



COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 27.9.2005  
SEC(2005) 1184

**COMMISSION STAFF WORKING DOCUMENT**

***Annex to the :***

**Communication from the Commission**

**”Reducing the Climate Change Impact of Aviation”**

***Impact Assessment***

**{COM(2005) 459 final}**

## TABLE OF CONTENTS

1.	The problem .....	3
2.	The objectives .....	11
3.	The options.....	13
4.	Analysis of impacts .....	28
5.	Comparing the options .....	37
6.	Stakeholder consultation .....	40
ANNEX 1 : GLOSSARY AND DEFINITIONS .....		42
ANNEX 2 : THE IMPACT OF AIRCRAFT ON THE GLOBAL CLIMATE .....		44
ANNEX 3 : SUMMARY OF STAKEHOLDER CONSULTATION RESULTS.....		47
ANNEX 4 : COMPARISON OF GROWTH IN AVIATION EMISSIONS TO COMMUNITY TARGET (EU15 BUBBLE) .....		50
ANNEX 5 : SPECIFIC EMISSIONS TRADING DESIGN ISSUES.....		51

## 1. THE PROBLEM

*Summary* Climate change is accelerating. Air transport already accounts for some 3% of anthropogenic CO<sub>2</sub> emissions, and if the sector grows as projected, its emissions will increase substantially and by 2012 neutralise around a quarter of the emissions reductions required by the Community's Kyoto targets for other sectors. At present the environmental costs of air transport are not fully reflected in the prices paid by users.

### 1.1. What is the problem?

#### 1.1.1. *The climate change challenge*

Climate change is accelerating. Over the 20th century the global average temperature rose by about 0.6°C, and the mean temperature in Europe increased by more than 0.9°C. Globally the ten warmest years on record all occurred after 1991.

The overwhelming scientific consensus is that current global warming is caused by human activity. Climate model calculations show that global warming is closely related to rising atmospheric concentrations of the greenhouse gases (GHGs) induced by our activities. Details, facts and figures are summarised in the Second and Third Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC).

Greenhouse gas concentrations are higher now than at any time in the past 450,000 years, and are projected to keep rising. Because of the long life-time of GHGs and the slow response of the climate system, past emissions will lead to an additional rise in temperatures during the 21st century, and atmospheric concentrations of GHGs are expected to increase further in the coming decades. As a consequence, surface temperatures are expected to increase by 1.4 to 5.8°C globally by the year 2100 (compared to 1990 temperatures), and by 2.0 to 6.3°C in Europe.

Climate change needs to be slowed down and the climate eventually be stabilised. On the basis of the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), the EU has established the long-term objective of a maximum global temperature increase of 2°C over pre-industrial levels – an objective that was most recently reaffirmed by the European Council in 2005. Achieving this target is an EU priority, but it is also a major challenge. It will require broader participation, on the basis of common responsibilities - differentiated by country - and the scope of action will need to be widened to cover all greenhouse gases and sectors. There is no easy way to prevent and mitigate the problem of human-induced climate change. Progress can only be made by many different contributions, large and small, achieved through a broad range of flexible instruments and measures.

Details about the impacts of climate change, and the implications of the 2°C objective in terms of the emissions reductions required, are set out in the

Commission Staff Working Document<sup>1</sup> that accompanies the Commission's Communication on "Winning the battle against global climate change".<sup>2</sup>

### 1.1.1. *The impact of aircraft on the global climate*

Air transport is important for modern societies as it facilitates economic and cultural exchanges and is a significant source of employment and growth in many regions. Unfortunately, aircraft also contribute to climate change. In 2003, the CO<sub>2</sub> emissions from international aviation<sup>3</sup> were about 3 % of total EU CO<sub>2</sub> emissions, or about 12 % of all emissions from national transport.<sup>4</sup>

However, the overall impact is greater than this figure indicates. Apart from emitting CO<sub>2</sub>, aircraft contribute to climate change through the emission of nitrogen oxides (NO<sub>x</sub>), which are particularly effective in forming ozone (a greenhouse gas) when emitted at cruise altitudes. Aircraft emissions also trigger the formation of "condensation trails" and are suspected of enhancing the formation of "cirrus clouds", effects which also add to the overall global warming effect. In 1999, the Intergovernmental Panel on Climate Change (IPCC) estimated the total climate change effect of aviation to be 2-4 times greater than the effect of its CO<sub>2</sub> emissions alone, *even without* considering any potential effects from cirrus cloud enhancement.

Annex 2 gives a more detailed summary of current knowledge about the climate change impacts of aviation.

## 1.2. **What are the risks if things stay as they are?**

### 1.2.1. *Continued gap between traffic growth and efficiency improvements*

Air transport has experienced strong growth almost continuously since the beginning of civil aviation. However, the climate change benefits of improvements in technology and operational efficiency over the last 50 years have been more than offset by the rapid growth in the sector.

The development of CO<sub>2</sub> emissions gives an indication of this. At global level, CO<sub>2</sub> emissions from international air transport reported to the UNFCCC by Annex I Parties increased by 48% from 1990 to 2002, corresponding to an annual growth rate of 3.4%. In absolute terms, GHG emissions from international aviation in 2002 were about 203 million tonnes CO<sub>2</sub> equivalent (MtCO<sub>2</sub>e),<sup>5</sup> corresponding to about 1.2% of the total national GHG emissions<sup>6</sup> reported by Annex I Parties.

---

<sup>1</sup> SEC(2005)180 9.2.2005

[http://europa.eu.int/comm/environment/climat/pdf/staff\\_work\\_paper\\_sec\\_2005\\_180\\_3.pdf](http://europa.eu.int/comm/environment/climat/pdf/staff_work_paper_sec_2005_180_3.pdf)

<sup>2</sup> COM(2005) 35 final 9.2.2005

[http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/com/2005/com2005\\_0035en01.pdf](http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/com/2005/com2005_0035en01.pdf)

<sup>3</sup> For definition see ANNEX 1: GLOSSARY AND DEFINITIONS.

<sup>4</sup> Based on data from Annual European Community greenhouse gas inventory 1990-2003 and inventory report 2005, Technical report No 4/2005, European Environment Agency

<sup>5</sup> This figure is only for Annex I countries – the significant emissions from countries such as Brazil, China, India, Indonesia, Singapore and Thailand are thus NOT included.

<sup>6</sup> Excluding emissions from international aviation and maritime transport and CO<sub>2</sub> emissions from land-use change and forestry

The EU accounted for about half of these aviation emissions<sup>7</sup>. GHG emissions from international civil aviation as reported by Member States to the United Nations Framework Conventions on Climate Change (UNFCCC) increased by 73% from 1990 to 2003, or about 4.3% pr year on average, thus increasing its share of from an equivalent of 1.2 to 2.3 % of total<sup>8</sup> EU GHG emissions. As explained in Annex 2, this represents a minimum estimate of the climate change impact as it does not include the significant non-CO<sub>2</sub> effects from aviation.

Historically, annual improvements in aircraft fuel efficiency have been of the order of 1-2%, thus largely surpassed by traffic growth. Clearly there is a likelihood that the rate at which improvements are made in the environmental performance of aircraft operations will continue to be cancelled out by the rate at which traffic grows, thus leading to a net growth in emissions. And while new technologies may bring significant improvements in decades to come as acknowledged by ACARE<sup>9</sup>, these improvements will need to be developed and applied much faster than at present if they are to match expected growth rates in air traffic.

### 1.2.2. *Unequal progress across sectors*

Achieving the 2°C objective will be a major challenge and will require significant additional mitigation efforts across all sectors. At the 2005 Spring Summit, the European Council called on developed countries to consider reduction pathways in the order of 15-30% by 2020. Continuous growth in aviation emissions would tend to cancel out the environmental benefits of these efforts, and thus increase the need for further measures to reduce emissions in other sectors. If the trend up to now continues, by **2012, growth in emissions from international aviation from the EU would neutralise more than a quarter of the reductions required by the Community's target under the Kyoto Protocol (to reduce emissions by 8% in 2008-2012)**<sup>10</sup>. So those sectors of the economy where mitigation measures are already applied are likely to be called upon to do more. There is then the risk that sectors already contributing most to emissions reductions could be affected disproportionately (see Figure 1).

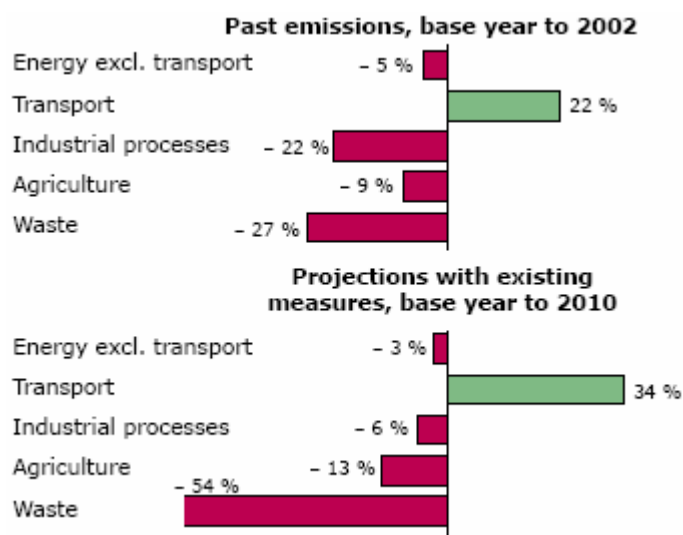
---

<sup>7</sup> 103,411 of 202,779 Mt<sub>CO2e</sub> - 2002 data as reported by Annex I Parties to the UNFCCC

<sup>8</sup> Excluding emissions from international aviation and maritime transport and CO<sub>2</sub> emissions from land-use change and forestry

<sup>9</sup> The Advisory Council on Aeronautics Research in Europe – see ANNEX 1: GLOSSARY AND DEFINITIONS.

<sup>10</sup> See ANNEX 4 for details.



**Figure 1: Change in EU-15 greenhouse gas emissions by sector from base year to 2002 and projections for change with existing measures from base year to 2010. Source: Analysis of greenhouse gas emission trends and projections in Europe 2004, European Environment Agency, Technical Report No 7/2004.**

### 1.3. What are the underlying reasons for this policy measure?

As already explained, the problem is the growing impact of aviation emissions on the climate, not air transport in itself. However, the rate at which emissions grow is the result of developments in air traffic and the rate at which technological improvements and innovations find their way into the market. Growth in air transport and the extent to which economic conditions stimulate the development and uptake of new technologies and practices are thus of key importance.

#### 1.3.1. Growth in air transport

Approximately 80% of European air traffic is due to tourism, while 20% is a mix of business travel and freight. On a global level, the World Tourism Organisation estimates that the global number of arrivals will increase from 720 million tourists worldwide in the year 2004 to 1600 million in 2020.<sup>11</sup> There is growth in both intra-European travel and inbound tourism from third countries.

Air transport is the second most common mode of transport for European holidaymakers, reflecting the fact that holidays abroad underpin much of the growth in air travel. Measured in numbers of trips, the car has a share of around 68% while air transport shows a share of 15%, so the car is the most important mode of transport for all tourism in Europe (international and domestic).<sup>12</sup> International tourism shows a much higher share for air transport (in international travel the car accounts for 47% and the airplane 39%), but the modal split for domestic tourism is very different.

Europe is responsible for a significant part of all global aviation. Passengers starting or ending their journey within Europe accounted for some 36% of all global

<sup>11</sup> World Tourism Organisation "Tourism: 2020 Vision", <http://www.world-tourism.org/facts/2020.html>

<sup>12</sup> coach travel is 9%, rail 6% and ferry 2%

passengers in 2003. More than two thirds of these passengers took intra-European flights, i.e. started and ended their flights in Europe.<sup>13</sup>

Apart from the “external” drivers - for example growth in disposable income promoting increased demand - changes within the aviation sector have also been a major contributing factor in stimulating traffic growth. In the past two decades, aviation policy in the US and the EU and, to a lesser extent internationally, has focused on liberalising and opening up the market. In the EU this was done in three “packages”. The first, adopted in 1987, started to relax established rules, e.g. by restricting the right of governments to object to the introduction of new fares. The second “package”, adopted in 1990, allowed greater flexibility over setting fares and capacity sharing, and extended the existing “freedoms” to all Community carriers. The third and last “package”, adopted in 1992, gradually extended freedom to third country carriers to provide services within the EU, which in 1997 led to the freedom to engage in cabotage, i.e. airlines in one Member State could operate routes within another Member State.

More than ten years after the effective liberalisation of the sector, the results are beyond dispute. In 1999 the Commission report “*The European airline industry: from single market to world-wide challenges*”, based on an in-depth analysis of the market, described a sector which was fast growing, dynamic and competitive. This is still essentially true.<sup>14</sup>

The introduction and pursuit of policies and initiatives designed to minimise regulation, if not deregulate altogether, and to promote competition, have had a striking effect by giving rise to ‘low cost’ or ‘no-frills’ services. Their growing popularity is proof that the stimulation of competition in the sector has allowed much more consumer-friendly pricing with a resultant increase in aircraft movements.

### 1.3.2. *The lack of appropriate price signals*

Although real, the indirect costs of aviation’s climate impact incurred by society are generally not reflected in the price paid by air transport users. These environmental costs are “external” to the transaction involving the air transport provider and the passenger or the cargo customer. If transactions exclude those external environmental costs, they generally lead to activity levels that are sub-optimal from a socio-economic point of view. When the negative impacts of air transport are not reflected in the price paid by users, the latter tend to use air transport to an extent where the marginal costs outweigh the marginal benefits from society’s point of view (although the individual traveller may receive greater benefits than costs).

The concept of external costs and the need to internalise them is a well established key pillar in the Commission’s White Paper on a Common Transport Policy<sup>15</sup> and, more generally, a reason for using economic instruments in environment policy.

---

<sup>13</sup> DG TREN – Analysis Of The European Air Transport Industry 2003, January 2005

<sup>14</sup> While the net profits of many carriers have suffered from the slowdown in the 2-3 years following September 11, the increasing competition from new low cost alternatives and recent oil price increases, traffic now grows rapidly again (at global level, ICAO estimated that passenger growth in 2004 grew by about 14% measured in RPK over 2003).

<sup>15</sup> Com(2001)370 of 12.9.2001

In many sectors, the use of taxes or regulation implies that the external costs of climate change are internalised at least to some extent. This is the case for transport sectors paying fuel taxes, even though this may not be the aim of the tax. Apart from the fiscal aims, such taxes also give a financial signal to users that their fuel use has negative implications for society that are not reflected in the fuel component of the price. Similarly, some of the costs of climate change are met by operators of installations participating in the EU emissions trading scheme, either through the need to buy additional allowances for marginal emissions or the costs of reducing emissions.

By contrast, the air transport sector currently does not have to pay the external costs of its effects on the climate, nor any equivalent charges. This represents a market failure and contributes both to over-reliance on air transport and to sub-optimal investment in and uptake of new technologies and operational procedures that minimise these effects. While air transport operators – like other companies - have inherent incentives to save costs on production factors including fuel, the point at which the consumption of each factor is optimised obviously depends on the costs and benefits of taking measures to reduce it. This can depend, in turn, on the extent to which the costs reflect damage caused to the environment.

