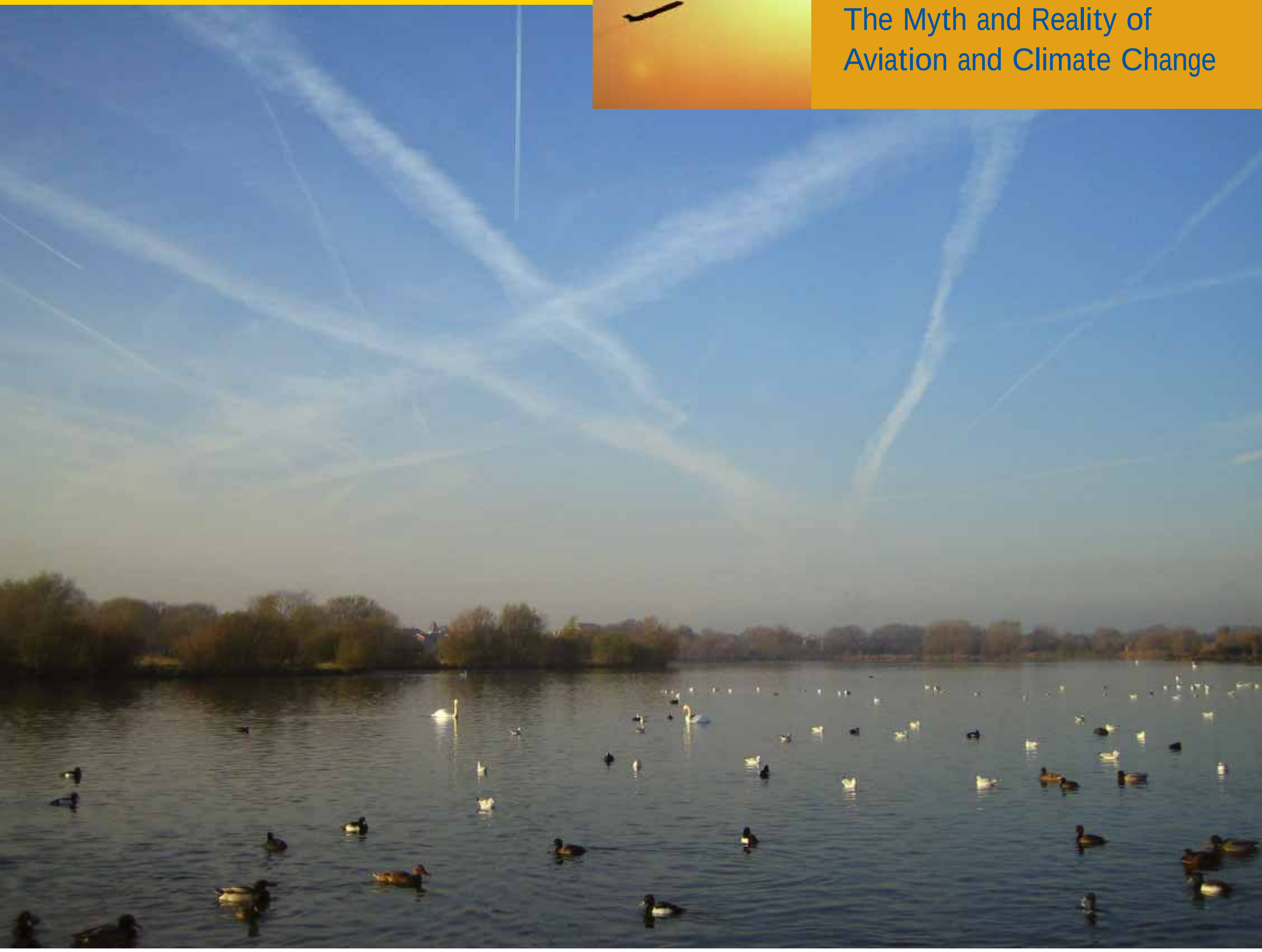
Clearing the Air

The Myth and Reality of Aviation and Climate Change



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Clearing the Air
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The Myth and Reality of Aviation and Climate Change

CLIMATE ACTION NETWORK EUROPE

European Federation for TRANSPORT and ENVIRONMENT

Contents

Introduction

The issue of aviation and climate change has moved up the European political agenda.

One reason for this is the rapidly rising emissions the sector is responsible for. A second, allied reason is that with climate policy in many other sectors having made significant strides in recent years it is becoming increasingly hard to justify the lack of action on aviation.

This report intends to satisfy the many demands for information and analysis on the issue of aviation and climate change coming from policymakers, the media and interested citizens. It brings together the findings of recent studies in light of the current political debate and discussions taking place about a range of policy options.

It is constructed around twelve important, but often controversial, questions surrounding the climate impact of aviation and what should be done about it at European level.

In Part 1, we examine some of the claims made about the impact of aviation on climate change and separate the myth from reality.

In Part 2, we explore some of the environmental measures that are under consideration in Europe, including ticket taxes and emissions trading. Again we examine the myths surrounding the (cost)effectiveness of these measures and explain the reality.

We have tried to keep the main text concise and to the point, in appreciation of the limited time that most readers will have at their disposal. Fuller explanations of historical background and scientific research can be found in the annexes.

Executive Summary

Section 1 gives an overview of the impact of aviation on climate change, and also examines the economic importance of the aviation sector.

The main conclusions of this section of the report are as follows:

- in 2000, aviation was responsible for 4 to 9 per cent of the climate change impact of global human activity – the range reflecting uncertainty surrounding the effect of cirrus clouds
- aviation has by far the greatest climate impact of any transport mode, whether measured per passenger kilometre, per tonne kilometre, per € spent, or per hour spent
- today's passenger aircraft are no more fuel-efficient than those that flew half a century ago
- the importance of aviation for the economy and employment is far less than its importance for climate change
- every segment of the aviation industry including manufacturers, airlines and airports is subsidised and enjoys major tax exemptions

Section 2 examines some of the policy options under consideration to combat the climate impact of aviation.

The main conclusions of this section of the report are:

- regional initiatives, such as those under discussion at EU level, provide the best hope for a multi-lateral solution to international aviation emissions for the foreseeable future
- EU-level action does not affect the competitive position of EU airlines compared with their non-EU competitors, provided that policies do not discriminate between EU and non EU carriers flying the same routes (which is obligatory anyway under the Chicago Convention)
- including aviation in the European Emissions Trading System (EU ETS) can be a good first step, provided the system is designed right
- additional measures like kerosene taxation and Nitrogen Oxide (NOx) emissions charges at airports are not only environmentally important but also justified in terms of cost effectiveness
- aviation is overwhelmingly an activity of the richest elements of society, measures to combat the environmental impact of aviation would not adversely impact the poor
- a 'development tax' on tickets is a good way to make up for the VAT exemption of international air tickets and would benefit poor regions, not hurt them

Part I

The Myth and Reality of
Aviation and Climate Change

1. How much does air transport contribute to climate change?

MYTH

Aviation makes only a minor contribution to climate change: 2 to 3%.

"Air transport contributes a small part of global CO_2 emissions – 2%."
IATA press release, 2nd Aviation Environment Summit (IATA 2006b)

"Contrary to common misconception, aviation is not a major emitter and in fact its contribution to EU emissions…will only account for around 5% of EU25 CO_2 emissions by 2030."
European Low Fares Airlines Association (ELFAA 2006)

"…aviation only accounts for about 3 per cent of global CO_2 emissions currently."
British Air Transport Association (BATA 2006)

REALITY

Aviation is currently responsible for 4 to 9% of the climate change impact of global human activity and its absolute and relative share is rapidly growing.

In fact, the contribution of aviation to climate change is currently 4 to 9% at the global level and 5 to 12% in the EU.

When a figure of 3% is quoted, or even lower, for the current contribution, the full story is not being told, and/or old information has been used:

- In 2004 the contribution of aviation to EU25 CO_2 emissions was indeed about 3%, but this figure refers only to the sector's contribution to, precisely, CO_2 emissions, rather than to its total climate impact, i.e. including NO_X emissions, contrails and cirrus clouds, which is 2 to 5 times greater than that of CO_2 alone (Sausen et al., 2005)
- The industry also uses old figures and hence ignores the rapid growth the industry has undergone over the last decade or more. For example, the 1999 IPCC Report on Aviation and the Global Atmosphere (IPCC 1999) stated that the contribution of aviation to CO_2 emissions was 2% and to made-made radiative forcing 3.5% in 1992, fourteen years ago. The rapid growth of aviation and aviation emissions means that situation has meanwhile changed. In 2005, emissions again grew by 1%. Growth in CO_2 emissions from international aviation since 1990, the base year of the Kyoto Protocol, now stands at 83%.

The estimate of a 5% contribution in the EU in 2030 is also flawed:

- It is based on a 'business as usual' scenario explored in a European Commission report published in 2003 (EC 2003). This scenario assumes very low growth rates for aviation emissions in the EU, a mere 1.6% per year between 1990 and 2030, while in reality there was 4.3% growth per year between 1990 and 2004. In addition, it ignores the fact that other sectors have emission reduction commitments under the Kyoto Protocol.
- It also ignores the non-CO_2 climate impacts referred to above.

A number of recent studies have concluded that the contribution of aviation to climate change will grow very significantly in the future if growth continues unabated and the EU takes its commitment seriously to keep global warming below 2 degrees Celsius.

According to the Tyndall Centre on Climate Change, in the most optimistic scenario aviation emissions will amount to 40% of total allowed emissions by 2050; in the most pessimistic scenario aviation emissions will equal total allowed emissions in thirty years from now (2036) (Tyndall 2005). In other words: all other sectors of industry would have to reduce their emissions by approximately 80% between now and 2050, or possibly even by 100% between now and 2036.

Annex 1 reviews the latest scientific evidence on the current as well as future predicted contribution of aviation to climate change.

2. How much more fuel-efficient have aircraft become?

MYTH

The aviation industry has continuously improved fuel efficiency.

"Aircraft entering today's fleets are 70% more fuel-efficient than they were 40 years ago."
IATA, 2005b

"Today's world fleet is about 70% more fuel efficient than they were 40 years ago."
Air Transport Action Group (ATAG) website, www.atag.org

"Over the past 40 years, the commercial aviation industry has made tremendous progress in…reducing CO_2 emissions per passenger-kilometre (by 70%) and in improving fuel efficiency."
Aviation Environment Summit conclusions, 2005

REALITY

Typical aircraft of the 1950s were as efficient as modern planes.

The figure of 70% was published in the IPCC's Special Report on Aviation and the Global Atmosphere (1999), which included a graph showing trends in the fuel efficiency of new jet aircraft coming onto the market between 1960 and 2000 (IPCC 1999; p. 298). This graph suggests the figure of 70% overall fuel efficiency gains between 1960 and 2000, and based on this figure the IPCC concludes that:
"The trend in fuel efficiency of jet aircraft over time has been one of almost continuous improvement; fuel burned per seat in today's aircraft is 70% less than that of early jets."

