAA's Future Airspace Strategy (FAS) aims to establish safe, efficient airspace that has the capacity to meet reasonable demand, balances the needs of all users and mitigates the impact of aviation on the environment. The Strategy will drive the implementation of Air Traffic Management (ATM) improvements that reduce greenhouse gas emissions from aircraft and contribute to minimising aviation's environmental impact.
- **UK/Ireland Functional Airspace Block (FAB):** Working with the Irish Aviation Authority (IAA), the CAA established a regulatory framework to support the delivery of a number of projects through the FAB, many of which have significant environmental benefits. It is estimated that over the next five years savings of over 50,000 tonnes of CO_2 will be made annually through more direct routings for airspace users. A rolling four year plan for the FAB is produced by the Air Navigation Service Providers, and approved by the regulators. The plan for 2011-2014 sets out over 25 projects, many of which will have environmental benefits.
- **Single European Sky:** The Single European Sky (SES) Package, being driven by the European Commission, is aimed at creating a harmonised regulatory framework for the European Air Traffic Management (ATM) system in order to enhance current safety standards, to contribute to the sustainable development of the air transport system and to improve the overall performance of ATM and Air Navigation Services.
- **SESAR (Single European Sky ATM Research):** SESAR is a European Commission led research and development programme to develop a modernised ATM system for Europe. SESAR aspires to ensure that this future system will ensure the safety and fluidity of air transport over the next thirty years. It also aspires to make flying more environmentally friendly and reduce the costs of ATM. One of the four high-level goals for SESAR is to enable a 10 per cent reduction in the effects flights have on the environment compared to 2005.

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PART 3: AVIATION NOISE

Aviation noise is, in many ways, the converse of climate change. As the impacts are often concentrated on local populations, any policy measures should ideally address local conditions and seek to engage local decision-makers.

Policies to mitigate the impact of aviation noise have led to considerable reductions in noise levels over recent decades, but do not appear to have improved public perceptions of the scale of the aviation noise issue. Aviation noise continues to be a politically sensitive issue, as evidenced by the strength of local opposition to proposed expansion of capacity and operations at Heathrow and other UK airports, or changes to flight paths. Within the wider noise debate, night noise is particularly sensitive.

Heathrow accounts for more than one quarter of the people affected by aviation noise at the European level. There are issues related to aviation noise at a number of UK airports.

Aviation noise affects considerable numbers of people living near airports across the UK. Partly as a result of the UK's relatively high population density, the top 15 UK airports account for more than one million of the 2.5 million people affected by aviation noise across the Europe Union (41 per cent of the total), based on the European standard

Figure 2: The top fifteen airports in the UK account for over one-third of the population affected by noise at the European level using standard measurements.

Airport	Designated by the DfT for noise purposes	Population Impact	Population as a percentage of the total number of people affected across the European Union
Heathrow	*	725,500	28.5%
Manchester		94,000	3.7%
Glasgow		63,600	2.5%
Birmingham		47,900	1.9%
Aberdeen		16,300	0.6%
Edinburgh		15,000	0.5%
London City		12,200	0.5%
Southampton		12,100	0.5%
Gatwick	*	11,900	0.5%
East Midlands		10,500	0.4%
Stansted	*	9,400	0.4%
Luton		8,600	0.3%
Leeds Bradford		8,400	0.3%
Newcastle		5,900	0.2%
Liverpool John Lennon		5,700	0.2%
	Totals	1,044,300	41.0%

Source: European Commission, CAA. Figures based on the populations affected by noise using the standard measure of 55 LDen- 2006 figures

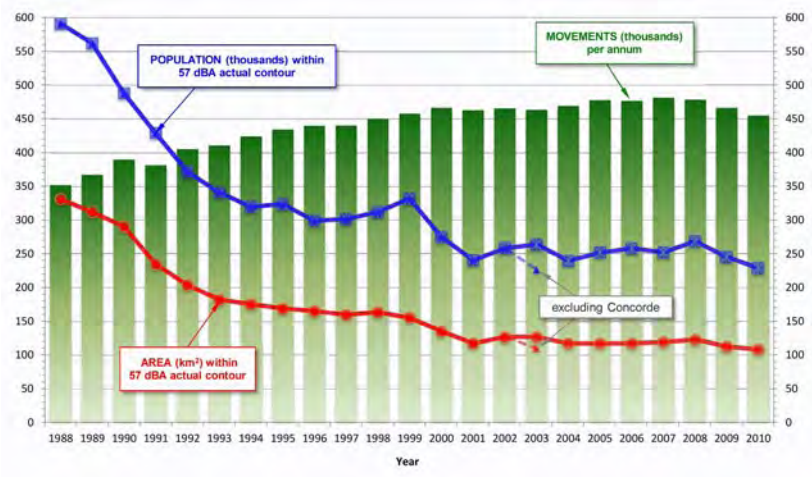
PART 3: AVIATION NOISE

Recent decades have seen considerable progress in reducing noise generated by aircraft. This has been driven by technological improvements and controls on the expansion of aircraft operations at selected airports.

measure of 55_{LDen}. The impact is heavily concentrated around Heathrow, which alone accounts for 28.5 per cent of the European population affected. Three airports are designated for the purposes of noise regulation: Heathrow, Gatwick and Stansted. Designation gives the Secretary of State the power to put in place certain noise mitigation measures at these airports.