#### **1.4. What would happen under a “no policy change” scenario?**

Long-term air travel growth has historically been closely related to economic growth and the indications are that the future of aviation will be marked by persistent growth. Forecasts of air traffic growth have been made by IPPC, ICAO, Eurocontrol and the aviation industry (Boeing and Airbus) and all are consistent in this regard. They suggest that we can reasonably expect an increase of around 3% per year in the number of flights in Europe, at least until the end of the decade, and that demand for European aviation should double between 2002 and 2025. In one recent analysis,<sup>16</sup> Eurocontrol examined the implications of 4 different scenarios<sup>17</sup> for the development of air traffic in Europe. The analysis suggests an average annual growth in the number of flight demands in the period from 2003 to 2025 of between 2.5 and 4.3%.

---

<sup>16</sup> "Challenges to Growth 2004 Report," Eurocontrol, December 2004

<sup>17</sup> The 4 scenarios are:

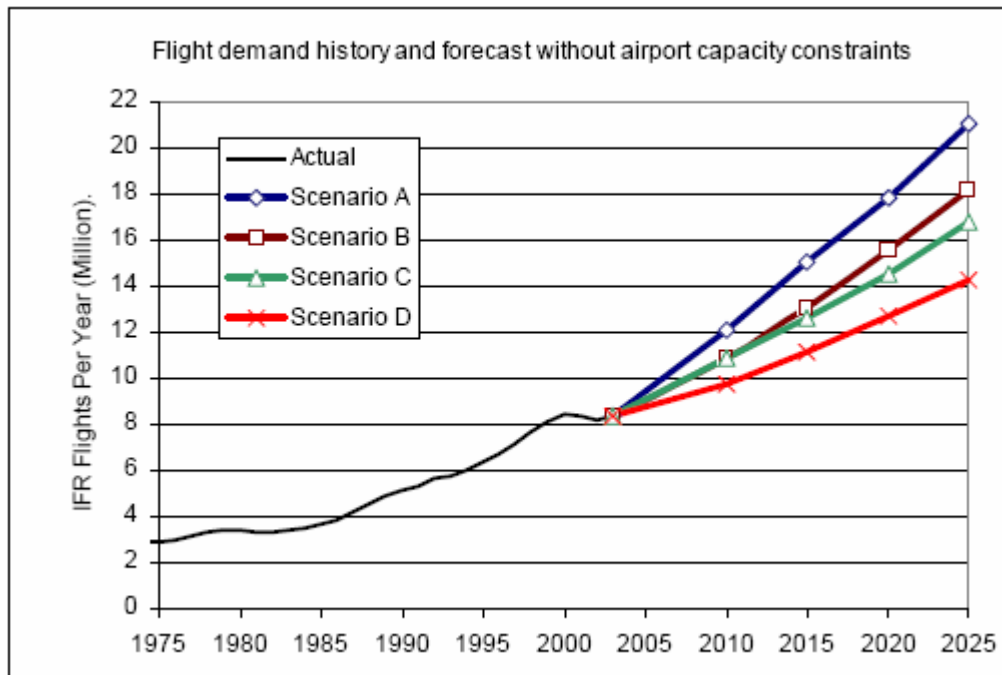
Scenario A: Globalisation and Rapid Economic Growth

Scenario B: Business as Usual

Scenario C: Strong Economies and Environmental Regulation

Scenario D: Regionalisation and Weak Economies





**Figure 2: Flight demand history and forecast** (Source: Eurocontrol)

An ICAO analysis in 2004, predicted that the world passenger aircraft fleet could double between 2002 and 2020 – from around 12,300 to 25,000 aircraft.<sup>18</sup> Based on Boeing, Airbus, ICAO forecasts and their own assessment, Eurocontrol forecasts probable worldwide growth in revenue passenger kilometres (RPK) of 4.7% per year over the period 2002-2015.<sup>19</sup> Airbus' market forecast states that the 9 trillion RPK forecast in 2023 will be generated largely in Europe (33%), Asia-Pacific (31%) and North America (26%).<sup>20</sup> Boeing's market forecast suggests that, in addition to these regions, South America, Africa and the Middle East will experience growth above the world average.<sup>21</sup> While there is of course no certainty that they will be sustained, average traffic growth rates of this order equate to the highest traffic growth rate scenario considered by the IPCC, who believed as recently as 1999, that, of the seven scenarios they had considered, this one was 'less plausible' given the state of the industry and planned developments at that time. Furthermore, growth is also expected to feature strongly beyond 2020.

Without changes to business as usual this level of continued growth in global and European air traffic will result in further growth of aircraft emissions. Available projections invariably suggest continued strong growth in fuel use and in emissions. Figure 3 shows an overview of selected emissions inventories with projections indicating more than a doubling of fuel use (and thus CO<sub>2</sub> emissions) in 2015 compared to the early nineties.

<sup>18</sup> Report of the Sixth Meeting of ICAO's Committee on Aviation Environmental Protection, 2 February 2004, para. 1.1.4

<sup>19</sup> Study on Current & Future Noise Exposure at and around Community Airports, ANOTEC consulting SL, 2004, page 1-26

<sup>20</sup> <http://www.airbus.com/media.gmf.asp>

<sup>21</sup> <http://www.boeing.com/commercial/cmo/2-2.html>

Inventory	Fuel used in early nineties	Fuel used in 2000	Projected fuel used in 2015	Projected fuel used in 2050
ANCAT/EC2	131.3	-	287.9	633.2
TRADEOFF	131.0	167.7	-	471.0
NASA	139.4	-	308.6	471.0
DLR	129.3	-	285.0	
AERO (excl. military!)	134.2	166.0 (1997)	257.8 (2010) 368.6 (2020)	-
EDGAR	167.8**	-	-	-

**Figure 3: Overview of different estimates and projections of fuel use for aviation** (Source: “Study on air quality impacts of non-LTO emissions from aviation”, Norwegian Meteorological Institute 2004). Note that this list is by no means an exhaustive list of existing projections.

The growth in aviation emissions will have implications for the reductions required in other sectors. According to the European Council, developed countries will need to consider reduction pathways in the order of 15-30% by 2020. By way of illustration, if the EU were to achieve this and if the high average growth rate in international aviation GHG emissions observed in the EU-15 in 1990-2002 continues, the relative contribution of these emissions would triple and by 2020 would already account for 6-8% of overall EU emissions<sup>22</sup>. This increase would offset a significant share of the reductions made elsewhere, thus necessitating a correspondingly higher effort to reach the environmental objectives. As overall emissions will need to be reduced further beyond 2020, when aircraft emissions are expected to continue growing, the contribution from aviation would increase even further in both relative and absolute terms.

### 1.5. Who is affected?

Climate change is a global phenomenon and will have different cost and competitiveness implications for different economic sectors. The Third Assessment Report (TAR) of the IPCC<sup>23</sup> gives an overview of the projected change for the 21<sup>st</sup> century. All regions of the world will have to face serious impacts on their economies and ecosystems, although different regions may be affected to a different extent by the various impacts. Even within Europe effects are likely to vary. For example, agriculture would be threatened by increased water stress more in southern Europe than in northern Europe, where some agriculture might even profit from changes in weather. Coastal regions would be more vulnerable to the impacts of sea level rise than inland regions, whereas the latter might be more likely to experience shortages of water supply for cooling thermal power plants, which in turn will affect security of electricity supply.

<sup>22</sup> Without counting aviation’s non-CO<sub>2</sub> impacts.

<sup>23</sup> [http://www.grida.no/climate/ipcc\\_tar/](http://www.grida.no/climate/ipcc_tar/)

This said, it is clear that climate change will have a disproportionate impact on developing countries because they are both more vulnerable to the impact and less able to respond to it than developed countries. Although the impacts on developing countries also differs from country to country, their economies often rely more heavily on climate-sensitive activities; they are often closer to environmental tolerance limits; and they are typically poorly prepared to adapt to climate change. In contrast, richer societies tend to be better able to adapt and their economies are less dependent on climate.

The IPCC's Third Assessment Report gives details of the different impacts of climate change and where they are most likely to occur.

## 2. THE OBJECTIVE

*Summary:* Aviation should be included in Community action to meet its climate change objectives by making improvements in environmental performance that outweigh the impacts of growth. There must be stronger incentives for air transport operators to reduce the impact on climate. The prices paid by transport users should better reflect the real costs to society.

### 2.1. What is the overall policy objective in terms of expected impacts?

From the description of the problem can be seen that air transport has an impact on climate change. It contributes with around 3% of the total greenhouse gas emissions in the EU to which adds the indirect effects e.g. from NO<sub>x</sub>. Furthermore, its projected growth indicates that this share is likely to increase in the coming years. The overall policy objective is therefore to address the growing climate change impact from aviation. Aviation must contribute to the achievement of the Community's overall objective of limiting the global temperature increase to a maximum of 2°C.

This concern was at the heart of the formulation set out in the Commission's sustainable development strategy on air transport and the environment (the "1999 strategy"): *"The long-term policy target must be to achieve improvements to the environmental performance of air transport operations that outweigh the environmental impact of growth"*.

The challenge is to make significant real progress towards achieving this objective. How this could be done is discussed below under three sub-objectives.

#### 2.1.1. Including the air transport sector in efforts to mitigate climate change

At present, international air transport is treated differently from most other sectors<sup>24</sup> in terms of how its greenhouse gas emissions are accounted for under the UNFCCC. Because of a lack of consensus on how to allocate the responsibility for these emissions between Parties to the UNFCCC, only CO<sub>2</sub> emissions from domestic flights are included in the Parties' national emission totals, meaning that emissions from international flights are dealt with separately just as a "memo item". Consequently, the latter are not subject to the quantified commitment reductions

---

<sup>24</sup> The same applies for international maritime transport

undertaken by Annex B Parties to the Kyoto Protocol. Although the Kyoto Protocol contains an explicit obligation for Annex I Parties to pursue the limitation or reduction of aviation GHG emissions, Parties are not subject to the same political pressure for international air transport as is generated by the targets set for other sectors.<sup>25</sup>

The Commission has consistently argued in favour of addressing this anomaly. Winning the battle against climate change requires efforts in all sectors and in all sections of society, and there is no justification for leaving significant potential emission reductions untapped. Various criteria and concerns could be used to define optimal strategies for the relative contributions of different sectors, but one factor is the extent to which regional action in Europe takes into account competition from third countries. In this respect mitigation measures in the air transport sector (as with transport in general) are likely to be less of a constraint. Air transport is, by its nature, geographically specific and intrinsically linked to the need to move people or goods from one place to another. As such, it is less vulnerable to substitution by similar activities or goods from outside the EU. For instance, a flight that takes a UK citizen to Spain cannot be substituted by a flight from the US to Mexico.

#### *2.1.2. Better internalisation of external costs of climate change*

To reflect the “polluter-pays” principle better in air transport, in conformity with Article 174(2) of the EC Treaty, users of air transport need to be faced with prices that are closer to the true costs implied by their choice to fly or to ship goods by air.

The costs of climate change are not easy to evaluate, and are even more difficult to summarise in a single figure. While major advances have been made in recent years, single estimates, as opposed to ranges, of the global cost of inaction must be viewed with caution. Moreover, recent work on monetary values in the scientific literature on all possible impacts of climate change has concluded that calculated values almost certainly represent only a part of the full cost.

The difficulty of estimating single figures from these cost ranges is not a reason for delaying action aimed at preventing society from incurring these costs, by taking pragmatic actions along the right lines. In addition, delaying action could increase the cost of taking action at a later date.

#### *2.1.3. Stronger incentives for air transport operators to reduce their impact on the climate*

Fuel costs are a significant part of the operating costs of air transport operations (as much as 25% according to IATA).<sup>26</sup> Air transport operators thus have inherent incentives to reduce fuel consumption, in the same way as road transport companies for instance. Because of the aeronautical implications of carrying extra load on board an aircraft, fuel economy has always been a significant consideration in air transport,

---

<sup>25</sup> This imbalance is exacerbated at operator level because international air transport, unlike most other activities, is exempt from energy taxes which could have a dampening effect on fuel consumption

<sup>26</sup> [http://www.iata.org/whatwedo/environment/aircraft\\_emissions.htm](http://www.iata.org/whatwedo/environment/aircraft_emissions.htm)

and in the last 40 years, emissions per passenger kilometre have been reduced by 70%.<sup>27</sup>

Yet there is still scope for improvements, although they come at a price. Deployment of known but more expensive technologies, optimisation of existing or emerging technologies and development of new ones all require further investments that aircraft manufacturers and airlines have to weigh against the benefits. It is important that society sends a strong and consistent signal that these opportunities must be exploited. As noted in the 1999 strategy, the objective of achieving improvements in the environmental performance of air transport operations that outweigh the environmental impacts of growth is ambitious, particularly in the field of CO<sub>2</sub> emissions. This requires new approaches that go beyond the traditional method of relying largely on improvements to technical environmental standards. So we need to aim for further improvements beyond “business as usual”.

## 2.2. Has account been taken of any previously established objectives?

The objectives discussed in the above section are not new but flow from decisions made by the Community over the last decade or so. The approach proposed in the Commission’s 1999 strategy was welcomed by the European Parliament and the Council. With the adoption of the 6<sup>th</sup> Community Environment Action Programme in 2002 both institutions reaffirmed their commitment to “*identifying and undertaking specific actions to reduce greenhouse gas emissions from aviation if no such action is agreed within the International Civil Aviation Organisation by 2002*”.<sup>28</sup> Since then the Council has repeatedly recalled the need for urgent action to reduce GHG emissions from international air transport and called upon the Commission to consider in a timely fashion such action and to make proposals.<sup>29</sup> Such action would also be in line with the Lisbon agenda and the EU’s Sustainable Development Strategy, which puts emphasis on the need to “get prices and incentives right” and on moving towards a situation where prices paid by transport users reflect the full costs to society.<sup>30</sup>

A number of more specific objectives for certain individual policy instruments have also been established in the past. These are discussed below in the context of each of the relevant instruments.

## 3. THE OPTIONS

*Summary:* Of the various options examined, some were not considered to be sufficiently effective or practicable (restricting air traffic volumes, regulatory standards, restricting access to EU airports for less efficient aircraft, voluntary agreements with airlines to reduce emissions and departure/arrival taxes or VAT on

---

<sup>27</sup> <http://www.iata.org/pressroom/speeches/2005-03-17-01.htm>

<sup>28</sup> Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme, OJ L 242 10.9.2002

<sup>29</sup> Council conclusions of October 2002, December 2003 and October 2004.

<sup>30</sup> Cf. COM(2005) 37 final: Communication From The Commission to the Council and the European Parliament on the 2005 Review of the EU Sustainable Development Strategy: Initial Stocktaking and Future Orientations, Brussels, 9.2.2005

air transport). Others were considered inadequate to achieve the policy objectives, but nevertheless worth pursuing (raising awareness of air transport users, improving air traffic management, R&D into air transport technology, applying energy taxes to commercial aviation, and improving the competitiveness of rail transport). The options that could most effectively achieve the policy objectives were considered to be en-route charges or taxes on aircraft emissions and impacts, and emissions trading. As there is a single market in air services, a Community-wide approach would be best.

### **3.1. What is the basic approach to reach the objective?**

In summary, the approach emphasises:

- halting the net growth in climate impacts attributable to air transport,
- providing stronger economic incentives to improve environmental performance,
- reflecting the true costs of air transport in the price.

This approach is generic and flexible – it provides a signal for change but leaves it up to the market and operators to identify the most cost-effective reduction options. It would give those operators choosing to use state-of-the-art technologies and environmentally friendly operating methods a competitive edge.