But the IPCC report only considered developments in fuel efficiency during the jet era – which is only part of the story.

When examining other aspects of technical development, such as aircraft speed and cruising altitude, the IPCC report did include the pre-jet period, going back as far as the 1930s. On the issue of fuel efficiency, however, the IPCC report was selective, taking only the jet era into account.

Research recently undertaken on behalf of T&E by the Dutch Aerospace Laboratory (NLR 2005) shows that this figure of 70% improvement is only part of the story at best and that over the last 50 years there has in fact been scarcely any improvement at all in aircraft fuel efficiency.

Aircraft manufactured in the early 1950s – such as the Lockheed Constellation – were two to three times as fuel-efficient as the early jets that succeeded them and virtually as efficient as the aircraft sold today.

The NLR report further states:

- *If one takes new aircraft from the early fifties (i.e. the last piston-engine aircraft) as the baseline, it shows that these last long-haul piston-powered airliners were* ***as fuel-efficient*** *as today's average turbojet aircraft.* [our emphasis]
- *If one takes new aircraft from the early sixties (i.e. the first jets) as the baseline (as presented in the IPCC report), an improvement of 55% is found rather than the 70% presented in the IPCC report."*

In short, the aviation industry has made almost no improvement in fuel efficiency over the last fifty years. Furthermore, the improvements made during the jet era have been exaggerated.

More details on the IPCC report and the NLR fuel efficiency study can be found in **Annex 2**.

3. How climate-intensive is aviation?

MYTH

Per passenger kilometre, modern aircraft are more climate-friendly than cars.

"The latest aircraft flying today often match the fuel consumption of modern passenger cars and in some cases – depending on speed and distance – even of high-speed trains. As technological and operational advances continue, a fuel consumption as low as 3 litres per 100 passenger-kilometres… is no longer uncommon."
IATA website (http://www.iata.org/whatwedo/environment/fuel_efficiency.htm)

"The next generation aircraft (A380 & B787) are targeting a fuel efficiency of 78 passenger miles per US gallon, which exceeds the efficiency of any modern compact car on the market."
IATA, 2005

"The green giant, more fuel-efficient than your car."
Airbus A380 website (http://events.airbus.com/product/a380_backgrounder.asp)

REALITY

Aviation is between two and ten times more climate-intensive than surface transport.

The aviation industry data ignore four crucial factors:

1. The figures of 3 or 3.5 litres per 100 **passenger** kilometres assume a full aircraft, i.e. a load factor of 100%, while they are in fact figures per aircraft **seat** kilometre. Load factors are typically only about 70%, however.
2. The occupancy rate of cars (and lorries) at distances competing with aircraft (i.e. long hauls) is higher than the average occupancy rate of 1.6.
3. The figure of 3 to 3.5 litres per 100 seat kilometres applies to long-haul flights with large aircraft. Aircraft that do indeed compete with surface transport are smaller and fly shorter distances – and are hence less efficient than 3.5 litres per 100 seat kilometres.
4. The climate impact of non-CO_2 emissions is ignored. Because of the effects of NO_X, contrails and cirrus clouds at high altitude, a litre of fuel burnt in an aircraft at such altitudes has a greater climate impact than a litre burned by land sources.

Passenger Transport

To our knowledge, the only study undertaken to date that takes all these factors into account in comparing modes of transport is *To Shift or Not to Shift* (CE Delft, 2003). All the other studies that have been published ignore one or more of the four factors.

The CE Delft study concludes that aviation performs three to ten times worse in terms of climate impact than cars on competing distances, and some two to ten times worse than high-speed trains.

The findings of the CE Delft study are explained in **Annex 3**.

Freight Transport

Although aviation is usually associated solely with passenger travel, a considerable share of the payload of a typical aircraft is freight, certainly on long-distance flights.

Unfortunately, in the field of freight transport there is no study that takes all four of the above-mentioned factors into account. The study *External Costs of Transport* (INFRAS/IWW 2004) ignores only the second factor and can therefore be considered the most comprehensive.

That report showed that when it comes to freight transport, aviation is even **worse** in terms of emissions than passenger transport. The external costs of aircraft-related climate change are approximately ten times greater than for lorries, the second worst mode.

The findings of the INFRAS/IWW study are explained in **Annex 3**.

Climate impact of aviation per euro spent

There are many ways to compare transport modes, but the metric most frequently used is 'climate impact per passenger or tonne kilometre'. It was the one used in both the CE Delft and the INFRAS/IWW study, cited earlier.

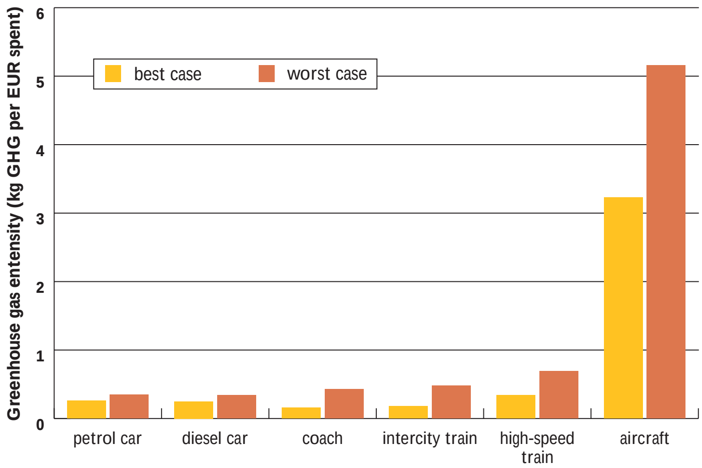
Although this metric may be logical from a logistical point of view, it is less so from the angle of economics. When choosing where and how to travel, people usually take two factors into account: how much time and how much money they want to spend. Lives are limited by time and by money, but not by distance.

The cheaper and faster the transport available, the further people will travel. All societies worldwide, now and in the past, spend approximately 1.1 hour a day travelling, and in societies where car ownership is over 200 per 1,000 citizens 10 to 15% of disposable income is spent on transport (Schafer 2000). As income goes up and transport becomes cheaper and faster, travel distances increase.

In macro-economic terms it is therefore more interesting to consider trends in the climate intensity of transport per hour or per € spent than per passenger kilometre. The metric 'climate impact per €' is of more than theoretical importance, as the United States government has set a 'greenhouse gas (GHG) intensity target' of -18% for 2012 compared with 2002, expressed in terms of greenhouse gas emissions per $ of GDP. But even in economies with absolute emission targets, such as the EU, it is vital to have knowledge of the climate intensity of different sectors if the aim is to break the link between increased GHG emissions and economic growth.

We analysed the climate impact per € spent of the different modes of long-distance passenger transport, in a best and worst case scenario from the aviation point of view.

FIGURE 1: RESULTANT EMISSIONS PER € SPENT ON DIFFERENT TRANSPORT MODES FOR THE JOURNEY COLOGNE-MILAN (800 KM).



The above graph shows that aviation is approximately ten times more climate-intensive, in terms of CO_2-equivalent GHG emissions per € spent, than other modes of transport. The exact score depends on assumptions, as described in **Annex 3**.

In addition, from a consumer's point of view it is not only relevant how climate-intensive their activities are per € spent, but also per hour spent. Using this metric, a similar picture emerges. The analysis of the climate intensity of aviation per hour spent in comparison with other transport modes can also be found in **Annex 3**.

The conclusions of this section are:

- Per *passenger kilometre*, aviation is two to ten times more climate-intensive than the passenger transport modes it competes with.
- Per *tonne kilometre*, air transport is approximately one order of magnitude (ten times) more climate-intensive than the second worst mode of freight, lorries.
- Expressed in alternative metrics – climate impact per € or per hour spent – aviation is approximately ten times more climate-intensive than other modes of transport.

4. How important is aviation economically?

MYTH

The economic contribution of aviation is far greater than its contribution to climate change.

“*Air transport contributes a small part of global CO_2 emissions – 2%. By contrast, the air transport industry supports 8% of global economic activity.”*
IATA 2006b

“Aviation’s global economic impact (direct, indirect, induced and catalytic) is estimated at US$ 2,960 billion, equivalent to 8% of world Gross Domestic Product (GDP).”
ATAG 2005

REALITY

It’s the other way round. Airlines cause 4 to 9 per cent of global human-induced climate change, and contribute 1% to global GDP and 0.1% to global employment.

A critique: apples, oranges, double counting and intransparency

First, it needs to be stressed that the figures of 2 and 8 per cent cannot be compared, being proverbial ‘apples and oranges’. The 8 per cent figure, on the one hand, captures all the direct, indirect and catalytic economic impacts of the aviation sector, thus including the effects of airports, aircraft manufacturing, etc., etc. The 2 per cent figure, on the other hand (discussed and dismissed earlier in this report), captures only the CO_2 emissions of the aircraft used in civil aviation – with emissions from indirect and catalytic activities certainly not included.

Second, the 8 per cent figure includes all the indirect and catalytic effects of aviation. Expressing this as a percentage of GDP seriously overestimates the economic importance of the aviation sector, as the reasoning followed in assessing these indirect and catalytic impacts is just as valid for any other economic activity.

“Let us take as an example the bakery industry. There are many bakers in the Netherlands, providing direct employment to many people as well as creating indirect employment at a variety of suppliers. On top of that, if people had not eaten bread for breakfast, they would be less productive. It is clear that this kind of reasoning can be adopted for each and every industry.”
CE Delft (2005b).

Third, the ultimate source of the 8% figure is not publicly available and so cannot be scrutinised. The figure originates from a brochure of the Air Transport Action Group (ATAG 2005), which states that the figures are based on a report by Oxford Economic Forecasting (OEF). When requested, ATAG confirmed that the underlying OEF report is not publicly available.

The direct contribution of aviation to GDP and employment: 1 and 0.1 per cent, respectively

A more useful comparison is to look at the direct emissions of airlines and their direct contribution to GDP and employment.

