Economic consideration of extending the EU ETS to include aviation

A REPORT PREPARED FOR THE EUROPEAN LOW FARES AIRLINE ASSOCIATION (ELFAA)

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Executive summary

Frontier has been asked to prepare this report by the European Low Fares Airline Association (ELFAA)[1]. The role of this report is to provide an objective assessment of the economic issues related to including aviation in the European Union Emissions Trading Scheme (EU ETS). It will contribute to the outcomes of the Aviation Working Group and the process being followed by the European Commission. Specifically, this report:

- carries out a systematic assessment of the literature to set out the evidence on the economic aspects of applying the EU ETS to aviation in an objective and robust manner;
- sets out a framework that focuses the debate on the important economic aspects of including aviation in the ETS and (where possible) comments on the impacts of proposed options;
- draws conclusions about the properties that should be reflected in an effective and well designed application of EU ETS to the aviation sector; and
- addresses the impact that EU ETS may have on competition in the airline sector.

The following is a summary of the key conclusions from this report:

Economic impact

- A full cost-benefit analysis is needed to make an objective judgement of the net benefits of aviation relative to the emissions that it generates and the relative merits of targeting policy at aviation relative to other sectors. The analysis would be used to come to a decision on whether environmental policy should be targeted towards aviation, and if so, what form it should take.
- Only after a proper cost-benefit analysis has been conducted should the options for how to deal with aviation emissions be considered. If it is determined that the inclusion of aviation in the ETS is the most appropriate option, then careful design is required to ensure that extending the EU ETS to aviation encourages efficient abatement in the aviation sector at the lowest possible cost.
- The contribution of aviation to total CO_2 emissions is material, but still relatively small. While within the EU-15 airline emissions may amount to around 4% of total CO_2 the figure is likely to be significantly lower once the 10 new member states are taken into account. Furthermore, while aviation is growing, research suggests that its share of total emissions is likely to be only

[1] ELFAA airline members are: easyJet, Flybe, Hapag-Lloyd Express, Norwegian, Ryanair, Sky Europe, Sterling, Sverige Flyg, Transavia and WIZZ Air. For more details, visit www.elfaa.com.

around 5% by 2030. Overall, aviation is a small contributor to carbon emissions compared to sectors such as power generation and road transport. Hence disproportionate attention may be being paid to aviation in comparison to other sectors from which greater reductions in CO_2 could be achieved.

- Aviation is a significant contributor to EU employment and GDP (reported to be 3.1 million jobs and GDP of €221bn in the EU-15), having particularly important knock-on implications for many other sectors, such as tourism. Aviation is also a key driver for integration with the new member states and growth under the EU Lisbon Agenda. Any impact that EU ETS may have on aviation is likely to have a disproportionate impact on the economies of the new member states where the aviation sector is currently less developed. There are additional concerns relating to the impact which uncertainty over allowance prices may have on a dynamic sector such as aviation given the experience of ETS Phase 1.
- While the European Commission has set out a broad cost-benefit framework for developing environmental policy it does not appear that this has been applied in deciding to place aviation in the EU ETS. An assessment of the net benefits (gross economic value added/tonne of CO_2 emitted) of aviation relative to other sectors that are major producers of CO_2 would show that although aviation emissions are material, the net benefits of aviation are considerably higher than several other sectors. This suggests that abatement in these other sectors should take a higher priority than abatement in aviation.

Scope for abatement and scheme design

- It is unclear how much additional scope for abatement there is within the aviation sector. Aviation already faces strong incentives to reduce fuel burn – and therefore CO_2 emissions – due to high jet fuel prices. The EU ETS would increase this incentive at the margin, but the impact on reduced CO_2 emissions is unclear. The value of including aviation in the EU ETS is therefore questionable.
- We have identified general opportunities for abatement in EU aviation of the order of some 17% of all emissions generated by EU flights. However, of these opportunities, almost half (or 8% of all emissions) are constrained by the way in which Air Traffic Management (ATM) acts and therefore putting aviation into the ETS would have no effect on these emissions. By contrast, replacing aircraft (one of the most effective steps airlines can take) could achieve a reduction of 1% of all emissions generated by EU flights per annum. Given the scale of the emissions issue that is due to inefficiencies in ATM there is an urgent requirement for the Commission to consider further policy that will include ATM activities within efforts to reduce CO_2 emissions and how this should be coordinated with other programmes to modernise ATM, such as SESAR.
- In designing the scheme for aviation, a scheme that covers the largest quantity of emissions would be most effective. This suggests that if aviation is included in ETS it should cover all flights into and out of the EU, regardless

of destination or origin of flight. Restricting ETS to only intra-EU flights would reduce its coverage to only 20% of EU aviation emissions and less than 1% of total EU emissions.

- At the same time, it is important that any scheme is based on robust science in order to have credible outcomes. Emissions directly linked to the environmental impact (rather than to an arbitrary multiplier of fuel burn) would have most chance of actually inducing the most efficient behaviour.

Allocating allowances

- Much of the present work in the area assumes that the long-run price of allowances will be lower than the current market price of c. €27 per tonne. However, this assumption is made without asking whether low allowance prices would be consistent with promoting a material level of abatement. Moreover, little consideration has been given to the key underlying drivers: the determination of the total quantity of allowances, the true shape of the marginal abatement cost curve of all participating sectors and the likelihood, or otherwise, of being able to offset commitments by abatement in other countries outside the EU through the use of Kyoto Protocol-based mechanisms.
- Once the quantity of allowances is determined, a process is needed for allocating these allowances to the aviation sector. We find that defining aircraft as EU ETS "installations" for allocation purposes is not a feasible solution. We conclude that, of the options considered to date, defining the installation as either the operator of the passenger (or freight) aircraft or as an airport would be workable options. Applying ETS directly to airports may, in practice, provide the most effective mechanism to pass on the incentives of ETS to airlines through landing charges.
- The quantity of any allocations to an installation must not depend on "grandfathering" of emissions, as this would discourage abatement before the EU ETS is introduced and would reward operators that have done less to reduce emissions. Allocations must be made on the basis of benchmarking of industry averages or hypothetical best practice. Out of the options available, revenue tonne kilometres (RTKs), has the potential to provide a relevant measure although there remain some practical issues to be resolved. This principle applies whether airline operators or airports are designated as the relevant installations.

The impact of the EU ETS on competition in the aviation sector

- Because the demand for aviation is sensitive to price, ETS may have a greater impact on the demand for air transport than it has had on the demand for products already included in the scheme.
- Furthermore, because the demand for the services of Low Fares Airlines (LFAs) is more sensitive to price than the demand for the services of the Full Service Airlines (FSAs) the relative impact of ETS would be greater on the LFA segment than on the FSAs.

- Current ETS allowance prices could add 5% to 8% to an LFA's average ticket price which would in turn reduce demand for LFA services by between 7.5% and 12%. In response to such price movements, it is likely that there would be a reduction in services on many routes, which would reduce the intensity of aviation competition. By contrast the impact of ETS on FSAs would be much more limited, reducing demand by only 2% to 3%. As LFAs tend to operate newer and cleaner aircraft than the FSAs (on average) other things being equal the distortion of competition between LFAs and FSAs may have the effect of reducing the drive towards introducing cleaner more energy efficient operations in the sector as a whole.
- In addition the process of allocating allowances may further affect competition between airlines. To avoid this effect, allocation must be made in a way that treats growing and static (or declining) airlines on a level playing field. This cannot be achieved if allocations are made to airlines in such a way that initial allocations and subsequent allocations for new services are made using different methods (e.g. granting allowances to airlines in one instance and requiring operators to purchase allowances in the other). A dynamic process of allowance allocation therefore needs to be developed that preserves a competitive level playing field for aviation over the entirety of the phase. Such a process would take account of growth of successful airlines and decline of unsuccessful airlines, and would not tilt their competitive advantage by virtue of their success or decline. Treating airports as the relevant installation may resolve this problem because all movements, regardless of whether or not they are "new" would impose the same marginal ETS cost on the airport operator.
- It seems to us that the only way to ensure that ETS allowances are allocated on an even-handed basis to all operators in the EU is that the allocation process has harmonised rules and administration through a central EC level process. It is our view that a process driven by the Member States is too susceptible to discrepancies and asymmetries of treatment between different Member States. This may have a material impact on competition between airline operators based in different countries if they have received very different treatment under the ETS by their own national governments.

1 Introduction

1.1 ROLE OF THIS REPORT

The European Commission (the Commission) is currently consulting on how to incorporate commercial aviation in the existing European Union Emissions Trading Scheme (EU ETS). Outcomes from this consultation will feed into the planned review of the EU ETS, due to take place in June 2006. The Commission will aim to put forward a legislative proposal by the end of 2006.

There are many important issues which the Commission will need to consider before determining whether and how aviation can be included in the EU ETS. To help with this task, it commissioned a feasibility study[2] that identified a list of key issues. Based on this study, the Commission has identified four issues that it considers to be at the centre of the debate:

- the type of entity made responsible for aviation's climate impact;
- the extent to which the full impact is addressed;
- the types of flights covered; and
- the approach taken for calculating and apportioning the sector's overall emissions limitation.

In addition, the Commission identified the impact on prices and the allocation of emission rights as needing further examination.

The Commission has taken an initial view on each of these issues and has now set up an Aviation Working Group under the European Climate Change Programme to consider how to resolve these issues[3]. In parallel, the Commission has invited the Council and the European Parliament to consider the policy and Commission's proposals, including questions of timing.

Frontier has been asked to prepare this report by the European Low Fares Airline Association (ELFAA)[4]. The role of this report is to provide an objective assessment of the economic issues relating to including aviation in the EU ETS. It will contribute to the outcomes of the Working Group and the process being followed by the Commission. Specifically, this report:

- carries out a systematic assessment of the literature to set out the evidence on the economic aspects of applying the EU ETS to aviation in an objective and robust manner (and by doing so, correct some significant misconceptions in the current debate);

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2 CE Delft (2005a) *Giving wings to emission trading* July 2005.

3 See annexe for the terms of reference of the Aviation Working Group.

4 ELFAA airline members are: easyJet, Flybe, Hapag-Lloyd Express, Norwegian, Ryanair, Sky Europe, Sterling, Sverige Flyg, Transavia and WIZZ Air. For more details, visit www.elfaa.com.

- sets out a framework that focuses the debate on the important economic aspects of including aviation in the ETS and (where possible) comments on the impacts of proposed options;
- draws conclusions about the properties that should be reflected in an effective and well designed application of EU ETS to the aviation sector; and
- specifically addresses the impact that EU ETS may have on competition in the airline sector.

1.2 APPROACH FOLLOWED

The European Council has set out guidelines[5] for developing Commission policies covering environmental policy for aviation. One of these requires the Commission to continue policy making on the basis of *"cost-benefit analysis of CO_2 reduction strategies"*.

Accordingly, this report adopts a cost-benefit framework to mitigating climate change. This ensures that outcomes favoured are those that minimise total economic cost (for a given level of abatement).

Key aspects of the approach followed in this report include the following:

- We employ an overall cost-benefit framework to ensure that all relevant evidence is evaluated. Such a framework allows very different issues to be calibrated and incorporated in the overall assessment.
- The extent to which environmental policy should be applied to aviation requires a better understanding of both (1) the impact of aviation on climate change relative to other sectors, and (2) how this impact compares with the economic benefits derived from aviation (also relative to other sectors).

To develop this analysis, the report considers:

- *costs relative to other sectors:* the climate change impact of aviation relative to other transport sectors and other sectors in the wider economy (including historic trends and future projections); and
- *(net) benefits relative to other sectors:* different measures of economic benefits created by aviation in comparison to other transport sectors and other sectors in the economy, and relative to each sector's level of carbon emission.

Our analysis is based on a review of the key literature in the area. We provide full references for the literature referred to in the development of this report. We have also made use of data requests and data gathered in meetings with various stakeholders including airlines and aircraft manufacturers.

There are a number of practical difficulties with extending the functioning of the EU ETS to aviation. The report focuses on the appropriate economic framework

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[5] European Commission (2005a). *Reducing the Climate Change Impact of Aviation,* COM (2005) 459 final.

for this policy but discusses practical implementation issues to a lesser extent. For example, there are clearly legal complications to how aviation can be included in the EU ETS (due to constraints in the Kyoto framework). The report will contain some discussion of the issues, but will not consider the topic in detail or make recommendations on such issues.

1.3 STRUCTURE OF REPORT

The remainder of this document is set out as follows:

- Section 2 sets the scene for considering the extension of the EU ETS to aviation;
- Section 3 discusses the policy context and how the scheme would need to be designed for including aviation in the EU ETS;
- Section 4 sets out the issues relating to how allowances should be allocated;
- Section 5 discusses the potential impact of the EU ETS on competition in the aviation sector;
- Section 6 summarises the key conclusions of the report.

In order to guide the reader through the conclusions of our report, each major section is prefaced by a text box highlighting the key conclusions contained in that section.

The annexes contain the following:

- Annexe 1 contains a review of the robustness of projections for growth in employment due to aviation;
- Annexe 2 details the operational decisions airlines can make that may have an impact on emissions;
- Annexe 3 provides some more detail on technical aspects of ETS design;
- Annexe 4 provides an illustration of the relationship between cost pass through and demand and supply elasticities;
- Annexe 5 provides the terms of reference for the Aviation Working Group set up under the European Climate Change Programme; and
- Annexe 6 provides a detailed bibliography.

2 Setting the scene

This section sets the *context* of aviation in terms of the extent to which it contributes to emissions but also its importance as creator and facilitator of economic activity. It sets out the important facts in the appropriate wider context of other greenhouse gas emitting sectors. It also sets out the policy context for proposals to include aviation in the EU ETS.

2.1 DEVELOPMENTS IN AVIATION

KEY POINTS

- *Impact of increases in costs of jet fuels:* Aircraft operators and manufacturers already have strong incentives to reduce fuel burn leading to reductions in greenhouse gas emissions. Advances in technology pursued by aircraft manufacturers have already led to fuel efficiency gains of 64% during the period 1970 to 2000 and are continuing.
- *Increase in demand for aviation:* The average growth rate in Europe is likely to be between 3.5% and 5% p.a. over the next 10-15 years. Growth in aviation is important for EU integration with the 10 new member states (where air transport connections are substantially behind those of the EU-15) and the EU Lisbon Agenda for employment and growth across the EU. Aviation also has broader positive impacts on important sectors of the economy such as tourism and financial services.
- *Growth in low fares airlines:* Liberalisation of the EU aviation sector has led to the success of what are known as low fares airlines (LFAs). LFAs have generally exhibited more efficient operations and higher load factors. They also tend to have newer fleets that are more fuel efficient and therefore have lower emissions compared to the more traditional full service airlines (FSAs).

In this sub-section, we investigate the key trends in the aviation sector, and what implications these may have for environmental policy making by the EU.

The key trends we find in the aviation sector are:

- the existing pressures for airlines to maximise fuel efficiency (and therefore minimise emissions) regardless of ETS;
- increases in demand for aviation; and
- liberalisation of the aviation sector and the success of LFAs.

Impact of increases in fuel costs

Fuel costs have risen sharply over the last few years. Market predictions are that fuel prices are likely to remain high in the future. Fuel forms a key cost driver of aviation - typically accounting for between 15% and 30% of airline operating costs. As a result, airlines always have a strong incentive to reduce their fuel burn. As fuel burn is directly linked to emissions, a high jet fuel price creates strong incentives to limit emissions.

Aircraft manufacturers have historically experienced pressure from aircraft operators to deliver savings in fuel burn (and therefore emissions) through improvements in design. In Figure 1, data for IATA member airline fleets shows that fuel efficiency increased by 64% between 1970 and 2000[6]. Aircraft manufacturers have also signed up to targets for fuel efficiency of aircraft in the future. European aircraft manufacturers, through the Advisory Council of Aeronautical Research in Europe (ACARE)[7], have set themselves voluntary targets to be reached by 2020. These include:

- a 50% cut in CO_2 emissions per passenger kilometre for new aircraft in 2020; and
- an 80% cut in nitrogen oxide emissions for new aircraft in 2020.

The targets are to be realised in part through a 15-20% engine improvement; and a 20-25% cabin improvement.

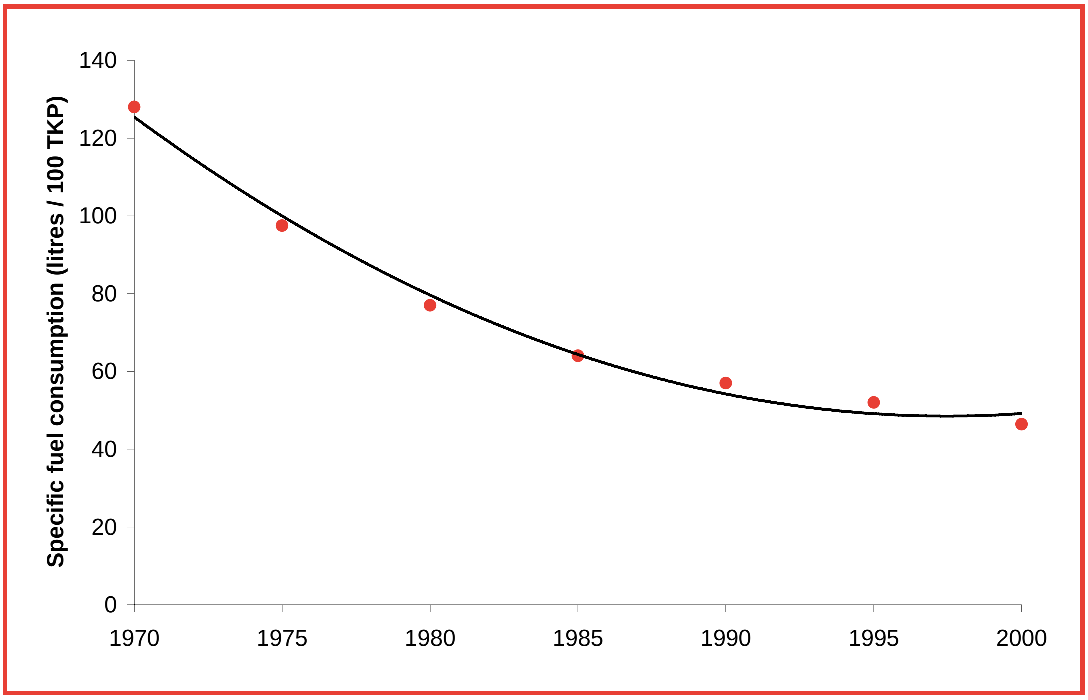

Figure 1: Fuel efficiency for IATA fleets during the period 1970-2000

Source: based on data from IATA

TKP – Tonne kilometres performed

6 IATA (2001b).

7 http://www.acare4europe.org.

Recent further increases in fuel prices have heightened the emphasis on fuel efficiency in the aviation sector. Figure 2 shows that whilst total energy use for road transport continues to rise, the latest figures available for the EU[8] show that energy use for aviation has stabilised, and actually fell during the period 2000-02.

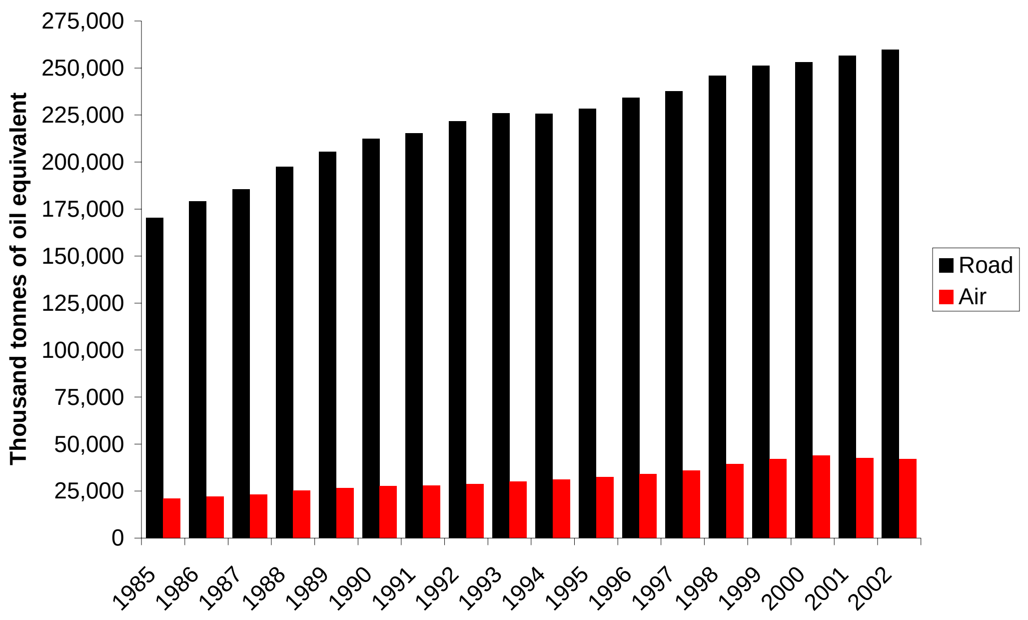

Figure 2: Total energy consumption by road and air transport in EU-15 during 1985-2002

Source: Eurostat

In the future, growth of emissions from air transport services in the EU will therefore be partially offset as airlines move to the latest technology and increase operational efficiency in order to limit fuel burn.

The inclusion of aviation in the EU ETS would have the same incentive properties on airlines as the incentives they already face due to high fuel costs. The additional effect of the ETS would be to increase the incentive to abate carbon emissions, but only at the margin.

Increases in demand for aviation

The average growth rate of demand for aviation in the EU over the next 10-15 years is predicted to be between 3.5% and 5% per annum[9]. In absolute terms, the

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8 Only for the EU-15

9 European Commission (1999) *Towards meeting the challenges of sustainable development,* COM (1999) 640 final predicts 5% growth per annum between 1990 and 2015. Boeing (2005) *Current market outlook 2005, Seattle* forecasts growth in Europe will be 3.5% between 2005 and 2024. This refers to all flights departing from or arriving in the EU.

number of aircraft movements is forecast to grow from a current figure of 9.2 million movements in 2005 to 11.4 million in 2011[10].