Technological advances in airframe and engine design have led to quieter aircraft. These advances have led to a dramatic reduction in levels of aircraft noise despite an increase in the number of movements. At major airports such as Heathrow, the number of people affected by aircraft noise has reduced significantly as a result of technological change, together with enforced adherence to specified flight paths (so called 'noise preferential routes').

Figure 3: The population and area affected by aircraft noise produced at Heathrow has fallen in recent decades despite increases in the number of movements.



Source: CAA

The UK's high population density, combined with the tendency for airports to be located near population centres, means that noise is likely to remain an issue irrespective of the pattern of future airport development. Considerable numbers of people remain affected by noise disturbance, despite the fact that the technological progress achieved during recent decades has led to a significant reduction in both the population and area around airports that are adversely affected by aviation noise.

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The development of the aviation policy framework presents an opportunity to develop a new, twin-track approach to noise policy focused on two high-level outcomes:
• seeking continued reductions in the numbers of people affected by noise; and,
• encouraging better mitigation of noise effects as well as enhanced engagement with communities.

A national policy response to noise that focuses exclusively on further noise reduction is unlikely to be successful. The policy framework should examine ways of achieving the twin outcomes of encouraging further reductions in noise levels and better mitigating the significant remaining noise impact.

Outcome 1 - Noise reduction. We expect there to be a continuation in the trend for improvements in technology to drive down aircraft noise. This note outlines a number of additional policy options that are available to Government, the regulator and industry to reinforce this trend through changes to regulatory or operational approaches, potentially backed-up by economic instruments.

Outcome 2 – Improved mitigation of noise and community engagement: Even with the projected reductions in aircraft noise, a significant number of residents near airports will continue to be seriously affected by aircraft noise. Noise policy should seek to give greater consideration to mitigating the affects of noise and finding ways for residents and airport owners to engage constructively on the issue.

While there has been significant progress on noise reduction, the second outcome has received relatively little attention. However, there is potential to generate improved outcomes for local communities through more constructive engagement.

Given the complexity of the aviation noise challenge, a package of measures is likely to be required, potentially including some innovative approaches. The rest of this section explores some examples of ideas which could deliver progress against either or both of these outcomes.

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Technological improvements are expected to contribute to further reductions in UK aviation's 'noise footprint' in the future.

■ OUTCOME 1: NOISE REDUCTION

The measures which could be used to encourage further reductions in aircraft noise and its impacts broadly fall into six categories:

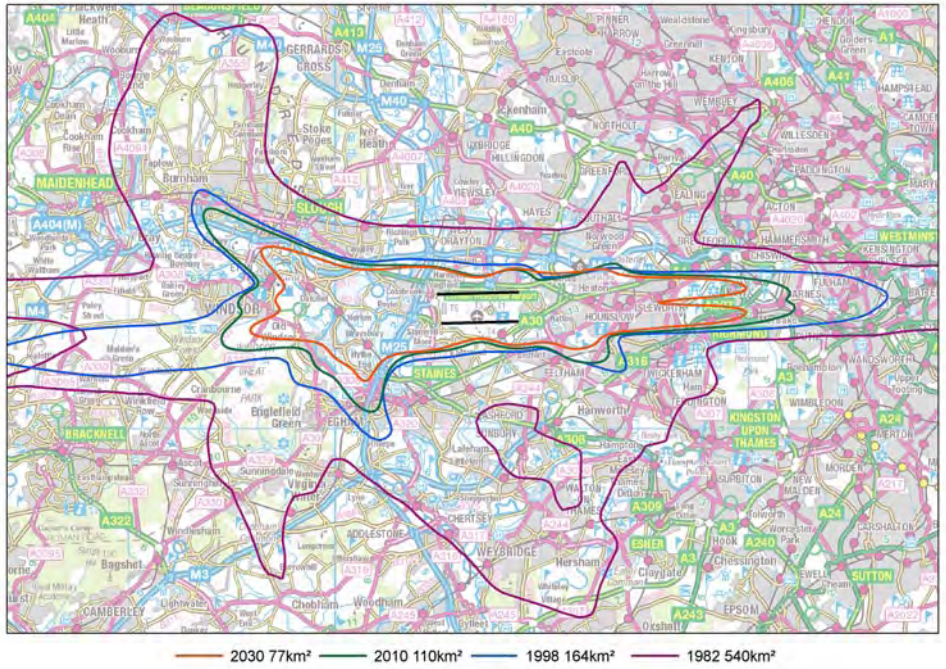
- Technological improvements;
- Information;
- Noise envelopes;
- Regulatory approaches;
- Operational measures; and
- Economic incentives.

The following sections explore a non-comprehensive set of the options available in each of these categories in more detail.

TECHNOLOGICAL IMPROVEMENTS

As aircraft fleets are renewed, and new and re-engined aircraft numbers increase, the noise footprint is projected to continue to fall, potentially by as much as 40 per cent by 2030.

Figure 4: Past improvements in the area affected by airport noise are expected to continue over the next few years



Source: CAA. The modelled 57dB Noise Contour at Heathrow for 1982, 1998, 2010 and 2030. 2030 contour based on 2007 forecasts of a two-runway airport operating in segregated mode with a movement cap of 480,000 ATMs.