In addition, it remains vital to continue or strengthen existing measures that contribute in other ways. This includes aeronautics research, more effective air traffic management systems in the framework of the Single European Sky, improved international design standards for aircraft and engines, etc. These are described in more detail below. In short, a combination of measures, including economic instruments, will be necessary.

### **3.2. Which policy instruments have been considered?**

Figure 4 gives an overview of the main policy instruments considered here. They have been grouped into three categories:

- (1) *Options that after preliminary screening were rejected for Community level implementation at this stage:* While potentially relevant at some future stage, at Member State level or for the pursuit of other objectives, these instruments are deemed to be ineffective, inefficient or impractical means of pursuing the policy objectives considered here.
- (2) *Options concerning existing actions that need to continue or be strengthened:* Existing instruments or policies that in themselves are deemed insufficient to achieve the policy objectives at least in the short to medium term, but where continued and/or strengthened efforts might be useful to complement further actions.
- (3) *Options considered in detail for implementation as a key instrument for pursuing the policy objectives considered here.*

<b>Measure/action</b>	<b>Category</b>
Restrictions on air traffic volumes	1
Regulatory standards	1
Restrictions on access to EU airports for the least efficient aircraft	1
Voluntary agreements with airlines to reduce emissions	1
Departure/arrival taxes, VAT on air transport, removal of public subsidies	1
Raising awareness of air transport users	2
Improving air traffic management (ATM)	2
Research and development in air transport technology and operations	2
Applying energy taxes to commercial aviation	2
Improving the competitiveness of rail transport	2
En-route charges or taxes on aircraft emissions and impacts	3
Emissions trading for aviation	3

**Figure 4: Overview of options considered**

### **3.3. Options rejected for Community level implementation at this stage**

#### *3.3.1. Restrictions on air traffic volumes*

Regulating air traffic volumes could conceivably address the growth in aircraft emissions very directly. At airports where air quality or noise problems exist, such an approach could generate significant environmental side-benefits, and restrictions on numbers of air traffic movements are already applied at some airports. However, while such an approach may be appropriate under specific circumstances at certain airports, it would not be proportionate or cost-effective as a Community measure aimed at reducing GHG emissions across Europe. This is because:

- it would preclude full use of existing airport capacity;
- it would involve a choice as to the desirable level of aviation activity, which could not be based on any objective measurements;
- it would breach the principle of subsidiarity, since whether applied directly as part of a regulatory procedure or indirectly by limiting expansion of infrastructure capacity, it is within the sphere of competence of the Member States.

#### *3.3.2. Regulatory standards*

Applying regulatory standards to aircraft could conceivably help to reduce some of the climate change impacts of aircraft operations. In principle there are two kinds of standards which could be applied separately or simultaneously: *technical design*

*standards* that affect the aircraft engine design so as to limit the emissions at source or *operating standards* that affect the way the aircraft is operated, whether on the ground or in the air, so as to limit or reduce emissions.

At present, *technical design standards* to limit emissions of certain pollutants from aircraft engines are recommended by the International Civil Aviation Organisation (ICAO). ICAO Contracting States either accept the recommendations or file a formal “difference” (a notification of non-application) if they do not intend to apply them. The recommendations apply only to new engine designs certified after a specific date mentioned in the recommendation. These designs are assessed independently and certified as compliant with the recommended standards before entry into service.

ICAO has established certification standards for emissions of oxides of nitrogen (‘NO<sub>x</sub>’), unburned hydrocarbons and smoke. These standards originate mainly from concerns about local air quality around airports rather than climate change and relate to emissions during the landing and take-off (LTO) cycle. There are no ICAO standards for emissions during the climb and cruise phases of flight. ICAO is currently devising a method for determining emissions during the climb and cruise phases. This work has been in progress for several years but is not yet complete. But it is only one element of what is required, namely the development of – and agreement on - *en route* standards for specific emissions (of which NO<sub>x</sub> is expected to be the first). As regards CO<sub>2</sub>, no standards exist. Some years ago ICAO did consider the introduction of a standard for CO<sub>2</sub> emissions, but concluded that, as these emissions are directly related to fuel burn, fuel price was a sufficient incentive for airlines to limit them. More recently, ICAO work to identify an appropriate aircraft efficiency parameter (with focus on fuel burn/CO<sub>2</sub>) concluded with no agreement.

Whilst the Commission and EU Member States should and will continue to work in the ICAO on these technical issues and push for progress, it is clear that this process is likely to be slow. However, *technical design standards* implemented at Community level only would significantly distort the market for large civil aircraft and jet engines in favour of manufacturers based outside the EU, given the very global nature of these markets. Moreover, as aircraft operating to, from and within the EU are not necessarily sold or registered in the EU, standards relating to the placing on the market of aircraft or engines would not be an option either.

In principle the EU could devise *regulatory operating standards* for the environmental performance of aircraft operating in EU. This option is explored in more detail below.

### 3.3.3. *Restrictions on access to EU airports for the least efficient aircraft*

To define which aircraft are ‘least efficient’ would require either a suitable regulatory performance standard or a definition of environmental efficiency/productivity (relating pollution level to production). As outlined in Section 3.3.2 no such indicators have been agreed at international level. This could be overcome by an EU agreement on a suitable efficiency parameter or standard. However, there would inevitably be difficulties in applying the chosen parameter and more importantly a prohibition to an aircraft whose technical and commercial lifetime has not expired.



Moreover, a measure establishing a threshold value as a performance indicator would not provide an incentive to perform better than required to meet the threshold.

On these grounds, the establishment of operational restrictions based on climate performance indicators agreed at EU level is considered a less promising avenue than the use of economic instruments which would provide more flexibility for aircraft operators. However, it must be noted that prohibiting certain types of aircraft remains possible in the EU for other reasons (such as safety and noise). Similarly, unless and until other more promising means of addressing the impact of aircraft exhaust emissions on climate have been tried and found to be effective and sufficient, this option cannot be discarded definitively.

#### 3.3.4. *Voluntary agreements with airlines to reduce emissions*

In its 1999 strategy,<sup>31</sup> the Commission discussed the necessary conditions and goals of a possible voluntary agreement. It also declared its intention to “*further investigate the appropriateness and possible benefits of reaching voluntary agreements....*”. Subsequently, in 2004, ICAO’s Committee on Aviation Environmental Protection (CAEP) endorsed a template agreement and guidance on voluntary measures. However, this path has not resulted in any concrete voluntary agreement being signed for a number of reasons.

The Commission itself could not enter into an agreement based on the template for legal and institutional reasons. In particular, there is a big difference between the approach in the template and the Commission’s approach as laid down in its 2002 *Communication on Environmental Agreements at Community Level*.<sup>32</sup> Whereas the latter speaks about industry commitments that may be “acknowledged” by the Commission by means of a Recommendation or an exchange of letters, the CAEP model provides for a real bilateral agreement. While it may be possible for individual states to enter into such arrangements, the Commission cannot sign such an agreement as a “partner” and take on the responsibilities identified in its section V.

More importantly, a voluntary instrument would fail to meet the objective identified above of providing stronger economic incentives to improve environmental performance. Large parts of the industry already use sophisticated fuel cost optimisation software to determine the profitability of different measures with impacts on fuel consumption, but a voluntary agreement would not shift the break-even point for such measures.

Quite apart from this, it appears very unlikely that it would be possible to agree with all parts of the aviation industry on something sufficiently ambitious. There is no indication that all carriers – including low cost and foreign ones - would be prepared to accept comparable commitments. This would entail obvious and unacceptable risks of unfair competition between those operators that accept commitments and those that do not (“free-riders”).

Even if a credible baseline could be established and an ambitious target covering all operators agreed, the voluntary nature (and thus the inherent lack of enforcement

---

<sup>31</sup> COM(1999) 640

<sup>32</sup> COM(2002) 412

mechanisms such as fines or penalties) in the ICAO template makes it highly uncertain that any improvement above business-as-usual would be achieved. A similar point was made in a recent OECD report,<sup>33</sup> which concluded that the environmental effectiveness of voluntary approaches is often questionable, and their economic efficiency is generally low, especially if there are no "credible threats" in the shape of penalties or alternative mandatory instruments. This problem had already been identified by the Commission when it acknowledged that while "*near-term action by the aviation sector toward reducing the growth of greenhouse gas emissions could be done voluntarily...*", this "*...could not alone achieve an ambitious emission reduction target...*" and "*...would have to be used in conjunction with other mechanisms...*".<sup>34</sup> This is another reflection of the point that a voluntary approach is not likely to be effective when one of the fundamental problems is the lack of sufficient economic incentives and signals.

### 3.3.5. *Departure/arrival taxes, VAT on air transport, removal of public subsidies*

#### a) Departure/arrival taxes

Another instrument which has been considered is a movement-based aviation tax. Such a tax would be added to the ticket price as a lump sum. For example, a flight departure tax could be levied on all flights leaving a Community airport.

A movement-based tax would provide environmental benefits to the extent that it had influenced air transport demand. However, it would provide no incentive for operators either to improve operational performance or to invest in cleaner technologies. As such it would only represent a rather crude reflection of the 'polluter pays' principle and not contribute to achieving the objectives of rewarding better performance and stimulating investment in cleaner technologies. To the extent that other more sophisticated options are available and deliverable, such taxes are not the preferred way of mitigating the climate impacts of aviation.

This is not to say that this instrument may not be justified for fiscal or other reasons, nor to deny that it could have positive environmental benefits through demand effects. Indeed, movement-based taxes are already used in several countries including some Member States. Moreover, movement-based taxes could potentially be used to supplement more specific environmental instruments in order to ensure that there is no competitive distortion between short-haul and long-haul flights. In such cases a suitable tariff structure for a departure tax could be differentiated between intra-European flights and flights with destinations outside the EU as a compensatory measure. Such a differentiation would be compatible with Community legislation as long as it did not distinguish between domestic and intra-Community flights.

---

<sup>33</sup> Voluntary Approaches for Environmental Policy: Effectiveness, Efficiency and Usage in Policy Mixes, OECD June 2003, ISBN 9264101772, <http://www1.oecd.org/publications/e-book/9703091E.PDF>

<sup>34</sup> Communication on Community objectives for the 33rd Assembly of the International Civil Aviation Organisation (ICAO) and ICAO Council decisions prior to this Assembly in the field of environmental protection - COM(2000) 821

## b) VAT on air transport

According to Directive 77/388/EEC (the "Sixth VAT Directive"), Member States should tax national passenger transport services either at the standard rate or at the reduced rate. Currently, domestic air passenger transport is subject to VAT in all except four Member States (Ireland, Denmark, the UK and Malta).

However, international air passenger transport is exempt from VAT in all Member States. Intra-Community air passenger transport is also exempt from VAT (except in Slovakia, where it is not legally excluded as an option).

The exemption from VAT of international passenger air transport (including intra-Community transport) is based on a "standstill" provision in the Sixth Directive (Article 28(3)(b) and Annex F17). This allows Member States to continue the exemption if it had already been applied by the time the Directive entered into force in their territory. This is an optional exemption: Member States can always renounce it. However, if they do introduce VAT on these services, they cannot reverse the decision at a later stage.

If the Commission were to propose the taxation of domestic and intra-Community air passenger transport, the Sixth VAT Directive would have to be amended to restrict the exemption provided for under Annex F17 just to international passenger transport from origins and to destinations outside the EU. Furthermore, if there were to be a single VAT rate (either the standard rate or the reduced rate), amendment of Article 12 of the Directive would also be necessary.

Different fiscal treatments and different approaches to charging for infrastructure can distort competition between transport modes. The main argument used for the EU introducing VAT on air travel is to remove one source of distortion between transport modes, since some Member States tax intra-community rail and bus services.

VAT is by no means a tax designed to address climate change issues. While the application of VAT to air transport would be fully consistent with, and could contribute to, reducing the climate impact of aviation by reducing demand, it would not provide a specific incentive to reduce emissions. Therefore, this option should only be implemented if other policy objectives warrant it or if possible alternatives prove undeliverable.

## c) Removal of public subsidies

In principle, the removal of public support (in various forms such as capital injections, loans or State guarantees) from an existing activity with external environmental costs can be an instrument for realising environmental objectives.

However, public subsidies to the aviation industry are currently illegal, save for rescue aid or restructuring aid and those cases of this nature that do exist are subject to strict controls under the State aid provisions of the EC Treaty. In the present context, therefore, the removal of subsidies would not offer a significant opportunity for environmental improvement.

### 3.4. Existing actions that need to continue and/or be strengthened

#### 3.4.1. Raising awareness of air transport users

Raising the awareness of consumers about the effects of their behaviour could directly influence one or more of the following factors:

- choice of mode of transport;
- choice of destination;
- choice of airline.

In reality, these choices are subject to constraints, and increased awareness will not necessarily lead to a change in behaviour. Nevertheless, raising users' awareness could have two separate functions.

First, it would allow them to make *more informed choices* and stimulate demand for environmental technologies by promoting products and services whose environmental impacts are lower.<sup>35</sup>

Second, it could also help *to increase public acceptance of other policies* designed to reduce the impact of aviation on climate change. If consumers are better informed about the impact they are causing on the climate while flying – or by buying goods transported by air - they are likely to better understand action in this domain, even if they result in a rise in the price of air transport.

Responses to the public consultation (see Section 6 and Annex 3) give some indication of what type of information citizens believe would influence their choices most as regards how often they fly, where they go, or which airline they travel with. Specific comparisons between different airlines on a given route and specific information provided during the flight were thought to be important by most respondents, while information in the media and at the time of booking a flight could also be effective in raising awareness.

Raising consumer awareness could also help encourage consumers to pay a supplement on the flight ticket or airfreight cost to offset the impact of the flight by using the revenue to finance emission reductions elsewhere.<sup>36</sup> However, on its own, this voluntary measure would not give airlines and manufacturers any incentive to make investments in cleaner technologies and renewable aircraft fuels in the long term. Moreover, examples from the liberalisation of the electricity market and the concomitant option to buy “green” electricity show that only a small fraction of consumers are willing to pay voluntarily, unless everyone is required to pay. This means that equity concerns and the problem of ‘free riders’ would arise if only a

---

<sup>35</sup> Communication from the Commission to the Council and the European Parliament, Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European Union, 28.1.2004, COM(2004) 38 final

<sup>36</sup> Such voluntary schemes already exist – see for example <http://www.atmosfair.de/> or [http://www.myclimate.org/EN/ticket/ticket\\_insert1.php](http://www.myclimate.org/EN/ticket/ticket_insert1.php)

subset of passengers or airfreight users volunteered to offset the greenhouse gas emissions of a flight.

Consumer awareness might also be raised by measures other than those described above, for example the dissemination of information about the impact of aviation on climate change in travel brochures or on travel websites.

Consumer awareness raising measures are unlikely on their own to have a significant effect on demand for air services, or to channel that demand towards more efficient operators. Nevertheless it can provide a useful reinforcing tool for other policy action and help to increase their benefits. A key question for any action of this type is at what level it should be carried out and who would bear the cost. Community level action in this field merits further consideration.

### 3.4.2. *Improving air traffic management (ATM)*

The IPCC Special Report (1999, p.273) estimated that improvements in ATM could help to improve overall fuel efficiency by 6-12% (i.e. lower fuel consumption for a given set of aircraft operations). Typically unnecessary fuel burn arises when aircraft:

- queue with engines running before take-off;
- fly sub-optimal flight profiles (eg. longer routes, or other than at optimal altitude etc.);
- are stacked in holding patterns before landing.