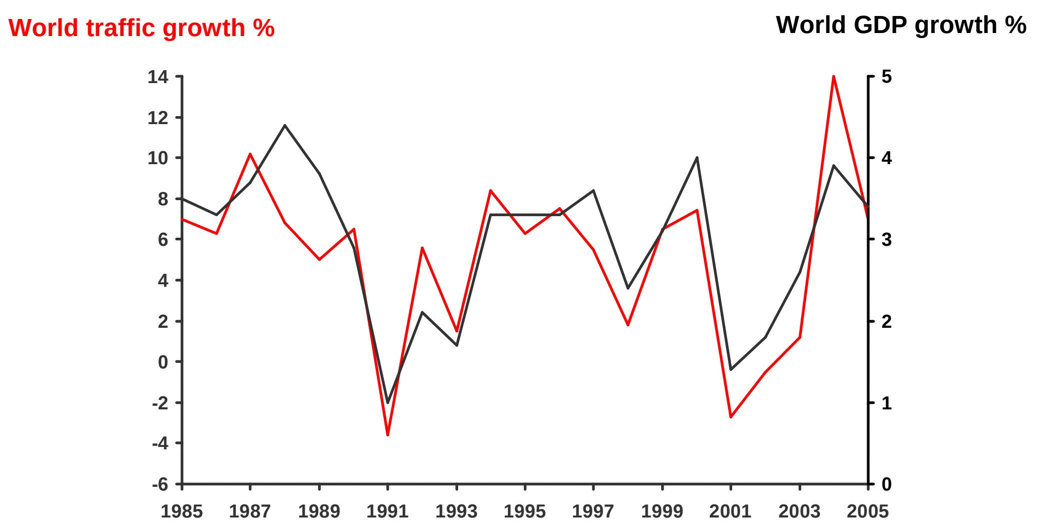

Figure 3: Aviation growth is correlated with GDP growth

Source: ICAO, Global Insight

Placing the growth in aviation in context, Figure 3 shows that over the last twenty years the rate of growth in aviation (on a worldwide basis) is very closely correlated with the rate of growth of the economy as a whole. This illustrates two important points. First, the rate of growth of aviation is neither unpredictable nor uncontrolled; rather it has a quite predictable relationship with general economic growth. Secondly, the growth in LFAs over the last twenty years, and in particular the growth in European LFAs in the last ten years, has not altered the relationship between the growth in aviation and general economic activity. This indicates that a significant part of the growth in LFAs has been substitution for growth in services by FSAs rather than fuelling additional growth in aviation as a whole.

The environmental policy debate regarding aviation to date has, in general, focused on the issue of growth and its impact on emissions. This debate has been conducted without reference to the benefits of aviation and the direct and indirect economic contribution of aviation relative to other greenhouse gas emitting sectors. It has also been carried out on the basis of some studies that use extreme assumptions for growth to give an unbalanced picture of likely future outcomes. For example, Tyndall (2006) uses scenarios for emission growth that are at the high end of forecasts developed by the UK government. They also

10 Eurocontrol (2005a) figures for IFR flights.

focus on the UK, which is at the higher end of EU-25 emissions and cannot be applied to the EU as a whole.

Aviation plays a critical role in promoting wider economic growth in the EU.

- The EU Lisbon Agenda[11] sets out a framework for achieving higher employment and economic growth in Europe. As part of this Agenda, improvement in transportation is seen as a key driver for the development of the internal market – leading to more jobs and economic growth[12]. Specifically, transport, including aviation, will play an important role in helping the new member states to catch-up with the EU-15. The average annual number of air passengers per capita in EU-15 in 2004 was 2.61. In comparison, for the EU-8, excluding Cyprus and Malta[13], this figure stood at 0.50[14]. Improvements in airline links are likely to lead to increased opportunities for investment in the new member states and help create a more mobile labour market between the EU-15 and the new member states.
- Amongst the benefits, evidence suggests that air travel directly sustains a large number of jobs in Europe, both directly in aviation (and service jobs related to airlines and passengers) and in related industries (such as aircraft manufacturing, etc.). Opening up new air routes also increases opportunities for business and tourism, particularly in regions that were previously less economically successful. The availability of direct air service connections greatly enhances the attractiveness of a region for tourists and inward investment. Furthermore, the financial and business services sectors[15], in particular, rely heavily on air transport to conduct business in the Single Market. These business sectors are a highly productive part of the European economy and their growth leads to important knock-on benefits for the wider economy[16].

However, increased numbers of flights do have negative impacts on the environment. Burning aviation fuel emits carbon dioxide (CO_2). It also emits nitrogen oxides (NOxs) that are greenhouse gases. NOxs have different impacts on climate change depending on the location and conditions of the emissions.

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11 The original Lisbon targets set in 2000 include increasing Europe's gross domestic product from 12% to 23% and employment by 11% in order to make it the most competitive economy in the world. See Gelauff and Lejour (2006) *The new Lisbon strategy – an estimation of the economic impact of reaching five Lisbon targets* Enterprise and Industry Directorate General, European Commission, January 2006.

12 see http://europa.eu.int/growthandjobs/areas/fiche04_en.htm.

13 Cyprus and Malta have a high proportion of holiday passengers per capita relative to the rest of the EU.

14 Eurostat.

15 The term "Financial and business services" typically refers to SIC section J: financial intermediation (banks, building societies, investment trusts, venture & development capital, life insurance, pension funding and fund management) and SIC section K: real estate, renting and business activities (real estate, renting of machinery, computer consulting, other computer related activities, R&D, legal activities, accounting, tax, management consultancy, market research and PR activities).

16 ONS (2003).

There are further effects due to the emission of water vapour and contrails. However, the relationship between these emissions and climate change is less well understood.

We consider the impacts of growth in demand for aviation in more detail later in this report.

Low fares airlines

Liberalisation of the air transport industry in the EU has led to the emergence of new business models including low fares airlines (LFAs). LFAs distinguish themselves by providing a low cost "no frills" service. This model was originally developed by Southwest Airlines in the US and was successfully propagated as deregulation of the market followed in Europe. It involves minimising costs and maximising efficiency in all aspects of the business in order to offer lower fares to consumers. Characteristics of the LFA model include:

- efficient operations that maximise aircraft utilisation and minimise fuel burn;
- use of standardised aircraft fleets that aim to reduce operational and maintenance costs for the airline;
- a focus on serving uncongested regional and secondary airports, which have fewer delays and necessitate less fuel loss due to holding patterns and long taxi times;
- the use of regional airports also means that passengers have shorter distances to travel to catch their flights thereby reducing hugely the number of miles travelled by road which is the greatest polluter;
- a "no-frills" in-flight service that costs less to deliver and reduces aircraft payload and therefore requires less fuel burn; and
- more passengers carried per flight and therefore less fuel and emissions per passenger.

Figure 4 below indicates that the average age of aircraft fleets of LFAs compared to full service airlines (FSAs) is decreasing. A younger aircraft fleet is associated with more efficient engines and lower fuel consumption per passenger km[17] and therefore lower CO_2 emissions.

17 IATA (2001), *Flight Path to Environmental Excellence.*

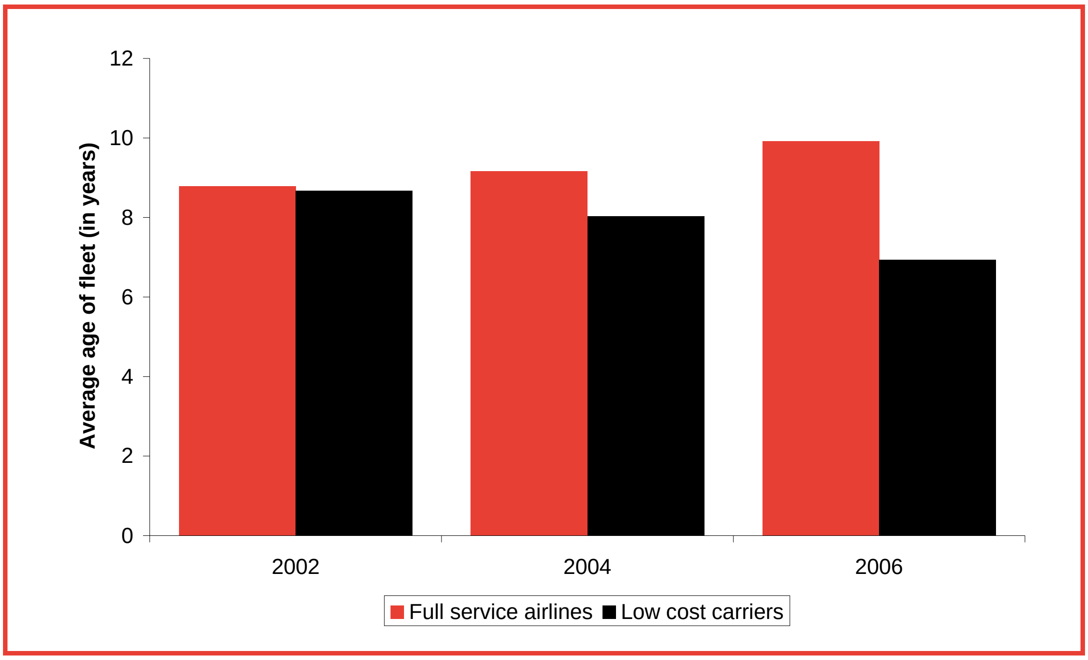

Figure 4: Average age of aircraft fleets in Europe

Source: Airbus

Based on a large fleet database of European full service and low cost airlines.

These figures result both from LFAs expanding their operations[18] as a result of the successes of the low fares business model and therefore acquiring new aircraft, but also from active programmes of aircraft replacement, exchanging older, and less fuel-efficient aircraft for more efficient aircraft.

Many of the reports calling for the inclusion of aviation in the ETS have noted the substantial growth in aviation as a cause of environmental concern. However, we note that within this overall growth profile, the activities of the LFAs have generally led to increased operational efficiency, increased the average number of passengers travelling per flight and have on average made use of younger and more fuel efficient aircraft.

18 According to ELFAA, the average annual growth rate of low fares airlines has been approximately 35% during the period 1999-2004. According to Eurocontrol, the first 6 months of 2005 have seen 33% more low fares flight movements in Europe than the previous 12 months.

2.2 SETTING AVIATION IN CONTEXT

KEY POINTS

- *Policy approach:* A framework for a cost-benefit analysis must include:
  - the costs of aviation (mostly greenhouse gas emissions);
  - the benefits of aviation in terms of its contribution to the EU economy; and
  - the net benefits of aviation relative to other sectors.
- *The costs of aviation:* In the EU-15, the average emission from aviation amounts to less than 4% of total CO_2 emissions. If the 10 new member states are added, the average proportion of emissions made up by the aviation sector will be smaller.
- The current debate has not given enough importance to growth in air transport in the new member states. Further growth in aviation is important for the development of the economies in the new Member States and for the competitiveness of the EU as a whole.
- Even if aviation emissions were to double in the next 20 to 30 years, it would still be a relatively small proportion of overall EU emissions. Studies indicate that of the order of 5% of CO_2 emissions for the EU would originate from aviation in 2030.
- *Benefits of aviation:* The economic benefits of aviation touch upon many sectors in the economy. The contribution of EU airlines, airports and the aerospace industry to EU GDP is reported to be c. 221 billion Euros creating c. 3.1 million EU jobs. There are knock-on benefits in important sectors such as tourism.
- *Cost-benefit approach:* The cost-benefit analysis should consider the net benefits of aviation (benefits/tonne of CO_2 emissions) relative to other sectors which are, or are being considered for targeting under Commission environmental policy. Such a study would find that although aviation CO_2 emissions are material, the net benefits of aviation are higher than several other sectors.

The Commission has set out a cost-benefit framework for developing environmental policy. However, the feasibility study[19] published by the Commission does not carry out a robust cost-benefit analysis to determine the type of environmental policy that should be set for aviation. Specifically it considers the environmental impact of aviation without placing this in the context of the direct and indirect economic benefits created by air transport. In this section we outline a framework for a cost-benefit analysis that should be carried out. However, the analysis is illustrative, as the scope of this report does not include a full-scale cost-benefit analysis. The framework sets out:

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19 CE Delft (2005a).

- the costs of aviation (mostly greenhouse gas emissions);
- the benefits of aviation in terms of contribution to the EU economy; and
- the net benefits of aviation relative to other sectors.

A full cost-benefit analysis would make an objective judgement of the net benefits of aviation relative to the emissions that it generates and the relative merits of targeting policy at aviation relative to other sectors. The analysis would be used to come to a decision on whether environmental policy should be targeted towards aviation, and if so, what form it should take. If it is found that it would be efficient to target aviation and that the most efficient policy would be to extend the EU ETS, then attention can turn to designing the scheme in a manner that ensures efficient overall abatement in the EU.

2.2.1 The costs of aviation

As the cost-benefit analysis relates to climate change policy, the costs of aviation in this context relate predominantly to CO_2 emissions. Figure 5 below illustrates the part aviation plays in emissions by sector in the UK. CO_2 emissions from domestic and international aviation contribute 5% to total UK CO_2 emissions. The proportion of CO_2 emitted by the aviation sector in the UK is slightly above the EU average. In the EU-15, the average emission from aviation amounts to less than 4% of total CO_2 emissions[20]. If the 10 new member states are added, the average proportion of emissions made up by the aviation sector is likely to be significantly smaller. This is because the average number of passengers per capita are lower in the accession countries. At the same time, sectors such as electricity generation in these countries are, typically, powered by CO_2 emitting coal rather than cleaner gas or nuclear fuels, as is generally more the case in the EU-15.

As can be seen in Figure 5, there are several more important sources of emission than aviation. The energy sector, with 34% of emissions, is by far the largest emitter of CO_2 in the UK. Road transport with c. 20% is also significantly higher.

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[20] In general, however, the proportion of CO_2 emitted by the different sectors in the UK follows a similar pattern as the proportion of CO_2 emitted by those sectors in the EU-15 and EU-25 countries.

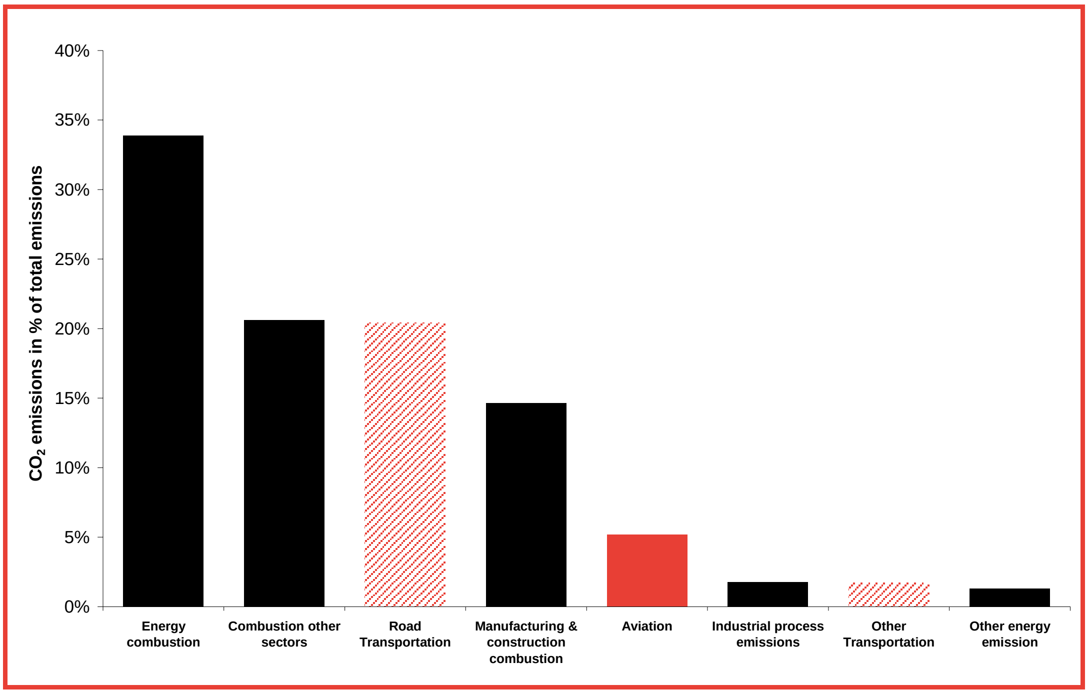

Figure 5: UK CO_2 emissions by sector (2002)

Source: EEA

While aviation in the 25 EU Member States accounts for a relatively small proportion of emissions, the debate to date has focussed only on the EU- 15, which is not necessarily appropriate given the importance of growth in air transport in the new member states. Concern about emissions from aviation has been based more on future forecasts for emissions due to forecast growth in the sector rather than the current level of emissions. However, it is clear that consideration has not been given to the importance of the growth in aviation for the development of the economies in the new Member States and for the competitiveness of the EU as a whole. Furthermore, even if aviation emissions were to double in the next 20 to 30 years, it would still be a relatively small proportion of overall EU emissions. A study by the Netherlands Environmental Assessment Agency[21] finds that total CO_2 emissions in the EU-15 from aviation will only grow to 5% by 2030. The economic contribution of aviation and its importance in terms of European integration are likely to outweigh these costs.

Whilst considering the projected growth in aviation emissions, projected reductions in other sectors need to be assessed critically. There is a growing body of evidence suggesting that targets for emissions reductions made for several other sectors, including the energy sector, for meeting obligations for the Kyoto period (2008-12) are not going to be fulfilled. Emissions in the UK have been on an upward trend since 2002. This may cast some doubt on whether emission

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21 Netherlands Environment Assessment Agency (2005) *Aviation in the EU Emissions Trading Scheme.*

reduction projections made in the literature for sectors such as energy are reliable.

Moreover, caution needs to be applied when developing policy based on future forecasts for emissions growth relating to aviation. Forecasts for growth in aviation to 2020 and 2050 are necessarily speculative and some have been based on changes to the current market structure for which there is no evidence to date. For example, prominent assessments[22] for growth in aviation emissions being used by policy makers appear to make assumptions for the growth of LFAs to long-haul travel – leading to forecasts of growth in long-haul travel that have no precedent. There is no evidence for such changes to the structure of competition taking place in the future[23].

2.2.2 Benefits of aviation

The economic benefits of aviation touch upon many sectors in the economy and therefore its overall impact is difficult to measure. However, this section highlights the importance of aviation as an economic driver and the issues that a cost benefit analysis should carefully consider. Details of checks for additionality due to aviation are set out in Annexe 1.

The economic benefits of aviation can be framed in terms of their contribution to overall gross domestic product (GDP)[24] of the EU. While consistent EU-wide figures are not easily available, a study published by IATA[25] finds that the contribution of EU airlines, airports and the aerospace industry to EU GDP was 221 billion Euros and that this activity created 3.1 million EU jobs[26].

Furthermore the contribution of aviation to GDP is growing because of the expansion of the aviation sector relative to activity in other sectors of the economy. According to OEF (1999), growth in aviation was at 4 times the rate of growth of UK GDP during the period 1975-2000[27]. The same publication attributes 2.5% of the trend increase in GDP to *growth* in the aviation sector (over and above the direct contribution of air transport to GDP).

There are several recently published studies that set out the benefits of aviation. The key studies are listed below:

- ACI (2004): York Aviation/Airports Council International *The social and economic impact of airports in Europe* January 2004.

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22 A report by the Tyndell Centre has received much coverage.

23 The low fares business model is not as conducive to long-haul travel.

24 Strictly speaking, there may be some benefits to welfare that are not included in GDP calculations, such as time savings during leisure time.

25 IATA (2004) *ATM implementation roadmap – short and medium term,* 15th October 2004.

26 This figure refers to jobs created directly, indirectly and induced.

27 Although, as shown in Figure 3, aviation growth as a whole is closer to two times world GDP growth.

- Amsterdam Economics (2004) *On the intimate relationship between airports and regional growth* Structural change in Europe 3, Innovative city and business regions, January 2004.
- ATAG (2005): Air Transport Action Group *The economic and social benefits of air transport*, 2005.
- BAA (2003): British Airports Authority *Economic benefits of aviation,* 2003.
- CE DELFT (2005b): *The contribution of aviation to the economy – assessment of arguments put forward* October 2005.
- DFT (2003): U.K. Government Department of Transport *The future of air transport* December 2003.
- ELFAA (2004) "Liberalisation of European Air Transport: The Benefits of Low Fares Airlines to Consumers, Airports, Regions and the Environment".
- IATA (2004a): International Air Transport Association *Environmental Review 2004*.
- IFV Cologne (2004): Institut für Verkehrswissenschaften an der Universität zu Köln *Die regionalwirtschaftlichen Auswirkungen des Low-cost-Marktes im Raum Köln/Bonn*, Studie für den Köln Bonn Airport, die IHK Köln und die IHK Bonn/Rhein-Sieg.
- OEF (1999): Oxford Economic Forecasting: *The contribution of the aviation industry to the UK economy* November 1999.
- OEF (2002): Oxford Economic Forecasting: *The economic contribution of aviation to the UK: Part 2 - Assessment of regional impact* 2002.

In summary, these studies set out the source of benefits to the economy as the following:

Source of benefit	Sub-category	Explanation of benefit
Increases in employment (assuming constant or increasing job productivity)	Direct	The aviation sector creates jobs that would not otherwise exist.
	Indirect	The aviation sector creates jobs and income in the value chain of goods supplied to the aviation industry which would not otherwise exist.
	Induced	Employment and income is generated by jobs directly and indirectly created by the aviation sector.
Business productivity growth		Provides easier (lower cost) access to inputs, customers and employees.
Foreign investment	Location of offices	Attracts businesses and new investment.
	In bound tourism	Increases the pool of possible tourist visitors.

Table 1: Benefits of aviation as set out in the literature

The literature finds the following impacts of aviation on GDP:

- the contribution of EU airlines, airports and the aerospace industry is 2.6% of EU GDP and created 1.9% of all EU jobs[28]; and
- direct employment in the UK due to aviation will rise at a much higher rate than the general UK economy (24% compared with 6.7%)[29].

The literature provides evidence for how this benefit is derived. Below, we provide further information on benefits derived through growth in employment, business productivity growth and foreign investment.

Increases in employment

Whilst a wide range of benefits of aviation are discussed in the literature, increases in employment are one of the benefits for which actual quantitative forecasts exist.

Surveys of European airports show that in 2001, for airports reporting traffic to Airports Council International (ACI), there were over 1.4 million jobs relating to

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28 IATA.

29 OEF (1999).

European airports[30]. OEF (2002) states that there were 180,000 direct and 200,000 indirect aviation sector jobs in the UK in 1998. OEF (1999) suggests that there were further induced jobs of the order of 25% of total direct and indirect jobs.

OEF also forecasts annual employment growth in the UK aviation sector up to 2030. These forecasts are set out in Figure 6 .

