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Aviation in the EU Emissions Trading Scheme

A first step towards reducing the impact of aviation on climate change

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Abstract

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The European Commission's proposal of September 2005 to include the aviation sector in the EU Emissions Trading Scheme can be seen as a step forward in taking up the aviation sector in climate policy. The environmental impacts of including aviation in the EU-ETS will depend fully on the design of the trading system, with particular emphasis on the total CO_2 emission allowances to be determined. In September 2005 the European Commission published its proposal in a Communication on policy instruments to reduce the climate change impacts of aviation. In this MNP report we are addressing Dutch negotiators and members of the Dutch and European parliaments who are not familiar with the details of the policy field with an overview of the main aspects of the policy issue. So far, aviation has not been included in European or international climate policies. However, as the overall climate impact of aviation is estimated at a factor of 2 to 4 higher than the impact of CO_2 emissions alone, it is significant enough to be brought forward. If the aviation sector is included in the EU emissions trading system, in the short term the sector is expected to account for carbon emission reductions by purchasing CO_2 allowances from other sectors. Impacts on the economy and the environment in the Netherlands are not expected to differ fundamentally from other countries. Kerosene tax and emissions charges may be worthwhile considering, although politically sensitive at international level.

Keywords: climate change, aviation, emissions trading, EU-ETS

Rapport in het kort

Luchtvaart in het EU emissiehandel systeem

Het voorstel van de Europese Commissie van september 2005 om de luchtvaartsector op te nemen in het EU emissiehandel systeem is een stap vooruit in het betrekken van de luchtvaartsector in klimaatbeleid. De milieueffecten hiervan hangen af van het ontwerp van het handelssysteem, in het bijzonder van de vastgestelde hoeveelheid CO_2 -emissierechten in het systeem. De Europese Commissie publiceerde het voorstel in een 'Mededeling over beleidsinstrumenten om de klimaateffecten van de luchtvaart' terug te dringen.
Dit MNP-rapport heeft als doel een overzicht van de belangrijkste aspecten van het beleidsvraagstuk te presenteren aan Nederlandse onderhandelaars en leden van de Tweede kamer en het Europese Parlement die niet bekend zijn met de details van het beleidsterrein. Op dit moment is de luchtvaartsector nog geen onderdeel van Europees of internationaal klimaatbeleid. Het totale effect van de luchtvaart op het klimaat is 2 tot 4 maal groter dan het effect van CO_2-emissies van de sector alleen. Daarom is het belangrijk om de sector wel te betrekken in het klimaatbeleid. Als de luchtvaartsector onderdeel zou worden van het EU-emissiehandel systeem, is de verwachting dat op de korte termijn deze sector betaalt voor het reduceren van CO_2 emissies door emissierechten te kopen bij andere sectoren. De verwachting is dat economische en milieueffecten voor Nederland niet anders zijn dan voor andere Europese landen. Vanuit kosteneffectiviteit is het is de moeite waard ook een kerosine-belasting of emissieheffingen als beleidsinstrumenten te overwegen, hoewel dat internationaal politiek gevoelig ligt.

Trefwoorden: Klimaatverandering, luchtvaart, emissiehandel, EU-ETS

Summary

In September 2005 the European Commission published a communication on “Policy instruments to reduce the climate change impacts of aviation”. This MNP report summarizes the potential impacts of the proposal at EU and national Dutch levels.

Climate impact of aviation significant enough to be addressed
If aviation is not included in climate policy, it will be more difficult to meet the long-term EU, and Dutch, climate target. The number of flights in European airspace is expected to almost double in the next 25 years, and this will increase the share of national and international aviation in total CO_2 emissions in the EU15 from a current 3.5% to 5% by 2030. In the same period, CO_2 emissions from aviation in the Netherlands are projected to double, from 4% to 8% (i.e. from 8 to 17 Mton CO_2). The overall climate impact of aviation is estimated as a factor of 2 to 4 higher than the impact from CO_2 emissions alone. This is because NO_x emissions and the formation of cirrus clouds, for example, also play a role.

Aviation in the EU Emissions Trading Scheme: A step forward in climate policy
The European Commission’s proposal to include the aviation sector in the EU Emissions Trading Scheme (EU-ETS) can be seen as a step forward in including the aviation sector in climate policy. It will be cheaper to reach the Kyoto target. The proposed instrument, EU-ETS, fits well into current EU and Dutch climate policies. In the longer term (after 2012), EU-ETS has the potential to develop into an incentive to improve environmental performance. Considering the long lifetimes of aircraft and the generally considered high costs of efficiency improvements, reductions in fuel consumption and emission improvements might take a while to materialize. In the shorter term, the aviation sector is therefore expected to account for carbon emission reductions by purchasing CO_2 allowances from other sectors. This means that most of the emission reductions do not take place in the aviation sector itself but in other sectors.

