

Alternatives to aviation

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ALTERNATIVES TO AVIATION

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Executive summary

This report was produced to provide an understanding of the potential for short-haul air travel journeys to be transferred to rail or coach services, or to use telecommunications to reduce the need to travel. The project also sought to review the current fiscal and legislative framework in which the aviation industry operates to determine any barriers to change. The research was commissioned in recognition of the fact that aviation is now the fastest growing transport contributor to climate change (CfIT, 2007b), and that the increase in air travel demand appears to be supported by governmental policy and market drivers at both the national and international level.

This project consisted of a literature review and consultations with eleven organisations to gain an indication of the potential for telecommunications to reduce air travel. Key findings are summarised below.

Alternatives to aviation

A review of the evidence base indicates that rail has the most potential to substitute the need for short-haul flights and that its ability to compete with air travel is strong. The role of coach travel in substituting short-haul flights is less clear owing to the lack of both empirical research studies and of baseline data. A review of the infrastructure indicates that its potential, whilst limited, should be explored further.

Our review of plane, coach and rail infrastructure indicates that in general air services enable journeys to be completed in shorter times than either rail or coach travel. The cost of air travel is found to be consistently higher than that of rail and coach travel, and coach fares are consistently lower than those of aviation and rail. The review also indicates that air travel is significantly more damaging on a passenger km basis in terms of climate change than the other modes considered.

Research literature suggests that the relationship between air travel and telecommunications is one of complementarity rather than substitution, although evidence of a substitution effect has been reported and organisations have responded positively to the potential for substitution. The literature indicates that there is a considerable likelihood that with intervention applications such as teleconferencing could play a greater role in reducing the need to travel in the future.

The consultations showed that a wide range of organisations already use teleconferencing facilities, and that all of the organisations surveyed agreed that teleconferencing is convenient, can save time and money, enables greater control over time and is less stressful than air travel, and can enhance an organisation's corporate image and CSR credentials. The organisations surveyed feel that face to face interaction will remain essential for the establishment of good working relationships but that for a range of purposes, most notably for internal meetings and external meetings with existing clients, interactions can be effectively conducted remotely via ICT thereby reducing, although not replacing, the need to fly.

Barriers to attaining desired behaviours

Income, price, quality of service, provision of alternatives and image/status were identified as the main factors affecting traveller behaviour. Rises in income, reductions in fares, increases in peoples' value of time, the currently poor substitutability of alternative modes and the positive image and status of air travel were found to favour the increasing use of aviation. The review of both literature and infrastructure indicates, however, that the reality of air travel and rail travel in particular are very different to what are widely held perceptions. Rail travel is, for example, able to compete in terms of both cost and journey time (when journey times are below three hours), and therefore enhanced marketing efforts on behalf of rail operators could help to overcome barriers that currently exist.

Fiscal and legislative framework

An examination of the current fiscal and legislative framework identified problems regarding the level and profile of taxes in relation to the negative externalities caused by the aviation industry. The Air Passenger Duty was found to be the only tax on air travel whilst VAT and fuel duty were zero-rated. The proposed new tax on flights, as well as the inclusion of aviation in the EU Emissions Trading Scheme, also gives rise to several new concerns, and it is recommended that these proposals warrant further scrutiny.

Potential impacts

Effects on the environment, particularly in relation to climate change, local pollution and noise, are likely to be reduced by a shift to alternatives to aviation. Impacts on the economy have been briefly considered, and indicate that concerns regarding the economy if short-haul air travel movements are curtailed are likely to be over exaggerated, particularly when issues such as the tourism deficit, availability of alternative employment/regional development, and fall in house prices through noise are considered.

Policy recommendations

Research highlights the need for any strategy to substitute air travel movements to comprise of many different components and to bring together stakeholders from a wide range of industries and professions. Key elements of such a strategy can be summarised as follows:

- **Remove the barriers that prevent people from making informed decisions about how to travel.** Information about the relative environmental impacts that different modes of transport have on a per passenger basis should be made easily accessible. The attractiveness of alternatives to aviation could be improved by enabling people who are unaware of the relative impact of different modes of transport to base their travel behaviours upon informed decisions. Travel awareness and information marketing campaigns could therefore encourage more sustainable behaviours. Tools that already exist to help people to calculate relative CO₂ emissions for different modes of transport, such as ‘carbon calculators,’ should be promoted as part of this.
- **Promote alternatives to aviation.** The aviation industry runs a number of effective advertising campaigns that have lauded the benefits of air travel. It is therefore necessary for the Government and service providers to run similarly aggressive marketing strategies to promote alternatives to aviation and to challenge what research has identified are relatively widely held misconceptions.
- **Engage with the public and businesses when formulating policy.** Policy needs to be based upon a clear understanding of the needs and perceptions of users. A comprehensive round of consultations will enable the relative strengths and weaknesses of short-haul air travel and its alternatives to be identified, and targeted strategies developed based upon the findings.
- **Implement fiscal measures to internalise the negative externalities generated by the aviation industry, to put a downward pressure upon demand, and to support alternatives to aviation.** There is a widespread consensus that the aviation industry is not made accountable for the negative externalities that it generates, and that it is therefore effectively subsidised. Moves to make levels of tax commensurate with the environmental impact of the negative externalities and to earmark aviation tax revenues for investment in more sustainable alternatives, such as rail travel, could therefore support the substitution of short-haul flights.
- **Target investment to encourage a modal shift.** The government should increase investment in alternatives to aviation to enhance their attractiveness. Investment is needed in the infrastructure to enable the substitution of short-haul flights, and to lower the costs associated with the use of these alternatives.

1 Introduction

1.1 Background

This report is the output of a study commissioned by Campaign for Better Transport to explore the potential for, and likely impact of, short-haul air travel journeys being transferred to rail or coach services, and for using telecommunication technology to reduce the need to travel. The project comprised of a literature review, a comparison of the fare, journey time and environmental impact of coach, rail and air services, and a round of consultations with eleven organisations, which were used to formulate recommendations to policy makers and other key actors.

This research has been commissioned in recognition of the large, and growing, contribution that aviation makes to climate change. Climate change is now recognised as being one of the key challenges faced by society, and aviation is one of the fastest growing transport contributors to greenhouse gases (Tyndall Centre for Climate Change Research, 2008). Over the past ten years the UK has seen a dramatic rise in the number of domestic and international flights, which is widely acknowledged as being unsustainable (CfIT, 2007b). Improvements to the energy efficiency of aviation and the introduction of renewable fuels will not be sufficient to offset the impact of the growth in demand for aviation (EEA, 2007). It has therefore been estimated that if the aviation industry continues to expand at this rate then to achieve the Government's overall target to reduce carbon emissions by 60% by 2050 (DTI, 2005) emissions from other transport sectors would need to be zero (FoE, 2005). This makes it necessary to manage the demand for air travel.

The increase in air travel demand is supported by governmental policy and market drivers, both at national and international level. Throughout the world airport capacity has and continues to be expanded. Taxes on air travel are limited by international agreements and in the UK the Air Passenger Duty is the only effective tax placed on the sector. Deregulation and the rise of low cost carriers increases competition and places downward pressure on fares.

The Future of Air Transport White Paper (DfT, 2004) estimated that aviation accounts for approximately 11% of the UK's total contribution to climate change, and the World Wildlife Fund (WWF, 2008) has recently predicted that aviation carbon emissions are growing at a rate of between four to five per cent per year.

Short-haul flights contribute a disproportionately large amount of emissions per passenger kilometre compared to longer flights, as fuel use is greatest during take-off and landing. Approximately 22% of flights in the UK in 2006 were domestic and although growth is now slowing domestic flights have increased nearly 42% between 1998 and 2007 (CAA, 2008). These types of flights should however be the ones most suited to alternative modes of travel such as rail and coach services. The aim of this report is to indicate the potential for short-haul flights to be substituted and the impact that this could have. It also seeks to highlight some of the key opportunities and barriers to attaining a shift to more sustainable forms of transport.

A section of this report focuses upon business air travel in recognition of the fact that a relatively large proportion of air travel movements - a quarter in 2006 (DfT, 2007b) – are for business purposes. This sector is very significant for airlines as the profitability of schedule flight is determined primarily by the occupancy of business and travel class seats. It could therefore be assumed that a reduction in business aviation travellers could have a disproportionate impact upon the viability of short haul flights.

1.2 Scope of the report

The report contains:

- A literature review that identifies the potential for reducing the need for short-haul flights, considers where there could be the most potential for cutting large volumes of air traffic, gives an indication of the reduction in CO₂ and NO_x emissions that may occur as a result, and outlines the current taxation requirements on the aviation industry;
- A review of current infrastructure provision encompassing coach, rail and air;
- An analysis of the results from consultations with organisations to indicate the potential for telecommunications to reduce levels of business air travel;
- Recommendations based upon the outcomes of the literature review and consultations with businesses.

1.3 Structure

The report has been structured as follows:

- Methodology;
- Background – an analysis of short-haul air travel movements and current aviation trends.

SECTION A: Literature review

- Alternatives to aviation - a review of the evidence base relating to the potential for rail, coach and telecommunications to substitute short-haul flights;
- Incentives and barriers to change – an outline of the key factors that are likely to affect air travellers' behaviour and impact upon the substitutability of short-haul flights. This discussion encompasses the current and proposed taxation and legislative context of the UK aviation industry, and examines whether there is scope to invest revenues from aviation taxes in alternative transport modes;
- Potential impacts of measures to reduce air travel – the impact of travel behaviours will be examined, primarily in terms of their impact upon the emission of greenhouse gases;

SECTION B: Modal comparisons

- Comparison of alternatives to short-haul flights – the characteristics of coach and rail journeys on routes where there is the highest demand for short-haul flights is examined relative to air services operating on these corridors;

SECTION C: Business consultations

- Research findings – analysis of the survey data;

SECTION D: Recommendations

- Recommendations to policy makers and other key actors – based upon research activities.
- Conclusions.
- Appendix A: Annotated bibliography.
- Appendix B: Questionnaire survey.

2 Methodology

2.1 General Approach

This section describes the methodological approach employed in this study. The approach taken consisted of a literature review of the existing evidence base, a comparative review of coach, rail and air services in terms of journey time, fare and environmental impact, and consultations with eleven organisations.

2.2 Literature Review

The nature of the subject area and time constraints faced meant that the search was focused on documents published in the last five years. Documents that were identified to be of particular relevance but that were published before 2003 were also included in the review. A relatively small body of research has been conducted into the potential for short-haul flights to be substituted by other forms of transport or for reducing the need to travel, and as such many of the documents reviewed have focused upon the relative attributes of alternatives to aviation from which the impact upon short-haul flights has been inferred.

Evidence to inform the study has been based upon a literature search conducted by the TRL Information Centre. These search results have been supplemented by additional references provided by Campaign for Better Transport and others documents that the study team knew to be of relevance. Many of the additional references were not identified in the literature search as this process only identifies documents which have undergone a formal review and publication process.

2.2.1 Databases searched

The following databases were referenced for our review:

- TRL Library KnowledgeBase (English language International Transport Research Documentation (ITRD)¹ + Library catalogue²);
- ScienceDirect;
- Transportation Research Information Services (TRIS).³

2.2.2 Search terms

The search terms selected were chosen based upon the scope of the report and then tailored to be appropriate to each of the databases searched. The search terms used were as follows:

Aviation, climate change, telecommunications, modal shift, transport mode, business travel, rail, coach, bus, coaches, buses, public transport, high-speed rail, TGV, HSR, rail bound transport, aviation tax, taxation, green taxes, travel behaviour, modal choice, smarter choices, journey time, duration, productivity, Wi-Fi on trains, value of time, enhancements, air travel, greenhouse gas, environment,

¹ ITRD is a multi-lingual bibliographic database that contains citations to international literature, research projects and computer programmes on all aspects of road research, transport, and traffic planning. The database contains approximately 850 journals from 40 countries as well as books, reports, dissertations, patents, conference proceedings, and standards and specifications.

² TRL's Library & Information Centre has collections of published materials in the form of books, periodicals, conference proceedings, standards, statistics, guidance notes and several thousand TRL Research Reports.

³ TRIS is the largest and most comprehensive bibliographic resource on all modes and disciplines of transportation. The database is produced and maintained by the Transportation Research Board (TRB) and contains over 640,000 records of published research.

carbon dioxide, nitrogen oxide, video conference, video conference, visual collaboration, teleconference, airport, airport expansion, Heathrow expansion, short-haul flights, reducing the need to travel.

2.2.3 Selection of studies for inclusion

The literature search resulted in the identification of 137 titles that met the inclusion criteria. Given the limited task timetable, these references were narrowed down through the review of their abstracts and an initial assessment of their likely relevance to this study. In addition the client identified six further studies for inclusion and these were combined with a selection of pre-existing materials gathered by the project team.

2.2.4 Quality appraisal

The focus upon research documents identified by TRL's Information Centre as opposed to those that would be identified by an internet search ensured that documents referenced met the quality standards of the scientific databases. The vast majority of journals indexed within the databases are peer-reviewed academic and research publications.

The annotated bibliography contains a descriptive and evaluative paragraph for each of the documents referenced which details the evidence that each publication is based upon, giving a further indication of the quality and authority of the sources cited.

2.3 Modal comparisons

Rail and coach services and infrastructure in the UK were reviewed to analyse their competitiveness with air travel in terms of time, cost and emissions data.

2.3.1 Routes analysed

The data was retrieved from searches of the services offered by various modes along the seven corridors that were identified to have the highest level of demand for air travel (based upon 2007 data published by CAA (2008)) as well as for two routes to mainland Europe destinations to highlight the potential for substituting short-haul flights to the continent. Despite the high volumes experienced on routes between London to Belfast International and City airports these have been excluded from this review as they are not readily accessible by rail or coach. For details of the routes reviewed see Table 18 and Table 19.

2.3.2 Data sources

Journey times and fares

The data for train journey times and costs was taken from www.nationalrail.co.uk and www.eurostar.com. The National Rail Enquiries database was used as it is the official information service for National Rail.⁴ The web resource provides information on all aspects of rail journeys, including fares and service times. The Eurostar website, which provides the same level of service information, was used as it is the only operator of high-speed rail services directly linking the UK to France and Belgium.

⁴ National Rail is the collective name for the train companies who operate Britain's rail service. Their rail travel service information provision is strictly regulated by the Department for Transport.

Data for coaches was sourced from www.nationalexpress.co.uk, the website of the operator National Express, which is Britain's only scheduled coach network and the largest scheduled coach service provider in Europe.

The flight data used in the comparison was obtained from www.opodo.co.uk. Opodo is the first Pan-European travel service which provides service information for over 500 airlines. It therefore gives access to air service information for a range of airlines on any given route.

Environmental impact

The data sources used for emissions data were:

- Coach emissions taken from the National Emissions Inventory Database at <http://www.naei.org.uk/> (2007);
- Rail emissions taken from the MEET program funded by the EU (Hickman, eds., 1999);
- Air emissions taken from *Kerosene and emissions from flight operations* (Lufthansa, 2006), adjusted for a radiative forcing index of 1.9.

The sources used for emissions data were selected because they stated the assumptions that the values were based upon. Aviation emissions data provided by Lufthansa was used, for example, because it is primary data and assumptions were based upon their average occupancy. The RFI of 1.9 was chosen because it was deemed to be the most credible approach to estimating the effect of aerospace emissions on global warming.

No attempt was made to perform a CO₂ emissions comparison for the two international routes as it was beyond the scope of this project to formulate a meaningful comparison owing to the need to take into account the electricity mix of the Eurostar trains and the distribution of emissions per passenger of coaches travelling through the channel tunnel. Comparisons made by other commentators have therefore been referred to.

2.3.3 Assumptions

There are several factors that need to be considered when attempting to compare different modes of travel. Decisions about which assumptions to make can affect the final comparisons significantly. Before reviewing the results of the comparison it was therefore important to consider the assumptions upon which the data would be compiled. Assumptions made are outlined below.

Distance from city centre

This analysis makes no attempt to quantify the additional travel time and cost associated with parts of the trip before and after the main journey. This tends to reflect favourably on air travel, as airports are often further from the city centre than train stations or coach stops.

Check-in time

The point to point time given in journey figures is often not a good reflection of the total journey time for air travel, as it ignores the associated check-in, check-out and security procedures. This comparison has added one hour to domestic air travel journeys and two hours to European flights to reflect this.

No empirical research was identified that assigned an average value to the actual time taken for check-in, check-out and security procedures at either the origin or destination airports. BAA (2008) recommend that passengers check-in one hour before the scheduled departure time for domestic flights, and two hours before the scheduled departure time for European flights. In order not to over compensate for the necessary formalities associated with air journeys, and to take into account the fact that the time taken for these procedures can vary considerably, these values were used as a basis for

comparison. This is likely to reflect favourably on air travel, but it is also less likely to be challenged as it is a robust figure which recognises that the check-in process can be shorter for a range of passengers, such as the increasing proportion of travellers who are choosing to check-in remotely online before arrival at the terminal.

Radiative Forcing

Journeys by aircraft have more of an impact on climate change than the raw volume of greenhouse gases emitted might suggest. As such, a radiative forcing index is used to make the impact on the climate directly comparable with that of other modes. There is some debate over the size that such an index should take but this analysis uses the figure suggested by the EU TRADEOFF project of 1.9 (Sausen et al., 2005).

Type of train

The CO₂ emissions for rail travel were based upon the assumption that the train was diesel as opposed to electric.

Occupancy

A large factor impacting on emissions per passenger km is the occupancy of the vehicle. A number of studies into emissions factors assume 100% occupancy, which leads to an understating of the true emissions per passenger. This comparison uses occupancy rates of 33% for rail travel, which is based upon the average load factor for rail routes as identified by the Strategic Rail Authority (2001, cited in CfIT, 2001) and of 60% for coaches, which is based upon estimates for intercity travel as used by the DfT (2007c). The occupancy assumption for air travel was the “Group fleet average” for Lufthansa, but this occupancy rate was not explicitly stated.

Booking tickets

The assumption was made that tickets were booked online either one month or one week in advance of the date of travel. No empirical research was identified that estimated how far in advance rail and air passengers book the tickets for their journey and so these intervals were used to give an indication of the relative competitiveness of modes. No walk-on fares for rail travel were included as this would not be comparable with air travel, or many coach services, which need to be pre-booked.

2.3.4 Data presentation

The results of the analysis were presented in a graphical format to enable easy comparison.

2.4 Consultations with organisations

Consultations were conducted by means of an e-mailed questionnaire. This was considered to be the approach most likely to generate reliable and valid data from respondents within a short time scale and at a minimum cost. The decision was made to conduct a self-completion survey as it was considered that this may obtain more accurate and considered information than one conducted by telephone.

2.4.1 The questionnaire

The questionnaire consists of questions designed to give an overview of baseline levels of usage of both air travel and telecommunications for business, and explores the cognitive⁵ and behavioural⁶

⁵ What a person believes about a concept, whether true or not

⁶ Reflects the actual behaviour of the individual

attitudes of the respondents. These were designed to give an indication of how the employees are likely to respond to various policy measures. To maximise both the quality and quantity of responses attempts were made to limit the number of questions asked. A large number of closed questions were also used to reduce the time necessary to complete the questionnaire, and also to assist analysis and enhance comparability.

The questionnaire was technically reviewed to validate the content of the survey and to assess whether the questions posed fulfilled the purpose of the study. The survey was then piloted within TRL to refine the content of the questionnaire.

2.4.2 Sample size

Time and budget constraints led to the decision to involve 10 organisations in the consultation, although the response rate was such that 11 organisations were included in the study. The response rate of e-mailed questionnaires can be highly variable, and therefore a decision was made to approach 20 organisations. Eleven of these organisations chose to participate. The consultations were all conducted in June 2008.

It is of interest to note that a number of organisations who did not return the survey expressed an interest in the research and a desire to participate, and in one case had completed the questionnaire, but were unwilling to submit a response owing to a concern that higher level, or additional, approval was required. A Business Development Manager approached was also keen to be informed of the outcome of the research, but reluctantly felt unable to participate owing to the sensitive nature of the questionnaire content. It could be inferred from this response that many companies feel that it is important to be seen to be 'green,' and that it is perhaps not desirable in the current climate to be associated with high levels of business air travel. This view was confirmed by a CSR Manager who participated in the research on the condition that their response was anonymised.

It was acknowledged that a sample size of eleven organisations would not be statistically representative, and could not therefore be used as a basis for quantitative analysis. The findings of the consultations are therefore indicative of the potential for telecommunications to reduce levels of business air travel.

2.4.3 Companies approached

To enable us to infer the relevance of the findings to a range of organisations we contacted organisations of a range of different sizes including those with multiple branches in the UK, international offices, and head quarters located in a number of different regions. We also sought to elicit responses from companies working in a number of different sectors, although the choice of sectors to represent was limited by our desire to involve companies who have experience of telecommunications, and whose employees also use air travel for business. Table 1 overleaf provides details of the companies approached.

Existing business contacts were used to identify potential respondents, and these were supplemented by companies identified from the 'Times Top 100 Companies' list. This resource was used to help ensure that organisations were approached that have varying numbers of employees, are from a range of sectors, have headquarters located in a range of different regions, and that have branches both in the UK and internationally.

The appropriate employee to contact was found to vary between organisations. A Head of Climate Change, Environmental Manager, Head of Transport Policy, and two CSR Managers were successfully approached, but where necessary staff with a broader range of responsibilities were contacted. Respondents therefore also included a Partner, two Business Development Managers, a Health and Safety Officer, a Senior Consultant, and a Head of Giving. The majority of respondents considered themselves to be Senior Management.

		Company										
		Aviva	BT	Business consultancy*	European bank*	European recruitment consultancy*	Global cosmetics company*	Global professional services organisation*	Global services company*	Grass Roots	Keltie	Natural Environment Research Council
Size (total no. of employees)	1 to 100					31					58	
	101 to 1,000			280	400+					311		
	1,001 to 5,000						1,448					3,000
	5,001 to 40,000							11,000+				
	40,000+	57,000	111,900						40,000+			
Multinational		✓	✓		✓	✓	✓	✓	✓	✓		
Multiple branches in UK		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector	Telecommunications		✓									
	Insurance	✓										
	Retail						✓					
	Legal										✓	
	Recruitment sales					✓						
	Financial				✓			✓				
	Services								✓			
	Research council											✓
	Business consultancy			✓				✓		✓		
	Location of HQ	London	✓	✓			✓		✓			✓
South West							Dorset					Swindon
South East									Hook			
Midlands				Nottingham								
East										Tring		
Europe					EU country							

Table 1: Profile of the organisations who participated in the search.

*indicates that these organisations wished to remain anonymous

2.4.4 Survey bias

It should be noted that when examining the attitudes of individuals responses can be biased, whether intentionally or not. In surveys such as these, where the purpose of the research is clear and where moral responses are, to a degree, being analysed, it is possible for individuals, either deliberately or unconsciously, to bias results to provide the responses that they feel that the researchers and/or their employer would like them to give to cast their organisation in a better light.

It could be argued that particularly when the research is based upon controversial and topical issues such as climate change respondents could give answers that they perceive to be the most socially acceptable, although not necessarily the most accurate. This therefore has the effect of limiting inferences that can be made from the results to the attitudes that the respondents are willing to express.

Providing anonymity to respondents is generally considered to be a means to eliminate this bias, and each participating organisation was offered this option. Two of the participating organisations stated that they wished to remain anonymous before agreeing to complete the questionnaire, and another four organisations requested that they be anonymised after viewing the report.

Questions have been designed to attempt to limit bias, and self completed questionnaires tend to be more reliable than those conducted verbally. Nevertheless its potential impact was considered whilst analysing responses.

3 Background

3.1 Global aviation market trends

Air transport is a fast growing industry. Preliminary findings of the Airport Council International (ACI, 2008) indicate that the industry achieved a growth rate of 5.6 percent in passenger traffic in 2007, which was reflected in growth rates experienced in the UK. This prediction is supported by the International Air Transport Association (IATA) who predicted that a further 600 to 700 million new passengers will fly in the next 5 years (2007). Although the overwhelming proportion of growth is predicted to be within Asia the second biggest expansion is expected to affect traffic within Europe (approx 150 million passengers between 2006 and 2011). Much of this growth is expected to occur within the short-haul market.

3.2 UK Air Traffic

From 1998 to 2007 air traffic in UK grew by approximately 60%. As shown in Figure 1 below most of the UK's overall air traffic movements originate from London.

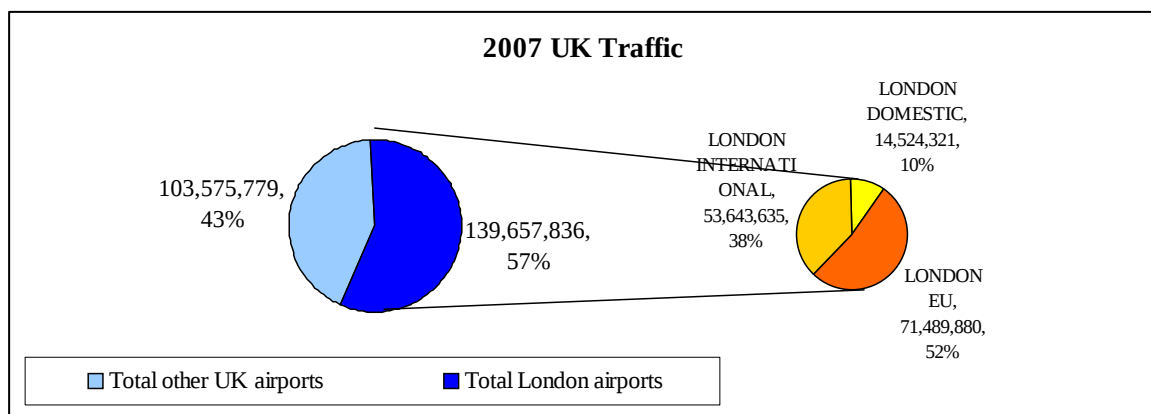


Figure 1: Passenger air traffic and growth from 1998 to 2007 at UK airports (CAA, 2008).

Despite remaining dominant, London's share of UK air traffic has fallen by five percent over the last decade and this has been partially attributed to the rapid growth in regional airport traffic stimulated by the growth of low-cost airlines, which have not had an impact upon hub airports like Heathrow. The nature of the trips undertaken from London airports has remained largely unchanged over the last decade.

The largest area of growth for UK air traffic movements has been in routes from regional UK airports to EU destinations as shown in Table 2 below. This has again largely been linked to the effect of the growth in low cost carriers. The lowest growth rate experienced in the last decade is for the domestic traffic from London airports, a notable exception being London City airport which experienced growth of almost 300% in their domestic traffic volumes.

	Domestic	EU	Other International
London area airports	19.34%	54.51%	23.99%
Other UK airports	52.99%	98.19%	48.38%
Total UK airports	41.65%	70.72%	28.05%

Table 2: Total air traffic growth between 1998 and 2007 (CAA, 2008).

The growth rates experienced by London airports are shown in Table 3 below.

	Domestic	EU	Other International	Total
Gatwick	47.29%	33.59%	0.64%	21.12%
Heathrow	-19.90%	2.89%	27.68%	12.41%
London City	292.84%	53.49%	238.97%	114.10%
Luton	75.29%	164.51%	119.60%	141.00%
Southend	29.28%	13,575.84%	-46.80%	1,116.65%
Stansted	108.54%	296.35%	146.34%	247.85%

Table 3: Total air traffic growth between 1998 and 2007 at London airports (CAA, 2008).

3.3 Domestic Traffic

Whilst the regional airports have experienced an overall growth in domestic traffic volumes, London airports have experienced a decline in domestic traffic volumes (see Figure 2 below).

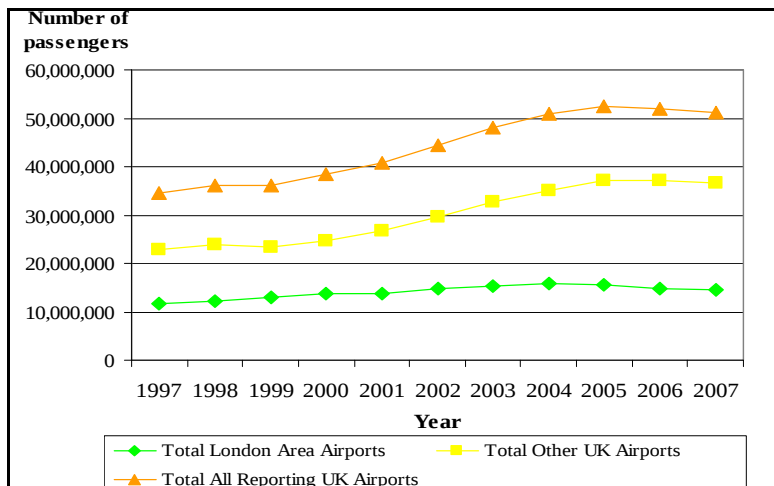


Figure 2: Growth in domestic air travel movements from 1998 to 2007 (CAA, 2008).

3.4 Traffic to the EU

The proportion of flights from the UK to Europe has increased by approximately 80% over the last decade (see Figure 3 below). Growth in EU traffic from the UK only dipped in 2001 as a result of the 11th September terrorist attacks. In 2007 flights from London airports to the EU grew by 60%.

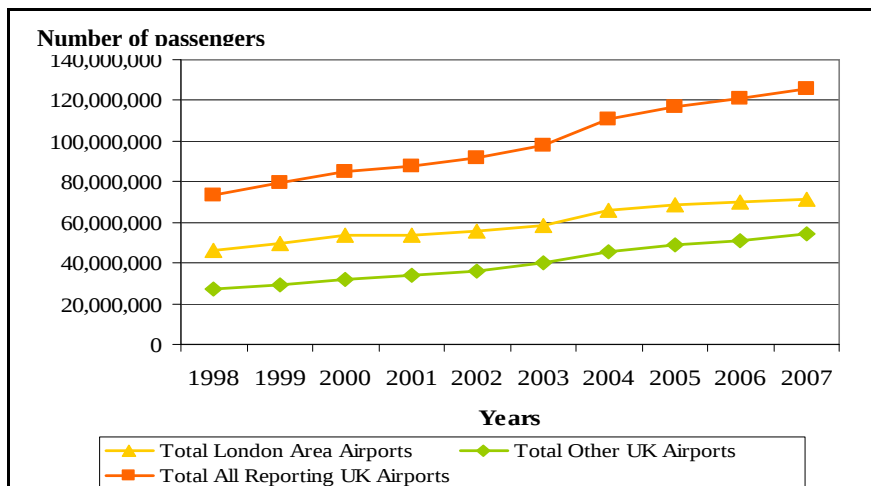


Figure 3: Growth in EU air travel movements from 1998 to 2007 (CAA, 2008).

The London airports that have benefited the most from the growth in EU traffic are Stansted, who experienced growth of over 400%, and Luton who experienced growth of over 200% from 1997 to 2007 (CAA, 2007). This is not surprising as these two airports are a hub for the low cost carriers Ryanair and EasyJet. In Europe the budget airline boom has had the most impact on the inter-European routes. So powerful was the low cost revolution that it has caused major schedule carriers to restructure their business models. Some carriers, such as Aer Lingus (who were in direct competition with Ryan air) were forced to radically redesign their business model to compete within this market.

Several regional airports have also profited from the low cost airline revolution. Coventry's passenger traffic grew from only 1,520 passengers in 1997 to over 539,441 passengers ten years later. The newly opened Doncaster Sheffield airport in 2005 served 904,515 passengers last year and air traffic at Prestwick Airport has grown by over 600% in the last decade because of the increase in low cost airline operations. Liverpool experienced double this growth rate from 1997 to 2007 as a result of the arrival of low cost carriers (CAA, 2007).

3.5 Traffic to Other International Destinations

The growth in traffic to other international destinations has been considerably lower than the growth in air traffic to European destinations. A significant amount of the international traffic departs from London and hence this will continue to create demand for short-haul flights from other UK regions to London to connect with these international flights.

3.6 Purpose of Travel

The air passengers market is usually segmented into the two main categories of leisure travellers and business travellers, both of which have different motivations for flying. The leisure segment is often split further into holiday, visiting friends and family and other miscellaneous.

Of those travelling abroad in 2006, approximately a quarter were business travellers compared to only 13% of non resident business passengers travelling to the UK (see Table 4 below). However the business sector is very significant for the airlines as the profitability of the schedule flight is determined mostly by the occupancy of the passengers travelling in business and first class.

	North America	European Union ⁷	Other Europe	Other areas	Total	% share by purpose of travel
Business visit	919	4,777	721	1,082	7,504	13
Leisure visit	3,768	33,722	3,369	8,101	48,983	87
Total	4,688	38,499	4,091	9,183	56,465	100
%	8.30%	68.18%	7.25%	16.26%	100.00%	

Table 4: Passenger journeys (in thousands) from the UK by purpose and destination in 2006 (DfT, 2007b).

⁷ Journeys made to the European Union includes domestic journeys within the UK.

Section A: Literature review

1 Alternatives to Aviation

There appear to be a number of viable alternatives to a proportion of short-haul flights originating in the UK. A review of literature has indicated that the three alternatives that have the most potential for substituting short-haul flights are rail, coach and telecommunications, notably video- and audio-conferencing.

1.1 Rail as an alternative to short-haul air travel

1.1.1 Background

National rail data shows that the number of passenger journeys undertaken by rail has increased steadily over the past seven years, as shown in Figure 4.⁸ The modal share of rail has however declined substantially over the past 50 years, although the trend identified Figure 5 suggests that this may be changing. A comparison of the market share of the domestic intercity market for rail and aviation shows that the market share of rail is almost four times as large as that of air (ATOC, 2008). Statistics show that 93 million long distance domestic rail journeys were made in 2006/7 compared to 24.9 million domestic air journeys, which highlights that rail is already a popular mode of travel (ATOC, 2008). This contention is supported by other research which suggests that where rail services are strong then air can struggle to compete (CAA, 2008; TRANSform Scotland, 2007; Transport 2000,⁹ 2006).

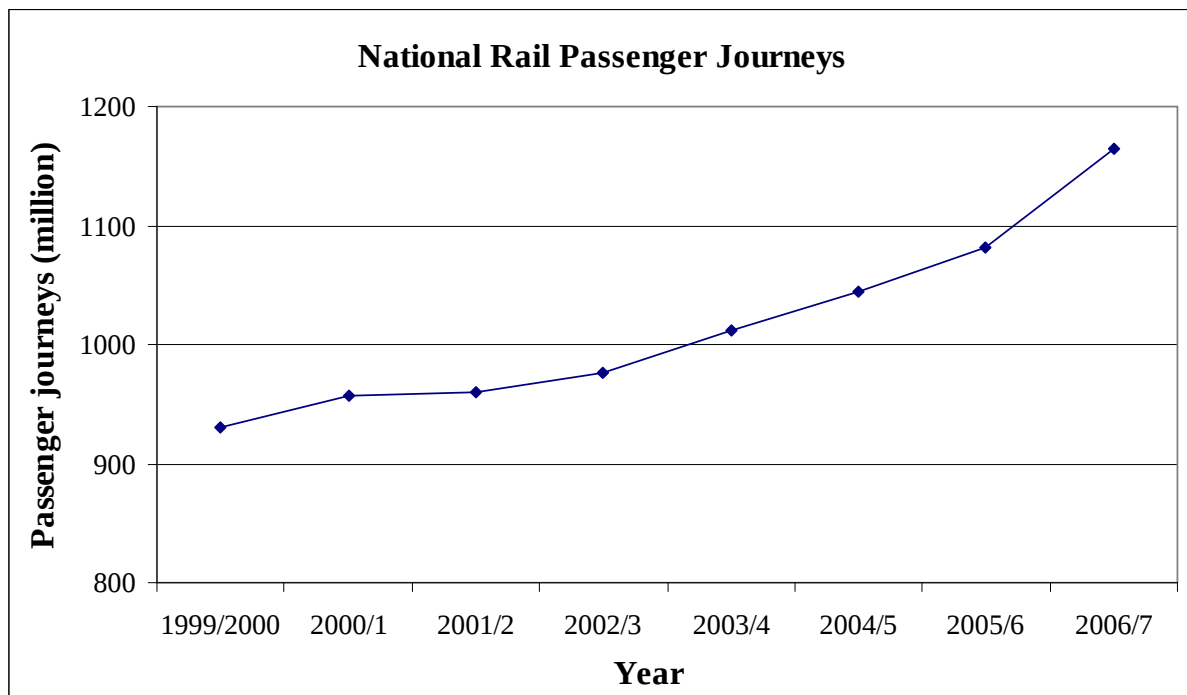


Figure 4: National rail passenger journeys (DfT, 2007b).

⁸ Figure 4 only looks at passenger journeys undertaken over the past seven years because in 1999 the methodology used to measure this statistic changed to take into account the fact that some journeys on routes undertaken by more than one operator were being double counted. This makes subsequent data incomparable with previous years.

⁹ Transport 2000 changed its name to Campaign for Better Transport in 2007.

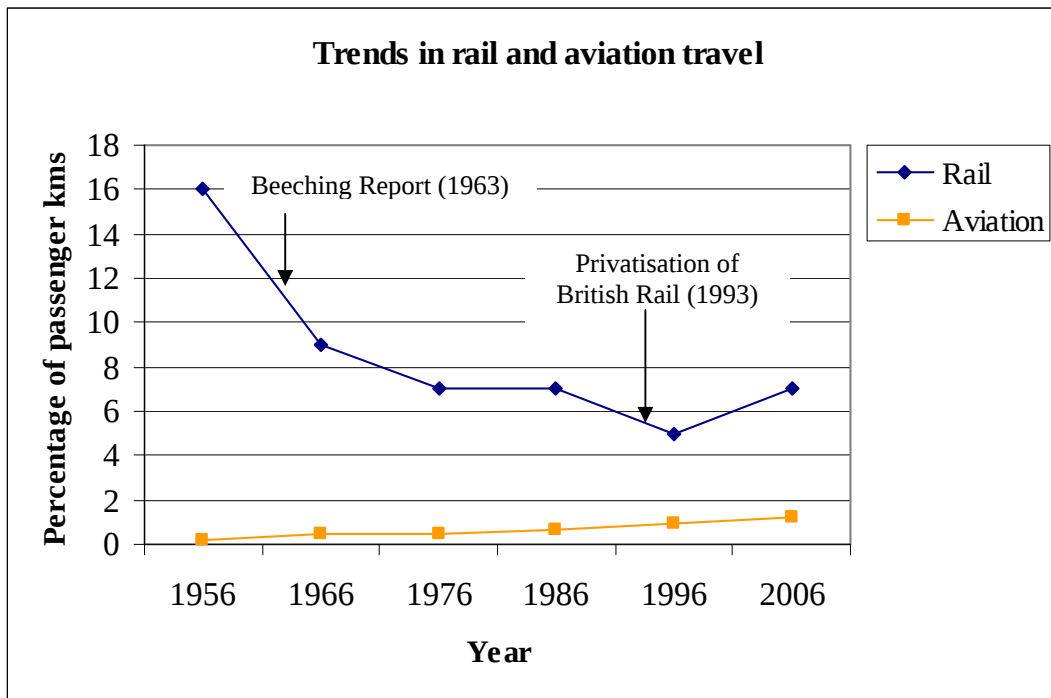


Figure 5: Trends in rail and aviation travel (DfT, 2007b).

A report published by ATOC (2007b) examined rail growth trends across Europe and identified that in the past decade passenger kilometres have risen by 42.2% and passenger journeys by 42.6%, which is the highest growth rate experienced in Europe. Their research shows that it is likely that growth in UK rail travel will continue at a high rate. This will, however, be dependent upon a number of factors.

National policy documents (DfT, 2004; DfT, 2007a; DfT, 2007c) state that accommodating this growth is one of the biggest challenges being faced by the industry. Numerous proposals have been made and high levels of investment committed to meet this capacity challenge, the details of which are set out in the rail White Paper '*delivering a sustainable railway*' (2007c). The White Paper suggests that if short haul flights were substituted by rail journeys then the necessary capacity would be available to accommodate this shift. Investment in the rail network will be necessary in order to accommodate growth, and as detailed in Section 4.1.3.1 Network Rail has already committed £21.4 billion to support this.

1.1.2 Evidence base

Numerous research reports have examined the potential for the rail network to compete with aviation on a short-haul basis. The research tends to focus upon the environmental case for substituting short-haul flights for rail journeys with many studies appearing to have been developed in relation to concerns over climate change and the high negative impact of CO₂ and NO_x emissions on the environment. The research does not tend to make distinctions between diesel and electrified rail services, with the former being considerably more polluting than electric and comprising more of the UK fleet of trains.

Research studies have considered competitiveness in relation to cost and journey time. The importance of journey time, particularly for businesses, has led to a focus on the potential of high speed rail to reduce the number of short-haul air journeys undertaken, particularly for business trips. High speed rail services have been introduced across the globe, which has led to a range of empirical research studies having been conducted to determine the impact these services have had upon modal splits. Research into the impact of high speed rail upon travel behaviours has tended to focus upon

mainland Europe, notably in relation to the French Train à Grand Vitesse (TGV) service. The TGV system was the first high speed network in Europe.

The literature search identified that relatively little empirical research has been conducted in relation to Wi-Fi provision on trains. Numerous reports have been published detailing the potential benefits of Wi-Fi and the technical details of the systems themselves, but the likely impacts detailed in these reports are largely anecdotal. Only one comprehensive study was identified by the literature search (Zhang et al, 2006) and this was itself designed to address the absence of studies into the impact of Wi-Fi on train users. This report did not consider the potential of Wi-Fi to improve the competitiveness of the rail network relative to air, but it explored the ways in which increased application of the technology might affect the productivity of business rail travellers.

1.1.3 Research findings

The rail network in the UK has extensive coverage which, since the opening of the Channel Tunnel, has extended to mainland Europe. An increasing number of stations in cities across the UK are being directly connected to destinations in Europe by rail, and through ticketing initiatives are increasing the convenience and reducing the cost of these services.

The rail network connects with all of the cities served by airports and its integration throughout the country means that access times are often shorter than those associated with air travel. Service frequency and connection times vary considerably across the network but the journey times of rail services on routes that are also served by short-haul flights tend to be amongst the shortest and the most direct. As these corridors tend to experience high levels of demand, particularly during the peak, the comfort of the travel experience can sometimes be compromised, but the often high frequency of services on these routes mean that demand is accommodated. The capacity of the rail network is discussed in Section 4.1.3.1 of this report.

The potential to extend the role of the railways to substitute the demand for some short-haul flights is something that has been discussed in numerous publications. Business travellers have, for example, been found to display a preference for rail travel over flying, and women business travellers have a strong preference for rail over both driving and flying (TRANSform Scotland, 2007). These attitudes highlight the potential for air travel movements to be substituted for rail, although they do not appear to reflect current levels of demand.

One of the most comprehensive studies was one undertaken by the Aviation Environment Federation (AEF) (FoE, 2000) which found that whilst there appeared to be a relatively limited scope for the substitution of short-haul flights to rail between many regional airports outside of London a large proportion of passengers of domestic flights are concentrated on a small number of routes. The authors conclude that *'upgrading a small number of railway lines to make them more attractive in terms of speed, reliability, frequency and price could have an appreciable effect on the overall domestic market.'*

This AEF research also estimated that even with no more investment in the rail system than already proposed (2000 context) there would be the potential to transfer more than 20% of all UK domestic passengers to rail services, and that by 2015 up to 14 million air passengers could be transferred to rail from short-haul flights per year. Their research reflected that of numerous others by indicating that the potential for substitution will be significantly greater if the UK high-speed rail network (namely the British Rail InterCity 125 and 225 services) is extended. The role of high-speed rail in enhancing the competitiveness of the rail network has been considered in section 4.1.3.2 of this report.

TRANSform Scotland (2007) have undertaken a detailed review of acknowledged advantages of rail travel relative to air. The review highlighted that rail can *'compete well'* with airlines on numerous routes in England and details that the popularity of rail between Manchester and London has led to airlines withdrawing services along this route.

A report produced by the Civil Aviation Authority (CAA, 2008) reveals that domestic air passengers have already begun to switch to rail services. The report, which focuses upon trends in the industry, states that while air used to be more competitive than rail in terms of speed, reliability and cost the balance has now changed in favour of rail. The data showed that the rate of decline in growth of air services is greater where air transport faces competition from rail, as shown in Table 5 below.

		1998 – 2003	2004	2005	2006	2007
UK domestic flights	Air services facing direct competition from rail	6.6%	3.8%	- 0.1%	- 4.1%	- 3.7%
	Air services <i>not</i> facing direct competition from rail	6.7%	4.9%	3.3%	-0.6%	-1.2%
UK flights to key EU cities	Air services facing direct competition from rail	-1.0%	-1.6%	-4.7%	-0.4%	-1.0%
	Air services <i>not</i> facing direct competition from rail	4.6%	1.7%	2.9%	2.6%	3.1%

Table 5: Effect of rail competition on UK domestic and EU air traffic growth rates (CAA, 2008).

According to CAA (2008) advertising campaigns for long distance rail travel are targeting air travellers, even to the extent that one promotion offered free rail tickets for passengers who exchanged their used boarding cards. The report concluded that as this trend has only been identified in the last two years, it is unclear as to whether it will be short term or long term; *‘to the extent that this [shift from air to rail services] is due to improvements in rail services, then it is likely to represent a longer term shift in the modal split of UK domestic travel. However, to the extent that it has been driven by increased journey times and inconvenience of air travel resulting from the current security measures at airports, then this effect may only be temporary’* (CAA, 2008).

The key advantages afforded by rail relative to air are summarised briefly below:

Accessibility and access times

Research indicates that railways stations tend to be easier and less time consuming to access than airports. They are often situated in city centre locations (as a result of the historic development of the infrastructure), which can be more convenient to access and closer to the final destination. City centres also tend to be served by branches of the rail network which extend across the UK. This can contribute to lower access times as not only can physical accessibility be easier but the need to participate in lengthy check-in and security processes is also largely foregone when travelling by rail (FoE, 2000; Sheldon, 2007; TRANSform Scotland, 2007). Even when the final destination is not a city centre travelling by rail provides enhanced accessibility to locations within the region and beyond (Transport 2000, 2006).

The CAA (2008) has found that the increased processing times necessitated by the extra security measures at UK airports, which were increased following a terrorism threat to transatlantic air services in August 2006, has enhanced the competitiveness of rail in terms of journey time. This is directly related to levels of convenience and comfort afforded to rail users. An American Express survey of business travellers cited by TRANSform Scotland (2007) found that the often high amount of queuing required at airports was deemed to be an *‘irritation’* for 69% of respondents and that *‘eliminating queues’* was the highest demand for travellers when asked what would most enhance

their flight experience. The new Heathrow Terminal 5 is designed for people to wait for no more than ten minutes for security checks and immigration. If these targets are met then this will significantly reduce the delay experienced by air travellers using this terminal. It is important to note, however, that this will only affect one terminal of many, and so its impact upon modal shift is likely to be negligible.

An extensive review of values of time in relation to rail and air transport found that those travelling by air assign a high value to the time lost in access procedures, although the value of this time was generally deemed to be less than the value accorded to actual journey time (González-Savignat, 2003).

Flexibility

Rail services tend to offer more flexibility in terms of connections, frequency of services, and ticketing (which can be open) relative to air (FoE, 2000; Sheldon, 2007). The frequency of flights was identified as being a key determinant of convenience in an Accenture travel survey (2005) cited by TRANSform Scotland (2007). The same report also cites a Barclaycard survey (2006) which identified that 40% of business travellers stated that a more regular train service would encourage them to travel by rail rather than by car. It is of significance to note that rail services on routes served by short-haul flights tend to be considerably more frequent than those elsewhere on the rail network. The Barclaycard survey (2006) also identified that 91% of business travellers valued the ability to change booking details, most notably flight timings (and passenger names), at short notice – something that is more possible for rail than air travellers.