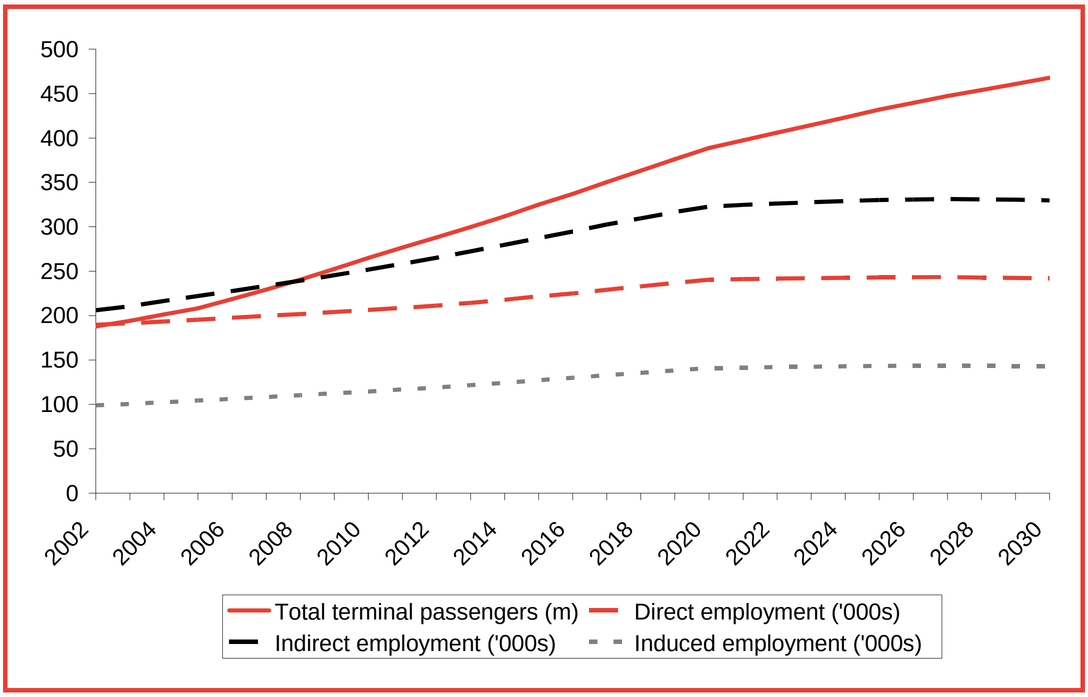

Figure 6: Forecasts for growth in passenger numbers and employment created due to the aviation sector

Source: OEF (2002)

OEF show a large rise in demand for air travel leading to growth in direct, indirect and induced employment in the aviation sector. The forecast also shows that OEF predicts that there will be a reduction in the incremental number of air travel related jobs required to meet increases in demand for travel. These productivity gains will lead to reductions in the rate of increase of aviation related jobs over time.

Translating forecast employment growth into additional future economic benefits is not necessarily straight forward. The cost-benefit analysis would need to check that new jobs created by the aviation sector would not otherwise exist. New jobs in the aviation sector, such as a sales person in a duty free shop could instead be created by a new shopping mall on the same site. Such a job might not, therefore, represent *additionality* due to the aviation sector. Similarly, a job created in the

30 ACI (2004).

aviation sector could be due to displacement from another region. Any marginal improvement in wages for jobs that would exist anyway does count as an additional benefit due to the aviation sector.

In Annexe 1, we set out details of the check we carried out for robustness of the forecasts presented by OEF.

Our assessment of the figures calculated for the UK finds that it is likely that significant *additional* employment created in the UK due to aviation will be of the order of that set out in Figure 6. OEF forecasts aviation related direct employment to rise by approximately 24% during the period 2006-20, from approximately 195,000 to 240,000. This suggests considerable benefit to the EU economy. For example, during the same period, the Office for National Statistics[31] forecasts that the overall UK labour force will grow by only 6.7%.

We now briefly consider each of the other drivers for economic benefit due to aviation.

Business productivity growth

In addition to generating employment, the literature finds that the aviation sector also contributes to the wider economy by helping to increase the productivity of other sectors.

For businesses dependent on transport links, locating close to a major airport hub with a large choice of destinations can help reduce the costs of doing business. In many cases, railways would not provide a competing option as they do not provide direct point-to-point travel options. Examples of cost reductions due to locating close to airports include:

- increased choice when seeking to source supplies;
- quicker access to customers;
- quicker access to other company offices; and
- access to a wider pool of talent (e.g. employees will be more willing to re-locate if they have cheap and easy options for travelling home).

A full cost-benefit analysis would typically value the benefit of being close to a good transport hub by estimating the value of time saved relative to being located far from transport links. Such quantification of benefits due to productivity growth is not available from the current literature that we have surveyed.

According to the ACI (2004) report[32] that provides evidence using surveys conducted with businesses across Europe, global accessibility offered by aviation can be important at a regional level as well as at a national level. For example:

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31 Office for National Statistics (2006) *Projections of the UK labour force, 2006 to 2020*, Labour Market Trends, January 2006.

32 ACI Europe (2004) *The social and economic impact of airports in Europe.*

- 31% of companies that relocated to the area around Munich Airport cited the airport as the primary factor in their location decision.
- 80% of manufacturing companies located in the area of Hamburg airport stated that air service connections are important to getting customers to look at their products.

A full benefits study would need to carry out a complete assessment of how aviation contributes to the productivity of other sectors. Sectors such as the financial and business services sectors form an extremely important part of the UK economy. The benefit study would need to take account of the magnified impact that aviation can have on the EU economy by improving the productivity of such sectors.

Foreign investment

In addition to the contributions identified above, there is significant literature linking aviation to the generation of inward foreign investment. Foreign investment is due to:

- business decisions to locate in a region with good air links; and
- in-bound tourism.

As with contribution to the financial and business sectors (set out above), impacts on tourism and wider business sectors will have a magnified impact on the EU economy as a whole. In terms of business decisions to re-locate, airports with good connectivity can attract companies to re-locate and invest. The ACI study provides the following evidence[33]:

- The Ile de France Region generates 30% of the French national GDP. Accessibility to Paris CDG Airport is a powerful factor in company location decisions, particular for the large global companies headquartered in the Paris area, and to firms engaging in new high-tech, innovative industries.
- Connections to Eastern Europe offered by Vienna Airport have enabled Vienna to provide the locations for East European headquarters of several global companies.
- The attractiveness of airports and their hinterlands is particularly strong for high-tech industries as evidenced by Copenhagen and Nice Airports.

Airports and air links also play an important role in the development of tourist regions.

- In the UK in 1997, two thirds of foreign visitors arrived by air, spending 81% of all spending by overseas visitors to the UK[34].
- Even for major European cities, air travel can account for a third or more of their foreign visitors[35].

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33 ACI Europe (2004) *The social and economic impact of airports in Europe.*

34 OEF (1999).

- In the past, charter carriers have played a major role in facilitating the development of tourism. LFAs are now opening up new markets to tourism and accelerating the growth in tourism, even in traditional markets such as UK and Ireland [36]. In contrast to charter carriers, LFAs operate year round services to the markets they serve. This results in more efficient use of tourism related facilities, such as hotels, restaurants, etc.

The survey evidence shows strong dependence on the strength of airline connections to deliver foreign investment, which in turn benefits the wider EU economy. A full benefit study will need to quantify these benefits due to the aviation sector.

2.2.3 A cost-benefit approach to aviation

In the preceding sections we have considered the level of emissions from aviation and the economic benefits created by the sector. Economic benefits of specific sectors of the economy are normally calculated by government agencies in the form of gross value added (GVA) by the sector to the overall national GDP.

Bringing together the GVA of a sector with its emissions provides a holistic view of the *net* benefits of the sector. Calculating the GVA/tonne of CO_2 emitted for a number of sectors allows a cross-sectoral comparison of net benefits.

We have carried out a net benefit calculation for the aviation sector. The GVA figures used for aviation are likely to be conservative as they do not include a full quantification of the benefits of aviation due to impacts on other important sectors to the EU economy (such as tourism, financial and business services sectors).

We compare the indicative net benefits of aviation with other sectors. The 2 other sectors illustrated in Figure 7 – road transport and energy - are sectors that emit greenhouse gases, and which the Commission will be considering in its environmental policy.

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35 ACI Europe (2004) *The social and economic impact of airports in Europe.*

36 ACI Europe (2004) *The social and economic impact of airports in Europe.*

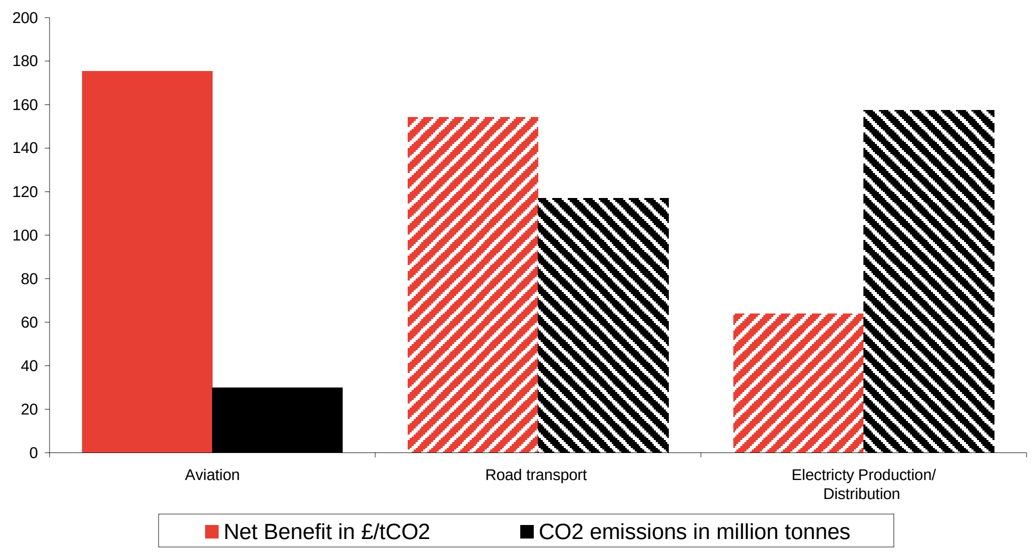

Figure 7: Estimated net benefit of selected sectors in the UK (2002)

Source: ONS, EEA, UK NAP

The figure illustrates how policy makers can develop a more holistic view of the sectors they should be targeting. For example, it shows that the estimated net benefit of aviation is high compared to the net benefit of other emission intensive industries. In particular, the figure illustrates that the net benefit of aviation is higher than the estimated net benefit of 2 sectors whose contribution to GDP exceeds the contribution of the aviation industry - the electricity sector and road transportation.

In comparing net benefits of sectors using forecasts, it is important to take steps to ensure that projections for other sectors are made equally credible to figures used for the aviation sector.

The cost-benefit analysis finds that although aviation CO_2 emissions are material, the net benefits of aviation are materially higher than other sectors that contribute more to EU carbon emissions.

3 Policy approach and design

3.1 POLICY APPROACH

KEY POINTS

- *How emissions trading works:* Emissions trading works by creating an additional marginal cost on participants for emitting CO_2. The overall effect should be for abatement to be carried out by those that find it cheapest to do so.
- *High-level principles for designing the EU ETS for aviation:* In designing the EU ETS for aviation, emissions reductions should take place at the lowest *overall economic* cost. Such an approach is consistent with the Commission's cost-benefit approach to addressing policy for aviation and the environment. This could mean emissions reductions from the aviation sector or it could mean *further* emissions reductions from other sectors.
- In terms of aviation, abatement occurs through:
  - carrying out activities in a way that reduces emissions (e.g. flying a shorter route or using a more fuel efficient aircraft); or
  - by reducing the activities carried out (e.g. by scheduling fewer flights). The extent to which either occurs should depend on the relative costs (and feasibility) of abating emissions in the different sectors.
- The economic costs of abatement include both the marginal costs of abatement and the loss of value by addressing the policy at the sector. This requires that the following principles are followed in designing the EU ETS for aviation:
  - the design should ensure that the full benefits and full costs are taken into account in the outcomes including loss of economic benefits created by the affected sectors;
  - wherever possible, the least cost options for abatement should be included in the activities that are subject to the EU ETS;
  - the stakeholders that are able to take decisions that lead to the lowest costs abatement should be included, wherever possible, in the incentive structure of the scheme; and
  - if key stakeholders cannot be included in EU ETS (such as ATM providers) then consideration should be given as a priority to the instruments that could be used to induce these stakeholders to reduce their output of CO_2.

The rationale advanced to date for the EC taking a more active part in aviation environmental policy has focused on contrasting the future forecasts of growth in aviation fuel burn with the historic emission reductions in other sectors (driven by climate change policy).

Such comparisons implicitly assume that aviation and activities in other sectors leading to emissions are equal in value and hence that the only relevant metric of comparison is the net emissions of each sector.

For example, CE Delft (2005a) states *"while the EU's total greenhouse gas emissions fell by 5.5% from 1990 to 2003, carbon dioxide emissions alone from the international aviation of the 25 Member States of the European Union increased by 73% in the same period"*. This constitutes a total EU reduction of 287 $MtCO_2e$ and an increase of 47 $MtCO_2e$ due to international aviation during the same period[37]. This kind of crude comparison does not reflect the complexity of the air transport market and the fact that towards the end of 2003 airlines were beginning to substantially increase their operations in the new member states.

3.1.1 Policy framework set out by the Commission

The Commission is considering how to deal with the environmental aspects of aviation within its overall environmental policy framework. In its communication published on 27th September 2005[38], the EC has set out an overall cost-benefit approach to selecting CO_2 reduction strategies: *"the need for cost-effective approaches points in favour of flexible economic instruments"*.

To meet its objectives, the EC has considered a number of possible actions at a number of levels. The results of the evaluation need to reflect the premise that policy should be predominantly based on market based mechanisms.

Through this evaluation, the Commission has disregarded a legislative approach based on regulatory standards such as the largely successful noise emission regulations, with penalties on airlines that fail to invest in quieter technologies and follow industry best practice.

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37 European Commission (2005a). Figures based on Annual European Community greenhouse gas inventory 1990-2003 (EEA (2003) and inventory report 2005 (EEA (2005)).

38 European Commission (2005a).

Options rejected at this stage	**Options concerning existing actions that need to be continued/strengthened**	**Options considered in detail for implementation**
Restrictions on air traffic volumes	Raising awareness of air transport users	En-route charges or taxes on aircraft emissions and impacts
Regulatory standards	Improving air traffic management (ATM)	Emissions trading for aviation through inclusion in the EU Emissions trading scheme (EU ETS)
Restrictions on access to EU airports for the least efficient aircraft	Research and development in air transport technology and operations	
Voluntary agreements with airlines to reduce emissions[39]	Applying energy taxes to commercial aviation	
Departure/arrival taxes, VAT on air transport, removal of public subsidies	Improving the competitiveness of rail transport	

Table 2: Overview of policies evaluated by the EC

Source: Annex to European Commission (2005a).

The Commission concluded that *"including aviation in the EU ETS seems to be the most promising way forward"*. However, it acknowledges that a number of design issues are crucial if the policy is to deliver its full potential for environmental and economic efficiency with regard to the ETS.

3.1.2 How emissions trading works

An emissions trading scheme imposes obligations on designated participants, and by doing so, creates incentives for them to reduce emissions at the least cost.

Some of its key features are listed below.

- *Obligation:* Firms operating in sectors included in the scheme must submit 1 allowance for each tonne of CO_2 emitted, or face a penalty.
- *Incentives:* As allowances have a value, the firm would consider whether it is possible to avoid emitting the CO_2 so that it can sell the allowance instead. If an allowance has been allocated to the firm free of charge, it has a value on

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39 It is to be noted, however, that such voluntary agreements are already in place between airlines and aircraft manufacturers.

the market and will therefore still impose a cost on the firm if it is used. The firm therefore has the same incentives for abatement whether it has to buy the allowances or has been freely allocated the allowances.

- *Market actions:* If the cost of abatement for a given firm is less than the price of the allowance, then the firm will be better off if it abates its emissions. If abatement is more costly than the allowance, then the firm will prefer to emit and use up an allowance, either from an existing endowment or by purchasing extra allowances from those who have surplus allowances.
- *Outcome:* The outcome should be that abatement is carried out by the firms (and sectors) that face the lowest cost of reducing emissions. Thus the target emissions level implied by the total volume of allowances in circulation is achieved at the least cost.

The EU ETS works in phases. The first phase started in January 2005 and continues until the end of 2007. Phase 2 consists of the period 2008-12. During each phase, the stock of allowances is fixed and is based on the sum total of allowances allocated by the 25 EU Member States through their national allocation plans (NAPs). The process followed is for each Member State to determine emission reductions required from the EU ETS (given the rest of its climate change policies) and to determine the size of allocation to individual "installations" using a defined methodology. The Commission is then responsible for approving these NAPs. The NAPs therefore allow Member States to jointly determine the volume of abatement required from the participating sectors.

Figure 8 illustrates the relationship between the total volume of allowances available under the EU ETS, the marginal cost of abatement and the price that allowances would be expected to trade for on the free market. The marginal cost of abatement curve determines demand for allowances. It traces out how the marginal cost of *additional* abatement increases as the stock of available allowances decreases. Its shape indicates how much harder each additional unit of abatement becomes as abatement increases. The price of an allowance will be set where this curve intersects with the fixed stock of allowances.

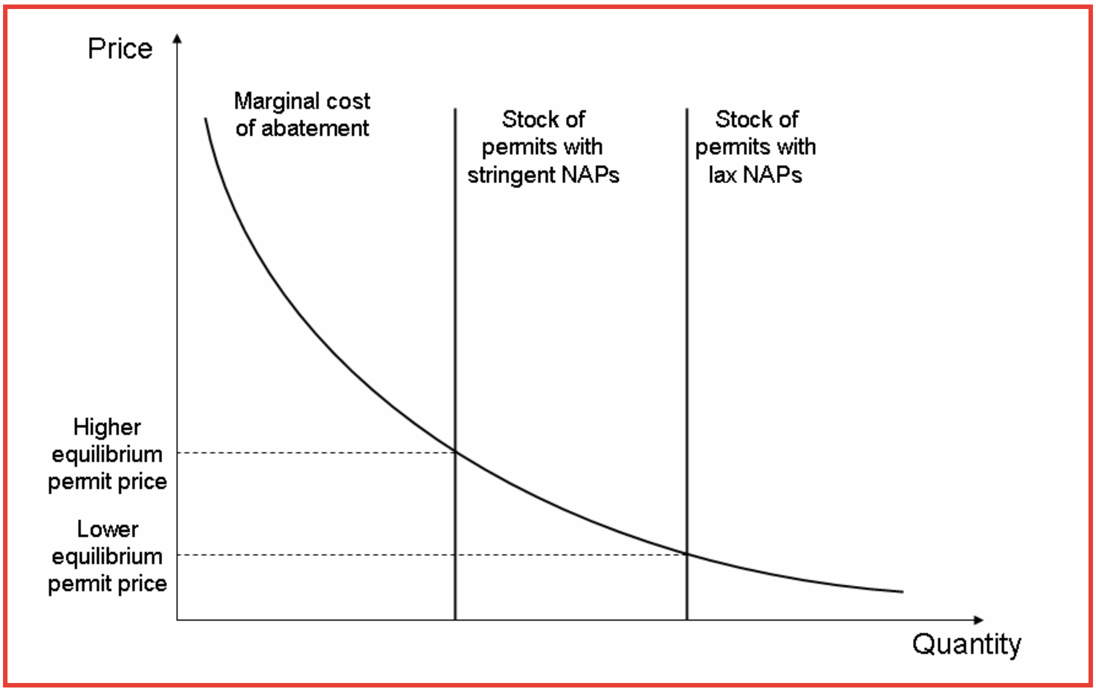

Figure 8: Illustration of how market forces will determine the price of a carbon allowance

Through their individual actions, Member States jointly determine the extent to which abatement takes place in the EU. If the available stock of allowances is small (i.e. stringent NAPs are published), this implies that more accelerated abatement will be required (see Figure 8). Demand for allowances will be high and so will be the price of allowances, meaning that relatively expensive abatement projects would be cost-effective. If the available stock of allowances is large, then less abatement will be required. There will be a lower demand for allowances and the price of an allowance will consequently be set at a lower level, leading to lower cost abatement options being viable.

The total volume of the allocation relating to aviation would therefore impact on the price of allowances (and extent of abatement) across the EU ETS in all sectors covered by the scheme.

The start of the EU ETS has been characterised by considerable uncertainty leading to fluctuations in price and criticisms by participants. The uncertainty partly stems from the newness of the scheme and the lack of knowledge participants have about how best to act within it. However, the organisation of the EU ETS has created its own uncertainties. Member States determine the number of allocations to the sectors in their jurisdiction. The determinations then go through an approval process with the Commission. Complications have occurred due to differing interpretation of the Directive by Member States and the iteration process that has been followed to finalise allocations. Indeed there are still outstanding uncertainties regarding the total allocation of permits under Phase 1 of ETS as well as the extent to which it will be feasible to "borrow" allowances from future ETS phases to meet commitments under the current phase.

3.1.3 Outcomes for policy in aviation

As noted above, the Council has called for a cost-benefit approach for emissions reduction strategies. This requires that policy is designed to reach efficient outcomes by considering a wide set of costs and benefits of abatement. A cross-sectoral scheme needs to consider all costs and benefits across the relevant sectors.

In terms of what this means for aviation - given a target level of emissions, the EU ETS should elicit emissions reductions at the lowest *overall* economic cost. This could mean emissions reductions from the aviation sector, or it could mean *further* emissions reductions from non-aviation sectors. In practice a combination is also likely, where aviation takes some options for abatement, up to the level made efficient by the price of allowance, but where further abatement would also be efficient in other sectors. As noted above, the LFAs (and other sectors in aviation) are already actively pursuing available abatement options in order to limit their fuel costs. As part of these efforts, LFAs have carried out extensive fleet renewal programmes to obtain more efficient engine and aircraft technology. It is debatable therefore whether increased incentives due to the EU ETS would promote any significant additional abatement.

Emissions reductions (or abatement) in aviation is achieved in two broad ways: by carrying out activities in a way that reduces emissions (e.g. flying a shorter route or using a more fuel efficient aircraft) or by reducing the activities carried out (e.g. scheduling fewer flights). The later option is not desirable when the positive benefits of aviation on economic growth are taken into consideration. However, it is inevitable that there may be certain routes where route profitability is already low and load factors are consistently low and where ETS could force airlines to rationalise their flight schedules.

In the case of designing environmental policy that includes aviation, a well designed scheme should allow market outcomes to determine whether and to what extent aviation emissions are controlled, or whether emissions are *further* reduced in other sectors. The extent to which either or both occurs should depend on the relative costs (and feasibility) of abating emissions in the different sectors. Within aviation, airlines that have taken advantage of the latest technology early to reduce fuel burn and emissions should be rewarded compared to airlines that have put off or taken late decisions to abate.

When assessing abatement costs account needs to be taken of both:

- the marginal reduction in economic benefits due to changes in activities leading to reduced emissions; and
- the marginal costs of carrying out the abatement activity.