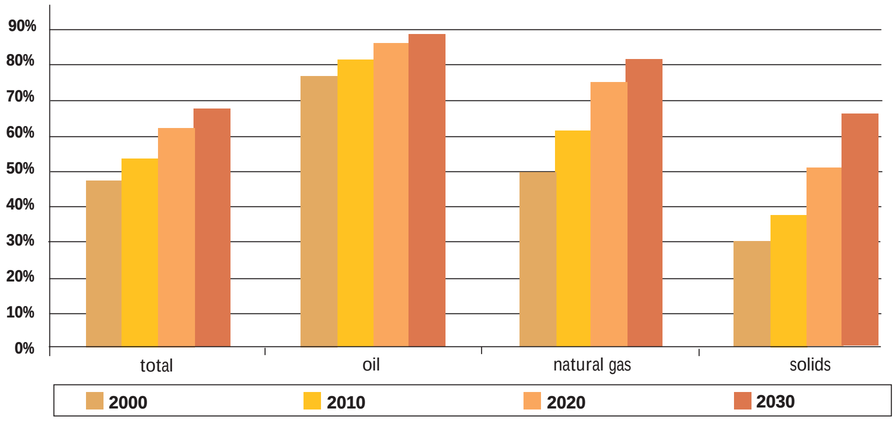
“ICAO estimates the direct contribution of civil aviation, in terms of the consolidated output of air carriers, other commercial operators and their affiliates, as $370 billion for the year 1998. These operators had 2.3 million employees on their payrolls. Further direct employment on-site at airports and by air navigation service providers accounted for another 1.9 million jobs while production by aerospace and other manufacturing industries generated at least 1.8 million jobs. Thus civil aviation directly contributed no less than 6 million jobs to world economies in 1998.” (ICAO 2002)

The $370 bn consolidated output is 1 per cent of the world’s GDP, which stood at $36,000 bn in 1998. The 2.3 million airline employees worldwide are less than 0.1 per cent of world employment, which stood at approx. 2.8 billion people in 1998. The total aviation sector (airlines, airports, manufacturers) provided a little over 0.2 per cent of total global employment.

Impact of fuel imports and energy dependence

In addition, the negative impacts of fuel imports are usually left out of the equation. By 2020, the EU will depend on imports from abroad for 86% of its oil consumption (EC 2003). Aviation will use some 15% of that. EU dependence on imported gas and coal in 2020 will be about 75% and 50%, respectively. Oil imports are increasingly concentrated in a limited number of countries.

FIGURE 2: DEVELOPMENT OF ENERGY IMPORT DEPENDENCE OF THE EU25 FOR OIL, COAL AND GAS. (SOURCE: EC 2003)



In 2005 aviation in the EU25 consumed approximately 1 million barrels of oil a day (allowing for 6% loss in the refining process). At today's prices of some €50 per barrel, this leads to the conclusion that aviation increases the EU's oil import bill by about €17 billion. Assuming constant prices and 3% annual growth of consumption, this figure is set to increase to €26 billion by 2020.

5. How well does the sector pay its way?

MYTH

The aviation sector covers the full costs of its operations and infrastructure.

"Airlines pay their way far better than other transportation means. They fully cover the costs of their operations and infrastructure."
IATA, 2004

"Air transport pays entirely for its own infrastructure … On top of that air transport is a cash cow for many governments."
IATA, 2006

REALITY

All parts of the aviation industry – airlines, airports and manufacturers – are directly subsidised and enjoy major tax exemptions.

Although the aviation sector has matured rapidly and become an everyday mode of transport for many people in the developed world, the industry still benefits from a wide range of both direct and indirect financial support, the latter in the form of tax exemptions. What follows is an illustrative, but by no means exhaustive, list of direct and indirect support to the sector.

Airlines: two tax exemptions and exploitation subsidies

In quantitative terms, the two most important forms of financial support to the aviation sector are probably the absence of fuel taxation and the exemption of international tickets from VAT. Based on current taxes on road fuels in the EU – about € 0.65 per litre on average – aviation's current exemption from fuel taxes would be worth about € 35 bn per annum in the EU.

Only a very small minority of countries levy (small) ticket taxes or fuel taxes on domestic flights – but by no means enough to compensate for the general exemption of the sector. This issue is treated further in Annexes 4 and 5.

In addition, airlines have received, and are indeed still receiving, direct aid:
"Since 1991 governments in the EU have paid over €20 billion in rescue aid for airlines; the US administration has supported its industry to the tune of $32 billion since 2001." (Lufthansa 2006).

The EU has also legalised start-up aid. In February 2005, the European Commission published 'Community Guidelines on financing of airports and start-up aid to airlines departing from regional airports'. These guidelines allow state aid of up to 50% of the start-up costs of regional airports and new connections departing from them, for a period of up to five years.

Airports: direct subsidies and indirect support through duty-free sales

A DIW paper (DIW 2003) shows that, from 1991 to 2001, financial support to German airports and air traffic control amounted to €134 million per year on average. The paper states:
"The aviation sector itself acknowledges that air transport is coupled with considerable environmental damages but argues that the industry, unlike other transport modes, covers its own infrastructure costs and maintains that this causes an intermodal distortion of competition between transport modes. This is, of course, not the whole picture." (DIW 2003)

A recent study undertaken by Deutsche Bank Research (DB Research 2005) states, in relation to Germany:
'For large airports, this support is confined to investment grants and totals about € 0.50 per passenger. By contrast, small airports receive an average of € 3.30 for operating cost subsidies and also € 5.90 for investment grants'.

As already stated, the cited 'Community Guidelines' allow state aid of up to 50% of the start-up costs of regional airports and new connections departing from them, for a period of up to five years.

Despite the abolition of duty-free sales on intra-EU flights in July 1997 – after fierce protests by the sector, which claimed job losses of up to 200,000 – duty-free sales are still a substantial source of income for airports. A case study for Schiphol carried out in 2000 found that a proxy of the missed tax income from the remaining tax-free shopping amounted to €2.3 per passenger from outside the EU to Schiphol, vice-versa (CE Delft, 2002b). This directly affects the price of tickets, as cross-subsidising aircraft landing fees with park and retail revenues is the rule rather than the exception.

Aircraft manufacturing: subsidies to Boeing and Airbus and VAT exemption

Aircraft manufacturing also enjoys numerous subsidies and tax breaks.

In Autumn 2004, a transatlantic row on aircraft manufacturing subsidies exploded, shedding light on a relatively hidden area of financial support to the aviation sector.

In October 2004, the US government stated that Airbus had received over €15 billion in government loans since 1967. In addition, again according to US estimates, Airbus had enjoyed €15 billion in subsidies. This sum is broadly in line with an estimate given in a DIW paper (DIW 2003), which converts this into a figure of 10-15% of accumulated turnover. DIW stresses that subsidies granted to the 1,500 suppliers of Airbus were not taken into account in the calculation.

In June 2006, the European Commission authorised the French Chamber of Commerce to subsidise Ryanair by up to €500,000 per year for three years to set up a new route from Toulon airport in France, to London Stansted.

In turn, the EU accused the USA of granting $20 billion on R&D subsidies to Boeing as of 1992, $3.2 billion worth of tax breaks over 20 years, $4.2 billion in infrastructure improvement subsidies, $200 million per year through the FSC (Foreign Sales Corporation) programme (still not fully abolished, despite being declared illegal by the WTO), and $1.6 billion of Japanese launch aid for the production of the 787 wings.

In addition, purchase of aircraft is exempt from VAT.

Part II

The Myth and Reality of Climate Policy Measures for the Aviation Sector

1. Should the EU go it alone, or is this a matter for ICAO?

MYTH

The international arena – ICAO – is the appropriate platform for action; the EU should not go it alone.

"Emissions trading may be a part of the solution. But it must be a global solution agreed through ICAO."
IATA 2006b

REALITY

ICAO has itself declared it will not set up an emissions trading system, is deeply divided over the issue of emissions charges and is outright hostile towards taxation of fuel. In the foreseeable future, only regional initiatives will drive climate protection in aviation forward.

Of course a global solution is in principle to be preferred over a regional one – no one contests that. But it is utterly unrealistic to expect ICAO – or any other global actor, whoever it may be – to act on this issue any time soon.

ICAO has always been extremely hostile towards any taxation of kerosene and its members are divided over potential application of emissions charges as options to reduce emissions from aviation.

The International Civil Aviation Organisation (ICAO) has always been hostile towards any taxation of kerosene

Although ICAO is significantly more open towards emissions trading, it has made it clear it does not intend to set up a system itself. In the run-up to the 35th ICAO Assembly in October 2004 the issue of emissions trading was intensively discussed. The Resolution on 'Market based measures regarding aircraft engine emissions' subsequently adopted at that meeting (ICAO 2004) contains the following wording on emissions trading:
'Under one approach, ICAO would support the development of a voluntary trading system that interested Contracting States and international organizations might propose. Under the other approach, ICAO would provide guidance for use by Contracting States, as appropriate, to incorporate emissions from international aviation into Contracting States' emissions trading schemes consistent with the UNFCCC process. Under both approaches, the Council should ensure the guidelines for an open emissions trading system address the structural and legal basis for aviation's participation in an open emissions trading system, including key elements such as reporting, monitoring and compliance.'

This wording shows that ICAO sees its role as being limited to 'supporting' a voluntary trading system, and 'providing guidance' for mandatory schemes, and issuing guidelines for both. It will not be setting up a system itself, nor does it intend to establish an organisation to do so. This possibility was in fact specifically rejected at a meeting of its environmental committee CAEP in February 2004.

MYTH

Climate policy measures in Europe would harm the European aviation industry because aviation is an international business subject to international competition.

"A European "go-it-alone" solution (…) will place European airlines at a disadvantage vis-à-vis their international competitors." Lufthansa 2006

REALITY

Climate policy for aviation can - and should ! - be designed in such a way that it does not discriminate on the basis of carrier nationality, to ensure the competitiveness of EU airlines does not suffer.

It is often argued that issues of competitiveness prevent 'unilateral' (i.e. EU-level) action being taken to address the climate impact of aviation. But this ignores the fact that it is possible – and even legally required ! – to implement policies in a non-discriminatory manner. More concretely: on international routes specifically, aircraft of different nationalities must be treated identically, as stated in Article 11 of the Chicago Convention (see text box).

Article 11 of the Chicago Convention

The laws and regulations of a Contracting State related to the admission to, or departure from, its territory of aircraft engaged in international air navigation ' (…) 'shall be applied to the aircraft of all contracting states ***without distinction as to nationality*** (emphasis added)

Available studies show that such non-discriminatory policies do not lead to significant economic distortions, nor do they significantly harm the competitiveness of EU airlines. European airlines can remain competitive with their non-EU counterparts even with relatively high CO_2 prices, higher than those seen in the EU Emissions Trading System (EU-ETS). As the report to the European Commission *Giving Wings to Emission Trading* (CE Delft 2005a) puts it:

2. Will EU airlines suffer if the EU goes it alone?

"To bring things into perspective, although aviation is an international business, it is less vulnerable to economic distortions than other sectors of the EU economy. This is for two reasons. First, the 'product' in the aviation industry, transportation, is by definition geographically bounded (to a major extent), with passengers and freight having relatively fixed origins and in many situations also relatively fixed destinations. An increase in the cost of European flights will not make a Frenchman with business in Denmark buy a ticket to America instead, and any air carrier operating between e.g. Paris and Copenhagen will be subject to exactly the same competitive conditions. In comparison, many other products would appear to be more vulnerable, as the only relevant aspect here regarding their purchase and use anywhere in the world is the cost associated with production of the product and transportation to its place of use. A second reason is that the air transport market is highly regulated by bilateral air service agreements that limit competition from airlines outside the EU."