Reliability

Literature details that the punctuality of rail travel is considerably better than for aviation despite perceptions to the contrary. ATOC (2008) detail that since 2000 punctuality has been gradually improving and Network Rail expect that by 2009 a total of 90% of all trains will reach their destination on time. ATOC's latest quarterly figures (July to September 2007) show that 90.8% of all trains on the network arrived at their destination on time. Of those that did not long distance services tended to be within ten minutes of their timetabled arrival time (2008). TRANSform Scotland (2007) stated that the reliability of arrival times was between 84 to 87% for rail, which is 21 to 22% better than that of air services. Furthermore air services are only deemed not to have arrived 'on-time' if they are over 15 minutes late, and even once flights have arrived passengers are not necessarily able to embark (TRANSform Scotland, 2007). The report cites statistics from a business travel survey conducted by American Express which found that 99% of respondents stated that their highest concern when booking travel is reliability.

Environmental impact

Whilst environmental concerns do not appear to be a key determinant of modal choice by either businesses or leisure travellers research undertaken by Sheldon (2007) indicates that growing sectors are becoming more environmentally conscious. This trend has also been identified by Leonard (2007). Other research reports suggest that business travel decisions are unlikely to be based largely upon environmental impact (Meersman et al, 1999; Mokhtarian and Salomon, 2002). A survey conducted by CfIT (2007a) explored attitudes to aviation and climate change and found that the same was true for leisure passengers. Only a small proportion of respondents stated that they would fly less frequently in the future, and of those who were expecting to this was primarily owing to changes in personal circumstances as opposed to a concern about the environmental impact of aviation. TRANSform Scotland (2007) however cite the managing director of European Rail who stated that '*growing concern among consumers for the environment has driven a lot of people towards train travel*' and detail that concerns over the environment have affected sales of EasyJet services.

Many airlines now give passengers the option of making their journey carbon neutral at the time of booking to reduce the environmental impact (CAA, 2008). The effectiveness of these measures has

been questioned, but they can nevertheless have an impact upon the way in which passengers perceive the impact of their journey.

Whatever the attitude of consumers, if the environmental implications associated with rail travel were better communicated then this may influence the decision of some users as to which mode to travel by (Sheldon, 2007).

Productivity

Numerous research studies have emphasised the ability of business travellers to make more productive use of their time when travelling by train relative to aviation (Crawford, 2006; FoE, 2000; Leonard, 2007; Sheldon, 2007; TRANSform Scotland, 2007; Zhang et al, 2006). Indeed recent research commissioned by WWF (2008) indicates that companies are planning to substitute flights for rail travel in order to enhance productivity. This is something that is discussed in greater detail in section 4.1.3.3 of this report.

The majority of research reports consider productivity in relation to Wi-Fi provision. TRANSform Scotland (2007) however discuss the productivity of business travellers on trains in relative depth. They cite a National Rail Passenger survey which found that 86% of business travellers had work that could be conducted on the train. Air travel is less conducive to work as the working environments are less amenable to productive work, the use of lap-tops and mobile phones when in the air is restricted, and the journey time is fragmented by check-in and security formalities and take-off and landing procedures. TRANSform Scotland (2007) suggest that on a 3 hour 42 minute journey by air just over an hour is available for work, whereas on a 4 hour 40 minute train journey by rail travellers could work for approximately 4 hours and 30 minutes. The increased stress levels typically associated with air travel relative to rail also suggest that air travellers will need more time to relax, thereby further reducing their productive use of time (American Express, cited in TRANSform Scotland, 2007).

Sheldon (2007) details that the ability of business travellers to make more productive use of their journey time when travelling by rail could be enhanced by providing facilities to support working at railway stations. He contends that the provision of lounges at airports provide environments which are more conducive to productive working than those of rail stations which enables business travellers to make more effective use of transfer time or waiting when services are delayed. TRANSform Scotland also detail the importance of considering the whole working environment provided on trains and state that whilst on-board working is the most prevalent activity amongst business travellers on trains, there is scope for more business users to make use of their journey time for work.

Journey time

The common factor between most of the attributes detailed above is their ability to reduce overall journey times. This is of particular importance for business travellers, who place an especially high value on time as indicated by the desire to make more productive use of travelling time (González-Savignat, 2003). The evaluation of values of time undertaken by González-Savignat (2003) also found that daily return and frequent travellers derive higher values of travel time than other users.

The generally enhanced reliability and reduced access and check-in times associated with conventional rail are all used as arguments to indicate the potential for rail to compete with aviation in terms of time. Experience will, however, vary greatly depending upon the routes travelled although our review of rail, coach and air services indicates that based upon the assumptions made rail can only compete with air in terms of journey time for journeys of under three hours in length. It has recently been suggested that this threshold has increased to between four and four and a half hours for business travel (Pepy, 2007 cited in TRANSform Scotland, 2007).

TRANSform Scotland (2007) note the importance of recognising that the quoted '*journey time*' of air services only represents a small part of the total overall journey time owing to formalities such as check-in and security clearance, none of which are associated with rail travel.

The importance of journey time was recently highlighted by Sheldon (2007) whose extensive market research study of business travellers found that when air travel was favoured over rail it was generally ‘a result of the distance being covered and the perceived speed of flying.’ The research indicated the value that can be obtained from promoting the comparable convenience, flexibility and the ‘door-to-door’ travel time offered by rail travel relative to air. A survey undertaken by Barclaycard cited by TRANSform Scotland (2007) also identified that the factor most likely to convince business travellers to substitute trips for other modes for rail was ‘faster trains.’

The perceived ability of the rail network to compete in terms of time is contested within the literature, although research studies considering the ability of rail to compete with aviation in terms of speed have tended to focus upon benefits afforded by high-speed as opposed to conventional rail. The ability of high-speed rail to compete with short-haul flights, particularly when journey times are below three hours (González-Savignat, 2003; Patterson and Perl, 1999; the Urban Mobility Corporation, 2003), is discussed in section 4.1.3.2 of this report.

Cost

Cost is a key consideration for many travellers in determining modal choice, and as such it has been examined in greater detail in section 4.1.3.4 of this report. The perceived ability of rail to compete with air services in relation to cost appears to be widely contested within the literature. Some commentators suggest that travellers perceive rail travel to be more expensive than it is and air travel to be less expensive than it is (Sauter-Servaes and Nash, 1995; TRANSform Scotland, 2007), but whatever the situation there appears to be scope for rail operators to improve fares and their structure, which some users find confusing (Coleman, 2006; Sauter-Servaes and Nash, 1995).

Other factors

TRANSform Scotland (2007) details that the environment of railway stations tends to be relatively comfortable and low-stress in comparison to air travel. They also cite a Passenger Focus survey (2007) conducted on East Coast InterCity services, which found that the quality of the restaurant service was one of the factors that encouraged travellers to journey by rail rather than air.

A perceived barrier in relation to convenience is that when travelling by rail in the UK luggage is almost always carried with the passenger as opposed to being transferred separately as in air travel (Givoni and Banister, 2007). This can be viewed as an advantage for travellers who prefer to keep their luggage with them, but it can also be a burden for some passengers, particularly if services are not direct and connections need to be made.

London Paddington and Victoria stations provide a luggage check-in and –out facility for passengers using rail services to connect with flights at Heathrow and Gatwick respectively, which enhances the convenience of using rail to substitute domestic short-haul flights connecting with long-haul flights. The service of LUFTHANSA on the Stuttgart to Frankfurt route is a good example of how collaboration between rail operators and airlines can considerably enhance the level of service offered to travellers.

Another consideration is the impact of safety on modal choice, which TRANSform Scotland (2007) also identified as being a concern amongst some business travellers when travelling by air. The same report also found the enhanced ‘comfort’ of rail travel relative to air to be a further competitive advantage.

1.1.3.1 Capacity of the rail network

As outlined previously demand on the rail network is growing at a relatively fast rate. ATOC (2007b) detail that in 2006 a total of 45.6 billion passenger kilometres were travelled and that 1.147 billion passenger journeys were undertaken. This is the highest rate of growth experienced on rail networks

anywhere in Europe, bar Ireland, and represents a growth of 6.5% and 6.7% respectively on 2005 data. The rail White Paper (DfT, 2007c) suggests that the government are expecting this level of growth to be sustained as they anticipate a doubling of traffic over the next 30 years. These figures raise concern for the ability of rail networks to accommodate growth, but proposals are specified within the Government's rail White Paper (DfT, 2007c) which suggested that an increase in capacity to cope with a growth rate of 22.5% and above from 2007 to 2014 is achievable if focused enhancements are made to the infrastructure. The White Paper sets out a range of measures to increase capacity, which include the provision of 1,300 new train carriages, the implementation of the major Thameslink upgrade through central London, other major station works at Reading and Birmingham New Street, and a programme to enhance infrastructure to increase train capacity and frequency, station redevelopment, the elimination of network capacity pinch-points and major power supply upgrades. The White Paper also outlines a commitment to improved signalling facilities and the introduction of high-speed Intercity Express trains, which are likely to increase the competitiveness of rail relative to short haul flights. This is a contention also expressed in the DfT's recent report '*Towards a Sustainable Transport System*' (DfT, 2007a). It states that a high-speed rail line may be necessary to increase capacity and contribute towards reduced demand for domestic air services. The potential that high-speed rail may have on enhancing the competitiveness of rail relative to aviation is discussed in section 4.1.3.2.

These proposals are supported by a commitment of Network Rail to invest £11.4 billion on stations, signals and tracks, £10.4 billion on maintenance, and £9.6 billion on rail expansion schemes (ATOC, 2008). The Association of Train Operating Companies (ATOC) outline that the need to enhance capacity will underpin investment decisions, with plans already being implemented to lengthen hundreds of station platforms, add new platforms, lay new tracks, increase the speed of lines, and add capacity through resignalling schemes (2008).

ATOC (ATOC, 2007a) have also produced a report demonstrating the potential to increase the capacity of the existing rail network to meet the predicted growth in demand. Their analysis of passenger needs, future demand pressures and examination of capacity pinch points also shows that passenger carrying capacity can, at least in principle, be increased to meet demand. ATOC focus upon enhancing the existing network, which they state will tackle '*most*' of the challenges faced by the industry, and do not propose the construction of any new lines to accommodate forecast growth. They suggest that larger trains with more seating capacity and a greater volume of trains can be provided on the network by making better use of the existing capacity through better network management and planning. Their research suggests that up to 55% more capacity could be delivered on key routes on the network. They also outline that many of the schemes to enhance capacity will have the effect of improving the reliability of rail services, which should enhance the competitiveness of rail travel in relation to short haul air travel movements, which are increasingly prone to delays. It should also be noted that these capacity improvements will require more maintenance, which could also lead to delays being experienced on the rail network.

The drive to increase the capacity of the rail network is reflected in actions undertaken by rail operators themselves, who have a key role to play in optimising the performance of the rail network (ATOC, 2007a). Crosscountry, for example, operate a large number of services across the UK from the south of England to Aberdeen. Their website outlines their commitment to increasing capacity and levels of service through a package of measures which include creating 35% more seats on evening peak services on key routes by June 2009 (the key routes and the baseline are not specified), introducing approximately 20,000 extra seats through Birmingham every weekday and providing five high speed longer trains with increased luggage space (Crosscountry, 2008). It is unclear as to whether these proposals are additional to the Government's commitment to increase capacity of the network.

1.1.3.2 High speed rail

Research has shown that where journey times are longer for rail services, routes can be dominated by air travel movements (Transport 2000, 2006). This suggests that if rail infrastructure in the UK is

upgraded to support high speed rail journeys the ability of rail to compete with aviation will increase. This has been confirmed by studies which have investigated the potential of high-speed rail in the UK to compete with short-haul flights. A report by FoE (2000), for example, cites an Intergovernmental Panel on Climate Change (IPCC) report which estimated that up to 10% of all European air passengers could eventually be transferred to rail and coach, and a study undertaken by the European Commission which estimated that approximately four percent of all EU air passenger journeys in Europe could be transferred to rail if a high speed rail network was developed. Recent consultations with organisations also indicate that investment in high speed rail would be the most effective government initiative in encouraging more sustainable business travel behaviours (WWF, 2008).

Research undertaken by the DfT (2004) indicates that passengers will choose to fly if the same journey will take more than three hours by train. Other research studies also state that high speed train services with a journey time not exceeding three hours can compete effectively with air services (González-Savignat, 2003; Patterson and Perl, 1999). Pepy (2007, cited in TRANSform Scotland, 2007) has, however, suggested that this threshold has increased to between four to four and a half hours for business travellers. This finding was based on the fact that the French rail operator SNCF found that journeys of less than four and a half hours that compete with airline routes have a market share of over 50%.

Pavaux (1991, cited in Patterson and Perl, 1999) detailed that if high speed trains could offer a journey time of less than three hours, then three quarters of air and conventional rail travel along the same corridor could be captured by the high speed service. The research does not indicate what proportion of the air journeys are likely to be substituted by the high speed rail service however, instead considering the combined air and conventional rail market. The introduction of the TGV service between Paris and Lyon and later Bordeaux and Paris confirmed that this modal shift is achievable (Patterson and Perl, 1999). The importance of the impact on journey time is also highlighted by the TGV case study, as the TGV has had a relatively minor impact upon air travel between Paris and Marseille, Nice and Toulouse owing to the higher journey times.

A number of other studies evaluate the feasibility of air travel movements being substituted for rail journeys in relation to distances covered. Lee and Chang's analysis of the competitiveness of different modes of transport (2006) concluded that high speed rail is most competitive over a distance of 200 to 500 km after which air travel becomes more competitive. Lee and Chang also cite research that suggests that the competitiveness of rail is greatest within a range of 160 km to 800 km (US Federal Railroad Administration, 2005). This supports the likelihood of a rail link between Edinburgh or Glasgow and London being able to compete with air, as such a route would cover a distance of approximately 600km and is a route undertaken by the majority of travellers from Scotland (Edwards, 2006).

This impact of journey time upon modal choice, as discussed in section 5 of this report, particularly for business travellers, has stimulated numerous studies into the potential for high speed rail to enhance the competitiveness of the rail network relative to air.

González-Savignat (2003) used demand modelling techniques to analyse the potential of high speed trains to compete with the short-haul aviation market in Spain. Her research findings are applied to a route between Barcelona and Madrid which is not currently served by high speed rail but where the air travel market has a share of 60% and where air traffic movements are amongst the highest in the country. The results show that high speed trains could have a considerable impact on the aviation market but that as journey times increase the competitive advantage of high speed rail decreases dramatically. The research supports the contention that where journey times are three hours or less the high speed train would have a '*considerable impact on the demand for air travel*' on the route.

The research results indicate that users have a high willingness to pay for travel time savings. The author states that those who chose to travel by air between Barcelona and Madrid based modal choice upon time savings in spite of the higher cost, which again suggests that high speed rail would be an effective means of redistributing the modal split.

The ability of high speed rail to substitute air travel journeys in Spain has been identified by research undertaken by DeRus and Inglada (1997, cited in González-Savignat, 2003) which detail how a high speed rail service between Madrid and Seville led to a reduction in the modal share of air travel along this corridor by 50%. This degree of substitution was supported by research undertaken by Inglada in 1996, again cited in González-Savignat (2003), which estimated that for long-distance travel the substitution effect from air travel to high speed rail between Madrid and Seville was approximately 52%.

González-Savignat (2003) cautions that the ability of high speed rail to attract air passengers will be negatively impacted by services that make intermediary stops, which considerably increase travel time and the perceived attraction of the services. She also found that those traveling by plane assign a high value to access times.¹⁰ Given that the access time to airports is usually greater than that of other modes it can be assumed that another point of key significance is the accessibility of high speed rail services, as passengers will to some extent base their modal choice on the location of the railway station.

An analysis of the effects of high speed rail services on modal choice in South Korea (Lee and Chang, 2006) also detailed the impact that access time and intermediary stops can have on the extent to which short-haul flights can be substituted. The research details the success that the Korean Train Express (KTX), introduced in 2004, has had in terms of substituting air journeys for rail. The study focused on the two year period between 2003 and 2005 over which time the number of air passengers traveling between areas served by the KTX decreased considerably, as shown in Figure 6 below. The number of air passengers undertaking short-haul flights on routes served by the KTX decreased by approximately 46% overall, which the authors state is comparable to the anticipated 50% decline in air travel anticipated for the proposed California High Speed Rail System in the US (Sacramento, 2004 cited in Lee and Chang, 2006). The research does not, however, indicate whether this decrease has been maintained.

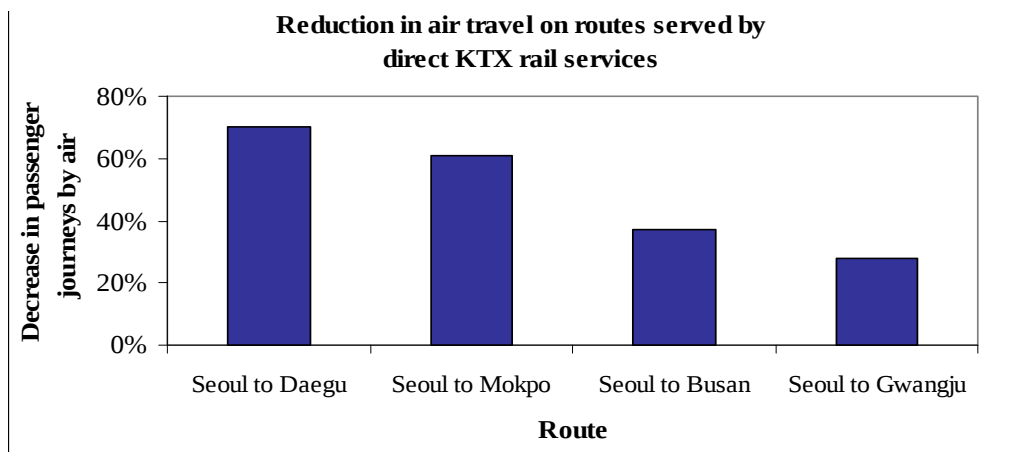


Figure 6: Reduction in the number of passengers travelling by air after the introduction of the high speed KTX rail services (Lee and Chang, 2006).

Air passenger volumes did not however decrease on routes between Seoul and cities that were served by indirect KTX services, which highlights the impact of convenience on modal choice and the benefits that can be afforded by the provision of direct high speed rail routes where there is high air travel demand. The authors stated that the need to transfer increased journey time by between 20 to 50 minutes thereby eroding time savings and reducing the competitiveness of the service. The research also identified that high speed modal share was relatively low (24%) partially as a result of the KTX station being located outside the city centre of Cheonan, thereby increasing the perceived

¹⁰ Access time has not been defined within the report, but it has been taken to mean the time taken to access airports from the point of origin.

access time and as a consequence reducing the competitiveness of the rail service. The authors state that whilst access time for high speed rail will often be lower than that for air services they could be higher than those associated with conventional rail as stations tend to be located outside city centres. This is something that will need to be taken into account when planning the introduction of such services. This is not always the case however. Givoni and Banister (2007) for example detail that high speed rail often has a travel time advantage over aviation as many rail stations are located within city centres, as opposed to the outskirts where airports tend to be located. Research conducted by Transport 2000 (2006) emphasises the need for high speed rail services to penetrate city centres.

The first high speed rail service that demonstrated the ability to substitute short haul flights was the French TGV service. The impact of the TGV upon air travel movements has therefore been the subject of numerous research reports.

The high speed TGV service between Lyon and Paris became operational in 1981 and resulted in a substantial decrease in air passenger traffic movements. The introduction of TGV services to other cities had a similar, although less pronounced, impact upon air travel patterns. This had the effect of decreasing the number of daily flights, and the size of aircrafts, on routes serving cities with TGV services from Paris (Patterson, 1998). The Airbus 300 was, for example, used on the Lyon-Paris route in 1978, although after the introduction of the TGV the use of this aircraft was substituted for the smaller 'ATR turboprop.'

The TGV service between Lyon and Paris has a travel time of two hours which prompted a 17% drop in air traffic on this route between 1981 and 1984 (Patterson, 1998; Patterson and Perl, 1999). The impact on air travel movements at Lyon-Satolas airport was such that total passenger traffic decreased by eight per cent over this period. The effect of the introduction of the TGV service between other cities was also to reduce air travel movements, although the impact was not as pronounced as that between Lyon and Paris. Patterson (1998) cites Pavaux (1991) who concluded that reductions in air travel movements were lower on other routes because the travel times were longer, which emphasises the need for the speed of rail services in the UK to increase if rail is to substitute short haul flights.

Figure 7 shows the growth rates experienced in short haul flights between Paris and other French airports served by TGV services. The Paris to Lyon service was introduced in 1981 and the service was extended to Marseille in 1982. The TGV Atlantique route opened in 1989, which serves Nantes, Bordeaux, Toulouse and Nice. Figure 7 indicates that the introduction of TGV services has had an enduring impact upon short haul flights along the TGV corridors (Patterson and Perl, 1999). Air France, for example, have curtailed services to French cities served by high-speed trains (Urban Mobility Corporation, 2003).

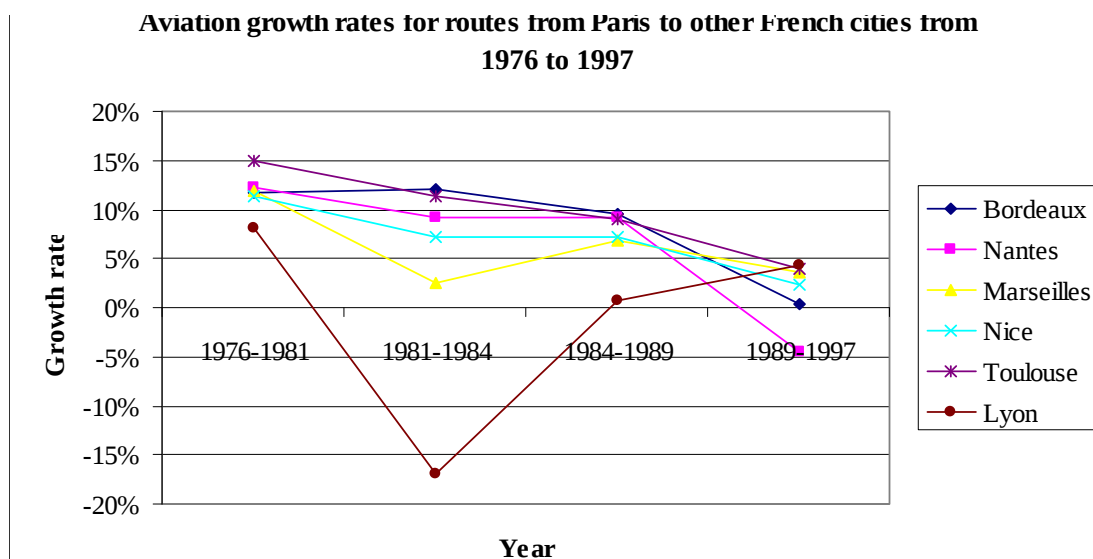


Figure 7: Growth rates in short haul flights between Paris and other French cities served by TGV services from 1976 to 1997 (Patterson and Perl, 1999).

The TGV network was extended to incorporate Eastern France and destinations in Luxembourg, Germany and Switzerland in 2007. Trains along this line are able to operate faster than anywhere else in France as it enables vehicles to travel at 320km/h rather than 300km/h. The introduction of this high speed service will reduce journey times by up to 50% (Briginshaw, 2007), which it is anticipated will have the result of large increases in modal share. Briginshaw (2007) states that the rail operator, SNCF, anticipated that within 18 months of opening passenger traffic would increase by 60% with half of the growth coming from newly generated rail traffic, specifically as people switch from air to rail. The SNCF already capture 55% of the journeys undertaken between Paris and Strasbourg in relation to air travel, for example, and they hope to increase this to 80% with 20% of travellers choosing to travel by air. The full services were only due to operate from December 2007 and so there are no publications detailing the impact that this route has had upon travel behaviour, but initial sales of tickets supported the view that modal share would increase as a result of the high speed rail link. It is not currently possible to determine what proportion of the additional demand has substituted air travel movements, or to what extent the enhanced service has generated additional travel demand.

It is also of significance to note that the TGV was also the first high speed train to be directly linked into an airport. The Lyon and Paris route, for example, operated between Lyon-Satolas airport and the Charles de Gaulle airport in Paris. This enabled the direct transfer from planes to trains, which increased the potential for short haul flights connecting with long haul international flights to be substituted by rail (Patterson and Perl, 1999). The Urban Mobility Corporation (2003) also attribute the success of high speed European intercity services to the level of convenience afforded by their connection to airports. They stated that these connections make it as easy for passengers to switch to a train which takes them directly to their ultimate destination as to a plane, thereby making it more likely to enhance the perceived substitution of short haul flights for rail. Bonnafeous (1987, cited in González-Savignat, 2003) estimated that 33% of TGV passengers divert from planes.

The likelihood of substitution for short haul flights that connect to long-haul flights will be higher if collaborative agreements between rail operators and airlines are established (Pita and Anton, 2001). In 1996, for example, the LUFTHANSA airline asked the SNCF to replace short haul air services from Charles de Gaulle Airport in Paris that offered a journey time of between two to three hours. The collaboration was seen to stem from the congested nature of the airport and the ability of high speed rail to replace short haul flights whilst providing an equal level of service quality (Pita and Anton, 2001). It has also been suggested that these circumstances could lead to the provision of through baggage handling services (Transport 2000, 2006).

Briginshaw (2007) quotes SNCF who state that in the near future TGV services will be able to operate at a speed of 360km/h. This is likely to further enhance the ability of high speed rail to substitute short haul flights.

A high speed rail link is already provided from London to Paris and Brussels via the Channel Tunnel Rail Link (CTRL) with the result being that nearly two thirds of the air and rail market to Paris was captured by the service (Givoni and Banister, 2007). Transport 2000 (2006) also note that the CTRL has already attracted the majority of the market where it does compete with air services. Evidence suggests that the potential for substitution in the UK is likely to be accelerated when Britain's High Speed 1, which links London St Pancras with mainland Europe, opens for domestic services in 2009 (Greengauge 21, 2007). With the Government considering a second high-speed rail route between London, Birmingham and Manchester a further shift from short-haul aviation to rail could be experienced. A preliminary review of the case for a North-South high speed rail link also found that the business case for such infrastructure is strong, particularly if connected to Heathrow and the CTRL (Transport 2000, 2006).

Transport 2000 (2006) found that the potential for high speed rail in the UK is such that a north-south high speed rail link could potentially reduce the need for airport expansion. Their report advocated a high speed route with two branches at the southern end, one serving central London and the other

Heathrow, which would then connect directly to the Midlands, the North, and Scotland. They estimated that this could result in journey times of two hours and 45 minutes from Heathrow to Edinburgh/Glasgow. Such a service could be used to serve city centres and key development areas, along with other locations that air services cannot penetrate. Transport 2000 (2006) anticipate that the volume of high speed train services on this infrastructure would also leave spare capacity available for other train services to operate.

A north-south high speed rail link would necessitate the creation of new rail infrastructure, but it would also meet the capacity provision that the DfT has stated would be required to accommodate additional surface access requirements of a Third Runway at Heathrow. The report (Transport 2000, 2006) also identified that rail connections from the CTRL to a domestic high speed rail service could enable short-haul European flights to be substituted for train journeys. They cite a Eurostar consultation submission (2003) which found that the available capacity on the CTRL was equivalent to that of an additional runway at a south-eastern airport.

High speed rail infrastructure is costly and will necessitate extensive investment. Levinson, Mathieu, Gillen and Kanafani (1997, cited in González-Savignat, 2003) for example analysed the full cost of high speed rail and found that it is '*significantly*' more costly to introduce than expanding an existing air service. Their analysis also determined, however, that when external costs are taken into account, such as the negative environmental impact of the short-haul flights which high speed rail schemes could substitute, high speed rail schemes can be considered to be cost effective.

1.1.3.3 Wireless Internet (Wi-Fi) Provision on trains

The rail network has the potential to provide a competitive advantage relative to aviation given the potential that it provides for business travellers to make more productive use of their time. The rail industry is therefore beginning to focus upon providing features which may enhance the travel experience for business travellers.

The importance of being able to make productive use of journey time was recently highlighted by a qualitative research study (Sheldon, 2007) which identified that business travellers consider trains to be more suited to their needs than planes where check-in, boarding and having to disable mobile phones and lap-tops was seen to restrict the ability to optimise their use of the journey time. A study conducted by Silicon.com (2006, cited in TRANSform Scotland, 2007) estimates that 22% of their passengers who switched from air to rail did so as a result of the availability of Wi-Fi. Systems such as Blackberry's can be operated without Wi-Fi (although their use is not permitted on planes), but the majority of applications cannot.

Initiatives to attract and retain the loyalty of business commuter and long-distance passengers and to retain competitiveness against other modes of transport have tended to focus upon the potential for equipping trains with modern onboard Wireless Internet (Wi-Fi) services. Not only can such services benefit the customers, but they can also help train operators to improve their fleet management, for example by facilitating real-time monitoring of onboard systems, communicating with crew and accessing in-carriage CCTV images, all of which could have positive impacts upon reliability (Crawford, 2006). These services have been available for use at stations for some time and are slowly being introduced on moving trains.

Wi-Fi services are being adopted by the US, UK and Canada, with services tending to initially be made available within business class coaches. The first commercial deployment of Wi-Fi technology was implemented by a national rail operator in Canada, VIA Rail, who have invested \$10million in the infrastructure which is aimed primarily at the needs of business travellers and students (Crawford, 2006).

Rail routes in the UK give passengers access to a mobile Wireless Local Area Network (WLAN), which does not depend upon satellite or mobile phone connections and therefore ensures continuity of connection. There do not appear to have been any attempts made to quantify the proportion of the UK

rail network that currently provide this service. Wi-Fi was first introduced in 2005 on Southern services between Central London and Brighton which carries approximately 40,000 passengers a day. Service usage on this route was recorded as being approximately 25 sessions per hour (Crawford, 2006). Great North Eastern Railway also provide internet access which is available for no charge in First Class and at a rate of £2.96 per half hour in other carriages. The perceived benefits of enabling customers to work interactively while traveling were such that GNER spent approximately £1 million equipping the first ten trains with Wi-Fi, and has committed to extending provision to the rest of its fleet (Modern Railway, 2005). Other UK rail operators have also announced that they intend to provide similar services (Leonard, 2007).

In the '*Delivering a Sustainable Railway*' White Paper the DfT (2007c) describe Wi-Fi as a 'new technology' and one that they intend to introduce on both new trains and in the refurbishment of older trains, along with power points. No indication is given as to what proportion of vehicles the service will be provided on, but it does state that implementation will be focused upon inter-urban train services.

Despite the perceived ability of wireless internet provision on trains to enhance service provision for business travellers, there has been a lack of empirical research conducted into the actual impact of this provision on travel behaviours. A study was conducted by Zhang et al in 2006 in recognition of the evidence gap. A literature review, which identified that '*studies on wireless internet on trains are virtually unavailable*,' was used as a basis for a survey design that was completed by 2,141 respondents. The findings identified that users were willing to pay for the service which users deemed has a positive impact, particularly amongst business travellers who deemed that the '*efficiency and value of their work on trains*' would improve with the use of wireless internet. Survey responses indicated that the provision would not only enhance productivity, but also improve the quality of the travel experience. The research was also effective in highlighting, however, that the potential benefits of wireless internet provision would be eroded unless the provision was supported by environments that were conducive to working. Respondents noted that larger tables, chairs, adequate personal spaces, and preferably access to an electricity supply would all be important. An analysis of the survey results based upon respondent characteristics showed that there were no significant differences between the attitudes of different types of business travellers.

The study by Zhang et al (2006) found that provision of wireless internet in train carriages was an effective means by which to reduce the amount of productive time 'lost' by travelling. Given the high value that businesses accord time the benefits of wireless provision were deemed to be particularly high for these users. The research in fact states that the service can lead to actual reductions in journey time, as access to real time travel information can be used to plan journeys more effectively.

Zhang et al (2006) emphasis the need for more empirical research into the affect of wireless provision on travel behaviours to be undertaken, but suggest that by effectively providing '*mobile work environments*' wireless internet services on trains are likely to have a positive impact on patronage by business travellers. Respondents said that they expected to travel more frequently if Wi-Fi services were provided. Impact upon air travel movements are not considered within the research.

The 2003 pilot of Wi-Fi on the VIA Rail network in Canada showed that 40% of passengers made use of the Wi-Fi, which was initially provided free of charge, and 96% said that it was a feature that they would like to see on trains, which suggests that such improvements could play a key role in enhancing the attractiveness of rail travel for a range of users. Companies with corporate VIA accounts said that they would use trains more if Wi-Fi was available (Crawford, 2006). A 2005 study undertaken by Les Editions La Vie du Rail based upon three central European countries found that nearly 65% of business travellers travel with their own computers, many of which have a Wi-Fi connection.

An article by Leonard (2007) reported on customer research undertaken by YouGov which found that most people would like access to the internet on trains and that it was a way in which new passengers could be attracted to use trains. The survey upon which her article is based identified that 52% of train users surveyed would like access to Wi-Fi onboard trains. The research also provided details of

the gains obtained by businesses by having access to these networks. Forty-five per cent of respondents felt that Wi-Fi access enabled them to respond to clients more quickly, and 39% said that it was particularly beneficial being able to keep in contact with staff. Seventeen per cent of respondents felt that it gave them a competitive edge, whilst 14% felt that the Wi-Fi services had helped them to take advantage of new business opportunities. The author uses the survey results to indicate that if more rail operators were to invest in Wi-Fi technology the attractiveness of rail could be enhanced relative to air travel.

Qualitative research indicates that facilities such as Wi-Fi and power points can improve the travel experience, particularly for business travellers, but that as their availability is not yet widespread they do not tend to feature prominently in peoples decision on which mode to travel on, which tends to remain based largely on journey time (Sheldon, 2007). The cost implications of providing Wi-Fi on trains are unclear, but research suggests that providing Wi-Fi technology necessitates only a limited retrofit of train carriages (Les Editions La Vie du Rail, 2005). This indicates that if more empirical research is produced indicating the potential benefits of providing these services the ability to enhance productivity could begin to have more of an impact upon the decision of whether business travellers will fly or travel by rail. Research conducted by Sheldon (2007) also shows that few respondents were aware of Wi-Fi provision on trains, despite the potential demand for the facility being high. Some business travellers also did not feel that rail operators were effective in communicating the benefits of rail travel, and so this is something that needs to be addressed if Wi-Fi is to have the optimum impact upon market share.

Research suggests that the technology could also be used to create opportunities for a range of applications which would further increase the convenience of rail, such as easy access to journey information and connecting services and facilities at the destination.

The benefits of Wi-Fi are likely to be greater if travellers have access to seats on trains and access to mains power. The later point is significant as appliances such as lap tops tend to have a battery life of approximately two hours. The DfT (2007a) have outlined that they plan to focus investment in the rail network on areas which are experiencing capacity constraints, and that they intend to provide power points on inter-urban trains as part of the refurbishment of train carriages (DfT, 2007c), so this appears to be an issue that will be addressed.

1.1.3.4 Cost considerations

Cost has a key impact upon modal choice, as is discussed in section 5 of this report, and it is therefore something that should be considered in a discussion of the competitiveness of one mode over another.

There is a growing body of literature detailing the impacts of the competition to the rail industry posed by low-cost airlines who travellers consider for trips over distances for which rail has traditionally been the most obvious option on the basis of cost (CAA, 2008; Sauter-Servaes and Nash, 2007). Sauter-Servaes and Nash (2007) and TRANSform Scotland (2007) argue that the perception of both business and leisure travellers that the cost of a journey is lower on low-cost airlines than rail is false – this is something that is backed up by our review of rail and air fares in section 7 of this report. Sauter-Servaes and Nash's analysis of the potential to apply low-cost airline pricing strategies to European railways nevertheless concludes that the rail industry '*must reduce costs and increase revenues if they are to remain successful during the coming years.*' Transport 2000 (2006) have, for example, found that the market share of rail in the Edinburgh and Glasgow travel markets has declined by nine percent and eight percent respectively as a direct result of enhanced competition from low-cost airlines. There are also, however, examples of where low-cost airlines haven't been able to capture a significant share of the market on routes served by high-speed rail. Following the construction of the Channel Tunnel for example low-cost carriers such as EasyJet have only managed to obtain a small share of the London to Paris market (Givoni and Banister, 1997).

Sauter-Servaes and Nash cite a market research study (Grunbert et al, 2004) conducted on passengers of low-cost airlines at six German airports. Findings showed that 20% of the travellers would have

travelled by rail if the low-cost fares were not available, and a further 13% said that they would have considered travelling by rail if the low-cost fares were not available. This supports the findings of a British Chambers of Commerce survey (2006, cited in TRANSform Scotland, 2007) which found that cost should be the second highest priority for rail improvement, with 65% of respondents detailing that it was either their first or second priority in determining modal choice and 49% stating that they travelled by air because they believed that the fares were lower.

The contention that rail travel can be competitive with air in terms of cost has been highlighted by the CAA (2008) and TRANSform Scotland (2007) whose separate analyses of equivalent air and rail fares on a number of routes revealed that, for those passengers willing to book in advance and with limited flexibility, the cheapest air fares tended to be matched by rail operators.

FoE (2000) state that airlines are in general able to offer '*substantially lower full-price return fares than rail.*' This is a contention supported by Coleman (2006) who states that above inflation fare increases on the price of rail fares are making many long distance rail travellers consider travelling with low-cost airlines instead. He details that some GNER fares between London and Scotland increased by 8.8% in 2006, and whilst lower rail fares are available they can be fairly inflexible in terms of travel time thereby undermining one of the key benefits of rail travel – convenience. Coleman highlights the fact that rail subsidies are falling (Virgin's West Coast subsidy decreased by 60% from £500 to £200 million in the space of two years) and that the Government expects fare revenues to fill this gap. This can lead to the above inflation fare increases being experienced by rail users, stemming in part from the fact that Britain's railway is publicly directed yet privately operated. He quotes the former transport secretary who emphasised that fare payers need to contribute to infrastructure and rolling stock improvements.

FoE (2000) anticipate that given the increasing liberalisation of air services in Europe competition between airlines is likely to keep fares low in the short to medium term. As discussed in section 5 of this report, however, the aviation industry does not currently have to pay for the full environmental or social cost of their operations. It is important to note that the same can also be said for rail, shipping and road users to varying degrees. Were policy to shift to make the industry and its users pay for the negative externalities generated by their operations, particularly in terms of CO₂ and NO_x emissions, then it could be assumed that the competitiveness of rail in terms of price could significantly increase, particularly if some of the revenues can be invested in rail infrastructure.

TRANSform (2007) state that it is important to examine relative costs on a broader level, taking the total cost of the trip (including the cost of time spent not working, whether overnight accommodation was necessary) into account. If this was done then the competitiveness of rail in relation to air travel could be enhanced considerably, depending upon the nature of the individual trips made.

Literature seems to suggest that rail is currently able to compete in the discount market (CAA, 2008; FoE, 2000), which is something that is backed up by our review of rail and air fares. This could be owing to a reaction of the rail industry to the range of innovative and creative business strategies employed by low-cost airlines to keep costs low and to retain their image as providers of low-cost transportation, as detailed by Sauter-Servaes and Nash (2007). Their study is effective in identifying some of the constraints faced by the rail industry when competing with airlines over ticket prices for certain routes. Airlines can be regarded as 'closed' systems in relation to origin and destinations, but railways are 'open' in that passengers can exit or board at any number of intermediary stops (although the greater the number of stops on a rail route, the greater the energy consumption). This reduces the ability of rail operators to introduce relatively low priced tickets on a specific route to compete directly as it would mean that passengers travelling anywhere on the route could buy this low-priced ticket even on stretches where there is no competition from the airline. Some headway is however being made, for example by the decision of numerous rail operators to make a limited number of tickets available at a discounted price over the internet. This effectively enables them to manage profitability whilst also reducing the perceived ticket costs and the cost of sales.

Research conducted by Sauter-Servaes and Nash (2007) indicates that the use of such strategies is resulting in the ability of railways to compete with air on a number of routes. They cite a market research study by Grunbert et al (2004) which found that passengers perceived rail ticket prices to be 42% higher on a route from Berlin to Cologne than air prices. The average price was, however, found to be 28% lower. The difference between perception and reality was explained by the advertising campaigns of low-cost airlines who promote the lowest available fares, which often do not include taxes or surcharges and the availability of which is often severely limited. This is an issue which is being addressed in the UK, both through legislation to increase the transparency of costs and by counter marketing campaigns conducted by rail operators. Coleman (2006) and TRANSform Scotland (2007) suggest that more simplified fare structures could also make the competitiveness of rail in terms of cost more transparent.

1.1.3.5 Rail-air integration

Givoni and Banister (2007) have investigated the role of railways specifically in terms of their relationship with aviation, and highlight ways in which the ability of rail to substitute the need for a short-haul flights that are typically undertaken in conjunction with longer flights can be maximised. They state that providing better integration between rail terminals and airports could lead to rail journeys replacing some air transport services and that greater collaboration between airlines and rail operators along these lines could lead to better use of capacity at airports and avoid the provision of short-haul flights that could be undertaken by rail.

The authors contend that most linkages between rail networks and airports tend to be '*accidental*' as airports tend to be built close to railway lines. They therefore indicate that gains could be achieved by examining these connections and identifying ways in which the rail services can be modified to serve a more clearly defined purpose – namely to increase the level of service frequencies or to enhance connection to the wider transport network with the intention of serving areas beyond the typical airport catchment area. This would reduce the extent to which rail services are provided to act simply as a mode of access to an airport and instead increase their ability to act as an alternative to short-haul flights.

Givoni and Banister (2007) detail that the role of rail travel in substituting short-haul flights can be enhanced if consideration is made to the position of the airport on the railway network. The ability to alter the position of the airport on the network is severely constrained, but increased provision of direct high frequency services is highly valued by users, particularly in relation to benefits in overall travel time, and so is a key element in terms of the competitiveness of rail service provision. Givoni and Banister (2007) use the example of rail provision to Zürich airport, which started off as a branch line in the 1980s and later became a main line, to show how airports can generate large demand for rail services, and how rail services can adapt to enhance their competitiveness.

To enhance convenience the location of the rail terminal relative to the air terminal is also of importance. Givoni and Banister (2007) found that by providing a rail interchange under air terminals, as has been done at Amsterdam Schiphol, London Stansted and Zürich airports amongst others, passenger perception of service integration increases. Benefits are only likely to be achieved, however, if the method of transfer between the aircraft and the train is relatively easy to make the transition between rail and air as seamless as possible.

1.2 Coach as an alternative to short-haul air travel

1.2.1 Background

Coach travel is a relatively low cost mode of transport that facilitates direct intercity travel throughout the UK and to a large number of destinations in mainline Europe. National Express for example, the largest coach service provider in the UK and Europe, provides coach services to over 1,000 destinations in the UK, Ireland and mainland Europe (National Express, 2008b). Coach travel cannot compete with other modes of transport in terms of journey time, which is often considerably longer than journeys undertaken by rail or air, but they do enable users to travel relatively long distances at a low cost, as is highlighted by our review of coach and air services in section 7 of this report. There are coach interchanges at the vast majority of UK airports with services running on virtually all corridors on which air services operate. The coach network also serves a wide range of other destinations and city centre locations which aviation is unable to penetrate. This means that coach travel provides an alternative to short-haul flights, the viability of which is likely to depend upon the values that travellers place upon time relative to cost.

Most available statistics appear not to differentiate between levels of coach travel from local bus service data, which reflects the general absence of literature relating to coach journeys and their potential to facilitate more sustainable travel behaviours. Statistics published by the DfT (2007b) indicate that the number of vehicle kilometres travelled by coach and non-local bus services over the past ten years has declined, as shown in Figure 8 below. Data from the past 50 years, presented in Figure 9, also shows that the total modal share of bus and coach journeys undertaken within this period decreased substantially, despite the number of coach journeys undertaken having increased substantially. From 1956 to 2006 the modal share of coach and bus services has decreased from 36% to 6%. The considerable decline in modal share over the past 50 years suggests that there is scope for coach travel to capture more of the market for intercity travel movements despite the fact that time is a key determinant of modal choice.

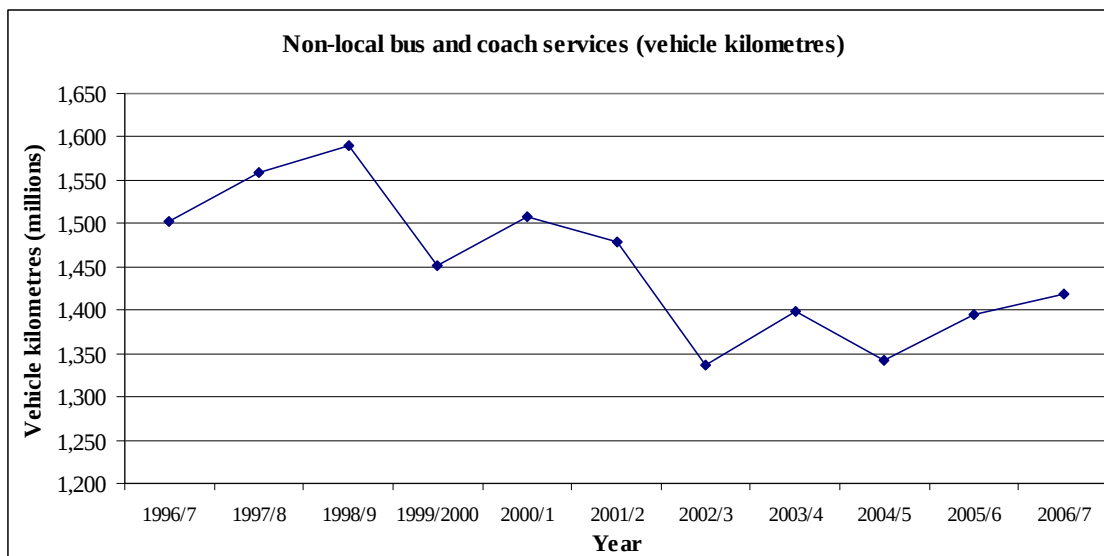


Figure 8: Non-local bus and coach services (vehicle kilometres) (DfT, 2007b).

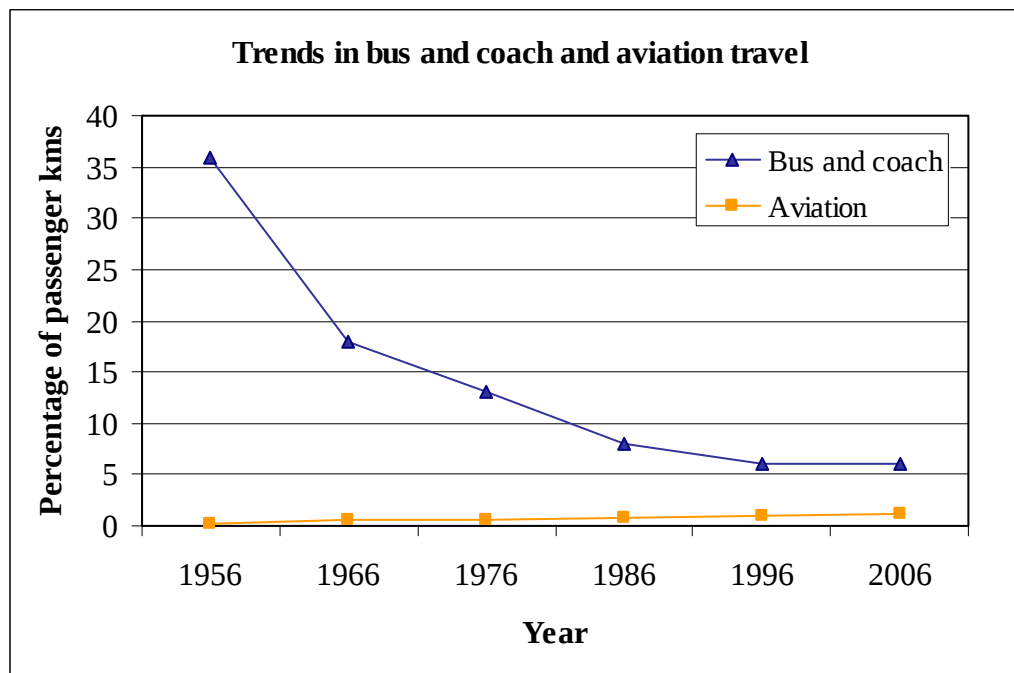


Figure 9: Trends in bus and coach and aviation travel (DfT, 2007b).