The speed of development in technological developments is likely to be driven by manufacturers responding to global trends. However, action at the local level, involving regulatory, operational or economic policies, has the ability to accelerate the uptake of these technologies at specific airports.

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Measuring and modelling aviation noise and assessing its impact is a challenging task but one that is essential to developing robust policy and sound decision-making.

INFORMATION

The measurement and modelling of noise issues is a complex discipline. The standard method of measuring aircraft noise is to take into account the number of noise events (i.e. arrivals and departures) combined with the sound levels and duration of those noise events over a given period to give an equivalent continuous sound level. Noise exposure contours can be used to provide a graphical demonstration of the distribution of noise in the vicinity of an airport, with the contour limits often based on an understanding of what constitutes the onset of annoyance due to aircraft noise, derived from research.

Based on research the UK Government has used 57 $dBA_{Leq\ 16hr}$ as the level of daytime noise marking the approximate onset of significant community annoyance. This contrasts with the 55 dBA_{Lden} level used for the purpose of compliance with

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The complexity of the available information on aircraft noise and its impact is one of the significant barriers to better engagement on noise issues. Improvements in information may have an important role to play in incentivising progress in aircraft noise performance and facilitating more constructive debate between the aviation sector and communities affected by aviation noise.

the EU's Environmental Noise Directive. The relationship between noise and annoyance is not exact, and varies according to individuals and locations.

However, statistical models, based on dose-response relationships derived from research, can be used to predict the impact on local populations at differing levels of aircraft noise. This impact can be portrayed graphically by means of noise exposure contours. The impacts of noise include annoyance, sleep disturbance, effects on children's learning and various health effects.

Many airports provide information on the noise impacts of their operations. However, where information is made available, residents and local authorities frequently complain that it is unclear, inconsistent or insufficient to understand impacts, or that the data cannot be trusted because it has been supplied by the airport itself.

In common with other environmental challenges such as climate change, the provision of robust information about aviation noise that can be readily understood could help to encourage further improvements in industry performance and facilitate the search for negotiated solutions, by helping local participants at the level of the airport and local community to develop a better understanding of the noise problems.

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It may be possible to define or set a 'noise envelope' within which aviation growth would be permitted, as technology and operations reduce noise from aircraft. It would be fundamental for clear outcomes to be established in order to ensure that the design of the 'noise envelope' set appropriate incentives.

NOISE ENVELOPES

Subject to the desired outcomes, a noise envelope could be implemented according to a number of approaches:

- **In terms of the inputs that contribute to noise created:** Input measures can be used as a proxy for the amount of noise created. Other things being equal the greater the level of inputs the more noise will be created. Measures such as numbers of air transport movements (ATMs) or passengers are in general relatively easy to understand and measure, objective and for the most part trusted by local residents and politicians;

- **By measurement of the noise itself:** Noise exposure contours can be used to provide a graphical demonstration of the distribution of noise in the vicinity of an airport. Setting a limit on contour area contains the extent of the noise impact but does nothing to minimise the number of people affected or put any restriction on the severity of the impact experienced by individuals within the contour area;

- **In terms of the impact created by noise:** Noise exposure contours and other metrics can be used to form dose-response relationships, which are statistical models that enable the impact of a given amount of noise to be predicted. The impacts of noise range from annoyance, sleep disturbance, effects on children's learning through to health effects. In principle, it would be possible to establish a noise envelope based on these impacts.

The three approaches could also be combined in different ways to give a composite metric. One option would be to assess the amount of environmental detriment per unit of aviation activity. For example, measurement of the noise exposure contour area divided by the number of air transport movements provides a relative measure of environmental efficiency.

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Policy decisions on the approach to airspace regulation can have a significant impact on the way that noise is distributed. The decision on whether to favour dispersion or concentration of flight paths is of particular importance. The Government has an opportunity to clarify its policy in this area.

REGULATORY APPROACHES

Both concentration and dispersion have advantages in terms of the distribution of impacts and disadvantages in terms of operational delivery. In the more densely utilised airspace of the south-east, there is a limit to the degree of dispersion that can be delivered safely, due to the extent of the airspace and complexity of the operation.

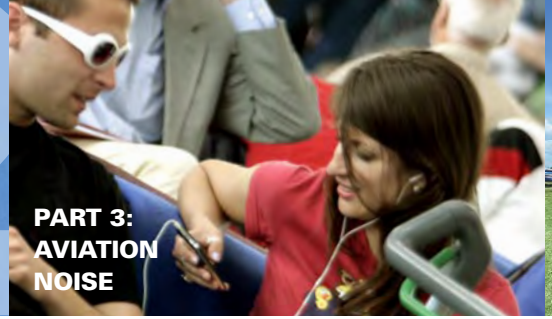
Future navigation performance capabilities will allow aircraft to fly chosen routes more accurately in most weather conditions. This increase in accuracy potentially permits the design of an airspace structure that has a number of routes that are flown precisely and as a consequence are closer together, although the complexity of managing UK airspace does not permit an infinite number of routes to be available that could lead to a dispersion effect through the switching on and off of routes in a systemised way – this would be neither practical nor optimal.