IATA estimates that eliminating delays in Europe would save 1 million tons of CO<sub>2</sub> emissions.<sup>3738</sup>

A ‘gate-to-gate’ approach to ATM, using more sophisticated technologies and combinations of technologies, could mitigate or obviate altogether some or all of these current constraints with consequential environmental benefits.

ATM is primarily concerned with safety, i.e. preventing collisions between aircraft. Airspace is divided into sectors, each with a team of controllers responsible for maintaining safe separation. They might require one aircraft to change speed, fly a longer route, change flight level or otherwise fly sub-optimally. ATM interventions within a sector are currently ‘tactical’ – i.e. they are not normally co-ordinated with ‘downstream’ sectors. This both creates a capacity bottleneck and implies, environmentally speaking, sub-optimal manoeuvres.

To alleviate this situation two concepts emerged in the 1990s:

---

<sup>37</sup> <http://www.iata.org/pressroom/pr/2005-03-18-01.htm>; “Environmental responsibility is a pillar of air transport industry”, of 18.03.2005

<sup>38</sup> This has to be seen in the light of the total EU aviation greenhouse gases which are in the order of 130 Million tonnes.

- ‘free flight’ – i.e. giving pilots information about neighbouring traffic and delegating to them accountability for safe separation;
- four-dimensional trajectory planning – i.e. extending the planning horizon beyond the single sector and thus sustaining separation by small speed adjustments in advance rather than less efficient adjustments close to or at the last minute.

Subject to further analysis, balanced use of these concepts might achieve environmental benefits via the application or one or more of the following operational practices:

- better management of departures at airports;
- use of more optimal flight paths;
- reduced distances flown;
- combining advanced technologies to obviate some traffic control limitations e.g. to ease some constraints on flight levels;
- further improvement of flow management to avoid holding patterns before landing;
- continuous descent approaches (also beneficial in terms of noise reduction).

These ideas are currently being explored by EUROCONTROL in the framework of their 20 year strategy, ATM 2000+, although some may emerge by 2010. This in turn needs to be seen in the context of the Single European Sky (SES) initiative, legislation on which was adopted in 2004. It provides the regulatory and institutional basis for de-fragmented, inter-operable European Air Traffic Control. We are now in the implementation phase, the technical element of which (‘SESAME’) will enable the co-ordinated and synchronised development and deployment of new generations of ATM systems. The implementation of SESAME is foreseen to take place gradually over the period 2008-2020

### 3.4.3. *Research and development in air transport technology and operations*

The European Community has made “Aeronautics” one of its Research and Development priorities with the ambition of minimising the environmental impact of aircraft. Its initial funding of €66 million for the pilot phase in the Second Framework Programme (FP2) in 1990-1991 has grown to €840 million for 2002-2006 in the Sixth Framework Programme (FP6). More than 350 research projects have been funded at a total cost of €4 billion. It is estimated that about 30% of this research has been dedicated to activities designed to reduce the environmental impact of aircraft, in particular CO<sub>2</sub> and nitrogen oxides (NO<sub>x</sub>). It includes research and development on advanced technologies and subsystems for aero-engines but also on technologies related to lighter airframes or improved aerodynamics and systems.

Furthermore, European Aeronautics, in its Vision 2020 report,<sup>39</sup> recognised the environment to be one of the key challenges for the future development of aviation and has set ambitious goals to reduce any risks that aviation might be causing damage to the climate. Indeed “The Strategic Research Agenda” developed by ACARE<sup>40</sup> has established a High Level Target Concept on the Greening of Air Transport with a plan for research and technology development for the next 15 years.

Low-NO<sub>x</sub> projects are a good example of research and development which contributed significantly to the development of NO<sub>x</sub> reduction technologies in the Second, Third and Fourth Framework Programmes. This work was further extended in the Fifth and Sixth Framework Programmes by two major aero-engine research projects:

- EEFAE (“Efficient and Environmentally Friendly Aero Engine”)
- VITAL (“EnVIronmenTaLly Friendly aero-engines”).

Together they attempt to meet the difficult challenge of researching, developing and demonstrating the potential of advanced technologies to reduce substantially the CO<sub>2</sub> and nitrogen oxide emitted by aero-engines. These technologies should be available in 2009 and could in the future cut up to 18% of the CO<sub>2</sub> emitted compared with the levels achieved by the best engines of 2000, and some 60% or more of the NO<sub>x</sub> emissions with respect to CAEP2 standards.

This research is fully in line with the ambitious goals set by ACARE for 2020 to develop and demonstrate technologies able to reduce fuel consumption (and hence CO<sub>2</sub>) by 50%, and NO<sub>x</sub> by 80%. Whereas significant progress is already being made, these targets still remain very challenging and much more research and development will be needed in the future, in particular on aero-engines but also on aero-dynamics, structures and on-board systems.

The Seventh Framework Programme will place even more emphasis on all of the above themes than under the previous Framework Programmes. The “greening” of air transport will be an essential activity for the future. It will include: *“the reduction of emissions and noise disturbance, incorporating work on engines and alternative fuels, structures and new aircraft designs, airport operations and traffic management”*.

Further research into alternative fuels, including synthetic kerosene, may reveal additional potential for reducing greenhouse gases emitted by aircraft. Some preliminary research has already taken place within the CRYOPLANE project into the possibilities of using hydrogen as aviation fuel. Without prejudging the solutions

---

<sup>39</sup> « European Aeronautics: A Vision for 2020 ». A report of the Group of Personalities chaired by the Commissioner Philippe Busquin. January 2001.

<sup>40</sup> ACARE (Advisory Council for aeronautics Research in Europe). Launched in 2001, it is the first operational example of a Technology Platform. It is comprised of 39 members representing all the stakeholders: Member States, Commission, manufacturing industry, academic and research centres, airlines, airports, Eurocontrol and certification authorities. ACARE has published 2 editions of its Strategic Research Agenda (October 2002 and March 2005)

which might emerge in the future, it is clear that much more research is needed to develop viable alternative fuel options.

In addition to the research and development of new technological and operational solutions to reduce aircraft emissions, assessment and better understanding of the impact of these emissions on climate change is also of paramount importance in order to take the right policy decisions and measures. This research commenced under FP4 and FP5 with a series of projects such as MOZAIC I to III, SCENIC and TRADEOFF. Under FP6 the Integrated Project QUANTIFY pursues this research and should help to reduce the uncertainties of the climate impact (RF) figures associated with the different transport sectors. Climate impact research will remain a priority under the Seventh Framework Programme.

#### 3.4.4. *Applying energy taxation to commercial aviation*

Based on a policy developed at international level during the infancy of civil aviation, it is now common for States to exempt fuel used for international air services from energy and similar taxes – a policy converted into mutual legally binding commitments in the many bilateral air service agreements concluded between States.

Historically, climate change concerns have not been the key driver behind the imposition of energy taxes, which were typically more motivated by fiscal and security of supply concerns. In this context, the exemption for aviation raises fundamental questions about equal treatment across sectors, the internal market, and general transport taxation policy.

In recent years, however, environmental objectives have increasingly also been highlighted as an argument for abolishing the exemptions for aviation. While energy taxation is in the first instance a fiscal instrument, the imposition of an energy tax on aircraft fuel would have significant environmental side-benefits as well. In this light, it is therefore relevant to consider the extent to which progress in its application could contribute to the achievement of the policy objectives of the present proposal.

Following the adoption of the energy products taxation directive,<sup>41</sup> Member States have the option to waive the exemption for fuel used for domestic flights and, subject to mutual agreement, for flights between EU Member States.

Member States can therefore already now and within the existing legislative framework introduce fuel taxation for *domestic flights*. So far, only the Netherlands has decided to do so.

Subject to mutual agreement, fuel taxation can also be introduced for *flights between two Member States*. However, in such cases it could be difficult to avoid discrimination on routes where non-EU third country carriers have traffic rights *and* continue to enjoy tax exemptions under the relevant bilateral air service agreements. Despite significant recent progress by the Commission and Member States, many bilateral air service agreements still contain legal obstacles to applying fuel taxation

---

<sup>41</sup> Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity



on an equal basis to EU and third country carriers even within the EU. The same goes for flights between EU and third countries, where, in addition, current EU legislation still provides for a mandatory exemption which cannot be waived.

Overall, the extension by Member States of energy taxation to aviation could provide side-benefits in terms of greenhouse gas reductions relatively quickly, but only to a limited extent. Domestic flights represent only about 10 % of emissions from all flights departing from EU airports. Extending the coverage to other types of routes is also already legally feasible, but in most cases would require further progress in the ongoing reform of the bilateral air service agreements. While negotiations have been launched with several third countries, and numerous agreements have been changed,<sup>42</sup> the process will take time. Moreover, the actual decision to tax remains with Member States. Although potentially helpful in terms of environment, the wider application of energy taxes to aviation is thus only likely to materialise in the medium to long term and is therefore not an option which can currently be considered sufficiently robust as the basis for a strategy for achieving the policy objectives set out above.

#### 3.4.5. *Improving the competitiveness of rail transport*

Substitution of air transport by alternative modes of transport is often highlighted as a potential way of reducing overall emissions. This suggestion came up frequently in the public consultation (see Section 6).

In this context the encouragement of modal shift from air to rail is particularly important. One of the objectives of the common transport policy as set out in the Commission's White Paper on European Transport Policy for 2010<sup>43</sup> is to allow rail to maintain its modal share in 2010 at the levels of 1998. In order to achieve this objective, several measures have been proposed and adopted by the Council and the European Parliament. The main feature of this policy until now has been to separate transport operations from the management of infrastructure to allow railway undertakings access to the infrastructure of other Member States for transport of goods by rail. The market will be thrown fully open on 1 January 2007. In 2004, the Commission adopted a proposal for a Directive to open the market for international passenger transport by rail in 2010 at the latest. The Commission's proposal includes a provision to allow cabotage on international services.<sup>44</sup> Passenger transport by rail has been stable in recent years, though conventional long-distance services have suffered from the emergence of high-speed services and low-cost air carriers. By 2010, large sections of the high-speed network funded under the Trans-European Transport Network will be operational. Market opening will encourage optimal use

---

<sup>42</sup> Close to 200 bilateral agreements have already been amended to allow, as a first step, for the possibility of taxing fuel supplied to third country aircraft operating on intra-EU routes.

<sup>43</sup> COM (2001) 370 of 12/9/2001

<sup>44</sup> Rail Infrastructure package or 'First railway package' adopted in February 2001 (Directives 2001/12; 2001/13 and 2001/14); the second railway package ('Towards an integrated European railway area') adopted in April 2004 (Regulation 881/2004 on the European Railway Agency as well as Directives 2004/49; 2004/50 and 2004/51) and the third railway package, proposed by the Commission in March 2004, which contains a proposal for the opening of the market for international passenger transport by rail (COM(2004)139) as well as a Regulation Rail Passengers' Rights (COM(2004)143).

of this infrastructure, and make a significant contribution in substituting short-distance flights with medium to long distance high-speed services.

The environmental impact of this substitution is likely to be modest in the short term as long-distance (international) rail transport only has a modest share of overall transport volumes. In the longer run, it is expected to increase as the full potential of the high-speed network is exploited. However, as rail transport generally also causes greenhouse gas emissions – and especially high-speed rail – the relative environmental benefit also depends on load factors and the future technological development of the two modes.

Moreover, while improving the competitiveness of rail in principle could in principle help curb the growth in emissions attributable to air transport, it will not contribute to the other objectives considered here, i.e. to provide stronger economic incentives to improve environmental performance and to better reflect the true costs of air transport in the price.

Therefore while current efforts to improve the competitiveness of European rail transport must continue they will not be sufficient to substantially change the current trends in aviation's climate impacts.

### **3.5. Options considered in detail in this proposal**

Policies to support improvements in ATM, to research or to increase the competitiveness of alternative transport modes have only limited or no impact on the price signals. Therefore they are complimentary rather than alternatives to the internalisation measures needed to achieve the objectives identified above.

#### *3.5.1. En-route charges or taxes on aircraft emissions and impacts*

The possibility of emissions charges or taxes has been raised, partly because of the legal difficulty of taxing aircraft fuel and partly because of the desire to find a way of more directly targeting the various environmental impacts of aircraft operations (including those not related to fuel burn). The notion of a charge – as opposed to a tax – is typically used for payments that are levied in return for some kind of service, e.g. the use of road or air space, or, in the case of environmental charges, payments that are specifically used to avoid, mitigate or offset the environmental impacts in question.

When considering aviation emissions charges or taxes, it is important to distinguish between those designed to tackle local environmental problems at and around airports, and “*en route*” charges aimed at the much wider impact of aviation's climate effects arising from emissions along the entire flight trajectory.

In 2002, the Commission published the results of a technical and legal study of “*en route charges*” aimed at mitigating the climate effect of air transport in Europe.<sup>45</sup> The analysis in Section 4.2 is essentially based on this study. Two policy variants were considered in detail.

---

<sup>45</sup> *Economic incentives to mitigate greenhouse gas emissions from air transport in Europe*, CE Delft, 2002

- An environmental charge: whereby an aircraft would incur a charge proportional to the volume of greenhouse gas emissions it discharged in EU airspace. This charge would raise revenue.
- A performance standard incentive (PSI): whereby the better an aircraft performed relative to a ‘standard’, the more money it would receive, and the worse it performed the more it would pay. The incentive would be designed to be revenue-neutral, so the sum of payments and revenues would equal zero.

In practice, a revenue-neutral performance standard incentive would correspond to a charge where revenues were recycled to industry using a measure of output (e.g. RTK) as a distribution key. As a result, such a measure could not be expected to have any significant effect on demand, and would only contribute with reductions from supply-side measures (e.g. changes in technology, operational procedures etc) which, according to estimates in the study, would reduce the environmental effect to about half of that of a charge. The analysis in Section 4 therefore focuses on the charge.

### 3.5.2. *Emissions trading for aviation*

In January 2005, the European Union Greenhouse Gas Emissions Trading Scheme (EU ETS) came into operation as the largest ever multi-country, multi-sector emissions trading scheme. Established under Directive 2003/87/EC, it covers 12,000 installations from the energy-intensive sectors of the EU economy. At the heart of the EU ETS is the common trading ‘currency’ of emission allowances. One allowance represents the right to emit one tonne of CO<sub>2</sub> (or its equivalent in other greenhouse gases). Member States draw up national allocation plans covering a specific time period, which give each installation in the scheme permission to emit a certain amount of greenhouse gases (that corresponds to the number of allowances subsequently received by that installation in its account in the electronic registry keeping track of all the allowances issued). The limit or ‘cap’ on the total number of allowances allocated creates the scarcity needed for a trading market to emerge, and thus delivers the environmental benefit. Companies that keep their emissions below the level of their allowances are able to sell their excess allowances at a price determined by supply and demand at the time. Those facing difficulty in remaining within their emissions limit have a choice between (a) taking measures to reduce their emissions, such as investing in more efficient technology or using a less carbon-intensive energy source, (b) buying the extra allowances they need at the market rate, or (c) a combination of the two, whichever is cheapest. This ensures that emissions are reduced in the most cost-effective way.

Aviation currently lies outside the scope of the EU ETS. In principle it could be included in the EU scheme in two ways:

- The European Commission could make a proposal for the inclusion of new sectors, to be decided by co-decision since it would require an amendment of the Directive.
- EU Member States could, on a unilateral basis, apply for the inclusion of new sectors (‘opt-in’). This option is already allowed by the Directive, but it would be subject to both Commission and Member State approval.