The following principles set out our view of the appropriate approach for cost-benefit based policy design:

- *The design should ensure that the full benefits and full costs are taken into account in the outcomes:* A holistic approach to incorporating activities in an emissions trading scheme improves the likelihood of achieving efficient outcomes. This follows because a larger set of activities with a broader spectrum of costs and benefits are included. There is therefore a greater chance that the outcome leading to the lowest overall economic cost is chosen. This has a number of implications for how aviation is included in the EU ETS:

- costs of emissions from aviation should be related to the benefits of aviation and compared with the equivalent costs and benefits of other sectors; and
- within aviation, inclusion of the widest possible scope of stakeholders and activities will increase the likelihood of an efficient outcome being achieved – the scheme needs wherever possible to cover *all* the agents who can influence the level of aircraft emissions.

- *The least cost options for abatement should be included in the activities covered by the EU ETS:* Within aviation, the lowest cost methods for achieving reductions in emissions need to contribute to reductions in emissions. As there is little transparency in the costs of different abatement options, incorporating the widest possible range of abatement *possibilities* will increase the chances of least cost options being chosen.
- *The stakeholders that are able to take decisions that lead to lowest costs abatement should be included (wherever possible) in the incentive structure of the scheme:* Incentives for reducing emissions should fall on stakeholders that are actually able to reduce emissions, and therefore all stakeholders that can, through their actions, reduce emissions should, ideally, be accommodated in the scheme.

Only after a proper cost-benefit analysis has been conducted should the options for how to deal with emissions be considered. If it is determined that the inclusion of aviation in the ETS is the most appropriate option, then careful design is required to ensure that extending the EU ETS to aviation encourages efficient abatement in the aviation sector at the lowest possible cost.

The next section sets out the high level framework that, in our view, should be followed to get the most efficient overall outcome in this sector. It is beyond the scope of this report to establish every detail of the appropriate design. That scheme design matters can be illustrated by our indicative calculations, which suggest that a further reduction in fuel consumption of 1% would lead to reductions in CO_2 emissions in Europe of over 2 million tonnes per year.

However, we note that there are already considerable incentives to reduce emissions due to high fuel prices that have the same properties as incentives due to the EU ETS. There are therefore questions as to how much abatement could actually be achieved by including aviation in the EU ETS.

3.2 DETERMINANTS OF SCHEME DESIGN

KEY POINTS

- *Would the scheme promote abatement?* There are currently strong incentives due to fuel prices. Additional incentives due to the EU ETS are likely to promote further abatement of emissions but only at the margin.
- *What abatement can take place?* The major decision-making that can lead to further CO_2 abatement comes both from aircraft operators and from ATM. Our estimates using industry figures is for abatement potential of the order of 17% of total CO_2 emissions p.a. for the entire fuel burn relating to arriving and departing EU flights.
- ATM impacts on most operational decisions and is intrinsic to reducing a large portion of CO_2 emissions that relate to operational decision making. We calculate that improvements in ATM would lead to potential reductions of c. 8% of CO_2 emissions p.a. for the entire fuel burn relating to arriving and departing EU flights.
- By contrast, aircraft replacement, which is one of the most significant actions that an airline can take, has the potential to achieve reductions of 1% per annum or c. 2,132,000 tonnes of CO_2 emissions per annum.
- *Scheme design:* Our analysis finds that the scheme should be designed as follows:
  - who faces the obligation? Although there a number of alternatives, aircraft operators are likely to most easily meet the requirements, but this incentive can be applied directly to airlines, or indirectly by requiring airports to submit allowances for CO_2 produced by relevant flights. Separate urgent consideration needs to be given to how Commission policy can ensure that ATM providers have incentives to contribute to abatement;
  - what is the unit of charge? - fuel burn;
  - what is the geographic coverage? - all arrivals and departures from EU airports – covering fuel burn over the entire flight;
  - what is the coverage of climate change effects? - CO_2 emissions only; and
  - what is the coverage of size of aircraft? - instrument flight rules (IFR) flights only and not visual flight rules.

3.2.1 Would ETS promote more abatement?

Whether EU policy for aviation is likely to elicit further abatement in the aviation sector is an important first consideration in designing the scheme.

As discussed above, the high price of jet fuel already creates strong incentives for aviation to reduce fuel burn, and therefore emissions. If the policy being considered can provide enough incentive to promote additional abatement within aviation – even if only at the margin – then an important consideration in designing the scheme is that it promotes maximum *efficient* abatement.

Abatement in aviation takes two forms. The first (and obvious) form of abatement involves an absolute reduction in the number of flights[40]. This would lead to less fuel being burned, and therefore lower CO_2 emissions. Increasing marginal costs through ETS is likely render some services unprofitable that were previously only marginally profitable.

The second impact on aviation can come through improvements in fuel efficiency as CO_2 emissions relate directly to fuel burn. In this regard the EU ETS would act in a similar way to fuel price increases by encouraging a range of actions that reduce fuel burn.

How the aviation sector has responded to historic increases in fuel prices provides an indicator for the extent to which the sector is likely to be able to react to further increases in operating costs due to the EU ETS.

During the last 3 years the price of aviation fuel has risen significantly; Figure 9 shows annual changes in the average price for jet fuel. The rise in prices has led to considerable concern in the aviation sector as fuel forms a considerable part of airline operating costs. By way of example, in 2002-03, British Airways spent 12.6% of its operating costs on aviation fuel[41]. As LFAs focus heavily on optimising their cost base, fuel costs typically make up a higher proportion of their operating costs. Ryanair's fuel costs as a proportion of operating costs have increased from 22% in 2003-04 to 26% in 2004-05[42].

40 Or, to be more accurate a reduction relative to the number of flights that might have occurred in the absence of the ETS.

41 Sourced from BBC news website, based on original data provided by the CAA.

42 Figures provided by Ryanair.

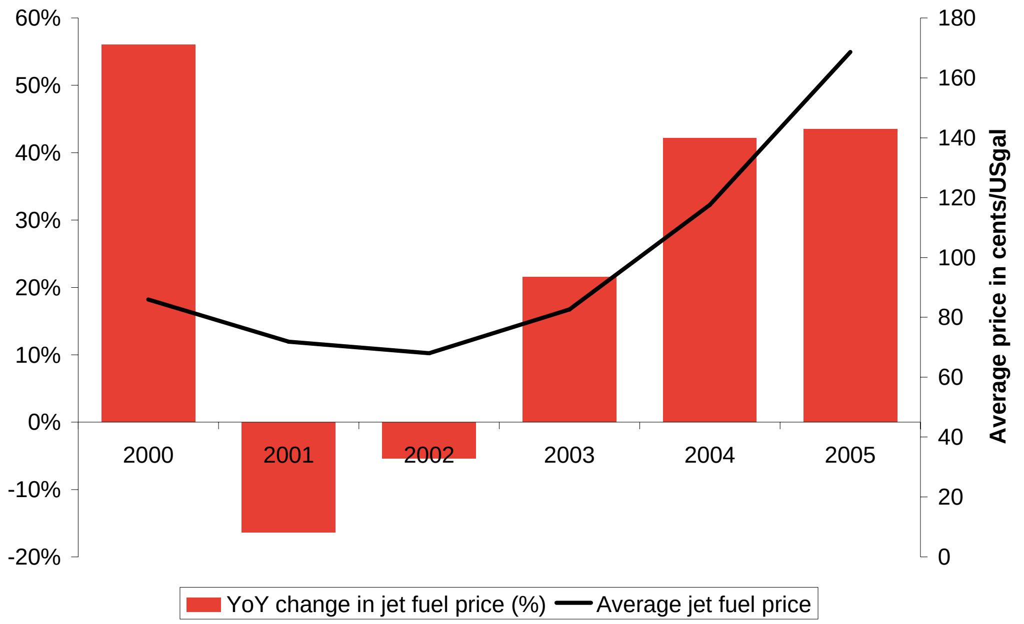

Figure 9: Average Jet fuel price – absolute and relative change to previous year for period 2000-2005

Source: Frontier calculations based on Exel Jet fuel index – an average of the five most important spot markets – Rotterdam, Mediterranean, Far East Singapore, US-Gulf, US-West coast

Figure 10 illustrates the historic effect that fuel prices have had on overall changes in fuel efficiency in the aviation sector. Due to the direct relationship between fuel burn and CO_2 emissions, the figure also demonstrates the relationship between rises in fuel and fuel efficiency measures which leads to lower CO_2 emissions. Figure 10 shows that for the 30 year period 1970-2000, efforts to become fuel efficient have closely tracked fuel costs.

Although there are a number of factors that an airline considers when choosing to acquire an aircraft (range, types of configuration, match with rest of fleet), the aircraft's fuel efficiency becomes significantly more important during periods of rising prices. The implication is that further rises (due to additional EU ETS allowance costs) would probably lead to further emphasis on improving the fuel efficiency of the aviation sector. Airlines already have a strong incentive, but further rises improve the business case for aircraft replacement and therefore may bring forward investment in new fleet.

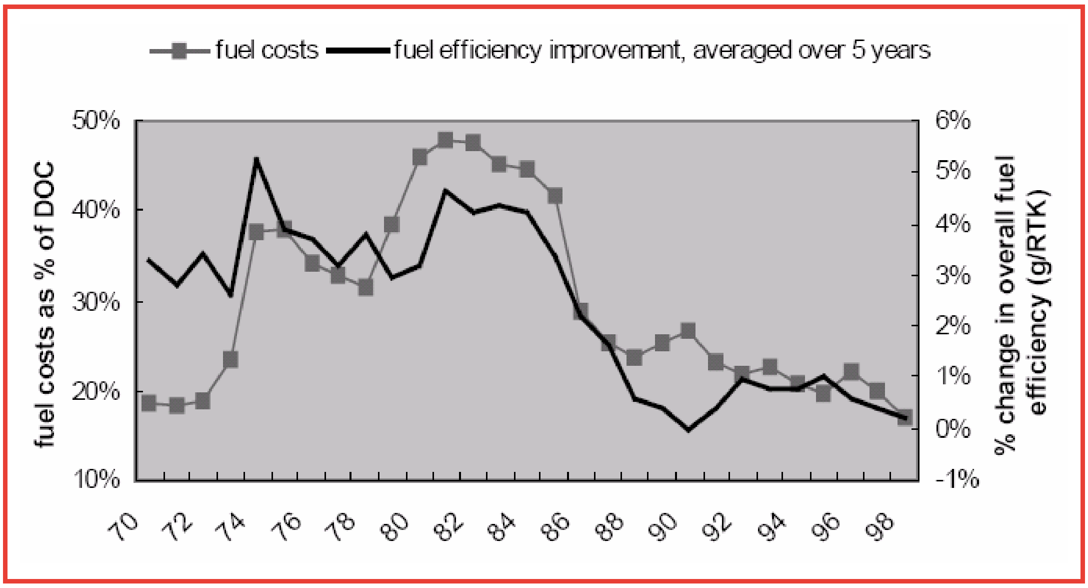

Figure 10: Developments in fuel costs and overall fuel efficiency of EU carriers

Source: CE Delft et al. (2002): Fuel prices and fuel efficiency: a historic overview, in: ESCAPE - Economic Screening of Aircraft Preventing Emissions - Annex V, p.4.

At the time of writing (March 2006) the price of allowances in the EU ETS is standing at approximately €27. Frontier preliminary analysis using data for European aircraft movements in 2004 suggests that the increment in cost relating to an average flight[43] from this cost would be of the order of approximately €285. This figure is equivalent to a 28% increment on the current fuel cost[44], which is of the same order as the recent historic annual increases in jet fuel price and suggests that the EU ETS is likely to lead to further incentives for efficiency gains, although it is difficult to quantify how much. These additional incentives are, though, only likely to be on the margin, as airlines already face strong incentives to increase fuel efficiency. The Commission will need to cultivate a good understanding of the nature of the abatement curve to ensure that any policy is suited to capturing the efficient available abatement.

3.2.2 Are there options for further abatement?

The previous section illustrates that the EU ETS, with current allowance prices, would create incentives for abatement at the margin. In the following discussion we investigate the extent to which additional emission reductions are actually possible in response to these incentives.

We have considered the abatement opportunities available to different stakeholders in the aviation sector and in different forms. To understand the opportunities, we held discussions with aircraft manufacturers (Boeing and

43 An average flight is assumed to be an A320 aircraft with 150 seats with a load factor of 70% and flying a distance of 700 kms.

44 Based on figures for 2004.

Airbus) and with a number of airlines. The assessment found that the majority of decision making that can lead to further CO_2 abatement comes both from aircraft operators and from ATM.

Air traffic management

Air traffic management (ATM) is described[45] as *"the dynamic integrated management of air traffic and airspace – safely, economically, and efficiently – through the provision of facilities and seamless services in collaboration with all parties"*. Its importance to CO_2 abatement opportunities in aviation should not be underestimated because they play an important part in determining and approving the final operational characteristics of each flight.

The impact of ATM activities can be considered in the short and medium term. In the short term, they determine the organisation of airspace, the interaction and interconnectivity between different control areas and procedures that determine routes and speeds, arrival/departure patterns and flight separation requirements. In the medium term, the ATM infrastructure determines the procedural extent to which information exchange occurs between different systems and the extent to which control of operational characteristics lie with ATM or aircraft.

ICAO is currently coordinating development of international ATM procedures. A 2005-25 roadmap has been set out for developing the "ATM operational concept". As part of this concept, a number of key performance indicators are being developed. In addition the EU's SESAR programme is working to develop the next generation European ATM system.

Including measures to improve efficiency of routing and flight time will be important. By way of illustration, Figure 11 illustrates data for European flights 500-800 km in length from 5 days in 2001. The black line represents the optimal distances between origin and destination. The vertical distance from the line represents the extent to which flights flew further than the optimal distance. Although some of the vertical distances will relate to essential diversionary routing due to weather and other restrictions, the majority relate to sub-optimal routing on the part of air traffic management.

45 IATA (2004b) *ATM implementation roadmap – short and medium term* Volume 2, 15 October 2004 citing *ICAO operational concept*.

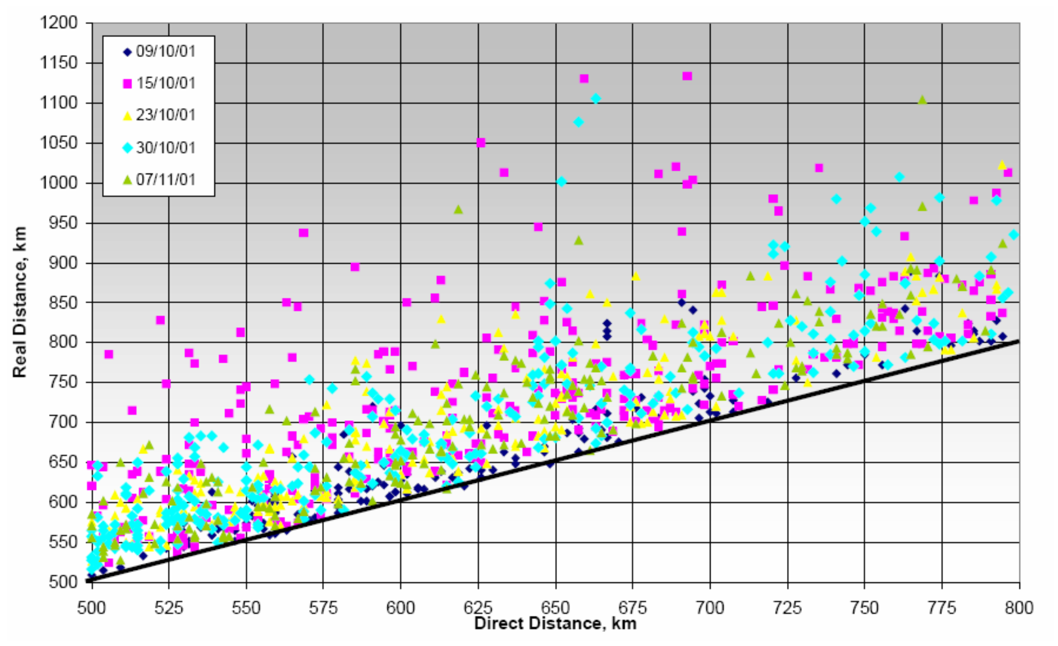

Figure 11: Direct distance in function of real distance – 500 to 800 km

Source: EUROCONTROL (2002), Environmental Key Performance Indicators, p.22

A special report on aviation and the global atmosphere[46] observed that new ATM systems based on improved communication, navigation and surveillance would have the potential to reduce the emission of greenhouse gases significantly (of the order of 6-12%). There is already precedent for such ATM led fuel efficiency improvements. An improvement in ATM allowing reduced vertical separation minima, was introduced by Eurocontrol in 2002. Analysis has indicated that it has led to reductions in fuel burn of the order of 2%[47].

We find that whilst altering the actions of ATM is key to eliciting reductions in emissions relating to operational activities of aircraft it is not realistic to consider including ATM in the EU ETS. For instance, ATM is highly fragmented and publicly owned in most countries. Given the scale of the emissions savings that could be made available by more efficient organisation of ATM there is an urgent need to consider the policy steps that would induce ATM to carry out the necessary improvements. In particular it is important to consider how EU programmes such as SESAR, which is intended to develop the next generation European ATM system, is coordinated to ensure that the environmental impact of ATM is properly addressed.

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46 IPPC (1999) *Special report: Aviation and the global atmosphere.*

47 Eurocontrol (2003) *Operational measures and the importance of sustainable development in aviation* , Skyway 31, Winter 2003.

Operational decisions

In responding to the price signals provided by EU ETS, airlines have a range of operational and strategic actions that they can take to reduce costs.

Operational decisions are decisions that are made in the short term by the pilot or the operational airline management. They are mostly based on the implementation of operating procedures that lead to fuel efficiencies. Our analysis is based on current technology. In calculating potential abatement resulting from the operational decisions, we have done so for the maximum possible opportunity to abate.

In annexe 2, we briefly describe the operational decisions that are considered to be viable. The descriptions of operational decisions are based on IATA (2005).

Strategic decisions

Strategic decisions are decisions that are made in the medium to long-term by airline management. Such decisions can take various forms. They could relate to the overall business strategy for choosing routes and determining fares (such as the choice between being an LFA or a FSA) or they could relate to how the fleet is managed (such as in the case of maintenance schedules) or investments to make the fleet more fuel efficient.

We are able to quantify the value, in terms of emissions reductions, of changes to the maintenance plan, the installation of winglets and the installation of riblets.

Aircraft maintenance affects the fuel efficiency of the aircraft. Increased frequency of engine washes, checks on flight control rigging, airframe buffing and paint condition all help to maintain the aircraft in efficient operating order. Airlines would, in general, schedule more frequent maintenance if the benefits of improved efficiency (including the benefit of reduced costs of EU ETS) outweigh the opportunity costs of having the aircraft out of service.

The aerodynamic design of wings has an important effect on the total drag during cruise and therefore on an aircraft's emissions. A market for retrofitting existing wings with winglets already exists. As many newer aircraft are delivered with winglets, only older and smaller aircraft will benefit from this measure. It is estimated that installation of winglets can save between 2-3% of fuel burn. A number of LFAs have recently retrofitted their aircraft with winglets.

Riblets are small grooves made in the surface of aircraft to reduce skin friction. They may offer opportunity for fuel efficiency gains in the future. However, there are currently no commercially viable offerings on the market.

Procuring newer aircraft

Perhaps the largest and most significant strategic decision that an airline can make to improve its fuel efficiency is to replace existing aircraft with newer more fuel efficient aircraft.

A large portion of R&D efforts made by aircraft manufacturers focuses on improvements in fuel efficiency. Newer aircraft, without exception, are more fuel efficient than the previous generation. For example, Ryanair calculates that its emissions have reduced by 30-40% for a 1 hr 20 min flight by upgrading from an older generation Boeing 737-200 to the latest generation Boeing 737-800.

Increases in operating costs due to fuel burn, relating to the EU ETS would make the case for the acquisition of newer aircraft more compelling.

Summary of potential abatement

We have carried out a preliminary assessment of the potential for reductions in emissions represented by each of the decisions set out above. It is based on a view of potential future abatement opportunities published by IATA in December 2004 and uses the most recent available air movement figures from Eurocontrol. It is likely that a significant proportion of the opportunities to abate have already been taken up airlines in their ongoing efforts to reduce fuel burn.

Figure 12 sets out the sources of savings that may be possible. They are of the order of 17% of the entire fuel burn for all flights departing from or arriving in the EU. This represents approximately 7% of the current UK sector wide annual CO_2 allowances and approximately 0.7% of the EU wide current annual CO_2 allowance pool.

Figure 12 also shows the suggested origin of these reductions. The measures are divided between operational decisions that are heavily influenced by the actions of ATM, operational decisions determined by aircraft operators and strategic decisions that are also determined by aircraft operators.

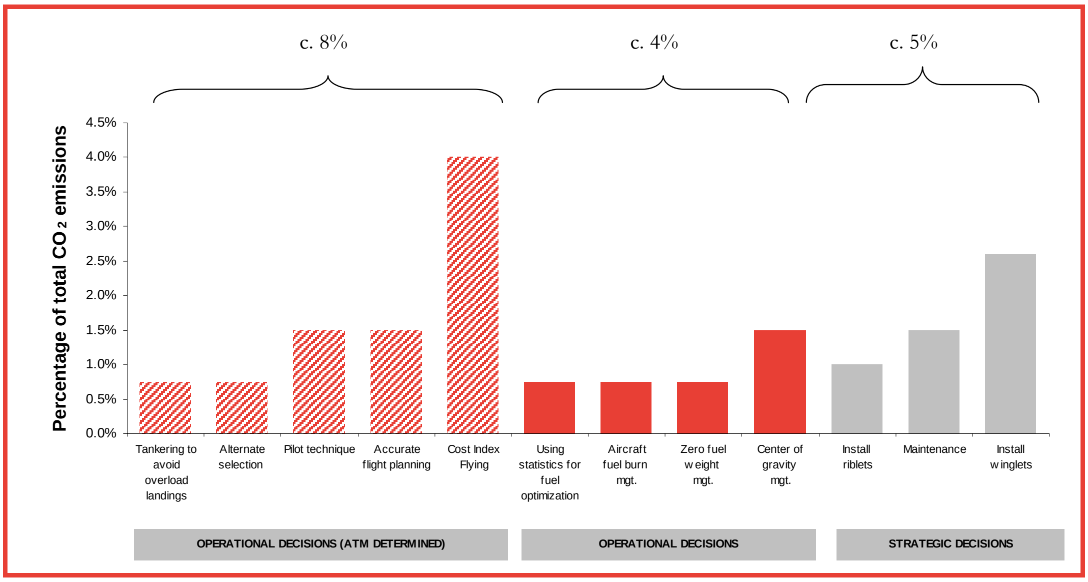

Figure 12: Indicative assessment of potential CO_2 reductions in Europe (based on current technology) shown as percentages of entire fuel burn of flights departing and arriving the EU

Source: Frontier analysis using data from Eurocontrol, AEA and IATA

Winglet figures assume all flights could benefit from installation of winglets.