1.2.2 Evidence base

The literature search identified that no research has been conducted in relation to coaches as an alternative to short-haul flights. Indeed research into coach travel in general is conspicuous by its absence. UK transport planning and policy documents make virtually no reference to coaches in their own right, and instead discuss them in conjunction with local bus services. ‘*The Future of Transport*’ transport White Paper (DfT, 2004), for example, dedicated only half a page to coach travel in which it identified coach travel as ‘*an affordable longer distance choice*’ for those with relatively low disposable incomes. Similarly the DfT’s response to both the Eddington and Stern reviews, which detailed ways in which transport can support economic growth whilst reducing carbon emissions (DfT, 2007a), did not mention the role that coach travel could play in providing relatively sustainable intercity travel. The absence of coach travel in key policy documents appears to be a considerable oversight given its role as a provider of low cost direct intercity travel and the environmental benefits that it confers relative to both rail and aviation.

The consideration given to coach travel within the literature can to some extent be shown in relation to a study of interurban services between Porto and Lisboa in Portugal conducted by Ribeiro and Pita (2001). This detailed that the journey between these two urban areas could be undertaken by car, train, coach and air. What followed was an analysis of the demand for car, rail and air travel along this corridor, based on survey data, and a complete absence of any reference to coach travel. This is symptomatic of the research area as a whole, which does not appear to consider coach travel to be a particularly viable alternative to other forms of transport.

The paucity of literature in relation to coach travel as an alternative to short-haul air travel movements could be owing to the fact that the rail network is more competitive than coach travel in terms of journey time. Research efforts could therefore have been focused on what is arguably the only mode of transport, other than the private car, that can be widely considered a viable alternative to short-haul flights.

1.2.3 Future potential

Key policy documents outline the need to focus upon improving the efficiency of the road network, and as a consequence reducing levels of congestion on the road network is a priority of local, regional

and national policy. Promoting bus use and improving services is also an objective throughout the UK. These objectives could have a positive impact upon the journey time and reliability of coach travel, improving the service that coach operators are able to offer. The dedicated lane on the M4 Spur to Heathrow airport, which gives priority to coach services, is an example of one such measure that is likely to have a positive impact on journey times.

Consultations with users of the transport network undertaken by the DfT (2007a) found that predictable journey times are regarded by many to be a priority. The response has been to focus on improving the performance of the existing network by targeting the most unreliable and congested sections of the highway network in order to improve the reliability of domestic movements. This is in line with recommendations of the Eddington review, which suggested that in order to enhance network productivity and efficiency infrastructure investment should be targeted at unlocking pinch points. The investment plans of the DfT (2007a) also emphasise that additional resources will be dedicated to supporting public transport. This is a result of the current priority to focus upon new infrastructure and invest in public transport around congested cities, and by addressing capacity constraints on priority links, such as those identified by Eddington (2006). These investments are likely to have a positive impact upon the service that coaches are able to provide, which could have the impact of increasing the number of journeys made on this mode of transport.

The DfT report (2007a) also details the importance of removing the barriers that prevent people from making informed decisions on how to travel based upon the relative environmental impacts that different modes of transport have on a per passenger basis. The benefits of coach travel relative to aviation and some rail services in respect of greenhouse gas emissions (see Figure 21 and Table 14 in Section 6.1.2 of this report) suggest that such a move could improve the attractiveness of coach travel for those who accord a high value to environmental impact. Therefore any moves to improve the access of travellers to information that enables them to make sound decisions based on environmental impact could have a positive impact, albeit slight, upon the modal share of coach travel relative to aviation.

The commitment of the DfT to *'examin[e], for the first time, potential cost-effective emissions reduction pathways for different types of journey and different transport modes'* would suggest that the reductions in emissions that coach travel could afford the transport network may increase the emphasis that is placed on the mode as an alternative to more polluting modes of transport, such as aviation. This could have the effect of increasing the evidence base and enabling a more thorough understanding of the ability of coach travel to compete with rail and short-haul flights over certain routes. The report does not suggest, however, that alternatives to domestic aviation will be sought, with the report stressing the importance that domestic aviation has to play for *'longer journeys'* within the UK for both business travellers and individuals.

1.3 Telecommunications as an alternative to short-haul air travel

1.3.1 Background

Information and communication technologies have long been used to enable people to communicate remotely, and the increasing sophistication of Information and Communication Technologies (ICT) suggest that there is the potential for applications such as teleconferencing to reduce the number of short-haul business flights that need to be made.

Statistics published by the DfT (2007b) indicate that the purpose of approximately 12% of all domestic and EU flights from the UK is business. The purpose of short-haul business flights will be broad, but it can be assumed that many of these journeys are likely to be undertaken to attend meetings. The ability of technology to enable remote visual collaboration between numerous individuals could therefore be considered to reduce the need for some of these individuals to travel. If such a substitution can be achieved then it could have direct environmental benefits in terms of short-haul flights foregone and could also bring considerable time and cost savings to businesses, who tend to be charged a premium for the air services that they use.

Organisations do not tend to collect data on the relationship between telecommunications and travel which means that it is not possible to establish current levels of usage. The impact of teleactivities are however growing in significance, and teleconferencing is already established in a wide range of organisations (Bannister, and Marshall, 2000), most notably in large multinational organisations (Button and Maggi, 1994 cited in Mokhtarian and Salomon, 2002). For the purpose of this review the term ‘teleconferencing’ will be used to incorporate both video and audio-conferencing applications, which are very rarely differentiated within the literature.

1.3.2 Evidence base

Despite the relatively widespread usage of telecommunications a search of the knowledge base has identified that only a limited body of research has been conducted into the ability of applications such as teleconferencing to reduce the need to travel, and in particular in relation to aviation. There also appears to have been an extremely limited amount of comprehensive research undertaken to establish the level and nature of usage of these technologies by organisations and as a result there is an absence of empirical studies on their impact on travel patterns.

The lack of research that has been conducted into the impact of telecommunications on short-haul flights may be owing to the perception that there is more potential for telecommunications to substitute car travel relative to air travel and that most gains can be obtained from telecommuting. Indeed discussions of the potential impact of ICT have focused upon their potential to reduce demand on road space in peak periods, and as a consequence the effects of telecommuting have been widely documented. The impacts of teleconferencing, which is deemed to be the form of telecommunications technology that has the most potential to have an impact upon the need to undertake business trips by air, have not been as thoroughly researched.

The limited information about the use of teleconferencing, its practical application and the potential that it has to reduce the number of business trips undertaken by air could also be related to the relative difficulty in engaging with businesses. The investment needed for businesses to obtain the full benefits of applications such as teleconferencing is also substantial, which could be limiting their uptake.

It should be noted that none of the literature identified considers the ability of telecommunications to reduce demand for short-haul leisure journeys. As a result the rest of this section focuses on the likely impact of telecommunications upon business travel.

The body of literature concerning the ability of telecommunications (notably teleconferencing) to reduce the need to travel is based around the argument of whether technology is supplementary or complementary to travel. Teleconferencing appears to be the application that has the most potential to reduce the need to undertake short-haul flights, but it is also however one of many forms of ICT that appear to have generated additional travel demand as the technology has contributed towards networks of contacts becoming more diverse and widespread and has increased the productivity and efficiency of communications, which can also stimulate demand for travel.

1.3.3 Research findings

1.3.3.1 Complementarity

Mokhtarian and Salomon (2002) argue that *‘for two entities to be substitutive they need to offer similar functions with similar properties.’* Their review of literature on the impact that telecommunications have upon travel behaviours, therefore suggests that whilst teleconferencing does enable activities that previously necessitated travelling to be undertaken remotely (Bannister, and Marshall, 2000) the key differences in the nature of electronic and physical interactions and the associated costs and benefits are likely to result in a preference for one over the other. Therefore it cannot be assumed that the impact of teleconferencing will be substitutive as its impact upon travel behaviour will be dependant upon the perceived advantages of one form of communication over the other, which is likely to vary between people and over time.

The authors based their conclusion that the relationship between teleconferencing and travel demand is one of *‘self-generation and complementarity rather than substitution’* (2002) on a comprehensive review of literature which suggests that *‘the growth over the last century in the use of both telecommunications and travel hints at a complementary relationship.’* The lack of empirical research studies upon which to base this review and the general absence of understanding of the extent to which the benefits afforded by travel and telecommunications are similar led the authors to conclude that there is *‘no clear dominance in relation to which is the preferred option’* but that the relatively small number of studies that have been conducted suggest that the *‘dominant empirical result’* suggest that the relationship is one of complementarity.

The research undertaken by Mokhtarian and Salomon emphasises the differences between the nature and potential outcomes of teleconferencing relative to physical interactions, and it is because the relative benefits of both forms of communication vary that the ability of teleconferencing to substitute the need for face to face contact is questioned. The authors found that face to face interactions could enhance the quality of information exchanged and facilitate additional benefits beyond the direct purpose of the meeting, such as improved business relationships and enhanced opportunities for networking. They also discuss the positive impact that a break from routine and spending time in different environments can have upon employees. They argue that none of these advantages tend to be achieved as effectively via teleconferencing. A research study conducted by Denstadli and Julsrud (2003) found that three of four financial directors considered personal contact to be *‘irreplaceable.’*

Mokhtarian and Salomon (2002) state that the key attribute of teleconferencing from a business perspective is its ability to act as a cost reduction strategy. The technology itself varies considerably in terms of cost and sophistication, but high costs can be incurred by organisations in relation to physical journeys, such as travel, time and accommodation costs, and so their review emphasises that the decision over whether to interact physically or electronically could be largely based on the perceived advantages to the business, which will vary largely between organisations and according to context thereby suggesting that it will be different to effectively determine the extent to which teleconferencing could supplement air travel. They note that any potential benefit that teleconferencing may have on the environment is likely to be of secondary importance to the business.

The notion of complementarity also refers to the extent to which ICT applications increase efficiency and productivity thereby encouraging the need to travel and offsetting some or all of trips substituted

by technologies such as videoconferencing. Bannister and Marshall (2000) produced a review of the potential to reduce the need to travel, and in their discussion of teleactivities they highlighted the fact that all forms of ICT can add substantially to the demand for travel, for example through its potential to widen networks of contacts. Teleconferencing applications are unlikely to have as profound an effect on generating travel as other forms of ICT, but the research studies widely report that meeting someone via a teleconference may later generate a journey to meet that individual face to face (Mokhtarian and Salomon, 2002). This could be exacerbated by the fact that more individuals are likely to be able to participate in meetings conducted by teleconference than had physical travel. Whilst these additional trips to the teleconferencing venue are unlikely to be made by air, the impact of increasing contacts could stimulate a desire to travel in the future (Albertson, 1997 cited in Mokhtarian and Salomon, 2002). It could however be argued that the enhanced networking opportunities afforded by teleconferencing are more likely to generate further travel.

Mokhtarian and Salomon detail that research into the impacts of teleconferencing upon travel behaviours is particularly limited and that a research project focusing on the relationship between demand for telecommunications and impact on travel behaviours has not yet been fully undertaken. The one research project that they cite as having been conducted along these lines was undertaken by Zumkeller in 1996. Zumkeller analysed travel diaries and communication activities made by 166 university employees on one day in 1994 and found that high levels of communication activity tended to be accompanied by high numbers of associated journeys. Whilst this research project did not relate to teleconferencing specifically, it serves to highlight how demand for ICT and travel are inherently linked.

The potential for teleconferencing to stimulate future travel has been used by Albertson (1997, cited in Mokhtarian and Salomon, 2002) to show how the time savings achieved from reductions in the need for face to face meetings and related travelling time can be eroded. He argues that such time savings can further be reduced by journeys which cannot be replaced by telecommunications, such as establishing business relationships which may have been achievable via face to face meetings, and finding suitable locations for teleconferences to be held. These latter points are however perhaps less of a concern now given the relative proliferation and development of teleconferencing facilities since the research was conducted.

Mokhtarian and Salomon (2002) attribute the potential of teleconferencing to the high costs that can be incurred by organisations who have to cover associated travel, time and accommodation costs. They emphasised that the decision over whether to conduct meetings face to face or remotely would largely be based on advantages that were conferred to the business as opposed to the environment, and as such the potential for teleconferencing was based upon its ability to act as a cost reduction strategy. The authors state that even if teleconferencing does not substitute the need to travel entirely the complementary relationship between teleconferencing and travel can mean that business trips that do occur can be more cost effective. This suggests that business travellers who undertake fewer trips but make use of teleconferencing facilities would have a higher value per journey than those who undertake more frequent business trips. The implication is that whilst the need to travel may not be removed by teleconferencing, it can be reduced and its value increased.

Stevens et al (2006) contend that whilst videoconferencing and audio-conferencing have long been promoted as being capable of substituting a proportion of long and short distance business trips, early forecasts have been proved to be overly optimistic. In their review of the future demand for investment in transport and telecommunications infrastructure they state that whilst ICT can in some cases (namely in terms of commuting) lead to reduced travel *'it is not expected that technology will fundamentally affect the growth of passenger transport'* and again conclude that *'the broad literature on the interaction of ICT and transport suggests that these are complementary rather than substitutes.'* These views are echoed by research undertaken by Bannister and Marshall (2000) who state that *'even if the direct influence of technology leads to the reduction of one set of trips, the indirect effects must also be included in any assessment of the real changes.'*

The extent to which teleconferencing can act as a substitute for travel will of course depend upon the nature of the interaction. Again research into this area is limited, although Mokhtarian and Salomon (2002) found that one of the most popular applications of teleconferencing is the opportunity that it provides for promoting new products. Their research states that this use of teleconferencing does not replace the need to travel because it uses teleconferencing as a marketing tool and that whilst the product would be marketed differently in the absence of teleconferencing facilities, it is unlikely that associated travel patterns would differ significantly as a result. Few other research studies appear to recognise the need to focus upon the purpose of teleconferencing activity.

Bannister and Marshall (2000) do not summarise the likely impact of teleconferencing specifically but considers it under the broader heading of '*teleactivities*.' Whilst they conclude that these interactions do provide the potential for trip substitution they do not believe that any real reductions in travel will result from the use of applications such as teleconferencing. They base this contention on the ability of ICT applications to generate more trips through increasing the contact network of individuals and state that unless all parties are convinced about the necessity and desirability of travel reduction strategies, and committed to this aim, levels of substitution are likely to be negligible.

Impact of teleconferencing on aviation

Most of the research detailed above focused on the ability of teleconferencing to reduce the need to travel by a range of modes of transport. This section details research reports which have focused specifically on the relationship between air travel movements and teleconferencing and found the relationship to be one based upon complementarity.

A research study by Erdal and Hallingby (1992) cited in Mokhtarian and Salmon (2002) is one of the few studies that examine the relationship between air travel and teleconferencing. The study focused on Norway and the impact that the fear of terrorism in relation to the first Gulf war had on air travel and telecommunications. They found that whilst air travel declined by at least 40,000 passengers in each of the three months that were analysed there was a negligible increase in ICT despite applications such as teleconferencing being promoted extensively within the media as a substitute at the time. The study does not detail the proportion of flights that were undertaken by business or leisure travellers, but given that the research states that the reduced propensity to fly resulted in trips being postponed or cancelled without an associated increase in the use of telecommunications these findings could indicate that short-haul flights may not be significantly substituted by teleconferencing facilities. It should however be noted that these circumstances were exceptional, and that the findings could therefore have limited applicability to the ability of ICT to substitute business trips under more standard operating conditions.

A research report published in 2004 by Denstadli similarly detailed that even in the aftermath of September 11 business air travel levels were not significantly impacted and that use of teleconferencing was not high. Their assessment of the impact of videoconferencing on Norwegian business air travel therefore suggested that even though the use of teleconferencing is likely to increase it is likely to remain complementary to face to face contact rather than acting as a substitute. Nevertheless the authors estimated that Norwegian substitution rates are likely to be between 2.5% to 3.5%, which indicates that whilst there is the potential for teleconferencing to reduce the need to undertake short-haul air travel movements, its impact could be minimal.

Another research study (Roy and Filiatrault, 2001) which attempted to measure the impact of new business practices and communication technologies on the behaviour of business travellers and their organisations also estimated that the rate of substitution of teleconferencing for air travel would be low. The results of their research, which is one of the few empirical studies that has been carried out, indicated that the substitution rate in 2000 as being between 3.6% and 8.6%. The research methodology consisted of 24 personal interviews, two focus groups with business travellers, and a survey of 1,139 business travellers conducted at seven Canadian airports. The results of the consultations found that most of the changes to business practices associated with telecommunications had been put in place in the early 1990's and that their impact had already been discounted.

Responses obtained suggested that business air travel will continue to grow, and although no differentiation was made between long- and short-haul flights it has been assumed that the likelihood of substitution would be similar for both, if not lower for short-haul air travel movements.

Transport Canada produce an aviation forecast annually based upon a comprehensive review of factors that may promote or constrain growth in the sector. Their 2006 report for the period 2006 to 2020 considered the impact that videoconferencing would be likely to have upon air demand and concluded that *'there is very little evidence of any significant amount of travel substitution resulting from the technology.'* They state that when teleconferencing was introduced in the 1970s it was estimated that up to 25% of business air travel could be substituted but that as its usage has increased it has become apparent that videoconferencing is instead complementary to air travel. As a result Transport Canada have estimated that whilst business travel would not decrease over the period telecommunications may reduce the level of growth in *'new business air travel'* by approximately 6%.

1.3.3.2 Substitution

Research reviewed tends to support the notion that teleconferencing will be complementary to business short-haul air travel as opposed to supplementary, but authors do provide salient examples of where the need to travel has been removed by teleconferencing. Bannister and Marshall (2000) detail a case study of an environmental conference that was held in 1997 and organised by the UK Institute for Chemical Engineers. Professionals were able to link up to the event electronically, and as a result the need for a number of individuals to travel was removed without affecting the primary purpose of the trip. The conference took place over several days and people participating remotely were able to view presentations, subsequent discussions and even view exhibition stands online. A travel impact analysis was made via a questionnaire that was filled in by participants from around the world and the results showed that 9,000 additional people would have attended the conference physically had electronic participation not been possible. The authors caution that the wider effects are less clear, and analysis of some of the implications may be contradictory. For example they again detail the complementarity argument, notably in relation to the fact that relationships initiated on the internet, which may not otherwise have existed, may generate additional trips, thereby converting teleactivity into physical travel. Nevertheless it highlights the fact that there are occasions that present the opportunity for a number of short-haul travel movements to be replaced by teleconferencing.

Another method by which it has been suggested that the number of air travel trips could be significantly reduced is to hold decentralised conferences. Decentralised conferences involve the connection of several locations via teleconferencing facilities. European Telecommunications Network Operators Association (ETNO) and WWF (2006) for example state that real substitution gains could be achieved by connecting a number of locations to one another by ICT to gain the benefits associated with both ICT and meeting face to face. Whilst this would not reduce the need to travel entirely, it is likely that it would reduce the need to travel by air.

Whilst supporting the notion of complementarity Mokhtarian and Salomon also state that teleconferencing is an effective way in which to conduct formal group meetings, which Van Ommeren (1997, cited in Meersman et al, 2002) estimates are the purpose of approximately 46% of business travel movements. Details are not given regarding how he calculated this estimate, but it nevertheless provides an indication of the nature of business travel, and implies that teleconferencing could reduce the need for some short-haul flights to be made.

Meersman et al (1999) produced estimates regarding the potential for business trips to be substituted by telecommunications which, whilst conservative, again suggest that there is the potential for some form of substitution. Their research takes into account the fact that the potential for substitution will vary according to context, and so have attempted to analyse the potential for teleconferencing to substitute the need to meet face to face for meetings by categorising the type of work undertaken by employees. They created 25 different categories of activities, each of which fell under the heading of either 'support,' 'service delivery,' or 'management.' It should be noted that their review was focused

upon road journeys undertaken by Cambridgeshire County Council employees, and as such the potential of telecommunications to substitute short-haul flights is not specifically considered within their research.

Meersman et al estimated that between five to 15% of business travel mileage could be reduced by teleconferencing. They also cite research projects undertaken by Van Ommeren et al (1997) which estimated that a maximum of 35% of business travel could be substituted, and by the ECMT in 1983 which estimated that 13 to 28% of business travel (excluding telecommuting) could be substituted by greater use of ICT. Stevens et al (2006) also cite a research study which suggests that in the longer term teleconferencing could displace up to 15% of business travel. These figures should be treated with caution as other research studies indicate that it is not possible to accurately determine the potential for a reduction in the demand for business related air travel movements given the relative lack of empirical evidence. It also needs to be noted that these substitution rates have been estimated for total travel, not just in relation to short-haul flights. They do however suggest that there is the potential to reduce the need to travel, and that initiatives to raise awareness of the potential benefits could, in time, have a positive impact upon travel patterns.

One empirical research study which found that the relationship between videoconferencing and travel appears to be substitutional was undertaken by Denstadli and Julsrud (2003). The study was based on a survey of financial directors in 563 companies based in Norway, 164 of which used videoconferencing. The results indicated that whilst videoconferencing has only substituted business travel to a small degree approximately 40% of videoconferencing users have managed to substitute some travelling, and 10% have experienced 'substantial' replacement. No indication is given as to whether any of the businesses surveyed experienced any generated travel as a result of using the technology. This substitution effect was evidenced despite the fact that the research identified that the full potential of videoconferencing has not been realised within the organisations surveyed as it tended to be used by a relatively small number of people for a limited range of purposes.

The survey (Denstadli and Julsrud, 2003) also indicated that attitudes to videoconferencing were positive in firms who already made use of the technology and in those who didn't. Costs associated with videoconferencing were perceived to be high however and whilst many of the directors surveyed considered travelling to be a burden they noted that a fundamental need of the business community is to make external contact, and that personal contact is often irreplaceable.

Research has been conducted into the use of conferencing at BT in the UK (James, 2007). Approximately six percent of BT employees (6,032 members of staff) were surveyed, with the staff surveyed selected to obtain a representative view of BT as a whole. The review of the social, economic and environmental impacts of teleconferencing found that 42% of teleconferencing users considered that their last conference call had definitely replaced a meeting. Seventy-two percent of conferencing users also found that the conference call had met all of its objectives. Only 29% of those did not feel that the objectives had been met attributed this to the virtual nature of the meeting.

Of the 859,784 face-to-face meetings avoided at BT by the use of teleconferencing eight percent were identified as having replaced air travel movements (James, 2007). It is not known what proportion of total air journeys undertaken by the company this represents. It could be expected that substitution would be higher at BT than other organisations, but the research is effective in highlighting the potential impacts that the technology can have upon travel behaviours.

Research conducted into the impact of soft measures in 2004 (Cairns et al) also used BT as a case study to indicate the potential for teleconferencing to reduce levels of business travel. Interviews with a company representative identified that the use of teleconferencing within the organisation is growing (in 2000 and 2003 by approximately 30% per annum) and that an internal survey of BT employees conducted in 2000 found that 75% of respondents felt that their last audioconference had replaced a face to face meeting.

A report produced by WWF and ETNO (2006) also supports the idea of substitution with the authors stating that teleconferencing can '*dramatically decrease the need for flying.*' Whilst they agree that people will continue to need to meet face to face occasionally they argue that an analysis of the actual need and efficiency gains can lead to some interactions, such as physical routine meetings, being substituted by virtual meetings. They believe that this will '*significantly*' reduce the number of physical trips that need to be made by organisations in a range of different sectors. Whilst organisations are under pressure to deliver short term profit and therefore tend to discount future costs the authors state that considerations of environmental improvements would further increase the number of journeys substituted. The report does not specify what proportion, or which types, of organisation this applies to.

The report (WWF and ETNO, 2006) states that increased use of ICT could lead to significant changes, and whilst it recognises that these changes could go in either direction as ICT can be viewed as a catalyst to a '*large extent,*' it remains confident of the substitution effect estimating that based upon the UK's experience a target of using audio-conference calls to replace 96.5 million meetings by 2010 could be set. Although they set this target in relation to audio-conferencing, they outline that the distinction between videoconferencing and audio-conferencing is becoming increasingly blurred as the technology enhances the capabilities of the two. A later research report published by WWF (2008) reiterates the potential for teleconferencing to reduce levels of business air travel. WWF commissioned a market research organisation, Critical Research, to survey businesses to determine current and future levels of business flights, attitudes towards videoconferencing, climate change and government initiatives, and whether they have a corporate policy that encourages 'green' business travel.

The survey of FTSE 350 companies yielded responses from 100 of those approached, with the results showing that the '*vast majority*' of companies surveyed have plans to reduce the amount that they fly whilst making greater use of teleconferencing. The extent to which these companies plan to use teleconferencing more to increase productivity as opposed to directly substitute air travel is unclear, although 75% of the organisations surveyed think that videoconferencing has reduced levels of business air travel within their company and 85% think that videoconferencing has the potential to reduce levels of air travel.

Impact of teleconferencing on aviation

Research studies that have been conducted into the impact of teleconferencing upon aviation tend to reinforce the contention that the relationship is one of complementarity, but they have also all identified that some substitution is taking place.

As outlined in Section 4.3.3.2 a research report by Denstadli (2004) stated that substitution rates in Norway are likely to be between 2.5% to 3.5%. In one of the few empirical studies that has been conducted in this area Roy and Filiatrault (2001) estimated the substitution rate as being between 3.6% and 8.6%. Transport Canada (2006) also found that telecommunications may reduce the level of growth in '*new business air travel*' by approximately 6%. Stevens et al (2006) cited further research studies one of which suggested minimum and maximum substitution rates of three percent and 11%, and another undertaken for Boston's Logan International airport, which suggested that between 13% and 23% of business air travel trips could be substituted by ICT.

Cairns et al (2004) also cite a number of further studies that suggest that teleconferencing can remove the need for business air travel. Apogee Research Inc (1994), for example, state that teleconferencing could substitute between 2 to 11% of business air travel, Burger states that it could substitute 40% of business air travel, and Cook and Haver (1994) state that it could substitute 25% of US business air travel by 2010). Arvai (1991), also cited in Cairns et al (2004) estimates that it could substitute 12% of business air travel by 2005, 25% by 2010, and 35% by 2020. Cairns et al (2004) caution that many of these estimates probably relate to the '*perceived transferability of meetings to technology, rather than the probability of this actually happening,*' which means that the actual impacts on air travel will be lower.

1.3.3.3 Modifications to travel patterns

Mokhtarian and Salomon state that whilst the demand for travel may not necessarily be reduced by teleconferencing it is likely that demand would be modified – a contention also supported by Cairns et al (2004). Whilst not removing the need to travel, this could suggest that some journeys could be made to different destinations by different modes. The lack of empirical data again makes it difficult to draw any conclusions and means that impacts can only be assumed. A study undertaken in 1988 however, cited by Mokhtarian and Salomon, gives an example of how modifications to travel behaviours resulting from the use of teleconferencing applications could result in the reduction of short-haul air travel movements.

The 1988 study, which has not been attributed to an author, refers to a videoconferencing meeting held in California. The use of teleconferencing technology meant that individuals were able to undertake shorter journeys than they would have had to make had the meeting not been conducted electronically. The effect of the distance travelled being reduced, however, meant that more participants attended the meeting. The per capita reduction in journey length to the meeting was estimated to be approximately 24%, but the total distance travelled by the total participants was estimated to have increased by 29%. Whilst this example supports the notion of complementarity, it also shows how teleconferencing can reduce the distance that delegates need to travel thereby increasing the competitiveness of other modes of travel relative to short-haul.

This contention is however questioned by other research, such as that by Mokhtarian and Salomon (2002) and Albertson (1997, cited in Mokhtarian and Salomon, 2002) which found that whilst teleconferencing applications are likely to increase the number of people involved in the interaction, and that these people are likely to undertake relatively short journeys to the teleconferencing venue, the impact that this is likely to have on reducing the number of longer journeys made is negligible as the additional attendees are unlikely to have attended the meeting if it had been conducted face to face.

1.3.3.4 Future potential

Research suggests that organisations are most likely to use teleconferencing applications when they perceive that time and cost savings can be achieved as a result. The increasing emphasis that is being placed on environmental and sustainability objectives and corporate responsibility could however become increasingly effective in encouraging organisations to increase their uptake of teleconferencing applications and reduce the number of short-haul business trips undertaken. Consultations with organisations support this contention with 74% of organisations surveyed by Critical Research for WWF claiming that climate change and the environmental debate has had a considerable impact on the way that their organisation operates (WWF, 2008). Making more use of audio- and videoconferencing and reducing the number of meetings requiring air travel (32% of organisations expect the number of flights undertaken to decrease) also features highly within the travel policy of the 70% of organisations surveyed who said that their organisation either has, or is developing, a corporate travel policy. The authors also highlight that other pressures, such as the increase in fuel prices and surcharges and the economic slow down, are also encouraging organisations to reduce the need to travel.

It can also be assumed that the likelihood of substitution could increase as technological advances continue to improve the quality and reduce the cost of teleconferencing facilities. Its impact is unlikely to be considerable, however, without a drive to increase the awareness of the benefits that the use of teleconferencing can have upon both businesses and the environment. Meersman et al (1999) stress the importance of making the potential benefits of teleconferencing clear to employers to encourage more teleconferencing initiatives to be implemented by organisations. Cairns et al (2004) also highlight the fact that the potential for teleconferencing to reduce business travel is highest in companies that adopt teleconferencing as a '*mainstream business practice*,' for example by making the necessary facilities available company wide and promoting their use. This indicates that the

likelihood of substitution will be greater if reducing air travel movements is incorporated into business strategy and its implementation driven from the top of organisations (WWF, 2008).

Mokhtarian and Salomon (2002) suggest that the ability of teleconferencing to reduce the need to travel could be assumed to increase over time as younger generations '*adopt and assimilate information technology*' and develop different '*values and norms*.' It is not, however, possible to determine the impact that this will have upon actual travel behaviours, and it is likely that the decision of whether to interact physically or electronically will continue to be based upon the perceived benefits.

Stevens et al (2006) whose review of the literature on the interaction of ICT and transport led to the conclusion that the relationship was complementary rather than supplementary also states that '*telecommunications will nevertheless increasingly be viewed as a potential substitute for travel*.' They appear to base this statement on the assumption that an increasing emphasis on climate change will lead to the search for an alternative to polluting forms of transport. They suggest that the enhanced ability to conduct videoconferencing from a wide range of locations with internet webcams and mobile video could enhance the penetration of the technology and that if the larger NICs, in response to pressures of oil prices and congestion, could use audio and video teleconferencing as a substitute for business air travel then by 2030 perhaps 10% of business travel could be replaced by some form of conferencing. They caution that some ICT applications could also increase the demand for infrastructure through productivity gains, but that ICT may, in the future, substitute demand for physical infrastructure such as airports and flights. Mokhtarian and Salomon (2002), strong proponents of the complementarity between ICT and travel, also detail that it is '*often argued*' that ICT will act as a '*substitute for increasingly costly trips*.'

The review of teleconferencing at BT identified that 80% of the respondents had increased their use of teleconferencing in the two years preceding the 2007 survey (James, 2007). A third of the 28% of respondents who had not used teleconferencing applications within the past month had targets for greater usage in future, and scope was also identified to increase conference usage amongst current users. BT employees already make extensive use of applications such as teleconferencing, which has reduced the need to travel, and the fact that there is additional scope to reduce the need to travel indicates that within committed organisations the rate of substitution could increase.

A report produced by WWF and ETNO (2006) calls for a policy shift to engage those working in technology with the potential use of ICT to help combat climate change. The publication details that developers of ICT are beginning to recognise the potential for using the technology to reduce CO₂ emissions, and that increased collaboration could help to reduce climate change by creating new solutions to enable ICT to facilitate more substantial reductions in the need to travel. This is reiterated in WWF's 2008 research report, which highlights the importance of developers making teleconferencing systems interoperable - 75% of the organisations that they surveyed stated that greater compatibility of systems would increase their future use of the technology.

WWF and ETNO (2006) recognise that the decision of whether to conduct an interaction physically or electronically rests on individual choice. They therefore state that raising awareness about the potential of ICT and implications to its use, such as increased efficiency and effectiveness, reduced costs and environmental impact, and providing incentives to increase uptake, could motivate a shift in thinking away from the traditional way of providing meetings. This could lead to a greater substitution effect in the future. They also make the key point that if ICT is to play an important role then it must reach a critical mass as the more people who have easy access to the technology, the greater the potential for substitution becomes. The importance of these factors in reducing the need to travel is supported by the 2008 survey of organisations commissioned by WWF which also identified the potential for a number of additional factors to increase use of videoconferencing. These include lowering the cost of technology, management support for videoconferencing, an increase in the price of air travel, and government intervention, such as a capital allowance for videoconferencing facilities and help with workplace travel plans.

2 Incentives and Barriers

This chapter aims to outline the issues that may act as incentives for and barriers to attaining a shift away from unsustainable levels of air travel. We start off by examining the major factors that affect travellers' behaviour, on which subsequent analyses will be based. These include:

- Income;
- Price (including taxes);
- Quality of service (e.g. journey time, reliability, information, convenience and comfort);
- Provision of alternatives;
- Image and status.

In light of the above, the following topics will then be examined:

- The current and proposed tax/legislative framework for the UK aviation industry and their problems;
- Changes that need to be made in order to make alternatives to aviation (e.g. coach, rail and telecommunications) more attractive;

This will highlight specific barriers that may exist in the current environment surrounding the UK aviation industry, and outline ways in which those barriers may be removed.

2.1 The major factors that affect air travel demand

The demand for transport is often said to be 'derived' by the need and want for other activities such as work, school or holiday. Changes at the macroeconomic level (e.g. industrial structure, level of trade, and movement of people) play a large role in shaping those needs and wants. Hence, understanding the factors that affect travel behaviour is often a difficult and multifaceted task. Nevertheless, the pool of empirical research available today suggests a few factors that are particularly of importance to understanding the drivers of air transport demand. For example, Hanlon (1999) suggests income, price (fares) and service quality as the three main factors affecting the demand for air travel. These factors are also known to be significant for other forms of public transport (see for example Balcombe et al. 2004). The sections below discuss these factors in turn, with additional mention on the availability of other modes as well as image and status.

2.1.1 Income

Income is regarded as a major determinant of overall transport demand. Doganis (1995) refers to a study by Lansing and Blood (1964) which identified that as income grows, people firstly spend more on non-essential goods and services, resulting in increased travel activity in general. Second, passengers place more emphasis on speed and comfort, and switch to modes such as the aeroplane. Such phenomena are observed both across time (e.g. between 1950 and 2000) and across sections (e.g. between different income groups in the UK, or between countries of differing levels of aggregate economic wealth) albeit with differences in magnitude.

Doganis (1995) draws upon recent studies which show that for a 1% rise in income (typically measured in GDP per capita), demand for air travel increases by 1.5 to 2.5%. In economic jargon, the income elasticity¹¹ is between 1.5 and 2.5. For example, Table 6 and Table 7 overleaf show the results of a study of income elasticities by BAA (1978, 1989) for various types of air travel. Note the higher elasticity (or sensitivity) for leisure flights.

Traveller type	Income elasticity
----------------	-------------------

¹¹ Elasticities are basically measures of sensitivity of one variable against another. In the case of income elasticity, the sensitivity of demand with respect to changes in income is being measured.

Short-haul leisure	2.3
Long-haul leisure	2.0
Short-haul business	1.6
Long-haul business	1.2

Table 6: Income elasticities (BAA, 1978).

Leisure segment		1989-93	1994-8	1999-2005
Short haul	UK resident	2.0	1.8	1.7
	Non-UK resident	1.8	1.8	1.7
North Atlantic	UK resident	2.0	2.0	2.0
	Non-UK resident	1.6	1.8	1.5
Middle East	UK resident	2.0	2.0	2.0
	Non-UK resident	2.0	2.0	2.0
Other long haul	UK resident	2.0	2.0	2.0
	Non-UK resident	2.2	2.2	2.2

Table 7: Predicted income elasticities for international leisure trips to and from London airports (BAA, 1989).

The rather simplistic conclusions from the studies of elasticities do not necessarily mean that there is a one-to-one relationship between wealth and travel demand. Cairns and Newson (2006) draw on existing data to explain that European countries with comparable levels of aggregate wealth (e.g. France and the UK) often have very different levels of air passenger demand (see Figure 10 overleaf).

In summary, the growth in income is likely to put an upwards pressure on air travel demand, especially with regards to leisure travel. A downturn in the economy with a reduction in income would have the opposite effect.

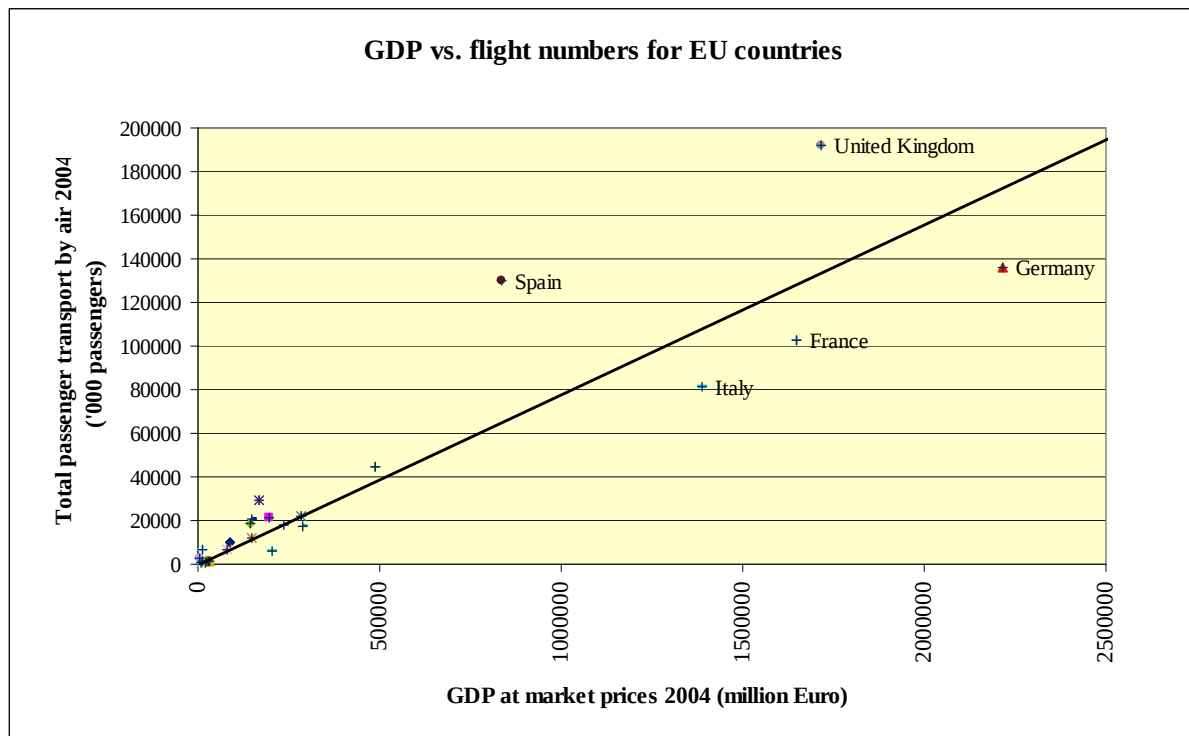


Figure 10: GDP vs. flight numbers for EU countries (Cairns and Newson, 2006).

2.1.2 Price (including taxes)

The price of the travel activity is another fundamental factor affecting demand. As with any goods and services, consumers decide on whether to carry out the travel activity based partly on how much the activity costs. In general, the higher the price, the lower is the demand.

The price for air travel is not set as straightforwardly as other 'normal' goods such as apples, where the rule of supply and demand dictates market price. Certain elements of the supply chain (e.g. airports) are often monopolised, and/or heavily regulated. The overall supply of air service is often limited by airport capacity and other infrastructure requirements, which are subject to planning regulation. Furthermore, most of the established airlines have historically received state aid and beneficial treatment (e.g. landing/take-off slots at major airports and exclusive rights to operate lucrative routes), although there is a recent trend towards liberalisation of markets across the world. Taxes and subsidies also affect the price that consumers confront, an issue to which we return later on.

Analogous to income, the effect of changes to the price of travel (e.g. through an increase in fares or taxes) can be expressed by an elasticity term. A recent meta-analysis of elasticities by Gillen et al (2007) in the Canadian context suggests that on the whole, the price elasticity of air travel is higher for leisure travellers compared with business travellers (see Figure 11). This is understandable given that business travellers do not carry the costs themselves and are less flexible in terms of choice, whereas leisure travellers are more likely to respond to a fare increase by either not travelling at all or changing where/how to travel. Figures from Straszheim (1978) are also in accordance with this observation (see Table 8). A more recent study by CAA (2005) shows that for leisure travellers from the UK, the price elasticities are somewhat lower, but increasing in magnitude over the past few years (see Figure 12).

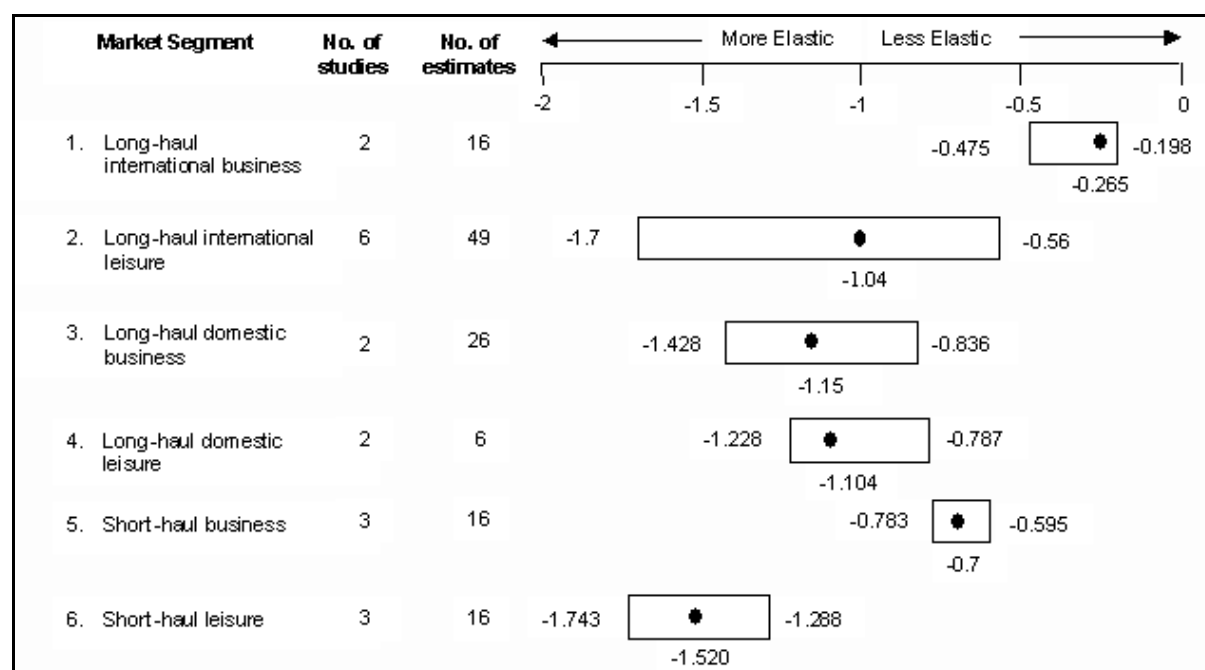


Figure 11: Overview of the evidence on price elasticity (Gillen et al, 2007).

Traveller Class (North Atlantic)	Price Elasticity (How much effect a 1% increase in fares would have on demand)
Business	-0.65
Full economy	-1.5
Discount	-2.7

Table 8: Price elasticities for various traveller classes (Straszheim, 1978).

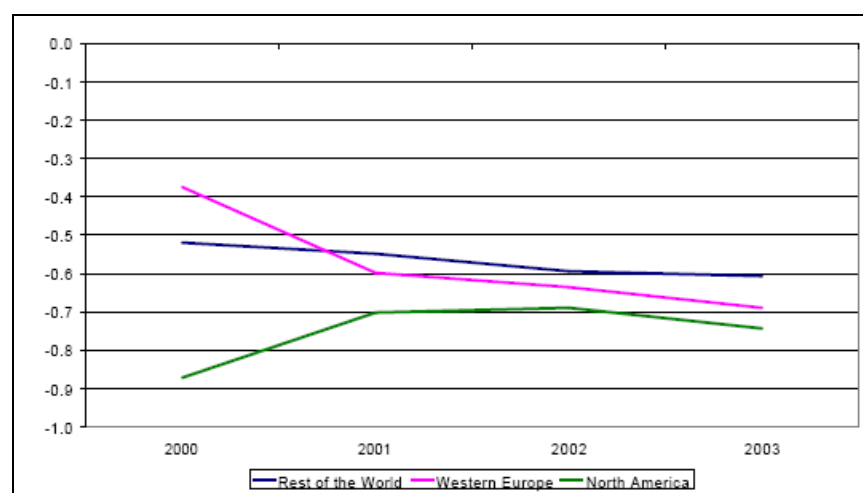


Figure 12: Changes to price elasticity over time for leisure travellers (CAA, 2005).

Recent trends indicate a continuous fall in the price of air travel in real terms. This is symbolised by the rise of low-cost carriers such as EasyJet and Ryanair. The continued move towards liberalisation of the aviation industry throughout the world (e.g. the transatlantic 'Open Skies' agreement) is also expected to put downward pressure on prices through increased competition. At the same time, there

are upward pressures on fares through increasing fuel prices, scarcity of landing slots, costs associated with security as well as the recent doubling of the Air Passenger Duty for practically all flights departing from the UK.

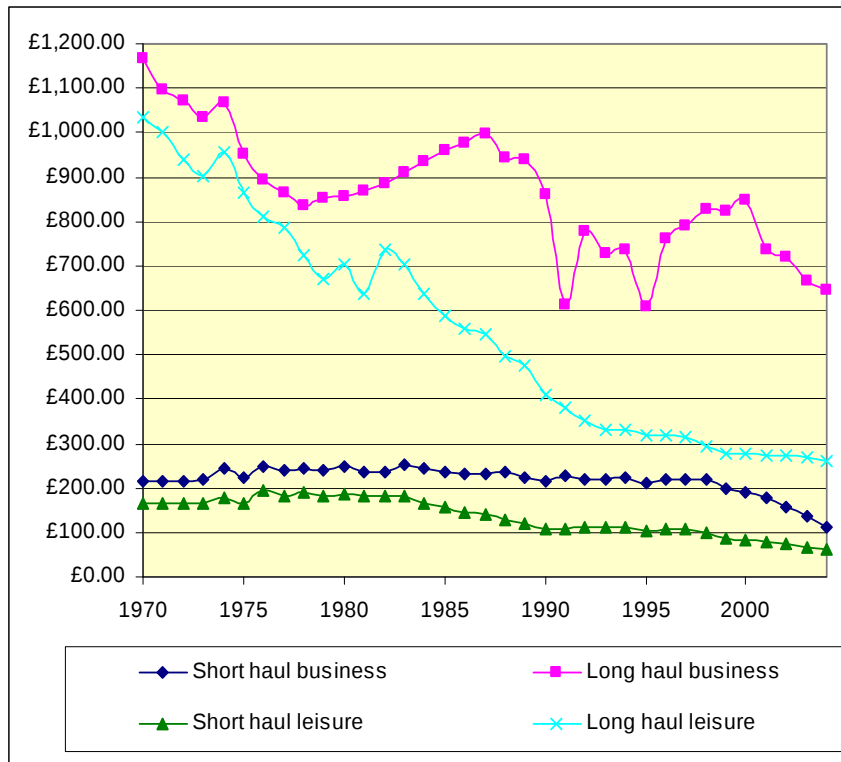


Figure 13: Changes to international fares paid by UK residents (Cairns and Newson, 2006).