Given the level of integration and competition in the internal aviation market and the specificities related to the accounting of emissions from international aviation under the UNFCCC, only a Community-wide approach is considered realistic. While a global, uniform system would ideally be preferable, this is not a realistic option at the present time. ICAO has recognised this by discarding the idea of a global system based on a new legal instrument set up under ICAO auspices. In contrast, the idea of incorporating international aviation emissions into states' existing trading schemes has been endorsed.

To be environmentally effective, any scheme should in principle cover as many emissions as possible. The following types of flights could be considered:

- domestic flights in EU Member States
- “intra-EU flights”, i.e. flights departing from *and* arriving at an airport in the EU
- international flights departing to/arriving from non-EU countries

To avoid unfair distortion of competition with third country carriers, only those scenarios in which all carriers or operators are treated equally should be considered.

Including aviation in the EU emissions trading scheme would require consideration of many design options, including how the full climate change impact of aviation emissions can be taken into account. A feasibility study on the possibility of including aviation in the EU ETS was prepared for the Commission and has been used as a key input in the analysis of impacts.<sup>46</sup>

### **3.6. How are subsidiarity and proportionality taken into account?**

The single market in air transport services within the EU is now a reality. If each Member State were to define its own approach to tackling the climate impact of aviation, this could easily result in different and potentially inconsistent approaches, which could distort competition. Experience and developments so far show that is difficult for a single Member State in isolation to address the problem effectively. This is borne out by the Council's repeated calls for the Commission to present proposals to address the problem. Nevertheless, Member States *do* retain competence in some areas of potential relevance for the various options. For instance, they are already permitted to introduce taxation on aviation fuel used for domestic purposes and, based on mutual agreement, for flights to other EU Member States.

## **4. ANALYSIS OF IMPACTS**

*Summary:* The environmental, economic and social impacts of (a) emissions charges and (b) emissions trading have been analysed in two different studies carried out for the Commission. The analysis provides an overview of the likely effects in qualitative terms and summarises the specific findings of two studies. Including

---

<sup>46</sup> [CE2005] Giving wings to emission trading, CE Delft, July 2005. See [http://europa.eu.int/comm/environment/climat/pdf/aviation\\_et\\_study.pdf](http://europa.eu.int/comm/environment/climat/pdf/aviation_et_study.pdf)

aviation emissions in the EU Emissions Trading Scheme would be effective both by reducing emissions in the aviation sector and through reductions made in other sectors and paid for by the aviation sector.

It was shown in Section 3 that the most effective measures for achieving the three policy objectives set out in Section 3.1 are:

- emissions charges;
- emissions trading.

Both options are economic instruments, which would lead towards internalisation of the external costs of climate change in prices. Each could, in principle, be designed to achieve the same level of emissions reduction, and in this sense their impact depends less on the instrument than on their design.

Because there are so many possible design parameters, it is not possible to analyse all the conceivable variations, and as this is a strategic proposal there is no point in doing so, since any detailed design assumptions would be somewhat speculative at this stage.

In accordance with the **principle of proportionate analysis** the likely impacts of each of the options are discussed and explained mainly in qualitative terms but illustrated with quantitative examples based on scenarios analysed in two studies produced for the Commission. Any possible future legislative proposal would be accompanied by another more detailed Impact Assessment.

#### 4.1. Comments on the studies and scenarios used

In the following analysis, conclusions regarding charges are based on [CE2002]<sup>47</sup> and conclusions regarding emissions trading are based on [CE2005]. Both studies analyse a range of options and combinations of design parameters.

The charges study analyses scenarios combining three different CO<sub>2</sub>-charge levels (€10, €30 and €50/tonne), with and without an additional charge on NO<sub>x</sub> of up to €6.0 /kg. All options are based on emissions in EU airspace.

The emissions trading study looks at three scenarios reflecting different combinations of choices of key design parameters, such as coverage of flights, coverage of non-CO<sub>2</sub> impacts, and allocation of allowances.

**The different options and results for charges and those for emissions trading are not directly comparable.** The analysis below therefore provides an overview of the likely effects in qualitative terms and summarises the specific findings of the two studies. **To make a comparison possible and to make the differences more transparent, a number of extra assumptions must be made, as explained in Section 5.**

---

<sup>47</sup> Economic incentives to mitigate greenhouse gas emissions from air transport in Europe, CE Delft, 2002.

## 4.2. Environmental impacts

This summary of the environmental effects of the two options is based on the scenarios contained in the two key studies, and covers only CO<sub>2</sub> and NO<sub>x</sub>. (For a more detailed discussion of these and other impacts see Annex 2 and [CE2005]).

### 4.2.1. Charges

The environmental impact of a charge would be the result of two different factors: firstly, airlines would have an economic incentive beyond that provided by fuel costs alone to improve efficiency further and cut emissions to the extent justified by the corresponding savings in the charges payable (supply-side measures). Secondly, to the extent that increased operating costs arising from such a measure were passed on to users, demand could be reduced (compared to a business-as-usual scenario) because of the higher cost of air transport (demand-side effects).

According to [CE2002], an emissions charge on CO<sub>2</sub> and NO<sub>x</sub> would reduce the forecast CO<sub>2</sub> emissions from aviation in EU airspace in 2010 by almost 2% (equivalent to 2.9 Mtonne CO<sub>2</sub>)<sup>48</sup> at the lowest charge level (€10/t CO<sub>2</sub> and €0/kgNO<sub>x</sub>), or by as much as approximately 13% (equivalent to 19.9 Mt CO<sub>2</sub>) at the highest charge level (€50/t CO<sub>2</sub> and €6/kgNO<sub>x</sub>).<sup>49</sup> For the same scenarios, the estimated NO<sub>x</sub> reductions varied between -2% and -15%. Over the medium term (10 years), these reductions are roughly equally attributable to supply-side responses by airlines (technical and operational measures) and to reduced demand for air transport.

If there were a charge for CO<sub>2</sub> only, it was estimated that CO<sub>2</sub> emissions would be reduced by 1.9% and 5.9% for charge levels at €10 and €30/tonne CO<sub>2</sub>, respectively. Even with no charge for NO<sub>x</sub> emissions, these were estimated to fall within the time horizon considered (2002-2010) because demand effects and the majority of supply-side measures available in the short term imply synergies rather than trade-offs between reductions of CO<sub>2</sub> and NO<sub>x</sub>. The relative reductions in NO<sub>x</sub> would be comparable to those of CO<sub>2</sub> for both charge levels (2.0 & 6.1% respectively).

### 4.2.2. Emissions trading

The environmental impact in this case would fully depend on the overall objective set for the aviation sector, together with that set for the other sectors that are already part of the EU ETS. However, for illustrative purposes, the scenarios in [CE2005] make assumptions about the environmental objective set. All three scenarios assume that aviation emissions are capped at their 2008 level. The cap for the other sectors that are already part of the EU ETS is implicitly derived by assuming two different allowance prices: €10/tCO<sub>2</sub> and €30/tCO<sub>2</sub>. The analysis demonstrates what effect this overall cap would have in 2012 compared to the reference scenario (business-as-usual). As the scope of flights covered varies between the scenarios, the absolute reductions differ. In relative terms, however, the reductions are purely a function of the same assumptions regarding the cap and the baseline growth – in this case

---

<sup>48</sup> These figures are based on the results from the CE 2002 study, but have been corrected to take into account the improved quality of available data on aviation emissions, in order to be consistent with more recent estimates presented elsewhere in this study.

<sup>49</sup> The forecasting period of this study was 2002-2010, the charge being introduced in 2002.

corresponding to a reduction of 19.9-25.9 MtCO<sub>2</sub> in absolute terms or 15%<sup>50</sup> compared with baseline CO<sub>2</sub> emissions.

In all three scenarios, for the allowance prices considered (€10/tCO<sub>2</sub> and €30/tCO<sub>2</sub>), the majority of emissions reductions are made in other sectors because of the lower abatement costs. For the scenario that can best be compared to the charging scenarios (“Option 3”),<sup>51</sup> the estimated reduction within the aviation sector in 2012 corresponds to about 1-3%<sup>52</sup> of baseline emissions (depending on the allowance price assumed), whereas the remaining reductions are made in other sectors but paid for by the air transport operators participating in the EU ETS. For the scenarios analysed, this transfer would be in the order of €128-744 million<sup>53</sup>, a figure obviously heavily dependent on the stringency of the cap imposed and on the actual price in the allowance market.

As with the charging study, [CE2005] estimates that even though all scenarios analysed assume that the obligations to surrender allowances are established only in respect of actual CO<sub>2</sub> emissions or a multiple thereof (i.e not as a function of e.g. NO<sub>x</sub> emissions), NO<sub>x</sub> emissions would also fall, at least in the short to medium term. The reasoning behind this is the same as for charges (see above). [CE2005] recommends that the potential adverse effects from any longer term CO<sub>2</sub>-NO<sub>x</sub> trade-offs in engine design should be addressed through other measures such as NO<sub>x</sub> airport charges.

### 4.3. Economic impacts

Both options would have some direct and indirect economic impacts at sectoral level (on air transport and other transport modes, on upstream and downstream sectors, and, under the emissions trading option, on the other sectors participating in the EU ETS). They would also have a direct impact on consumers, and in some cases on government revenue. The macroeconomic level (GDP growth and employment) could also be indirectly affected. Finally, the impacts on regions and countries throughout the EU could be different.

#### 4.3.1. Macroeconomic impacts

Macroeconomic impacts are complex as they result from both negative and positive direct and indirect effects. Other things being equal, a reduction in aviation activity and in air transport demand meaning a slight decrease in the business-as-usual

---

<sup>50</sup> Scenario 1 differs in this respect as it assumes that non-CO<sub>2</sub> impacts are integrated and capped in the EU ETS through an approximate multiplier of 2 on CO<sub>2</sub> emissions. The implication is that in this scenario any growth of CO<sub>2</sub> emissions beyond 2008 levels would have to be compensated by buying double the amount of allowances from the other EU ETS sectors. The corresponding figure for the implied relative reduction would be 28-29 %.

<sup>51</sup> This scenario assumes coverage of CO<sub>2</sub> and flights in EU airspace only and 100% auctioning of allowances.

<sup>52</sup> As pointed out in [CE2005], this result is not directly comparable to those from the study [CE 2002] on emission charges. One methodological difference is related to the way supply-side effects have been estimated and included. Because of the shorter time horizon in the analysis in [CE2005] (2008-2012) compared to that of [CE2002] (2002-2010), supply-side measures have been assumed not to occur to the same extent – see [CE2005] for a detailed explanation.

<sup>53</sup> From 10€/ton \* 12,8 Mt<sub>CO2</sub> to 30€/ton\*24,8 Mt<sub>CO2</sub> – see also [CE2005].

growth scenario of 4% per annum, would be more likely to lead to a small redistribution of future GDP growth rather than a decrease. This is because demand for goods and services (food, holidays, etc.) is unlikely to change unless there is no alternative to air transport for sourcing a particular category of goods or services. For example, a consumer not wishing to pay more for a product transported by air would probably choose another similar product which had not been shipped by air. That consumer's disposable income, and hence overall demand in the economy, would only be reduced if the consumer had no choice but to pay the increased price because the product demanded is only ever transported by air. Therefore, lower growth in the income and employment levels of airports, aircraft manufacturers, and all activities which make use of air transport, might be offset by positive effects in the form of increased employment and income levels generated from substitute activities (e.g. activities related to more local tourism alternatives, other transport modes, etc.).

Where the introduction of an economic instrument would lead to government revenues,<sup>54</sup> the macroeconomic effects depend on how that revenue is used. If a government chooses to increase public spending, there would only be short-term expansionary effects. If a government chooses to use the revenues to decrease levels of conventional taxes on e.g. private income or company profits, overall societal welfare levels would increase, since addressing an environmental issue has coincided with conventional tax reductions.

However, in any event, in terms of overall GDP growth and employment, the net impact would be very small for the scenarios envisaged in the above mentioned studies. In order to give an idea of the order of magnitude, it is helpful to refer to a simulation of the impact of an increase in VAT using the Commission's QUEST model, where the revenue is used to reduce direct taxes. While VAT is different as regards the sectoral scope of the tax base, it can be considered that, in the medium term once the effects have spread through the economy, most of the results should more or less – in proportion to their revenue – hold true for other indirect taxes or equivalent economic instruments, such as an aviation emission charge or an emissions trading scheme, in that all of them have an effect on the prices of goods and services. The QUEST simulation showed that the impact on GDP of an increase in VAT generating revenue in the order of €3-4 billion, equivalent to revenue from an emission charge of €30/tCO<sub>2</sub>, would be approximately - 0.002% after 1 year, and +0.026% after 10 years. Even though this simulation can only give a rough idea of the impact of the scenarios considered and does not include effects on income distribution among economic stakeholders, it shows that the overall order of magnitude for the economy as a whole is very small. It is furthermore important to note that while it might not be reflected in the conventional macro-economic indicators, the internalisation of at least a part of the external environmental costs of aviation's climate impact would have a positive impact on overall welfare.

---

<sup>54</sup> For example, according to [CE2002], an emissions charge would generate revenues in 2010 of between 1 bn € at the lowest charge level, up to 8,6 bn € at the highest charge of € 50 per tonne of CO<sub>2</sub> and € 6 per kg of NOx.



#### 4.3.2. *Impacts on the aviation sector*

The total operating results of airlines are determined mainly by the profit margin per unit transported, and market share in combination with the size of the air transport market. [CE2002] concluded that in the case of a charge, both EU and non-EU carriers are likely to pass on the whole of the charge to their customers. Similarly, [CE2005] argues that actual cost increases would be passed on under emissions trading (depending on whether allowances are allocated for free or are auctioned), thus enabling carriers to maintain the same profit margins. If both types of measures would be applied equally to EU and non-EU carriers there would be no significant effects on their competitive position. However, as it can be assumed that the elasticity of demand is higher if the ticket price is lower, it is likely that the reduction in demand resulting from a price increase on a low fare ticket is much more important than on e.g. a transatlantic flight ticket. In this respect, different effects on the different market segments can not be excluded. Second-order effects such as cross-subsidisation by carriers using profits generated on routes outside the scope of the measure towards routes covered by the measure could in principle have an effect. However, as neither measure would affect the profits of non-EU airline companies on routes outside their scope they would not free up any extra funds for cross-subsidisation. Both studies concluded that second-order effects would be very small.

The main economic impact on airlines would therefore be a reduction in future forecasted demand, meaning a lower rate of growth in air traffic. The impact on demand would depend on its price elasticity, taking into account substitution by other transport modes (substitutability with land transport is generally low except on certain short-haul routes) and between destinations (substitutability is lower for business than for leisure flights). [CE2002] estimated that growth in demand on routes in EU air space covered by a CO<sub>2</sub> charge of €10 to €50 per tonne would be lowered by a cumulative amount of 1.0 to 4.5% over 8 years compared with the reference scenario in 2010. Since the reference scenario is predicted growth of 4% per annum for the intra-EU market, the reduced growth in demand due to the introduction of an emission charge of €50 per tonne CO<sub>2</sub> would thus equal just one year of autonomous demand growth over 8 years. For routes to and from the EU the reduced growth in demand due to the charge would be less than six months of autonomous demand growth.