ATM impacts on most operational decisions and is intrinsic to reducing a large portion of CO_2 emissions that relate to operational decision making.

One-off benefits (current technology)	Percentage reduction
Air traffic management (ATM) influence	8.4%
Other airline operational decisions	3.8%
Airline strategic decisions	5.2%
Total	**17.4%**
Procuring new aircraft (annual benefit)	1.0%

Table 3: Indicative assessment of abatement opportunities

Source: Frontier analysis using data from Eurocontrol, AEA and IATA

We calculate that improvements in ATM would lead to potential reductions of approximately 8% of CO_2 emissions for the entire fuel burn for all flights departing from or arriving in the EU.

As discussed above, aircraft procurement forms a key strategic decision to improve its fuel efficiency (and therefore its CO_2 emissions). IATA finds that new aircraft replacement would lead, on average, to a 1% improvement in efficiency per annum to 2010. A 1% annual improvement in fuel efficiency for the entire EU fleet would constitute a reduction of 2,132,000 tonnes of CO_2 per annum (based on the current size of aviation). However renewals of specific old aircraft, or delays to such renewals, may have much larger individual effects due to the large cumulated difference in fuel efficiency from the current efficiency frontier that they may represent.

As shown in the analysis above, changing how ATM providers act would be most effective at reducing emissions. Considering how ATM contributes to environmental policy and reduced carbon emissions therefore needs to become an urgent policy priority.

3.3 THE SCOPE FOR THE SCHEME

There are a number of important scoping aspects that need to be designed that would determine the extent to which the extension to aviation has efficient outcomes.

Under the incentives created by the EU ETS, abatement is undertaken by those who find it cheapest to do so relative to other participants in the EU ETS. In a scheme in which aviation is just one of many sectors, it is possible that the price of allowances would be lower than the cost of many options for aviation abatement. In such a situation, most abatement might be expected to occur in sectors other than aviation, with the aviation being a net buyer of allowances. However, even in such circumstances there may still be low cost opportunities for abatement in aviation that could be encouraged. The EU ETS should provide the incentive for aviation to behave in the most environmentally efficient manner.

The following section sets out views on scheme design that:

- seek (to the extent that it is efficient) to create incentives for abatement to take place in the aviation sector;
- determine who carries out the abatement; and
- determine who (in the aviation sector) faces the burden of the EU ETS.

In assessing the options, our criterion for assessment in favour of cost efficient outcomes. However, an important principle that has not received sufficient attention in the reports on ETS and aviation to date is that, insofar as it is practicable, the scheme design should not distort competition between airlines. That is, the design should not favour one airline or group of airlines over others on any other grounds than their behaviour as regards emissions of CO_2.

At its simplest, if stakeholders such as airlines are competing on a route, and one airline faces the EU ETS and the other does not, then this would result in the latter gaining a competitive advantage in the market for air travel.

This leads us to an important conclusion regarding the incidence of ETS: that it is essential that *all* the participants in any given route (which in most cases would be treated as a distinct economic market) should face the same ETS regime. This requires that no stakeholders in any route affected by ETS market are exempted due to their country of ownership (or the country of ownership of their aircraft) or any other such arbitrary factors.

For the avoidance of doubt, to state that all stakeholders should be covered by the same ETS rules, this means that they should be subject to the same marginal costs as a result of the need to present allowances to account for CO_2 emissions and they should be subject to the same rules for allowance allocation. These issues are dealt with more below in the section on the economic and competitive impact of ETS on the aviation sector.

There are, however, a number of important (and more frequently debated) scoping aspects that need to be determined.

- Who faces the obligation?
- What is the unit of charge?
- What is the geographic coverage?
- What is the coverage of climate change effects?
- What is the coverage by size of aircraft?

The following section provides a summary of the findings:

Who should face the obligation?

Those facing the obligation to submit allowances should also have the ability to control emissions. Clearly aircraft operators are the immediate party with the greatest incentive to reduce emissions and should therefore be subject to the incentives provided by the obligation to submit allowances[48]. However, the method by which this incentive is applied is open to question. We consider this problem in Section 4 where we address the problems of defining the "installation" which attracts allowances. It is possible to apply the relevant incentive either by making the airline directly responsible for submitting emissions allowances, or indirectly, by making airports submit allowances for the CO_2 produced by relevant airport users.

We have also highlighted the importance of ATM in its contribution to additional fuel burn and therefore emissions. While we do not consider it practical to include ATM in the EU ETS there is a clear need for focus at the Commission level on how ATM is designed to maximise aviation fuel efficiency (for instance through the SESAR programme).

The Frontier assessment focuses on targeting the burden on those stakeholders that are best placed to reduce emissions. Table 4 provides a summary of the findings. A full assessment of the different options is provided in Annexe 3.

Stakeholder	Preliminary Commission view	Frontier assessment
Aircraft operator	Yes	Yes
Airport operator	X	Yes
Fuel supplier	X	X
ATM provider	X	Yes (likely as separate policy)
Aircraft manufacturer	X	X

Table 4: Summary assessment of stakeholders

Aircraft operators and providers of ATM services together exert the greatest influences over fuel burn. These influences are largely independent of each other (that is they are separable). They should therefore be jointly considered for inclusion in the scheme.

An alternative to aircraft operators would be airport operators.

What should the unit of charge be?

From an economic perspective the unit of charge employed should:

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48 Noting that placing incentives on airlines to increase efficiency also creates incentives on aircraft manufacturers to provide continual reductions in fuel burn.

- (directly) relate to the emission of gases that impact on climate change (mostly CO_2 and NO_x);
- should be controllable by the entity facing the burden; and
- should be measurable.

Aviation fuel burn causes emissions of CO_2. There is a constant relationship between fuel burn and CO_2[49]. Fuel burn is also the cause of NO_x emissions that lead to climate change effects.

Aviation fuel burn can be controlled by operating routes more efficiently so that less fuel is burned and by reducing the number of flights operated. The former is, in part, within the control of the providers of ATM. The later is firmly an operating decision for the aircraft operator.

Fuel burn is also easily measurable by aircraft operators. We can see no reason not to use fuel burn as the unit of charge for airlines.

What should the geographic scope of the scheme be?

There are a number of options for the geographic scope over which the EU ETS should apply.

Efficient outcomes occur if abatement takes place at lowest cost. To ensure lowest cost, we design the scheme to have the widest possible scope. The more flights and the more emissions that are included, the more opportunity there is for ensuring that the least cost options are chosen. A narrower definition would lead to considerable reductions in possible CO_2 abatement. From this analysis, it is clear that the options with 'all arrivals and departures from EU' are likely to offer the widest scope – and therefore – the greatest likelihood of an efficient outcome. Table 5[50] shows that restricting the EU ETS to only intra-EU flights would mean that ETS covered only 20% of the emissions from flights starting or finishing in the EU.

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49 1 kg of aviation fuel burn corresponds to 3.15kg of CO_2 emission.

50 Our analysis is based on CE Delft's analysis on CO_2 emission in various geographical scenarios (see: CE Delft (2005a)) and Frontier assumptions.

Geographic coverage	Emissions (tonnes of CO_2)	Proportion of largest coverage
All intra-EU flights	42.4 million	20%
All arrivals at EU (fuel burn over EU airspace only)	46.7 million	22%
All departures from EU (fuel burn over EU airspace only)	46.7 million	22%
All arrivals & departures from EU (fuel burn over EU airspace only)	93.5 million	44%
All arrivals at EU (fuel burn over entire flight)	106.6 million	50%
All departures from EU (fuel burn over entire flight)	106.6 million	50%
All arrivals and departures from EU (fuel burn over entire flight)	213.2 million	100%

Table 5: Emissions coverage by each geographic region

Source: Frontier analysis using CE Delft (2005a)

It is beyond the scope of this report to consider the practical and legal difficulties of imposing such a scope. However, application of ETS to airports, who would then pass on the appropriate costs to airlines operating to those airports would seem to be a means of applying the scheme to all airlines using European airports. The figures in Table 5 however indicate starkly how much potential for CO_2 abatement would be lost if the Commission limits the scope of ETS to its narrowest geographic extent simply to avoid the difficulties of imposing a more effective and comprehensive scheme.

How should all the effects of climate change be captured?

The use of a multiplier to capture wider climate change effects is not recommended because recent EU-funded research[51] finds that the science is not well enough understood to develop a correct multiplier and the multiplier would not guarantee reductions in wider climate change effects when abatement is more cost effective in other sectors – leading to the choice of a CO_2 only measurement.

51 Forster, P M. de F., Shine, K P., Stuber, N (2006) *"It is premature to include non-CO2 effects of aviation in emission trading schemes"*. Funded by a NERC research fellowship and the European Union Framework 6 Integrated Project (QUANTIFY).

Which flights should be covered?

There has been some debate regarding a number of arbitrary ways in which aircraft sizes can be categorised for EU ETS and which sizes should or should not be included in the scheme.

These include range, number of passengers and weight. Aircraft sizes can also be distinguished by whether they follow instrument flight rules (IFR) or visual flight rules (VFR). IFR applies to normal passenger and freight aircraft and VFR applies to smaller short distance flights with small aircraft.

The feasibility study[52] suggests that the EU ETS should apply to all commercial IFR flights regardless of aircraft size or the nature of the service (passenger or freight) being undertaken. Including VFR flights would add administrative cost with very small benefits in terms of reductions to emissions. In our view this approach seems sensible.

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52 CE Delft (2005a).

4 Allocating allowances

In this section we discuss the importance of the method by which allowances would be allocated to aviation under the ETS.

Our review is divided into two parts. First, the determination of the total quantity of allowances that are allocated to the aviation sector were it to join the EU ETS has consequences for the overall price of allowances, not just for aviation but for all sectors falling within the trading scheme. There are far too many uncertain variables that will affect the price of allowances over the years relevant to phases 2 (and possibly 3) to make a meaningful forecast of allowance prices. However, we highlight the key factors and sensitivities that would determine that impact with the intention of identifying research that should be undertaken before the total quantity of allowances allocated to aviation is finally settled.

Secondly, we look in more detail at relevant issues in the allocation process for aviation. Among the issues we identify are:

- The process of allocating allowances requires a clear definition of the "installation" that would attract allowances. The definition of this "installation" presents particular problems in the context of aviation given its growth rate and the dynamic nature of competition.
- The allocation of allowances within aviation would have potential consequences for the behaviour of the sector prior to the introduction of the scheme. In particular, the incentive for operators to reduce emissions in the run up to emissions trading may be reduced if operators perceive that early savings could reduce their initial allowance allocation.
- The process of initial allowance allocation and the allocation of allowances to new aircraft (or operators) over the course of the phase could have a material impact on the dynamics of competition between airlines by altering the cost base of airlines operating with aircraft receiving differential treatment under the ETS.

4.1 DETERMINING THE QUANTITY OF ALLOWANCES FOR THE AVIATION SECTOR

KEY POINTS

- *The main influences on the price of allowances:* The price of allowances have risen considerably since the start of the EU ETS and indications are that it could rise further during phase 2, although forecasting prices is extremely difficult. In the future, the key drivers of price are likely to be:
  - the marginal cost of abatement;
  - economic growth;
  - the price of other commodities; and
  - options available for abatement and the shape of the abatement curve.
- *How adding aviation would affect overall allowance prices:* Adding aviation to the EU ETS would effect the supply/demand balance for allowances. The change in demand for allowances would be determined by the design of the scheme for aviation (discussed earlier). In determining the quantity of allowances for the aviation sector consideration should be given to the fact that aviation is a significant generator of absolute and relative economic benefit.
- Changing the demand/supply balance in relation to aviation would alter the price of allowances across the EU ETS. Policy makers should pay attention to the following when determining allocation to the aviation sector:
  - the likely impact of allowance volumes on the rate of increase in allowance prices over time and on the stability of the resulting price;
  - the technical ability of each sector (including aviation) to react to this price signal by adopting cleaner technology;
  - the economic consequences on each sector in terms of their ability to pass through the increased costs of ETS and the consequences for the level of demand in each sector and financial strength of the operators in each sector; and
  - the wider impact on the EU economy of these factors through the effect which the above factors would have on the GVA created directly and indirectly by each of the affected sectors.

Ultimately the price of ETS allowances will be driven by the interaction of the demand and supply of allowances. Recent reports (e.g. CE Delft (2005), ICF (2006)) assume allowance prices in the future that lower than the current price at which allowances are traded. There are reasons to believe that these projections do not pay sufficient attention to the possibility that allowance prices could rise significantly in real terms and indeed may need to if sufficient abatement activity is to be promoted to achieve Kyoto targets.

At the time of writing (March 2006) the price of allowances in the EU ETS is standing at approximately €27 per tonne of CO_2. We have estimated above (in section 3.2.1) that the immediate increment in costs to an airline for an average flight in Europe would be approximately €285.

Forecasting the long-run price level within the ETS is extremely difficult, as it is dependent on many different factors, some determined by policy makers, some by broader external economic factors. Moreover, the actual market price at any point in time could fluctuate significantly around the long-run trend because of short-run differences between supply and demand and because of uncertainty and changes in market expectations.

Since trading in allowances began at the start of 2005, the price of allowances has increased significantly. There was substantial uncertainty before the scheme began as to what the price of allowances would be. In part, this was due to uncertainties inherent in the scheme. For example, the quantity of allowances is set individually by each Member State through a fragmented process reliant on the European Commission approving individual national allocation plans (NAPs) for each Member state. Until all NAPs have been published and approved by the Commission, it is difficult to forecast with accuracy the aggregate number of allowances that would be issued.

In fact, the distribution of allowances was not finalised until well into 2005 when the scheme had been up and running for several months. Consequently, the price of a permit fluctuated during the early part of 2005; starting below € 10 per tonne of carbon dioxide and reaching a peak of € 29.10 in July (see Figure 13). It has been fairly stable since then, trading in a range of € 20 – 27 per tonne of CO_2. Indeed some degree on uncertainty over the final level of allowances remains. For instance in February 2006 the Commission rejected the UK's attempt to increase the size of its Phase 1 NAP allocation by 20m tonnes CO_2.

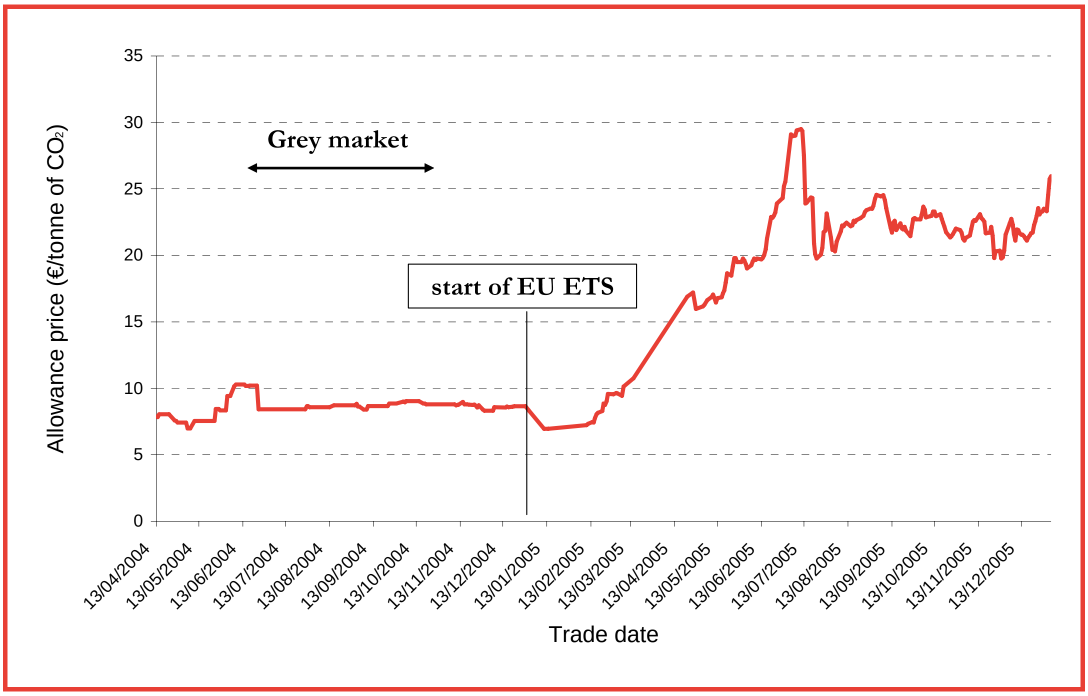

Figure 13: Price of 2006 EU allowances

Source: Spectron

The step change in prices since the start of the EU ETS can be explained as follows. Although national governments require agreement from the European Commission, permitting them to decide their NAPs individually created perverse incentives. Giving domestic firms a generous allocation provides national firms with a valuable tradable resource, yet all governments are able to play this game with negative consequences for the overall level of abatement in the EU. This may have led to an initial perception of an oversupply of allowances in Phase 1. This perception is likely to have driven, to some degree, the low prices observed during the initial period of grey market trading, when draft NAPs were being published. The subsequent increase in permit price is likely to have reflected the perception that the aggregate allocation of allowances would be smaller than had been anticipated, following the Commission requiring certain Member States to reduce the number of allowances included in their draft plans.

As the market for ETS allowances is very new (allowances have only been trading for 13 months) it is arguable that the market has not yet matured and so the path of allowance prices may not by indicative of the long run trend. However, it is equally difficult to assert, without supporting evidence and in advance of decisions regarding the quantity of new allowances to be created, that the long run price of CO_2 allowances will fall significantly from its current level.

In addition, it remains to be seen how the price of allowances develops as Phase 1 nears its end and the final balance for emissions for 2005-07 compared to the total allowance allocation becomes clearer.

If ETS is to be effective in constraining CO_2 emissions, we would expect that the interaction of economic growth with fixed or declining limits on CO_2 emissions would lead to an upward trend in the real price of CO_2 allowances over time.

We think it is crucial therefore that all the factors affecting these trends are properly analysed and the economic consequences of the decisions taken are fully investigated.

4.1.1 The main influences on the price of ETS allowances

EU ETS allowances have a single price across the EU. Like other freely-traded goods, the price of allowances is determined by the balance between supply and demand.

Under Phase 1 of the EU ETS, each firm has been provided with an initial, free allocation of allowances per year. The number of allowances allocated to each firm is decided by the government of each member state, subject to the agreement of the European Commission (EC). Decisions for each country are published in a National Allocation Plan (NAP). This framework for allowance allocation was set out in European Directive 2003/87/EC.

The total supply is the total number of allowances set out in all the NAPs. Supply of NAPs can only vary if the total number of allowances across all the NAPs is increased or decreased (with these changes being approved by the Commission).

The EU ETS is also designed to work within the Kyoto protocol framework. In certain circumstances firms would be able to gain credit for emissions reductions they undertake in other countries. In countries that have signed the Kyoto Protocol, firms can complete pollution reducing projects and substitute the emission reductions carried out for allowances in the EU using the Kyoto Joint Implementation/Clean Development Mechanism (JI/CDM). In other countries, certified emissions reductions can be counted towards a firm's target by using the Clean Development Mechanism, also permitted under the Kyoto Protocol. In both cases, the emissions reductions count towards the target of the country in which the firm is buying the allowances, not the country in which the emissions reduction takes place. In both cases, the justification is the same as that underlying any emissions trading scheme: carbon abatement should be done at least cost, wherever in the world that happens to be.

These mechanisms may have important consequences for the price of EU ETS allowances in Phase 2. Whether firms in the EU ETS take advantage of allowances using other Kyoto mechanisms will depend on the price of EU allowances, the regulatory hurdles presented by the host country and the level of limits placed by Member States on the number of allowances that can be added via these schemes. Reports such as ICF (2006), which find that the inclusion of aviation would have little effect on the price of EU ETS allowances, assume access to substantial (possibly unlimited) allowances from other Kyoto mechanisms. This assumption is, as yet, untested.

Overall the price of allowances will be determined by the interaction between the supply of allowances set out in the NAPs and the demand for EU ETS allowances, which is driven by a number of factors. These include the following:

- *The marginal cost of abatement.* The (allowance price) market outcome represents a costing and aggregation of the range of possible types of abatement across all 25 countries, across all the sectors covered by the EU ETS and in other Kyoto Protocol countries with which allowances could be exchanged. Demand varies as the cost of abatement for the different sectors included in the EU ETS increases or decreases. Firms operating in any one sector have the option to use up allowances or abate their output of CO_2. As described above, if ETS is working effectively we would expect each participating sector to engage in such abatement activity as can be achieved at less cost than the market price of allowances and the market price ultimately to be determined by the cost of the marginal abatement activity across the participating sectors as a whole. Some reports (e.g. Trucost 2005) suggest that average abatement costs across the EU could be €40 per tonne CO_2. If this is the case then it is quite feasible to envisage allowance prices rising to such a level, if not higher, during future phases of the ETS.
- *Economic growth.* If demand for CO_2-emitting products and activities increases then, other things being equal, more carbon emissions will be required, leading to a higher demand for allowances. Given a fixed supply of allowances, economic growth in general can be expected to raise allowance prices and faster economic growth will raise prices more quickly.
- *The price of other commodities.* Oil and gas prices fluctuate considerably and are hard to predict but can impact on the price of ETS allowances. For example, an increase in the price of oil and gas (as has occurred in recent years) leads to a substitution away from gas and to coal for electricity generation which in turn leads to a higher demand for allowances and hence drives up allowance prices.
- *Abatement options and shape of the abatement curve.* The shape of the demand curve for allowances will be determined by the marginal cost of abatement. The slope will depend on the scale of the available abatement options at that particular cost. If there are many options the curve will be flat and the price of ETS allowances will be relatively insensitive to fluctuations to the level of supply of allowances. If on the other hand abatement options are very limited then the slope of the abatement cost curve will be steep and the market price will be highly sensitive (and will change rapidly) with changes in the volume of allowances provided by the scheme. Figure 14 provides an illustration of the demand for and supply of allowances and how their intersection helps determine the price of allowances.