The aviation sector could therefore withstand a more stringent form of climate policy than many other energy-intensive exporting industries 'on the ground' without significantly losing competitiveness. This is important. If Europe wants to maximise the effectiveness of its climate policy at minimum cost to the EU as a whole, it should not let its climate policies be dictated by the carbon prices that can be borne by the most vulnerable sectors. That would cause economic hardship for some sectors and virtually no pain for others – such as the transport sectors. It is better for the European economy and for cost effectiveness to take a more differentiated approach towards climate policy.

Finally, we would stress that is it absolutely essential that European and foreign carriers are treated exactly the same on specific routes. The real challenge for policy makers is to ensure that this happens.

3. Is a kerosene tax 'blunt and ineffective'?

MYTH

A kerosene tax is a blunt and ineffective instrument.

"An aviation fuel tax would be a blunt and ineffective instrument and we must strongly resist it, on both environmental and economic grounds."
Eddington, 2005

REALITY

An aviation fuel tax leads to 'double dividends': lower pollution and higher employment. A tax of 0.125€ per litre (only one-fifth the level on road fuels) would already reduce aviation CO2 emissions by 10% – while using the revenues to lower taxes on labour would create over half a million jobs in the EU.

Background

The aviation sector is almost entirely exempt from fuel tax. Within the EU, the Netherlands is the only country that taxes aviation fuel on its (very few) domestic flights. The historical background to this is explained in **Annex 4**.

Why fuel taxes are beneficial

It is often argued that emission charges or taxes are a blunt and ineffective way to achieve emission reduction goals, while emissions trading is an elegant solution. Fuel taxation for aviation is not blunt or ineffective, though. It is far better to tax undesirable things – in this case, energy use and the associated CO_2 emissions – than to tax desirable things like employment. Yet our economies do exactly the opposite.

Double dividends: Reduce pollution, boost employment

An important advantage of a revenue-raising economic instrument to tackle climate change (such as a fuel tax, a CO_2 charge, or an auctioned CO_2 permit) is that the ensuing revenues can be used for all sorts of purposes. Economists are generally in favour of lowering bad, 'distorting' taxes, such as those on labour, and call this the 'double dividend': less pollution, more labour.

The OECD states that:
"One important policy conclusion is that, in terms of competitiveness, it will generally be preferable to employ an environmental tax (or, equivalently, auctioned tradable permits), and use the revenue raised to reduce the rates of existing, distortionary, taxes on business, than to allocate permits through a non-revenue-raising 'grandfathering' procedure" (OECD 2003).

Employment impact

Probably the most advanced quantitative study in this field (one of the few studies taking technological adjustments after energy taxation into account) is a French study (Lemiale and Zagamé 1998). They showed that a modest energy tax – $10 per tonne of oil equivalent, or less than 1 cent per litre – implemented in six EU Member States and rechanneled into lower social security charges on labour would boost GDP by 0.27% and employment by 0.78% in the medium term.

A kerosene tax equal to the level of road fuel taxes in the EU – €0.65 per litre – would yield approximately double the revenue of the $10 per toe general energy tax. Rechanneling these revenues into lower social security charges can therefore be expected to boost total employment by over one per cent – equivalent to several million jobs in the EU.

Environmental impact

All in all, there has been surprisingly little research into the potential environmental impact of a tax on aviation fuel. The aviation industry commonly cites the findings of a study conducted by Resource Analysis in 1999 for the European Commission (RA 1999) which contains an analysis of kerosene taxation based on calculations with the so-called AERO model.

However, this model seriously underestimates the environmental effects of a fuel tax because it fails to take into account the measures that the aviation industry would take to improve fuel efficiency when faced with such a tax – so-called 'supply side' measures. This has been recognised by both ICAO and the authors of the report. More details on this are provided in **Annex 5**.

In this report we have therefore opted to use figures from a 2002 CE Delft study on emissions charges (CE Delft 2002a). This report builds on analysis performed on the issue for ICAO, itself analysing a broader string of supply-side measures (although not all). The results are shown in Figure 3 below.

A kerosene tax of € 0.125 per litre, one-fifth of the average tax on road fuels in the EU, would yield a 10% reduction of aviation CO_2 emissions

A kerosene tax in the EU is legally feasible

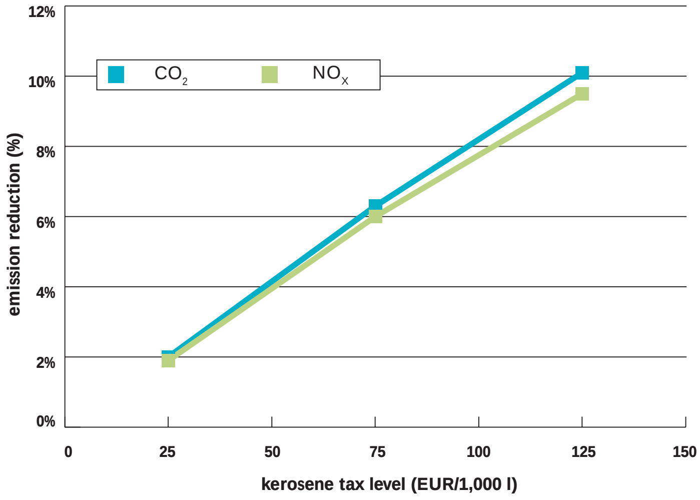
It is a common misconception about fuel taxes that to apply them would be illegal under the terms of the Chicago Convention (a sort of ICAO 'constitution'). In fact, the Chicago Convention only prohibits taxing fuel that is already on board an aircraft when it arrives in a country. In the numerous bilateral air service agreements that have been established, however, this prohibition has been widened to a general tax exemption for fuel on international flights. Nevertheless, a kerosene tax on intra-EU flights is legally feasible with the agreement of the States concerned, as pointed out in the Directive on the Taxation of Energy Products (2003/96).

A recent European Commission paper ('New sources of financing for development', April 2005) rightly points out that:

"a kerosene tax on intra-Community and domestic flights could be implemented by making it mandatory while allowing for the possibility to exempt all carriers on specific routes where non-EU carriers operate and benefit from exemptions under unchanged Air Service Agreements (ASAs). Ongoing renegotiation of ASAs would then gradually allow for the taxation of third country carriers on intra-EU flights".

Fortunately, non-EU carriers only use some 3% of the fuel used on intra-EU flights, as the aviation market is not yet a particularly open one. Under the EU-US bilateral air service agreement – which is currently being negotiated – that would change, however.

FIGURE 3: IMPACT OF A KEROSENE TAX ON CO_2 EMISSIONS FROM AVIATION IN EUROPE, BASED ON A CONVERSION OF RESULTS FROM (CE DELFT, 2002A).



The above graph shows that a kerosene tax of € 0.125 per litre – only one-fifth of the average tax on road fuels in the EU – would yield a 10% reduction of aviation CO_2 emissions. The effects are approximately evenly split between supply-side and demand-side effects (more fuel-efficient aircraft and less air transport, respectively).

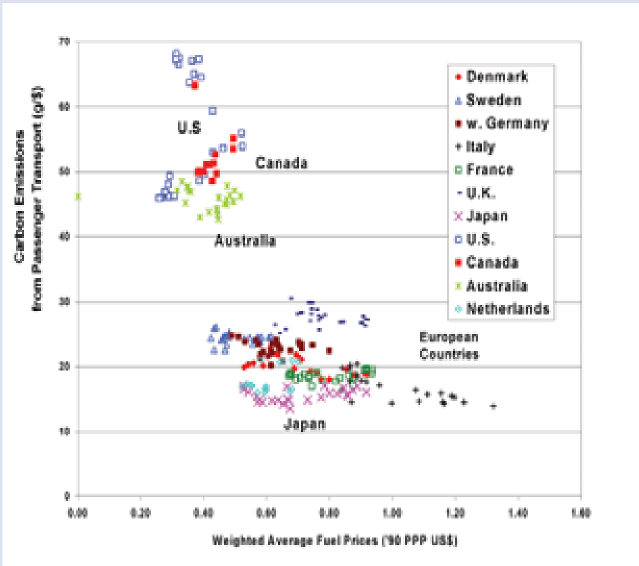
Interpolation of Lemiale and Zagamé's results suggests that the rechanneling of revenues would boost total employment by about 0.3 per cent – or over half a million jobs.

Have road fuel taxes worked?

In arguing that fuel taxes have not worked, people often point to road transport and the fact that European road transport emissions have increased despite taxation. This is a serious over-simplification, of course. Internationally, it is all too clear that countries where road fuel prices are low consume far more fuel than those where prices are high, even when corrected for differences in per capita income. This is illustrated in Figure 4.

As the graph shows, the carbon energy intensity of road transport various enormously between regions and this variation can to a large extent be explained by differences in fuel prices.

FIGURE 4: CARBON EMISSIONS VERSUS FUEL PRICES IN SELECTED COUNTRIES.



But isn't emissions trading better ?

Many reports state that emissions trading is more cost-effective than other economic instruments such as fuel taxes or emissions charges. The argument then usually runs that emissions trading allows measures to be taken where they are cheapest and hence leads to the lowest possible overall CO_2 abatement costs. We treat this argument separately in Chapter 6 on emissions trading.

4. Should Value Added Tax be paid on international tickets?

MYTH

Taxes are not the answer. They just fill government coffers.

"Taxes are not the answer. They do nothing for the environment. And they kill the economic social benefits that air transport brings."
IATA, 2006

REALITY

The current exemption of international air tickets from VAT is unfair, as it is ultimately other sectors that pay. It is also socially unjustifiable, and although VAT is not directly linked to environmental impacts, its introduction will reduce artificial demand for aviation.

Background

International air tickets are currently exempt from VAT. Although less publicly debated, from a fiscal point of view the exemption of international air travel from VAT is just as important as the fuel tax exemption, certainly if air travel is not considered a 'basic good' and therefore subject to the higher VAT rate.

Ending this exemption would be good for all three pillars of sustainable development.

- Economy: It would level the transport playing field, as other modes of international passenger transport are often not exempt. Even in cases where these are likewise exempt, though, it leads to the unfair situation of other economic sectors having to pay higher taxes to make up for the lost income, thereby indirectly subsidising international passenger transport. Introducing VAT would make it possible to lower 'bad' taxes such as those on labour.
- Environment: the exemption keeps air tickets artificially cheap, leading to artificial demand for air travel and hence extra environmental impacts.
- Social: the VAT would be paid by air travellers who are richer than average; see Chapter 7.

In the EU, unanimity is required to change VAT rules (see box), which makes such change both complicated and unlikely. Taxes on air tickets can be decided upon by individual Member States, however, and can therefore serve as a practical alternative to make up for the VAT exemption. Also, ticket taxes can be more flexibly designed to cope with the 'border effect' – the competitive threat from airports outside the taxed zone. Ticket taxes are treated in the next chapter.