The development of airspace management technology, which forms the basis of the CAA's Future Airspace Strategy and the European Single European Sky initiative, creates a window of opportunity for the Framework to define policy on the issue of concentration versus dispersion.

A menu of approaches could be examined:

- Trend towards concentration: In the absence of policy intervention, new navigation technologies, which increase navigational accuracy and enable aircraft to keep to the 'centre-line' of existing flight paths would lead to a continuation of the current trend of concentration on existing Noise Preferential Routes (NPRs).

- Full dispersion: Under this approach, the burden of noise would be spread across the population, but with defined periods of relief. This option could potentially increase operational

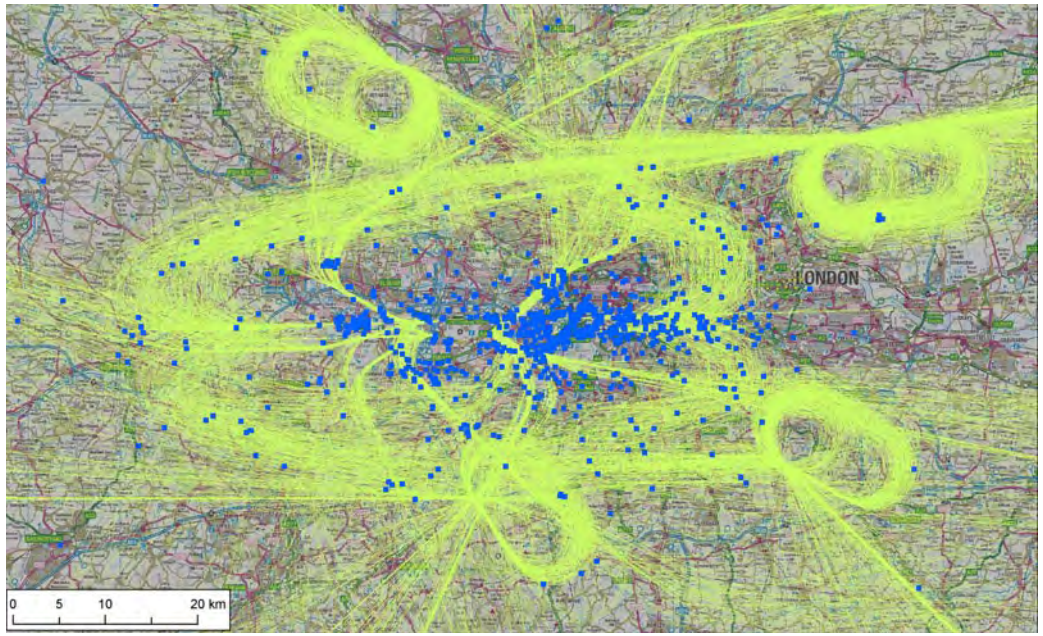


complexity significantly, and may impact on capacity.

- Dispersion within each route: Improvements in navigational technology enable aircraft to fly with increased accuracy within existing NPRs. Accordingly, it would be technically feasible to designate multiple flight paths within a NPR and combine a policy of concentration with alternation between these paths. However, complexity may become the limiting factor in terms of the number of options that may be available.

- Alternation of airspace system: Sydney airport alternates between ten distinct airspace arrangements. Flight paths are concentrated within each configuration, but local residents benefit from predictable periods of relief from noise disturbance. In the heavily utilised airspace over the South-East of the UK, the complexity of operations may preclude the viability of this option.

Figure 5: Complaints are heavily correlated with the distribution of flight paths



Source: Heathrow Airport Ltd. Sources of noise related complaints received by Heathrow Airport, 2010

It should be noted that a fully dispersed option would have an adverse impact on airspace capacity and the CAA would not be in favour of such a policy.

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The operational practices employed by airports and airlines can have a considerable influence on the level of noise created, the impact of the noise and the populations affected. A number of alternative practices could be employed to reduce noise emissions.

OPERATIONAL MEASURES

Potential measures which could be implemented in order to reduce noise emissions include:

Landings:

- **Continuous descent approaches (CDAs).** In contrast to a conventional airport approaches, aircraft using CDAs descend continuously from the level of the bottom of the holding stack (or higher if possible). A continuous descent requires significantly less engine thrust than prolonged level flight.
- **Steeper approaches** work by changing the standard angle of approach for landings so that the aircraft is at a higher altitude for longer, thereby reducing noise for some local residents.
- **Displaced thresholds** work by shifting the runway landing threshold to a point further along the runway and thus further within the airport boundary.

Take-offs:

- **Continuous climb departures (CCDs)** are the take-off equivalent to continuous descent approaches, with aircraft allowed to climb at a consistent rate of ascent up to the cruising flight level instead of only being allowed to climb in stages, which generates a greater noise impact as well as increased CO_2 emissions.

Some of these options would be easier to apply than others. For example, continuous descent approach procedures have been in place for a number of years at Heathrow, and an industry code of practice is well established[IX]. In contrast, ideas such as CCDs are less advanced and may even require considerable changes to standard international operating protocols and/or airport configurations.