Similar arguments apply to emissions trading. The impacts on operating results would again depend mainly on demand which, for equivalent allowance price and charge levels, would in principle be the same. For the three scenarios analysed, the reduced growth in demand over the time horizon used (2008-2012) would vary from 0.1 to 2.1 % (for CO<sub>2</sub> allowance prices of 10 € to 30 €), which should be seen against a baseline assumption of about 4% growth *per year*, i.e about 17%.

#### 4.3.3. *Impacts on ticket prices*

The two studies both give estimates of initial price increases. In the case of a €10/tCO<sub>2</sub> charge, the increase in price of a return flight for an individual passenger would be in the order of €1 to 4. At the higher end of the range of charge levels considered, a €50 charge with a complementary NO<sub>x</sub> element would imply increases of €5 to 29 per flight per passenger.

With emissions trading, the scenarios analysed, with CO<sub>2</sub> allowance prices of €10 and €30, were estimated to lead to an initial price increase of €0.2 to 9 per return flight for an individual passenger (remember that these estimates are *not* directly comparable. A comparison is made after the necessary adjustment in Section 5)<sup>55</sup>.

#### 4.3.4. *Impacts on freight transport*

Neither of the studies specifically examined the impacts on freight costs. However, some comments can be made. Goods moved by air tend to be of high value in order to offset the generally higher cost of using this mode. The ICAO reported that the world air cargo sector grew 13% in 2004 and currently forecasts that strong growth will continue. The airlines could be expected to pass on to those who use their freight services any increases in the costs of providing these services, occasioned either by an emissions charge or inclusion in an emissions trading scheme. However, there is no reason to assume higher relative price increases for freight than for passenger transport. Given the modest price increases envisaged, the buoyancy of this segment of the sector, and the relatively high value of goods involved, the most likely initial impact would be a marginal reduction in the rate of growth. To illustrate, some industry forecasts that cargo traffic growth will average 6.2% per year for the next 20 years, so the relative effect of all the charging and emissions trading scenarios considered in the two studies would be marginal.

#### 4.3.5. *Impacts on other sectors participating in the EU ETS*

An aviation emissions charge would have no particular impact on sectors participating in the existing EU ETS, apart from the general impacts that would apply equally to other sectors (e.g. from the price of air transport services, or the positive effects of redeployment of revenue generated by the charge).

The inclusion of aviation in a closed emissions trading scheme would have the same impact on non-aviation sectors as an emissions charge. However, incorporating aviation into the EU ETS would, in principle, have a more direct impact on those already participating in the scheme. Including aviation emissions under the EU ETS cap would work both through supply and demand side emission reductions in the aviation sector and through reductions made in other sectors and paid for by the aviation sector.

The scenarios in [CE2005] illustrate this point. In all of them, the majority of emissions reductions are made in other sectors. Although the share reduced within aviation increases as the market price of CO<sub>2</sub> increases, it remains low (up to about a quarter) at an allowance price of €30/tonne. This is because, in the short term at least, aviation is expected to have higher relative costs for reducing emissions compared to the current options available within the EU ETS (from those in the scheme and from those outside who generate credits under the flexible mechanisms: Clean Development and Joint Implementation).

---

<sup>55</sup> It is here assumed that only actual additional operational costs would be reflected in the prices. If opportunity costs were passed on in full the increases could be higher, but would result in windfall profits to the operators.

Whether or not abatement costs increase across the expanded EU ETS depends entirely upon the overall cap set (and therefore the emissions reduction effort required) and the extent to which use is made of the Kyoto flexible mechanisms. If the allowance price were to rise as a consequence of aviation's inclusion in the EU ETS, it would be because allowances become scarcer and depend on how much scarcer, i.e. on the environmental objective set.

Under the EU ETS scenarios analysed in [CE2005] (assuming a cap on aviation's emissions at 2008 levels), the estimated amount of allowances that aviation would buy in the year 2012 ranges from 12,8 to 24,8 MtCO<sub>2</sub>. This corresponds to slightly more than 1% of the allowances allocated for the 2005-2007 period (figures for 2008-2012 will not be available until autumn 2006). To put this into perspective, it has been estimated that variability in demand for allowances due to natural weather fluctuations is significantly greater than this range. Based on results from the Primes model for the EU-25 an additional demand in 2010 of the order of 25 Mt would be expected to cause a price increase of about €2/tCO<sub>2</sub> for allowance prices in the range of €10-30/tCO<sub>2</sub>. Any such price increase would have different impacts on the participants of the existing scheme, where there as in any market will be both winners and loser as a result of price changes. However, seen as a whole, these participants from the existing scheme are winners because the extra compliance costs associated with freeing up the allowances sold to the aviation participants are more than compensated by the price that the aviation participants pay for these allowances.

#### 4.3.6. *Impacts on peripheral and isolated regions*

Any impact on peripheral regions will depend on the policy's effect on prices. For a comparable environmental impact this would be lower with emissions trading linked to the broader regime, than for closed trading or charges. As explained earlier in the section, with an open emissions trading regime the level of price change is likely to decrease the rate of growth in demand only to a limited degree. Therefore the overall effect on prices and demand, and therefore on peripheral regions, would be small.

Places with high dependence on aviation for transport (islands, isolated areas, peripheral regions) would be affected more than regions that have less or no dependence on aviation. In some cases this could shift traffic to other modes while in others there may be no realistic alternative to aviation. In these latter cases, EU legislation provides for the possibility of creating public service obligations, supported by appropriate public funding.

#### 4.3.7. *Impacts on tourism*

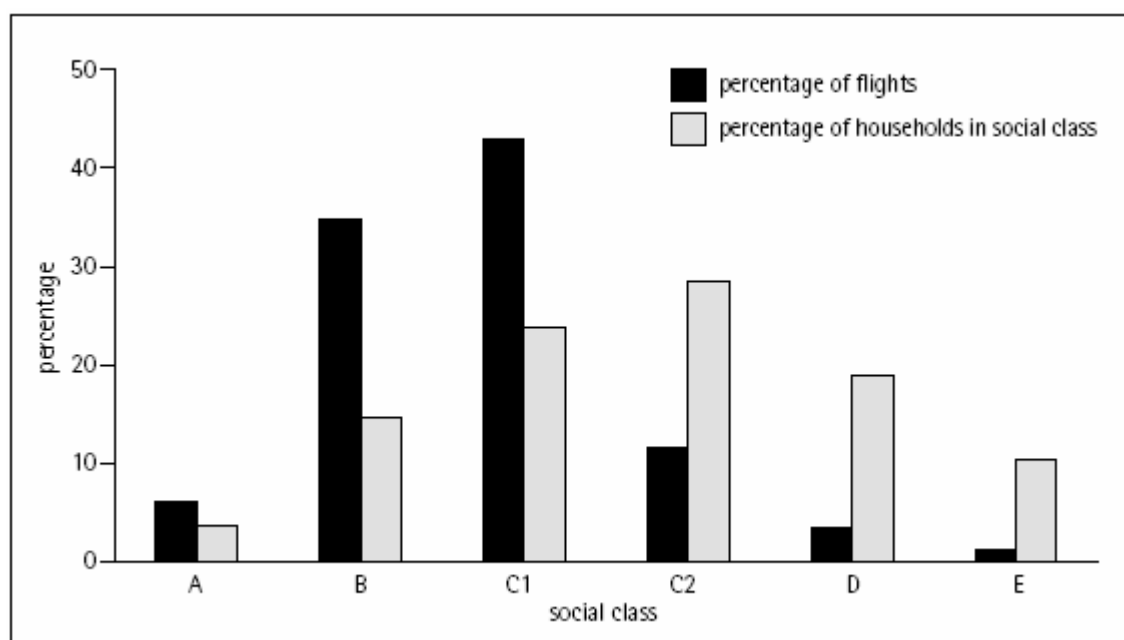
As mentioned above, any aviation emissions charge, European or worldwide, would favour short-distance over long-distance tourism. Thus the charge would help reverse the current trend of choosing tourist destinations further and further away, and thus increase environmental efficiency. It is not distortion of competition, but instead encourages more efficient allocation of (environmental and financial) resources in the economy as a whole. However, the impact on the spatial distribution of tourism would have distributional economic effects: regions that could be reached by other modes of transport would find tourism increasing and regions with a high proportion of aviation-based tourism would have lower growth rates.

Similar considerations apply to emissions trading. At comparable marginal cost impacts for the aviation industry (i.e. assuming a charge rate set at a level comparable to the price level of the EU ETS allowance market) the impacts would be the same. However, for the same environmental outcome, the impact on demand and thus on tourism would be smaller under emissions trading than under charges, as explained in Section 5.

#### 4.4. Social impacts

A recent study from the United Kingdom<sup>56</sup> pointed out that “despite the fall in relative prices, leisure air travel remains highly skewed towards the better off”. Using 1999 figures from the UK it showed that on average people from the top three social classes took more than four times as many flights per year than those in the bottom three.

The study also showed that even for low cost flights, higher social classes represent a disproportionate share of the customers compared to their numbers – this trend is illustrated in Figure 5.



**Figure 5: Distribution of low costs flights by social class in 2001 (Source: IPPR & UK CAA<sup>57</sup>)**

<sup>56</sup> “The sky’s the limit”, Grayling & Bishop, Institute for Public Policy Research, United Kingdom, 2003

<sup>57</sup> Definition of the social classes used :

A Professional people, very senior managers, or top-level civil servants.

B Middle management in large organisations, top management or owners of small business concerns with appropriate qualifications, principle officers in local government and civil service, educational and service establishments.

C1 Junior management, owners of small establishments, and all others in non-manual positions.

C2 All skilled manual workers, and those manual workers with responsibility for other people.

D Semi-skilled and un-skilled manual workers, and apprentices and trainees to skilled workers.

While the UK figures cannot be assumed to be representative for the EU, there is good reason to assume that they would actually be a conservative estimate. Given the long running presence and relative high degree of penetration of low-cost airlines in the UK market, the tendency for air travel to be a preserve for the richer parts of the population can be assumed to be more pronounced than in other parts of the EU, and in the EU as a whole.

Overall, it is therefore reasonable to assume that any measure increasing the cost of air transport tickets would be progressive in terms of its distributional impacts. Although *relative* price increases might be highest on low fare tickets (because the price is lower from the outset), the wealthier parts of the population would still tend to pay a relatively large share of the overall extra costs.

A similar conclusion is likely to hold for the distributional impacts of any increases in air freight rates. Air freight tends to comprise high value goods, the consumption of which can be assumed to be relatively greater in higher income classes than in lower income classes.

## 5. COMPARING THE OPTIONS

*Summary:* The main difference between the options concern the potential for economic efficiency gains which emissions trading represents if combined with the existing scheme, compared to an aviation-only charging scheme. Emissions trading also has better potential for wider – and even global – application.

In principle, and subject to certain assumptions, the effects of charges or emissions trading would be identical. As already mentioned above, the quantitative results from the two studies cannot generally be directly compared as they are developed from a range of different assumptions and scenarios. This section explains the actual differences.

The main criteria applied are effectiveness and efficiency. However, additional criteria are introduced to take account of institutional, political and legal constraints. For the purposes of this assessment, which aims to provide a basis for a *strategic* decision on which option(s) to take forward, these criteria are also decisive for determining the relative advantages of the different options.

### 5.1. Effectiveness

Charges and emissions trading are equivalent measures given certain theoretical assumptions, and both instruments can in principle be used to achieve the same environmental result. However, the way they work in practice is different.

With emissions trading, the environmental impact would in principle be known from the outset since the reduction target (the “cap” on emissions) is part of the regulatory design of the scheme. This would not be the case with a charge. Conversely, whereas under a charging scheme the marginal cost would be known to operators, there

---

<sup>E</sup> Those entirely dependant on the state long-term, through sickness, unemployment over six months, old age or other reasons. Casual workers and those without a regular income.

would be uncertainty under an emissions trading scheme because it would depend on the market. So instead of uncertainty about environmental outcome, the operators involved would have uncertainty about marginal costs.

Both instruments would in principle be able to cover the same categories of flights and emissions, although the study on charges only explored scenarios delimited geographically (EU airspace) and not by route (thus excluding emissions on international flights outside EU airspace).

Intra-EU flights only	52
All flights departing from EU territory	130
All emissions within EU airspace	114

**Figure 6: Estimated emissions by route category in 2004 (MtCO<sub>2</sub>). (Source: EUROCONTROL)**

## 5.2. Efficiency

Emissions charges and emissions trading are theoretically also equivalent in terms of economic efficiency, for a similar scope. However, there is a difference in terms of *interplay with other sectors*, as the result of including aviation in the EU ETS.

Combining the reduction target for aviation with that for other sectors by including the sector in the wider EU ETS increases overall economic efficiency by allowing the same amount of reductions to be made at a lower overall cost to society. In practical terms, and assuming that generally higher abatement costs in the aviation sector, at least in the short term, would tend to make it a net buyer, the emissions reduction objective determined for the sector would be met by reductions *within* the sector corresponding to what is economical given the allowance price on the market. In additions there would be reductions *made elsewhere* but funded by the aviation sector through the purchase of allowances (or Kyoto credits) on the market in sectors where they can be bought at lower costs than within the aviation sector. This greater efficiency of the emissions trading option, if opened up to other sectors, compared to an emissions charge, can also be looked at from the other perspective: if the emissions charge were equivalent to the allowance price, emissions trading would be expected to deliver more emission reductions than emissions charges.

## 5.3. Potential for wider application

As the Commission has already stressed,<sup>58</sup> to win the battle against climate change we need wider international participation. This implies that Community action, where relevant and possible, should also be assessed in terms of its potential for wider – and one day possibly even global - application by other States. By building on robust and credible principles which could consistently be applied by other States, the EU would increase the likelihood of others using its actions as a model.

<sup>58</sup>

COM(2005) 35 final 9.2.2005  
[http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/com/2005/com2005\\_0035en01.pdf](http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/com/2005/com2005_0035en01.pdf)

As regards *emissions charges*, the situation is not so promising in this respect. Although there are not the same legal obstacles as for fuel taxes, the concept of emissions charges remains contentious at international level. It was the single most difficult issue discussed at the 35<sup>th</sup> ICAO Assembly in October 2004, and is still under consideration in ICAO.<sup>59</sup>

In contrast, **the concept of *emissions trading for international aviation* has been explicitly endorsed by ICAO**, which *inter alia* has decided to pursue an approach where States who wish to do so would include international aviation in their existing emissions trading schemes consistent with the UNFCCC process. This is obviously an advantage in terms of its potential for wider and global application by other States. On the other hand, the ICAO 35th General Assembly has also urged contracting States to refrain from unilateral implementation of greenhouse gas emissions *charges* prior to the next session in 2007, where this matter will be considered and discussed again.

#### 5.4. Legal certainty

The level of legal certainty as regards the robustness of the two approaches also differs.

In its 1999 judgment in the Braathens case<sup>60</sup>, the European Court of Justice ruled a CO<sub>2</sub> tax illegal under *Council Directive 92/81/EEC of 19 October 1992 on the harmonization of the structures of excise duties on mineral oils*<sup>61</sup>. The Court argued *inter alia* that there is a direct and inseverable link between fuel consumption and the polluting substances on which the tax was levied, and that the tax therefore were to be regarded as levied on consumption of the fuel itself for the purposes of Directive 92/81, under which fuel taxation was banned.