VAT on international transport in the EU

The last comprehensive study on this topic was carried out in 1997 (KPMG 1997), for the then 15 EU Member States. Assuming there have since been no changes to the VAT rules of individual countries, the following conclusions can be drawn from this report:

- In two EU Member States (France and Greece) aviation has a competitive advantage in the international leisure and business market, as both international leisure and business travel by rail, sea and bus are subject to VAT while aviation is not.
- In eight EU Member States (Austria, Belgium, Denmark, Finland, Germany, the Netherlands, Spain and Sweden), aviation faces a competitive advantage in the international market, as international leisure travel by rail, sea and bus is subject to VAT while international business travel by rail, sea and bus is not.
- In the five remaining EU Member States (Ireland, Italy, Luxembourg, Portugal and the UK) aviation does not face a competitive advantage due to VAT exemption, as both international air travel and international rail, sea and bus transport are exempt from paying VAT.

The study does not cover international passenger transport by car, which is logical as cars and their fuels are taxed at a high VAT rate over the entire EU. The table below summarises the results.

TABLE 1: DO EU MEMBER STATES CHARGE VAT ON INTERNATIONAL TRANSPORT? (EU15)

	Aviation	Coach and Rail	Car Fuel
Leisure Travel	No	Yes: 10 MS No: 5 MS	Yes
Business Travel	No	Yes: 2 MS No: 13 MS	Yes

VAT: the legal situation

In the EU there are no legal obstacles to introducing VAT on intra-EU flights. However, the current rules governing VAT on international passenger transport are somewhat burdensome. Attempts are therefore being made to reform the system of levying VAT on international passenger transport; see the following box.

Excerpt from European Commission consultation paper on VAT (CEC 2005b)

'The current rule governing passenger transport services, which is taxation according to the distance covered, has proven to be very impractical and difficult to apply in an internal market without fiscal borders. It implies that a coach company which transports tourists from Paris to Amsterdam needs to apply French, Belgian and Dutch VAT to each relevant part of the journey, and pay the corresponding amount of VAT to the tax authority of each of these respective Member States. (…)

"The Commission would propose to tax the supply of passenger transport services, irrespective of the means of transport used, at the place of departure (..). For purely internal transport in one Member State, this rule would not change the present situation, while for international transport, it would ensure that passenger transport services to a large extent continue to be taxed where they are actually consumed, without the complication of having to split up the price according to the distances covered in each Member State."

This text points to a viable way to introduce VAT on air tickets, simply by changing the rules governing VAT collection.

5. Are ticket taxes to fund development aid a good idea?

MYTH

Air ticket taxes hurt tourism and therefore development.

"The problems of the developing world are serious. But the solution is not to tax the industry that is at the backbone of global tourism. Making travel more expensive will do more harm than good in the developing world."
IATA, 2005

"Furthermore, there is a trend in some Member States to impose taxes on air travel under the guise of "environmental taxes", or in the case of France "a tax for third world development". This is sloppy thinking and simply puts more money into the pockets of governments with no benefit to the environment or developing countries."
ELFAA, 2006

REALITY

Ticket taxes are a good way to make up for the VAT exemption for international air tickets and would have a negligible impact on tourism to Africa.

Background

Taxes on air tickets can be decided on by individual Member States and can therefore serve as a practical alternative to make up for the VAT exemption. Also, ticket taxes can be more flexibly designed to cope with the 'border effect' – the competitive threat from airports outside the taxed zone.

Ticket taxes for development aid

The idea of taxing airline tickets and using the revenues to achieve the Millennium Goals was presented by the French President Chirac at the World Economic Forum in Davos in January 2005. It was subsequently discussed at meetings of EU Finance Ministers, at the Gleneagles summit on Africa and climate change in July 2005, and at a development conference in Paris in March 2006.

In a closing statement at this conference, 13 countries expressed their intention to implement the 'international air-ticket solidarity contribution': Brazil, Chile, Congo, Cyprus, Ivory Coast, France, Jordan, Luxembourg, Madagascar, Mauritius, Nicaragua and Norway.

The aviation industry has dismissed the idea from the start, as illustrated by the quotes above. The message: ticket taxes would do development more harm than good. This is misleading and shows very little corporate social responsibility.

As the facts show, if we consider Africa, in 2004 only 1.6% of flights departing from EU airports had this continent as their destination (EUROCONTROL 2005). It can be estimated that if the EU introduced a French-style ticket tax, demand for air travel there would drop by 1%. This means that:

- 98.4% of air travel would raise revenues for development aid for Africa while not flying to the continent (almost 95% of air travel departing from EU airports has a European or North American destination);
- 99% of flights that go to Africa would still go ahead and also raise revenues for aid.

In addition, treatments for malaria, AIDS and tuberculosis are better targeted to deliver benefits to the worst off in society than air tickets, which often have beach resorts as their destination.
Finally, the ticket taxes are designed such that – price-insensitive – first- and business-class travellers pay far more than tourist-class travellers, so that tourism would hardly be hurt.

Ticket tax schemes in the EU

Below we give three examples of ticket tax schemes in force in the EU. All of them exempt transfer flights and are based on departing flights from airports within the countries' territories.

The UK

The UK has an Air Passenger Duty (APD) on departures from the UK. The design of the duty suggests it was intended to make up for VAT exemption on air travel – although at the time of announcement it was said to be in lieu of a kerosene tax. The APD distinguishes between passenger class (economy class on the one hand, first/business class on the other) and destination.

TABLE 2: THE UK'S AIR PASSENGER DUTY.

Destination	Economy class	Business/first class
Certain European destinations*	£ 5 (€ 7)	£10 (€ 14)
Other destinations	£ 20 (€ 29)	£40 (€ 57)

* These 'certain European destinations' are the EU, Switzerland, Norway, Iceland, Bulgaria, Romania and Turkey.

Calculations are based on an exchange rate of £1 = €1.433.

Recently the UK government also announced that it will use part of the revenue from its Air Passenger Duty for development purposes. These revenues currently amount to approximately £1 billion, or €1.4 billion, a year.

France

On 23 November 2005 the French Council of Ministers decided to support the idea of a tax on air tickets to fund development aid and on 22 December the French Parliament gave its approval. The tax, to be introduced on 1 July 2006, applies to all passengers departing from French airports. The revenues are expected to amount to € 200 million a year.

TABLE 3: THE FRENCH TICKET TAX RATES.

Destination	Economy class	Business/first class
Intra-EU	€ 1	€ 10
Other destinations	€ 4	€ 40

Sweden

Sweden intends to introduce a ticket tax, probably in 2006. Its principal aim is environmental, but as Sweden saw no scope for unilaterally introducing a tax on emissions, it was turned into a passenger tax.

TABLE 4: PROPOSED SWEDISH TICKET TAX RATES.

Destination	Economy, business & first class
Europe (jncl. Turkey and Russia)	SEK 94 (€ 10)
Other destinations	SEK 188 (€ 20)

Other countries

Chile has introduced a €2 tax for flights leaving Santiago Airport, yielding about € 4 million a year in revenue. As already mentioned, two more EU Member States (Cyprus and Luxembourg) and eight other countries (Brazil, Congo, Ivory Coast, Jordan, Madagascar, Mauritius, Nicaragua, and Norway) announced similar plans in Paris in March 2006.

Ticket taxes would have a negligible impact on tourism to Africa

6. Is emissions trading the best solution?

MYTH

Emissions trading is more cost-effective than other instruments.

"In my view, the right approach is emissions trading."
Eddington, 2005

"Emissions trading is potentially the most environmentally effective and cost-efficient approach to address CO_2 emissions from aviation."
AEA, 2005

REALITY

It is cost-effective for Europe to go further in aviation than just the first – welcome ! – step of including the sector in the EU ETS.

Background

Including aviation in the European Emissions Trading System (EU ETS) is one step towards addressing the climate change impacts of the sector. It will put a price on emitting CO_2 and hence provide an incentive to reduce those emissions.
The actual effectiveness of such inclusion depends largely on how it is designed. Four factors stand out (CE Delft 2005):

- The geographic scope: intra-EU only, all flights departing from EU airports, or all flights from and to EU airports? The last of these options covers four times as much emissions as the first – over 200 MT and over 50 MT of CO_2, respeticely.
- Non-CO_2 emissions: will they be addressed and if so, how? As we have seen, the total climate impact of aviation is 2 to 5 times that of CO_2 emissions alone.
- The cap: it is well known – in theory and in practice – that scarcity of permits is needed to achieve reductions.
- Permit allocation: by means of grandfathering, benchmarking or auctioning? Auctioning is the most efficient and fairest way to allocate emission permits.

But even if inclusion had the maximum ambition level – all flights from and to EU airports, non-CO_2 emissions too, a rigorous cap and auctioning of permits – additional instruments such as fuel taxation will remain necessary, from the perspective of both effectiveness AND cost effectiveness. Below we explain why.

Effectiveness
First, emissions trading alone will not do much to reduce the climate change impact of aviation. To get a feeling of the order of magnitude: a typical price of € 20 per tonne of CO_2 in the ETS corresponds with a kerosene tax of only 5 €ct per litre.

This CO_2 price might change in the future, of course. Theoretically it is possible to make the cap far more stringent, thereby driving CO_2 prices up. In practice, though, it is unlikely to come anywhere close to levels equivalent to those mentioned in the Energy Taxation Directive, for example (the €330 per 1,000 litres of kerosene as of 2010 corresponds with € 132 per tonne of CO_2).

It is well known that some sectors in the ETS are sensitive to competitive distortions vis-à-vis foreign competitors, particularly industries making energy-intensive products that are traded on the global market. If the cap in the ETS is seriously tightened, such distortions might become serious enough to lead to relocation of production (or – less visibly – decisions not to start such activities in the EU). This would entail costs to the EU economy and reduce the environmental benefit because of so-called 'carbon leakage' to other parts of the world.

The cap of the EU ETS is therefore likely to remain relatively generous and CO_2 prices modest as a result. This limits the environmental effectiveness of the scheme: CO_2 prices that are likely to stay around 10 cents or so per litre or even lower are not expected to make much difference.

Cost effectiveness
Second, many reports state that emissions trading is more cost-effective than other economic instruments such as fuel taxes or emissions charges. The argument runs that emissions trading also covers other economic sectors, which allows measures to be taken where they are cheapest and hence leads to the lowest possible overall CO_2 abatement costs.

The key problem with this analysis, though, is that the costs of climate policy may comprise more than just the costs of abatement. When we consider regional (e.g. EU-level) climate policy, there are also competitiveness costs at stake, as we have seen in the previous paragraph.

In Chapter 2 it was argued that climate policies for aviation do *not* give rise to significant competitiveness costs because they can – and should – be designed on the basis of equal treatment on specific routes, irrespective of the nationally of the carrier concerned, all of this in accordance with the 'non-discrimination' Article 11 of the Chicago Convention.

Thus, a cost-effective climate policy for Europe minimises not just abatement costs but competitiveness costs as well. Such optimisation hence implies – assuming equal climate ambitions – stricter climate policies for sectors that would not suffer from competitive distortions (such as aviation) than for those that might suffer as a result (some of the ground-based sources described earlier). It is consequently cost-effective for Europe to pursue more climate policies for aviation than mere inclusion of the sector in the ETS.