The fundamental requirement to ensure safety protocols, as well as the need to ensure that all aircraft are appropriately equipped, prevents an immediate change in operational practices. Certain operational measures may also involve a trade-off between aircraft noise and other environmental impacts, such as CO_2 emissions.

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CASE STUDY: **Case study: Steeper approaches vs Displaced thresholds**

One potential way to reduce aviation noise in the immediate vicinity of airports is to introduce steeper airport approaches or by applying displaced thresholds operations. As **Figure 6** below suggests, both operational changes have the effect of increasing the altitude at which aircraft over-fly local communities. Both alternatives would benefit local residents. However, displaced threshold operations have the additional advantage that those living closest to the airport, who are currently worst affected by aircraft noise, would enjoy the greatest benefit.

In common with the other operational changes listed above, both steeper approaches and displaced threshold operations would need to satisfy a number of safety tests before being introduced and require changes to established international operating protocols. Furthermore, dependent on current configuration, airports may need to undertake significant re-engineering work in order to accommodate the altered landing procedures necessary to execute these operational changes.

By way of illustration, **Figure 7** and **Figure 8** give an indicative view of the noise reductions that could be achieved with a 1000m displacement of the landing threshold at Heathrow. Such a change would benefit those living closest to the airport that are currently worst affected. For those residents who live within 3km of the airfield boundary, the noise reduction benefits would be equivalent to a step change in aircraft technology.

Figure 6: Steeper approaches and displaced thresholds both offer the potential to deliver noise relief for local communities

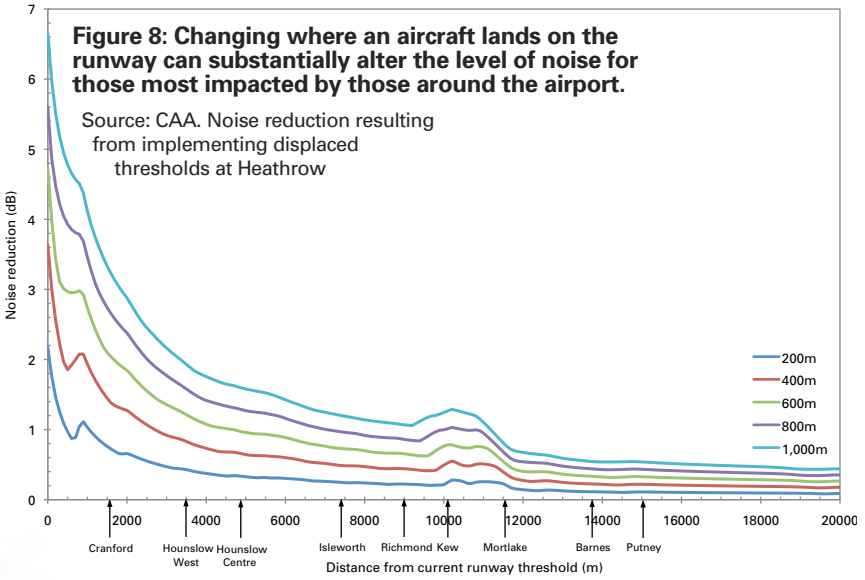
Figure 7: Displaced thresholds can have significant benefits for both the number of people and area affected.

Leq Level	Change for 1000m displacement	
	Area	Population
>57	-2%	-5%
>60	-2%	-8%
>63	-1%	-12%
>66	-2%	-31%
>69	-3%	-47%
>72	-4%	-66%

Source: CAA. Change in area and population affected by noise disturbance (various levels)

Figure 8: Changing where an aircraft lands on the runway can substantially alter the level of noise for those most impacted by those around the airport.

Source: CAA. Noise reduction resulting from implementing displaced thresholds at Heathrow



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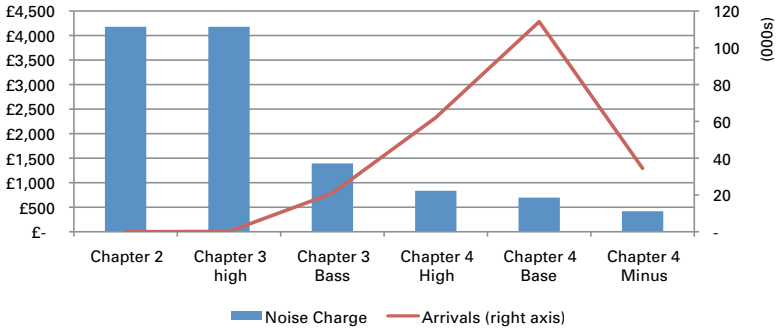
Economic instruments could play a greater part in dealing with noise, consistent with the 'polluter pays' principle.

ECONOMIC INCENTIVES

Noise-based charges - Economic instruments have been applied in aviation in an attempt to reduce noise emissions. Noise-based charging is a well-established part of the pricing structures at a number of airports in the UK, including the three noise-designated airports, Heathrow, Gatwick and Stansted. However, Air Navigation Service Providers (ANSPs) currently make no distinction in their charging structures to account for variations in the noise performance of different aircraft.

Figure 9: The majority of aircraft at Heathrow meet the quieter Chapter standards for aircraft noise, and face lower landing charges.



Source: CAA, Heathrow Airport Limited.