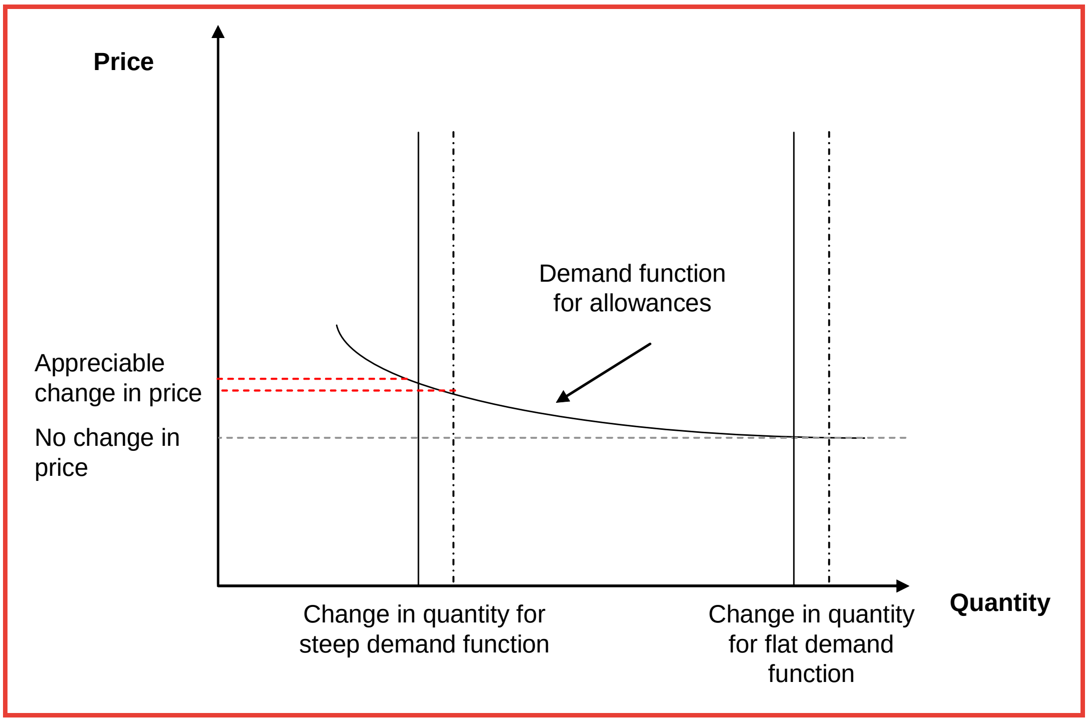

Figure 14: Illustration of impact of shape of demand function on change in price of allowances

The large number of influential factors makes the future price of carbon allowances impossible to forecast with any degree of certainty. Understanding the shape of the abatement cost curve is vital, while loose NAPs or the supply of large numbers of allowances from other Kyoto mechanisms (i.e. JI/CDM) could dampen price rises. The current debate appears to take these important issues for granted. An accurate estimate of the position and slope of the abatement cost curve is needed, as is a debate regarding the determination of NAPs and the tradability of abatement options from other Kyoto Protocol countries.

4.1.2 How adding aviation would affect overall allowance prices

Including aviation in the EU ETS would potentially affect the EU ETS by changing the supply/ demand balance for allowances. If both the supply and demand for allowances increases equivalently, the overall price of allowances would be approximately unchanged from a scheme without the aviation sector. However, this outcome is unlikely.

The exact demand for allowances would depend on the qualifying participants, the geographic scope for the scheme, the measure used to determine emissions and what they are required to submit to emit 1 tonne of CO_2. These issues were discussed in the previous section of this report.

As discussed earlier, the supply of allowances should be determined by the Commission. However, in determining the quantity of allowances for the aviation sector, the relationship between the total volume of allowances and the likely growth in the aviation sector needs to be considered. While aviation may be growing strongly off a small base of CO_2 emissions, we have shown that the sector is a significant generator of economic benefits[53]. For aviation to be treated in an even handed way compared to other sectors included in ETS these issues need to be debated. The principles for the allowance allocation to aviation would need to be established.

This is not to argue that ETS allowances should be sufficient to cover unconstrained growth in output (and hence CO_2 emissions). However, it is inappropriate for policy makers to determine the total allocation of emissions allowances without paying full regard to the following consequences:

- the likely impact of the volume of allowances on the rate of increase in allowance prices over time and on the stability of the resulting price to fluctuations in demand and supply conditions and to other economic shocks;
- the technical ability of each sector (including aviation) to react to this price signal by adopting cleaner technology;
- the economic consequences on each sector in terms of their ability to pass through the increased costs of ETS and the consequences for the level of demand in each sector and financial strength of the operators in each sector; and
- the wider impact on the EU economy of these factors through the effect which the above factors will have on the GVA created directly and indirectly by each of the affected sectors. In this regard it is important to also consider the extent to which different sectors (including aviation) are able to absorb the cost increases implied by imposing ETS and the impact which this may have on the demand for their services.

53 Both absolutely and per tonne of CO_2 produced.

4.2 ALLOCATING ETS ALLOWANCES

KEY POINTS

- No specific proposal has been put forward to date for how allocations would be determined for aviation. The key areas that need to be determined urgently include: (1) the definition of the "installation"; (2) the method of allocating allowances to aviation; and (3) the impact of the allocation process on competition between airlines.
- Defining the aircraft as an installation does not appear to be a workable solution. There is a need to investigate this issue in detail and to consider alternative definitions of the installation. The most obvious definition would be the operator of the passenger or freight services, but this creates significant issues in terms of creating competitive distortions between airlines. For this reason the option of allocating allowances to airports should at least be considered.
- Consistency of treatment with other sectors suggests that aviation should receive free allocations. Grandfathering of allowances based on historic CO_2 emissions is unacceptable as a method for allocating allowances because it discourages abatement before ETS is introduced and rewards operators that have done less to reduce emissions.
- The solution is to allocate allowances based on industry averages or a pre-determined standard based on industry best practice. RTKs may form an acceptable basis for allocation, although some issues still remain.
- However, the allocation of allowances can affect competition between airlines depending on:
    - how an allocation is made to existing installations/operators and how it is made to "new entrants"; and
    - how different Member States allocate allowances between carriers.
- Attention needs to be given to dynamic processes for allocating allowances that treats growing and static (or declining) airlines in an equitable way. Defining the installation as an airport rather than an airline may avoid many of these problems.
- In order to avoid distortion of competition between operators based in different Member States it is necessary that each Member State applies identical allocation rules (including the relationship of total allocation to projected need). This requirement points towards the need for harmonised rules and administration through a centralised process at Community level.

In this section we consider the process of allocating allowances between firms operating in the EU ETS and particularly the implications of different allocation processes for the aviation sector.

Allocating allowances

In principle, regardless of the allocation process for allowances, all firms covered by the EU ETS would face the same marginal costs of CO_2 emission. However, alternative allocation mechanisms can have an impact on participants in the EU ETS on two levels.

First, the allocation process may itself distort the decisions of participants in the run-up to the introduction of ETS so as to manipulate their initial allocation of emissions allowances. Secondly, the allowance mechanism may create distortions between different airlines based in different EU countries or between airlines operating in different geographic markets or between airlines following different business models (such as the LFAs in comparison to the FSAs).

The primary policy question regarding the establishment of an emissions trading scheme is to decide whether the allowances created under the scheme would be sold to the participants by the regulating body or would be endowed to them according to some pre-determined set of rules. The choice of whether to sell or allocate allowances and the basis on which an allocation would be performed imply significant transfers of value between government and the firms participating in the ETS.

4.2.1 Approach to allocation adopted in Phase 1

Under Phase 1, allowances have been allocated to existing market participants, rather than auctioned. Member States allocate allowances to fixed installations such as combustion plants – irrespective of who owns them. By way of illustration, the UK NAP includes 123 power stations[54]. The total annual allocation to these power stations amounts to approx. 130 million allowances per year which reflects about 53% of the total annual number of allowances to be allocated to installations in the UK.

The UK allocates allowances to installations in two stages. In the first stage, the total number of allowances is allocated to each sector. In the second stage, allocations are then made to individual installations in the sectors.

On average, in Phase 1, the UK allocated allowances to sectors that were equivalent to their projected emissions for the period[55]. However, the power sector was allocated fewer allowances than its projected needs[56]. Figure 15 shows the allocations to sectors in the UK relative to their emissions in 2003.

54 UK NAP.

55 In determining the allocation of allowances at activity level, the UK has used provisional updates of CO_2 emissions projections from the DTI's updated Energy Projections (UEP). The UEP projections are calibrated with historic data and model emissions on a 5 yearly basis (for the years 2005 and 2010) for individual sectors.

56 For more detailed information see Defra (2005) EU Emissions Trading Scheme - Approved National Allocation Plan, May 2005.

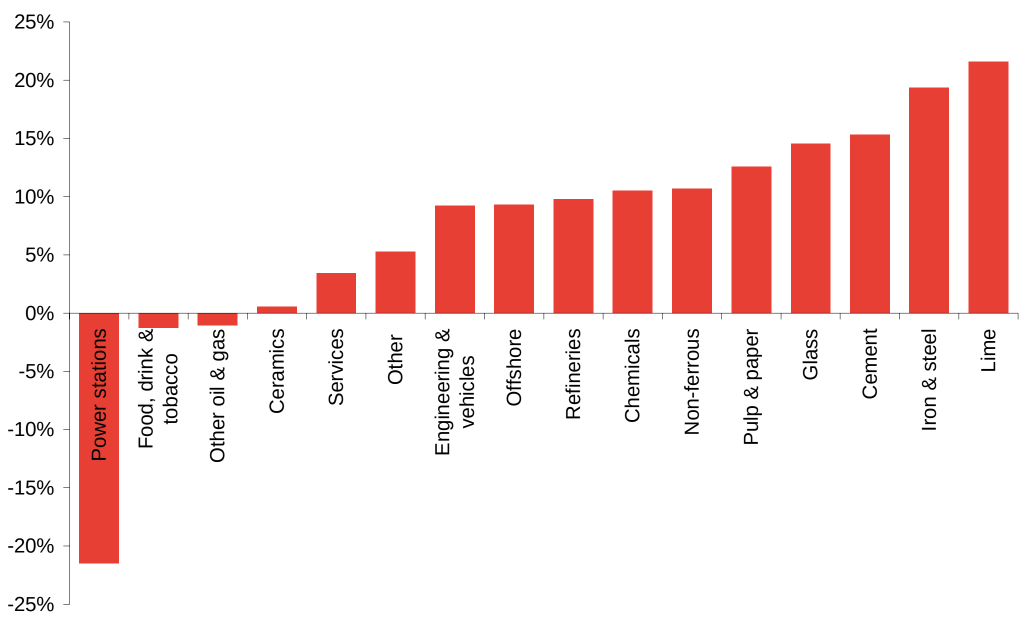

Figure 15: Percentage difference between actual sector emissions in 2003 and annual NAP allocations

Source: UK NAP

A new installation is eligible for allowances from what is known as the new entrant reserve. The new entrant reserve is a nominated quantity of allowances that the Member State holds back from allocation at the beginning of the phase. A firm that already owns several qualifying installations (and therefore has already been allocated several allowances) can obtain further allocations when it commissions a new qualifying installation during a phase. Unlike the initial allocation, many (but not all) member States have used an auction process to allocate allowances from the new entrant reserve.

4.2.2 Allocating allowances to aviation

At the time of writing there is no specific proposal as to how EU ETS allowances would be allocated to the aviation sector. Without such a proposal, however, it is impossible to evaluate the impact that the ETS would have on the aviation sector and how effective it is likely to be in promoting efficient abatement activity on the part of airlines. We have identified three key areas that need urgent consideration before the application of ETS to aviation can be fully evaluated. These areas are:

- the definition of the "installation" in aviation;
- the method of allocating allowances to aviation; and
- the impact of the allocation process on competition between airlines.

We discuss each of these issues below and draw preliminary conclusions for the design of ETS for the aviation sector.

Defining the "installation" for aviation

In Phase 1 "installations", which attract CO_2 allowances, have been defined as physical plant with a capacity to generate carbon emissions. In light of this it has been stated that the relevant installation to be used for aviation should be the individual aircraft. This means that under the rules of the ETS, each aircraft would have to have a greenhouse gas emissions trading permit (effectively a licence to operate and to emit carbon dioxide) and each aircraft would receive an allocation of allowances.

The approach of attaching allowances to individual generators of CO_2 may work in sectors such as power generation, where the number of "installations" is small and does not change significantly from year to year. Taking the same approach to aviation, however, presents a major challenge because of the number of aircraft involved, the rate of growth of the sector and the dynamic way in which new aircraft are introduced to replace older less efficient craft.

Defining the relevant installation as the aircraft presents significant practical difficulties compared to the situation with the existing ETS.

- In many cases the ownership and operation of aircraft are separate, with airlines operating aircraft under leases, many of them short term. Granting allowances to the aircraft owners would create the significant complexity of separating allocations (and the obligation to present allowances in exchange for CO_2 emitted) from the organisation (the airline) that is actually in a position to affect emissions levels.

  While contracts between lease companies and airlines could be structured so as to pass on the correct incentives, the ability to do so is untested and depends, among other things on the intensity of competition in the aviation leasing market.

- Whereas a power station's location is fixed and all of its CO_2 emissions are covered by the EU ETS, an aircraft's location is not. Apportioning allocations to aircraft based on their specific geographic scope of operation could distort the way in which different operators organise their fleets before and after the introduction of ETS to manipulate allocation rules in their favour. The scope to do so may also be greater for operators with wider geographic networks, leading to a distortion between airlines with different geographic footprints.

- If the installation in aviation were to be defined as the aircraft there would be many more such installations than is the case in, for instance, power generation. By way of example, the UK has 123 power stations covered by ETS[57], while there are around 1,000 passenger and freight aircraft registered in the UK[58] and a large quantity more flying in and out of the UK.

57 UK NAP.

58 UK Civil Aviation Authority.

Furthermore, the rate of turnover of installations in the power sector is very slow. By contrast a database of EU airline fleets suggests that approximately 30% of aircraft are 5 years old or less[59]. For the most part new aircraft that are added to the European fleet will tend to be more fuel efficient than the fleet average and certainly more efficient than older aircraft being retired. If ETS is to be successful in increasing abatement activity within aviation it would need to encourage (other things being equal) the replacement of older less fuel efficient aircraft with newer more efficient models. Given the extent of turnover and replacement of aircraft, if the installation is to be defined as an aircraft it would be necessary to define the initial allocation of allowances and the allocation from the new entrant reserve in such a way that provides at least as favourable a treatment for new aircraft as for existing aircraft. This would be impossible if allowances for existing aircraft are allocated for free while allowances for new aircraft had to be acquired through an auction process.

- Drawing a distinction between aircraft that have historically been operated within the ETS zone and those that have not, could reduce the liquidity of the aircraft (leasing) market. After an initial ETS allocation, two identical aircraft, one that has been operating within the ETS zone and therefore has an allocation and one which has not and therefore has no allocation would cease to be of equal value to ETS zone airlines, even though they have identical characteristics in terms of carbon emissions.

- This problem is exacerbated when we consider the fact that under existing ETS rules, allocations are granted to each installation from the NAP of the relevant Member State. If the allocation for an aircraft is granted by one Member State, what would happen if that aircraft is sold (leased to) an operator acting in a different State? Could airlines operating multiple hubs in different EU States gain or lose allowances by moving individual aircraft between different routes on their network within the EU?

- Finally, there would be a need to address the treatment of allocations granted to aircraft that are taken out of operation (or sold/leased to airlines operating outside the EU ETS). Would these allocations be transferable to replacement aircraft or would they be lost to the operator?

For these reasons defining the installation as an aircraft for EU ETS does not appear to be a workable solution.

Proper consideration should be given to defining the installation for aviation in alternative ways. The immediate alternative definition for the installation would be the operator of passenger or freight services, as the organisations with direct control over a significant proportion of aviation abatement opportunities. These organisations make the operational and commercial decisions that determine the carbon emissions from aviation. This solution avoids the complex issue of how the aircraft leasing industry interacts with airlines to share the impact of EU ETS, avoids the complexity of forecasting the geographical locus of operation of each

59 Airbus.

individual aircraft and avoids the complexity of allocating and reallocating allowances as individual aircraft enter or leave the fleet. An allocation mechanism based on operators could send efficient signals, although there remain significant issues relating to the national allocation of allowances, given the international nature of airline competition. We outline below (in Section 5) the issues that could be created in terms of competition between airlines if airlines are treated as the relevant installation.

As noted above, an alternative worth consideration is to treat *airports* as the relevant installation, placing on the airport operator the obligation to present allowances for emissions relating to relevant arrivals and departures.

The first virtue of this proposal is that airports are fewer in number, not mobile and more slowly changing than airlines. Hence the model applied to power generating plant in Phase 1 of the EU ETS is more directly applicable to airports than to airlines.

Airports would have to be allocated allowances on some basis related to the CO_2 production of relevant flights using that airport (in which case the arguments favouring benchmarking over grandfathering set out below apply equally to airports as to airlines). The airport would then need to submit allowances relating to the fuel burn of all relevant flights using that airport.

This alternative could possibly have the virtue of avoiding some of the discrimination between incumbent carriers and new entrants identified in Section 5 below. However, consideration would have to be given to the way of passing on this incentive to airlines in airport charges in such a way as to reward efficient behaviour and induce continual reductions in emissions.

If this approach were to be followed consideration would have to be given to other detailed issues, such as how the correct coverage of ETS would be achieved. Clearly intra-EU flights can be completely covered by measuring the fuel consumption of arrivals only, as could the total impact of flights *arriving* at EU ETS airports from outside the EU. However, the treatment of flights departing the EU would need to be addressed.

The method of allocating allowances

Consistency with treatment in other sectors would suggest that the aviation sector should receive free allocations of allowances, taking into account the potential for abatement after allowing for growth and the economic benefits created by aviation.

The two main ways in which allowances can be allocated to existing participants can be categorised as:

- grandfathering based awarding of allowances based on the participant's historic emissions; and
- benchmarking based on awarding allowances relative to some estimate of average or efficient emissions.

Grandfathering

The first option is relatively straightforward to implement. A period of time is designated as the relevant one for measuring historic emissions. The CO_2 emissions for each installation are measured for that period and allocations under the ETS set in proportion to these historic emissions.

However, grandfathering is clearly unacceptable as a method for allocating allowances for several reasons. In particular, if airlines obtained allowances in proportion to their actual carbon emissions they would have an incentive (other things being equal) to reduce their abatement efforts in order to acquire a larger ETS allocation. Furthermore, grandfathering provides more allowances to those airlines operating less efficient aircraft and hence rewards operators that have done less to improve the environmental performance of their fleet prior to the start of ETS. Such an outcome would be doubly unjust. Not only would it provide financial reward to operators that have taken fewest steps to mitigate the environmental impact of their activities, but also in many cases the immediate options for emissions reduction may be greater for these carriers, so that even if their level of activity remains constant they are more likely to be a net seller of allowances.

Benchmarking

The solution to these problems is to decouple the allocation of allowances from the specific emissions of individual participants. Instead of using actual emissions, figures based on industry averages or hypothetical best practice can be used to allocate allowances. Under this option, each individual participant cannot materially affect their allowance allocation by their own actions, but has an incentive to reduce emissions (for a given level of output) before ETS is even introduced, because by outperforming the benchmark used for allocating allowances the firm can put itself in the position of being a net seller of allowances once ETS commences.

A benchmarking approach would help:

- reduce carbon emissions *before* the introduction of ETS; and
- favour airlines with cleaner aircraft and those producing less CO_2 per passenger kilometre because they are operating at higher load factors

An allocation based on revenue tonne kilometres (RTKs) may lead to incentives to meet the goal set out above:

- *Increased incentives for early action:* First, by using a global average benchmark rather than actual emissions each airline has an increased incentive to reduce emissions before the start of ETS to maximise their surplus of allowances and to be a net seller[60]. Making the benchmark non-specific to aircraft type means that operators of older less efficient aircraft have a strengthened incentive to replace these with newer models as this does not affect their ETS

[60] In practice of course not all airlines will achieve this but they will all have the additional incentive to strive to reduce emissions.

allocation. When the allocation is made, operators with less clean fleets (than average) would be allocated relatively fewer allowances (compared to their actual emissions) than operators of newer more efficient fleets.

- *Increased incentives for higher load factors:* The fact that the benchmark is based on averages means that operators are rewarded for having high load factors and can make further gains by improving load factors and thus reducing emissions per RTK. Operators with below average load factors would be allocated relatively fewer allowances (compared to their actual emissions) but can establish parity with their rivals by subsequently improving aircraft utilisation.
- *No distortion between freight and passenger flights:* However, a refinement that needs to be considered to the RTK approach is to evaluate whether separate weightings are required for freight and passenger RTKs. For an aircraft can carry a greater weight of freight than passengers (on average) then freight carriers would be allocated more allowances per tonne of CO_2 currently emitted than passenger airlines. One possible solution might be to allocate allowances between passenger and freight (in total) in proportion to total kilometres, and then within each segment in proportion to an appropriate metric such as revenue tonne kilometres (RTKs) for passengers or available tonne kilometres for freight.

Furthermore, even under a benchmarking approach there remains a problem of allocating allowances to airlines based on a historic baseline of services when this baseline is some time in the past and airlines are growing at differential rates. Such an approach would always disadvantage the growing airline over the airline in steady state or decline, as the growing airline would receive fewer allowances relative to the current scale of its operations.

The impact of the allowance allocation process on competition between airlines

The preceding discussion is framed in terms of the initial allocation of ETS allowances, because the focus has been on avoiding distortions to airline behaviour *prior* to the introduction of ETS.

However the method of allocating allowances is equally important in a dynamic sense in considering how competition develops between airlines over time. In this regard the important distinctions are between:

- how an allocation is made to existing installations/operators and how it is made to "new entrants"; and
- how different Member States allocate allowances between carriers.

Assuming that airlines are defined as the relevant ETS installation, a new entrant in aviation would be any operator, aircraft or service that is introduced after the initial allocation process. Given the fast growth of aviation and the dynamic nature of competition in the sector the comparative treatment of new entrants and incumbents is clearly very important in determining the competitive impact of ETS.

Under Phase 1, the majority of allowances have been allocated to incumbent firms according to rules set down in each Member State's NAP, while a proportion of allowances have been held back in a "new entrant reserve". The Directive sets out how the new entrant reserve can be used. There is, however, some scope for variation in application across Member States. A comparison of NAPs for Phase 1 shows that the proportion of allocations reserved for new entrants and future sector growth ranges from about 1% of total allowances (Germany, Austria and Poland) to more than 10% of total allowances (Netherlands and Luxembourg). Most Member States are not specific about the sector to which the allowances can be allocated and have set out an auction mechanism for allocation in most cases.

The potential competitive impact of EU ETS on airlines is discussed in more detail in Section 5 below. This impact covers both the effect of raising the marginal cost of air travel by placing a cost on CO_2 emissions *and* the allocation process between airlines.

We find that the impact of the allocation process on competition between airlines is complex. But in our view if new entrants and incumbents are treated differently with respect to allowances then this could distort competition between airlines in a number of ways. In particular, by allocating allowances to incumbents while forcing new entrants (including new services) to purchase allowances, a cost advantage is provided to incumbents that would advantage them relative to the new entrants.