The reduction of other taxes made possible by a fuel tax and the added reduction of energy imports only add to the argument.

For these reasons, additional instruments to reduce CO_2 emissions from EU aviation – over and above inclusion in the ETS – are therefore perfectly justifiable in terms of cost effectiveness.

7. Are environmental measures for aviation bad for the poor?

MYTH

More expensive air travel is bad news for the poor.

"Air transport contributes to citizens' desire for more travel at democratic prices."
AEA 2006

REALITY

It's the rich that fly, even in this era of low-cost carriers – if aviation paid its true costs we could help the poor a lot more.

Air passengers are well-off

As a rule, individual airline passengers are better off than users of other transport modes and than the general population.

Figure 5 shows passenger data from the British Civil Aviation Authority confirming these findings. In this graph households are distinguished according to social class, 'A' households being the wealthiest, with 'E' households depending on welfare.

As the figure shows, the highest income classes – a quarter of the UK population – account for almost 50% of flights from UK airports, while the lowest income classes – some 27% of the UK population – account for only 6-7% of flights. High incomes are thus over-represented at British airports by almost 100%, and low incomes under-represented by 75%. It should be noted that distribution data for 2001 were very similar.

These findings are confirmed by the results of social science research among German passengers using different transport modes, based on a questionnaire sent to representative households (Figure 6).

FIGURE 5: DISTRIBUTION OF LOW-COST FLIGHTS BY SOCIAL CLASS IN THE UK IN 2004. (SOURCE: CAA 2005)

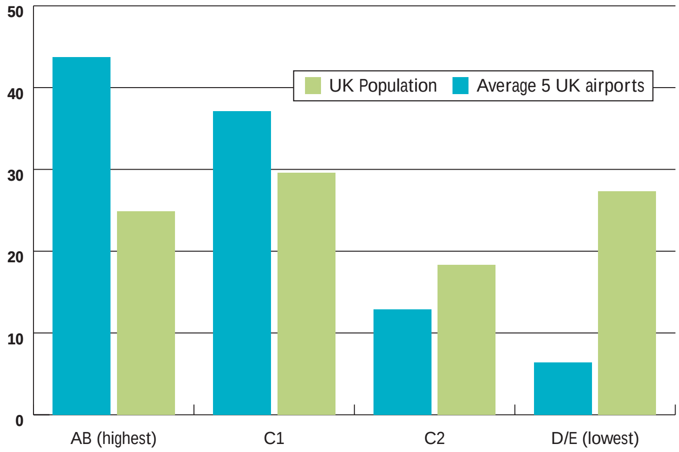


FIGURE 6: MAIN MODE FOR HOLIDAY TRAVEL: SHARE OF RESPONDENTS PER INCOME BAND. (SOURCE: SCHUBERT 2004)

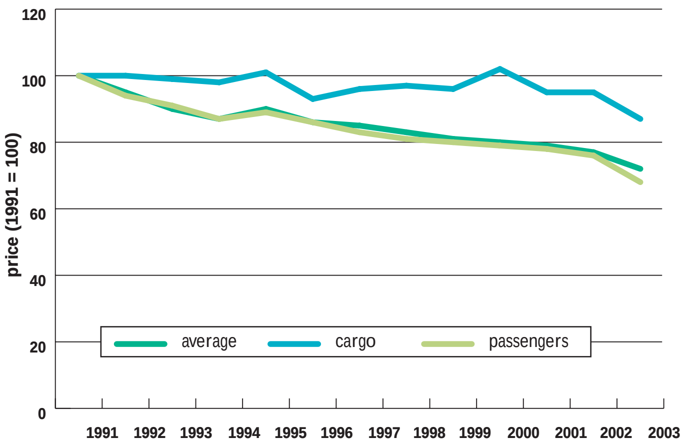
Trains and coaches were more often used by the poorer sections of the population. Cars were the mode of choice for families. Figure 6 also indicates that the decline in ticket prices has not changed the social structure of airline passengers at all. The share of people earning more than the average income actually increased.

This analysis was confirmed by a survey carried out at the biggest low-cost German airport, Cologne-Bonn. According to this survey, the average monthly income of the passengers was around €2,500 – about double the German average personal monthly income of about € 1,200.

Impact of climate change policies on poorer air passengers

Although we have seen that aviation is generally used by the well-off, concerns still exist about the potential impacts of climate change policies on ticket prices. In that respect it is useful to look at the historic development of these prices. The average yield (revenue) of airlines per passenger kilometre is an excellent indicator, as airlines' revenues are passengers' costs.

FIGURE 7. DEVELOPMENT OF REAL PRICES PER PASSENGER KILOMETRE, CARGO TONNE KILOMETRE AND AVERAGE. (FIGURES ARE FOR AEA AIRLINES ONLY AND HENCE EXCLUDE DATA ON LOW-COST CARRIERS.) (SOURCE: AEA 2004)



As can be seen, passenger transport has become cheaper at a rate of approximately one quarter per decade, or some 3% per annum, even excluding the impact of the rise of low-cost carriers. Overall, air transport has become 2.5% cheaper per year and is now 28% cheaper than it was 13 years ago.

It is estimated that a fuel tax of € 0.302 per litre (cited as a 'minimum' in the EU's Directive on the Taxation of Energy Products; see Annex 4) would increase airlines' operating costs by 18%. This is equivalent to six years of autonomous cost decrease. In other words, such a tax would cause a stand-still in the downward trend in ticket prices over six years. After that, the downward trend would continue. As airlines will find ways of dealing with such a tax (i.e. make their operations more fuel-efficient), the impact on ticket prices is very likely to be even more modest.

Subsidising aviation to help the poor is extremely ineffective and inefficient

Even if all the evidence did not point towards aviation being the preferred mode of transport for developed countries and the well off, the fact remains that government budgets are a finite resource, and development and poverty relief budgets probably even more so.

From a social policy perspective, even if the poor were to benefit more from aviation, subsidising aviation as a means to protect the interests of the poor or developing countries is a very meagre tool, and hence a waste of public money. Taxes on fuel or tickets could cause a few poor people not to fly, but targeted spending of the revenues could benefit many more poor people. Improving health care and education, raising development budgets and measures related to income and social security are just a few examples. It is calculated that the revenues arising from eliminating aviation tax exemptions in the UK would make it possible to employ 200,000 extra nurses or teachers (Sewill 2005).

Annexes

Annex 1: Background on the climate impact of aviation

This annex examines how the scientific evidence for the climatic impact of aviation has developed over recent years.

1999: IPCC Special Report on Aviation and the Global Atmosphere

In 1999 the climatic impact of aviation was comprehensively assessed, for the first time, in the IPCC *Special Report on Aviation and the Global Atmosphere* (IPCC 1999). The most striking conclusions of this report were:

- In the base year 1992, the central estimate of the contribution of aviation to man-made climate change was approximately 3.5%, excluding cirrus clouds.
- the total impact was two to four times that of CO_2 alone, with a middle estimate of 2.7.

2001: IPCC Third Assessment Report – man-made radiative forcing 1.33 W/m2

The next relevant report was the IPCC's *Third Assessment* report (IPCC 2001). Annex II.3.11 of the 'Scientific Basis' report contains figures on global anthropogenic radiative forcing, i.e. from all sectors. For 2000, the figure is 1.33 W/m^2. Excluding aviation impacts, which cannot be derived exactly from the report but can be estimated at some 0.07 W/m^2 (25 mW from CO_2 alone x 2.7), the total global radiative forcing impact of human activities excluding aviation by 2000 can be estimated at 1.26 W/m^2. We will use this value in the rest of this section.

2003: TRADEOFF project and summary of AAC workshop – contribution of aviation to global total 3 to 11% in 2000

A new official IPCC estimate of the global warming impact of aviation has not yet been made, but science has obviously progressed since the publication of the 1999 report. Most of the research has taken place in the framework of TRADEOFF, a European Commission-sponsored research project in which most of the scientific community in the field participated. The executive summary of the TRADEOFF project was published in February 2003 (UIO 2003) and contained the figures shown below.

TABLE A1: Estimated radiative forcing in 2000 and 2050 for different elements of aviation-induced climate change (table copied from summary of the TRADEOFF project).

Year	CO 2	O_3	CH_4	H_2O	Contrails	Cirrus	DirectS ulfate	Direct Soot	Total
2000	28	16 -32	-6 - -12	1-3	5-9	50 – 100*	-3 - -4	2 - 3	93 - 154
2050	75	42 – 90	-13 – - 40	2-8	15 - 28	150 – 300*	-8 - -11	7 -10	270 -424

* It should be noted that the figures for cirrus are maximum estimates.

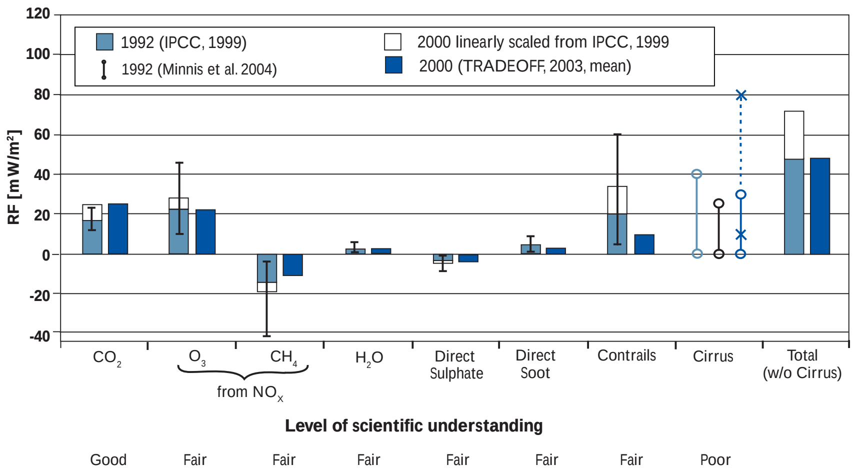
Comparing the 2000 data with the 1.26 W/m^2 total figure excluding aviation, the conclusion is that the total impact of aviation in 2000 varied between 43 (assuming no impact from cirrus) and 154 mW/m^2, or between 3.3 and 11% of total radiative forcing.

The same figures were reiterated in the summary report of the AAC workshop that took place from 30 June to 3 July 2003 in Friedrichshafen (Schumann 2003).

2005: Joint paper – contribution of aviation 3.7 to 9.2% in 2000

The latest development is that in June 2005 a paper from leading authors was accepted by the Meteorologische Zeitung (Sausen et al., 2005). The conclusions of that paper are summarised in Figure A1.

FIGURE A1: Radiative forcing (RF) [mW/m²] from aviation for 1992 and 2000, based on IPCC (1999) and TRADEOFF results. (Black bars denote 2/3 confidence intervals of the IPCC (1999) value, lines bounded by circles different upper bounds for the RF from aviation-induced cirrus clouds. The lower-bound TRADEOFF estimate for cirrus has been set at zero, as the range was not quantified in these studies. The total does not include the contribution from cirrus clouds.)