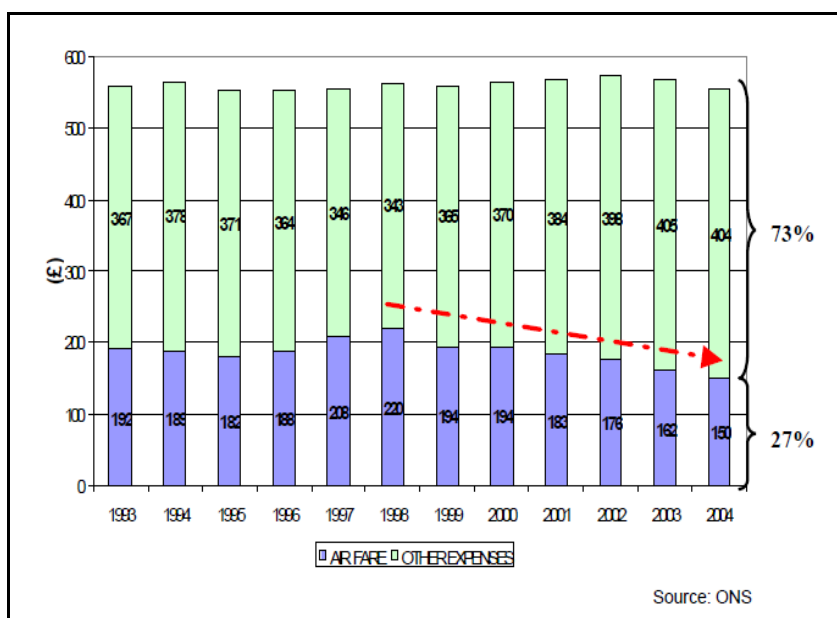


Figure 14: Reduction in air fares for UK leisure travellers to Europe¹² (CAA, 2005).

In summary, prices have a large effect on the demand for air travel, with leisure travellers more sensitive to price changes compared to business travellers. Prices themselves are governed not only by

¹² The “other expenses” in the figure are based on ONS figures on average spending per visit abroad, plus costs of accessing the airport (assumed to be £25 pounds for 2004)

the business objectives of airlines, but by the overall supply (often constrained by the capacity of infrastructure), level of competition and governmental taxes/subsidies.

2.1.3 Quality of service (e.g. journey time, reliability, information, convenience and comfort)

The literature also identifies quality of service as an influential factor in determining travel behaviour. Here, service quality refers to a composition of various aspects, ranging from time-related components (such as journey time, waiting time and access/egress time) to less easily quantifiable attributes such as ride comfort and reliability.

In general, there is a scarcity of information surrounding this topic in relation to air travel. This may in part reflect the methodological difficulties in isolating the effects of one particular element of service, and/or the difficulty of obtaining reliable data. However, the literature on land-based public transport (e.g. Balcombe et al. 2004) suggests that the effects of time-related components are highly dependent on travellers' value of time, which varies by type of user (business vs. leisure) distance and mode. In principle, business users and long distance travellers are more sensitive to changes in time; this may be a reasonable assumption to make when considering air travellers as well.

From a different perspective, Bleijenberg (2002) suggests that people are limited in terms of their 'time budget' and have historically spent around 1.1 hours a day on travel per day (see Figure 15 below). This suggests that in the long run, improvements in speed will likely be offset by longer distance journeys so that the travel time will remain the same. For example, a faster train service may allow people to live further from work. The improvement of transport links may therefore have the unwanted effect of adding to journey distances, and hence emissions and fuel consumption.

In summary, the quality of service (such as journey time) does affect the demand for air travel, albeit to different degrees depending on the type of traveller. Long-distance business travellers are likely to be most sensitive to changes in overall travel time.

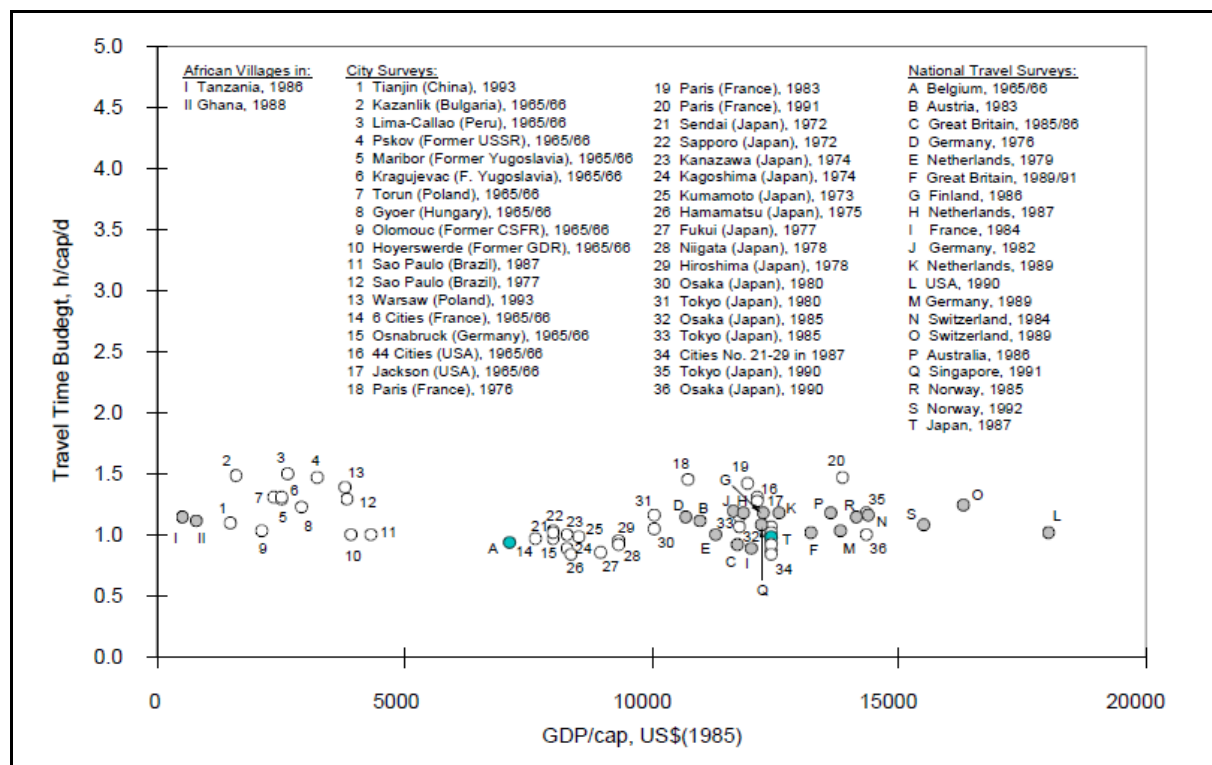


Figure 15: Constant Time Budget (Blijenberg, 2002).

2.1.4 Availability and quality of substitutes

Discussions so far have examined the demand for air travel in isolation from other modes, such as rail and coach. However the availability and quality of such substitute modes are likely to affect the total demand for air travel.

Again, there is a shortage of information to determine the exact relationship between these modes. Vicario (1999) and Gordon (2000) show '*diversion rates*' (the proportion of new demand for a particular mode X which came from mode Y) for UK inter-urban transport, whereby 6% of new rail demand is identified to have come from former air travellers, whilst the figure is zero for coach. See Table 9 below.

From:		Rail	Coach	Car	Air	Generated	No. of studies
To:	Rail	-	20	60	6	14	2
	Coach	60	-	22	-	18	1
	Car	42	10	-	1	47	1

Table 9: Diversion rates (%) for inter-urban journeys (Vicario, 1999, and Gordon, 2000 in Balcombe et al, 2004).

Another study involving the EC's TREMOVE model (EC, 2006b) forecasted that the inclusion of aviation in the EU Emissions Trading Scheme, with an estimated allowance price of €30/tCO₂ in 2020 (equivalent to a 4% increase in air fares) would reduce overall demand for air transport by 1.5%, 14% of which would be picked up by other modes: passenger train demand would increase by 0.3% and coach by 0.1%.

Although conclusions are difficult to draw under the existing evidence, rail travel may offer a certain level of substitution for air travel, although at current the effect seems to be limited. This is not to say that such shifts are impossible in the future. In principle, an improvement of one mode (in terms of price, journey time, comfort or any other attribute) should make it attractive to the other mode all else being equal.

2.1.5 Image and status

Image and status may also be elements that affect the demand for air travel. Sewill (2005) refers to the '*wonderful image*' that the aviation image currently attracts. Tol (2006) mentions that an overseas holiday may not be totally substitutable by domestic ones, because of peoples' perception of it being a status symbol. This is aggravated by the marketing and lobbying of the aviation industry, which Sewill (2005) depicts as 'extremely effective.'

Alternatively, a change in the social perception of flying may lead to changes in peoples' behaviour. The recent surge in voluntary carbon offsetting schemes suggests that consumer concerns towards environmental harm caused by their activities are real. Sewill (2005) amongst others advocate the further provision of information to educate the public, including the mandatory provision of information on CO₂ emissions when booking flights.

A recent public study by Ipsos MORI quoted in Cairns and Newson (2006) found that support for a policy to constrain air travel growth was popular, with less than 22% of respondents opposed to such a policy. There was also a roughly 60% support for airlines to pay higher taxes to reflect environmental effects, even if this meant higher fares.

2.2 The current and proposed tax and legislative framework and their problems

The previous section mentioned the effect of the price on consumer behaviour, which in turn is affected by the extent of taxes and subsidies. Hence, fiscal policy plays a crucial role in determining consumer demand. Businesses also plan their investments and operational practices according to their financial impacts. Fiscal policy is set out, enforced and limited by the legislative framework at local, national, EU and international level.

This section aims to present the current fiscal and legislative environment surrounding air travel, including changes proposed for the near future. It provides a lead into the next section, which discusses the major issues that need to be addressed, for changes to be made in ways that will encourage alternatives to aviation.

Taxes on air travel within and from the UK are currently limited to the Air Passenger Duty (APD), which is levied on a per-passenger basis. Tickets are basically exempt from VAT, and aviation fuel for commercial flights (both aviation gasoline and jet fuel) is not subject to Fuel Duty. Shopping at airports is partially given duty-free treatment. As a result, there are claims that the aviation industry is not meeting its responsible share of contributions to the public purse. This issue be discussed further in Section 5.3 of this report.

There is some uncertainty surrounding the changes anticipated in the near future, with plans being made to incorporate the aviation sector into the EU Emissions Trading Scheme (EUETS), in parallel with proposals for a new flight tax that would replace the APD.

These points surrounding the current and propose tax and legislative framework are described in more detail below.

2.2.1 Air Passenger Duty

Legislation defines the APD as ‘*a duty of excise which is levied on the carriage, from a UK airport, of chargeable passengers on chargeable aircraft*’ (HMRC, 2008). An excise duty differs from VAT in the sense that it is not reclaimable for business purposes.

In practice, most commercial flights are subject to the duty, whilst short pleasure flights lasting less than 60 minutes and taking off/landing at the same airport, aircraft with a take off weight of less than 10 tonnes or with fewer than 20 seats and flights from the Scottish Highlands/Islands are exempt. Additionally, most passengers making a connection do not pay APD on their second or subsequent flight as long as those flights are booked together at the same time. Children under 2 years of age are also exempt, given that they are not provided their own seat.

The APD was introduced in the December 1993 Budget by Kenneth Clarke, and was initially set at £5 for certain European destinations¹³ and £10 for all other destinations. The rates have undergone several revisions, being doubled in 1997, differentiated by seat class in 2001, and re-doubled in 2007. This has resulted in different tax rates for different circumstances; a passenger heading to a European destination in economy class would pay £10 in APD, whereas one flying to Tokyo in business class would be subject to a £80 APD (see Table 10 overleaf).

¹³ The discounted rate covers all domestic flights within the UK, flights to member states of the EU and its dependant territories within the lines 32°W and 45° E longitude and 81°N and 26°N latitude, and since 2007 flights to signatories to the European Common Aviation Area that are not also members of the EU (i.e. Norway, Iceland, Croatia, Macedonia, Albania, Bosnia and Herzegovina, Serbia, Montenegro and Kosovo). Passengers flying to Switzerland, Turkey and Liechtenstein are also given the discount.

Date from which rates apply	European rate		Non-European rate	
	Economy class	Other classes	Economy class	Other classes
1 November 1994	£5		£10	
1 November 1997	£10		£20	
1 April 2001	£5	£10	£20	£40
1 February	£10	£20	£40	£80
November 2009	To be replaced by new aviation duty			

Table 10: Historical and current rates of Air Passenger Duty (Leicester and O'Dea, 2008, based on data from HM Treasury – Financial Statement and Budget Reports and Pre-Budget Reports, various years).

According to Governmental figures, total revenue from the APD has typically oscillated around £1 billion (in 2006 prices) for the last 10 years, but is forecast to roughly double to around £2 billion following the rate rise announced in the December 2006 Pre-Budget Report (Leicester and O'Dea 2007). See Figure 16 below.

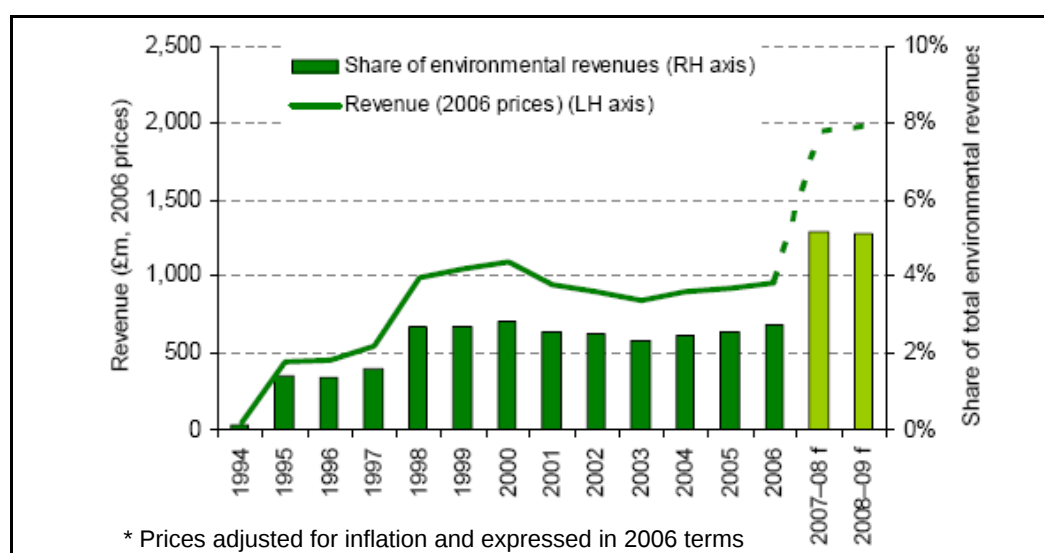


Figure 16: Revenue from the Air Passenger Duty (Leicester and O'Dea, 2007).

The APD is essentially a boarding tax, and is similar in nature to airport charges.

2.2.2 VAT Exemption

Air travel is currently exempt from VAT in the UK, on grounds of legislation stating that all forms of public transport services¹⁴ receive such treatment. Trains, coaches and buses similarly receive VAT exemption. VAT rules also state that the supply (sale and charter, including hire and lease) of qualifying aircraft¹⁵ is exempt from VAT.

VAT is levied as a proportion of the price of the commodity or service. It is levied on domestic air travel in many countries, whilst only a group of developing countries charge VAT on international flights. All Member States of the EU, with the exception of Denmark, Ireland and the UK, charge

¹⁴ According to HMRC, passenger transport services are supplied when a vehicle, ship or aircraft is provided together with a driver or crew, for the carriage of no less than 10 passengers, including the driver and crew.

¹⁵ This is legally defined as any aircraft of a weight of not less than 8000kg which is neither designed nor adapted for use for recreation or pleasure.

VAT on domestic aviation services, although (except for Germany and the Netherlands) they provide a discount compared to the basic rate (Keen and Strand, 2007).

2.2.3 Fuel Tax Exemption

In the UK, air travel is also exempt from Fuel Tax, for both domestic and international flights. The terms of taxation for fuel to be used on international flights are dictated by Article 24 of the 1944 Convention on International Civil Aviation (The Chicago Convention), which states that ‘*fuel, lubricating oils [and other items] on board an aircraft of a contracting State, on arrival in the territory of another contracting State and retained on board on leaving the territory of that State, shall be exempt from customs duty, inspection fees or similar national or local duties and charges.*’ Keen and Strand (2007) argue that this prevents airlines from tanking in lower-tax jurisdictions, and advocate reform at a collective level if this was deemed necessary.

Where bilateral air service agreements exist, they often provide a reciprocal exemption of fuels uplifted on both sides. According to ICAO (1998), 97% of agreements contain such provisions. Keen and Strand (2007) also point out that within the EU, there is no legal impediment to Member States amending their bilateral agreements to allow the taxation of aviation fuel used on flights between them, but this would only be limited to their national carriers. Such agreement would provide an advantage for carriers from other countries, and perhaps because of this reason, no EU Member State seems to have so far opted for this approach.

Domestic flights are subject to fewer difficulties, and many countries do levy a tax on fuels used for domestic aviation. Rates are in most cases similar for aviation gasoline (used in smaller planes) and jet fuel, but where differences exist, jet fuel is often lower.

2.2.4 Duty Free

Sewill (2005) points out the advantage created to the aviation industry by the duty-free sales of certain goods at airports. Alcohol, tobacco and perfume may be purchased free of duty for flights to outside the EU, whilst a wider range of goods may be purchased without VAT for all destinations. Sewill argues that there is no rational reason why duty-free and VAT-free sales at airports should continue, and that there are no international legislations or agreements to keep the UK from ending this practice.

2.2.5 Inclusion of Aviation in the EU Emissions Trading Scheme

The European Commission issued a proposal in late 2006 to include aviation in the existing EU Emissions Trading Scheme (EUETS). This has received support from the UK Government, as well as industrial bodies such as IATA, partly due to the relative legislative ease in bringing about such a system compared to a common tax at EU level.

According to the original proposal, the scheme would cover all flights arriving at or departing from an airport in the EU, starting in January 2012. Allowances would be determined at Community level by reference to average emissions from the sector in the years 2004-2006. These allowances will then be allocated to aircraft operators free of charge according to a benchmark¹⁶, although a fixed percentage (starting at 10%) would be auctioned. Under such arrangements, the aviation sector would not necessarily need to cut carbon emissions by itself; it is anticipated that the sector would be a net buyer of allowances from other sectors.

The effectiveness and fairness of such scheme is likely to depend on the details. Critics such as Tol (2007) and Sewill (2005) argue that the proposed allocation methodology effectively subsidises the industry at the cost of the taxpayer, as the majority of allowances will be given out at no cost. Also, it

¹⁶ Tol (2008) suggests that the proposed benchmark is effectively the same as grandfathering (where allowances are handed out for free based on past emissions), because company-specific values are used as opposed to the conventional practice of an industry-wide one.

would favour incumbent operators against emerging airlines, as the latter would need to purchase credits rather than receiving them at no cost.

2.2.6 *Proposals for a new Flight Tax*

In October 2007, the Government announced that the APD would be replaced from November 2009 by a new tax levied per flight and differentiated by distance. For a specific flight, a fixed amount would be levied irrespective of the number of passengers on board, implying that the greater the load factor, the lower the tax burden would be per passenger. This has the intended effect of encouraging better utilisation of aircraft and minimising environmental effects.

Similar to the ETS, the overall effect of the tax is likely to depend on the details. HM Treasury (2008) suggests Maximum Take-Off Weight¹⁷ of the aircraft as the basis of the duty, and a banded system for defining the distance travelled. How such a scheme would actually change behaviour is an empirical matter, and warrants careful investigation.

¹⁷ The justification given by the Government is that Maximum Take Off Weight and CO₂/NO_x emissions are correlated.

2.3 Changes needed to make alternatives to aviation more attractive

The previous two sections outlined the bases of air traveller demand and the current/proposed tax and legislative framework. Here, we provide a discussion on how the framework can be improved to increase the viability of alternatives to aviation, including rail, coach and telecommunication. More specifically, we look at how:

- aviation can be made to cover its external costs
- the new framework should be planned carefully to mitigate unwanted effects and distortions
- the new framework may raise funds to invest in alternative modes of transport, or other sectors

2.3.1 *The coverage of external costs*

Almost all forms of transport activity are sources of so-called negative externalities (or external costs); costs that arise from an economic transaction which are not accounted for by the parties immediately involved. Costs to society in the forms of noise, air pollution, accidents and climate change effects are all characteristic of externalities as they will not be carried by either the producer (e.g. airlines and airport operators) or the consumer (i.e. the traveller).

There are a number of studies that have attempted to quantify the negative externalities of aviation. Dings et al. (2003) focused on emissions and noise externalities, and concluded that climate externalities are around €7.20 per 1,000 passenger-kilometres for short-haul flights (approximately €3.60 per passenger) and €4.40 for long-haul flights (€26.40 per passenger). The figures rise to €17.90 per 1,000 passenger-kilometres for the short-haul flight and €6.10 for the long-haul flight, (or €8.95 and €36.60 per passenger respectively) when the effects of contrails are included. Other similar studies include Pearce and Pearce (2000) and Bleijenberg and Wit (1998). Their findings suggest that noise and air pollution externalities are sensitive to local parameters such as population density and house prices, whilst climate externalities are relatively similar across countries.

The figures from these studies suggest that the current level of APD more than cover the climate externalities. However, Leicester and O'Dea (2007) mention the huge uncertainties that surround the external costs of aviation, especially due to the climate change effects of non-CO₂ elements such as contrails. There is also some evidence of the social cost of carbon (SCC) being higher than those used in the studies, as noted in the Stern Review (2006). The SCC is a subject matter in itself, and a full analysis is beyond the scope of this paper. However, the general conclusion from the Stern Review is that the SCC depends heavily on the stabilisation target, and increases as atmospheric concentrations become closer to the target. For a stabilisation target of 450-550ppm, the SCC would start at a range of \$25-30 per tonne of CO₂ in the year 2000.

The ways in which externalities can be internalised are well established, at least in theory. Regulation and taxation may be used to impose the costs onto the producer of externalities, so that they are made visible, or 'internalised.' In general, toxic substances such as dioxin are better regulated through bans, limits and other physical forms of regulation, whilst for greenhouse gases a more flexible approach, through the use of market mechanisms, are often thought to be appropriate.

In the context of this report, there are three main lines of thought that may be followed:

Emissions Tax / Fuel Tax

Sewill (2005) amongst others note that the first-best approach would be to tax the externality itself, in this case the greenhouse gases, in the form of an emissions tax. This would be proportionate to the harm caused by each flight to the global atmosphere. Although uncertainties still exist in terms of the mechanisms by which aircraft emissions affect the climate, a good proxy would be the level of fossil fuel used, possibly multiplied by a coefficient to take into account the non-CO₂ component. In other words, a fuel tax would be regarded as an approximate measure against climate externalities.

As mentioned in the previous section, there are difficulties (both legally and technically) with the introduction of such a tax in the UK context. The Chicago Convention as well as the numerous bilateral agreements makes the taxation of fuel for international flights legally difficult. Norway for example, introduced a tax on aviation fuel in 1999 but had to abolish it within months as it transgressed a number of bilateral agreements (Leicester and O'Dea, 2007).

A concerted effort would be needed, at least within the European region, to harmonise the direction on tax; otherwise airlines may opt to fuel their aircraft in countries where the tax is lowest. This problem, known as 'tankering' is noted by others to be exaggerated. Keen and Strand (2007) note that the Norwegian aviation fuel tax introduced at a rate of 16 US cents per gallon in 1999, led to little or no such practice, probably due to the low rate of duty.

A Flight Tax or VAT

Absent an emissions tax (or fuel tax as a proxy), there may be a case of using other forms of fiscal measures such as the current Air Passenger Duty, the proposed new flight tax, or VAT, which may be used as levers to internalise externalities. Cairns and Newson (2006) note that there is a case for using the APD, at least in the short term, to dampen demand. An important issue to note is the fact that VAT would be reclaimable for business users, whereas excise duties such as the APD are not. If there is an argument against taxing business users, the addition of VAT on fares may be considered a relatively attractive measure.

Emissions trading

In principle, emissions trading has similar effects to a tax in that external costs will be accounted for in market transactions. However, as noted before, the effectiveness and fairness of any scheme is highly dependent on the details, including the allocation mechanism, the overall allowance and the basis of the permits. There is a case for such details to be further scrutinised, given the strong current preference of the major actors for this approach.

2.3.2 Mitigation of unwanted effects

Previous sections have highlighted the need for the fiscal and legislative framework to better incorporate the externalities of aviation. Whilst instruments such as fuel tax, APD and emissions trading are sound in principle, care needs to be taken to mitigate perverse incentives and unwanted effects on the environment and economy. Issues of such nature are described below.

Migration of emissions

The potential problem of 'tankering' raised earlier, suggested the need for a concerted effort at regional (EU) level to harmonise tax policies. Similarly, there may be a case that the increase of taxes on air tickets may have unwanted effects. Mayor and Tol (2007) suggest that the recent doubling of the APD may have a negative effect on carbon emissions, because it reduces the relative price difference between near and far holidays. Assuming a relatively low substitutability between domestic and foreign holidays, tourists from the UK would on average choose to travel further abroad due to the relative rise in the cost of holidays closer to home (e.g. continental Europe). FitzGerald and Tol (2007) also point out that the inclusion of aviation in the EUETS (absent further international cooperation) may have the effect of shifting tourists from the Far East, Australia and the Americas to destinations other than Europe.

Transaction costs

Taxes and regulation inevitably bring about costs for administration and enforcement. There needs to be a balancing act between the completeness of the scheme and its administrative burden. An ill-designed scheme may absorb all the extra revenues from the scheme in administrative costs, which otherwise may have been used for other purposes.

Fairness and equal footing

Concerns regarding the current framework stem partly from the perception that aviation is given preferential treatment e.g. through the exemptions in various taxes and that it is not fulfilling its obligations to support public services. For example, motorists are levied taxes on the acquisition, ownership and running of their vehicles via VAT, Vehicle Excise Duty and Fuel Duty respectively.

Land based public transport, including buses and trains, do not attract VAT as explained earlier. They are also subject to a lower effective rate of Fuel Duty, due to the rebates being offered in the form of the Bus Service Operators' Grant (BSOG) for buses, and the 'red diesel' rate for trains.

The unequal footing created by the various levels of taxation has attracted criticism from various authors. For example, Sewell (2005) notes that claims made by the aviation industry on their benefit to wider society (e.g. as a significant employer, or as a provider of public transport) are often ill-founded and not adequate to justify the current exemption. On the other hand, Volterra (2003) claims that it is '*hard to believe that the relative size of these contributions reflects any economic rationale or the scale of their respective external impacts.*' Future frameworks need to be designed in light of such concerns.

	Effective Fuel Duty (2003 levels)
Cars	45.82p/litre (ULSP/ULSD)
Buses	9.14p/litre (after rebate)
Trains	4.22
Air	None

Table 11: Fuel duty rates for various modes (Volterra, 2003).

Distributive effects

There are also claims that increased air fares through taxes will disproportionately affect the poor. Such claims however, are countered by data from the CAA (2004, cited in Cairns and Newson, 2006) showing that of the 62,849 leisure passenger trips terminating at Gatwick, Heathrow, Luton, Manchester and Stansted, 76% of passengers were from socio-economic groups¹⁸ A, B and C1, and 24% were from groups C2, D and E. Cairns and Newson (2006) also state that whilst the average UK household income was approximately £28,700 in 2002/03, the average household income for UK leisure passengers making international trips from UK airports were £33,531 at Birmingham, £54,488 at Heathrow, and £61,995 at London City Airport.

Sewill (2005) also claims that any tax increase in air travel is likely to be progressive in nature. The overall effect on equity is likely to depend on whether substitutes (such as rail) are available, and how revenues from extra taxes will be used. (See following section for further discussion)

¹⁸ The commonly used 'ABCs' classification system for socio-economic groups involves six reference categories, with 'A being those in senior managerial, administrative or professional roles, B being those in a middle managerial role or equivalent, C1 containing those in junior managerial or supervisory roles, C2 being skilled manual workers, D being semi-skilled and unskilled labour and E being those with no income other than a state pension or benefit' (CAA, 2005).

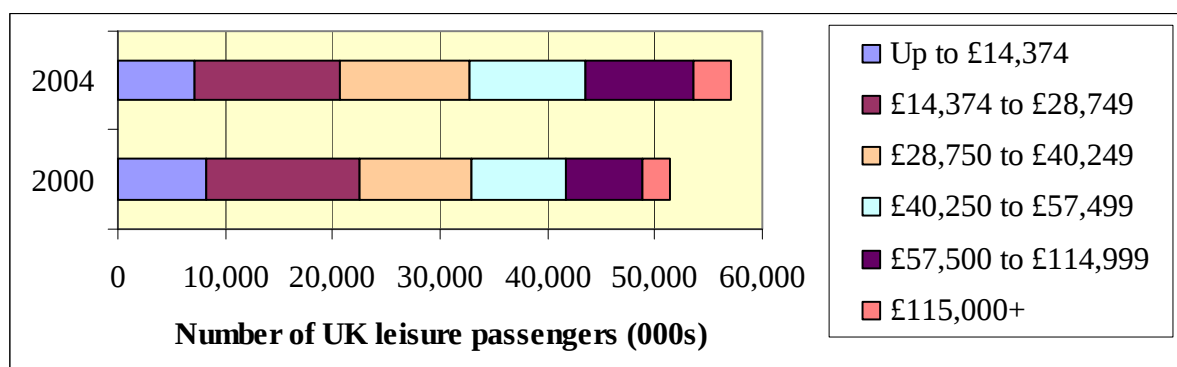


Figure 17: International leisure trips from Manchester, Gatwick, Heathrow, Stansted and Luton by income band (Cairns and Newson, 2006).

2.3.3 The treatment of revenue

The internalisation of externalities was noted as the primary principle behind (increased) taxation or emissions trading. A secondary (yet no less important) issue is the way in which the revenue from the taxes are to be used.

Sewill (2003) estimates that as a result of the tax exemptions, the net tax subsidy to the aviation industry is around £9 billion per annum (see Table 12 below). Since then, APD has doubled, but fuel tax has also increased to 50.35p/litre, meaning that the figure would still be similar today under this calculation method.

	£ billion per year
Fuel tax (basis of 45.8p/litre)	5.7
VAT	4.0
Duty free	0.4
Deduct APD	-0.9
Net tax subsidy	9.2

Table 12: Lost revenue to the treasury in 2003 (Sewill, 2003).

In the context of the proposed inclusion of aviation in the EU Emission Trading Scheme, FitzGerald and Tol (2007) conclude that if permits are given out to airlines free of charge, the industry would effectively receive a subsidy of €3.0 billion per year at the permit price observed in January 2007, and €39.6 billion if permit prices increase to levels advocated by Stern et al. (2006).

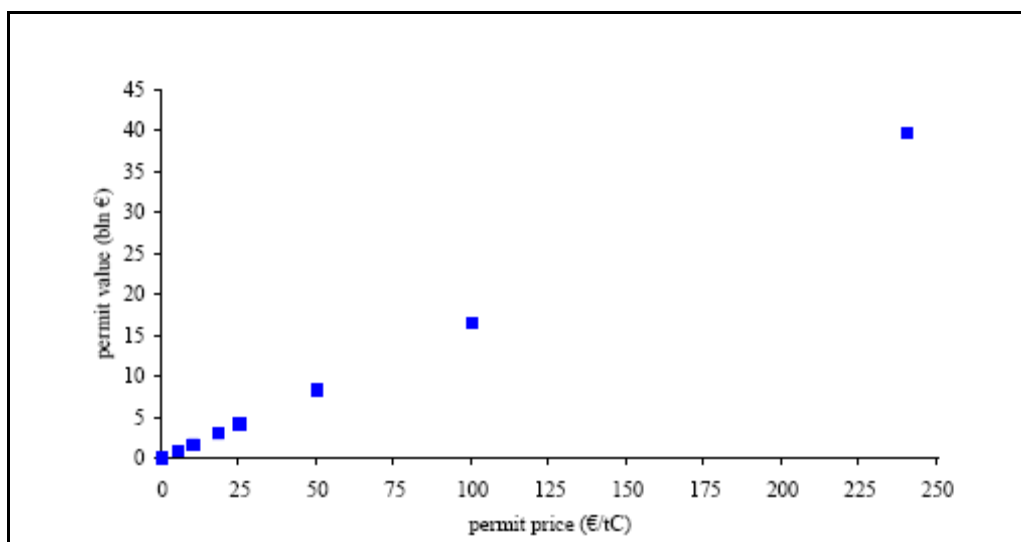


Figure 18: Potential subsidy to airlines from grandfathering ETS permits (FitzGerald and Tol, 2007).

The exact way in which these potential sources of revenue can be used is a matter of politics and public choice. One option would be to feed all extra monies into the general account, to use for health, education or any suitable purpose.

An alternative would be to earmark the revenues to fund alternative forms of transport, such as high-speed rail. Relying on figures from CfIT (2004), £9 billion of extra revenue would be roughly sufficient to build 180km of high speed rail per year.¹⁹

The third option would be to cut revenues from other forms of taxes such as income tax, a concept which is likely to increase the public acceptability of the policy change. This is shown to be the case with road pricing, where responses from the public turn favourable when presented with the option of a reduction of other motoring taxes.

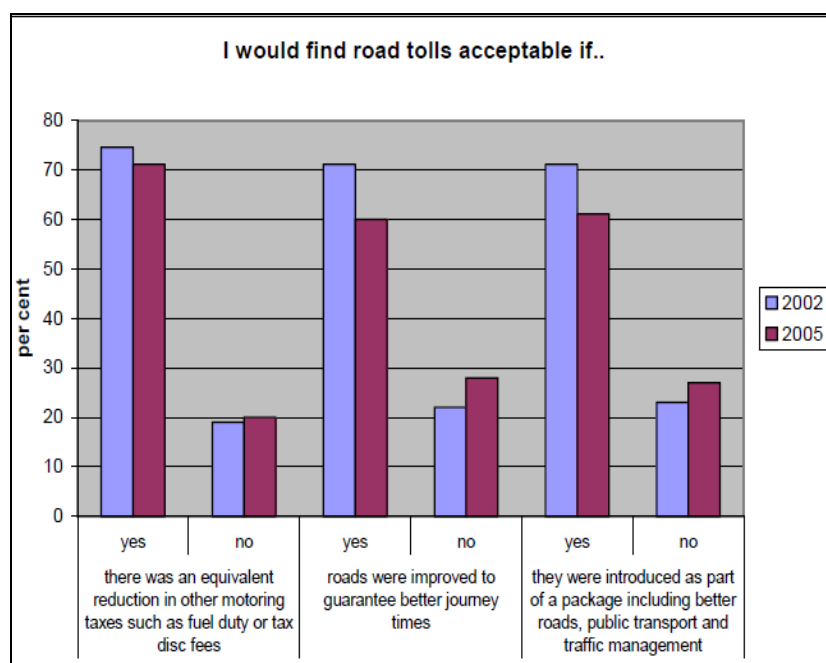


Figure 19: Acceptability of Road Pricing (RAC Foundation, 2006).

¹⁹ This assumes an exchange rate of 1.4 Euros to the Pound, and the same cost per km as the Channel Tunnel Rail Link (roughly 70 million Euros per kilometre).

3 Potential impacts of measures to reduce air travel

This chapter looks at the possible impacts of implementing measures to reduce short-haul air travel. Described are impacts on overall travel behaviour, consequences for the UK's greenhouse gas emissions, other environmental impacts, congestion and the financial and economic impacts.

3.1 Impact on greenhouse gases

3.1.1 *Reduction in travel*

If business travel could be reduced by increased use of ICT, there would be a large saving in greenhouse gas emissions. A survey by University of Bradford and SustainIT at BT (James, 2007) calculated that every conference call that replaced a meeting saved a minimum of 40kg of travel related CO₂. Air travel accounted for 48 per cent of avoided miles, but only 8 per cent of avoided trips. If NO_x and radiative forcing was added to this the actual saving in contributions to climate change would be even larger. Using conferencing (e.g. broadband) does consume electricity which would equate to a small amount of GHG emissions; depending on the grid mix. This was calculated as 5.4% of the emissions generated from a face-to-face meeting. University of Bradford and SustainIT (James, 2007) concluded that BT saved over 54,117 tonnes of CO₂ per year by using conferencing.

3.1.2 *Modal shift*

The level of reduction in GHGs will depend on the mode that is switched to. This is most likely to be rail, so a comparison of rail and air emissions is most useful.

Rail emissions

In the UK rail traction is provided by a mix of electric and diesel with different associated emissions. Traction in the UK rail network is supplied by a mixture of diesel and electricity. Around 40% of the national rail network is electrified, about 70% of energy use by trains is from diesel. Using the current average electricity generation mix for the national grid electric trains generates significantly less CO₂ per passenger than diesel. Some newer electric trains emit around 40g of CO₂ per passenger-kilometre and whereas some diesel trains emit as much as 112g/pkm (RSSB, 2007). The emissions per passenger km is very sensitive to the number of passengers. The SRA (2001, cited in CfIT, 2001) detailed that the average load factors (seat occupancy) on rail routes was 33%, although this will vary considerably depending on route and time of day with some routes reaching around 185% capacity at peak times. Other factors relating to the type of train, use of regeneration braking, route and passenger loading will also have an effect. The official Defra (2007) average figure for UK rail is 0.0602 kg of CO₂ per passenger km. This is calculated using the DfT Network Modelling Framework (NMF) Environmental Model and has been based on total electricity and diesel consumed by the railways in 2005/06 provided by ATOC, and the total number of passenger kilometres for 2005/06 from DfT rail statistics. The factor for conversion of kWh electricity into CO₂ is based on the 2005 grid mix. This does not include light rail or underground figures. High speed trains normally generate more emissions than conventional trains, as air resistance increases with speed increasing fuel use. The CO₂ emissions of high speed trains can range from 0.05 to 0.09kg per passenger kilometre with 30% occupancy (Transwatch, 2007). Acceleration and braking consumes more fuel than a constant speed, so stopping services are normally less fuel efficient.

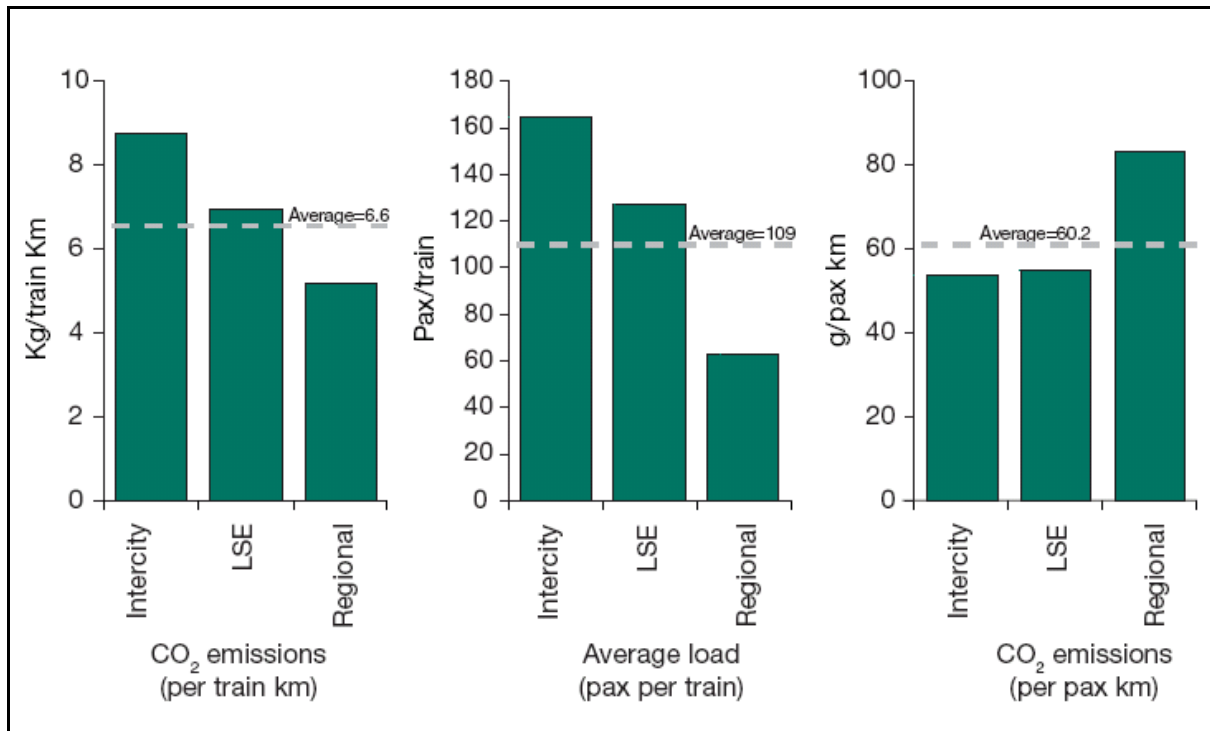


Figure 20: Train CO₂ emissions (DfT, 2007).

Air emissions

The emissions for planes are influenced by factors such as (EEA, 2006):

- Type of aircraft;
- Type of engines and fuel used;
- Emission characteristics of the engines (emissions per unit of fuel used depending on engine load);
- Location (altitude) of operation;
- Loading factor.

The impact of contrails have also been found to depend on time of day. Contrails reflect solar radiation back into space and also trap heat in the lower atmosphere; overall the balance has a warming effect. At night only the trapping effect occurs, therefore night flights contribute more to climate change. Climatic factors also have an effect, contrails only form when the temperature is low enough and the humidity is high enough for water vapour to condense.

The Defra (2007) values for CO₂ emission factors are 0.1580 kg per passenger km for domestic flights and 0.1304 kg for short haul international flights. The emissions factors are based on typical aircraft fuel burn over illustrative trip distances listed in the EMEP/CORINAIR Emissions Inventory Guidebook (EEA, 2006). To this, a 9 to 10% uplift factor should be added to take account of non-direct routes (IPCC, 1999) and this does not take into account other greenhouse gases or the impact of contrails. If the uplift factor and the 1.9 radiative forcing index suggested by TRADEOFF (Sausen et al, 2005) are added a domestic journey by rail generates around a 10th of the emissions the same journey would produce by plane. The loading factor for aircraft is normally around 68%, although low cost airlines are usually higher, for example around 80%. BA state that the ATP and Boeing 737-200, which are often used for short haul flights produce up to 35g and 50gs of carbon per passenger-km respectively (FoE, 2000) and the double-decker A380 hailed as a new more fuel efficient plane has been reported as emitting 80g with 550 seats occupied (Webster, 2007). Other figures suggest aircraft emit between 300g and 70g, of CO₂ per passenger-km with a 70% loading. These figures do not include the impact of other types of pollutants such as NO_x, contrails or the effect on cirrus cloud formation.

Comparison

Research conducted by AEA Technology and Environment and Paul Watkiss Associates (2006) found that flights between London-Paris and London-Brussels generate between 8 and 11 times more CO₂ emissions than the Eurostar train does for these same journeys (see Table 13 below). The relative emissions generated are based upon actual passenger numbers, exact distances of rail and air routes, actual aircraft types in use on different routes, and the mix of electricity sources used by Eurostar trains. In all cases the Eurostar was more energy efficient than air travel.

Journey	Mode	Emissions of CO ₂ (kg per passenger return journey)	Emissions of CO ₂ (g per passenger km)
London to Paris (return)	Short-haul air from Heathrow (average)	122	168
	Eurostar	10.9	11.0
London to Brussels (return)	Short-haul air from Heathrow (average)	160	219
	Short-haul air from Gatwick (average)	222	322
	Eurostar	18.3	24.3

Table 13: Comparison of the CO₂ emissions of rail and short-haul flights (Paul Watkiss Associates and AEA Technology Environment, 2006).

It is clear that a shift from air to rail would create a significant reduction in CO₂ emissions. The environmental benefits achieved on domestic routes are, however, likely to be less substantial than those detailed in Table 13 above as the fleet of Eurostar trains are electric whilst most of the UK fleet of trains are currently diesel services, which tend to be considerably more polluting. A comparison of the CO₂ emissions of different modes is given in Figure 21 overleaf, which indicates that the environmental performance of both rail and coach travel relative to aviation is good. The data in Figure 21 is based on the assumption that load factors are 20% for urban buses, 60% for intercity coaches, 40% for intercity rail, 30% for all other trains, 70% for domestic airlines, and 30% for cars. The estimate for aviation includes a factor for radiative forcing. Road, air and diesel-powered rail vehicle emissions have also been increased to take into account refinery losses, and electric powered vehicles take into account losses in the grid.

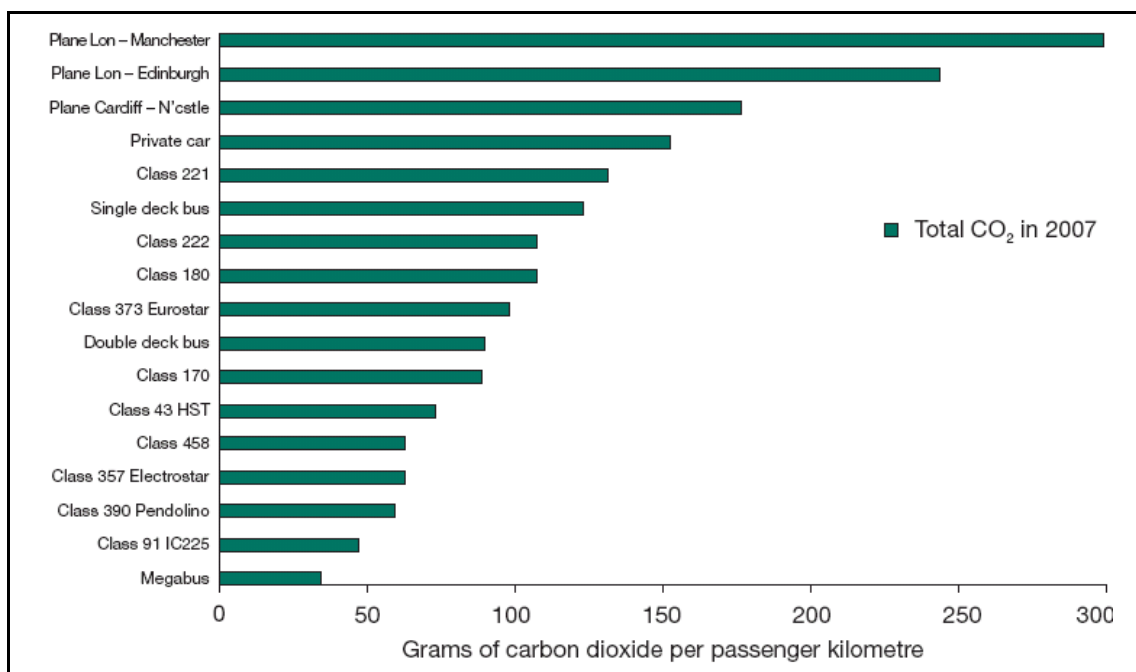


Figure 21: Intermodal comparisons of CO₂ emissions in 2007 (DfT, 2007c).

AEF (2007) have also attempted to compare emissions of CO₂ from different modes of transport. Their research recognised the fact that accurate figures cannot be identified owing to varying occupancy levels of vehicles, journey lengths, speeds, and the age and type of vehicles. Using a variety of studies (not listed) Table 14 was compiled to give an indication of how the modes compare.