Given this ruling the distinction between a fuel tax and a greenhouse gas charge might have to rely not on the difference in the base of the levy (e.g. fuel versus emissions) but on other factors such as the use of revenues collected. The Braathens case concerned a tax, not a charge, so it is from this case not clear what criteria the Court would consider as sufficient to distinguish a charge from a tax.

In contrast, the case clear cut for emissions trading. Emissions trading is not a tax but an environmental instrument, adopted with Article 175 of the EC Treaty as the legal basis, and this option therefore does not imply the same legal risk as the charge option does.

#### 5.5. Overview

The table below summarises the advantages and disadvantages of the two options.

---

<sup>59</sup> What guidance to recommend to States regarding the use of environmental charges has been under consideration in ICAO more or less continuously since 1991. Their possible use in helping combat climate change has been considered without agreement since 1999.

<sup>60</sup> Case 346/97 - Braathens Sverige AB v Riksskatteverket (ECR [1999] I-3419).

<sup>61</sup> Official Journal L 316 , 31/10/1992 P. 0012 - 0015

	Advantages	Disadvantages
<b>Emissions charges</b>	<p>Certainty about marginal costs to operators once charge level has been set</p> <p>Would generate revenues that could provide double dividends by reducing levels of conventional taxes</p> <p>Potential for giving incentives to reduce non-CO<sub>2</sub> impacts</p> <p>Could build on existing infrastructure for collecting en route air navigation charges</p>	<p>Uncertainty about achievement of a given environmental outcome</p> <p>Political agreement on what to use revenues for could prove difficult</p> <p>Consistency with ICAO policies, largely predating climate concerns, is disputed by some third countries</p> <p>Limited prospects for wider application by other countries in short-to-medium term</p>
<b>Emissions trading</b>	<p>Certainty about the environmental outcome once a cap has been defined</p> <p>The same environmental outcome can be achieved at lower cost as aviation could be included in the existing scheme</p> <p>Potential for giving incentives to reduce non-CO<sub>2</sub> impacts</p> <p>Would add volume and potentially liquidity to existing EU allowances market</p> <p>Concept of integrating international aviation in States' emissions trading systems endorsed by ICAO</p> <p>Greatest potential for wider application by other states in the short-to-medium term</p> <p>Legally more robust than charges</p>	<p>Uncertainty about marginal costs to operators</p> <p>Could have financial impacts for some operators already included in the EU ETS</p> <p>Non-allocation of aviation emissions under the UNFCCC complicates integration in EU ETS</p> <p>May require flanking measures to safeguard against adverse effects from trade-offs until all effects can be covered</p>

**Figure 7: Overview of advantages and disadvantages.**

## 6. STAKEHOLDER CONSULTATION

*Summary:* Wide response from NGOs, businesses and individuals

A public consultation on Reducing the Climate Change Impact of Aviation was held from 11 March to 6 May 2005 in preparation for a Communication. Two different questionnaires, one for individuals and one for organisations, were available online to elicit views, opinions and ideas on aviation and climate change. The standard Commission internet tool for Interactive Policy Making was used. The questionnaire for individuals was aimed at the general public, and replies were anonymous. The questionnaire for organisations contained more detailed and technical questions, and involved identification of respondents. The consultation was based on self-selection of those who consider themselves to be concerned about this issue and cannot therefore be regarded as representative<sup>62</sup>. The objective was rather to allow as many

<sup>62</sup> For example 29% of individual respondents claimed that they feel seriously annoyed by aircraft noise, which is not likely to be representative for the EU and suggest that comparatively many respondents are resident who live close to an airport.



as possible to express their views, however both questionnaires were available in English, French and German only.

### **Consultation of individuals**

In all, 5564 responses from individuals were received. Most replies came from the UK, Germany, Belgium and France, perhaps reflecting the languages in which the questionnaire was available. In addition, numerous individual letters were received from citizens, in particular from Germany, the Netherlands and the United Kingdom.

### **Consultation of Organisations**

A total of 194 organisations participated in the consultation. Positions from three Member States were received (UK, Austria, and France). A number of individual companies, and the major European airline, airport and manufacturers associations, submitted responses. The largest single fraction of respondents was NGOs.

*There is a brief summary of results in Annex 3 and a more extensive report on the results can be found at:*

*[http://europa.eu.int/comm/environment/climat/aviation\\_en.htm](http://europa.eu.int/comm/environment/climat/aviation_en.htm)*

## ANNEX 1 : GLOSSARY AND DEFINITIONS

ACARE	The Advisory Council on Aeronautics Research in Europe. Comprises about 30 members, including representatives from the Member States, the Commission and stakeholders, including manufacturing industry, airlines, airports, service providers, regulators, the research establishments and academia. See: <a href="http://www.acare4europe.org">www.acare4europe.org</a> .
ATM	Air Traffic Management
CAEP	Committee on Aviation Environment Protection of the International Civil Aviation Organization ( <a href="http://www.icao.int">www.icao.int</a> )
CO <sub>2</sub>	Carbon dioxide, see Annex 2.
EU ETS	The EU Greenhouse Gas Emissions Trading Scheme established by Directive 2003/87/EC.
ICAO	The International Civil Aviation Organization ( <a href="http://www.icao.int">www.icao.int</a> )
IPCC	The Intergovernmental Panel on Climate Change ( <a href="http://www.ipcc.ch">www.ipcc.ch</a> )
LTO	Landing-and-take-off. The international standards regulating emissions from aircraft engines are based on performance under standardised test conditions simulating a landing-and-take-off-cycle - the ICAO LTO-cycle. The emission values represent standardised indicators for the amounts of pollutants emitted at four typical thrust settings and timings to represent the total emissions of NO <sub>x</sub> , smoke, unburned hydrocarbons and CO below 3000 feet
NO <sub>x</sub>	See annex 2.
QUEST	<p>QUEST is a model used by the European Commission. It was designed to analyse the economies in the member states of the European Union and their interactions with the rest of the world, especially with the United States and Japan. The focus of the model is on the transmission of the effects of economic policy both on the domestic and the international economy.</p> <p>For a detailed description, see Roeger and in't Veld (1997): <a href="http://europa.eu.int/comm/economy_finance/publications/economic_papers/economicpapers123_en.htm">http://europa.eu.int/comm/economy_finance/publications/economic_papers/economicpapers123_en.htm</a></p>
RPK	Revenue-Passenger-Kilometres.
RTK	Revenue-Tonne-Kilometres
SES	Single European Sky - an ambitious initiative to reform the architecture of European air traffic control to meet future capacity and safety needs launched in 1999 and introducing new EU legislation adopted in 2004. See <a href="http://europa.eu.int/comm/transport/air/single_sky/index_en.htm">http://europa.eu.int/comm/transport/air/single_sky/index_en.htm</a>
SESAME	The SESAME programme is the European air traffic control infrastructure modernisation programme. It will combine technological, economic and

regulatory aspects and will use the Single Sky legislation by synchronising the implementation of new equipment, from a geographical standpoint in all European Union member states, as well as an operational standpoint by ensuring that aircraft equipage is consistent with ground technological evolutions.

See [http://europa.eu.int/comm/transport/air/single\\_sky/sesame/index\\_en.htm](http://europa.eu.int/comm/transport/air/single_sky/sesame/index_en.htm)

TAR	Third Assessment Report of the IPCC – see <a href="http://www.ipcc.ch">www.ipcc.ch</a>
UNFCCC	United Nations Framework Convention on Climate Change – <a href="http://unfccc.int">http://unfccc.int</a>
Emissions from national transport	Under the UNFCCC rules, Parties report emissions from national transport (including domestic air transport) as part of their national inventories. Emissions from international air transport are not included but reported separately as a memo item (see also below).
International aviation emissions	According to the IPCC Guidelines emissions from the use of fuels for international air transport are excluded from national emissions totals. This provision has been reflected in the “Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, part I: UNFCCC reporting guidelines on annual inventories” (UNFCCC reporting guidelines) that have been adopted under the Convention process. The UNFCCC reporting guidelines stipulate that “Parties should also report emissions from international aviation and marine bunker fuels as two separate entries in their inventories”. This information should be reported in a table of the common reporting format (CRF) which is specifically designed for this purpose (table 1.C). In addition, Parties are required to provide an explanation on “how they distinguish between domestic marine and aviation emissions ... and international bunker emissions” in their national inventory reports (NIRs), and an explanation on “how the consumption of international marine and aviation bunker fuels was estimated and separated from the domestic consumption” in the CRF table 1.C.

For an overview of the definitions of domestic and international flights consult document FCCC/SBSTA/2003/INF.3 available from the UNFCCC’s website (<http://unfccc.int>).

## **ANNEX 2 : THE IMPACT OF AIRCRAFT ON THE GLOBAL CLIMATE**

The impact of aviation on climate was analysed in detail in a Special Report by IPCC (1999) and more briefly in the IPCC's (2001) Third Assessment Report. These results have been updated by Sausen et al. (2005) based on a recent EC research project, TRADEOFF (contract EVK2-CT-1999-00030). A summary is given below.

Present commercial subsonic aircraft operate at cruise altitudes between 8-13 km (in the upper troposphere-lower stratosphere), where they release gases and particulates (aerosol), thereby altering the atmospheric composition and changing the energy balance of the atmosphere-earth system. Primary emissions from aircraft include carbon dioxide (CO<sub>2</sub>) and water vapour (H<sub>2</sub>O), nitrogen oxides (NO<sub>x</sub>= NO+NO<sub>2</sub>), sulphur oxides (SO<sub>x</sub>), soot and unburned hydrocarbons.

According to the IPCC (1999), the total amount of burned fuel and emissions of carbon dioxide, NO<sub>x</sub> and water vapour from aviation are well known. In 1992 aircraft emitted 0.14 Gigatonnes Carbon (GtC)/year (about 2% of total anthropogenic carbon dioxide emissions for 1992, accounting for 13% of the emissions from the transport sector). The transport sector is rapidly growing in an expanding world economy, aviation being the fastest growing transport mode. As a consequence, aviation fuel use will also increase rapidly and enhance aircraft emissions. Model calculation based on different scenarios projected into the future show emissions in the range between 0.23-1.45 GtC/year by 2050.

Although direct emissions of CO<sub>2</sub> from aircraft are relatively well known, the emissions of other gases and particles are subject to greater uncertainties and the climate impact is much more difficult to quantify due to a number of direct and indirect effects. This is primarily because of their different residence times in the atmosphere and different radiative properties, how the emissions modify the atmospheric composition by chemical reactions, and the way they trigger the formation of contrails and other clouds. In order to compare the climate impact of the different gases and particles, and their direct and indirect effects, the concept of radiative forcing (RF) has been used. It expresses a change in the energy balance of the earth-atmospheric system (here measured in milliWatts per square metre (mWm<sup>-2</sup>). Positive radiative forcing values imply warming, negative values imply cooling. Currently, RF is the best consensus descriptor for comparing the climate consequences of diverse effects, such as changes in greenhouse gas concentrations and clouds, and has been used for quantifying aviation effects by the IPCC (1999) and more recently by Sausen et al. (2005).

Current knowledge of the principal components from aircraft emissions as regards radiative forcing is summarised below.

**Carbon dioxide** is the most important greenhouse gas (GHG) because of the large quantities released and the long residence time of this gas in the atmosphere. Increasing concentrations of GHGs have a direct positive RF effect and tend to warm the earth surface. RF from CO<sub>2</sub> is well known.

**Water vapour** released into the troposphere and lowermost stratosphere has a short residence time because it is quickly removed by precipitation; so the direct RF is small. However, water vapour emitted into the upper (cold) regions of the troposphere often triggers the formation of line shaped contrails, which tend to warm the earth's surface. Persistent contrails may also disperse to form (optically thin) cirrus clouds (called contrail cirrus), which could have an

additional warming effect. The direct RF of water vapour and the RF of linear contrails is fairly well known, however, RF associated with contrail cirrus is highly uncertain.

**Sulphate and soot aerosols** have a much smaller direct forcing effect compared with other aircraft emissions, but their RF is opposite in sign. Soot absorbs heat and has a warming effect; sulphate reflects radiation and has a slight cooling effect. In addition, accumulation of sulphate and soot aerosol might influence the formation and the radiative properties of clouds. Direct RFs are fairly well known, but indirect RF through changing cloud properties is highly uncertain.

**Nitrogen oxides** have an indirect effect on the quantity of ozone in the upper troposphere and lower stratosphere. Nitrogen oxides are chemically reactive gases which produce **ozone (O<sub>3</sub>)** under the influence of sunlight. As a consequence of complex tropospheric chemistry, NO<sub>x</sub>, will also reduce the ambient atmospheric concentration of **methane (CH<sub>4</sub>)**. Both O<sub>3</sub> and CH<sub>4</sub> are strong greenhouse gases. The RF of ozone and methane are opposite in sign and fairly well known. Overall the positive ozone RF dominates the negative methane effect.

Short-lived elements such as water vapour, NO<sub>x</sub>, and aerosols remain concentrated near flight routes and therefore have a more regional effect on climate. The total climate impact of aircraft emissions is a superposition of the RF from the principal components, their direct and indirect effects. Table 1 (Sausen et al. 2005) summarises our current knowledge:

**Table 1:** Radiative forcings (RFs) from aviation [mW/m<sup>2</sup>]. The best estimates for 1992 by IPCC (1999) and two estimates for 2000 are given: one is derived from IPCC (1999) by linear interpolation, the second is based on the mean values resulting from the TRADEOFF project (Sausen et al. 2005). As in IPCC (1999), the TRADEOFF RFs for CO<sub>2</sub>, O<sub>3</sub> and CH<sub>4</sub> were scaled by a factor of 1.15 to account for systematic biases resulting from assumptions in the emission inventories. The RFs from O<sub>3</sub> and CH<sub>4</sub> are both a result of aircraft NO<sub>x</sub> emissions.

Year	Study	RF [mW/m <sup>2</sup> ]							
		CO <sub>2</sub>	O <sub>3</sub>	CH <sub>4</sub>	H <sub>2</sub> O	Direct Sulphate	Direct Soot	Contrails total	(w/o Cirrus)
1992	IPCC (1999)	18.0	23.0	-14.0	1.5	-3.0	3.0	20.0	48.5
2000	IPCC (1999) scaled to 2000	25.0	28.9	-18.5	2.0	-4.0	4.0	33.9	71.3
2000	TRADEOFF	25.3	21.9	-10.4	2.0	-3.5	2.5	10.0	47.8

Table 1 summarises the best estimates of radiative forcing (RF) from aircraft emissions reported by IPCC (1999), the TRADEOFF project, and other related research. Reliable RF figures for contrail-induced cirrus clouds are not available and have been omitted. Studies conclude that aviation emissions have a significant impact on climate and that both the direct and indirect effects must be taken into account. Total RF is about 2-4 times higher compared with CO<sub>2</sub> only (IPCC 2001); latest results from TRADEOFF are somewhat smaller (around two times higher).

Although there is a noticeable difference between IPCC (1999) and TRADEOFF regarding the RF of O<sub>3</sub> and CH<sub>4</sub>, the actual RF figures (RF<sub>O<sub>3</sub></sub> + RF<sub>CH<sub>4</sub></sub>) correspond closely (about 11 mW/m<sup>2</sup>). The most striking difference concerns the estimates of RF from contrails, TRADEOFF reporting a much smaller RF (factor 3-4) compared to IPCC (1999). The figures reported by the TRADEOFF project are based on more observation of contrails, better understanding of formation process, and improved modelling techniques. The RF from aviation-induced cirrus clouds might be as large as the present estimate of total RF (without cirrus). However, our present knowledge about these aircraft-induced cirrus clouds is too poor to provide a reliable estimate of the associated RF (Sausen et al. 2005). Research should be intensified to increase our knowledge of RF from contrail-induced cirrus clouds.