Assuming allowances are allocated to aircraft operators then airlines introducing new services and with faster rates of growth would be competitively disadvantaged (through having a higher cost base overall) relative to incumbent airlines with stable or even declining services. The asymmetric treatment of incumbents and new entrants would dampen competition between airlines in general, because new players seeking to compete with existing ones would be at a relative disadvantage.[61]

Furthermore, given that the dynamic growth in European aviation is largely within the low fares segment, asymmetric treatment of existing and new services would tend to be to the competitive disadvantage of the LFAs. We have shown earlier that LFAs tend to operate newer and more efficient aircraft and have higher load factors, which means lower carbon emissions per passenger kilometre (or per RTK). Discriminating in the allocation between incumbent and new entrant services would thus tend to disadvantage those services that are on average the least polluting.[62]

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61 This distortion would be even greater if aircraft rather than operators were the unit to which allocations were made, as this would also discriminate against the replacement of older aircraft with newer more efficient ones.

62 As a principle, we would argue that there is no reason to discriminate against growing airlines. While recognising that the overall growth in aviation represents an environmental challenge, at any point in time all active operators contribute to that problem (as total of under c. 4% of EU emissions) in proportion to their emissions. Furthermore, insofar as new operators are *replacing* incumbent ones and doing so with cleaner aircraft, it is clear that the latter should not be protected to any extent by an ETS allowance allocation process.

Considering the alternative proposal of defining the installation as an airport, raises the possibility of avoiding much of the difficulty of discrimination between new and existing airline services, because the cost to the airport of an additional movement should depend on the CO_2 emissions related to that movement, not on whether that movement is an "existing" or a "new" service. This seems to be a considerable merit of relating ETS to airports rather than airlines.

In our view it is important that attention is given, as a matter of urgency, to developing dynamic processes of allocating ETS allowances that cannot be distorted by polluting behaviour but treat new entrants and incumbents (including growing and static or declining airlines) on an equitable basis.

However, none of these considerations address the competitive distortions that could be created between airlines if Member States allocate their allowances in different ways, or do not allocate on an equally timely basis[63]. Distortion would occur if Member States allocate different total quantities of allowances to the airline sector compared to its projected emissions, use different rules to allocate between airlines or reserve different proportions of allowances for the new entrant reserve (assuming the existing asymmetric treatment).

None of these problems can be adequately addressed through the existing mechanism of allocating allowances to different firms through the NAPs of Member States. In order to avoid distortion of competition between operators based in different Member States it is necessary that each Member State applies identical allocation rules (including the relationship of total allocation to projected need). This requirement points towards the need for harmonised rules and administration through a centralised process at Community level [64].

63 Noting the delays in finalising the Phase 1 NAPs.

64 And, by extension, any other sector in the ETS in which competition occurs at the pan-European level.

5 Impact of EU ETS on the airline sector and competition between airlines

The EU ETS may have a significant financial impact on airlines, although the nature and magnitude of this effect would depend on precisely how the scheme is designed and implemented. There have been a number of efforts to analyse this impact including CE Delft (2005c), Oxera (2003) and Trucost (2004)[65].

However, these reports typically assume:

- a low range of allowance price movements; and
- full cost pass through of ETS in *all* instances.

As we have noted, we do not share the view that the current ETS price (c. €27 per tonne of CO_2) is an aberration and that long-run prices will be significantly lower than that level. In our view it is equally possible that long run prices may be as high or higher (and increasing) in the long term.

In addition, we think the assumption that increases in marginal costs would simply be passed on in higher ticket prices cannot be relied upon. The overall impact of ETS on ticket prices is complex and hard to predict, as we outline below.

In particular, the existing reports have considered only the impact of increased marginal costs from ETS, whereas it is also necessary to take into account the impact of the allowance allocation mechanism. While it is clear that the increased marginal costs resulting from the application of the EU ETS would increase fares to some degree (other things being equal), would the allocation of allowances also have an impact on fares? In this regard we note that in the power generation sector wholesale prices have risen as a result of ETS but so have profits. It appears that generators have, to an extent, passed on the marginal costs of ETS to their customers *and* profited from their allocation of CO_2 allowances. The question is whether aviation might in fact be affected in the same way?

Finally, while ETS design issues may have an impact on the overall level of prices (and profits) in the aviation sector, it may also have a profound impact on the dynamics of competition between airlines. We also examine this aspect of ETS. In our view it is reasonable, indeed it is to be expected, that ETS might affect competition between airlines. But insofar as it does, it should do so along the dimension of environmental impact. That is, if ETS causes airlines with lower emissions to gain some competitive advantage then this is an aspect of ETS to be welcomed. If, however, some aspects of ETS favour certain airlines or classes of airlines for reasons outside of their environmental impact then this is inappropriate and reflects a failing of the ETS design.

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65 Trucost (2004) *Emissions trading and European Aviation – the effects of incorporating aviation into the EU Emission Trading Scheme.* March 2004.

In this section we consider the impact that EU ETS may have on fares in the aviation sector and hence the knock-on impact on airlines and competition.

This impact can be divided into two parts:

- the impact of increased marginal costs resulting from putting a price on CO_2 emissions; and
- the impact of the allowance allocation mechanism of the market structure and competitive process.

To answer the long term questions completely requires a formal economic model of the way competition works between airlines. This is outside the scope of this report. Nevertheless, we believe that the fundamental drivers of this competition are clear and the potential impacts can be discussed in this context.

Paying particular attention to the way in which design decisions for EU ETS may affect the competitive outcomes, in particular:

- the relevance of the geographic scope of ETS to inter-airline competition;
- how the process of allocation vs. auctioning of allowances would impact on competition between growing and static airlines; and
- whether different airline business models may be more or less favoured by EU ETS.

5.1 THE EFFECT OF EU ETS ON AIRLINE MARGINAL COSTS

KEY POINTS

- Assuming that the additional marginal cost of the EU ETS is faced by all airlines, the impact of EU ETS on prices in general and in any particular market would in practice depend on the elasticity of demand (and supply) in the relevant market.
- Furthermore, the (average) price of an airline ticket has to cover more than just the incremental cost of moving an additional passenger in order to make a contribution to fixed costs. Hence, even if ETS were fully passed through in higher prices airlines would experience a fall in operating margins.
- The financial impact of ETS on LFAs will be much more severe than on FSAs because the demand for their services is much more sensitive to price. Our indicative analysis suggests that current allowance prices could lead to a reduction in demand of c. 7.5% to 12% for LFAs. By contrast an FSA would face reduction in demand of only c. 2% to 3%.
- These figures demonstrate that ETS has the potential to distort competition between FSAs and LFAs to the detriment of LFAs, despite their more efficient business model.

EU ETS places a marginal cost on all participants in the scheme that emit CO_2 due to the requirement to submit allowances. The marginal cost is therefore simply the price of allowances. This marginal cost applies to all operators regardless of whether the operator is holding freely allocated allowances or whether it has to buy allowances to meet its obligations.

Recent reports[66] written on the financial impact of ETS have tended to assume that the full cost of ETS would be passed on in higher ticket prices. It is worth examining this assumption to consider the short run and long run impact of an increase in marginal costs resulting from ETS.

We assume that it is obvious that within any one market *all* operators must be subject to the same ETS rules and therefore subject to the same marginal costs. This requires that no airline on any route affected by ETS is exempted due to its country of ownership (or the country of ownership of their aircraft) or any other arbitrary factor.

Given that both the demand and supply of aviation services would be price-sensitive it is in practice the case that not all of any increase in costs due to ETS would be passed through in higher prices (see Annexe 4 for a graphical

[66] Includes CE Delft (2005a).

illustration of this point). The impact of ETS on aviation prices in general and in any particular market would in practice depend on the elasticity of demand (and supply) in the relevant market.

However, even if it were the case that airlines were capable of passing through the whole of the increase in marginal costs in higher ticket prices, this would not neutralise the short run impact of ETS on aviation. The (average) price of an airline ticket has to cover more than just the incremental cost of moving an additional passenger[67] in order to make a contribution to fixed costs. Hence, even if ETS were fully passed through in higher prices airlines would experience a fall in operating margins. The greater the elasticity of demand faced by the airlines, the greater would be this impact on margins.[68]

The reports cited above make various assumptions regarding the elasticity of demand for air travel. In addition, Dresdner Kleinwort Wasserstein Research (2003)[69] and Government of Canada[70] have produced recent demand elasticity estimates. These are summarised in Table 6 below.

Study	Elasticity of demand
OXERA annual impact in period 2008-12	-0.8 (business) -1.5 (leisure)
CE DELFT impact in 2012	-0.2 to -1.0
TRUCOST impact in 2002	-1.0 to -1.5
DKWR	-0.5 to -1.4
Government of Canada	-0.7 to -1.5

Table 6: EU ETS impact on aviation

Source: CE Delft, Oxera, Trucost, Dresdner Kleinwort Wasserstein Research, Government of Canada

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67 And the incremental revenue from each aircraft has to exceed the incremental cost of moving the aircraft.

68 For the avoidance of doubt, we are referring to market elasticities here, which is the percentage amount that total market demand changes in response to a 1 per cent rise in prices by all participants. Airlines also face what we term "firm-specific" elasticities, which represent the percentage amount that the demand for one airline's services would change in response to a 1 per cent rise in prices by that airline alone. Clearly the firm specific elasticity would be expected to be much greater than the market elasticity. The more intense is competition between airlines on a given route the higher will be each airline's firm-specific price elasticity.

69 Dresdner Kleinwort Wasserstein Research (2003) *Aviation Emissions: Another Cost to Bear*, pp30-38.

70 Government of Canada, Department of Finance, http://www.fin.gc.ca/consultresp/Airtravel/airtravStdy_2e.html).

In the absence of estimates of the relevant supply elasticities it is not possible precisely to establish what proportion of the increase in costs due to ETS might be passed on in ticket prices in the short run.

However, the range of elasticities quoted in the studies indicates that the overall elasticity of demand may be well below 1 for the services provided by FSAs, while the elasticity of demand for the services of LFAs (including leisure travel) is likely to be well above 1.

This is significant because it suggests that the financial impact of ETS on LFAs would be much more severe than on FSAs.[71]

Our estimates presented above suggest that the cost of EU ETS for an average intra-EU flight would be c. €285 based on an allowance price of €27 per tonne CO_2. This equates to c. €2.72 per passenger[72], which is approximately a 5% increase on an average fare of c. €50. However, as we have discussed previously there is no reason to believe that long-run allowance prices must be at or below the current level. If allowance prices were to rise to €40 per tonne CO_2 (which corresponds to some views of the average marginal abatement cost for the EU) this would be equivalent to an increase of €4 on average per passenger or 8% on the average fare.

If the elasticity of LFAs demand is 1.5, then increases of this magnitude would lead to reductions in demand of 7.5% to 12%, implying a total reduction in revenues of c. 2.5% to 4% for LFAs. By contrast an FSA facing an elasticity of 0.8 would see a price increase of, for example, 2.5% to 4% on an illustrative fare of €100, which would lead to only a 2% to 3% reduction in demand, implying an *increase* in revenues of c. 0.5% to 0.8%.

These figures demonstrate that ETS has the potential to distort competition between FSAs and LFAs, because of the higher price elasticities faced by the low cost airlines.

An additional reason why FSAs would face lower price elasticities than their LFA rivals is their use of short-haul flights as feeder services for long-haul services from hub airports. These long-haul services have a higher proportion of business traffic and are much more strictly regulated in terms of rights to operate these services (especially on North Atlantic routes). As a consequence, the elasticity of demand faced by the FSA on these services is lower, prices are higher relative to incremental costs and so the FSA has a greater ability to pass through cost increases on these routes.[73]

Because FSAs use short-haul flights as feeder services for their long-haul routes many FSA passengers on these shorter routes may be quite insensitive to changes

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71 The significance of an elasticity of 1 is that below that level a rise in price results in an *increase* in revenues, because demand is not very price-sensitive. If the elasticity exceeds 1 a rise in price results in an *fall* in revenues, because demand is more price-sensitive.

72 Calculated for an Airbus 320 with 150 seats operating at 70% load factor.

73 This has been demonstrated by the ability of FSAs to pass through higher fuel surcharges on long distance flights as compared to short haul routes.

in the price of the feeder journey, because that leg represents only a proportion of the longer journey and because the cost of the feeder leg is only a small proportion of their total flight cost.

As a consequence, it is likely that the impact on FSAs' traffic volumes and profits from feeder legs falling within EU ETS would be less than the impact on the competing LFAs. This would be true notwithstanding the fact that the ticket price on the FSA of the feeder leg may be very similar to the ticket price charged by the LFA.

5.2 THE IMPACT OF ETS ALLOWANCES ON COMPETITION BETWEEN AIRLINES

KEY POINTS

- The allocation of ETS allowances can affect airline prices if the process of allocation has the effect of changing the fixed costs of existing and potential operators on any given route.
- Whether it does so depends on whether the allocation creates distortions by providing a targeted gain to existing operators or affects the cost base of all carriers, including both incumbents and new entrants. This in turn depends on whether the allocation process for allowances treats entrants and incumbents in an even handed manner.
- To avoid distorting the market it is essential that allowance allocation must treat incumbents and new entrants (including increased services from existing carriers) in an even-handed manner as possible. Ideally, this would be true both at the launch of the ETS Phase and on an on-going basis during the course of the Phase.
- Failure to do this would mean that operators that are static or in decline would be provided with a competitive advantage relative to their growing rivals. This is despite the fact that growing carriers would tend to acquire the cleanest, most efficient aircraft with lower emissions.

In perfectly competitive markets (i.e. text book examples) prices are determined by marginal costs, while fixed costs (which do not change with the quantity of output) have no impact on the level of prices that the firms in that market are able to charge.

However, if companies also have fixed costs then they need to charge prices above marginal cost in order to recover their fixed costs. If they are unable to do so they would make losses (or at least earn less than a commercial return on their investment) and would, in due course, choose to leave the market. But the ability of these firms to recover their fixed costs is based on the extent to which competition between firms reduces allowing appropriate mark-up over marginal cost.

Provided entry and exit to the market is sufficiently easy, it is possible for the market to establish a mechanism which broadly allows firms to recover their fixed costs and yet protects against the possibility of the persistent generation of losses or excess profits. If entry and exit is sufficiently easy, firms would react to the discovery of a market with weak competition and high profits by entering that market to try to gain a share of the excess returns. This process can continue until a normal competitive level of prices and profits is established. Similarly, if competition becomes so intense in a market that firms cannot recover their fixed costs (or marginal costs rise, given a particular intensity of competition that was previously maintaining normal profits) then some firms would choose to leave the market. This reduces the intensity of competition on the remaining firms, who are able to raise their prices somewhat until normal profits can be achieved.

The airline sector (in particular the deregulated airline sector where the right to fly between any pair of destinations is guaranteed and airport slots are readily available) has significant similarities with this model of competition.

With entry and exit controlling the level of profits, the level of fixed costs can affect the equilibrium level of prices and competition in the market. It follows from this that the allocation of ETS allowances can affect airline's prices if the process of allocation has the effect of changing the fixed costs of existing and potential operators on any given route.

Whether it does so depends on whether the allocation provides a targeted gain to existing operators or affects the cost base of all carriers, including both incumbents and new entrants. This in turn depends on whether the allocation process for allowances treats entrants and incumbents in an even handed manner.

If incumbents receive ETS allowances which are not available to new entrants, then the profit from these allowances would not attract new entry, because entrants would not enjoy the same advantages. Incumbents would therefore treat allowances as a targeted gain and would not pass any of the value through in lower prices. However, if incumbents and entrants were entitled to the same allowances then the cost base of both groups would be reduced, encouraging market entry which would reduce prices.

We conclude, therefore, that from the point of view of creating a level playing field for competition it is essential that allowance allocation must treat incumbents and entrants in as even-handed manner as possible. Ideally, this would be true both at the launch of the ETS Phase and on an on-going basis during the course of the Phase.

The effect of a discriminatory allocation of ETS allowances would give a windfall gain and/or competitive advantage to:

- operators that are not growing and so have a higher proportion of aircraft receiving ETS allowances; and
- operators that choose *not* to replace existing aircraft with newer more efficient aircraft.

Neither of these outcomes seems to be compatible with the objectives of environmental policy.

If an airline is growing relative to its rivals it is presumably doing so because it is offering a more compelling and more highly valued service to its customers. It would be wrong for the EU ETS allowance allocation to create distortions by positively favouring operators that are being demonstrably less successful than their rivals in the market.

Furthermore, it would be perverse if an ETS allocation process were adopted that actively discouraged airlines from replacing existing less fuel efficient aircraft with new more fuel efficient aircraft, because to do so would mean the loss of future ETS allocations by the operator. Yet an allocation process that provides more allowances to existing services than to new services has exactly that effect.

We note that many of the issues listed here could be avoided if airports, rather than airlines were designated as the installation for the purposes of ETS. However, detailed thought would need to be given to the mechanism by which the incentive to abate is passed on to airlines in airport user charges. This would depend on the way such charges were calculated and how they reflected, amongst other things, the use of different types of aircraft.[74]

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74 While designating airports as the relevant ETS installation might have benefits in terms of creating a level playing field between new and existing services, it raises other difficulties such as how to measure the flight distance-related element to emissions costs that would now have to enter into landing charges, how differences in operational efficiencies between airlines could be captured and how minor modifications to aircraft could be encouraged.

6 Conclusions

The growth in air transport has fuelled the assumption that aviation should be included in the EU ETS. However, the proposals to place aviation in ETS have been made without adequate reference to true scale of aviation emissions relative to those from other sectors, the economic benefits created by aviation and the impact that ETS might have on the sector and the different business models within the sector.

In this report we identify a number of important questions which need to be addressed before aviation should be included in the EU ETS. These range from the effectiveness of including aviation in the EU ETS at all, to detailed consideration of scheme design and allowance allocation processes to the impact of ETS on the aviation sector and competition between airlines.

We have identified a number of important issues that need further consideration before EU ETS is applied to aviation. These are:

- Given the economic contribution of aviation (and its particular importance to the development of the new member states) a proper cost benefit analysis must be conducted to confirm whether aviation is the most important priority for inclusion in ETS. An assessment of the net benefits (gross economic value added/tonne of CO_2 emitted) of aviation relative to other sectors that are major producers of CO_2 would show that although aviation emissions are material they are not as large as some commentators claim, while the net benefits of aviation are significantly higher than several other sectors. This suggests that abatement in these other sectors should take a higher priority than abatement in aviation.
- What is the real scope for abatement from aviation other than by reducing the volume of services? Aviation already faces strong incentives to reduce fuel burn and therefore CO_2 emissions - due to high fuel prices. The impact of ETS on further CO_2 reductions is unclear. The value of including aviation in the EU ETS is therefore questionable.
- Almost half of the possible reductions in CO_2 emissions from aviation require improvements in ATM rather than decisions under the direct control of airlines. If aviation is considered to be a priority it seems therefore equally urgent for the Commission to consider further policy that will direct policy towards ATM development.
- If aviation is to be included in ETS it should cover all flights generated by the EU, regardless of destination or origin of flight. Restricting ETS to only intra-EU flights would reduce its coverage to only 20% of the aviation emissions and only 0.8% of total EU-25 emissions.
- More work is required in establishing the drivers of allowance prices. Too little is known about the shape of the overall marginal abatement cost curve. Also current discussions are too vague regarding the determination of the total volume of allowances and the options to off-set commitments by abatement in other Kyoto Protocol countries.

- A final decision is needed on the definition of "installation" that attracts allowances. Defining the installation as an aircraft is not feasible. Consideration needs to be given to treating operators of passenger (or freight) aircraft or airports as the relevant installation. Applying ETS directly to airports may, in practice, provide the most effective mechanism to pass on the incentives of ETS to airlines through landing charges.
- Allowance allocations must be based on benchmarked figures, not grandfathering of emissions. RTKs have the potential to provide a relevant measure although there remain some practical issues to be resolved.
- More consideration needs to be given to the commercial impact of ETS on aviation. The demand for aviation is price sensitive. Significant price increases could lead to a dramatic fall in demand, which could have wider damaging economic effects. Furthermore, because the demand for the services of LFAs is more sensitive to price than the demand for the services of the FSAs the relative impact of ETS would be greater on the LFA segment than on the FSAs. This may have the effect of reducing the drive towards introducing cleaner more energy efficient operations in the sector as a whole.
- In addition, the process of allocating allowances may further affect competition between airlines. Allocating allowances to incumbent airlines while forcing new entrants (and new services) to buy allowances would distort competition and discourage the development of newer cleaner fleets. A dynamic process of allowance allocation needs to be developed that preserves a competitive market for aviation and delivers environmental benefits. Treating airports rather than airlines as the relevant installation could facilitate more equitable competition between new and existing airline services and encourage environmentally efficient substitution of aircraft with more efficient ones.
- To ensure that ETS allowances are allocated on an even-handed basis to all operators in the EU the allocation process must have harmonised rules and administration through a centralised process at Community level. Basing the allocation on the NAPs of Member States is too susceptible to discrepancies and asymmetries of treatment that may have a material impact on competition between airline operators based in different countries.

Annexe 1 – Check on the robustness of projections for growth in employment due to aviation

We have reviewed the OEF forecasts to establish whether they actually represent economic growth. The check is in two dimensions:

- *Magnitude:* we have checked whether the magnitude of forecasts appears plausible, based on the body of literature.
- *Additionality:* we have checked the extent to which the benefits would have been present without aviation. We checked whether appropriate techniques have been used to only capture additional jobs in the analysis.

Table 7 sets out the review process for forecasts of direct employment. Actual historic data provides a check for the forecasts[75].

Assessment of direct employment	**OEF (2002)**	**Historic date benchmark – ACI (2004)**
Check on magnitude of forecasts		
Direct jobs created per 1 million passengers	1,041[76]	950[77] (1,120[78])
Increase in productivity of employees over time	Will decrease from 3% to 2% p.a.	2-3% p.a. over last five years
Check for additionality		
Level of additionality assumed up to 2010	28%	x

Table 7: Critique of OEF figures

Source: Frontier analysis of various sources

75 The ACI (2004) report is based on the analysis of survey data collected from the ACI membership of 450 airports in 45 European countries. It therefore offers a check against actual historic data.

76 For 2001.

77 For 2001 based on survey of 59 EU airports.

78 For 1998 based on survey of 23 EU airports.

Magnitude: The study finds that the initial number of direct jobs per million passengers is within the range of figures developed using surveys carried out in 1998 and 2001 by ACI.

Similarly, OEF's assumption for productivity change in employees over time (leading to fewer employees per million passengers) is similar to analysis for a 5-year period carried out by ACI.

Additionality: Our analysis suggests that OEF have assumed that only approximately 28% of new aviation jobs are actually additional and should be included for the purposes of calculating benefits. This figure suggests a conservative approach to additionality has been adopted.