Means of transport	Miles per gallon (or equivalent)	Emissions of CO ₂ per kilometre (g)
Rail - normal suburban	around 50-150 miles per gallon per passenger* (18 - 52 kpl)	<i>approx 130 – 45</i>
Rail - high speed, few stops	around 40-80 miles per gallon per passenger* (14 - 28 kpl)	<i>Approx 165 – 80</i>
Bus - well used service	around 80 - 140 miles per gallon per passenger (28 - 50 kpl)	<i>Approx 80 - 45</i>
Air - (below 500 miles)	around 10 - 20 miles per gallon per passenger (4 - 8 kpl) - including radiative forcing index at 1.9	<i>approx 460 - 330</i>
Air - (long journeys)	around 20 - 30 miles per gallon per passenger (8 - 12 kpl) - including radiative forcing index at 1.9 - higher than short haul, as much of the energy for any flight is used in take-off and climbing)	<i>Approx 330 - 210</i>

Table 14: Approximate energy consumption of different modes of transport (AEF, 2007).

Hickman et al (1999) have made an intermodal comparison of a long distance trip between Vienna and Rome. The rail journey was measured between the two city centre railway stations, and for aircraft between the Vienna airport and Rome Fiumicino. Six scenarios were generated based upon the fleet and load factors (as shown in Table 15), and parameters were set as shown in Table 16. The results of the comparative analysis are shown in Figure 22 below. Again, this comparative analysis indicates that in terms of environmental impact rail consistently performs favourably to air.

	Current fleet (1995)	Best available technology (1995)	Estimated future fleet (2010)
Maximum load factors	Scenario A	Scenario B	Scenario C
Average load factors	Scenario D	Scenario E	Scenario F

Table 15: Scenarios with varying fleet and load factors used as a basis for Hickman et al's analysis of the CO₂ impact of rail and air journeys (1999).

Parameter set	Mode	Value
Current technology emission factors	Rail	TGV Est
	Air	Average fleet on route London-Paris 1993
Best available technology emissions factors	Rail	TGV Duplex
	Air	Airbus 320
Future technology emissions factors	Rail	33:33:33 mix of TGV Est, TGV Duplex and future TGV
	Air	1994-2010 reduction factors applied to London-Paris fleet
Average load factors	Rail	Load factor 0.70
	Air	Load factor 0.65
Maximum load factor (100%)	Rail	Load factor 1.0
	Air	Load factor 1.0

Table 16: Parameters upon which Hickman et al's analysis of the CO₂ impact of rail and air journeys is based (1999).

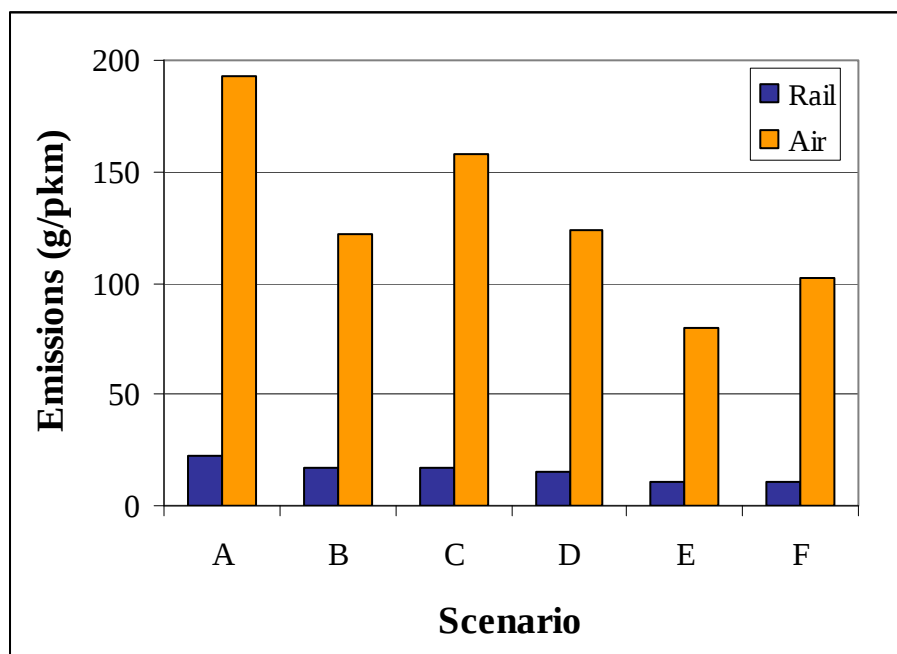


Figure 22: CO₂ emissions (g/pkm) for each long-distance journey scenario detailed in Table 15 above (Hickman et al, 1999).

Planes also emit around 6 to 16 times as much NO_x as trains, this is without employing a multiplier to take account of fact that NO_x emitted in the upper troposphere generates ozone more easily than that released at the surface. In addition there is the impact of contrails, which does not apply to surface transport.

3.2 Other environmental impacts

3.2.1 Reduction in travel

In addition to its contribution to climate change, aviation is also a source of:

- Stratospheric ozone reduction, leading to increased surface UV radiation
- Local pollution, e.g. increased ozone and NO_x
- Noise

- Traffic around airports with associated pollution and congestion

Therefore a reduction in air travel would also bring other environmental benefits, especially to those living in the vicinity of airports. Reducing aircraft noise, improving local air quality (e.g. reduction of PM₁₀, CO, NO₂ and VOC (Volatile Organic Compounds)) as well as the reduction of road congestion may be ancillary benefits brought about by the reduction of air travel. This is likely to produce a favourable impact on the health and quality of life for local residents and the environment.

3.2.2 Modal shift

Air pollutants

A shift from air to high speed rail will also decrease the emission of other air pollutants, such as CO, VOCs and NO_x, but would increase emissions of SO₂ (see Table 17). High speed rail uses more fuel and so will emit more emissions than conventional rail services. If the proportion of UK electricity generated by renewable sources is increased the emissions of electric trains would be less and if a greater proportion of rolling stock was electric rather than diesel this would also have an impact. The Sulphur Content Of Certain Liquid Fuels Directive sets maximum levels for the sulphur content of gas oil of 0.1% from 2008. This will lower emissions of SO₂ and PM₁₀ from diesel trains.

London to Manchester	Grammes per passenger journey					
	CO ₂	NO _x	PM ₁₀	CO	NMVOC	SO ₂
Car journey (single person)	52,943	330	8	2,162	297	7
High-speed rail (current)	12,920	31	2	6	1	71
Domestic air	99,046	99	3	130	13	9

Table 17: Emissions from Regional Journeys by Private Car, High-Speed Rail and Domestic Aircraft (100% occupancy) (CfIT, 2001).

Noise

It is difficult to compare noise as it is very location specific. A shift to rail may result in additional noise if the number of trains running is increased and in general higher speed trains generate more noise than conventional trains. Rail operates along a transport corridor and potentially an increase in rail noise could impact along the whole of this corridor, although it is only likely to be a nuisance in residential areas. Aircraft noise is associated with the region around an airport and its flight paths, and so a reduction in take-offs and landings would decrease noise impact for local residents. Anecdotal evidence suggests that the noise emitted from aircraft is generally deemed to have a more negative impact upon residents than that emitted from trains.

Land use and biodiversity

The impact of modal shift on land use and biodiversity are also difficult to predict. If a shift in demand from air to rail prevented airport expansion there would be benefits in terms of land use and biodiversity. Rail can also impact on biodiversity. For example, the rail network has around 30,000 hectares of line-side vegetation, and Network Rail land crosses over 400 legally protected sites, which are home to a variety of protected species (DfT, 2007b). If just the loading or frequency of existing rail services are increased there will be little additional impacts (apart from an increase in fuel consumption from the additional weight), however if new infrastructure such as rail tracks are constructed there will be additional environmental impacts associated with this.

3.3 Economic impacts

The reduction of a proportion of short-haul flights could also have a number of positive impacts on the economy. Likely economic impacts are complex and out of the scope of this paper, but a few points were raised in the literature. These include the fact that congestion around airports would be reduced therefore improving the efficiency of the road network, and that businesses could benefit from reduced costs associated with the need to conduct face to face meetings as a result of ICT. Literature suggests that house prices in certain locations could benefit from a reduction in aircraft noise, and that negative impacts on regional development and employment rates caused by a reduction in the growth rate of aviation tend to be overstated and are not necessarily correct.

Section B: Modal comparisons

1 Modal comparisons

This chapter attempts to compare the transport modes of coach, rail and air in relation to journey time, cost and CO₂ emissions.²⁰ The data was retrieved from searches of the services offered by various modes along the corridors which were identified to have the highest level of demand for air travel, and therefore theoretically the greatest chance for substitution.

1.1 Comparison of modes

The relative competitiveness of modes in relation to journey time, cost and CO₂ emissions is analysed in relation to seven different routes. Five of these are domestic routes which data has shown experience the highest volumes of short-haul air passenger movements in the UK (see Table 18 below). Despite the high volumes experienced on routes between London to Belfast International and City airports these have been excluded from this review as they are not readily accessible by rail or coach.

Route	Domestic passenger air travel movements
London to Edinburgh	5,619,309
London to Glasgow	4,594,575
London to Manchester	3,229,255
London to Belfast International	3,482,199
London to Belfast City	2,053,649
London to Aberdeen	1,935,152
London to Newcastle	1,675,013

Table 18: Routes identified as having the highest volumes of passenger air traffic based upon 2007 data (CAA, 2008).

The high volumes of demand for air travel along these corridors suggest that there could be the most potential for substituting air traffic movements on these routes. The CAA (2008) has indeed already noted that air travel movements have been in decline on these routes, and they have attributed part of this decline in air travel to competition from rail operators (see Table 5 in section 4 of the report).

A review of coach and rail services to Paris and Brussels has also been included to highlight the potential for substituting short-haul flights to mainland Europe destinations.

Route	Domestic passenger air travel movements
London to Paris	2,236,412
London to Brussels	898,088

Table 19: Air passenger travel movements between London airports, Brussels and Paris based upon 2007 data (CAA, 2008).

²⁰ The data for train journey times and costs was taken from www.nationalrail.co.uk and www.eurostar.com, that for coaches was taken from www.nationalexpress.co.uk, and the flight search www.opodo.co.uk was used to find flight times and costs.

All data in the following comparisons are for single journeys between any airport or station serving London, and any airport or station serving the named destination. Details of the assumptions made when compiling this data are outlined in the methodology section of this report.

1.1.1 Comparison of UK Domestic Routes

Journey time

The journey times for coaches were consistently the longest, and those for air travel consistently the shortest, given the assumptions made (see Figure 23 below). Notably there is little variation for distance in the times for air travel – rail travel was very competitive in journey time travelling between London and Manchester, but took over twice as long travelling to Aberdeen. The findings support the contention that rail can be competitive with aviation in terms of journey time for journeys of three hours in length and under.

Journey times did not vary significantly with time of day or length of booking period.

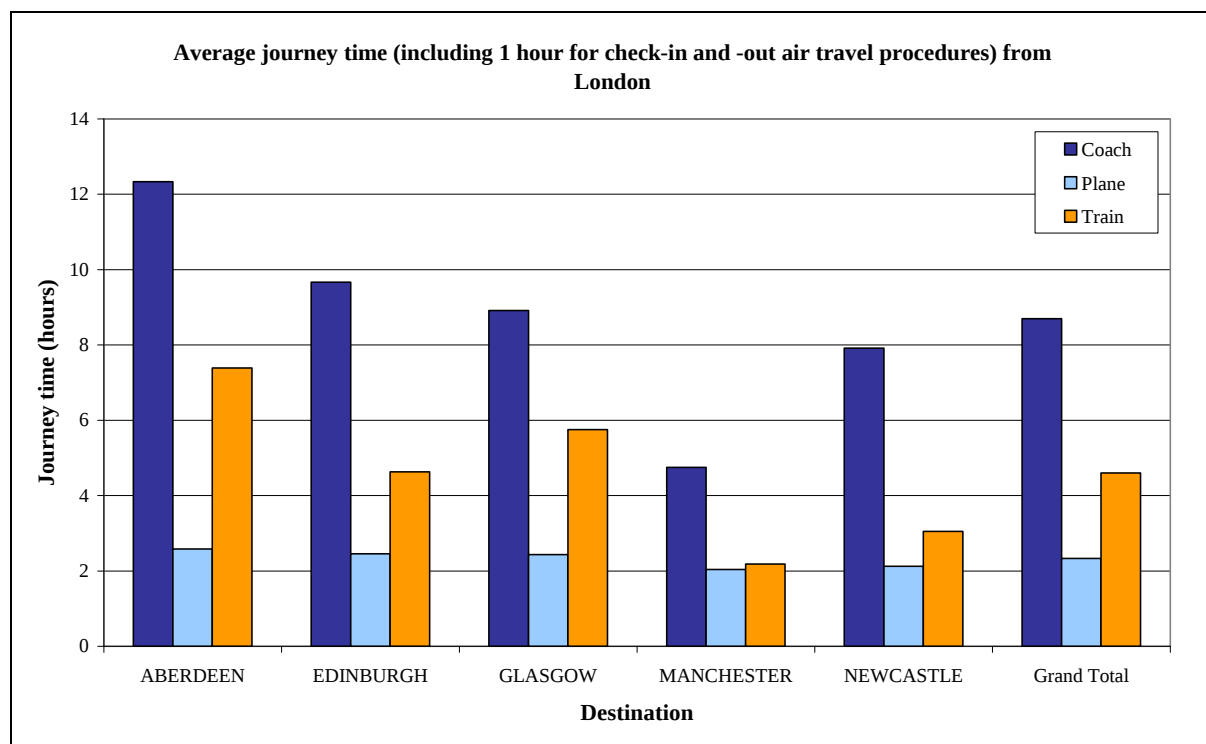


Figure 23: Average journey time for coach, plane and rail journeys along the corridors with highest demand for air travel movements.

Fare price

The average cost, shown in Figure 24 below, also showed a consistent relationship between the three modes. Air travel was consistently the most expensive and coach travel the cheapest, although train travel was virtually identically priced on some routes.

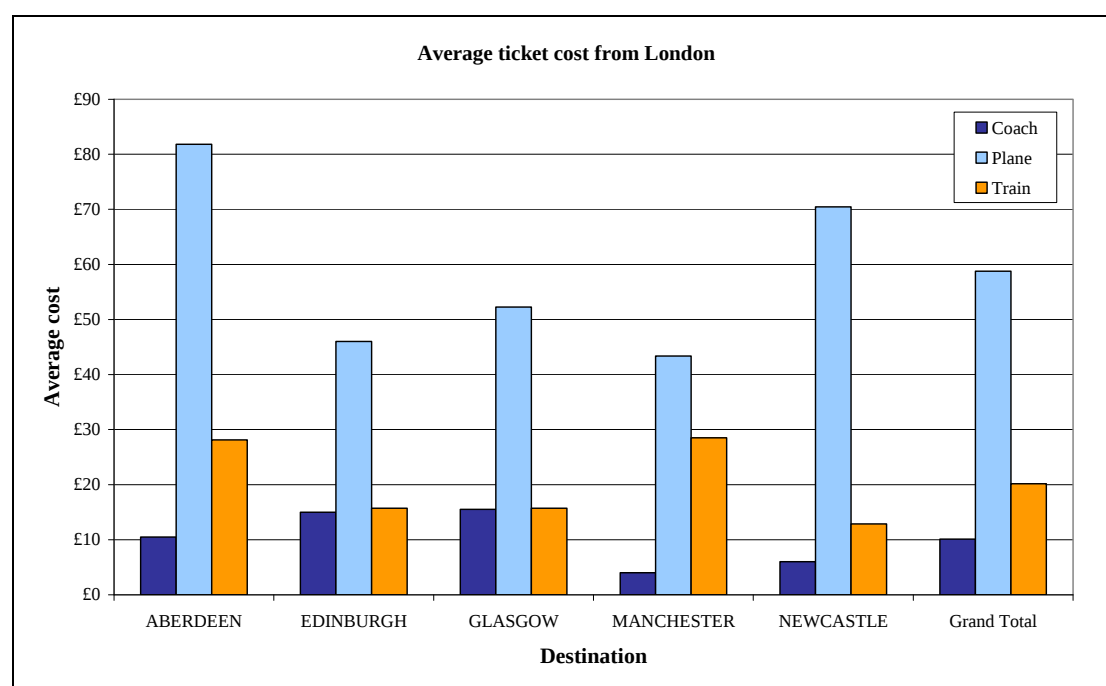


Figure 24: Average cost for coach, plane and rail journeys along the corridors with highest demand for air travel movements.

The cost of leaving before 9am on a weekday varied quite widely from the cheapest fare available on some routes, as shown in Figure 25 and Figure 26 below. In general coach prices were consistent at all times of travel (although no pre-9am departures were available to Edinburgh and Newcastle).

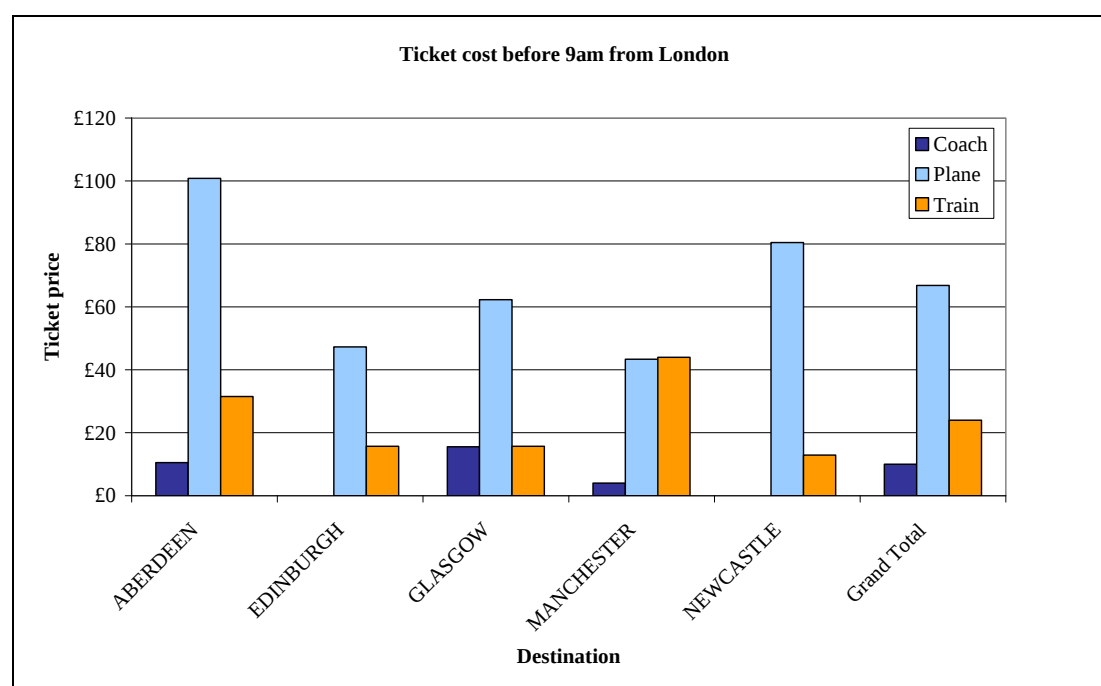


Figure 25: Average cost for the cheapest coach, plane and rail journeys undertaken before 9am along the corridors with the highest demand for air travel.

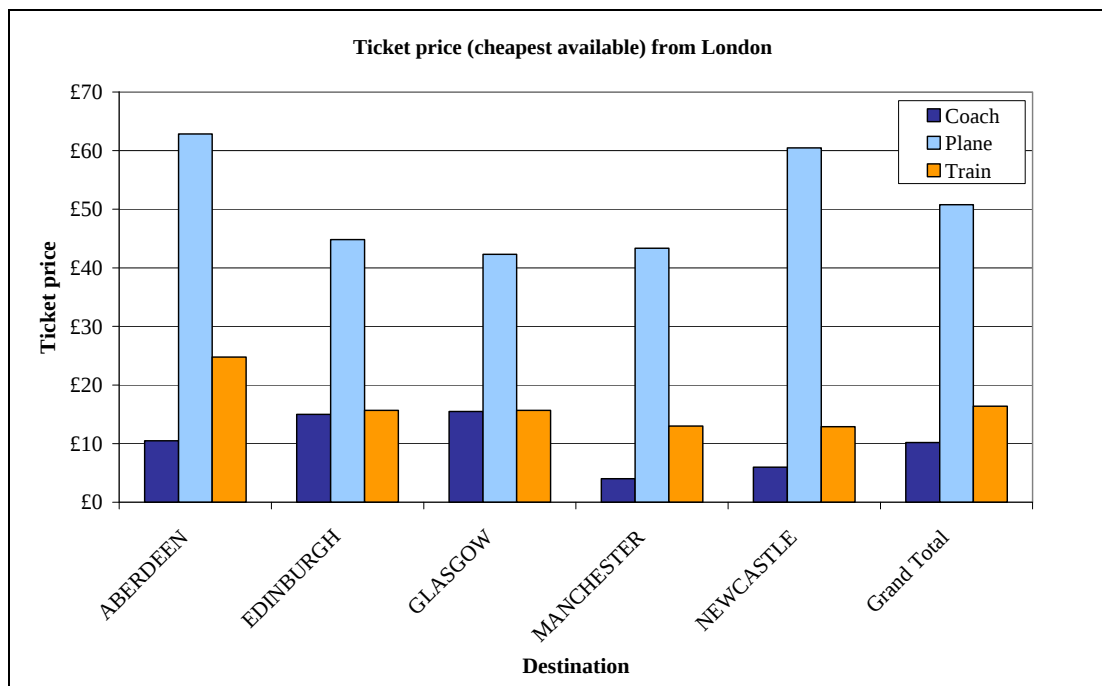


Figure 26: The cheapest fare available for coach, plane and rail journeys undertaken at any time along the corridors with the highest demand for air travel.

In general the cost of plane journeys did not seem to correlate well with the time of departure – in cases where reductions are seen, this is likely to be because the cheapest flight happened to occur at a different time of day. It was only in the case of train journeys that a noticeable trend for prices to be higher during the morning peak was found.

Whilst it may be possible to obtain a cheaper fare given more extensive effort, these values represent the picture that is initially presented to the traveller.

In one case (travelling from London to Manchester) the premium for leaving before 9am pushed the price of the train ticket to be higher than that of the equivalent journey by plane.

Finally the prices were split by the amount of advance notice available – one week or one month. Lower prices were often available for travellers booking one month in advance, but this was not always the case (see Figure 27 overleaf).

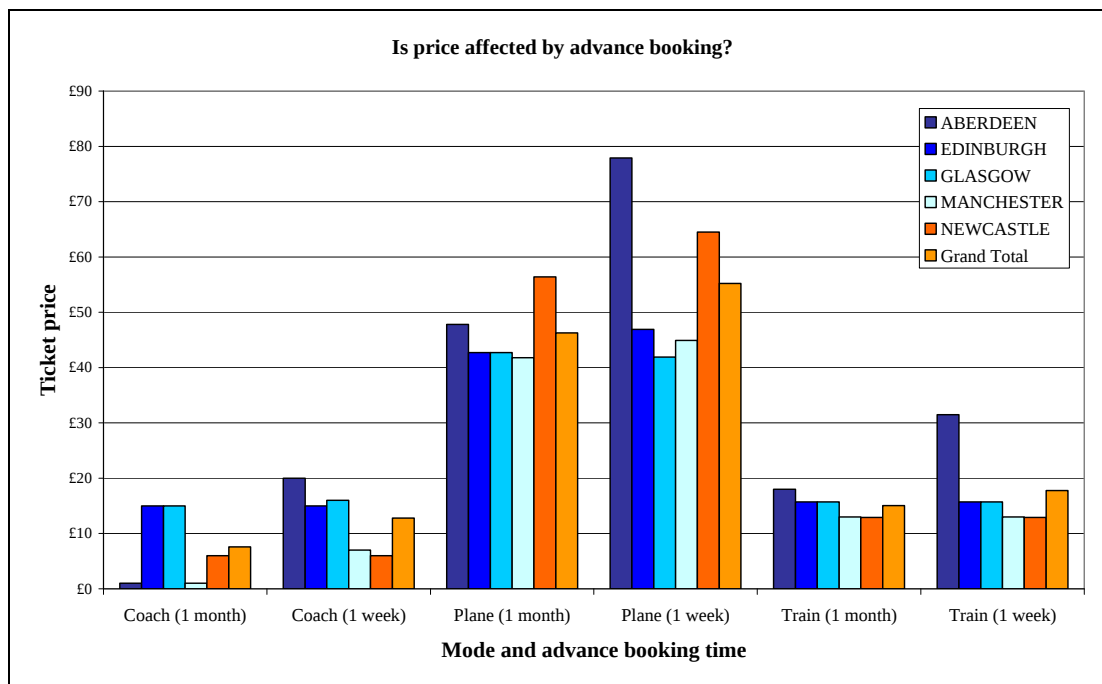


Figure 27: Comparison of the cost of coach, rail and plane journeys when booked one month and one week in advance of travel.

Environmental impact

Figure 28 below shows the comparative CO₂ emissions for each mode of transport in g/ passenger km. These are highly dependant on the assumptions made, so this chart should be reviewed with the assumptions outlined in the methodology in mind.

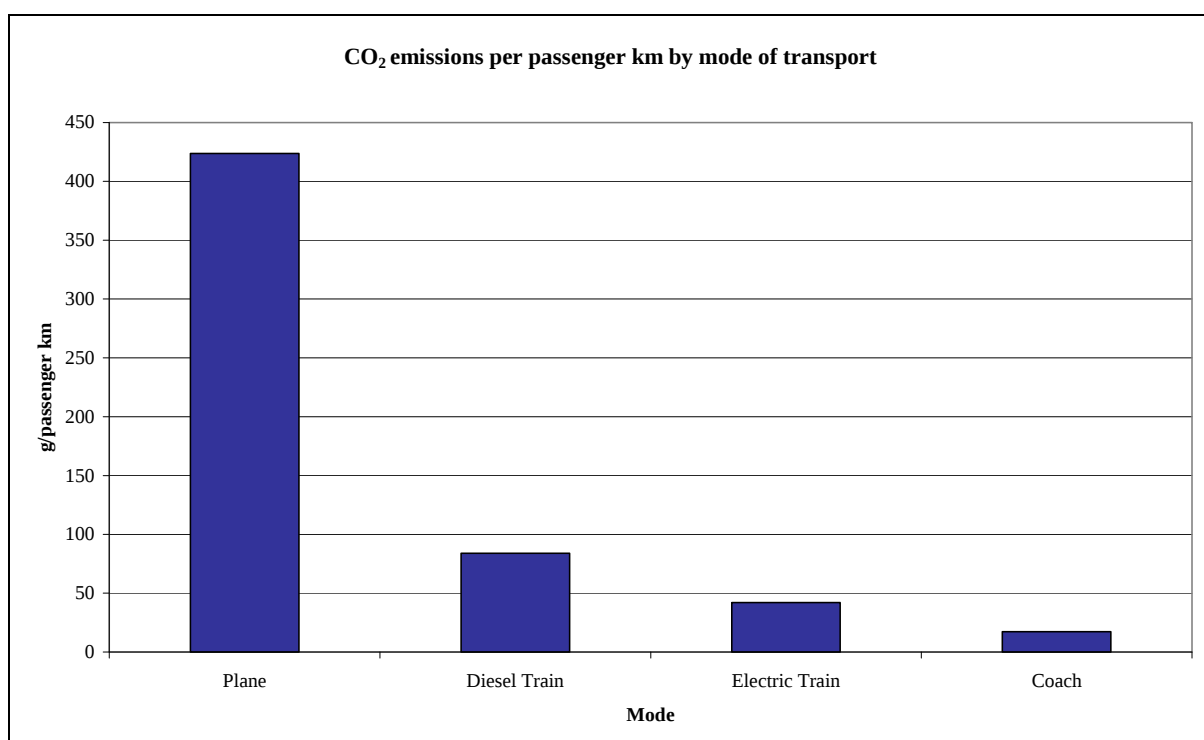


Figure 28: Comparison of the CO₂ emissions of planes, coach, diesel and electric trains.

The degree of caution that is required when drawing conclusions based upon this emissions data can be inferred from the chart below which indicates the extent to which CO₂ emissions data can vary according to assumptions made. Assumptions can be made on a range of factors such as occupancy levels, length of journey, age and type of vehicle and speed.

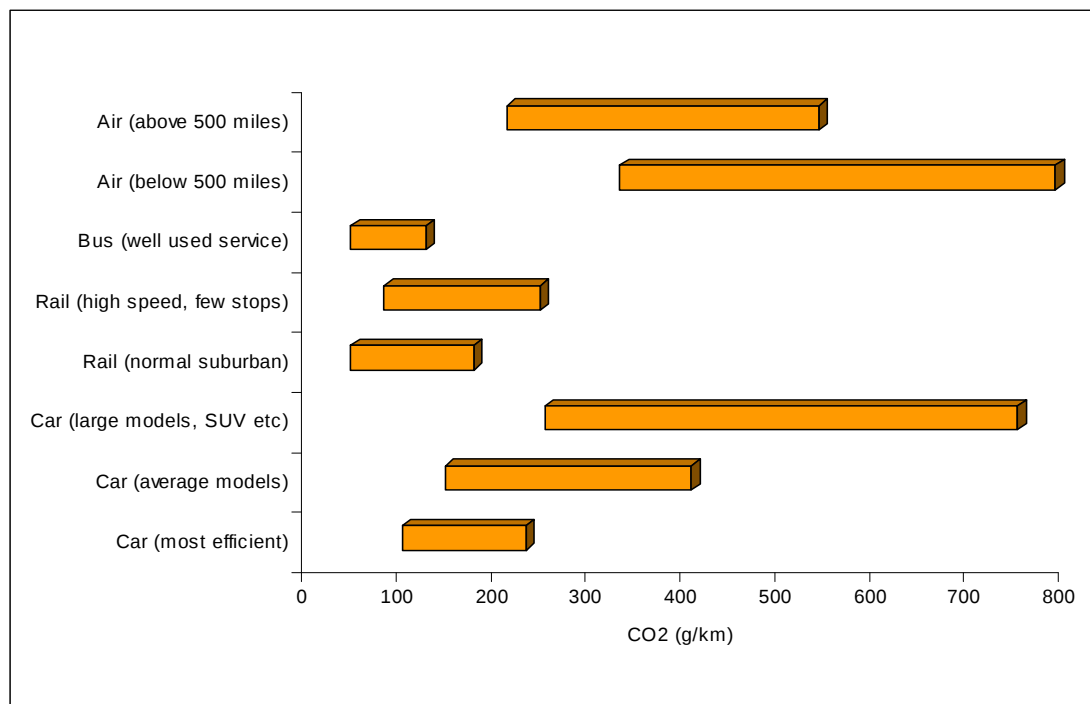


Figure 29: Extent to which CO₂ emissions vary in accordance with assumptions made (Adapted from AEF, 2007).

1.2 Comparison of Short-Haul European Routes

Journey time

Figure 30 shows the journey times for these international journeys. While coach travel is still much slower than the other modes, train travel is very competitive with aviation. The trains used on the Eurostar route are significantly faster than domestic train travel in the UK.

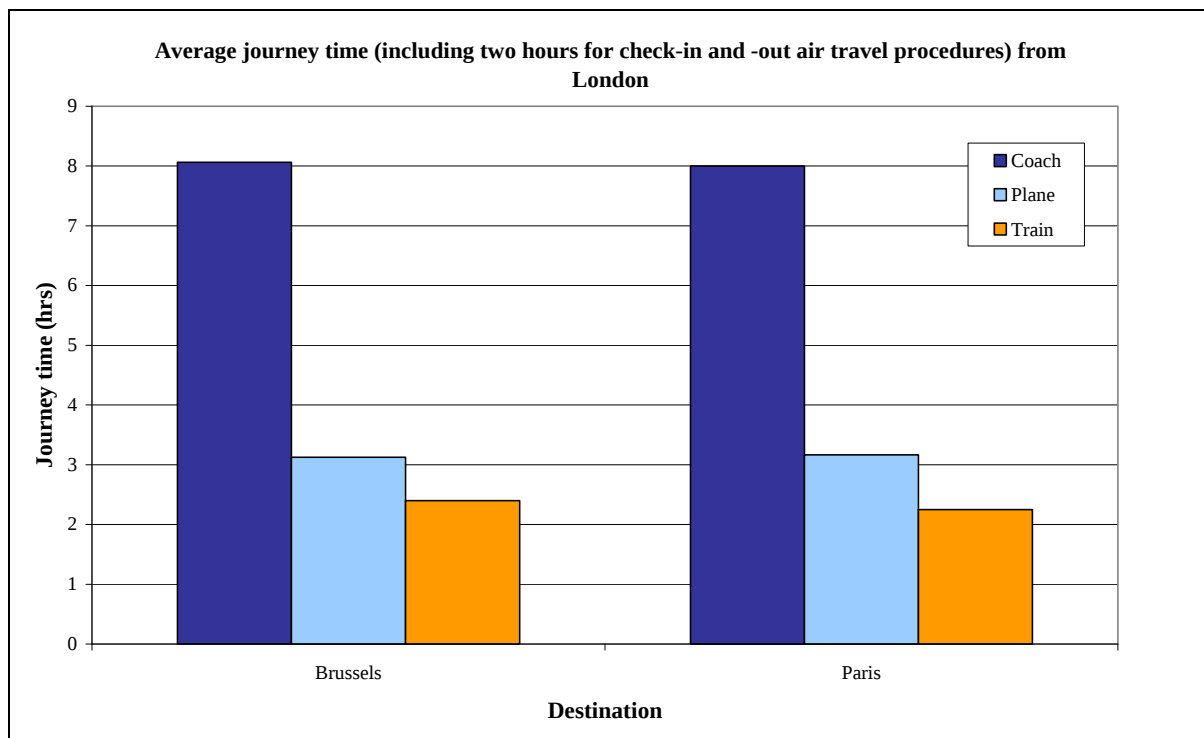


Figure 30: Average journey time for coach, plane and rail journeys between London, Brussels and Paris

Fare price

Figure 31 overleaf shows that the train tends to be the most expensive method of travel for journeys to Brussels and Paris, with coaches again being the cheapest option.

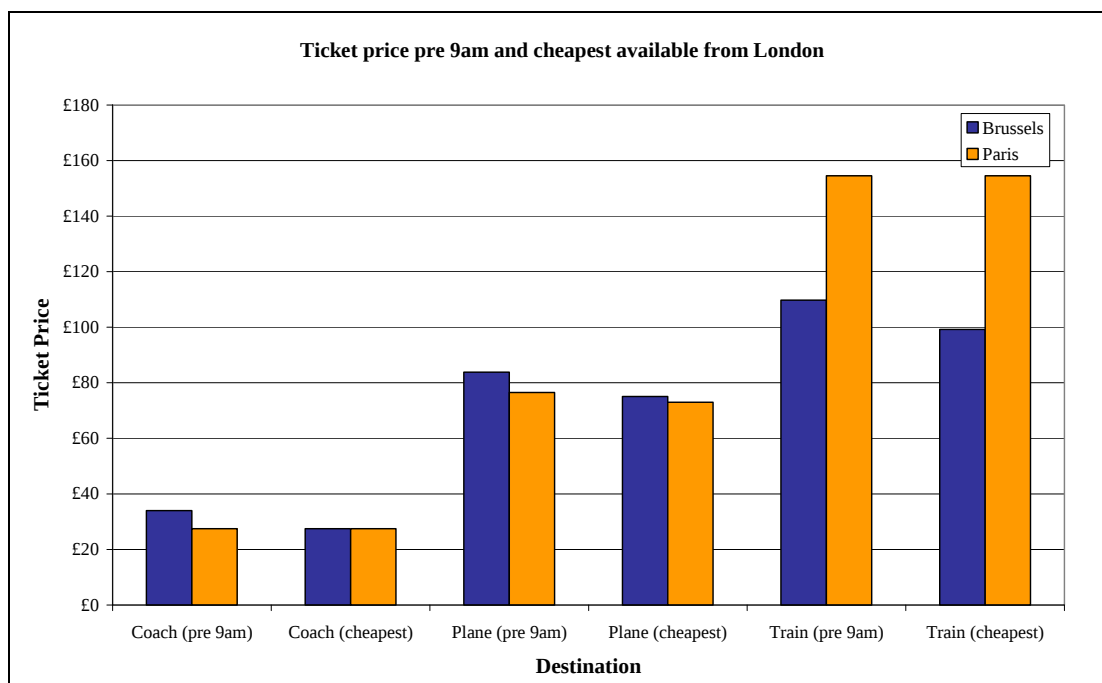


Figure 31: The average fare before 9am on a weekday and the cheapest fare available for coach, plane and rail journeys from London to Brussels and Paris.

Exploring this further in Figure 32 we see that although some advance tickets are available, which made train travel comparable in cost to aviation, these tickets are not always available. Interestingly,

coach journeys were consistently cheaper when booked a week in advance compared to booking a month in advance.

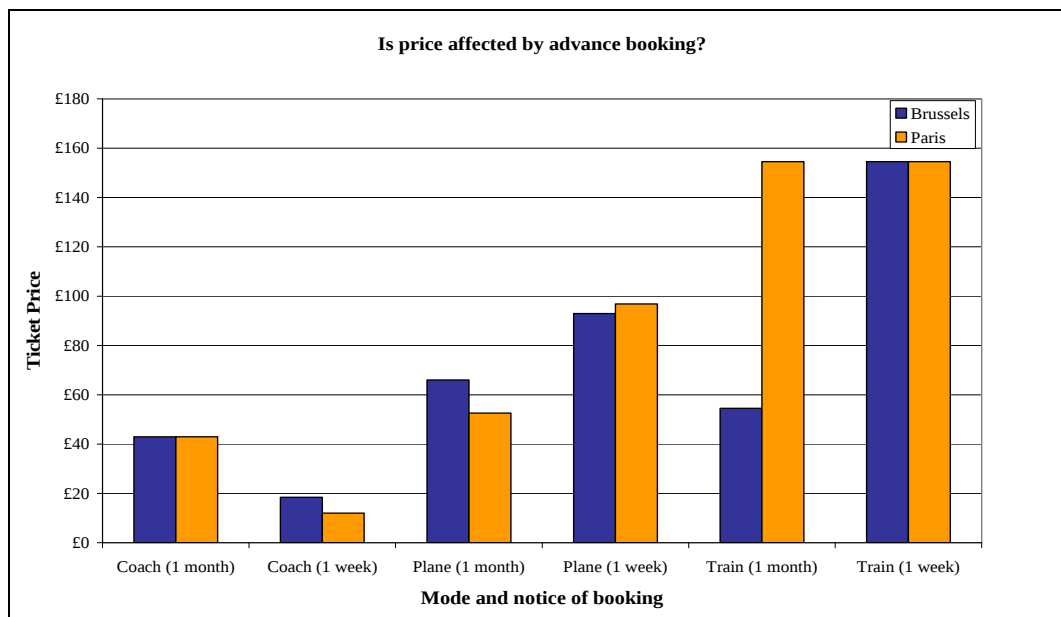


Figure 32: Comparison of the cost of coach, rail and plane journeys when booked one month and one week in advance of travel.

Environmental impact

No attempt to perform a CO₂ emissions comparison for the international journeys was attempted. Attempting to account for the electricity mix of the Eurostar trains and the distribution of emissions per passenger of coaches travelling through the channel tunnel means a meaningful comparison is beyond the scope of this project. The most robust comparison that has been made to date was conducted by Paul Watkiss Associates and AEA Technology Environment (2006) as detailed in Section 6.1.2 (see Table 13). They found that on routes between London to Paris and London to Brussels Eurostar was more energy efficient than air travel. They estimated that air travel generated between 8 and 11 times more CO₂ than rail travel on these routes.

Section C: Consultations with organisations

1 Research findings

If air travel movements are to be substituted for interactions via telecommunications it is important to gain an understanding of the perceptions and attitudes of employees towards air travel and teleconferencing. As highlighted by the literature review, little research has been conducted into the ability of applications such as teleconferencing to act as an alternative to travel, and in particular in relation to aviation. This lack of evidence is a barrier to making accurate assumptions regarding the ability of telecommunications to reduce the need to travel. A robust scientific analysis of the likelihood of reducing business air travel via the use of telecommunications is beyond the scope of this report. Instead we conducted a small number of consultations to gain an indication of the potential for substitution. The small sample size cannot be representative of industry as a whole, but the diverse range of organisations contacted will enable some qualitative conclusions to be drawn.

The analysis that follows therefore seeks to gain an indication of:

- Current use of telecommunications;
- The importance accorded to meeting people face to face;
- Corporate policy;
- Attitudes towards the environment, teleconferencing, and air travel.

1.1 Current levels of air travel

All of the organisations surveyed (n=10) state that a proportion of their employees fly for business purposes. The employees who do fly do so at least once every six months.

Table 20 below shows the proportion of employees that fly for business purposes for ten of the eleven organisations surveyed, and the approximate frequency with which these employees fly. There does not appear to be a relationship between the location, sector or size of organisations and the proportion of employees that fly for business purposes. Nor does there seem to be any relationship between the proportion of employees that fly and the frequency with which they fly. The sample size is not large enough to determine whether there is a relationship between the proportion of employees that fly and whether the organisation is multinational. The lack of identifiable trends could be owing to the sample size, although it is also likely that the large number of internal factors that can have an impact upon whether, and how often, employees travel for business leads to considerable variations between organisations with otherwise similar characteristics, particularly as many decisions are made on an individual level.

Organisation	Location of respondent	Multiple offices in...		% of employees who fly for business purposes	Average frequency of flights undertaken by those who fly for business
		UK	Internationally		
Keltie	London	X	X	20%	Monthly +
Business consultancy	Nottingham	✓	X	5%	Six monthly +
Grass Roots Group	Tring	✓	✓	15%	Monthly +
Global services company	Hook	✓	✓	40%	Weekly +
European recruitment consultancy	London	✓	✓	40%	Six monthly +

European bank	London	✓	✓	20%	-
NERC	Swindon	✓	X	8%	Six monthly +
Aviva	London	✓	✓	-	Monthly +
Global cosmetics company	London	✓	✓	5%	Six monthly +
Global professional services organisation	Edinburgh	✓	✓	10%	Monthly +
BT	India ²¹	✓	✓	80%	Monthly +

Table 20: Levels of air travel within the participating organisations

All of the organisations that responded to this question detailed that employees within their organisation who fly for business purposes do so at least once every six months. As shown in Table 20 above the global services company is the only organisation with employees that tend to fly once a week or more. Two of the three organisations that are not multinational are amongst the four organisations who fly the least frequently (at least once every six months).

As shown in Table 21 below, six of the ten organisations that gave information about the destination of business flights detailed that their employees undertake domestic flights. All of the organisations surveyed have employees that fly to Europe, nine of which also undertake long haul flights. Basic analysis of the results indicate that smaller organisations tend to make fewer domestic flights relative to larger organisations and that smaller organisations tend to make more long-haul flights. This could be because these companies do not have branches within these countries. The size of an organisation doesn't appear to have any bearing upon the percentage of European flights undertaken, and nor does the sector or whether an organisation is multinational.

Organisation	Location of respondent	Multiple offices in...		Destination of flights		
		UK	Internationally	UK	Europe	Long-haul
Keltie	London	X	X	0%	50%	50%
Business consultancy	Nottingham	✓	X	0%	95%	5%
Grass Roots Group	Tring	✓	✓	20%	40%	40%
Global services company	Hook	✓	✓	0%	80%	20%
European recruitment consultancy	London	✓	✓	0%	100%	0%
European bank	London	✓	✓	10%	10%	80%
NERC	Swindon	✓	X	80%	19%	1%
Aviva	London	✓	✓	58%	9%	33%
Global cosmetics company	London	✓	✓	-	-	-
International professional services organisation	Edinburgh	✓	✓	40%	40%	20%
BT	India	✓	✓	50%	25%	25%

Table 21: Destinations of flights undertaken by business travellers

²¹ BT's international Travel Procurement Support team are located in India.

1.2 Current levels of teleconferencing

All of the organisations that responded to this question (n=10) state that employees within their organisation use teleconferencing facilities, although the level of usage appears to vary greatly.

The ten organisations that responded to this question detailed that their employees use telecommunications, although the level of usage within organisations appears to vary greatly as shown in Table 22 overleaf, as does the frequency with which they are used. Responses do indicate that the use of telecommunications within larger organisations may be more widespread. There is also the indication that where ICT facilities are used by more employees they are also used more frequently by these employees than where usage is less widespread. Responses indicate that a potential trend could be that multinational companies make more use of ICT applications for interacting. This could be related to the fact that internal meetings are the purpose that organisations consider to be the most conducive to interactions via ICT.

There does not appear to be a relationship between the usage of teleconferencing facilities and business sector, which would not be surprising as client base and journey purposes, which can vary widely within sectors, could be considered to have more of an impact.

Organisation	Location of respondent	Multiple offices in...		% of employees who use teleconferencing facilities	Average frequency of use of teleconferencing facilities by those who use them
		UK	Internationally		
Global cosmetics company	London	✓	✓	-	-
Business consultancy	Nottingham	✓	X	1%	Six monthly +
Keltie	London	X	X	10%	Monthly +
European recruitment consultancy	London	✓	✓	100%	Weekly +
Global services company	Hook	✓	✓	40%	Monthly +
European bank	London	✓	✓	40%	-
Grass Roots Group	Tring	✓	✓	50%	Monthly +
Aviva	London	✓	✓	60%	-
International professional services organisation	Edinburgh	✓	✓	60%	Weekly +
NERC	Swindon	✓	X	80%	Weekly +
BT	India	✓	✓	99%	Weekly +

Table 22: Levels of use of teleconferencing facilities within the participating organisations

1.3 Relationship between levels of business air travel and use of telecommunications

Teleconferencing facilities tend to be used more widely within organisations than business flights are undertaken.

The responses, as shown in Table 23 overleaf, indicate that teleconferencing facilities are used more widely within organisations than business flights. It is only within Keltie and the business consultancy that more employees tend to fly for business than use teleconferencing facilities. These are two of the smallest companies surveyed, and so perhaps smaller organisations have fewer, or less

sophisticated, teleconferencing facilities in house. This contention is supported by the fact that Keltie is the only organisation that does not think that the quality of teleconferencing facilities is adequate to replace face to face communication for any purpose. Keltie and the business consultancy are also two of the three companies surveyed who are not multinational and so do not have employees located overseas to meet clients within other countries and who do not need to communicate with internal colleagues via ICT.

The responses show that the global services company is the only company within which employees take flights more frequently than they use teleconferencing facilities. It is interesting to note that the global services company is also the only organisation to use external teleconferencing facilities, which indicates that they are less readily available for employees to use than in organisations where the facilities are internal.

Organisation	Levels of teleconferencing use		Levels of business air travel	
	% of employees who use teleconferencing facilities	Average frequency of use of teleconferencing facilities by those who use them	% of employees who fly for business purposes	Average frequency of flights undertaken by those who fly for business
Global cosmetics company	-	-	5%	Six monthly+
Business consultancy	1%	Six monthly +	5%	Six monthly+
Keltie	10%	Monthly +	20%	Monthly+
Global services company	40%	Monthly +	40%	Weekly+
European bank	40%	-	20%	-
Grass Roots Group	50%	Monthly +	15%	Monthly+
Aviva	60%	-	-	Monthly+
International professional services organisation	60%	Weekly +	10%	Monthly+
NERC	80%	Weekly +	8%	Six monthly+
BT	99%	Weekly +	80%	Monthly+
European recruitment consultancy	100%	Weekly +	40%	Six monthly+

Table 23: Levels of business air travel and teleconferencing use

1.4 Future usage of telecommunications and business air travel

All of the organisations surveyed (n=11) agree that telecommunications can reduce the need to travel.

The nine respondents who answered the question stated that the use of teleconferencing within their company has increased over the last five years. Two of these companies, NERC and the international professional services organisation, also feel that business air travel has decreased over this period. Four respondents, Keltie, the business consultancy, Grass Roots Group and the European recruitment consultancy, felt that levels of business air travel had also increased over this period. This indicates that whilst the increased use of telecommunications is not necessarily leading in a direct reduction in the number of flights undertaken, it could be reducing the level of growth with remote interactions therefore substituting some of the demand. This contention is supported by the fact that all of the eleven organisations agreed that 'telecommunications can reduce the need to travel.' No one felt that

telecommunications have increased the need to travel, or that telecommunications were not able to reduce the need to travel. Eight of the ten organisations who responded to the question answered that they felt that there was scope to further increase the usage of telecommunications within their organisation in the future. One of the organisations who did not feel that there was scope to increase their use of telecommunications was BT owing to the already extensive use of telecommunications across their organisation. The other organisation is Keltie, who feels that the quality of teleconferencing facilities prevents more extensive use.