## References

IPCC, 1999: Aviation and the global atmosphere - A special report of IPCC working groups I and III. Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA, 365 pp.

IPCC, 2001: Climate Change 2001 - The Scientific Basis. Contributions of working group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA, 881 pp.

**Sausen, R., Isaksen I., Grewe V., Hauglustaine D., Lee D.S., Myhre G., Köhler M., Pitari, G., Schumann U., Stordal F. and Zerefos C., 2005:** Aviation radiative Forcing in 2000: An Update on IPCC (1999); Meteorol. Z. (accepted).

### **ANNEX 3: SUMMARY OF STAKEHOLDER CONSULTATION RESULTS**

#### Consultation of individuals

There is widespread support for the policy objective to include the air transport sector in efforts to mitigate climate change (82% fully agree), to include the cost of the climate change impact in the price of air transport (68% fully agree), and to strengthen economic incentives for air transport operators to reduce their impact on the climate (72% fully agree).

Most respondents fully agree that “increasing the price of air transport would be acceptable if it is necessary to reduce aviation's impact on the climate”, and completely disagree - or tend to disagree - that “increasing the price of air transport should be avoided as it could have an effect on jobs and growth”. Most fully agree - or tend to agree - that “increasing the price of air transport should be avoided as fewer people could afford to fly” and that “increasing the price of air transport would be acceptable since it would affect “frequent flyers” most”.

In all 55% of respondents feel themselves not well informed about the climate change impacts of air transport. A majority considered that comparisons between emissions of different airlines on a given route would influence a lot how often, where and with what airline people fly.

A total of 2244 respondents made use of a free-text field at the end of the questionnaire. While there were some critical remarks, the vast majority of respondents explicitly supported action to reduce aviation's impact on the climate.

Many respondents considered action to reduce demand for air transport essential to reduce emissions from the aviation sector. There was strong support for promotion of alternative transport modes, especially rail. Tax-exemption of kerosene was considered unacceptable and unfair by many. Price signals were more important than relying on individual action, as people would wonder why they should do something to reduce their impact on the climate if others did not do the same. Raising awareness was considered an important way of influencing demand for air passenger and freight transport. Other suggestions were to restrict flights (particularly at night), to limit the number of times a person could fly in a given period, and even that frequent flyer bonuses should be abolished or even converted into penalties.

There was a strong demand for cleaner and emission-free aircraft. The question was raised why there are biofuels for cars, but not for airplanes. Some responses mentioned hydrogen as a possible alternative fuel source, and one respondent drew attention to the fact that airplanes have already flown using this fuel.

While some highlighted the benefits of air travel for cultural exchange, many people called for a change to the emerging lifestyle of flying around Europe for short leisure trips.

Offsetting emissions by emissions reductions elsewhere or sinks was supported by some respondents, while others objected that this would allow airlines to buy the right to pollute.

Many respondents highlighted the need to incorporate the external costs of flights into the price, because otherwise the market could not function correctly, but was also pointed out that the full cost is difficult if not impossible to calculate.

Some demanded that non-EU industrialised countries should take action as well. Most respondents mentioning this topic nevertheless advocated action by the EU and some explicitly mentioned that they considered the EU to be strong enough to take action on its own, giving an example to the rest of the world. A few respondents proposed an international air travel tax that would be payable to the UN.

### **Consultation of Organisations**

There was general agreement among organisations to include the air transport sector in efforts to mitigate climate change, to internalise the external costs of climate change in the price of air transport, and to strengthen economic incentives for air transport operators to reduce their impact on the climate. Many airlines and manufacturers believe that this should be done under ICAO guidance and in accordance with ICAO's existing policies. Some manufacturers do not think that further incentives to reduce emissions are necessary. Several other organisations highlighted the urgency of taking action.

Two Member States (France, UK) consider emissions trading to be the most effective instrument. Airlines, manufacturers and airports also prefer emissions trading to any other economic instrument, as long as the system is open to other sectors and limited to CO<sub>2</sub>. They consider this to be the instrument that is environmentally most effective and cost-efficient. Some companies active in the aviation industry argue that we need to accept that the aviation sector will not be able to reduce its emission substantially in the next few years. Although there is cautious acceptance by some environmental NGOs for emissions trading, some doubt that it will be possible to find an agreement that is effective enough. If emissions trading is chosen, NGOs demand ambitious targets for emission reductions, a system that is closed for the sector (though some NGOs would be satisfied if this applies only at the beginning), inclusion of non-CO<sub>2</sub> effects or avoidance of trade-offs with other emissions through strict regulation, and auctioning of allowances. One industry association is opposed to the inclusion of aviation in the EU ETS, because it believes that the aviation industry will easily be able to pay for their CO<sub>2</sub> allowances (a small cost compared to the cost of a flight), while the consequent increased cost of allowances would be a bigger problem for their members, especially those competing internationally, as it believes these costs feature more strongly in the final product price.

Fuel taxation is the preferred option of one Member State (Austria) and most other organisations. Airlines and manufacturers object explicitly to fuel taxation. Both they and the airports would consider emissions charges more acceptable. Some of them suggest using such charges to address the non-CO<sub>2</sub> effects of aviation on the climate and to support research. Some NGOs imply they would like to see measures like fuel taxation in addition to inclusion of aviation in the EU ETS, because of aviation's relatively high impact on the climate and because air transport is not as vulnerable to international competition as some other industries that produce goods. VAT on air transport is not considered by many to be a key instrument, but it could be easily implemented, would produce some beneficial effects, and the revenue could be used to promote rail infrastructure.

There is strong support by organisations that are not active in the aviation industry to reduce demand for air transport. One Member State (France) argues for a reduction in the growth of air transport in the long term by promoting alternative modes of transport. According to the statements of the organisations, fuel taxation and the inclusion of external costs are needed for aviation in order to create a 'level playing field' and to make other modes of transport more attractive. It was pointed out that much air travel was probably unnecessary. Aviation is



considered as a new, comfortable mode of transport, but one which is not sustainable in its current form even in the short to medium-term future. Changes in lifestyle were necessary therefore, to be achieved through EU measures in combination with raising awareness.

Among other measures, air traffic management is mentioned as important both by aviation industry companies and NGOs. It could increase efficiency and help reduce contrails and cirrus cloud formation.

In the long-term, respondents emphasised the importance of research into new aircraft concepts, other ways of reducing emissions, and alternative fuels. The possible use of biofuels in air transport was also mentioned.

One Member State wanted to limit EU measures to intra-EU flights only; two other Member States were undecided. There was widespread support among organisations also to include flights arriving from or departing to non-EU countries in EU measures as well. The main arguments used were to ensure a 'level-playing-field' for intra-EU and long-haul flights (reduced risk of economic distortion through cross-subsidisation by foreign carriers, and the ability of carriers to register their operations in any country), to avoid making long-haul flights more attractive than intra-EU flights, to minimise the environmental impacts of aviation, fairness, and to give a signal to the rest of the world. Arguments against were the risk of air traffic detouring and the fact that there was no alternative transport mode for long-haul flights.

**ANNEX 4: COMPARISON OF GROWTH IN AVIATION EMISSIONS TO  
COMMUNITY TARGET (EU15 BUBBLE)**

<b>European Community Bubble (EU-15)</b>				
<b>Overall greenhouse gas emissions</b>				
			<b>Unit</b>	<b>Notes/explanation</b>
A	Community Kyoto reduction target	8,00	%	Compared to baseline (1)
B	Baseyear emission total	4253	MtCO <sub>2</sub> e	EC GHG inventory (2)
C	Absolute reduction target	-340,24	MtCO <sub>2</sub> e	=B/100*A
<b>International aviation emissions</b>				
D	EU15 international aviation GHG emissions, 1990	62,05	MtCO <sub>2</sub>	EC GHG inventory (2)
E	EU15 international aviation CO <sub>2</sub> emissions, 2003	106,70	MtCO <sub>2</sub>	EC GHG inventory (2)
F	Average growth rate 1990-2003	4,26	%	=(E/D)^(1/(2003-1990))-1
G	2012 emissions if growth rate prevails	155,308	MtCO <sub>2</sub> e	=E*(1+F)^(2012-2003)
H	Growth in int. aviation emissions 1990-2012 if current growth rate prevails	93,26	MtCO <sub>2</sub>	=G-D
I	<b>Aviation growth compared to Community Kyoto target</b>	<b>27,4</b>	<b>%</b>	<b>=Abs(H/C)</b>

Notes:

(1) The base year for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O is 1990; for the fluorinated gases 13 Member States have chosen to select 1995 as the base year, whereas Finland and France have chosen 1990. As the EC inventory is the sum of Member States' inventories, the EC base year estimates for fluorinated gas emissions are the sum of 1995 emissions for 13 Member States and 1990 emissions for Finland and France.

(2) Annual European Community greenhouse gas inventory 1990-2003 and inventory report 2005, Technical report No 4/2005, European Environment Agency

## ANNEX 5: SPECIFIC EMISSIONS TRADING DESIGN ISSUES

### Type of entity made responsible for aviation's climate impact

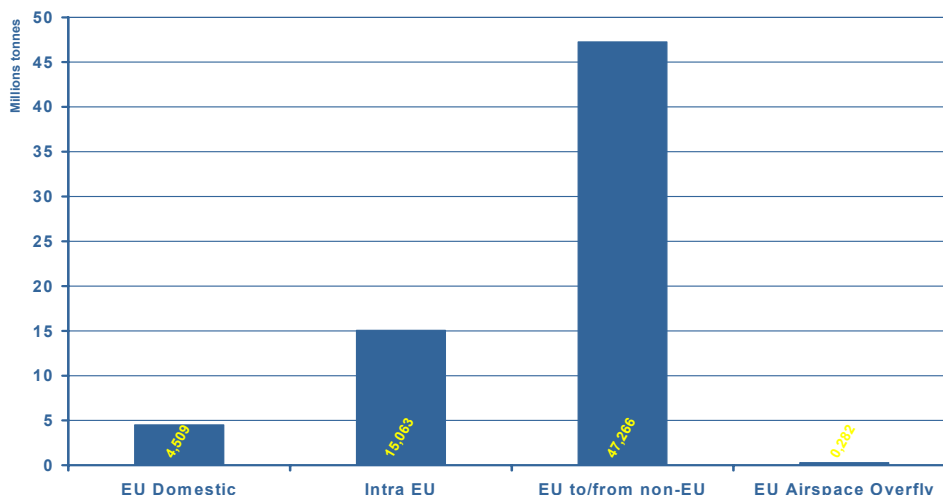
Different actors could conceivably be made responsible for aviation emissions as trading entities in the EU ETS. In [CE2005] the following options were considered in detail:

- (1) Aircraft operators
- (2) Airports
- (3) Fuel suppliers
- (4) Providers of air traffic management (ATM)
- (5) Aircraft manufacturers

In summary, *option (1) was deemed to be most advantageous* because the price signals and incentives established by the scheme would directly apply to those who are in control of most of the decisions that can influence, directly or indirectly, the aircraft emissions, both in the short term (e.g. operational) and long term (e.g. investments in fleet improvement). For details, see [CE2005].

### Types of flights covered

Figure 1 shows estimates of total fuel burn of all in- and outbound flights in 2004 according to route type. Disregarding emissions from overflights<sup>63</sup>, the widest possible scope of coverage obtainable would be to include all emissions from all flights arriving at EU airports and all flights leaving EU airports.



**Figure 1: Estimates of total fuel burn of all in- and outbound flights in 2004 according to route type. Source: EUROCONTROL estimates based on traffic data**

<sup>63</sup> Emissions from aircraft that fly through EU airspace without stopping are relatively low, and including them would be associated with a number of additional technical, political and legally issues.

However, to maximise *the potential for wider and eventually global application*, the scheme should be based on principles that would ensure 100% coverage but no double counting of emissions if similar principles were applied globally.

*Coverage of emissions from both arriving and departing flights would, if similar measures were taken by third countries, result in double counting. It is therefore proposed that only emissions from departing flights should be included. This approach would be simple, proportionate and consistent also if globally applied.* Alternatively, the scheme could conceivably cover all emissions from both flights departing and flights landing. However, in that case a possibility for exemptions should arguably be envisaged to enable taking into account if other states took similar measures. Such a system would be more complex to administer.

### **Extent to which the full impact is addressed**

The EU ETS in principle covers the greenhouse gases covered by the Kyoto Protocol and listed in Annex II to the directive, although at present only carbon dioxide is accounted for in the activities covered in Annex I of the directive. As explained in Annex 2, aircraft operations not only result in emissions of greenhouse gases, they also have other, indirect impacts on the climate.

In [CE2005], the issue of how to address the full climate change impact is addressed extensively. Ideally, the incorporation into the EU ETS of the different direct and indirect impacts of aviation would require the use of a metric by which equivalence amongst the different impacts can be measured with respect to the currency used in the scheme (global warming potential /tonnes of CO<sub>2</sub> equivalent).

The study suggests that there is currently no such metric by which equivalence can accurately be established. Addressing the full climate impact therefore necessitates a pragmatic approach until scientific progress is made in formulating suitable metrics. Pending such progress, *two options exist for dealing with the non-CO<sub>2</sub> impacts*:

- The use of a higher retirement rate for aviation emissions within the ETS. This would imply that the number of allowances to be retired for each tonne of CO<sub>2</sub> emitted by an aircraft would be greater than for other sources, thus reflecting that the climate impact of the activity associated with the emission of 1 tonne of CO<sub>2</sub> from an aircraft on average is higher than for emissions from other activities within the scheme.
- Incorporation of CO<sub>2</sub> emissions only in the EU ETS, combined with flanking measures to address other impacts.

### **Approach for calculating and apportioning the sector's overall emissions limitation**

According to the UNFCCC reporting guidelines emissions from the use of fuels for international air transport are excluded from national emissions totals.

As a result, emissions from international flights are not included in the figures used to calculate the amount of Assigned Amount Units (AAUs) that Annex B Parties to the Kyoto Protocol dispose over to keep track of their quantitative emissions limitations. Because the tradable allowances used in the EU ETS – EUAs - are essentially AAUs that in the registries have been earmarked as EUAs through the allocation process, this constitutes a complication

with respect to the integration of such emissions into the EU ETS. Member States do not possess AAUs corresponding to the international aviation emissions, so if allowances are to be issued to aviation participants, a solution must be found on how to equip them with AAUs or otherwise ensure that the integrity of the accounting system is not compromised e.g. through double counting. [CE2005] identified a number of potential solutions to this problem.

Another implication of the non-allocation of international air transport emissions is that they are not covered by the EU's Burden Sharing agreement. An important reason for allowing a degree of subsidiarity as to the quantity of allowances to be distributed to stationary sources in the existing scheme was the Burden Sharing agreement, which established different emission reduction targets for each Member State. As international aviation is not covered by this agreement, no such barrier to harmonised allocation exists for this sector. A uniform EU allocation method would make it easier to prevent competitive distortions, as all the entities covered would be allocated allowances according to exactly the same rules. For Member States it might also reduce the administrative costs associated with allocation decisions. ***It is therefore proposed that any allocation of allowances to aviation participants in the EU ETS should take place on the basis of a harmonised allocation methodology.***