Indirect and induced jobs: We also considered OEF's forecasts of indirect and induced employment created by the activities of the aviation sector. From the forecasts provided by OEF, we are able to calculate the average multiplier relationship between the creation of direct employment and the creation of indirect and induced employment. In Table 8 we set out benchmarks for the multipliers used in other literature.

	OEF (2002)	OEF (1998)	BAA (2003)	ATAG[79] (2005)	IFV Cologne (2004)
Indirect	1.1	x	x	1.21	x
Induced	0.5	x	x	0.54	x
Total	1.6	1.31	3	1.75	2.3 (1.5 for LFAs only)

Table 8: Critique of multipliers used for indirect and induced jobs in relation to direct employment created by aviation

Source: Frontier analysis of various sources

The benchmarks suggest that OEF is at the lower end of the scale, and that it has again adopted a cautious approach to attributing employment growth as benefits of aviation growth.

79 Figures for aviation and aerospace.

Annexe 1 – Check on the robustness of projections for growth in employment due to aviation

Annexe 2 – Explanation of operational decisions

Below we briefly discuss the operational possibilities that are considered to be viable. The descriptions of operational decisions are based on IATA (2005).

- *Pilot Technique:* Analysis of fuel management information systems suggests that fuel performance of various crews can vary on average in the range of plus or minus 2.5% from planned fuel burns. This range widens on short-range flights where a more significant portion of the flight is spent manoeuvring. Proper training, emphasis on fuel economy, adequate standard operational procedures, proper management leadership and accountability greatly impacts on fuel performance. According to IATA[80], a further 1% to 2% of fuel consumption can be saved if crews consistently apply all of the available fuel saving procedures:
  - better auxiliary power unit management;
  - efficient start up and taxi speeds;
  - engine-out during taxiing out;
  - selecting the most efficient departure runway (based on ground taxiing and direction of onward flight);
  - determining the most efficient trade-off between speed and altitude on departure;
  - optimizing post departure flight profile;
  - managing cruise altitude and speed;
  - planning the efficient descent profile;
  - extent to which low noise/low drag approach procedures are followed;
  - reducing flaps during landing;
  - idling engine reverse on landing; and
  - engine-out during taxi in.
- *Cost Index Flying:* According to IATA, the best way to plan and fly "optimal" profiles is to use a Cost Index optimization system, both at the flight planning stage and for real time flight management in the cockpit. Airlines that make proper use of Cost Index optimization at the flight planning stage, and on a day-of-flight basis, would achieve the greatest savings. With any optimization system, the system optimizes to a target parameter; in this case, the Cost Index, which is a ratio of the true time cost per minute to the actual fuel cost.

80 IATA (2004c).

Since fuel costs, and in some cases, time costs vary with the route, the Cost Index needs to be used specifically for each route.

- *Accurate Flight Planning:* optimizing each flight and avoiding predetermined routes or unnecessary altitude capping saves a significant amount of fuel. An adequate flight planning system will:
  - optimize the route laterally, and
  - use Cost Index to manage the flight vertically.
- *Use of statistics to optimize fuel use:* Fuel in excess of minimum regulations should be planned carefully. Historic fuel use data can yield valuable information to both the dispatchers and crews. Analysis of historic data can be used to determine the right amount of fuel for the flight.
- *Alternate selection:* According to IATA, diversions will occur about one in a thousand flights. Diversions are about one third for mechanical reasons, one third for medical reasons and the rest for weather. Most of the weather related diversions were most likely anticipated based on the forecasts. It is therefore possible to select the most efficient alternate based on circumstances. Airlines should systematically review the availability of the closest alternate for each destination. If the chance of diversion is very small, then select the closest alternate based on realistic distance to travel as per the anticipated ATC routing. When the chance of diversion increases, a more appropriate alternate should be planned taking into consideration all factors that can minimize the impact on the operation.
- *Aircraft fuel burn management:* Different aircraft of the same model develop slightly different fuel burn characteristics. The differences can amount to 5% of total fuel burn. Accurately tracking each aircraft and adjusting flight plan fuel burns will reduce the carriage of unnecessary fuel. This is particularly critical for long-range aircraft.
- *Tankering:* Tankering is the carrying of fuel in excess of that required for the sector being flown. Depending on circumstances, the potential savings from tankering varies between airlines. According to IATA, an adequate tankering process could yield significant savings. Proper fuel supply management will prevent tactical tankering, which is normally costly.
- *Zero fuel weight management:* Proper estimation of the zero fuel weight is critical because it will decrease the carriage of unnecessary fuel or prevent a possible last minute delay for additional fuel. It will also have a significant impact on the flight profile.
- *Centre of gravity management:* Flying with an aircraft loaded to the most forward centre of gravity consumes approximately 3% more fuel above baseline. Centre of gravity loading while flying with the most rearward centre of gravity reduces fuel consumption by as much as 1.5% depending on the aircraft type.

Annexe 3 – Further details of scheme design

WHO FACES THE OBLIGATION?

Efficient cost allocation requires that those that have strongest capability to reduce costs actually incur the costs. This ensures that those facing the incentive to reduce costs also have the means to reduce the cost. Acknowledging this view, the Commission comes to the following conclusion: [81] *"It is fundamental that the entity made responsible must be the one with the most direct control over the type of aircraft in operation and the way in which they are flown"*.

In considering extending the EU ETS to aviation, one of the parameters to be designed relates to who actually faces the obligation to deliver allowances (in relation to measured CO_2 emissions in each period). Several options have been set out by the Commission feasibility study[82].

- aircraft operator;
- airport operator;
- fuel supplier;
- air traffic managers; and
- aircraft manufacturers.

The Commission's preliminary view is that only aircraft operators should face the obligation under the EU ETS. This section considers each possible stakeholder in turn to determine which option would ensure that the costs of the EU ETS are faced by those that are in the best position to reduce them (i.e. abate).

Aircraft operators

Aircraft operators determine fuel burn to a large extent by choosing routes and frequencies, as well as by their operating practices on the ground. However, fuel burn is also determined by ATM. Moreover, on the ground, fuel burn is greatly influenced by airport operators.

Aircraft operators currently face a strong incentive to reduce fuel burn due to high fuel prices. The EU ETS would be most beneficial if the additional operating costs it creates leads to even greater abatement. We agree that aircraft operators should face the obligation to reduce fuel burn. However, other stakeholders that influence fuel burn also need to be considered for inclusion.

Airport operators

Airport operators can influence fuel burn through the following:

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81 European Commission (2005a) COM (2005) 459 final.

82 CE Delft (2005a).

- *Capacity provision:* airports help determine[83] the extent to which aircraft are required to use holding patterns when waiting to land at an airport, the extent to which they are required to queue for take-off and for the availability of gates.
- *Infrastructure provision:* airports can reduce fuel burn by supplying equipment that can help aircraft operators be more fuel efficient. For example, aircraft can provide tugs for pulling aircraft and access to ground power in place of aircraft auxiliary power.
- *Operational procedures:* airports determine fuel burn on the ground through better procedures used for taxiing and runway selection. In December 2004, IATA estimated[84] that each extra minute of taxiing costs between $25-50. This figure would now be higher due to higher fuel prices.

Airport operators do not, however, have an important influence over fuel burn during flight, where most of the fuel is burned.

Nevertheless applying ETS directly to airports may, in practice, provide the most effective mechanism to pass on the incentives of ETS to airlines through landing charges.

Fuel suppliers

Fuel suppliers do not directly influence whether the fuel is burned in the most efficient manner. Furthermore, while the price of fuel clearly has some impact on aviation demand, fuel suppliers have no direct control over the price of fuel, therefore no realistic way of encouraging abatement.

While inclusion of fuel suppliers in the EU ETS might lead to still higher fuel prices it could also simply lead to airlines seeking to source their fuel supplies from outside the EU. Insofar as this is feasible it would seem to favour airlines with operations both within and outside the EU over airlines operating entirely (or almost entirely) within the EU. This leads us to believe that placing fuel suppliers within the EU ETS could distort inter airline competition by favouring airlines with wider geographic networks of routes.

Finally, if fuel suppliers *and* airlines were to be included within EU ETS this would lead to an issue of double marginalisation" where aviation emissions could be counted twice for ETS purposes. Avoiding this problem by excluding airlines from the ETS in favour of fuel suppliers would seem to us to be perverse as airlines have a far greater ability than fuel suppliers to influence the aggregate carbon emissions of the airline industry.

In our view, therefore it is difficult to see a compelling argument for applying the EU ETS to the suppliers of aviation fuel.

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83 There may be constraints on how the airport can act due to local planning laws and obligations placed on it by regulatory regimes.

84 IATA (2004c) *Guidance material and best practices for fuel and environmental management.*

Air Traffic Management

As discussed above, ATMs have a strong influence over in flight fuel burn. They often unilaterally determine routes, speeds and characteristics of in flight manoeuvring.

IATA estimates that ATM improvements could lead to emission reductions of between 6-12%. Our analysis of the operational decisions that could be determined by ATM suggests that the scope for reductions in emissions is likely to be in the region of 6-8.5%.

There is therefore a strong case for ATM to be made sensitive to the carbon emissions created by its decisions by making ATMs subject to a form of environmental policy. Any such policy should ensure that in the situation where the ATM has more than one safe option, then it has the clear incentive to choose the option that reduces emissions.

Reforming ATM includes reducing holding patterns, use of more efficient routings due to the design of functional airspace blocks and enhancing optimal flight profiles. It also consists of making use of more advanced technology to help with communications, navigation and surveillance.

The Commission appears to be treating reform of ATM separately from environmental policy towards aviation. As can be seen in Table 2, the Commission has acknowledged that ATM improvement is required, but has determined that all that is required is a strengthening of current policy. It sees the EU ETS as a separate policy to be implemented. Our view would be that the importance of improvements in ATM provision to determining whether aviation can reduce its emissions dictates that ATM improvements should be addressed as a matter of urgency in parallel with the extension of the EU ETS to aviation.

Aircraft manufacturers

Aircraft manufacturers influence aviation emissions by designing and constructing aircraft and supplying them to aircraft operators. By improving fuel efficiency they can influence the amount of fuel burned.

However, aircraft manufacturers operate in a highly competitive market and this market places pressure on manufacturers to constantly improve the fuel efficiency of their aircraft.

High recent fuel prices have created strong demand for fuel efficiency measures from aircraft operators. According to the aircraft manufacturers we consulted, fuel efficiency is a key factor in determining the sales of aircraft. This demonstrates that the incentive on airlines to burn less fuel is being transferred to aircraft manufacturers in terms of demand for more efficient aircraft.

In our view, therefore, it is unlikely that there is any additional benefit from including aircraft manufacturers in the EU ETS. Indeed, if the double marginalisation problem is to be avoided it is clear that it would always be more efficient to attribute emissions to airlines than to the suppliers of aircraft.

COVERAGE OF CLIMATE CHANGE EFFECTS

Aviation has a number of impacts on climate change. CO_2 emission is one of these. However, there are further climate change effects that occur mostly at a cruising altitude of the range of 30,000-43,000 feet due to:

- emissions of NO_x which increase ozone and decrease methane in the atmosphere;
- water vapour in the form of condensation trails; and
- soot and sulphur particles (aerosols).

Scientists understand the direct and indirect impacts of CO_2 more than the other emissions. They are far from being in agreement about the effects of water vapour, soot and sulphur particles.

To capture the full climate change effects of aviation, a wider measure than fuel burn may be required. Measuring fuel burn captures the climate change effects of CO_2 emissions. However, it does not capture the full direct and indirect effects of all the emissions. For this reason, it has been suggested that a multiplier on fuel burn might be used to capture more effects.

The advantage of a multiplier approach is that it takes account of aviation having multiple effects on climate change compared with other sectors in the EU ETS. It is also easy to administer.

However, including the multiplier has significant disadvantages.

- The scope of climate change effects due to aviation is not well understood, and therefore the aviation industry is likely to get wrongly penalised.
- When it is cost-effective for abatement to take place in the aviation sector, the higher penalty will create a stronger incentive to reduce emissions (and therefore wider climate change effects). However, when it is cheaper to abate in other sectors, then aviation simply pays for extra CO_2 emission reductions in other sectors, but *does not* actually reduce the wider climate change effects due to aviation. As it is likely that abatement in other sectors will in most cases be cheaper than in aviation, the multiplier will not have the effect of reducing the wider climate change effects of aviation. It will lead to arbitrarily greater CO_2 reductions in other sectors, which are not comparable to the wider climate change effects of aviation.

An alternative to multipliers, "flanking instruments" can target wider climate change effects of aviation. Several different forms of flanking instruments have been suggested:

- regulation of cruise altitudes to limit the production of contrails and cirrus clouds;
- landing/take off circle (LTO) NO_x certification;
- cruise NO_x certification; and
- NO_x–related airport landing charges.

Flanking instruments would sit outside the EU ETS and do therefore not need to be explicitly considered at this stage. Examples of such flanking instruments can be seen in Switzerland and Sweden[85]. Both schemes apply emissions surcharges to the landing fees (which have been reduced accordingly to ensure overall revenue neutrality). The rate of surcharge depends on which category (out of 7) the engines fit in. The range of surcharge is from 0% for aircraft with engines in the best category, to 30% (Sweden) or 40% (Switzerland) for engines in the worst category.

85 IATA (2000) *Environmental review 2000.*

Annexe 4 - Cost pass through and demand & supply elasticities

There are only two situations in which an increase in marginal costs leads to a *complete* pass through of costs in higher prices. Either the supply of aviation services is perfectly elastic (that is, provided price equals marginal cost the industry is prepared to supply *any* level of capacity) or demand for aviation services is completely insensitive to the price of tickets. These two cases are illustrated in Figure 16 & Figure 17 below.

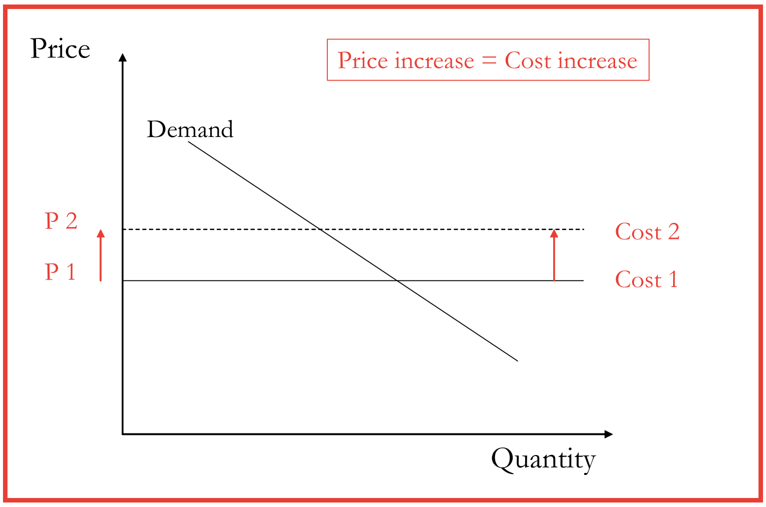

Figure 16: If supply is completely elastic then an increase in marginal costs is fully passed through in prices

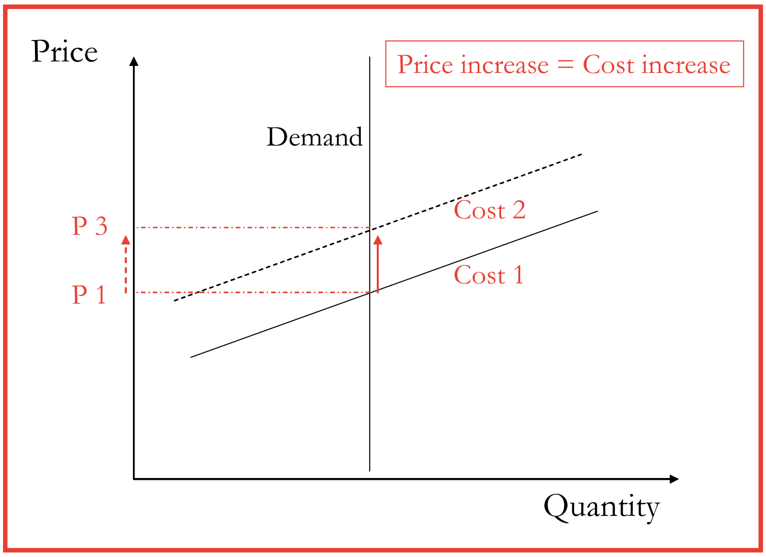

Figure 17: If demand is completely inelastic then an increase in marginal costs is also fully passed through in prices

However, neither of these scenarios is plausible for aviation. Demand for air travel is clearly not insensitive to price, while the supply curve would only be perfectly elastic if marginal costs were constant and the market conditions corresponded to a text-book model of perfect competition.

In practice both the demand for and supply of air services are price sensitive. In these circumstances, an increase in marginal costs will not be fully passed on in higher prices, as illustrated in Figure 18 below.

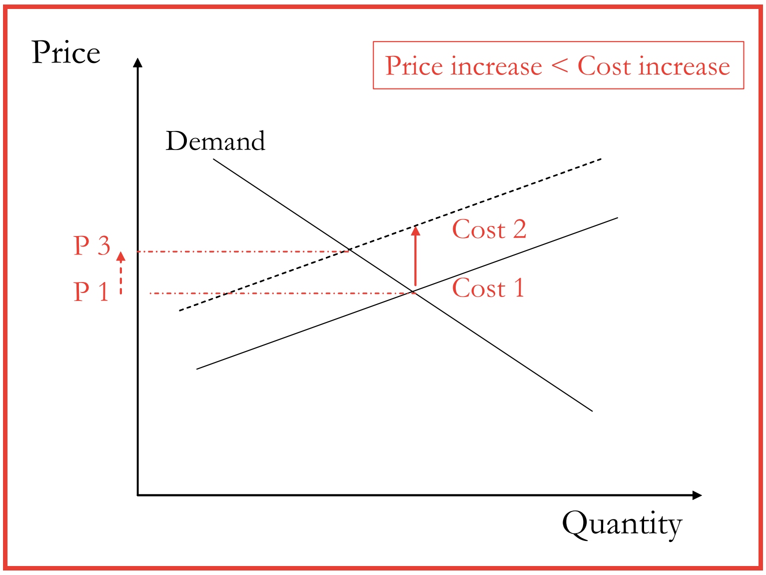

Figure 18: When demand and supply are price elastic full cost pass through cannot be achieved

The more price-sensitive demand is to movements in price, the smaller the proportion of the cost increase will be passed through in higher prices, as illustrated in Figure 19.

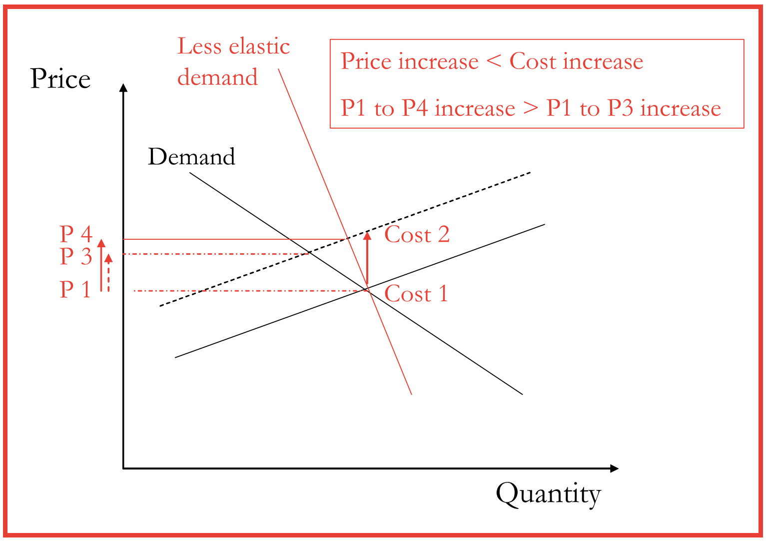

Figure 19: Price increases in response to ETS will be greater when demand is less sensitive to price

Annexe 4 - Cost pass through and demand & supply elasticities

Annexe 5 – Terms of reference for the aviation working group set up under the European climate change programme

The purpose of the working group is to advise the Commission services and will consist of experts from Member States and key stakeholder organizations including industry, consumer and environmental organisations. This working group shall assess the necessary ways, as listed below, of incorporating the climate impact of aviation into the European emissions trading scheme (EU ETS)[86], taking full account of the precautionary principle.

Coverage of the climate impact of aviation

The group shall:

- assess how monitoring and reporting the climate impact of aviation can be addressed by adding further annexes to Decision 2004/156/EC, taking the existing methodologies used therein as a benchmark and noting the potential for achieving greater accuracy over time;
- explore whether the flexibility offered by the tier system of Decision 2004/156/EC would be appropriate for the aviation sector or whether further harmonisation is required;
- analyse the possibility that incomplete coverage of the climate impact of aviation could provide an incentive for reduction of one impact within the scheme at the expense of another outside the scheme;
- consider the complementary use of charges or other flanking measures to establish full coverage of the climate impact of aviation in order to avoid the identified potential adverse effects from incomplete coverage.

Scope of emissions covered

The group shall consider the flights and emissions covered, taking into account the need: to limit differences of treatment between short-haul and long-haul services, to examine differences in the accessibility of peripheral regions, to reflect on how the EU model can be extended to other countries as the EU ETS itself expands, and to capture a significant quantity of emissions in line with the environmental objective of combating climate change.

Approach used for calculating and apportioning the overall emissions limitation for the aviation sector

The group shall consider:

86 Directive 2003/87/EC.

- the different models used within the EU and internationally to calculate growth and emissions projections for both the aviation sector and other sectors of the economy, and the different assumptions used therein;
- the range of overall emissions limitations which should be considered for the aviation sector, taking into account different results from models;
- which elements of setting and apportioning the overall emissions limitation can be harmonised across the EU;
- the impact on the competitiveness of Community industry, the impact on the price of tickets (considering inter alia the existence of alternative means of transport) and on emission allocations and the proportionate distribution of costs between industry and transport end-users;
- how to ensure that the accounting system established in Commission Regulation (EC) No 2216/2004, which ensures consistency between trading under the EU ETS and trading under the Kyoto Protocol, is not adversely affected by the inclusion of aviation.

Any design solution needs to balance the introduction of specific rules for aviation against the overall objective of its inclusion in the EU ETS, i.e. to contribute towards tackling climate change in the simplest and most cost-effective manner possible.

Compliance

The group shall consider how existing compliance measures currently applied to the aviation industry can be used in addition to those already instituted under the EU ETS to ensure compliance with the obligations imposed by the scheme.

Administration

The group shall consider how best to administer aviation's inclusion in the EU ETS taking into account the conclusions reached on emissions limitation, the registries system and compliance. This working group will submit its conclusions in the form of a report by 30 April 2006 at the latest.

Annexe 6 - Bibliography

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