1.5 Corporate Policy

Only two organisations (n=11) have a policy that discourages air travel.

Levels of business air travel are only likely to be reduced if organisations are committed to this aim and if all parties are aware of the desirability of travel reduction strategies (Bannister and Marshall, 2000). All of the organisations contacted have a CSR policy in place, which highlights an awareness of concerns over the impact that their operations have. The respondent from the European bank, which has its headquarters in Europe, was unaware of whether their CSR policy incorporates aviation. This indicates that little consideration may be given to the environmental impact of aviation within this company, which is interesting given that it operates on an international level. Responses state that the CSR policies at both the European recruitment consultancy and Keltie do not discourage employees from flying. Indeed these two organisations are the only two who state that the environmental impact of a business decision does not have an impact upon whether or not it is implemented. Along with the European bank, these are also the only two organisations to state that the cost effectiveness of an interaction is more important than its environmental impact.

No organisations have a policy which ‘strongly discourages’ employees from using air travel for business purposes, and only two (NERC and the global cosmetics company) have a policy which discourages air travel. The other six organisations encourage employees to consider alternatives to aviation, all but one of which (BT)²² details that there is scope to increase use of telecommunications within their organisation. This suggests that if organisations are made more aware of the role that telecommunications can play as an alternative to aviation, and if this is effectively communicated throughout the company, then some substitution effects may be experienced. This of course assumes that CSR has an impact upon the decision of whether or not to fly for business. BT, the global services company and the international professional services organisation all state that CSR does not necessarily impact the travel behaviour of employees. This indicates that any interventions to increase use of telecommunications should be targeted at the employees throughout the organisation, as it is ultimately individuals that make the decision of how, or whether, to travel for business, but it also highlights the need for CSR policies to be better integrated into the day to day operations of organisations.

There appears to be a general awareness that being seen to be ‘green’ is important for the brand of a company, with only the European recruitment consultancy and the global cosmetics company disagreeing with this statement.

1.6 Availability of teleconferencing

All but one of the organisations surveyed (n=11) have teleconferencing facilities available in-house.

Audio and videoconferencing were the most frequently used forms of teleconferencing with seven out of the ten organisations who answered this question stating that they use both of these. All but one of the organisations surveyed stated that they used either video or audio conferencing. Keltie and NERC use videoconferencing rather than audioconferencing, and the business consultancy and the European

²² BT does not feel that there is scope to increase use of telecommunications as they are already used extensively throughout the organisation.

recruitment consultancy use audioconferencing but not videoconferencing. The only organisation not to use either of these teleconferencing applications is the European bank, who is one of three organisations surveyed (the others being Aviva and the European recruitment consultancy) that use telepresence to interact. Only one of these three organisations were able to give an accurate estimate of how often the telepresence systems were used, which is the European recruitment consultancy who use the application once a week or more. The European bank and Aviva also stated that they used web conferencing applications.

Three organisations were unable to give an accurate estimate of how often teleconferencing facilities are used, although all but one of the other organisations (the business consultancy, who use teleconferencing at least once every six months) said that they use them once a month or more (Keltie, Grass Roots, and the global services company), if not once a week or more (NERC, BT, the European recruitment consultancy and the international professional services organisation). There does not seem to be a correlation between the size of an organisation, or the sector in which it operates, and the extent to which it uses ICT applications for remote collaboration.

The global services company is the only organisation to use external audio and videoconferencing facilities, which they use once a month or more. These facilities are used by approximately 40% of their employees, which indicates that they may benefit from having internal access. All of the other organisations have teleconferencing facilities available in house. The internal availability of teleconferencing facilities does not, however, mean that they are frequently used. BT, NERC, the international professional services organisation and the European recruitment consultancy are the only organisations to use the internal facilities once a week or more, which suggests that in many organisations there could be scope to increase their usage. Almost all of the employees within BT and the European recruitment consultancy make use of these facilities, and in the international professional services organisation approximately 60% of employees use them. None of the organisations surveyed use both internal and external facilities, although some organisations may benefit from the availability of both. External facilities can, for example, give access to a wider range of ICT applications than may be available in-house, and to more sophisticated technology.

Grass Roots Group, the business consultancy and the European recruitment consultancy state that business air travel within their organisations is increasing. All of these organisations have teleconferencing facilities available in house, although only a minimal number of employees within the recruitment consultancy use these facilities, and these employees only make use of them at least once every six months. Of the organisations who feel that business air travel within their organisations is likely to increase only the European recruitment consultancy makes extensive use of teleconferencing facilities, with almost all employees using them once a week or more.

Business air travel is decreasing within NERC and the international professional services organisation, and in both of these organisations teleconferencing facilities are used once a week or more by 80% and 60% of employees respectively using these facilities.

1.7 What affects the decision of whether or not employees use air travel for business?

The largest influence on behaviours amongst the sample is client requirements.

Over half of the organisations consulted with stated that the following factors influence the decision of whether or not employees use air travel for business (n=11);

- Cost effectiveness (agreed by nine organisations);
- Client requirements (eight organisations);
- Time (seven organisations);
- Availability of technology (seven organisations);
- Pricing (six organisations);
- Environmental impact (six organisations).

Reliability was also considered to be important by five organisations, although CSR (three organisations) and safety (only one organisation), appear to be considered to be less important.

The largest influence on behaviours appears to be client requirements, with five organisations stating that this is the main consideration. Two organisations (the business consultancy and Aviva) detailed that time was the largest influence, with a further two (the global services company and the European bank) stating that cost effectiveness is the main consideration. NERC stated that their main concern was the reliability of air services and of teleconferencing technology.

1.8 Trip purpose

There is the most opportunity for internal meetings to be conducted by telecommunications, although little potential for external meetings with new clients, or networking, to be conducted remotely.

The decision of whether to travel will inevitably vary depending on the purpose of the journey to be undertaken.

The responses of organisations, detailed in Table 24 overleaf, indicate that telecommunications can fulfil all of the trip purposes that organisations were questioned about. The international professional services organisation also detailed that in-house training events could be effectively conducted via telecommunications. There is no apparent trend in relation to the size, sector, or number of branches that an organisation has and the predilection for purposes being fulfilled by air travel or telecommunications.

Purpose	Purpose of flying (N=11)	Purpose of telecoms (N=10)
Attending external meetings (with clients)	10	8
Attending internal meetings (with colleagues)	7	10
Networking	3	3
Conference attendance	8	3
Marketing activities	3	2
Generating sales	2	1

Table 24: The main purposes cited by respondents for using air travel and telecommunications

Only one organisation, Keltie, felt that telecommunications could not effectively replace face to face interactions for any purpose.

There appears to be a preference amongst the sample for external meetings to be conducted face to face, and to attend conferences physically, but for internal meetings to be conducted via telecommunications. Attitudes towards other types of trips tend to be more divided.

Respondents were also asked about the type of trip purposes that could most effectively be conducted by telecommunications, and those for which they thought face to face communication would be irreplaceable. Their responses indicate that there is likely to be the most opportunity for internal meetings to be conducted by telecommunications. All of the organisations, with the exception of Keltie, felt that internal meetings could be conducted most effectively remotely, rather than face to face. It is important to note, however, that Keltie has only one office, and so this question will not apply to them.

There also appears to be a potential, albeit fairly limited, for the following types of trips to be conducted by telecommunications:

- Conference attendance;
- Marketing activities;
- Generating sales.

Attending external meetings with existing clients

The opinion of respondents was divided over whether meetings with external clients could be conducted remotely or not. Seven of the organisations surveyed felt that meetings with existing external clients could more effectively be conducted remotely, whilst the other four (Keltie, the European bank, NERC, and the international professional services organisation) felt that it would be impossible to replace face to face communication for external meetings. This suggests that the attitude of individuals arranging such meetings is likely to have a particularly large bearing upon whether telecommunications will be able to reduce levels of business air travel to meet external clients. Attending external meetings was the main purpose for which the organisations undertook flights, which will make it particularly beneficial to increase awareness of both the clients and the organisation itself of the benefits, and impacts, of using teleconferencing instead of meeting face to face.

Conference attendance

NERC and the European bank both thought that remote conference attendance would be more effective than physical attendance. Three of the other organisations stated that remote conference attendance would be viable (BT, Aviva, and the international professional services organisation), whilst the other six considered this to be impossible. Conference attendance was detailed as being one of the main purposes of business flights.

Marketing activities

The international professional services organisation was the only company that felt that marketing activities could be conducted effectively remotely. Four other organisations (Aviva, the global services company, the global cosmetics company and the European recruitment consultancy) did, however, feel that marketing could possibly be conducted remotely. The other six organisations that participated thought that it would be impossible to market services and products without face to face communication.

Generating sales

Aviva was the only organisation who felt that sales could be generated remotely more effectively than face to face. Half of the other participating organisations thought that it would be impossible for sales to be generated remotely, whilst the other half thought that it might be possible.

Responses indicate that there is not likely to be the potential for external meetings with new clients, or networking, to be conducted remotely. None of the organisations surveyed felt that meetings with new clients would be conducted by telecommunications and Aviva and BT were the only organisations who thought that networking could be conducted more effectively remotely than face to face. The international professional services organisation was the only other organisation that considered that networking may be possible remotely – the other eight organisations stated that remote networking would be impossible.

Other

The international professional services organisation also considered that in-house training programmes could be conducted more effectively remotely.

1.9 Attitudes towards telecommunications and air travel

All of the organisations surveyed agreed that teleconferencing is convenient, can save time and money, enables greater control over time and is less stressful than air travel, and can enhance an organisations corporate image and CSR credentials.

Organisations were asked to provide an overview of their attitudes towards telecommunications and business air travel. Respondents' level of agreement with statements relating to telecommunications and air travel was measured according to five categories: 'strongly agree,' 'agree,' 'neither agree nor disagree,' 'disagree,' or 'strongly disagree.' The statements have been grouped below to give an indication of the perceived strengths and weaknesses of telecommunications, and of the factors that compromise the potential for telecommunications to substitute levels of business air travel.

Perceived strengths of telecommunications relative to air travel

Eight of the eleven respondents agreed that telecommunications offer many benefits relative to air travel, and none of the organisations surveyed felt that there are no drawbacks associated with business air travel.

Attitudes towards the positive statements towards teleconferencing and the negative statements towards air travel indicate that on the whole organisations perceive that the relative advantages of using teleconferencing applications are:

- Teleconferencing can save time/air travel is very time consuming (no organisations disagreed with either statement);
- Teleconferencing can save money/business air travel incurs a range of additional expenses (no organisations disagreed with either statement);
- Telecommunications enable greater control over time than interactions involving air travel (no organisations disagreed);
- Telecommunications are convenient to use (no organisations disagreed);
- The use of teleconferencing facilities can enhance an organisations CSR credentials and corporate image (no organisations disagreed, although Keltie and the European recruitment consultancy did not agree that flying has a negative impact on CSR);
- The use of telecommunications tends to be less stressful than air travel (no one disagreed);
- The quality of the technology is adequate (only Keltie and Grass Roots felt that it was poor);
- Telecommunications are reasonably priced (only NERC and BT disagreed)
- Air travel is not reasonably priced (only the European bank and BT disagreed);
- Teleconferencing facilities enable meetings to be arranged at short notice and are easier to arrange than those necessitating air travel (Keltie was the only organisation not to agree with these two statements);
- Teleconferencing facilities enable a larger number of employees to attend meetings than would have been able to travel by air (only the global cosmetics company disagreed);
- Teleconferencing technology is not difficult to use (only NERC disagreed)
- Delayed or cancelled flights have been a problem (only the European recruitment consultancy and the global cosmetics company have not experienced problems relating to delayed or cancelled flights);
- Teleconferencing facilities enable employees to have a better work/life balance (only the global cosmetics company and NERC disagreed, although the European recruitment consultancy did not feel that flying necessarily has a negative impact upon work life balance).

Perceived weaknesses of telecommunications relative to air travel

BT and the global cosmetics company were the only two organisations to agree that telecommunications have no drawbacks, and all but two of the organisations surveyed (NERC and Keltie) felt that flying offers many benefits relative to interacting via telecommunications

The responses indicate that the main drawback of teleconferencing is that it cannot replace face to face contact, with only Grass Roots disagreeing with this statement. Related to this point is the fact that face to face contact can make it easier to build a working relationship, and that teleconferencing cannot always meet all of the objectives of an interaction. Grass Roots also noted that face to face meetings provide more opportunities for socialising, whilst teleconferencing interactions tend to be strictly business. The global services company also finds that personal contact is of particular importance for organisations as business is done on trust. Similar to this concern is that Keltie note that a key drawback of telecommunications is that subtleties of body language are not conveyed, which again makes it more difficult to build a rapport and leads to the perception that air travel is the only viable way of doing business with overseas clients.

Aviva and BT are the only organisations that find that telecommunications can make it easier to build a working relationship rather than meeting face to face, and disagree with the statement that meetings tend to be less effective when conducted via telecommunications. It is unclear as to the extent to which they regard air travel as being complementary to these remote interactions.

BT is the only organisation to find that telecommunications can meet all objectives of an interaction. This could be owing to the fact that the level of sophistication of teleconferencing facilities within their organisation is likely to be higher, or as high, as that used within other companies.

NERC noted that the need to provide training and support to staff to enable use of telecommunication facilities and knowledge of the systems is also considered to be drawback.

Statements that organisations neither agree nor disagree with

The responses from the eleven organisations indicate that there is a lack of consensus over the following statements, with many organisations neither agreeing nor disagreeing with them. The sample size is too small to enable any firm conclusions to be drawn from these responses, but it could be considered that these are factors which do not feature highly in the decision making process when deciding whether to conduct an interaction via telecommunications or face to face via air travel. Statements for which responses were conflicting and where several organisations neither agreed nor disagreed are:

- Flight schedules are convenient;
- Airports are difficult to access. Companies that disagreed with this statement are located in London, with another in Edinburgh, which has its own airport, and another in Hook, which has relatively easy access to the London airports. Organisations that find airports difficult to access are located in Swindon, Nottingham, and another in London.
- Air travel is comfortable;
- In-flight service and entertainment/facilities are good;
- I have concerns over the safety/security of either myself or my luggage.

1.10 Impact of policy interventions

All but one of the organisations surveyed (n=10) feel that increased awareness of alternatives to aviation could reduce levels of business air travel.

BT and Keltie are the only organisations who did not think that there was any scope to increase the use of telecommunications within their organisation (although Aviva did not answer this question). This is the case within BT owing to the already extensive use of telecommunications, which are used by ‘almost all’ employees (it should be noted, however, that despite the high use of telecommunications approximately 80% of BT employees also fly for business once a month or more). In Keltie only 10% of employees use teleconferencing facilities (which compares to 20% that fly for business), that are available in-house. Keltie did, however, state that if the quality of telecommunications were to increase then this could perhaps reduce levels of business air travel.

Table 25 below details the attitudes of organisations to numerous policies. The reaction of organisations to each of these approaches gives an indication of their potential effectiveness in substituting air travel movements with telecommunications.

Policy intervention	Number of organisations who think that this could reduce levels of business air travel (N=11)
Increased awareness of alternatives to aviation	9
Clients recognising 'green' credentials	8
Communication of time/cost benefits associated with the use of telecommunications relative to aviation	8
Increased awareness of negative environmental impact of aviation	7
Improved quality of telecommunications	6
Reduced cost of telecommunications relative to the cost of flying	4
Increased availability of, and access to, telecommunication facilities	4
Financial assistance to enhance teleconferencing facilities	3
Availability of travel planning resources	1

Table 25: Attitudes of organisations towards a range of policy measures

It is interesting to note that despite nine of the organisations surveyed stating that cost effectiveness influenced their decision of whether or not to travel for business, only four thought that a reduction in the cost of ICT relative to flying would reduce levels of business air travel. This could be the result of a discrepancy in the data, or it could be a reflection of the general low elasticity of demand for business air travel.

There does not appear to be any relationship between the size of an organisation, the number of branches, the sector worked in, or the frequency at which employees fly or use telecommunications in relation to attitudes towards different policy options. The response of organisations is effective in highlighting that enhancing the extent to which organisations are informed of the relative impacts, and performance, of aviation and its alternatives could stimulate behavioural change. It also serves to illustrate the impact that client perceptions have to behaviour. The consultations identified that after cost effectiveness client requirements have the most impact upon the decision of whether, or how, to travel. This again points towards the desirability of a campaign to increase awareness of the impacts of air travel, and the available alternatives, in an attempt to influence the behaviour of organisations and their clients.

Organisations did not identify any other policies that might support a shift from air travel to a greater use of telecommunications.

1.11 Who should policies target?

It is important to convince all employees within an organisation of the desirability of reducing levels of business air travel.

The survey responses indicate that larger multinational companies are more likely to have their own internal travel department, as business flights at both the global services company and the international professional services organisation are booked through such departments. BT, another large multinational company, stated that they book all of their flights via an external travel agency.

There appear to be no other significant trends relating to the size, number of branches, or the sector worked in in terms of how travel arrangements are made.

In many organisations the decision of how, or whether, to travel will be made by individual employees. Four companies (the business consultancy, the global cosmetics company, NERC and the European recruitment consultancy) have administrators/secretaries that make travel arrangements for employees. Administrators are also used to book flights at Aviva, although some of their employees also book their own flights. Employees book their own flights at the European bank. It will therefore remain important to convince all parties of the desirability of travel reduction strategies, although perhaps beneficial to target the travel planning departments in larger organisations. Responses from BT, the global services company and the international professional services organisation, which state that whilst CSR policies are in place they do not necessarily have an impact on whether employees use air travel for business, highlight the importance of fostering commitment throughout an organisation and for CSR policies to be better integrated into the day to day operations of organisations.

Section D: Recommendations to policy makers

1 Background

There seems not to be any clear policy direction with regards to aviation in the UK. The Climate Change Bill, which will be the first long term legally binding framework to tackle climate change, was introduced in Parliament in 2007 and is due to receive Royal Assent in late 2008. The Bill will commit the UK to reducing CO₂ by 60% by 2050, but it does not explicitly address the expansion of the aviation industry. Indeed governmental policy appears to support proposals for airport expansion and limit taxes on air travel despite the acknowledgement that aviation accounts for a considerable proportion (estimated to be 6% by CfIT, 2007b) of the UK's total contribution to climate change.

It is clear that the Government needs to accelerate efforts to reduce the negative environmental impact of aviation if it is to meet its target of reducing carbon emissions. It is likely that a package of policy levers, incorporating technical, fiscal and behavioural measures, will be required to reduce the growth of aviation. Technological improvements that enable aircraft to be operated more efficiently, and that lead to the development of improved types of aircraft and low carbon fuel will be a fundamental part of any approach to tackle CO₂ emissions from aviation, but this will not be sufficient to offset the impact of the growth in demand for aviation (EEA, 2007). This project has focused on the alternatives to aviation to gauge the potential for a modal shift, or to remove the need to travel. It has also reviewed the taxation and legislative context of the UK aviation industry to identify whether they are currently acting as a barrier to more sustainable behaviours.

This section contains recommendations to policy makers based upon the research activities carried out. These recommendations have also been supplemented with recommendations to other actors in recognition of the fact that it will require a multi-agency approach, and widespread commitment, if the number of short-haul flights undertaken is to be significantly reduced.

2 Rail travel

Research indicates that rail has the most potential to substitute the need for short-haul flights, and that where rail journeys do not exceed three hours in length aviation can struggle to compete in terms of both journey time and price (CAA, 2008; DfT, 2004; Gonzalez-Savignat, 2003; Patterson and Perl, 1999; TRANSform Scotland, 2007; Transport 2000,²³ 2006). Rail travel is also highly competitive in terms of environmental impact, with flights between London to Paris and London to Brussels generating between eight and 11 times more CO₂ than the Eurostar train does for these same journeys.

A review of demand for short-haul air services highlighted that a relatively large proportion of demand for domestic flights is concentrated on a fairly small number of routes (see Table 26 below, which details the UK domestic routes with the highest levels of demand for air travel). This suggests that upgrading service provision and quality on a number of corridors could have a considerable impact on the likely substitution of air travel movements. The rail White Paper '*delivering a sustainable railway*' (DfT, 2007c) indicates that the necessary capacity would be available to accommodate any such modal shift, and Network Rail has already committed £21.4billion to invest in the rail network to accommodate growth.

Route	Domestic passenger air travel movements
London to Edinburgh	5,619,309
London to Glasgow	4,594,575
London to Manchester	3,229,255
London to Belfast International	3,482,199
London to Belfast City	2,053,649
London to Aberdeen	1,935,152
London to Newcastle	1,675,013

Table 26: Domestic routes identified as having the highest volumes of passenger air traffic based upon 2007 data (CAA, 2008).

2.1 Recommendations to policy makers

The literature review conducted indicates that policies incorporating the following policy measures would enhance the likely rate of substitution of short-haul flights to rail:

Infrastructure measures

- **Invest in high speed rail infrastructure.** It is widely acknowledged that rail journey time should not exceed three hours if it is to compete with aviation (CAA, 2008; DfT, 2004; Gonzalez-Savignat, 2003; Patterson and Perl, 1999; TRANSform Scotland, 2007; Transport 2000,²⁴ 2006). The potential for substitution, particularly amongst business travellers, is therefore greater if the UK high-speed rail network is extended. Research documents that high speed rail can not only enhance the modal share of rail, but that it can also reduce the number of flights, and lead to a decrease in the size of aircraft, that operate on certain routes (Gonzalez-Savignat, 2003; Patterson and Perl, 1999). High speed rail also serves to increase the capacity of the rail network. It is therefore important to continue to conduct research into the extension of high speed rail infrastructure.

²³ Transport 2000 changed its name to Campaign for Better Transport in 2007.

²⁴ Transport 2000 changed its name to Campaign for Better Transport in 2007.

The UK government has already proposed to introduce a new generation of intercity express trains and a high-speed route connecting London, Birmingham and Manchester, but it is also important to examine the implementation of high speed rail links on others corridors where there is a high level of demand for short-haul flights, both domestically and to mainland Europe. Research suggests that a large proportion of short-haul air passengers are concentrated on a relatively small number of routes (FoE, 2000). Upgrading a relatively small number of railway lines to make them more attractive in terms of speed could therefore have a considerable impact upon substitution between rail and air services. At the UK level it is likely that a rail link connecting Scotland and London, a route undertaken by the majority of air travellers from Scotland, would provide considerable substitution effects. Other points to consider include:

- The potential for high speed rail to be linked to the Channel Tunnel Rail Link should be explored to enable short-haul flights to Europe to be substituted for rail services.
- It is important that high speed railway stations are located within city centres, as access times for high speed rail can be higher than those associated with conventional rail, therefore eroding time savings. The potential for serving city centres and key development areas that air services cannot penetrate should be exploited.
- The potential for high speed rail to substitute the need for connecting flights can be enhanced if rail terminals are linked directly to airports. Collaborative agreements between rail operators and airlines therefore need to be encouraged.

It is important to note that levels of energy consumption are higher for high-speed than conventional rail services, but their environmental impact remains significantly below that of air services.

- **Increase the accessibility of railway stations.** An advantage of rail travel over air travel is that stations are generally easier to access with many located in city centre locations. The lower access times can have a significant impact upon total journey times, and so measures to further enhance the accessibility of railway stations and to increase their role as ‘hubs’ for other modes of surface transport will be beneficial.

Management measures

- **Review capacity and levels of demand across the rail network to identify capacity pinch points.** The need to manage capacity was emphasised in the White Paper ‘Delivering a Sustainable Railway’ (DfT, 2007c), but much progress still needs to be made. A large proportion of passengers tend to be concentrated on a number of routes, and so to improve the passenger journey experience it is therefore important to identify pinch points where passenger comfort may be compromised, and to implement plans to address these problems.
- **Encourage collaboration between rail operators and airlines.** A research study undertaken by Givoni and Bannister (2007) details that many linkages between rail networks and airports tend to be accidental, with many airports having been built close to railway lines. The ability of rail to substitute short-haul flights, particularly those connecting with long-haul flights, could be maximised by reviewing rail provision to airports and examining how rail services can be enhanced to serve a more clearly defined role. Collaboration between rail operators and airlines could lead to better use of capacity at airports, and higher levels of substitution from air to rail. The increasing cost of fuel also means that airlines can benefit from providing high-speed rail services to complement their air services on short-haul routes.
- **Prioritise improvements to the rail network to corridors where there is the highest demand for air travel.** Research indicates that a relatively large proportion of passengers on domestic flights are concentrated on a small number of routes (FoE, 2000). Service

enhancements in terms of reliability, frequency and price could therefore have a substantial impact upon rates of substitution between rail and air services.

- **Provide guidance on the development of CSR to include aviation.** Consultations have highlighted that whilst the vast majority of organisations have a CSR policy, many do not discourage employees from flying. Policy makers should consider providing guidance to organisations to encourage them to consider alternatives to aviation. Evidence indicates that CSR policy does not necessarily impact travel behaviours, but the inclusion of business air travel and the ability for a proportion of it to be substituted for rail travel increases the likelihood of rail being considered when deciding how, or whether, to travel.

Information provision

- **More actively promote the benefits of rail travel relative to aviation and increase the prominence and profile of such campaigns.** Research indicates that growing consumer awareness of the relative environmental impacts of rail and air travel is resulting in changes in behaviour. It is therefore important for the comparatively low environmental impact of rail travel to be effectively communicated.

A key part of information marketing campaigns must be to aggressively market strengths of rail travel and to challenge misconceptions of air travel. The quoted journey time of air travel, for example, often only represents a small part of the total overall journey time owing to formalities such as check-in and security clearance. Similarly the advertised price of air travel tickets does not tend to be the true total cost, with hidden extras, such as tax and insurance, also needing to be paid.²⁵ Our review of rail and air services found that the perception of both business and leisure travellers that the cost of a journey is lower on a low-cost airline than on rail is false, particularly when rail travel is booked in advance. Price is a key determinant of modal choice for leisure travellers, which makes this a particularly important point to communicate. The rail industry must market their strengths

Financial measures

- **Explore the potential to invest in enhancements to the rail network to support a modal shift.** Research conducted by Gonzalez-Savignat (2003) used demand modelling to demonstrate that users have a high willingness to pay for travel time savings, but the substitution effect is likely to be greater if the Government provided some financial support for the implementation of improvements. High speed rail infrastructure in particular is costly, and will necessitate extensive investment. When external costs, such as environmental impact, are taken into account then high speed rail schemes can be considered to be cost effective, but financial support is likely to be needed to assist implementation. Financial incentives could also be provided to enable onboard Wi-Fi services to be rolled out across the rail network as opposed to them focusing on inter-urban train services.
- **Explore the potential to intervene to minimise rail fare increases.** The literature review identified that a common misconception is that low-cost carriers offer lower prices than rail travel (Coleman, 2006; Sauter-Servaes and Nash, 2007). Our review of rail and air travel backs up the contention that rail travel is competitive with air travel in terms of price, but some commentators nevertheless argue that the rail industry needs to reduce costs and increase revenues if they are to be able to operate effectively (Sauter-Servaes and Nash, 2007). There is particular importance for rail fares to be kept down on corridors that compete directly with airlines. Price is a key determinant of modal choice for leisure travellers, and so above inflation fare increases that are being experienced by rail travellers need to be kerbed. Rail subsidies are falling with the government expecting fare revenues to cover the short-fall,

²⁵ A draft regulation stating that advertised air fares will have to include all taxes, fees and charges is due to be approved by the European Parliament in late July. This will go some way to addressing this misconception.

but the government needs to consider providing more support to rail services to minimise cost increases whilst enabling continued investment to improve the journey experience.

2.2 Recommendations to other actors

Infrastructure measures

- **Increase the level of integration between airports and connecting rail services.** The ability of rail to substitute short-haul flights that are typically undertaken in conjunction with longer flights can be maximised by providing better integration between rail terminals and airports. This can also lead to better use of capacity at airports. Airports, airlines and rail operators should therefore collaborate to identify ways in which rail services can support and complement air services. Service providers should therefore:
 - Consider the potential for providing rail interchanges within, or near to, airports. Convenience is a key determinant of modal choice, and this can be enhanced by enabling easy transfer between rail and air services.
 - Examine connections between rail terminals and airports, which tend to be located close to railway lines. Review ways in which rail services to nearby railway station/s can be modified to integrate better with the airport, for example by increasing the level of service frequencies or wider connections to the transport network. Research indicates that increased provision of direct high frequency services is particularly highly valued by users owing to the overall savings in journey time that it affords (Gonzalez-Savignat, 2003; TRANSform Scotland, 2007).
 - Identify ways to improve passenger convenience. The convenience of using rail services to connect with flights can, for example, be enhanced by providing a luggage check-in and –out facility at certain railway stations. This service is provided at London Paddington and Victoria connecting with flights to Heathrow and Gatwick respectively and enhances the level of convenience afforded to passengers.
- **Provide facilities on-board and at stations to enable business travellers to make more productive use of their journey time.** To increase the likely substitution short-haul air travel movements to rail services for business travellers the rail industry needs to focus upon providing features that enhance the travel experience for business travellers.
 - The provision of airport style ‘lounges’ at railway stations would provide an environment more conducive to working during transfer time.
 - Trains and railway stations should be equipped with Wireless Internet (Wi-Fi) services. These can help operators to improve fleet management as well as enabling travellers to make more productive use of their journey and transfer time. Rail operators have announced that they intend to provide these services, but policies should be put in place to support this provision on new trains and refurbishment on old trains across the entire network. Proposals for providing Wi-Fi provision appear to be focused upon inter-urban services, but availability of these services needs to be widespread so that they can feature in peoples decision on which mode to travel on.
 - Power points should be provided at both stations and on carriages to support use of laptops during journeys.
 - Provide on-train environments that are conducive to working. The benefits of Wi-Fi provision are likely to be eroded if tables, an electricity supply and adequate personal spaces are not available to support working.

Management measures

Rail operators should seek to:

- **Minimise the number of intermediary stops on routes of high demand.** The ability of high speed rail to attract air passengers is negatively impacted by services that make intermediary stops, as these considerably increase travel time and the perceived convenience of such services.
- **Provide direct services where feasible to reduce transfer time.** Time savings afforded by rail travel can be eroded by high transfer times between services, and so it is important that on corridors where demand for air travel is high rail journeys (see previous Table 26) should be direct to increase the competitiveness of the rail services.
- **Increase the frequency of rail services.** The frequency of rail services across the network, but particularly on key routes, should be maintained and where possible increased to improve the convenience and flexibility of rail travel.
- **Continue to focus upon increasing, and increasing awareness of, the reliability of rail services.** It is a frequent misconception that rail services are less reliable than air services. The reliability of journey times is a key concern of business travellers, and as such rail operators should increase awareness of the actual reliability of rail services. Operators should also, however, continue to seek to increase the proportion of trains that arrive at their timetabled time.
- **Review connections across the rail network to identify where total journey times can be reduced.** Reliability, connectivity and access times of rail services generally work in the favour of rail travel, although experience can vary greatly depending upon the routes travelled. There is therefore the need to review connections across the rail network to identify areas where connections are poor and where journey time can be reduced.
- **Facilitate better network management and planning.** Operational support should be provided to improve the efficiency of the rail network. Operational enhancements can be used to increase passenger carrying capacity and improving the reliability of rail services, both of which can increase the competitiveness of rail travel relative to aviation. This is likely to necessitate collaborative working with rail operators to deliver improvements.
- **More aggressively market the benefits of rail travel relative to aviation.** Rail companies are beginning to increase the number and profile of advertising campaigns detailing the competitive advantages of rail travel. It is important that the strengths of rail travel continue to be aggressively marketed to emphasise that in terms of environmental impact, fare and journey time rail services can compete with air travel.

Organisations can support the substitution of business air travel for rail by:

- **Adopting travel plans, and ensuring that reducing levels of business air travel is actively included within these.** Workplace travel plans are packages of measures produced by employers to encourage a balance between the need to travel and the impact of this travel on the environment and to increase awareness of how individual actions can have a positive impact. Employers should make use of the extensive DfT guidance available (<http://www.dft.gov.uk/pgr/sustainable/travelplans/work/>) and adopt travel plans that promote alternatives to aviation and discourage air travel.

3 Information Communication Technologies (ICT)

Business travel constitutes a significant proportion of total passenger trips (approximately 25% in 2006 (DfT, 2007b)), and an even larger proportion of airline revenue. It is therefore important for policy makers to identify ways in which levels of corporate air travel can be reduced. Face to face communication will never be capable of being entirely substituted by remote interaction, but the enhanced sophistication and quality of teleconferencing facilities suggests that for some purposes interactions can be more effectively conducted via ICT, thereby removing the need to travel at all. Teleconferencing facilities are already established in many organisations, so the necessary infrastructure for such a shift is largely in place. It is therefore likely that, with intervention, teleconferencing applications could play a greater role in reducing the need to travel in the future, leading to direct environmental benefits in terms of journeys foregone, and also considerable time and cost savings to businesses, who tend to be charged a premium for the air services that they use.

3.1 Recommendations to policy makers

Infrastructure measures

- **Invest in improvements to ICT technology.** The perceived quality of teleconferencing applications is limiting their uptake within some organisations, and so supporting the research and development to enhance the technology could have a positive impact upon the substitution of air travel movements within organisations. It is important to not only increase the quality of the technology, but it will also be important to enhance the compatibility of different systems to maximise their application.
- **Collaborate with developers of ICT.** The government should create dialogue with these developers to encourage the development of new solutions to enable ICT to facilitate more substantial reductions in the need to travel and to more effectively mimic the features of face to face interactions. Benefits could be obtained, for example, by discussing trip purposes that can, but rarely are, undertaken by ICT, such as conference attendance and marketing activities. Developers could then be worked with to seek to enhance the functionality of their systems to more effectively meet these specific needs, where possible, to increase the viability for substitution for a wider range of purposes.

Management measures

- **Commission independent research into the impacts of teleconferencing upon travel behaviours.** It is not possible to accurately determine the potential for a reduction in the demand for business related air travel movements given the relative lack of empirical evidence. Comprehensive research needs to be undertaken to determine current levels of usage of teleconferencing applications within organisations and their impact on travel patterns. There is also the need to explore the purpose of teleconferencing and business air travel to obtain a meaningful indication of the likely rate of substitution. Few research studies appear to recognise the importance of isolating the purpose of interactions.
- **Set targets for reducing levels of business air travel within organisations.** These do not have to be mandatory, but the potential for providing formal recognition for those who do achieve them could be explored. Organisations do not tend to collect data on levels of use of telecommunications and air travel, and so setting targets may encourage organisations to monitor their travel behaviours and motivate them to make them more sustainable.
- **Actively work with organisations.** The potential for substitution is likely to be higher if a concerted effort is made to increase uptake of these technologies. Research (Denstadli and Julsrud, 2003) and consultations indicate that the full potential of videoconferencing has not been realised within many organisations as it tends to be used by a relatively small number of

people for a limited range of purposes. Consultations also indicate that organisations agree that there is more scope to increase their use of ICT. Intervention could therefore be effective in increasing the penetration of these facilities within organisations. This approach is likely to be particularly effective if efforts are focused on fostering high level commitment within organisations.

- **Commission independent research to formulate a robust evidence base as to the actual benefits of teleconferencing to businesses.** Consultations indicate that time and cost savings are enabled by substituting short-haul flights for teleconferencing, but conclusive unbiased information does not appear to be available as to the extent of these benefits. Clear messages as to the possible benefits could encourage organisations to increase take-up of ICT.
- **Identify and engage with the wider business community to disseminate best practice approaches to using ICT to reduce the need to travel.** Research (Bannister and Marshall, 2000; Mokhtarian and Salomon, 2002) and consultations have identified a number of innovative approaches to using ICT to substitute aviation. For example delegates can attend conferences remotely, viewing presentations, discussions and exhibition stands online, and teleconferencing is increasingly being used to market and promote new products. Consultations indicate that not all businesses are aware of such applications of the technology, which implies that benefits could be attained from learning from the experience of others. Consultations indicate that there could be particular benefit from focusing on enhancing the perceived ability of external meetings to be conducted remotely.
- **Provide guidance on the development of CSR to include aviation.** Consultations have highlighted that whilst the vast majority of organisations have a CSR policy, many do not discourage employees from flying. Policy makers should consider providing guidance to organisations to encourage them to consider reducing the need to travel by using ICT. Evidence indicates that CSR policy does not necessarily impact travel behaviours, but the inclusion of business air travel increases the likelihood of it being considered when deciding how, or whether, to travel.
 - The Global Reporting Initiative (GRI), a network of 30,000 stakeholders, has collaborated with the United Nations Environment Programme to provide a standardised framework for corporate sustainability reporting. The government should support this initiative, which seeks to continually improve its reporting mechanisms, and work with its developers to ensure that reducing levels of business air travel are adequately considered within the reporting standard, and thereby adopted by the companies that voluntarily adopt the guidelines.

Information provision

- **Raise awareness within organisations of the negative impact that aviation has upon the environment.** Not all individuals are aware of the impact that their carbon footprint has upon the environment, and so moves to inform employees of the relative environmental impact of different ways of working and travelling could encourage use of ICT. Environmental messages, particularly those associated with climate change, can be complex, but organisations should have immediate access to information that clearly sets out the implications of travel and operational behaviours and ways in which negative impacts can be mitigated. Consultations identified this as one of the most effective policy interventions in terms of reducing levels of business air travel.
- **Increase awareness of alternatives to aviation.** Consultations identified that increased awareness of alternatives to aviation is the policy intervention most likely to reduce levels of business air travel within a range of organisations.

- **More actively promote the benefits of teleconferencing to business and the environment, and increase the prominence and profile of such initiatives.** Evidence suggests that without intervention to enhance the awareness of potential benefits of ICT behaviours are unlikely to change. The decision on how employees collaborate will continue to be based upon perceived relative benefits, and it is therefore important that benefits of ICT, and the potential of the technology to substitute air travel movements, are effectively communicated throughout organisations. The strengths of ICT relative to air travel need to be marketed aggressively as those for aviation to compellingly contest the presumption that ‘being there’ is more important for business than ‘being green.’ Consultations identified this as one of the most effective policy interventions in terms of reducing levels of business air travel.

Financial measures

- **Explore the potential for intervening to support increased uptake of teleconferencing applications.** The cost implications of teleconferencing applications are not prohibitive to all organisations, but the investment required for businesses to obtain the full benefits of these applications can be substantial. This could be limiting their uptake, particularly within SMEs, and so their ability to substitute air journeys could be enhanced if financial support was made available to provide the infrastructure within organisations to enhance the penetration of the technology. Remote collaboration is only possible if the systems are implemented by a critical mass, and so subsidising provision for some could support enhanced use of the technology for others. Consultations suggest that relatively small organisations, and those with only one branch, may particularly benefit from financial assistance for teleconferencing facilities, as the viability of investing in this technology could be considered to be lower within these companies. Four of the organisations consulted with felt that policy intervention to reduce the cost of telecommunications relative to the cost of flying could reduce levels of business air travel. Three organisations also felt that financial assistance to enhance teleconferencing facilities would reduce air travel.

3.2 Recommendations to other actors

Management measures

- **Market ICT as a cost reduction strategy.** Developers should more aggressively promote the role that ICT can play as a cost reduction strategy. Organisations are becoming increasingly aware of the benefits to operating sustainably, although research suggests that organisations are most likely to use teleconferencing applications when they perceive that time and cost savings can be achieved as a result. Businesses tend to be charged a premium for flying and associated costs, which include time and other travel related costs, such as accommodation, make the process particularly resource intensive. ICT is unlikely to remove the need to travel entirely, but by complementing face to face contact the value of air travel movements, when they do occur, tend to be higher. Costs associated with teleconferencing facilities are often perceived to be high, which makes it particularly important to emphasise the savings that they can accrue.
- **Increase awareness of external teleconferencing facilities and promote their use.** The use of external facilities gives organisations access to local high quality teleconferencing facilities. This access may enable a greater range of trips to be substituted by technology that it may not be viable for the organisations to invest in internally. Four of the organisations consulted with felt that increased access to telecommunication facilities would reduce levels of business air travel, and only one used external ICT facilities. The existence of these centres therefore needs to be more widely promoted by the centres themselves.
- **More aggressively promote ICT.** The developers of ICT systems that enable remote interaction should exploit and more aggressively market their potential to increase the ‘green’

image of businesses, to combat the negative environmental impacts of aviation, and to reduce costs.

- **Adopt travel plans and ensure that reducing levels of business air travel is actively included within these.** Organisations should be encouraged to implement workplace travel plans. Workplace travel plans are packages of measures produced by employers to encourage a balance between the need to travel and the impact of this travel on the environment and to increase awareness of how individual actions can have a positive impact. Employers should make use of the extensive DfT guidance available (<http://www.dft.gov.uk/pgr/sustainable/travelplans/work/>) and adopt travel plans that promote alternatives to aviation and discourage air travel.
- **Encourage partners and suppliers to reduce the number of business flights undertaken.** This could be most effectively achieved if it is included in the procurement process. Consultations indicate that the largest influence on whether employees travel by air for business appears to be client requirements, and that greater recognition of ‘green’ credentials by clients is likely to be one of the most effective policy interventions in terms of reducing business air travel. This suggests that organisations not only need to look at their own use of ICT, but to reflect this in their procurement processes to influence the behaviours of others.
- **Formally train staff in the use of ICT to encourage more effective and widespread use of teleconferencing internally.** An organisation noted that training and support is needed to enable staff to make the most use of teleconferencing facilities. The general lack of knowledge of the systems and their functionality was considered to be a drawback for this company, and therefore the provision of tailored training to fulfil this need could provide cost effective to organisations by helping to ensure that the maximum benefits are obtained from the available technologies.

Information provision

- **Ensure that information is disseminated throughout an organisation.** Consultations and literature (WWF and ETNO, 2007) indicate that the decision of whether, or how, to travel is often made at the individual level, sometimes regardless of any CSR policies that companies have in place. It is therefore important that senior management effectively communicate the existence, and benefits of, alternatives to aviation through all levels of an organisation if substitution effects are to be experienced.

4 Coach travel

There is a general absence of literature relating to coach journeys and their potential to facilitate more sustainable travel behaviours and most statistics appear not to differentiate between coach and local bus service data. Time is a key determinant of modal choice, which makes coach travel unlikely to capture a significant share of short-haul air travel movements, but it is a low cost, direct mode of transport that serves virtually, if not all, of the corridors in England and mainland Europe on which air services operate. Research has also shown that on a per passenger kilometre basis coach services generate less CO₂ emissions than other forms of inter-urban transport (AEF, 2007). It is therefore recommended that policy makers:

4.1 Recommendations to policy makers

Infrastructure measures

- **Explore the potential for making changes to infrastructure to increase the performance of coach travel.** Opportunities for reducing the journey time of coach trips, for example by designating coach-only or high occupancy vehicle lanes on motorways, may increase the attractiveness of coach travel. Participants of the WWF's One Planet Mobility project devised a prototype for such a motorway-based coach system (WWF, 2008a).

Information provision

- **Increase the extent to which coach and local bus services are differentiated between in UK transport planning and policy documents** to establish a better understanding.
- **Commission independent research to fill the current gap in empirical evaluation of coach travel.** There is not currently a sound evidence base from which coach travel, and the role that it can play as an alternative to aviation, can be appraised. Research should include;
 - Information that can determine the exact relationship between coach travel and other modes of transport.
 - Consultations with both users and non users of coach travel to identify the key areas in which coach travel can compete with short-haul aviation and reasons for which it is not considered to be a viable alternative to short-haul aviation. There is currently a need for a better understanding of the priorities of existing and potential coach travellers.

4.2 Recommendations to other actors

Information provision

- **Market the benefits of coach travel.** Cost and environmental impact are all preferable for coach travel over rail and aviation. These benefits should therefore be capitalised upon by coach operators and marketed to increase awareness amongst the public. Coach travel will not be a viable alternative for some users, but consumers are becoming increasingly aware of their carbon footprint and price is a key determinant of modal choice.

5 Economic instruments

Taxes on air travel within and from the UK are currently limited to the Air Passenger Duty (APD), which is levied on a per-passenger basis. Aviation fuel for commercial flights is not subject to Fuel Duty, and tickets are essentially exempt from VAT in accordance with UK legislation that states that public transport services are not required to pay VAT. There are therefore claims that the aviation industry is not being made accountable for the negative externalities that it generates, and that it is not fulfilling its obligations to support public services. Sewill (2003) estimates that as a result of the tax exemptions the net tax subsidy to the aviation industry is around £9 billion per annum. APD has since doubled, but fuel tax has also increased, meaning that the figure would still be similar today. According to CfIT, this could build approximately 190kms of high speed rail per year.

The current fiscal and legislative frameworks are enabling the price of air travel to be kept relatively low. The price of air travel has a direct impact upon the decision of most leisure passengers upon whether or not to fly, and so the current arrangements can be seen to be driving demand. The European Parliament has recently voted to include aviation in the EU's Emissions Trading Scheme (ETS). It is the EU's first legislation to reduce greenhouse gas emissions from aviation and therefore represents significant progress, although a series of compromises mean that it has been described as 'a historic missed opportunity' (European Federation for Transport and Environment, 2008). There are also proposals to replace the APD from November 2009 with a new tax levied per flight and differentiated by distance travelled, which could encourage better utilisation of aircraft and minimise environmental impacts. The literature review indicates that additional policies are, however, required. These include:

- **Explore the feasibility of taxing the negative externalities, such as greenhouse gases, themselves in the form of an emissions tax.** There are still uncertainties in terms of the way in which aircraft emission affect the climate, but a good proxy would be by taxing the level of fossil fuel use, possibly multiplied by a coefficient to take into account the non-CO₂ components. A policy shift to make the industry and its users pay for the negative externalities generated by their operations, particularly in terms of CO₂, NO_x emissions and noise, then it could be assumed that the competitiveness of alternatives to aviation, particularly rail travel, could considerably increase.
- **Consider a mechanism that would enable aviation tax revenues to be ring-fenced for investment in alternative forms of transport,** or to minimise the tax burden on these services.
- **Commission an independent review of the fiscal and legislative framework in which the aviation industry operates.** The Air Passenger Duty is currently the only tax on air travel and aviation does not have to pay VAT or fuel duty, which has led to concerns that aviation is not being made accountable for the negative externalities that it generates. The Government should consider how the fiscal and legislative framework could be modified to use fiscal measures as levers to internalise negative externalities, put a downward pressure upon demand, mitigate unwanted effects, minimise transaction costs, and to provide a more fair and equitable basis for operation. A new tax has been proposed for flights and aviation is now included in the EU Emissions Trading Scheme, but scrutiny of these proposals indicates that many opportunities have been missed and that complementary measures should be implemented.
- **Engage with airlines and governments across Europe to harmonise tax regimes.** A number of bilateral agreements currently make the taxation of fuel for international flights difficult. A united approach can also help guard against potential negative impacts of acting independently. 'Tankering,' whereby airlines opt to fuel their aircraft in countries where the tax is the lowest, can, for example, undermine measures that are implemented in the national context.

- **Push for a review of the terms relating to aviation's entry into the EU ETS.** The legislation has been designed to reduce CO₂ emissions from aviation, but a number of compromises reached fail to make the proposal effective in reducing greenhouse gas emissions. The scheme will not come into effect until 2012, airlines will be able to buy permits from other sectors without restrictions, and limits on the amount of CO₂ that can be emitted need to be stricter if it is to be effective. Policy makers also need to push for a multiplier to be added to account for the non-CO₂ impacts that aviation has because the directive currently only addresses CO₂ emissions as opposed to the NO_x emissions emitted at altitude, and the impact that aviation-induced clouds can have on climate change. The aviation sector will also be allocated 85% of the allowances free of charge, which represents a considerable subsidy to the sector.