Economic and environmental impacts could be limited
According to some scenario calculations based on certain assumptions with regard to design parameters, including aviation in the EU-ETS in the 2008-2012 period will somewhat increase both the demand (+1%) and price of CO_2 allowances. Increases in ticket prices could range from €0 to €20 for an average round trip. In the longer term, the climate objectives would require large reductions and could significantly limit the CO_2 emission allowances in the EU-ETS and lead to higher costs (irrespective of whether aviation is included in the EU-ETS or not). The environmental impacts of including aviation in the EU-ETS will depend fully on the design of the trading system, with particular emphasis on the total of CO_2 emission allowances to be determined. Economic and environmental impacts for the Netherlands are expected not to differ fundamentally from other countries.

ETS design parameters and possible flanking measures will determine environmental impact
The design for including aviation in EU-ETS will be crucial for the environmental impact of the system. Design parameters include the geographical scope of the system, accounting for non-CO_2 climate impacts, the methods to allocate emission allowances (e.g. grandfathering, auctioning) and the choice of trading entities, as well as the interplay with the Kyoto Protocol and the monitoring method. With regard to the geographical scope and the type of flights covered, inclusion of all flights departing from EU countries will lead to a higher

environmental impact than including only flights between EU countries. To what extent the inclusion of all flights in ETS could affect future volumes and re-routing of trade passenger flows to and from the EU will require further research. Including only CO_2 in the EU-ETS will result in a simpler but less environmentally effective system, compared to accounting for the full climate impact of aviation. Flanking measures are then needed to address the non-CO_2 climate effects of aviation. An emission charge might then be practical and effective. Auctioning is the most cost-effective when it comes to choosing an allocation method.

Fuel tax and emissions charges worthwhile to consider as well, though politically sensitive

A kerosene tax and emission charging, with revenues earmarked for climate policy, are straightforward instruments for internalising external costs and for stimulating (fuel) efficiency improvements and CO_2 emission reduction from the aviation sector. A tax is in line with Europe's goal to reduce distortions in competition between different energy products. A charge could also be used to address the non-CO_2 emissions, such as NO_x emissions, possibly complementing fuel taxes and/or CO_2 emissions trading.

Contents

1 Aim of the report

In September 2005 the European Commission published a communication called “Policy instruments to reduce the climate change impacts of aviation” (CEC, 2005a). The main instrument proposed by the Commission in this document was inclusion of the aviation sector in the European Union Emissions Trading Scheme (EU-ETS).

This MNP report aims to present an overview of the main aspects of the policy issue to Dutch negotiators and members of the Dutch and European Parliaments who are not familiar with the details of the policy field. It has the character of a quick-scan.

The report evaluates the Commission’s proposal on its effectiveness in reaching its goal, focusing on:
- the potential for reducing the climate impact of aviation;
- environmental and economic effects for the Netherlands and
- the effectiveness of alternative policies such as fuel tax or an emission charge.

In order to do so the next chapter discusses the climate impact of aviation. Chapter 3 presents the goal and the characteristics of the Commission proposal. Chapter 4 discusses the policy context of the proposal. Chapter 5 evaluates three possible instruments: emissions trading, fuel tax, and emissions charging. The final chapter discusses environmental and economic impacts of including aviation in the EU-ETS.

2 Climate impact of aviation

The aviation sector is one of the fastest growing climate change contributors in Europe. Though aircraft fuel efficiency is continually improving (1-2% per year (IPCC, 1999)), this improvement is outweighed by the growing demand for air travel. As a result, CO_2 emissions from aviation are expected to grow much faster than total CO_2 emissions in the EU. This will increase the share of national and international aviation in total CO_2 emissions in the EU15 from a current 3.5% to 5% by 2030 (CEC, 2003)). In the same period, CO_2 emissions from aviation in the Netherlands are projected to double, going from a share of 4% to 8% (i.e. from 8 to 17 Mton CO_2). The CO_2 emissions from Dutch aviation are expected to grow faster than total CO_2 emissions in the Netherlands. As a result, the relative importance of the Dutch aviation sector with respect to climate change will increase.

CO_2 emissions form only a part of aviation's contribution to climate change, with NO_x emissions and the formation of cirrus clouds also playing a role. The radiative forcing of aviation is broadly estimated at 2 to 4 times higher than its CO_2 forcing alone, not including the effects the formation of cirrus clouds (Sausen et al., 2005; Wit et al., 2005; Cames and Deuber, 2004; IPCC, 1999).

Projections of the sector's growth potential in Europe up to 2050 suggest that this sector alone could threaten the target set by the European Council (European Parliament and Council, 2002; Council of the European Union, 2005) up to a maximum increase of 2 °C average global temperature compared to pre-industrial levels (Bows et al., 2005).