Where airports levy noise charges, these are typically heavily differentiated between the different "Chapter" noise categories of aircraft established by ICAO[X]. The vast majority of modern aircraft operating in Europe fall within the quieter end of Chapter 3 to Chapter 4 noise categories. Airports are increasingly sub-dividing their charges within individual Chapter categories to encourage quieter operations. An illustration of the breakdown of charges at Heathrow is provided at **Figure 9**.

Applying the cap-and-trade approach to noise - Using a similar concept to the 'cap and trade' approach used in emissions trading systems, a 'noise trading system' could be adopted. As with other 'cap and trade' systems, the benefit of such an approach is that it would lead the aircraft operators who generate the noise disturbance to internalise the impact of the disturbance caused to local communities.

Such economic instruments would be complex to implement in practice and further work would be required to establish the feasibility of such approaches.

However, for the purposes of illustration, we provide a stylised example of how such a system might work:

- The primary capacity cap at airports would be expressed in terms of noise emissions, rather than aircraft movements as at present;
- A 'noise emissions envelope' or quota would be set for each airport level, for example based on modelled estimations of the population affected at a given noise level (see 'noise envelopes' section under regulatory approaches);
- Initial 'noise allocations' would be given to airlines operating at each airport. These allocations would be made on the basis of past performance;
- The size of the overall cap would be reduced over time, for example in line with the long-term trend of technological improvement. This ensures residents get continued benefit from technological improvements.
- As capacity caps are no longer expressed in terms of aircraft movements, aircraft operators who outperform the cap can potentially benefit from increased throughput at an airport, subject to satisfying safety requirements. Airlines are therefore incentivised to address fleet noise performance in order to generate additional flights, subject to infrastructure and operational constraints. Alternatively, noise-efficient airlines can sell surplus quotas to other operators.

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The aviation policy framework offers an opportunity to explore new ways of encouraging improved engagement between airports and their local communities.

■ OUTCOME 2: IMPROVED COMMUNITY ENGAGEMENT

The experience of recent years suggests that a policy approach based exclusively on noise reduction is likely to fail. Despite the positive trends towards noise reduction, the strength of feeling of those affected by noise has, arguably, increased.

There are a number of potential reasons for this:

- **Subsidiarity:** Previous policy frameworks have not given sufficient clarity or generated consensus about the appropriate balance between national strategic interest and the concern of local communities;
- **Lack of trust:** The relationship between many local communities affected by aviation noise and the aviation sector is complicated by a lack of trust. Local communities are often highly sceptical of both airports and the authorities. Rebuilding this trust, and getting interested parties to engage in a mutual search for solutions appear to be key to a more constructive dialogue on noise;
- **Incomplete institutional arrangements:** The current institutional framework offers limited channels for local communities to express their concerns about aviation noise. Accordingly, local citizens' concerns are heavily skewed towards the national political process via complaints to Members of Parliament.
- **Mismatch between costs and benefits:** The highest volume of complaints about aircraft noise does not necessarily come from the area subject to the greatest noise impact. Communities closest to an airport often benefit from significant local employment which may offset the impact of noise disturbance. In contrast, in other areas, residents may not perceive a direct benefit from being located close to the airport.
- **A conflict of interests:** In the main, airlines and airports face relatively weak incentives to agree ways of reducing their noise impact on local populations. Similarly, affected communities may feel that an airport's ultimate interest is to expand its operations, suggesting that they have little interest co-operating with an airport on noise.

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The policy framework should therefore look to generate a solution that offers more effective channels of recourse to those that remain affected by aircraft noise.

Improved engagement and communication between the aviation sector and local communities would appear to be a prerequisite for a framework which aims to generate lasting consensus around aviation policy. Given the starting point, it will clearly be challenging to achieve such consensus. However, there do not appear to be any reasons, in principle, why the aviation sector and civil society should not be able to engage more effectively on noise issues. This could take the forms of collective processes of engagement at the community level, or institutional arrangements that allow space for debate and develop confidence among local communities in the information supplied by industry players.

The aviation sector has a mixed history with regard to the assurances made by airports to local populations. Many residents in communities around Heathrow cite commitments made at the time of the Terminal 5 planning process, the spirit of which was subsequently broken when runway expansion was proposed, as a reason for the erosion of trust in the industry. However, other legal or political assurances, such as the Cranford Agreement and the commitment not to build an additional runway at Gatwick until at least 2019, have remained robust over time.

There may be potential to explore legal or quasi-legal agreements such as contracts between airports and local residents, or restrictive covenants on properties in exchange for compensation or mitigation measures. Similarly, formal political commitments such as undertakings or local agreements have been shown to have considerable weight.

COULD THOSE IMPACTED BY NOISE ALSO RECEIVE MORE TANGIBLE BENEFIT?

As noted above, those communities that tend to complain most about noise disturbance often do not perceive direct benefits from being located near the airport.