6 Aviation policy

The Government is currently considering the expansion of a number of airports, despite the likelihood that these proposals may negatively influence the UK's carbon footprint, and discourage more sustainable travel behaviours. This report has identified that viable alternatives to aviation do exist and that it is not sustainable to continue to meet increasing demand for air travel through airport expansion. It is therefore recommended that policy makers:

- **Commission an independent review of aviation policy.** The Government's commitment to climate change may be compromised by the numerous proposals having been made for airport expansion. The Government is therefore encouraged to rethink its position in relation to the development of the aviation industry to set a consistent policy message on climate change.
- **Commission an independent review of the impact of alternatives to aviation and airport expansion.** Conflicting information has contributed to an inconsistent analysis of the impacts of expansion of the aviation industry. A new review of the most up-to-date evidence on the impacts of aviation on climate change could be undertaken, which would, include the full range of impacts of airport expansion and its alternatives. This could inform the basis for future strategic planning.
- **Airport expansion should only be considered after other options have been exhausted.** There is a growing body of literature that indicates that demand can be met by more sustainable alternatives to aviation. Aviation demand may also be managed in a way that protects the environment and the economy. The Government could review all such alternatives before developing proposals for airport expansion.

1 Conclusions

Evidence suggests that rail services are already regarded as a threat to aviation growth. Where air services are in direct competition with rail services, growth in demand for aviation is declining (CAA, 2008). The literature review and the review of rail infrastructure indicate that rail travel is competitive with air in terms of price and journey time when journey time does not exceed three hours. The literature review has indicated that people increasingly perceive the cost of flights to be lower than those offered by rail, but this no longer seems to be the case.

For coach travel, research suggests that there is a potential for short-haul flights to be substituted by this mode, although the likelihood is that the proportion of short-haul flights substituted will be low owing primarily to the longer journey times.

Telecommunications have the potential to substitute short-haul business flights, although the likelihood of this occurring is again uncertain. The literature indicates that the relationship between air travel and telecommunications is one of complementarity rather than substitution, but some replacement has been reported. Evidence and consultations suggest that it is likely that, with intervention, applications such as teleconferencing could play a greater role in reducing the need to travel in the future.

The consultations show that a wide range of organisations have already integrated the use of teleconferencing facilities into their businesses and that all of the organisations surveyed agreed that teleconferencing is convenient, can save time and money, enables greater control over time and is less stressful than air travel, and can enhance an organisation's corporate image and CSR credentials. The organisations surveyed feel that face to face interaction will remain essential for the establishment of good working relationships but that for a range of purposes, most notably for internal meetings and external meetings with existing clients, interactions can be effectively conducted remotely via ICT thereby reducing, although not replacing, the need to fly. All of the eleven organisations surveyed agreed that telecommunications can reduce the need to travel. Client requirements appear to be one of the key determinants to behaviours, although it seems that the decision of whether, or how, to travel is often ultimately made by an individual.

A review of the key factors influencing passenger demand found a number of elements favouring the increasing use of aviation. Income, price, quality of service, provision of alternatives and image were identified as having the most impact upon traveller behaviour. Rises in income, reductions in fares, increases in peoples' value of time and the positive image of air travel all appear to have contributed towards growth in air travel. The review has highlighted that the current fiscal, legislative and information policies fail to counteract these drivers of demand.

An examination of the current fiscal and legislative framework identified potential discrepancies regarding the level and profile of taxes in relation to the negative externalities caused by the aviation industry. The Air Passenger Duty was found to be the only tax on air travel, whilst VAT and fuel duty were zero-rated. The UK Government has proposed a new tax on flights, and has supported the idea of including aviation in the EU Emissions Trading Scheme, but the likely effects of these steps will depend heavily upon the details of each scheme, which will warrant further scrutiny.

It was argued that the potential for a modal shift is likely to be enhanced if taxes are commensurate with the negative externalities generated by air travel activity, and if these revenues could be ring-fenced for investment in the infrastructure of alternative modes or to reduce the tax burden for these services. The full coverage of external costs, mitigation of unwanted effects (such as tankering and migration of emissions), minimisation of transaction costs and fairness and equity were noted as important elements to consider in designing a new fiscal/legislative framework for the aviation industry.

A modal shift is likely to have a wide range of positive environmental impacts, most notably in relation to climate change, local pollution and noise.

The negative impact upon the economy of reducing air travel demand was argued to be overstated, particularly when issues such as the tourism deficit, availability of alternative employment/regional development, and fall in house prices through noise were considered.

The findings of the evidence review and the consultations indicate that viable alternatives to aviation do exist, and that they can be made more attractive through changes in public policy, better technology and personal attitudes.

National aviation policy is currently contradictory and lacking any clear direction, but on a national level there is now a broad consensus that tackling CO₂ emissions should be a priority, and that meeting unfettered demand for air travel is not only unsustainable, but undesirable.

Comprehensive, unbiased evidence is relatively hard to come by, which may be why there has not been the same commitment to reducing emissions from aviation as there has been for surface transport. It is therefore imperative that gaps in the knowledge are identified and businesses and individuals are consulted with to inform the development of a clear policy framework which will support the development of alternatives to aviation in a deliverable and measurable fashion. A framework to support the reduction of the negative impact and growth of the aviation industry would be most effective if challenging targets for reducing green house gases specifically from the aviation sector were set.

The policy recommendations detailed in this report indicate that strategies to substitute short-haul flights for alternatives will need to have many components. Stakeholders from a wide range of industries and professions will need to work together to increase the viability of reducing levels of short-haul air travel and of fostering support and commitment towards adopting more sustainable behaviours at all levels.

Fundamental to any such approach will be clear leadership from government, as without the political support to reduce CO₂ emissions from short-haul aviation the full potential to substitute air travel movements for more sustainable alternatives will not be realised.

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Appendix A.

Annotated Bibliography

A.1 Journal articles

Briginshaw, P. (2007) *TGV Est shows Eastern promise*. International Railway Journal Vol 47 No 6 p.46-48

The author discusses the potential impacts of the TGV Est European line in 2007 prior to its operation. No methodology is outlined but it appears that the article is based upon interviews with the rail operator SNCF who hope that the 50% reduction in journey time facilitated by the service will capture 60% of the market from air and conventional rail services within 18 months. Barriers to implementation are outlined, notably in terms of the need to secure adequate funding to construct the route, as are measures that have been put in place to enhance the competitiveness of TGV Est, such as by providing good connections. Proposals to expand the TGV network are also outlined, indicating that the potential for rail to reduce the market for short-haul flights will continue to increase in mainland Europe.

Coleman, P. (2006) *If you can't beat 'em, copy 'em*. Rail Professional No. 107 p.16-17

This article was published in response to the above inflation fare increases announced by the rail industry in December 2005. The author details that regulated fares increased by an average of 3.9% and unregulated fares rose by an average of 4.5%. The author reports that this has led to users expressing the sentiment that it may be cheaper to travel by air than by rail to some domestic destinations. The article explores some of the reasons behind the fare increase and recommends actions that the rail industry could take to minimise the potentially negative impacts of the fare increases.

The article is not based upon any original research but provides a balanced view of real and perceived differences between rail and air fares, briefly analyses the marketing strategies used by each mode, and discusses the possible negative implications of reducing rail fares and implementing strategies employed by the low-cost airlines.

Crawford, D. (2006) *Train of thought*. ITS International V. 12 No. 3 p31-2

This paper details usage of Wi-Fi services on trains on an international basis and details the advantages offered to both the rail operators themselves in terms of improved fleet management, and also in enabling passengers to make more productive use of their time whilst travelling. The paper focuses upon the introduction of Wi-Fi on VIA Rail, the Canadian national rail operator who pioneered the use of Wi-Fi on trains in 2003.

The paper is not based upon any original research and largely consists of a technical discussion of differing technologies being used to provide wireless internet connections, but it also gives an insight into the positive feedback from market research undertaken by VIA Rail. The market research identified, for example, that 96% of passengers surveyed said that Wi-Fi was a feature that they would like to see on trains, with 50% of users being willing to pay for the facility. An analysis of the market research has led VIA Rail to expect between 40 to 50% of business travellers will make use of the services. No details are provided of the sample size of the market research study upon which these findings are based, nor as to how respondents were selected.

Denstadli, J., and Julsrud, T. (2003) *Videoconferencing: increased use, less travel?* Swedish Road and Transport Research Institute No. 3 2003 p.7-8

This article summarises a report with the same title published in Norwegian on the effect of videoconferencing on the use of business travel. The research aimed to examine the use of and attitudes towards videoconferencing in Norwegian businesses, and looked at the impact of the use of videoconferencing on travel patterns. The findings were based upon the analysis of responses to a postal survey sent to financial directors in 563 companies, 164 of whom used videoconferencing. The sample covered a range of different types and sizes of companies and included those who the authors recognised as being at the forefront of videoconferencing usage.

The study showed that whilst attitudes to videoconferencing were positive in both firms who did and did not use the technology, the costs associated with videoconferencing were perceived to be high and three quarters of respondents considered personal contact to be irreplaceable. The survey found that 40% of videoconferencing users had managed to use the application to substitute travel, but that only 10% had experienced any substantial reduction in the need to travel. No indication is given of whether any additional travel was generated by use of the technology. The authors therefore concluded that videoconferencing has only had a limited impact upon business travel within the companies surveyed, but that this could be because the use of videoconferencing in general appears to be relatively underdeveloped.

Edwards, J. (2006) *Benefits of an Edinburgh – Newcastle high-speed rail link.* Engineering Sustainability (Proceedings of the ICE) Vol 159 No 2 p.71-78

The highest volume of air traffic within the UK is between central Scotland and London. This paper discusses how the construction of a high-speed rail link between Edinburgh and Newcastle to reduce the Edinburgh to London rail journey time to an equivalent flight time would be likely to have the greatest impact upon modal shift from air to rail than on any other route in the UK. The paper focuses upon the technical specification that such a route would require and how it could be financed, but also touches upon some of the impacts that this would have, primarily in relation to reducing carbon emissions from aircraft.

The author concludes this detailed technical paper by stating that the UK must develop a network of high-speed rail links to reduce the reliance of the UK on air travel.

Givoni, M., and Banister, D. (2007) *Role of the railways in the future of air transport.* Transportation Planning and Technology Vol 30 No1 p.95 – 112

This paper suggests that rail services are often regarded as only being providers of access to airports, and that this underestimates the potential role that they could play in relation to substituting short-haul flights. The paper discusses the role that railways could play in the substitution of air services and, with an intended policy audience, it examines the role that intermodal co-operation, and possibly integration, could have on substitution. This review of both case-study evidence and theory therefore looks at the relationship from a different angle to most similar discussions which tend to focus upon the relative competitiveness of each mode.

The paper does not incorporate any original research, but does look at case-studies, such as the TGV and Channel Tunnel, from a different perspective. The authors stress the role that railways could have in providing an integrated transport service for medium distance journeys of up to 800km and in replacing the short-haul element of air journeys that consist of two flights and a transfer at a hub airport. They detail that full co-operation between airlines and rail operators could enhance the effectiveness of each industry.

Gonzalez-Savignat, M. (2004) *Competition in air transport: the case of the high speed train.* Journal of Transport Economics and Policy Vol 38 No 1 p.77 – 108

This paper analyses the potential of high-speed rail to compete with the airline market on a corridor between Barcelona and Madrid. A high-speed rail service does not operate on this route, and so competitiveness has been analysed in relation to a model based upon passenger preferences relative to the characteristics of alternatives. Demand modelling is also used as a means by which to predict the substitutability of the high-speed train for short-haul flights on the route. The depth of analysis is heightened by comparing the potential substitution for different types of journey and user.

The research findings indicate that a high-speed train would have a considerable impact upon the airline market and that the level of impact will be depend upon journey time given that as time increases the market share of high-speed rail decreases. It does not, however, argue that high-speed rail should replace air travel on this route, rather that they should be complementary.

Lee, J., and Chang, J. (2006) *Effects of high-speed rail service on the shares of intercity passenger ridership in South Korea.* Transportation Road Record: Journal of the Transportation Research Board No. 1943 p.31-42

This paper provides a detailed analysis of the impact that the introduction of a high-speed rail service in South Korean, Korean Train Express (KTX), has had upon other modes operating on the intercity routes. The KTX was operational in 2004 and although patronage levels are approximately half of those originally estimated, the number of users has continued to increase and the number of air and coach passengers travelling on these routes has decreased considerably, particularly on the Seoul to Busan corridor.

The paper contains a comprehensive discussion of the competitive advantages of rail, coach, air and car according to speed and distances travelled. Changes in modal shares following introduction of the KTX services are clearly outlined for both direct services and indirect services to enable a detailed discussion of the relative benefits based on travel distance. Other attributes of each mode are discussed and key issues highlighted by the analysis that need to be addressed in the future to maintain the performance of high-speed rail are outlined.

Leonard, P. (2007) *Wi-fi on the move.* Rail Professional No. 119 p20 – 21

This article charts the substantial growth in the use of Wi-Fi over the few years preceding the publication, and discusses how rail operators can benefit from installing Wi-Fi facilities. It is important to note that the author works in the marketing department of T-Mobile UK, one of the providers of Wi-Fi systems.

The article cites numerous surveys that have been undertaken into the attitudes and behaviours of what it is assumed are rail users, although whilst the article details the relevant findings it does not provide much insight into the surveys themselves, their aims or the way in which they were conducted. Findings are summarised from YouGov research, which found that 45% of users had started using Wi-Fi within the last 12 months, and that 52% of respondents expressed a preference for being able to use the service on trains. The findings of the survey also provide a detailed insight into the advantages that it provides to businesses. The 2005 National Passenger Survey is also cited to support the business case for the provision of Wi-Fi on trains.

The report outlines the benefits that Wi-Fi can afford to users in terms of an enhanced travel experience, business in terms of the enhanced productivity of journey times, and also rail operators who could experience increases in patronage as a result.

Les Editons La Vie du Rail (2005) *Wi-fi please business passengers and operators, alike.* Rail and Public Transport No. 29 p.32

This brief article describes the implementation of Wi-Fi to provide onboard internet services on trains. The description is based upon the use of Wi-Fi on Scandinavian trains, introduced in 2003, and on GNER services in the UK. The discussion focuses upon the benefits that these services can bring to rail operators and their ability to enhance fleet management, but also discusses the potential advantages conferred to business passengers. The article contends that the introduction of the facility is a relatively straightforward and low cost process.

The authors conducted a study of three central European countries which analysed the potential advantage of Wi-Fi in terms of the fact that nearly 65% of business travellers have their own computers. No details are given of how the study was conducted or what type and size of sample was used. The findings are only briefly referred to within the article, which makes it difficult to gain much insight into the impact that Wi-Fi provision may have on business travellers. The article summarises that enhanced service provision is necessary on trains, for example in terms of the availability of Wi-Fi, if they are to be competitive with low-cost airlines.

Meersman, H., Van De Voorde, E., Winkleman, W., Van Vuren, T., and Lake, A. (1999) *Assessing the impact of advanced telecommunications on work-related travel.* Series World Transport Research – Select Proceedings of the 8th World Conference on Transport Research, Volume 3 (p.639-52). Imprint Kidlington, Oxford: Elsevier Science Ltd

This paper was produced to provide a ‘*first insight*’ into the types of work or worker who are the most likely to be able to make use of telecommunication initiatives. The study, which was funded by the then DETR used a UK County Council with 19,000 employees as a case study from which to analyse the type of work that is most amenable to being carried out by telecommunication technologies, and therefore which is the most likely to achieve a reduced need to travel. The limited scope of the study means that assumptions will need to be made regarding the transferability of the results, particularly given that none of the trips made were undertaken by air. The potential for impacts upon short-haul flights therefore needs to be inferred and the estimated impacts on emissions and journey time will not be applicable.

The research findings are based upon numerous qualitative research techniques, such as focus groups, structured interviews, a staff survey and a work location survey, but given the nature of the information collected the authors note that an objective analysis was problematic. Conclusions were therefore based to some extent upon judgements, for example in relation to when considering which business activities could be conducted remotely.

The paper identified that there are identifiable business benefits to making greater use of telecommunications. A considerable proportion of the study focused upon telecommuting and the impact on infrastructure was only considered in relation to road traffic (notably in terms of impact on peak travel periods) as opposed to aviation, but the report also considers videoconferencing as a means to substitute face-to-face meetings, which the report estimates account for approximately 46% of business travel.

The report concludes that the main environmental benefits from ICT will come from telecommuting rather than from business travel mileage.

Modern Railways (2005) *Internet on the move: train operators offer mobile internet service.* Modern Railways Vol 62 No 685 p.18

This article has been produced by the Modern Railways journal to outline the internet facilities provided on trains operated by Great North Eastern Railway (GNER) and Southern, both UK railway operators. The article has been written to target the rail industry and to detail experience of these two rail operators with Wi-Fi services. The article examines the advantages that the technology confers to

both users and operators along with detailed technical and service aspects, such as the price that users pay for the service and the way in which the technology works. The article is relatively neutral but appears to advocate use of the technology and its expansion across more of the rail network.

Mokhtarian, P., and Salomon, I. (2002) *Emerging travel patterns: do telecommunications make a difference?* in Mahmassani, H. (2002) *In Perpetual Motion: travel behaviour research opportunities and application challenges*. Elsevier Science Ltd

This document is an extensive review of literature, focused on that published in the 10 years preceding the study, which aims to determine whether technological changes are likely to have an impact upon travel trends. The review discusses ICT as a partial solution to the growing costs associated with travel, and explores the contention that substitution of journeys for ICT is likely to become a phenomenon of the increased use and availability of telecommunications.

This review analyses the evidence base in terms of likely impact of ICT at the macro level, in terms of specific applications, and at the micro level (activity based). The application of teleconferencing is considered within this comprehensive review which considers a number of potential relationships between ICT and transport, namely; substitution, generate, modification and neutrality. The impact upon air travel movements is not mentioned but the review of the literature enables inferences to be made based upon the findings.

The review suggests that in relation to teleconferencing the primary relationship is one of complementarity rather than substitution. The authors recommend caution when making inferences based on the research findings given the limited evidence base.

Monteith, G. (2006) *High speed, high priority*. Rail Professional No. 106 p.26

This article has been written by a member of the Institution of Civil Engineers (ICE) to give an overview of why they feel a new north-south high speed rail link between Scotland and London is necessary for Britain's economy. The report outlines the increase in domestic flight movements and the importance of journey time when encouraging people to switch modes. The article proposes that a north-south high speed link could capture the majority of the market share between Scotland and London with the competition reducing prices and enhancing capacity on other parts of the conventional rail network. The relative sustainability of this option relative to air and road traffic is discussed along with more technical details of the proposals, such estimates of cost and lead time. Despite the engineering focus specification details that are determined to be of importance in relation to the success of the scheme give an insight into factors affecting the potential for rail to substitute short-haul flights.

Patterson, J. (1998) *Positive environmental impacts of high-speed rail: air emission reductions from aviation*. Rail International No 9 – 10 p.232-5

The purpose of this paper was to quantify the changes that occurred in French civil aviation with the introduction of the high-speed rail TGV service. Data from the International Civil Aviation Organisation (ICAO) was used to calculate and compare growth rates of aviation, in terms of passenger volumes and aircraft movements, at five French airports (Lyon, Bordeaux, Toulouse, Marseille and Nice) from 1975 to 1996. The growth rates were then analysed in the context of the TGV service provision to enable the impact of the TGV service on the aviation industry to be estimated.

The author found that introduction of the TGV service led to decreases in the number of daily flights and size of aircraft flying to Paris from cities with the TGV service. The data is manipulated in a number of ways to effectively demonstrate the impact that the TGV has had upon each of the five cities served by the TGV. The author does not make any explicit links between the decreased growth rates and the environmental impact, but the reduction in emissions that this has led to is inferred.

Patterson, J., and Perl, A. (1999) *The TGV effect: a potential opportunity for reconciling sustainability with aviation*. World Transport Policy and Practice Vol 5 No 1 p 39-45

This paper uses the impact of the TGV service on the French domestic aviation industry to argue that journeys of under three hours on high speed rail may become an alternative to short-haul flights. The authors consider some of the potential impacts that this may have on airport infrastructure, the expansion of long-haul airline markets, and economic and environmental sustainability.

The authors examine the external constraints on the aviation industry, such as greenhouse gases, environmental policy initiatives and fossil fuel reserves to set the context to benefits that could be attained from substituting short-haul flights for rail journeys. The impact of the TGV on the aviation industry is analysed and opportunities for the two industries to complement each other, for example through constructing TGV stations inside air terminals, are also discussed. The review is effective in outlining the key aspects of the argument for the need to substitute a proportion of short-haul flights for rail travel.

Sauter-Servaes, T. and Nash, A. (1995) *Applying low-cost airline pricing strategies to European railroads*. Transportation Research Board No. 1995 p.1-8

This paper details that European railroads need to reduce costs and increase revenues if they are to retain their competitive advantage over short-haul flights. The paper details strategies used by the low-cost airline industry to reduce fares and considers the extent to which these can be adopted by the rail industry. Potential barriers to applying strategies are considered in light of the inherent differences between the rail network and aviation industry and evidence is given to show relative successes and failures of the rail industry in attempting to transfer low-cost airline strategies. Strategies are considered under four main headings; reducing operating costs, reducing perceived ticket costs, practising yield management, and increasing revenues by offering amenities.

The report provides a practical insight into ways in which the rail industry could enhance their competitiveness in terms of price with airlines in an EU context, and market their low fares more aggressively to help reduce the perceptions that airline fares are lower than they actually are and that rail fares are higher than they actually are. Findings are based upon a series of e-mail and telephone interviews although no details are given as to the sample size or type.

Sheldon, R. (2007) *Head to head with the airlines*. Rail Professional No. 119 p22 – 23

This paper highlights the findings of a market research survey that explored business travel habits and identified how the needs of business passengers could be better met by the rail network. No details are given of the sample size, only that the qualitative research study was conducted by interviews, and that respondents made a variety of journeys each month across the UK by rail. The research gives a good insight into passenger attitudes to and opinions of both rail and air services and provides a clear overview of ways in which the competitiveness of the rail industry could be enhanced as a result.

The research found that there is little to differentiate between air and rail in terms of cost, and that when air travel was chosen over rail it was generally the result of distance and the perceived speed of flying. The paper concludes that rail operators need to focus their marketing efforts on promoting the comparable convenience, overall door-to-door travelling time, and flexibility of rail. It also states that business travellers consider train travel to be more conducive to work productivity than air, and therefore recommends measures such as introducing business lounges at stations and wireless internet services on trains. It also emphasises that rail operators are increasingly likely to be able to capitalise upon the relative environmental advantages associated with rail travel relative to air.

Urban Mobility Corporation (2003) *Intercity high speed rail service abroad*. Innovation Briefs Vol. 14 No. 3 p. 2 – 3

The article outlines the convenience and speed of the European high speed rail network and the impact that this has had on encouraging business travellers to substitute short-haul flights for rail services. No original research has been conducted as a basis for this article which uses journey time data and the impact on the aviation industry of the high speed rail network in Europe and in the Asia Pacific region to discuss the benefits of intermodal rail-air connections and to make the case for a high-speed rail system in the US.

The article is effective in highlighting the key advantages that high-speed rail can have over aviation and car travel. Practical considerations are also detailed, such as the relatively high cost of implementation and ways in which it could be financed in the US.

Zhang, M., Marchau, V., van Wee, B., and van der Hoorn, T. (2006) *Wireless internet on trains: impact on performance of business travellers*. Transportation Research Record: Journal of the Transportation Research Board No. 1977 p277-285

This paper focused on the implementation of wireless internet provision on trains on train users, particularly upon business travellers. A literature review was conducted to highlight gaps in knowledge in relation to the impact of information systems in general upon train users. A survey was then conducted to examine how wireless internet might affect travel and work performance, and to determine whether users would be willing to pay for the service, and about the service characteristics that users would like to see.

The sample size of 2,141 respondents was achieved by Dutch Railways supporting the research study and publicising the questionnaire. The survey was conducted online, but given the widespread use of the internet the researchers did not feel that this would introduce a bias to the responses. Analysis of the responses from the 2,141 participants indicated that access to wireless internet can be expected to increase the productivity of business travellers during the journey and were effective in emphasising the high value of time for organisations. A willingness to pay was identified along with the need to make the train environment conducive to work, for example through ensuring the availability of larger tables, chairs, and preferably access to an electricity supply.

A.2 Research reports**Association of Train Operating Companies (ATOC) (2007b) *Ten-year European rail growth trends: Britain's railways – the fastest growing in Europe*. URL: <http://www.atoc-comms.org/admin/userfiles/10%20YEAR%20GROWTH%20REPORT-1.pdf>**

This quantitative study examined the growth performance of Britain's railways relative to those experienced in 17 other mainland EU countries in 2006. An average of the three years 1995, 1996 and 1997 was used as a base year comparator as the authors found this to be a representative comparator. The paper compares the performance of 2006 with this base.

The analysis of levels of growth experienced on rail networks across Europe found that passenger journeys in the UK increased by 6.7% to 1.147 billion, which is the highest rate of growth experienced in any of the countries studied with the exception of Ireland. The analysis also found that passenger kilometres increased by 42.2% in the UK in 2006, which is the highest increase experienced anywhere in Europe. Their forecast for 2007 estimated that passenger kilometres travelled by rail were likely to be at an all time high. The authors concluded that the UK rail industry now faces a challenge in terms of how this growth will be accommodated, but remain confident that measures set out in the Rail White Paper are sufficient to meet the increasing demands on capacity.

Aviation Environmental Federation (AEF) (2007) *Carbon dioxide emissions, and climate changing effect: how does air compare to other means of travel?* Aviation Environmental Federation, UK

The Aviation Environment Federation is a non-profit making environmental association that was established in response to growing concerns about the negative environmental impact of aviation. The AEF provides advice and information to its members, who range from local authorities to businesses and community groups, and has representation on national Government and European Commission working groups. This publication demonstrates the impossibility of making accurate comparisons between the CO₂ emissions of different modes and routes. It uses a wide range of research studies (none of which are referenced in the document) to give an indication of how modes compare. Their review of estimates of emissions of CO₂ (per kilometre and in kgs), each based on different assumptions, demonstrates the extent to which estimates vary according to factors such as occupancy levels of vehicles, length of journey, age and type of vehicle and speed. This reference is effective in revealing the difficulties faced when comparing the emissions of different modes, and was therefore used to inform our review.

Balcombe et al. (2004) *The Demand for Public Transport*. URL: <http://www.demandforpublictransport.co.uk/TRL593.pdf>

This collective study by TRL and other academic institutions reviewed the evidence base on the determinants of the demand for public transport, covering principally urban surface transport in Great Britain. In addition to price, quality of service, income and car ownership, the study also considered the effect of new transport modes (e.g. guided busways), the relationship between land use and public transport, as well as developments in policy and technologies.

Price elasticities were found to differ between short and long run, as well as by mode. Limited evidence on elasticities with respect to in-vehicle time were found, whilst other parameters of service quality were often estimated in relation to in-vehicle time. The effect of income on public transport demand (including the effect of increased car ownership) was found to be substantial.

Banister, D., and Marshall, S. (2000) *Encouraging transport alternatives: good practice in reducing travel*. London: The Stationery Office

This book, funded by the European Commission, provides a systematic review of the potential to reduce levels or proportions of car based journeys in relation to the application of measures such as planning, land use and development. The publication is aimed at policy makers and seeks to encourage alternatives to travel, particularly in terms of reducing the use of the private car, to improve the efficiency and sustainability of the transport network. The underlying theme is that the role of the car can be redefined through the implementation of a range of measures designed to reduce the need to travel. Case studies and examinations of good practice highlight the potential for journey substitution or switching to modes which have a less negative environmental impact.

The chapter of most relevance to this study explores the role that technology can have in reducing travel. Teleconferencing is not referred to as an application in its own right within the book, but is incorporated under the heading of ‘teleactivities.’ The evaluation of its potential to substitute trips is therefore of limited value given that it is evaluated alongside other forms of aspatial interactions, such as e-mail or transactions for commercial services, such as telebanking. The discussion of teleactivities as a whole is also limited, which reduces its potential to meaningfully contribute to the potential for teleconferencing applications to reduce the need to travel.

Bleijenberg (2002) *The Driving Forces Behind Transport Growth and their Implications for Policy*. URL: <http://www.cemt.org/topics/env/Brussels02/Bleijenberg.pdf>

This paper was presented as part of an international seminar titled “Managing the Fundamental Drivers of Transport Demand” hosted by the European Conference of Ministers of Transport

(ECMT). It aimed to identify the fundamental drivers of transport in a historical context spanning the last two centuries.

It identified a continuous increase in the distance travelled per person per day, from a few kilometres to 40 kilometres in the last 200 years. This was found to be accomplished by the shift in mode, from horse power to rail and so forth. However, the daily amount of time spent on travelling was found to remain constant at around 1.1 hours per person per day. The increase in travel speed was found to offset the extra distance covered by the average traveller, and was noted to be the main driver of demand growth. This trend was noted to favour air travel in the future, and the requirement for policies to develop safe and clean air travel was addressed as a priority.

Cairns, S., and Newson, C. (2006) *Predict and Decide – Aviation, climate change and UK policy*. URL: <http://www.eci.ox.ac.uk/research/energy/downloads/predictanddecide.pdf>

The authors of this research report, which was funded by the UK Energy Research Centre, are a Senior Research Fellow working jointly at TRL and UCL, and an independent researcher, both of whom have a background in sustainable transport policy. This publication is a comprehensive review of the evidence about the significance of aviation to climate change. The report also evaluates potential policy measures for mitigating its impacts. The consultation draft generated responses from some 90 stakeholders, which helped to ensure that the review provided an accurate depiction of the issues covered. The authors found that the opportunity exists for the demand for air travel to be reduced through the adoption of more sustainable travel behaviours. The publication also gives an indication of the impacts that such a shift could have upon the environment and economy, factors affecting the demand for air travel, and the role that fiscal and legislative measures could have in reducing emissions from aviation. This review has therefore been used to inform several sections of our report.

Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A., and Goodwin, P. (2004) *Smarter choices – changing the way we travel*. URL: <http://www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/smarterchoiceschangingthewaywetravel.htm>

The DfT commissioned this report into what is a relatively new strand of transport policy to enhance understanding of soft measures, and to estimate the potential effects of each measure. Researchers from University College London, the Robert Gordon University (Aberdeen) and the consultancies Transport for Quality of Life and Eco-Logica conducted literature reviews and consultations to analyse each soft factor separately, and assess their combined potential impact.

The authors reviewed the potential role of work and school travel plans, personalised travel planning, public transport information and marketing, travel awareness campaigns, car clubs, car sharing schemes, teleworking, teleconferencing and home shopping. They concluded that each of these measures, when implemented within a supportive policy context, can be an effective and cost effective means of facilitating choices to reduce car use. It is emphasised that their effectiveness will ultimately depend upon the degree of commitment and policy framework within which soft factor interventions occur. The report cautions that it is still relatively early days for soft factors and that the picture is therefore changing rapidly as experience and understanding of these measures increases. Based upon existing experience the report indicates that teleconferencing could reduce total business travel (i.e. not only air travel) by between 10 and 30% in organisations that promote its use. They state that public sector intervention could be needed to make adoption of teleconferencing facilities mainstream.

CAA (2005) *Demand for Outbound Leisure Air Travel and its Key Drivers*. URL: <http://www.caa.co.uk/docs/5/Elasticity%20Study.pdf>

This report examined the factors influencing demand for outbound leisure travel in the UK. Analysis was conducted in terms of the effects of income, wealth, air fares and composition of population on

leisure air travel. The research was based on interviews with industry representatives, econometric estimation of demand elasticities, and a stated preference study of passengers at Stansted Airport.

Income was found to be a significant determinant of leisure travel. The wealthiest/most professional groups in society were found to take a disproportionately large number of leisure trips abroad. Consumers' sensitivity to price was found to have increased in recent years, due to greater fare transparency and greater choice in destinations, service providers and frequency. However, the overall demand for leisure travel was also found to be increasingly influenced by other factors such as accommodation costs and costs of leisure activities at the destination, as air fares account for only under one third of total costs of a leisure trip abroad.

CAA (2008) *Recent trends in growth of UK air passenger demand*. URL: http://www.caa.co.uk/docs/589/erg_recent_trends.pdf

The CAA is an independent specialist aviation regulator and provider of air traffic services. It is a private company, which is not funded by the Government, who regulates all aspects of aviation from economic regulation to airspace policy, safety and customer protection. This report is the most recent edition of an annual publication which analyses how growth in different segments of passenger traffic at UK airports has changed in recent years. It also seeks to identify reasons for these changes. The report encompasses broad economic trends, competition with other modes of transport, aviation cost pressures and attitudes towards the environment. It also examines the propensity of different types of passengers to fly. This publication has therefore been a key reference and has been referred to throughout our report.

Commission for Integrated Transport (CfIT) (2007) *Attitudes to aviation and climate change*. URL: <http://www.cfit.gov.uk/docs/2007/climatechange/pdf/2007climatechange-survey.pdf>

This research report conducted by MORI for CfIT gives a detailed insight into current and likely future travel behaviours in relation to aviation and an indication of the relationship between this and attitudes towards climate change. The results appear to be geared towards policy makers and transport planners who could use the findings to help determine how certain sectors of the population are likely to respond to various measures. The findings of the report are based upon focus groups, face to face interviews with 1,122 randomly selected survey respondents and further interviews with business travellers and people living near airports. Results were then quantified and the implications discussed at a one and a half day event attended by stakeholders from the aviation industry and environmental lobby. Attitudes expressed towards climate change have been applied in our report to help determine the extent to which the increasing prominence of the climate change agenda will increase the likelihood of travellers substituting short-haul flights for alternatives and to identify competitive advantages of rail over air, and vice versa.

CfIT (2001) *A comparative study of the environmental effects of rail and short-haul air travel*. URL: <http://www.cfit.gov.uk/docs/2001/racomp/racomp/pdf/racomp.pdf>

CfIT is an independent body, established in the 1998 'Integrated Transport' White Paper, who advises the Government on integrated transport policy and its interaction with wider Government objectives. CfIT produce a wide range of evidence based reports which are aimed to develop a consensus amongst stakeholders. This research study has been produced by AEA Technology Environment in collaboration with AEA Technology Rail and the CAA, to analyse the comparative environmental impacts of high speed rail and short haul air traffic for regional domestic journeys. The report also considers how these environmental impacts are likely to change in the future. The main domestic flight routes in Great Britain have been compared in relation to greenhouse gas emissions and other atmospheric emissions. The environmental impacts of noise and land-take have also been examined. The report has therefore contributed towards our understanding of the impacts that any substitution of short-haul flights may have.

CfIT (2004) *High-speed rail: International Comparisons*. URL: <http://www.cfit.gov.uk/docs/2004/hsr/research/index.htm>

CfIT is an independent body, established in the 1998 '*Integrated Transport*' White Paper, who advises the Government on integrated transport policy and its interaction with wider Government objectives. CfIT produce a wide range of evidence based reports which are aimed to develop a consensus amongst stakeholders. This report, which makes international comparisons of the implementation of high speed rail, was produced by the transport consultancy Steer Davies Gleave. It was commissioned to help determine the reasons behind Britain's lack of investment in high speed rail relative to other countries and to make recommendations about how Britain's appraisal criteria and processes should be changed to better reflect the benefits of high speed rail. The research involved a review of high speed rail developments, markets and appraisal processes in Britain, France, Italy, Spain, Germany, Japan and Australia. This research report was of general interest to the project team, although particularly in relation to its analysis of the costs of a high speed rail line in Britain which were used to give an indication of the potential benefits of ear-marking aviation tax revenues for investment in alternative modes of transport.

DfT (2007a) *Towards a sustainable transport system – supporting economic growth in a low carbon world*. London, UK: Stationery Office (TSO)

This discussion document has been published in response to the Eddington and Stern reports by detailing the way in which transport can support sustainable economic growth whilst reducing carbon emissions. The sets out the DfT's policy and investment plans for the period to 2013-14 and proposes a longer-term transport strategy, building on the model recommended in the Eddington review.

The document provides recommendations for the policy-making process based upon the DfT's evidence base. These centre around improving the performance of the existing road network, focusing on the most unreliable and congested sections in order to improve efficiency and reducing transport related emissions of CO₂ and other greenhouse gases whilst improving quality of life, and the safety, security and equality of the transport network.

Despite providing recommendations on how to reduce the emissions of greenhouse gases from the transport network the report emphasises that '*domestic aviation has an important role to play*' for '*longer journeys*' within the UK. Whilst the DfT recognises that improvements in rail services can contribute to reduced demand for domestic flights, it reinforces the valuable connections that domestic flights can provide for businesses and residents. Coach travel is also not mentioned within the report, which reviews the national transport network, despite its likely potential to act as a substitute for some short-haul domestic flights.

Dings et al. (2003) *External Costs of Aviation*. URL: <http://www.umweltdaten.de/publikationen/fpdf-l/2297.pdf>

This report, undertaken on behalf of the Federal Environmental Agency of Germany aimed to quantify the external environmental costs of aviation. Climatic impacts from aviation were valued both in terms of the damage cost and prevention cost, leading to a middle estimate of 30 Euros per tonne of CO₂ equivalent, with a possible range between 10 and 50 Euros per tonne. The analysis also included the effect of contrails on climate change, which was found to have a large influence on the end figure. A mid estimate of the impact of a contrail-causing aircraft kilometre was suggested to be approximately eight times as high as an aircraft kilometre that does not lead to persistent contrails.

Regional and local impacts were also quantified using the damage cost approach, which included the avoidance or adaptation costs (e.g. costs of zoning around airports). It was found that for aircraft flying up to a few hundred kilometres, external costs related to landing and take-off (LTO), such as noise, were found to be dominant. Aircraft flying over 1000km were found to cause climatic external costs in excess of LTO impacts. The level of external costs (without contrail impacts) varied from

around 5% of fares (long-haul flights, new technology, no contrail formation) to roughly 25% of the fare for 200 km flights. However, these figures rose sharply when the effect of contrails were taken into account.

European Telecommunications Network Operators Association (ETNO) and World Wildlife Fund (WWF) *Saving the climate @ the speed of light: first roadmap for reduced CO₂ emissions in the EU and beyond*. URL: [http://www.etno.be/Portals/34/ETNO%20 Documents/Sustainability/limite%20Change%20Road%20Map.pdf](http://www.etno.be/Portals/34/ETNO%20Documents/Sustainability/limite%20Change%20Road%20Map.pdf)

This report was produced to highlight the lack of collaboration between ICT and climate change and to raise awareness of the potential reductions in CO₂ emissions from the transport sector that could be achieved by more targeted use of ICT. The report, which is aimed at a policy audience, proposes the formulation of an EU wide strategy to use ICT to reduce the need to travel. They emphasise the importance of setting targets and producing an action plan to support their attainment. The authors detail that progress may require the use of incentives and engagement with a range of stakeholders if it is to be effective.

The report suggests that a target for 2010 could be to reduce CO₂ emissions by 50 million tonnes through the use of ICT. They estimate, for example, that 24 million tonnes of CO₂ could be reduced each year by half of the EU25 countries employees replacing one meeting with one audio-conference call per year, and by replacing 20% of all business travel in EU25 countries by the use of videoconferencing. It is not specified what proportion of these foregone trips are likely to have been made by air.

It is unclear as to how they formulated this estimate as it seems to be in contradiction to numerous other research studies that have been conducted into the relationship between ICT and travel. Indeed the report seems to largely omit references to empirical research studies and instead quotes information from the websites of ICT companies about the potential for video- and audio-conferencing to reduce the need to travel.

Despite their predication that ICT can lead to a widespread reduction in CO₂ emissions the authors recognise that enhanced use of ICT could result in a move in both directions as ICT is, to a large extent, viewed as a catalyst to travel. Nevertheless the report sets out key actions and recommendations that should help ensure that the impact of ICT upon climate change is positive.

Fitzgerald, J., and Tol, R. (2007) *Airline Emissions of Carbon Dioxide in the European Trading System*. URL: <http://www.fnu.zmaw.de/fileadmin/fnu-files/publication/tol/RM4465.pdf>

This study utilised the Hamburg Tourism Model (HTM) to analyse the effect of including aviation in the EU Emissions Trading Scheme on global CO₂ emissions.

The changes to total CO₂ emissions from international aviation were calculated to be minimal: - 0.01% at current permit prices, and -0.13% for the higher price set by the Stern Review. Tourist numbers in Europe were estimated to fall by up to 0.6%, whilst increasing in the rest of the world. The grandfathering of permits were estimated to give away a subsidy of €3 billion at current prices, and €40 billion at Stern Review prices. On the other hand, the auctioning of permits would only have a minimal effect on the airline industry.

Friends of the Earth (FoE) (2000) *From planes to trains: realising the potential from shifting short-haul flights to rail*. URL: http://www.foe.co.uk/resource/reports/planes_trains.pdf

Friends of the Earth is an environmental campaigning organisation. The organisation has produced a wide range of publications since its inception in 1978, an increasing number of which are focused upon climate change and potential solutions to the challenges faced. Most of the research produced by FoE, including this document, is designed to influence the Government and policy makers. This

particular report, produced by the Aviation Environmental Federation, evaluates the potential for substituting a proportion of short-haul flights for rail journeys, and considers the environmental impacts that such a modal shift may have. The nature of the report makes it directly relevant to our study. The report examined a number of routes between cities where demand for air travel is high and where the distance involved made rail a realistic alternative. The study formulated a number of scenarios, ranging from 'best case' where all air traffic was moved to rail, to more modest estimates, although the later also assumed that 50% of air traffic could be transferred to rail. The report concluded that in the best case scenario air demand equivalent to a heavily used runway in the South East could be transferred by 2015, thereby having implications for the need for aviation expansion.

FoE (2005) *Growth scenarios for EU & UK aviation*. URL: http://www.foe.co.uk/resource/reports/aviation_tyndall_research.pdf

This report was produced by the Tyndall Centre for Climate Change Research at the University of Manchester for Friends of the Earth. This comprehensive report reviews the scientific, policy and economic context to managing greenhouse gas emissions from aviation and assesses the contraction and convergence model developed by the Global Commons Institute. Implications of aviation growth in the EU are discussed with the assumption that it will continue to grow unrestrained. Aircraft emissions scenarios are developed by the authors for each EU nation, the results of which indicate that even the least economically developed nations will need to reduce their carbon emissions to meet Government targets. In terms of the UK the report states that aviation will account for 134% of the level of emissions that we should be producing to stay below 550ppm (to achieve a 60% reduction) of CO₂ (with a radiative forcing of 2.7). The extensive scientific analysis of different carbon emission levels has helped to inform our review of the current situation and the likely impacts of a modal shift.

Gillen et al. (2007) *Air Travel Demand Elasticities: Concepts, Issues and Measurement*. URL: http://www.fin.gc.ca/consultresp/Airtravel/airtravStdy_e.html

This study reviewed the existing economics and business literature on empirically estimated price elasticities of air travel demand in Canada and other major developed countries. Elasticities were found to differ amongst the various types of air travel: business and leisure travel; long-haul and short-haul travel; and international and North American long-haul travel. Business travellers were found to be less sensitive to price changes compared to leisure travellers. Within leisure travel, demand for long-distance flights were found to be less elastic compared to short distance flights.

Hickman, J., Hassel, D., Journard, R., Samaras, Z., and Sorenson, S (1999) *Methodology for Calculating Emissions and Energy Consumption*. MEET Deliverable, European Commission DG VII

This report produced and published by TRL was one of many reports funded under the European Commission's MEET (Methodologies for Estimating Air Pollutant Emissions from Transport) project. The aim of the project was to provide a comprehensive set of data and models, along with a comprehensive method of calculation using the data and models, to calculate pollutant emissions and the fuel or energy consumption of various transport modes at a strategic level. This specific report summarises all of the individual methodologies and corresponding emission factors and functions produced under the MEET project. The findings of this report were used to calculate carbon dioxide emissions per passenger kilometre for rail travel in our review of the emissions produced by rail, coach and air travel.

Intergovernmental Panel on Climate Change (1999) *Aviation and the global atmosphere - a special report of IPCC working groups I and III*. Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA. URL: <http://www.grida.no/Climate/ipcc/aviation/index.htm>

The IPCC is a scientific intergovernmental body set up by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP). The organisation was established

to provide decision-makers and others interested in climate change with an objective source of information. The IPCC does not conduct any research themselves, nor does it monitor climate change data, but it does assess the latest scientific, technical and socio-economic literature produced. This assures that their publications are of a high scientific and technical standard, which is why this reference was used to help determine the environmental impact of short-haul aviation relative to other modes, such as coach and rail, in our review. This publication is widely recognised as one of the most comprehensive assessments of the effects of aviation on the global atmosphere. The report also considers how potential changes, such as economic, regulatory and institutional, may impact emissions in the futures.

James, P. (2007) *Conferencing at BT: results of a survey on its economic, environmental and social impacts*. URL: <http://www.btplc.com/Societyandenvironment/Reports/BTconferencingsurvey2007.pdf>

This report was produced by Professor Peter James of the Environmental Management department at the University of Bradford. He currently leads the UK Centre for Environmental and Economic Development's (UK CEED) SustainIT programme. This programme aims to develop a better understanding of the relationship between ICT and sustainable development, and to show how technology can be used to obtain environmental and social benefits for individuals, businesses, and communities. This research report was produced as part of this programme and focused upon the social, environmental, and economic impacts of video- and audio-conferencing at BT. The report was therefore used to inform our review of likely impacts of the use of these technologies. Impacts of conferencing on travel have only been referred to briefly within their report, and the author explicitly states that inaccuracies could arise from interpretation of their research, for example as a result of individuals overestimating the benefits of teleconferencing and the research not taking into account the ability of additional travel to be generated by ICT – the impact of which other literature has suggested could be significant. Their research was, however, based on a representative sample of 6,032 BT employees and whilst only 15% (905 respondents) provided usable responses it gives an insight into attitudes towards, and likely impacts of, these technologies.

Keen and Strand (2007) *Indirect Taxes on International Aviation*. URL: <http://www.blackwell-synergy.com/action/showPdf?submitPDF=Full+Text+PDF+%28240+KB%29&doi=10.1111%2Fj.1475-5890.2007.00046.x>

This study examined the various indirect taxes and charges on international aviation and their potential as a source of finance for development or tackling climate change. The strengths and weaknesses of the various instruments were discussed.

The case for increasing indirect taxes on international aviation was argued to be strong. The authors mention several justifications for a tax increase. Firstly, the current burden is very low, despite the significant contributions of the sector to border-crossing environmental damage. Secondly, aviation is just as proper an object of taxation as any other commodity. Third, incipient competition is likely to result in inefficiently low levels of tax. A tax on aviation fuel was argued to be effective in directly addressing the key border-crossing externalities, whilst a tax on final ticket prices would have greater revenue raising potential and possibly a distributional effect. Departure/arrival taxes were mentioned to face the least legal obstacles. Possible synergies between these policies were demonstrated, including a combination of fuel tax and ticket tax.

Leicester and O'Dea (2008) *Aviation taxes*. URL: <http://www.ifs.org.uk/budgets/gb2008/08chap9.pdf>

This report was presented as part of the 2008 Green Budget by the Institute for Fiscal Studies. It examined the current taxation scheme in the UK relating to air travel, provided an overview of the rationale for taxation and presented the implications of a new tax on flights.

External costs, such as emissions, noise, pollution and congestion were discussed as rationales for taxation. International agreements such as the Chicago Convention were found to prevent fuel for international flight to be taxed. The Government's proposed new tax on flights would allow the level of emissions to be targeted more effectively than the current Air Passenger Duty (APD). It would strengthen incentives for better utilisation of aircraft, and could also be extended relatively easily to freight flights. To target the external costs of aviation, the duty was recommended to be set up to vary by aircraft type, aircraft emissions and departure airport, as well as distance travelled. Winners from the change were suggested to be those travelling on short distances on full, clean and quiet planes from airports away from residential areas. The trade-off between sophistication and costs of administration/compliance was also noted, together with the potential interaction with the EU Emission Trading Scheme.