From this graph we can draw the following conclusions:

- Estimates of radiative forcing from aviation in 2000 vary from 48 mW/m² (without cirrus clouds) to 128 mW/m² (highest estimate, with cirrus clouds).
- The total radiative forcing is 1.9 to 5.1 times that of CO_2 alone (which is taken to be 25 mW/m²).
- This represents some 3.7 to 9.2% of total man-made radiative forcing in 2000 – which stood at around 1.26 W/m², excluding aviation, as indicated earlier.

Contribution of aviation in the EU: 5 to 12% in 2005

In 2004, total greenhouse gas emissions in the EU25 were 4,980 MT of CO_2-equivalents, excluding international aviation and shipping (EEA 2006). Emissions from domestic aviation were 13 MT and from shipping 152 MT. Total emissions *excluding* aviation but *including* shipping were hence 5,119 MT CO_2-equivalents. We assume these emissions remained stable in 2005; given the stability of emissions over the period 1998-2004 this assumption is not very contentious.

In 2005, CO_2 emissions from aviation departing from EU25 airports were 132 MT, a growth of 1 per cent over 2004 figures (EUROCONTROL 2006). Applying multiplication factors of 1.9 to 5.1 to aviation CO_2 emissions then yields a contribution to total climate change in the EU of between 4.7 and 11.6% in 2005.

The future: massive growth, a massive issue

In March 2005, EU leaders confirmed that global warming should be limited to a maximum of 2 degrees Celsius above pre-industrial levels and that the EU should therefore consider reductions of greenhouse gas emissions by 15 to 30% by 2020 compared with the Kyoto baseline levels in 1990.

If these ambitions were to be realised, total greenhouse gas emissions in the EU25 by 2020 would range from 3,732 (-30%) to 4,532 MT (-15%) CO_2-equivalents.

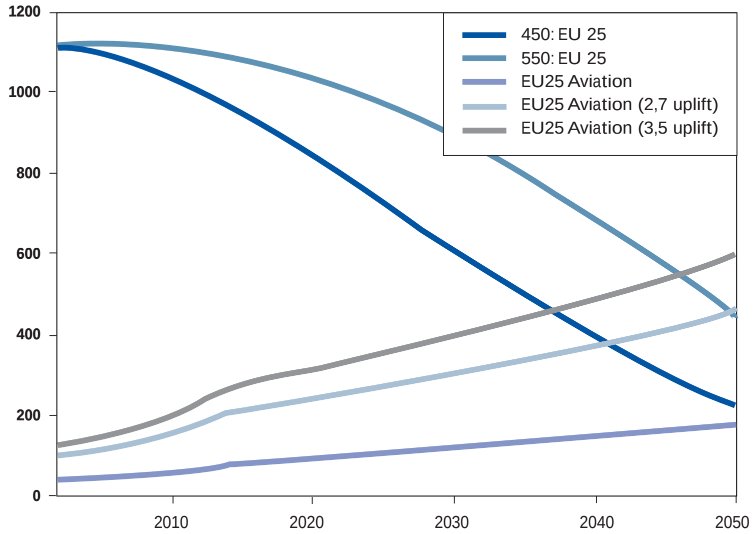
Assuming annual aviation emission growth rates between 2002 and 2020 of 2% (lower case) to 3.5% (upper case), total CO_2-equivalent emissions from international aviation would range from 397 MT (2% emission growth per year, 1.9 multiplier) to 1,247 MT (3.5% emission growth per year, 5.1 multiplier). This yields a minimum contribution of aviation to EU greenhouse gas emissions of some 8%, and a maximum contribution of some 24%.

Furthermore, a report by the Tyndall Centre on Climate Change (Tyndall 2005) shows just how important aviation emissions are at the moment, and will continue to be in the future.

First, Tyndall assessed how the total climate impact of the EU25 would have to develop in order to meet the 2 degrees target cited above, which is often associated with a CO_2 concentration of 550 ppm (parts per million). Over the last year, however, it has become clear that, to meet this target with reasonable confidence, the atmospheric concentration of CO_2 should not exceed 450 ppm (parts per million).

Second, Tyndall built scenarios for aviation emissions growth if the sector remained unchecked. The resultant plots are shown in Figure A2.

FIGURE A2: Downward lines: EU25 total emission trends necessary to achieve the 2 degrees target: upward lines: EU25 aviation emissions trend, if unchecked.



The figure shows that, if unchecked, aviation emissions will consume a significant part of the 'climate cake'.

In the most optimistic scenario, aviation emissions will amount to 40% of total allowed emissions by 2050; in the most pessimistic scenario, thirty years from now – in 2036 – aviation emissions will equal total allowed emissions.

In other words: if aviation emissions remained unchecked and the EU is still serious about achieving its climate objectives, other sectors will have to reduce their emissions by approximately 80% between now and 2050, or even by 100% between now and 2036.

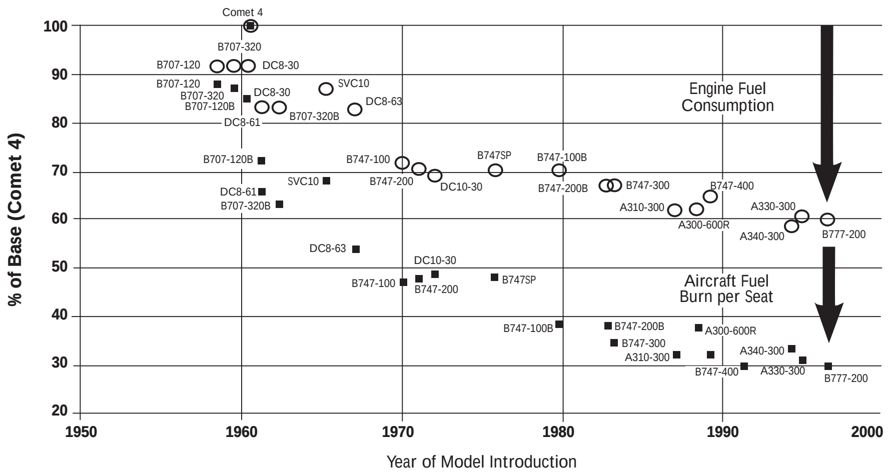
Annex 2: Background on aircraft fuel efficiency

This annex examines the improvements made in the fuel efficiency of aircraft.

Past and future gains in aviation fuel efficiency have been widely debated. A commonly cited figure of 70% gains between 1960 and 2000 is widely used as a reference for the industry's technological achievements. This figure was published in the IPCC's *Special Report on Aviation and the Global Atmosphere* (1999), which included a graph showing trends in the fuel efficiency of new jet aircraft coming onto the market between 1960 and 2000 (IPCC 1999; p. 298). This graph – reproduced in Figure 3 below – suggests the figure of 70% overall fuel efficiency gains between 1960 and 2000, and based on this figure the IPCC indeed concludes that:

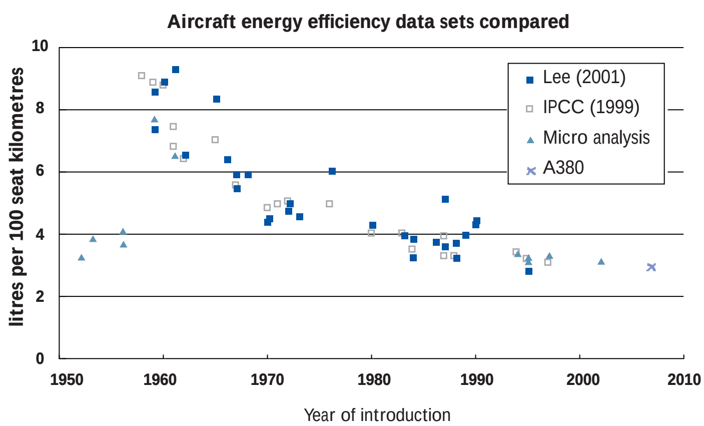
"The trend in fuel efficiency of jet aircraft over time has been one of almost continuous improvement; fuel burned per seat in today's aircraft is 70% less than that of early jets." (IPCC 1999)

FIGURE A3. The IPCC's Figure 9-3, which forms the background of 70% fuel efficiency claims. (Source: www.grida.no/climate/ipcc/aviation/avf9-3.htm)



Recent research undertaken on behalf of T&E by the Dutch Aerospace Laboratory (NLR 2005) shows that this figure of 70% improvement is only part of the picture at best and that *over the last 50 years* aircraft fuel efficiency has in fact hardly improved at all. Figure A4 shows the results of the analysis of this report.

FIGURE A4. Development of fuel efficiency of new aircraft (in Megajoules per available seat kilometre) plotted against the first year of production.



Note that aircraft manufactured in the early 1950s – such as the Lockheed Constellation – were two to three times as fuel-efficient as the early jets that succeeded them and virtually as fuel-efficient as the aircraft on sale today.

The report states:
"From this figure the following observations may be made:

- *If one takes new aircraft from the early fifties (i.e. the last piston-engine aircraft) as the baseline, it shows that these last long-haul piston-powered airliners were* ***as fuel-efficient*** *as today's average turbojet aircraft. [emphasis added]*
- *If one takes new aircraft from the early sixties (i.e. the first jets) as the baseline (as presented in the IPCC report), an improvement of 55% is found rather than the 70% presented in the IPCC report."*

The picture of aircraft fuel efficiency continuously improving is incomplete at best. Today's new aircraft are indeed much more fuel-efficient than the earliest jets of the early 1960s, but these early jets burned two to three times more fuel than the aircraft they replaced, such as the Lockheed Constellation. The fuel consumption, per seat km, of aircraft sold in the 1950s is comparable to that of a typical new aircraft on sale today.

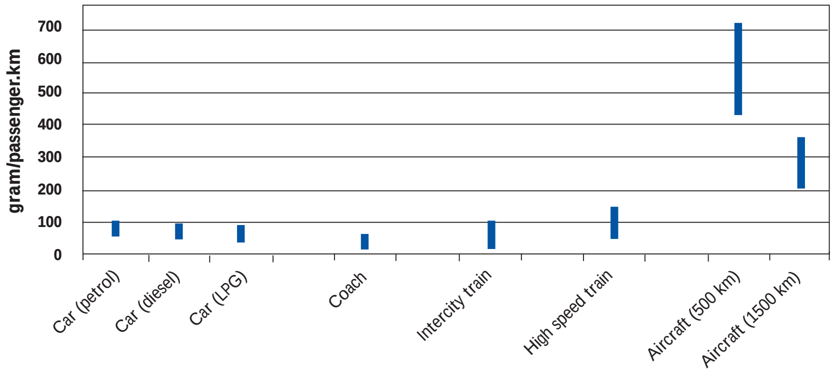
Annex 3: The climate impact of aviation and other transport modes

This annex provides background information to Chapter 3, in which the climate impact of aviation was compared with that of other modes of transport

Emissions from passenger transport modes

The CE Delft study *To Shift or Not to Shift* (CE Delft, 2003) compared the CO_2-equivalent emissions of most forms of passenger transport and arrives at the conclusions summarised in the graph shown in Figure A5 below.