It follows that a reformed institutional framework should allow the debate to focus on bespoke solutions for individuals or specific communities. Given the need to tailor solutions to local needs, the menu of potential options is necessarily very broad. Some illustrative examples that could be worthy of consideration:

- **a council tax rebate scheme funded through a levy on airport charges;**
- **direct compensation schemes to those that face the greatest noise impact;**
- **improved noise insulation programs for those who face the greatest impact;**
- **preferential arrangements for local residents using the airport, (for example free or discounted airport parking, access to fast-track security lanes, discounts applied in airport shopping precincts, access to premium airline lounges when travelling or preferential benefits linked to airline loyalty schemes);**
- **airport engagement in community projects, for example providing funding for community facilities or services.**

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■ MOVING FORWARD

In light of the sensitivity of aviation noise, the policy framework will need to develop an approach which meets a number of criteria, in order to move forward on noise:

- Political credibility and sustainability;
- Operational efficiency;
- Create appropriate incentives for both the aviation sector and local communities.

This may involve a combination of measures across one or more of the following areas:

- **Technical –** to deliver further improvements in noise performance;

- **Economic –** to create appropriate incentives on the aviation sector to manage the aviation noise issue efficiently, and to deliver improvements where there is an economic case for doing so; and also to consider whether there is potential to design compensation schemes which internalise the noise problem and unlock local opposition;

- **Institutional –** to address the trust deficit between local communities and the aviation sector, and also to generate greater convergence of local and national priorities and also to narrow the gap between across institutional frameworks, technical measures.

PART 4: LOCAL AIR QUALITY

The current legislative framework governing air quality is generally considered to be credible and robust. There does not appear to be in any merit in proposing significant amendments to the existing arrangements.

Indeed, there may be lessons to be learned from the outcome-based, non-sectoral approach to air quality that could be useful in addressing other environmental impacts, for example as part of an alternative approach to noise policy.

The UK has adopted an outcome-based, non-sectoral approach to addressing air quality, based on the implementation of European legislation.

The Government's National Air Quality Strategy provides the Government's policy framework for air quality management and assessment in the UK. It identifies air quality standards and objectives for key air pollutants which are designed to protect health and the environment.

Of these pollutants, levels of particulate matter (PM10) and nitrogen dioxide (NO_2) continue to exceed the national air quality standards and objectives in some areas, especially in and around London. Aviation activity causes emissions of both pollutants, in particular nitrogen dioxide:

• **Particulate matter (PM10 and PM2.5):** Most PM emissions in the UK are caused by road traffic, with engine emission and tyre and brake wear being the main sources. Construction sites, with high volumes of dust and emissions from machinery are also major sources of local PM pollution, along with accidental fires and burning of waste. However, a large proportion of PM comes from natural sources, such as sea salt, forest fires, sometimes originating far from the UK as is the case with Saharan dust.

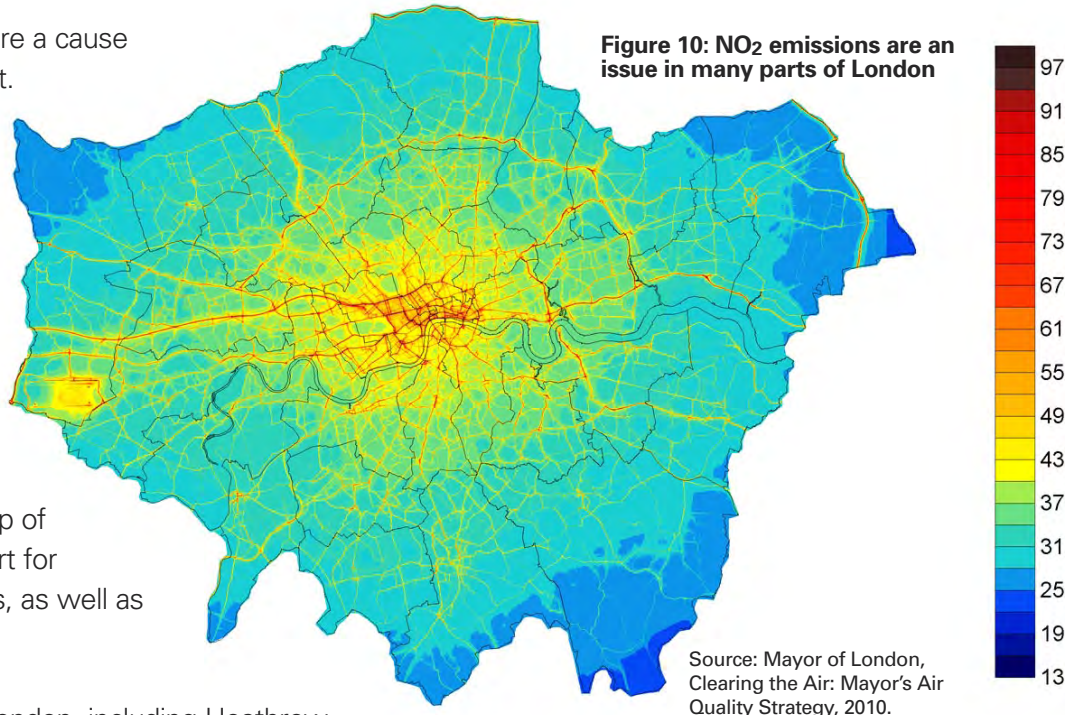
• **Nitrogen dioxide (NO_2):** All combustion processes, including aviation, produce oxides of nitrogen (NOx). In the UK, road transport and heating systems are the main sources of these emissions. NOx is primarily made up of two pollutants - nitric oxide (NO) and nitrogen dioxide (NO_2).