Mayor and Tol (2007) *The Impact of the UK Aviation Tax on Carbon Dioxide Emissions and Visitor Numbers*. URL: <https://www.fnu.zmaw.de/fileadmin/fnu-files/publication/working-papers/htm13taxukwp.pdf>

This study used an economic model to estimate the impact of the recent and proposed changes in the Air Passenger Duty. The doubling of APD is shown to have a perverse effect of increasing CO₂ emissions, because it reduces the price difference between near and far holidays. Tourists to the UK, as well as those from the UK to countries near to the UK were shown to fall, whilst tourists to countries far from the UK would increase. A carbon tax is shown to decrease emissions with higher rates.

Paul Watkiss Associates and AEA Technology Environment (2006) *Exact title unknown*. Eurostar.

This study was commissioned by Eurostar but conducted on an independent remit by a consortium of Paul Watkiss Associates and AEA Technology Environment, both multi-disciplinary consultancies. The research was conducted to determine exactly how much CO₂ is produced on a journey undertaken by Eurostar. The research report, which has not been made publicly available in its entirety owing to the commercial sensitivity of the information, has produced what appear to be the most detailed estimates produced. They are based upon actual passenger numbers and aircraft types, exact distances of rail and air routes, and the mix of electricity sources used by Eurostar trains. The findings show that passengers who fly between London, Paris and Brussels generate ten times more emissions of CO₂ than travellers who journey by rail.

Pearce, B., and Pearce, D. (2000) *Setting Environmental Taxes for Aircraft: A Case Study of the UK*. URL: http://www.uea.ac.uk/env/cserge/pub/wp/gec/gec_2000_26.pdf

This paper estimated the external costs of aviation and the rate of an externality tax for Heathrow Airport. The relevant externalities covered were CO₂, NO_x and noise. Global externalities (i.e. climate effects) are argued to be common to aircraft types regardless of the country, whilst local externalities (i.e. noise and air pollution) are shown to differ by context; this leads to the suggestion that the former may need harmonisation across countries whilst the latter should not. The authors conclude that the optimal level of taxes would add just over 0.5% to the price of a short haul European flight, and just under 2% for a long haul flight, comparable to current levels of APD. Scope for behavioural change through taxation is noted to exist in many ways; airlines could change airport choice, change aircraft type or choose not to fly at all. Aircraft/engine manufacturers would face incentives for technological development. Otherwise, taxes would raise revenues which could be used for compensation, or hypothecated to funds to finance carbon sequestration or development of new technologies.

Rail Safety and Standards Board (2007) *Improving rail's energy efficiency*. Research Report T618, July 2007. London

The Rail Safety and Standards board applies knowledge, analysis and technical expertise to inform and resolve challenges faced across the rail industry. This report examines the environmental

implications of rail operations for both traction and non-traction purposes, to assess its current efficiency and to make recommendations for improvements in the short- and long-term. This research report has been produced in recognition of the fact that energy needs to be used more efficiently and that ways in which savings can be made need to be identified. It concludes that there are a number of significant opportunities for conserving energy, and with measures widely implemented the author estimates that the industry can save approximately £68 million per annum for the next ‘few years’ and reduce CO₂ emissions by approximately 521,000 tonnes per annum. The report is fairly technical in that it examines how the rail industry consumes diesel and electrical traction energy but it makes comparisons of UK train energy performance, based upon literature searches, which have been referred to in our report to evaluate the environmental impacts of rail travel.

Sausen, R., Isaksen, I., Grewe, V., Hauglustaine, D., Lee, D., Myhre, G., K^ohler, M., Pitari, G., Schumann, U., Stordal, F., and Zerefos, C. (2005) *Aviation radiative forcing in 2000: an update on IPCC (1999)*. *Meteorol. Zeitschrift*, 14, 555–561, 2005

TRADEOFF is an EU funded project that investigated the impact of aviation on the atmosphere. In particular it focused on NO_x emissions, ozone, and the chemical lifetime of methane from subsonic aviation. The project involved developing a large database of aircraft-borne measurements of atmospheric constituents from research aircraft and routine commercial flights in the year 2000. This information was used to validate the output of 7 state-of-the-art atmospheric models. Once validated the models were used to analyse the impact of aircraft on the atmosphere, which included variations with route and altitude. The TRADEOFF project calculated a radiative forcing index (RFI) of 1.9, which is considered by most to be the best and most current estimate. The RFI does not, however, include the effect of changes to cirrus clouds which is very difficult to model. The data from this project was used to inform our review of the environmental impacts of aviation, and also our comparison of the environmental impacts of rail, coach and air services.

Sewill, B. (2005) *Fly now, grieve later: how to reduce the impact of air travel on climate change*. URL: <http://www.aef.org.uk/downloads/FlyNowFull.pdf>

This report was commissioned by the Aviation Environment Federation as a follow on to the 2003 publication ‘*the hidden cost of flying*.’ Sewill, an economist who has been an adviser in the Treasury and to the British Bankers Association, this time examines the technical, economic, social and political issues associated with the fiscal regimes that apply to aviation. The document argues that aviation is the most environmentally damaging industry and echoes the findings of the 2003 report which found that aviation is effectively subsidised by approximately £9 billion a year. This report is of direct relevance to our review as it evaluates the external costs of availability, the feasibility of tax increases, and the economic arguments for airport expansion. It has been used to inform our review of the potential impacts of increases in tax levels, peoples perceptions of the industry, and the relative effectiveness of different forms of taxation.

Sewill, B. (2003) *The Hidden Cost of Flying*. URL: [http://www.aef.org.uk/downloads/ Hidden Cost.pdf](http://www.aef.org.uk/downloads/HiddenCost.pdf)

This report was commissioned by the Aviation Environment Federation to evaluate the economic case for aviation growth because whilst the environmental case against airport expansion is relatively well known, the economic case has been the subject of less research. The author is an economist who has been an adviser in the Treasury and to the British Bankers Association. The research reports recognises that aviation is an important industry, but does not support the uncontested growth of the industry and the low levels of tax that the industry pays. The favourable tax regimes are said to have helped to account for the success of the aviation industry, and serves to artificially inflate forecasts of future growth. The report concludes that aviation tax should be made more equitable and made to pay for more of its external costs – the author contends that the result would not necessarily be an increase in costs or negative growth, and that the business case for doing so is strong. This research has been used specifically to identify the amount of revenue that has been lost to the treasury (estimated to be £9 billion in 2003) from aviation failing to be made fully accountable for its costs.

Tol, R. (2006) *The Impact of a Carbon Tax on International Tourism*. URL: <http://www.fnu.zmaw.de/fileadmin/fnu-files/publication/working-papers/htm13taxwp.pdf>

This study used the Hamburg Tourism Model (HTM) to analyse the impact of a carbon tax on aviation fuel on international tourism.

A global tax at the rate of \$1000 per tonne of carbon equivalent was shown to reduce emissions from international aviation by only 0.8%, due to the small proportion of the tax in relation to the air fare, an even smaller portion on the total cost of the holiday, as well as the low price elasticity of travel demand. Such a tax was shown to affect not only long-haul flights, but short-haul flights as well due to the disproportionate level of emissions during take-off and landing. Medium distance flights would be least affected. As a result, tourist levels to nearby locations and intercontinental destinations would fall, whilst mid-distance destinations would increase their attractiveness. It is also shown how a tax limited to the EU would encourage EU tourists to stay closer to home, leading EU tourism to grow at the expense of other areas. The author concludes that a carbon tax on aviation fuel would have little effect on either international tourism or emissions.

TRANSform Scotland (2007) *The railways mean business: attracting business travellers from air to rail*. URL: http://www.transformscotland.org.uk/info/docs/2007-11-21_The_Railways_Mean_Business.pdf

This comprehensive report effectively outlines the key advantages that rail travel can have relative to short-haul air travel. The document draws together a relatively broad range of literature to make the case for business travellers substituting short-haul flights for rail journeys. No original research has been conducted by the author, although existing sources of information are analysed from a new angle.

The report focuses upon the use of non-sleeper services between Glasgow and London and Edinburgh and London by business travellers, and identifies changes that can be made in a relatively short time-scale to enhance the rail service provided for business travellers. The aim of the report is to highlight issues that can be used by rail operators to more effectively market their services to business travellers, and as such the author discusses advantages and perceived disadvantages of rail travel and undertakes a review of literature as a basis upon which to recommend ways in which the service offering can be improved.

Transport 2000 (2006) *Fog on the runway: how calls for a third runway at Heathrow have overlooked the potential of high-speed rail to meet travel demand*. URL: http://www.bettertransport.org.uk/files/pdfs/Fog_on_the_Runway.pdf

This focused report highlights the need for the debate about the potential for a high-speed north-south rail link to be considered in relation to aviation policy. The report argues that high-speed rail can substitute the need for a considerable proportion of short-haul flights on certain routes. It also states that rail links to Heathrow will need to be enhanced to support its future growth and that developing the role of airports as transport hubs can increase the potential for short-haul journeys to be substituted for rail.

The report reviews key policy documents and proposals for the expansion of Heathrow and for a North-South high-speed rail link. The authors consider the likely impacts upon the short-haul aviation market, the competitiveness of the rail network relative to aviation, accessibility of the conventional rail network, and ultimately upon the need for further expansion of aviation infrastructure and co-operation between the rail and aviation industries.

Volterra (2003) *Fiscal treatment of public transport*. URL: http://www.volterra.co.uk/publications/01/fiscal_pt.pdf

This paper compared the levels of taxation and subsidy in the UK across three modes of transport; air, rail and bus. The study was limited to quantifying the net revenue of each mode to the government, and no attempt was made to calculate external costs.

It concluded that, net of subsidies and duty free, the aviation sector is a contributor of £750 million to governmental revenue, mainly via the Air Passenger Duty. Rail and bus services were illustrated as a net recipient of governmental subsidies, in the range of £1.6 billion for rail, and £650 million for bus.

Wit, R. et al (2005) *Giving wings to emissions trading: inclusion of aviation under the European trading system (ETS): design and impacts*. Delft, CE, Netherlands. Report for the EC, DG ENV, ENV.C.2/ETU/2004/0074r

This report was commissioned by the European Commission to develop concepts to address the full climate change impact of aviation through emissions trading. The study, produced by authors from CE Delft, Manchester Metropolitan University and the Oeko-Institut in Berlin, examined ways in which all climate change impacts of aviation could be captured within an emissions trading scheme, propose viable ways in which to include aviation into the existing EU Emissions Trading Scheme (EU ETS) and to assess the qualitative impact of any such policy options. The research is a comprehensive research report detailing climate change impacts of the aviation sector, but it is primarily designed for policy makers. The report concludes that emissions trading should be considered alongside other measures to tackle aviation climate impacts and that it is unlikely to pose any notable challenges other than those already encountered in the EU ETS. Our review considered the findings of this report and incorporated details of the likely impacts of proposals on fare price and the demand for air travel.

WWF (2008) *Travelling light: why the UK's biggest companies are seeking alternatives to flying*. URL http://www.wwf.org.uk/filelibrary/pdf/travelling_light.pdf

The WWF is a global conservation charity who uses scientific information to suggest and evaluate solutions to environmental challenges. This report forms part of the One Planet Mobility project, which WWF-UK has been working on over the last 18 months with 35 leading EU organisations from the transport sector. The project seeks to find practical solutions to reducing carbon emissions in the UK.

This research project, conducted by the market research company Critical Research, details the findings of a survey designed to outline the desire of companies to reduce levels of business air travel to reduce their carbon footprint and their attitudes towards videoconferencing. The research objectives were also to ascertain whether companies have a corporate policy that encourages green travel, and to measure whether any government initiatives would encourage green business travel. Driven by the recognition that work related air travel is a major driver of aviation growth and that videoconferencing technology can remove the need to travel, WWF-UK commissioned Critical Research to undertake a survey of business travel practices among FTSE 350 companies. One hundred of these companies agreed to be interviewed. The findings indicate that the vast majority of organisations surveyed plan to reduce the amount that they fly and improve their productivity through greater use of videoconferencing and rail alternatives. Respondents also, however, stated that some intervention will be needed to maximise the reduction of business air travel, namely government investment in videoconferencing, and improved quality and interoperability of videoconferencing systems.

A.3 Policy documents

Department for Trade and Industry (DTI) (2005) *Energy white paper: our energy future – creating a low carbon economy*. URL: <http://www.berr.gov.uk/files/file10719.pdf>

This White Paper outlines the UK Government's energy policy and long-term strategy. The policy document details ways in which energy challenges could be overcome and the opportunities for shifting the UK towards becoming a low carbon economy. It is geared towards the research community, local authorities and the private sector and is based upon extensive analysis and modelling.

The Paper recognises that climate change is a key challenge, and that with levels of CO₂ having risen a third since the industrial revolution the risks associated with global warming, such as droughts and flooding, are likely to increase. The White Paper therefore sets out a commitment to sustainable development and highlights ways in which social, economic and environmental goals can be achieved at the same time. It emphasises a commitment to achieving a 60% reduction in CO₂ emissions by 2050 and is the first energy policy to comprehensively address environmental problems. In terms of transport the White Paper focuses upon hybrid and low carbon biofuels and has been used to help set the context of our report.

DfT (2007c) *Delivering a Sustainable Railway*. URL: <http://www.dft.gov.uk/about/strategy/whitepapers/whitepapercm7176/multideliversustainrailway>

This White Paper was produced by the Government to help plan for the growth and development of the UK rail network over the next ten years. It provides a framework within which rail operators and local authorities will need to operate. It has been a valuable resource for our review as it provides an indication of the direction in which rail policy is moving. This reference has therefore helped us to determine whether the capacity of the network will be able to accommodate a partial shift from short-haul aviation to rail and whether the DfT is likely to support the development of high speed rail or InterCity Express services, which have the potential to accelerate a modal shift by enhancing the competitiveness of rail relative to aviation.

DfT (2007d) *Delivering a sustainable railway: summary of key research and analysis*. URL: <http://www.dft.gov.uk/about/strategy/whitepapers/whitepapercm7176/railwhitepaperresearch/pdfevidencepack>

This publication is a compilation of the main evidence that underpins the analysis in the '*delivering a sustainable railway*' White Paper (DfT, 2007c). The report contains a set of detailed industry statistics collated from a wide range of official sources. The tables and charts featured in the report are not accompanied by any narrative and so it is not possible to determine how these statistics were collected or the purpose of each of the analyses. This is likely to be owing to the fact that it is a supporting document of the White Paper which has the explicit aim of providing a more detailed view of the rail industry. The data enabled us to gain a more detailed insight into the railway industry and network, which was used to inform our report, particularly in relation to the likelihood, and impacts, that a shift from aviation to rail may have.

DfT (2004) *The Future of Transport: a Network for 2030*. URL: <http://www.dft.gov.uk/about/strategy/whitepapers/fot/thefutureoftransportwhitepap5710>

This transport White Paper provides an overview of the direction in which the Government anticipates the transport network moving in the next thirty years. This document is a framework within which local and regional Government will need to operate and align their own strategies with. It is therefore a key reference when seeking to determine the likelihood of a modal shift being supported by Government policy. The overarching aim of the document is to enable the growth in transport demand to be managed more effectively. This includes providing a more reliable and free-flowing service on the road network and a faster more reliable service on the rail network and committing to

levels of investment to support measures which help enable this to be achieved. It also outlines that aviation should be made to meet its external costs ‘*over time*,’ although does not specify in what way. The White Paper made very little reference to coach travel, which is perhaps indicative of the role that it is expected to play in managing the future demand for transport.

DfT (2003) *The Future of Air Transport*. URL: <http://www.dft.gov.uk/about/strategy/whitepapers/air/>

This White Paper provides a strategic framework for development of airport capacity over the next thirty years. The White Paper provides an overview of the aviation sector and outlines the direction that developments are likely to take. The document is geared towards relevant public bodies, airport operators and airlines and provides the context in which their operations will need to be planned. Environmental impacts, aviation expansion and air travel forecasts are encompassed within this policy framework, all of which have a bearing upon the issues considered within our report. The White Paper stresses the economic value of aviation, but also details that enhancements to the rail network could help to meet some future demand for travel on certain routes. It also states that the accessibility of airports by modes that minimise environmental impacts will be a key factor in considering proposals for new airport capacity.

Eddington, R. (2006) *The Eddington Transport Study. Main Report: Transport’s role in sustaining the UK’s productivity and competitiveness*. URL: http://www.hm-treasury.gov.uk/independent_reviews/eddington_transport_study/eddington_index.cfm

The Eddington Review was commissioned by the Chancellor and the Secretary of State for Transport to advise the Government on the long-term links between transport and the UK’s economic productivity, growth and stability, within the context of the Government’s commitment to sustainable development and the environment. The report published in 2006 was the result of a year long research project that highlighted the key role that transport plans in supporting the continued economic success of the UK, and which set out policy recommendations. The report found that national connectivity is good and that there is not necessarily any need to construct new infrastructure, with the challenge being to instead manage the existing network more effectively. Eddington recommended that the Government focus on capacity constraints and unreliability and to bring forward and assess measures that could address these issues, particularly on the most heavily used and economically significant parts of the network. In line with the Stern Review, Eddington also recommended that prices across all modes should reflect their true cost to society through the appropriate fiscal and legislative instruments.

European Commission (EC) (2006a) *Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community*. URL: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0818:FIN:EN:PDF>

This document outlined the proposal by the Commission of the European Communities to include aviation in the EU Emissions Trading Scheme. It covers the context, history of consultation/impact assessment, legal aspects and budgetary implications of the proposed policy.

It is suggested that aircraft operators be the entities responsible for compliance, and that the scheme would cover all flights arriving at/departing from an airport in the Community starting in January 2012. Flights between EU airports will be covered from January 2011. The total number of allowances will be determined at Community level by reference to average emissions from the sector in the years 2004-06. These allowances will then be allocated to operators (through a benchmark) free of charge. Aircraft operators will be allowed to buy allowances from other sectors, and use project credits (ERUs and CERs) from JI/CDM up to a certain level. Domestic aviation will be treated in the same way as international aviation.

EC (2006b) *Impact Assessment of the inclusion of aviation activities in the scheme for greenhouse gas emission allowance trading within the Community*. URL: http://ec.europa.eu/environment/climat/pdf/aviation/sec_2006_1684_en.pdf

This document assessed the environmental, economic and social impacts of including aviation in the EU Emissions Trading Scheme, and the variations of impacts with regards to scheme design. The assessment is conducted by a combination of analyses using three formal models-AERO, PRIMES and TREMOVE. AERO is an aviation-specific model, whilst PRIMES simulates a market equilibrium for energy supply and demand in the EU. TREMOVE is a transport and emissions model, designed to study the effects of different transport and environmental policies on the emissions of the transport sector.

Results show that aircraft operators are the desired entity, as no other type of entity has more control over investments/operational decisions. An open system, integrated with the EU ETS is shown to be preferable to a closed system. Aviation will be able to buy allowances from other sectors in the EU ETS, but not vice versa because international aviation emissions are not assigned amount units under the Kyoto Framework. The broadest possible geographical scope of all departing and arriving flights is shown to give the biggest environmental, competitive and industrial benefits. Initially, only CO₂ emissions will be included in the scheme, although the Commission will place further proposals for NO_x emissions. The initial level of allowances is shown to be crucial in determining the positive environmental effects. A single, sector-wide benchmark based on emissions per tonne-km is suggested to be the best basis of allocation. The scheme would only have a marginal effect on the profitability of and competition in the sector, and would have a small impact on demand growth.

HM Treasury (2008) *Aviation duty: a consultation*. URL: http://www.hm-treasury.gov.uk/media/E/2/consult_aviation310108.pdf

This document outlined the Government's proposed changes to the taxation of air travel. The newly proposed tax would replace the current Air Passenger Duty, and would be levied on a per-plane basis. The Government proposes the basis of the duty to be the Maximum Take-Off Weight (MTOW) of each aircraft, the two stated reasons being that MTOW is a readily used measure and that it provides a reasonable proxy for the environmental impact of a flight. The duty per flight would be based either on a straight multiplication of the MTOW with a rate per tonne, some more complex continuous functions of MTOW, or a set of discrete weight "bands" based on MTOW. Alternatives to the MTOW are also given, including the level of NO_x emissions in the landing/take-off (LTO) cycle, and CO₂ emissions in the LTO cycle.

A.4 Other contributions

Airport Council International (ACI) (2008) *Worldwide passenger traffic grows 5.6% in 2007*. ACI Press Release 30/01/2008

The ACI is the international association of the world's commercial airports. It is a non-profit organisation which promotes best practice in airport management and operations. Part of its role is to influence international and national legislation, policy and standards, based upon the interests of the airports that it represents. The association is also a source of information about the operations of the aviation industry. This press release is the most recent monthly report from the association and was used to help inform our understanding of the current trends experienced in the aviation industry. The document provides an overview of and background to the increase in demand experienced in 2007, during which time global passenger traffic rose by 5.6%.

ATOC (2007a) *Exploring the potential - 25 ways to unlock the potential of the existing rail network: a discussion paper*. URL: <http://www.atoc-comms.org/admin/userfiles/ATOC-25-final-4-may.pdf>

This discussion paper was published to demonstrate the potential for increasing the capacity of the existing rail network to accommodate the predicted growth in demand. It examines passenger needs, future demand pressures and network 'pinchpoints' and suggests ways in which they could be overcome.

The paper is designed to complement Route Utilisation Strategies produced by ATOC, each of which provide a thorough evidence-based review of a number of routes proposing enhancement schemes that could be implemented over the next ten years. This paper builds upon these Strategies to provide a 15 year view at what the potential to accommodate the additional demand on the rail network may be. The paper is structured around the different regions of the UK, and consists of practical examples which suggest that up to 55% more capacity could be delivered on a number of routes. The authors also suggest that such measures will enhance the reliability of train services. Their recommendations are location specific and are based upon making the best use of the existing railway rather than proposing new lines, such as a high speed North-South rail link.

ATOC (2008) *Fact file*. URL: <http://www.atoc-comms.org/admin/userfiles/FACT%20FILE%20Feb%2008.pdf>

This publication is a comprehensive reference point for statistics relating to Britain's rail network. It provides a background to the industry by means of a wide range of statistics. The rest of the report sets out a wide range of statistics relating to Britain's railways in relation to growth, punctuality, safety, passenger security, rolling stock, infrastructure, stations and passenger information. It also has a section relating to the 2007 National Passenger Survey. The report is not accompanied by an explanation of where the statistics were sourced from, but it appears that they are all based on the operation of ATOC itself.

Civil Aviation Authority (CAA) (2006, 2007, and 2008) *Air traffic statistics*. URL: <http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=list&type=su bcat&id=26> and personal communications

The Civil Aviation Authority (CAA) is a regulatory body for the UK aviation industry and collects data from various sources including more than 60 UK Airports. Information is supplied on each individual air transport flight with other movements, such as private flights, being reported as a block monthly total. This data is then validated by the CAA Economics team and then published on their website as excel downloads. This is made available to anyone wanting to use the information. CAA data downloads from 1998 to 2007 have been used in this TRL report to show the trends over the last decade. The 2007 data used in this report was based on CAA's preliminary findings and the data files were directly provided to TRL by the CAA as the final data downloads were not available on the website during the analysis. Statistical downloads for domestic terminal passenger traffic, EU and other international traffic, and route analyses of EU and other passenger traffic covering the period from 1998 to 2007 were all used to inform our report.

Department for Environment, Food and Rural Affairs (Defra) (2007) *Guidelines to Defra's GHG conversion factors for company reporting*. Defra: London

Defra is a UK Government department whose remit involves tackling climate change on a national and international level, primarily by reducing greenhouse gas emissions. Emissions factors are required to estimate the CO₂ impact per km from passenger transport and these guidelines are the current official set of government emissions factors. The conversion factors enable businesses to convert data sources, such as fuel consumption, into CO₂ equivalent data. The guidelines outline typical business activities and provide equivalent conversion factors. Of relevance to our report are the conversion factors for transport, which were used to help determine the likely impact on CO₂

emissions of a substitution of short-haul flights to rail. The Defra report found that high speed trains normally generate more emissions than conventional trains with carbon emissions ranging from 0.05 to 0.09kg per passenger kilometre with 30% occupancy. The Defra values for CO₂ emission factors for short-haul aviation are 0.1580 kg per passenger km for domestic flights and 0.1304 kg for international flights.

DfT (2007e) *Adding capacity at Heathrow airport: consultation*. URL: <http://www.dft.uk/consultations/closed/heathrowconsultation/consultationdocument/>

This consultation document follows on from the 2003 *The Future of Air Transport* White Paper (DfT, 2003) by seeking to determine views on how Heathrow could be developed over the next 20 years. The Government supports the further development of Heathrow and this document outlines the findings of a range of organisations, including BAA, the HA, NATS and the CAA, in relation to how such development could occur within acceptable noise and air quality limits, and with improved public transport access to the airport. The report details current and predicted future demand along with several proposals for development. It has informed our report by helping to set out the context, giving an indication of the likely future strategy at Heathrow, and by considering the environmental impact of development along with the potential for Air Passenger Duty to encourage behavioural change.

Doganis, R. (1995) *Flying off course: The Economics of International Airlines*. Routledge: London and New York

The author has over 25 years of experience in the aviation industry during which time he has acted as an advisor to both academics and airlines. This is the second version of this publication, with the update being produced in response to changes within the international airline industry – notably its rapid expansion. The author attributes much of this increase in demand to falling costs and fares and protection from internal and external competition. The book also outlines the poor financial performance of the aviation industry, an apparent contradiction that the author is unable to explain. This publication, which is recognised as a key reference within the aviation industry, has been useful in helping to explain aviation trends, and in particular for outlining factors affecting passenger demand for air services.

Economic Analysis Policy Transport Canada (2007) *Transport Canada Assumptions Report 2006-2020*. URL: <http://www.tc.gc.ca/pol/en/Report/Assumptions/2006/Assumptions06-20-TableOfContents.htm>

This strategic planning document produced by the Economic Analysis Policy department of Transport Canada, the Canadian Governments transport department, is their most recent annual aviation forecast. The report contains estimates of demand and its distribution which are based upon extensive economic modelling and a review of a range of factors which may either promote or constrain growth of the air travel market. As part of this process Transport Canada have made assumptions regarding the impact of 12 socio-economic, supply and strategic factors on demand for air travel over the period from 2006 to 2020. One of the factors identified was ‘*new technology*,’ which considered the impact that telecommunications, notably videoconferencing, might have upon aviation demand.

The authors undertook a brief review of literature that had been undertaken in relation to the impact of teleconferencing on business travel, and concluded that teleconferencing applications were likely to be complementary to demand for business air travel. They did, however, note that growth may be reduced by approximately 6% less than may have been anticipated in the absence of the technology.

Eurocontrol (2005) *Low-cost carrier market update: September 2005*. Eurocontrol

Eurocontrol is a European organisation who produces and co-ordinates pan European air traffic management strategies and associated action plans for their implementation. The overall aim of the organisation is to increase levels of safety in air traffic management, which it does by working with its

stakeholders who include civil and military organisations, European institutions, and international aviation bodies. Eurocontrol provides information on the airline industry via a number of publications, one of which is a review of the low-cost airline market. This detailed analysis, which incorporates air traffic statistics, forecasts and market analyses, helped to provide a background to the aviation industry. It provided a detailed analysis of low-cost operations, which are responsible for much of the growth in short-haul flights and for increasing the competitiveness of air services relative to other modes. The report was effective in providing details of the rapid growth experienced in this market.

Goodall, C. (2007) *Video conferencing: at last a good alternative to travel?* URL: <http://www.carboncommentary.com/2007/10/29/38>

This article looks at the ability of videoconferencing to substitute air travel movements. The author recognises that whilst video conferencing has been used since 1927 and that ever since commentators have been predicting that its use would become widespread. It is acknowledged that this has not yet happened, but suggests that as the sophistication of the technology increases and the costs decrease the likelihood of it reducing the need to travel could increase. The disadvantages of video conferencing are outlined, along with the high costs of installing facilities that are most able to replicate face to face interactions. The article nevertheless concludes that the increasing emphasis on carbon neutrality video conferencing may be the most feasible way of offsetting the emissions produced by employee travel.

Greengauge 21 (2007) *The next steps for high-speed rail in Britain.* URL: http://www.greengauge21.net/assets/GG21_TheNextSteps_1107.pdf

This report details that following the planned opening of Britain's first high speed domestic railway in 2009 the Government appears willing to consider a second high speed railway linking London with Birmingham and Manchester. The report effectively summarises the Government's current stance in relation to high speed rail and cites recent key policy documents, such as the Eddington Review, the Rail White Paper, and *Towards a Sustainable Transport System* (DfT, 2007a). Greengauge 21 outline their proposals for five potential corridors for high-speed rail in this context and suggest how they could alleviate current congestion issues faced by the rail network whilst also addressing wider challenges, such as climate change via reducing the need for domestic air services. This discussion is supplemented by recommendations for the planning process and long-term strategy of the Government.

Hanlon, P. (1999) *Global Airlines: second edition.* Butterworth-Heinemann: Oxford

This is the second edition of the publication, with the update being produced in response to changes within the airline industry. The author, who has an academic aviation background, details that the most important development has been the emergence of four major alliance groupings and the potential implications that this may have for the industry. The book is a general reference book for the aviation industry and charts the progress of the industry, although its main audience is policy makers and managers within airlines, government departments, regulatory authorities and other bodies concerned with civil aviation. It provides a comprehensive insight into the aviation industry and as such is also a key reference for students. In the context of our report it has been of particular use in outlining the key factors that affect demand for air travel, the implications of which are reviewed in the text.

International Air Transport Association (IATA) (2007) *2007 marks the peak of this cycle – the outlook has become more challenging.* IATA industry presentation December 2007. URL: http://www.iata.org/NR/rdonlyres/4CC9ABE8-2D5A-454A-977A-DE86E956B62A/0/Industry_Outlook_Presentation_Dec07.pdf

IATA is the global aviation trade organisation with 240 airlines as members, which represent 94% of scheduled international traffic. They were formed over 60 years ago to enhance understanding of the

aviation industry amongst decision makers and develop commercial standards, although its main purpose is to represent the interests of international airlines and to influence policy accordingly. This presentation, delivered to the aviation industry by IATA's Chief Economist, details the industry's financial forecast for 2008. The presentation was used to contribute towards an understanding of the aviation context. Information detailing the '*serious threat*' of climate change policies to further expansion was presented along with financial and operational data which indicates that lower profits and revenues are expected in 2008 than previous years owing to higher fuel prices and the economic climate in the US.

Office of Fair Trading (OFT) (2007) *BAA: the OFT's reference to the competition commission*. URL: www.oft.gov.uk/shared_oftr/reports/transport/oft912.pdf

This report is the output of an investigation of the OFT into BAA and identifies whether the company prevents, restricts or distorts competition. The publication details that BAA owns over 60% of all UK airports and that its activities impact upon a large number of businesses and passengers. The market analysis conducted within the report concludes that despite increasing competition between airlines, largely driven by the entry and growth of low cost carriers, the market share of BAA in the South East of England and Lowland Scotland is too high. The analysis is driven in part by the fact that much of the proposed development as outlined in *The Future of Air Transport* White Paper (DfT, 2003) would occur at BAA owned airports. The OFT found that there is evidence of poor quality services at BAA airports, particularly in the South East of England, and that this relatively low quality is related to high levels of demand. The publication was referred to within our report to help set the context and to determine current operating conditions.

Pita, A., and Anton, F. (2001) *The effects of high-speed rail on the reduction of air traffic congestion*. Proceedings of the AET European Transport Conference, held 10-12 September, 2001 (CDROM)

The aim of this document is to highlight the trends observed in passenger travel by both rail and air in the past few years, as well as exploring the possibilities for air and rail operators collaborating in the future in order to reduce air traffic congestion.

The paper is based on the contention that rail is the mode that has the most potential to substitute the need for short haul flights. Their focused analysis of European road, rail and aviation infrastructure is successful in emphasising the potential for high speed rail to compliment air services. The increasingly congested nature of aviation infrastructure, and the external costs accrued as a result, is used in an argument that states that collaboration between modes is necessary to enhance the efficiency and quality of European intercity travel.

Riberio, N., Pita, F. (2001) *The importance of speed and reliability in interurban services for business travellers – mode competition in the Lisboa/Porto corridor in Portugal*. Proceedings of the AET European Transport Conference. London: PTRC Education and Research Services Ltd

This paper was co-authored by an employee of a Spanish transport consultancy and an employee of an airport in Portugal to determine the importance of speed and reliability on modal choice. The study was based upon journeys between Lisboa and Porto, the two largest cities in Portugal. Several demand and forecasting studies for road, rail and air were conducted along with 445 interviews with rail, road and air passengers, selected on a random basis, to support the analysis of demand patterns and forecasts. The study was designed to address the lack of baseline data on travel demand in this corridor, despite planned investment in large scale initiatives on this route, and to help to enable future modal share to be determined. The paper focuses upon travel behaviours of business travellers, and provides an insight into the value that they accord journey time, frequency, perceived costs and reliability. Speed and reliability were found to have the most impact upon modal choice, although 82% of air passengers stated that they would not consider an alternative mode of transport for their journey.

Segal, J. (2006) *High speed rail – the competitive environment*. URL: http://mvaconsultancy.com/publications/High_Speed_Rail.pdf

John Segal, an employee of MVA transport consultancy, presented this paper at the ETC in 2006. The publication analyses the competitiveness of high speed rail in relation to other modes of transport. The paper compares the relative attributes of air, rail, car and coach in terms of journey time and factors that are valued by leisure and business markets. The authors also compares market share of rail, low-cost and traditional airlines and features a relatively crude demand forecast for high speed rail. The paper concludes that high speed rail can compete with both air and the private car, and that it can also be complementary to air travel. Their assessment of economic impacts however states that there is rarely a financial case for high speed rail.

Stevens, B., Schieb, PA, Andrieu, M., Bohlin, E., Forge, S., Blackman, C., Morgan, T., Stambrook, D., Ashley, R., and Cashman, A. (2006) *Infrastructure to 2030 – telecom, land transport, water and electricity*. OECD Publications Service

The purpose of this report is to assess the future demand for investment in infrastructure and to identify opportunities and challenges that may be faced in the future. It is part of a wider project funded by voluntary contributions from governments, public agencies and corporations to provide recommendations for enhancing infrastructure's contribution to economic and social development.

Their review of telecommunication infrastructure to 2030 focuses on the technical aspects of the infrastructure and practical implementation issues. It does, however, also consider its potential impact on transport infrastructure, the environment and the economy. The report states that whilst the potential impact of telecommunications is often overestimated, they can reduce the demand for flights and therefore airport expansion. They do caution that what estimating their impact the effect that telecommunications can have on increasing demand on transport infrastructure through increased productivity and the stimulation of additional activities should also be considered.

Transwatch (2007) *Facts sheet f(b) - carbon emissions: high speed rail and air compared*. URL: <http://transwatch.co.uk/transport-pdfs/transport-fact-sheet-5b.pdf>

Transwatch is an independent organisation funded by a private trust. The aim of the organisation is to support research and disseminate information by becoming the non-governmental point of reference for factual transport data. This document compares the CO₂ emissions of high speed rail and air travel and comprehensively details the assumptions upon which the calculations are based. The author also critically analyses emissions estimates made by other a number of other commentators. It is a concise but factual source of information about the CO₂ emissions associated with these two sectors, and as such was used to inform our review of the environmental impacts of rail and air travel.

Tyndall Centre for Climate Change (2008) *Energy and Climate Change*. URL: <http://tyndall.web.man.ac.uk/about.php>

The Tyndall Centre for Climate Change is a UK organisation responsible for undertaking interdisciplinary research in support of sustainable responses to climate change. The Centre is based at the University of Manchester. This document provides details about the organisation, such as its aims, research areas and collaborations. It also describes each of the research areas, one of which is to reduce the demand for aviation, giving a concise overview of aviation emissions and climate change policy. The information contained within the document was used to help set out the context for our review.

UK Airport News (2007) *Noise complaints soar at East Midlands Airport*. URL: <http://www.uk-airport-news.info/east-midlands-airport-news-190707.htm>

This publication is an information source that provides up to date news on UK airports. It was produced to bring all articles published about UK airports together, and as such it is now a large resource. This particular article details complaints about noise pollution generated by the East Midlands Airport, and it was referred to within our report in relation to the impacts of air services, specifically in relation to house prices. The article is effective in highlighting the extent of the impact that noise from airports can have upon local environments, and the effect that it can have on wellbeing.

Webster, B. (2007) *Superjumbo that takes you into space*. URL: <http://www.timesonline.co.uk/tol/news/uk/science/article1350450.ece>

This article was authored by the Transport Correspondent from the Times newspaper. The article has been produced to describe the double-deck Airbus A380, which is said to have less of an environmental impact than a hybrid car. The aircraft, which can carry 853 passengers, is said to emit 80g of CO₂ per passenger kilometre. It also consumes 2.9 litres of fuel per 100 passenger kms compared to an average air craft consumption of five litres. This document was used to help inform our analysis of the potential impact of reducing the demand for air travel journeys.

World Wildlife Fund (WWF) (2008) *Climate pollution from aviation increasing*. URL: <http://www.sciencedaily.com/releases/2008/01/080101201618.htm>

WWF is a global environmental organisation who conduct research into a vast range of conservation issues such as climate change. This article, published online by ScienceDaily, is based upon the response of WWF to the EU Environment Council in Brussels where the authors deemed that ministers had not taken adequate steps to curb emissions from the aviation sector through the European Emissions Trading Scheme. This article details growth in emissions from aviation and suggests that, despite a strong stance taken by the Government in Bali climate talks, there continues to be a relatively lenient approach in relation to curbing aviation emissions. This reference proved useful in helping to set the context of our report.

Appendix B.

Questionnaire

Alternatives to Aviation: Business Survey

Background

The Campaign for Better Transport, a national organisation that works to reduce the environmental impact of transport, has commissioned TRL to explore the potential for telecommunications and IT to reduce business air travel. To gain an understanding of this issue from a business point of view, we have asked managers from a range of organisations to complete the following survey. This will give us an indication of the potential for substituting business air travel with telecommunications.

We would be grateful if you could complete the following survey based upon your knowledge and experience of practices within your organisation.

Please note that we will not use your contact details for any other purpose, nor will we pass them on to other parties.

For more information please contact:

Anne Binsted abinsted@trl.co.uk (01344) 770568 or
Ko Sakamoto ksakamoto@trl.co.uk (01344) 770709

Organisational profile

Your name _____

How many branches does your company have: in the UK? _____
internationally? _____

Which office are you based in? _____

Which of the following best describes your position in your organisation?

- ☐ Chairman/Director/Vice-President
- ☐ Senior management
- ☐ Middle/junior management
- ☐ Technical specialist
- ☐ Other professional
- ☐ Administrator
- ☐ Other

Other: _____

Which department do you work in?

- ☐ Executive/upper management
- ☐ Finance
- ☐ Marketing
- ☐ Production/operations
- ☐ Distribution

- ☐ Sales
- ☐ HR
- ☐ IT
- ☐ Administration
- ☐ Other

Other: _____

Background information

Business air travel

1. What proportion of employees within your organisation fly for business purposes? _____ **XX%**

If business flights are not undertaken then please go to **q. 7**

2. Of the employees who do fly for business, on average do often do you think that they fly?

- ☐ Once a week or more
- ☐ Once a month or more
- ☐ Once every six months or more
- ☐ Once a year or more
- ☐ Less than once a year
- ☐ Don't know

3. Of flights undertaken, approximately what proportion of these have destinations in:

the UK	_____	XX%
Europe	_____	XX%
Long-haul	_____	XX%

4. What do you think is the main purpose(s) for the trip when employees within your organisation travel by air?

- ☐ Attending external meetings (with clients)
- ☐ Attending internal meetings (with colleagues)
- ☐ Networking
- ☐ Conference attendance
- ☐ Marketing activities
- ☐ Generating sales
- ☐ Other (please specify below)
- ☐ Don't know

Other: _____

5. Who usually makes your business travel arrangements and bookings?

- ☐ Internal travel department
- ☐ External travel agency
- ☐ The employee who is travelling
- ☐ Administrator/secretary
- ☐ Other (please specify below)
- ☐ Don't know

Other: _____

6. Would you say that business air travel within your company is:

- ☐ Increasing
- ☐ Remaining stable
- ☐ Decreasing
- ☐ Don't know

Use of teleconferencing**7. What proportion of employees within your organisation use teleconferencing facilities? _____ XX%**

If applications such as teleconferencing are not used for business purposes within your organisation then please go to **q. 13**

8. Of the employees who do use teleconferencing facilities, how often do you think that they use them?

- ☐ Once a week or more
- ☐ Once a month or more
- ☐ Once every six months or more
- ☐ Once a year or more
- ☐ Less than once a year
- ☐ Don't know

9. Which types of teleconferencing system are used within your organisation?

Please tick more than one box if multiple options apply.

- ☐ Audio conferencing
- ☐ Video conferencing
- ☐ Telepresence
- ☐ Don't know
- ☐ Other (please specify below)

Other: _____

10. Are teleconferencing systems used available in-house, or are external facilities used?

- ☐ Available in-house
- ☐ Facilities are external
- ☐ Both internal and external
- ☐ Don't know

11. What is the main purpose(s) for using telecommunications? If more than one applies, then please tick multiple boxes.

- ☐ Attending external meetings (with clients)
- ☐ Attending internal meetings (with colleagues)
- ☐ Networking
- ☐ Conference attendance
- ☐ Marketing activities
- ☐ Generating sales
- ☐ Other (please specify below)
- ☐ Don't know

Other: _____

12. Would you say that the use of teleconferencing within your company over the last 5 years has:

- ☐ Increased
- ☐ Remained Stable
- ☐ Decreased
- ☐ Don't know

Corporate policy**13. Does your company have an environmental or CSR policy?**

- ☐ Yes
- ☐ No
- ☐ Don't know

14. Which of the following options do you think best describes your company policy regarding business air travel?

- ☐ Employees are strongly discouraged from using air travel for business purposes
- ☐ Employees are discouraged from using air travel for business purposes
- ☐ Employees are encouraged to consider alternatives to aviation
- ☐ There are no policies in place to limit air travel
- ☐ Don't know

15. Please tick all of the following statements that you agree with:

- ☐ The environmental impact of a business decision has an impact upon whether or not it is implemented
- ☐ The cost effectiveness of an interaction is more important than its environmental impact
- ☐ It is important for your company's brand to be seen to be 'green'

16. Which of the following factors do you think influence the decision of whether or not employees use air travel for business?

- ☐ Pricing
- ☐ Time
- ☐ Availability of technology
- ☐ Reliability
- ☐ Client requirements
- ☐ Safety
- ☐ Environmental impact
- ☐ Corporate Social Responsibility
- ☐ Cost effectiveness
- ☐ Don't know
- ☐ Other (please specify below)

Other: _____

17. Which of the above factors do you think has the most influence on the decision of whether or not employees use air travel for business?**Attitudes towards air travel and telecommunication technologies****18. How do you perceive telecommunications?**

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
No drawbacks	☐	☐	☐	☐	☐
Many benefits relative to air travel	☐	☐	☐	☐	☐
The technology is difficult to use	☐	☐	☐	☐	☐
The technology is reasonably priced	☐	☐	☐	☐	☐
The quality of the technology is poor	☐	☐	☐	☐	☐
Teleconferencing facilities enable meetings to be arranged at short notice	☐	☐	☐	☐	☐
Telecommunications make it easier to build a working relationship than travelling by air to meet face to face	☐	☐	☐	☐	☐
Teleconferencing facilities enable a larger number of employees to attend meetings	☐	☐	☐	☐	☐
Telecommunications cannot replace individual face to face communications	☐	☐	☐	☐	☐

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Teleconferencing is capable of meeting all of the objectives of an interaction	☐	☐	☐	☐	☐
The use of telecommunications tends to be less stressful than air travel	☐	☐	☐	☐	☐
Meetings tend to be less effective when conducted via telecommunications than meeting face to face	☐	☐	☐	☐	☐
The use of teleconferencing facilities can enhance an organisations CSR credentials and corporate image	☐	☐	☐	☐	☐
Teleconferencing can save money	☐	☐	☐	☐	☐
Telecommunications are very convenient to use	☐	☐	☐	☐	☐
Teleconferencing can save time	☐	☐	☐	☐	☐
Telecommunications enable greater control of time than interactions involving air travel	☐	☐	☐	☐	☐
Teleconferencing facilities enable employees to have a better work-life balance	☐	☐	☐	☐	☐
Interactions conducted via telecommunications rather than involving air travel do not enable time to be saved	☐	☐	☐	☐	☐

19. Are there any other key benefits or drawbacks that you associate with telecommunications? If so then please specify.

20. How do you perceive flying for business?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
No drawbacks	☐	☐	☐	☐	☐
Many benefits relative to interacting via telecommunications	☐	☐	☐	☐	☐
Air travel is reasonably priced	☐	☐	☐	☐	☐
Flight schedules are convenient	☐	☐	☐	☐	☐
Delays/cancelled flights have been a problem	☐	☐	☐	☐	☐
Airports are difficult to access	☐	☐	☐	☐	☐
I prefer flying for business to staying in the office	☐	☐	☐	☐	☐
Corporate air travel can have a negative impact on an organisations CSR credentials and corporate image	☐	☐	☐	☐	☐

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Air travel is comfortable	☐	☐	☐	☐	☐
Air travel is very time consuming	☐	☐	☐	☐	☐
In-flight service and entertainment/facilities are good	☐	☐	☐	☐	☐
Less people can attend meetings that necessitate air travel	☐	☐	☐	☐	☐
Corporate air travel has a negative impact on the work/life balance of employees	☐	☐	☐	☐	☐
The need to travel by air can make meetings more difficult to arrange	☐	☐	☐	☐	☐
Business air travel incurs a range of additional expenses	☐	☐	☐	☐	☐
I have concerns over the safety/security of either myself or my luggage	☐	☐	☐	☐	☐

21. Are there any other key benefits or drawbacks that you associate with air travel? If so then please specify.

22. Which of the following interactions do you think could most effectively be conducted remotely rather than face to face? Please tick all that apply.

- ☐ Attending external meetings with *existing* clients
- ☐ Attending external meetings with *new* clients
- ☐ Attending internal meetings (with colleagues)
- ☐ Networking
- ☐ Conference attendance
- ☐ Marketing activities
- ☐ Generating sales
- ☐ Other (please specify below)
- ☐ Don't know

Other: _____

23. Which of the following interactions do you think could not be conducted remotely rather than face to face? Please tick all that apply.

- ☐ Attending external meetings (with clients)
- ☐ Attending internal meetings (with colleagues)
- ☐ Networking
- ☐ Conference attendance

- ☐ Marketing activities
- ☐ Generating sales
- ☐ Other (please specify below)
- ☐ Don't know

Other: _____

The relationship between telecommunications and air travel

24. Which of the following statements do you agree with?

- ☐ Telecommunications can reduce the need to travel
- ☐ Telecommunications do not reduce the need to travel
- ☐ Telecommunications have increased the need to travel

Future use of telecommunications and air travel

25. Would you say that there is scope to increase the extent to which telecommunications are used within your organisation?

- ☐ Yes
- ☐ No
- ☐ Don't know

26. Do you think that any of the following would reduce levels of business air travel within your organisation?

- ☐ Increased awareness of the negative environmental impact of aviation
- ☐ Increased awareness of alternatives available to aviation
- ☐ Increased availability of, and access to, telecommunication facilities
- ☐ Clients recognising 'green' credentials
- ☐ Communication of time/cost benefits associated with the use of telecommunications relative to aviation
- ☐ Improved quality of telecommunications
- ☐ Reduced cost of telecommunications relative to the cost of flying
- ☐ Availability of travel planning resources
- ☐ Financial assistance (such as government grants or loans) to enhance teleconferencing facilities
- ☐ Other (please specify below)

Other: _____

27. If none of the above, then please try to state why not.

Thanks very much for taking the time to respond to this questionnaire.