FIGURE A5:
Average CO_2-equivalent emissions of different transport modes operating over long distances in 2000. (In the case of aircraft a 2.7 multiplier on CO_2 emissions has been applied, thereby following IPCC 1999.) (Source: CE Delft 2003)

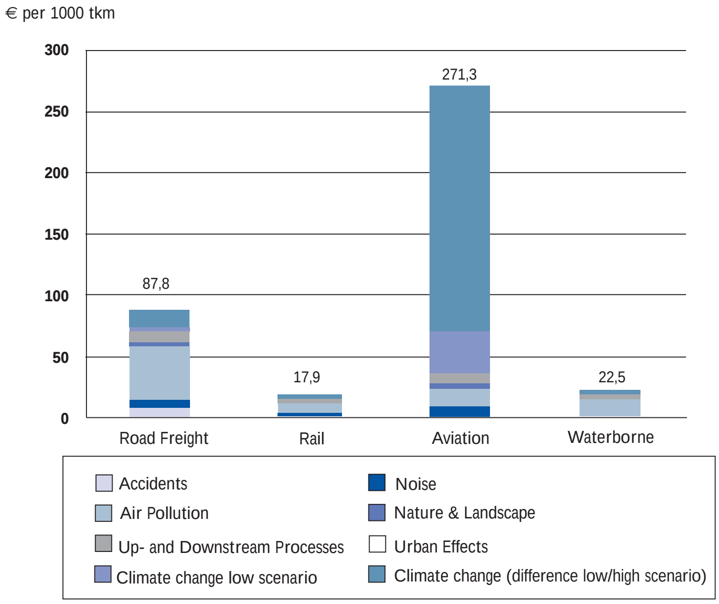


This report thus draws the conclusion that aviation is three to ten times worse in terms of climate impact than cars on competing distances, and some two to ten times worse than high-speed trains.

Emissions from freight transport modes

Aviation is the worst mode of freight transport, too, in terms of emissions, as Figure A6 shows. The external costs of climate change associated with aircraft are approximately ten times greater than those of lorries, the second worst mode.

FIGURE A6:
Average external cost of freight transport, excluding congestion, in € per 1,000 tonne kilometres, in the EU17. (Source: Infras/IWW, *External Costs of Transport* (2004))



Comparing aviation's climate impact to other modes of transport per € spent

Our analysis is based on the CE Delft study *To Shift or Not to Shift* (2003), with cost figures added for each transport mode. We examined the case of a journey between Cologne and Milan, a distance of 800 km, which is the average stage length of aircraft flying in the EU. We considered both the case of using a low fare carrier (Germanwings) and a legacy carrier.

TABLE A2: Overview of assumptions for the analysis of climate intensity per € spent.

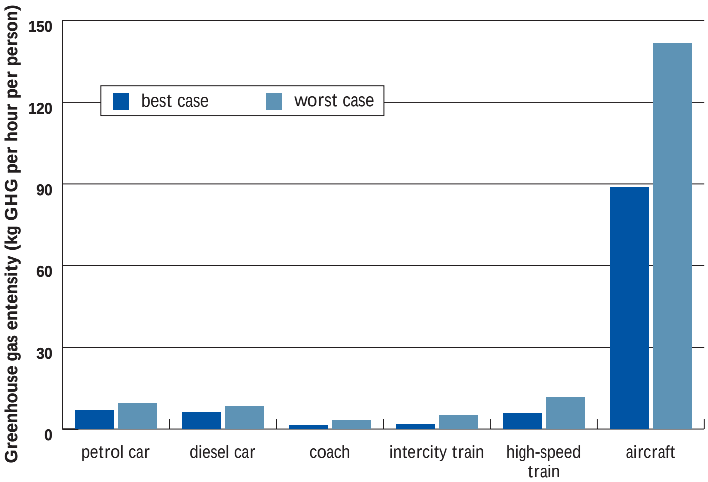
Vehicle type	€ spent per trip	Source
Petrol car	212	VW Golf 1.6, www.autobudget.de
Diesel car	192	VW Golf 1.8 SD www.autobudget.de
Coach	95	Eurolines
Intercity train	132	www.db.de
High speed train	153	www.db.de
Aircraft (Low fare)	97	Germanwings ticket + taxes + transport city centre
Aircraft (Legacy)	132	Lufthansa ticket + taxes + transport city centre

The results of this analysis are reported in the core text of this report, in Chapter 3.

Comparing aviation's climate impact to other modes of transport per hour of travel

From the consumer's point of view it is not only relevant how climate-intensive their activities are per € spent, as described in Chapter 3, but also per hour spent. A synopsis of the greenhouse gas emissions of different transport modes per person per hour is shown in Figure A7 below.

FIGURE A7: Emissions per hour spent on different transport modes for the route Cologne-Milan, allowing for check-in, boarding and travel time to and from airports and stations.



This graph shows that in this important alternative metric – per hour – aviation is also by far the most greenhouse gas-intensive mode of transport, being at least one order of magnitude (ten times) more-climate intensive than alternative forms of transport, and often even more.

Annex 4: Background on kerosene taxation

This annex describes the historic background of aviation's exemption from fuel tax and describes the Dutch and Norwegian fuel taxes for domestic flights.

Historic background

The exemption of aircraft fuel from taxation is in stark contrast to the taxes levied on road fuel. It has its origins in the early days of civil aviation. The following comment by an airline representative in 1938 gives a useful impression of the way fuel tax was considered in those days:

"The unfairness of requiring the same amount of tax on aircraft fuel as on motor fuel can best be illustrated by comparing the performance data of an average transport plane with that of an average passenger bus. The illustration is made between a thirty-passenger highway bus, powered with a 150 horsepower engine, reputed to travel about ten miles for each gallon of fuel consumed, and a fourteen passenger air liner powered with engines developing two thousand and two hundred horsepower and flying about two miles for each gallon of fuel consumed. Thus, the airliner consumes five times as much fuel as the highway bus to transport 7/15ths as many passengers an equal distance. Or, look at it this way: assuming both transportation units were loaded to capacity, the bus operator can carry thirty passengers ten miles on one gallon of fuel, while the air transport operator would have to use three planes and burn fifteen gallons of gasoline to carry the same number of passengers the same number of miles. Hence, we have a tax load ratio of 15 to 1 unfavorable to the airline operator." (Hinshaw 1938, p.84)

During the Second World War, the future of the then nascent aviation industry was laid down in the Chicago Convention, the founding treaty of the International Civil Aviation Organisation, the UN body that governs international aviation.

In those days, civil aviation was seen as an instrument for peace, as it would enable international contacts. A smooth development of the sector was the founding idea of the Convention:

"Whereas the future development of international civil aviation can greatly help to create and preserve friendship and understanding among the nations and peoples of the world, yet its abuse can become a threat to international security (…) (…) agreed certain principles and arrangements that aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically (…)"

ICAO objective

Today, the ICAO website states that the organisation's principal objective is the "development of safe, regular, efficient and economical air transport" (www.icao.int). Sustainability is *not* currently part of ICAO's primary remit.

EU Directive

The EU's Directive on the Taxation of Energy Products (2003/96) mentions € 0.302 per litre, equivalent to €132 per tonne of CO_2, as a minimum level of taxation of kerosene (and diesel) for the 2004-2009 period – provided kerosene is not exempted from taxation, that is. Such a tax would be equivalent to 15 to 20% of airlines' operating costs. As of 2010, the minimum tax would be €0.33 per litre. The average tax level of road fuels in the EU (the weighted average for petrol and diesel, including VAT) currently stands at approx. € 0.65 per litre, approximately double that rate.

EU25 aviation (departures from EU airports) consumed approx. 55 billion litres of fuel in 2005. Using the €0.302 tax level, this leads to a tax exemption of €17 billion in 2005. Using the €0.65 tax level, the exemption is €36 billion.

The Netherlands

On 1 January 2005 the Netherlands introduced a kerosene tax on domestic flights of €0.20628 per litre. The expected revenue was €14 million. The main reason for its introduction was a budget deficit.

Norway

Norway has a fuel tax on fuel used for domestic flights of NoK 0.53 (€ 0.07) per litre. The expected revenue for 2006 is in the range of NoK 500 million (€65 million).

Annex 5: The environmental impact of kerosene taxation

This annex describes the flaws in calculations of the environmental impact of fuel taxation and shows that the benefits have been underestimated.

Background

In 1999 the European Commission published a study by Resource Analysis (RA 1999). This study, which analysed kerosene taxation using the AERO model, considered a tax level of €0.245 per litre, at that time the minimum level of excise duty on diesel. (The Directive on the Taxation of Energy Products 2003/96 stipulates that by 2004/2010 the minimum level should be €0.302/0.330 per litre.)

The report expressed the emission reductions from kerosene taxation relative to certain baseline emissions. It is not clear which emissions were contained in this baseline – the report refers to "EU related routes". Based on other sources we can estimate that this baseline scenario comprises emissions from intra-EU routes plus departing flights from the EU to third countries. The fuel tax scenario that has this geographic coverage – scenario 1 – leads to 9.6% emission reduction by 2015 (p.54).

The report bases its results on calculations with the AERO model. A closer analysis of these results reveals that the tax of €0.245 per litre – almost a doubling of the assumed cost of fuel – would not lead to any efficiency improvement (p.51: fuel consumption per revenue tonne kilometre remains constant !). In other words: according to the AERO model *there will be no 'supply-side response' to higher prices*.

It is precisely this aspect of the AERO model – it's ignoring of changes in airlines' behaviour – that has been heavily criticised, implicitly by the authors themselves (Resource Analysis) and more explicitly by ICAO.

Criticism by the authors

As the Resource Analysis report itself explains:

"… possible responses related to the aircraft mix operated, which could have a further effect on the reduction of fuel use and emissions, are:
1. manufacturers' response
2. shortening aircraft lifetimes
3. changes to airlines' purchasing behaviour.
In the standard AERO computations, these responses are not taken directly into account, *because of the number and arbitrariness of the assumptions that would be needed …"* (p.54, emphasis added).

Criticism by ICAO

ICAO's Forecast and Economic Support Group (FESG 1997) undertook a review of the AERO Modelling System. Conclusion number 8 of the review team was as follows:

"*The lack of consideration of potentially important supply side effects, for example in the impact of an aviation fuel tax in stimulating the development of more fuel efficient technology, is a significant weakness of AERO."* (conclusion viii).

This evidence shows that the 1999 RA study seriously underestimates the likely environmental impacts of a kerosene tax. The model used is incapable of investigating the most important reason of all for introducing a fuel tax – namely, an increase in fuel efficiency.

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About T&E

T&E is Europe's principal environmental organisation campaigning specifically on transport. Members are drawn from NGOs in nearly every European country, all of whom promote a more environmentally sound approach to transport.

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