As **Figure 10** shows, NO_2 concentrations are a cause for concern at and around Heathrow Airport. The highest concentrations beyond the airport boundary occur close to roads in the vicinity of the airport.

The primary causes of NO_2 emissions around Heathrow airport are:

- Ground-level aircraft operations emit large amounts of NOx,
- Landside vehicles including cars, taxis, coaches, and freight, which will be made up of a combination of traffic accessing the airport for both passenger and freight related journeys, as well as other general traffic.

Figure 10: NO_2 emissions are an issue in many parts of London



Source: Mayor of London, Clearing the Air: Mayor's Air Quality Strategy, 2010. Modelled NO_2 annual average concentrations (µg/m3) for the year 2008

Modelling of NO_2 concentrations in west London, including Heathrow, clearly shows that the highest concentrations are predicted close to main roads. It is important that airport-related road traffic sources of emissions, including private cars and freight are tackled. However, concentrations of NO_2 are also predicted to be high within the airport boundary and it is important to continue to work to reduce emissions from airport operations in order to improve local air quality.

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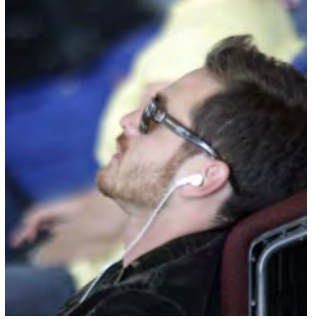


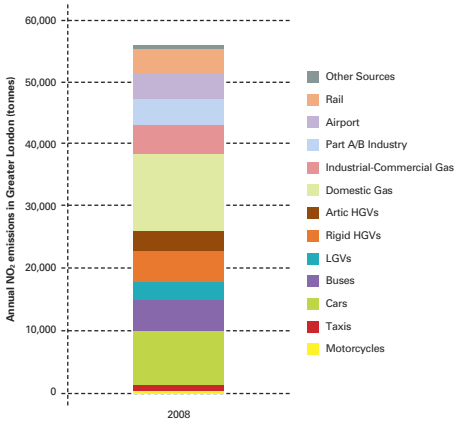
NOx EMISSIONS FROM ALL SOURCES IN GREATER LONDON IN 2008

The European Union's air quality Directive (2008/50/EC) sets standards for a variety of pollutants that are considered harmful to human health and the environment. These standards, which are based on WHO guidelines, include limit values, which are legally binding and must not be exceeded. The Directive, including the emission concentration limit values, has been transposed into English law by the Air Quality Standards Regulations 2010.

These limit values comprise a concentration value for the pollutant, an averaging period over which it is measured, the date by which the limit values are to be achieved and in some cases an allowable number of exceedences of the value per year. The Directive also includes target values, which are set out in the same manner as limit values, but which are to be attained where possible by taking all measures that do not entail disproportionate costs.

By adopting a non-sectoral approach focused on an overall target for tackling NOx emissions, the legislation enables reductions to be made in the most efficient manner possible across sectors.

Figure 11: Aviation activity is one of many sources of NO_X emissions.



Source: Mayor of London, Clearing the Air: Mayor's Air Quality Strategy, 2010. Modelled NO_2 annual average concentrations (µg/m3) for the year 2008. NOx emissions from all sources in Greater London in 2008

CONCLUSIONS

Aviation Policy for the Environment is the second in the CAA's series of three Insight Notes intended to inform the development of a Sustainable Framework for UK Aviation.

In this note we have:

- Considered the environmental challenges facing the aviation sector and identified some overarching principles that should guide Government in determining when and how to intervene;

- Examined the climate change challenge, concluding that, while the overall policy framework should ideally be set at a supranational level, there are significant technical and operational measures that can be taken forward at a national level to improve the UK aviation sector's emissions performance;

- Looked in detail at the issue of aviation noise. We conclude that a twin-track approach is required to deliver significant progress: the sector should continue to seek a reduction in the number of people affected by noise; but a new approach to engagement with local communities is also required. The development of the policy framework presents an opportunity to develop a new, more constructive approach to noise policy.

- Reviewed the existing framework governing local air quality issues. We consider that the current approach is generally seen to be credible and robust. There does not appear to be any merit in proposing amendments to the existing arrangements. Indeed, the outcome-based, non-sectoral approach to air quality may offer a useful case study that could be applied to other environmental impacts.

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I http://www.caa.co.uk/docs/589/UK_CAA_Response_To_Sustainable_Aviation_Framework.pdf

II Committee on Climate Change (2009), Meeting the UK aviation target – options for reducing emissions to 2050

III Committee on Climate Change (2009), Meeting the UK aviation target – options for reducing emissions to 2050

IV Committee on Climate Change (2011), Meeting Carbon Budgets - 3rd Progress Report to Parliament

V 'Hedonic pricing' is a technique based on the idea that external factors such as environmental impacts are captured in the prices paid for goods or services. For example, in the context of noise, hedonic pricing theory assumes that, all other factors being equal, the impact of noise on communities should be reflected in property prices.

VI http://www.sustainableaviation.co.uk/2011/progress-report-2011/

VII Accent Research into Consumer Preferences, http://www.caa.co.uk/docs/2107/2131ConsumerResearch06122011.pdf

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