3 Goal and characteristics of the proposal

Until now aviation is not part of EU climate policies nor is the sector included in the Kyoto Protocol, because of difficulties to reach international agreement on the allocation of emissions of international flights to individual countries. The goal of the current Commission proposal is to include the aviation sector in greenhouse gas (GHG) mitigation policy. Three policy instruments are under discussion there: kerosene taxation, emission charging and emissions trading. The Commission sees emissions trading as the most promising and cost-effective way to mitigate GHGs. Including aviation in the review of the existing EU-ETS system is targeted for the summer of 2006.

The idea of emissions trading is that certain actors receive a number of carbon permits (or "allowances") allowing them to emit a certain amount of CO_2. If they emit more CO_2 than this ceiling (or "cap") allows, they can choose to either reduce emissions, by increasing environmental performance, for example, or by decreasing flight movements. Alternatively, they can purchase additional permits from other sectors. Reductions will thus take place in the sector where reduction is cheapest.

A number of technical design elements are crucial if the policy is to deliver its full environmental and economic potential. These design elements include:
- the type of entity made responsible for aviation's climate impact (e.g. airports, fuel suppliers, aircraft manufacturers or aircraft operators);
- the extent to which non-CO_2 climate effects of aviation are addressed (e.g. including those in EU-ETS or use of flanking instruments);
- the types of flights covered (e.g. all flights, intra-EU flights, all flights departing from the EU) and
- the sector's overall emission limitation and the approach taken for calculating and apportioning the sector's overall emission limitation (e.g. auctioning, benchmarking, grandfathering).

These technical design elements will be further examined by a special working group to be set up under the European Climate Change Programme.

The public and stakeholder opinion

In Eurobarometer polls both climate change and air pollution are rated among the top four environmental problems causing worry to EU-25 citizens. Citizens regard climate change in the Netherlands as the fourth most important problem – from a large set of ecological, economic and social problems– to be solved. A public consultation by the Commission on the current proposal received 5564 responses from individuals and 198 from organizations. Compared with scores from other polls taken by the Commission, this is high (CEC, 2005b).

The poll revealed general agreement among citizens and organizations to include the air transport sector in efforts to mitigate climate change. Many airlines and manufacturers believed that this should be done under the International Civil Aviation Organisation (ICAO). Airlines, manufacturers and airports preferred emissions trading to any other economic instrument, as long as the system was open to other sectors and limited to CO_2. Airlines and manufacturers objected explicitly to fuel taxation. Along with the airports, they considered emission charges to be more acceptable and some of these organizations suggested using such charges both to address the non-CO_2 effects of aviation on climate and to support research.

ICAO's 188 member countries have not been able to agree on regulatory standards or emission charges applicable to CO_2 emissions. However, ICAO has endorsed the concept of international open emissions trading to be implemented through voluntary emissions trading or the incorporation of international aviation into the existing state schemes.

Environmental NGOs agree that incorporation of international aviation in the emissions trading system would be a first step, but not enough, to reduce the impacts of aviation on climate change. They fear that in this way tougher measures are being avoided, and declare state fuel taxation and en-route charges to be necessary as well (T&E, 2005).

The Dutch airline, KLM, is in favour of incorporating aviation into an international emissions trading system. Though they would prefer a global system, the KLM would be willing to participate in a European-wide system (KLM, 2005).

4 The policy context of the current Commission proposal

Before assessing the three policy instruments in the Commission's proposal (chapters 5 and 6) we find it relevant to look at the policy context of the proposal (sections 4.1 and 4.3) and the progress thus far with the instruments discussed (section 4.2).

4.1 EU policy: objectives

The four policy objectives emerging are reduction of climate change, reduction of climate change caused by aviation, internalization of external costs and reduction of the distortion in competition between energy products.

Climate policy

The European Commission has taken many climate-related initiatives since 1991, when it issued the first Community strategy to limit CO_2 emissions and improve energy efficiency. Climate Change was also one of the priority issues in the 2001 Sustainable Development Strategy (CEC, 2001a).

In 2005, the Commission adopted the Communication, "Winning the Battle against Climate Change", outlining key elements for the EU's post-2012 strategy. This communication highlights the need for broader participation by countries and sectors not already subject to emission reductions (like international aviation), the development of low-carbon technologies, the continued and expanded use of market mechanisms and the need to adapt to the inevitable impacts of climate change (CEC, 2005c).

Climate policy for aviation

With specific reference to air transport and aviation the Commission published an initial communication in 1999 called "Air transport and the environment" (CEC, 1999). Here, a long-term policy target was set for achieving improvements to the environmental performance of air transport operations that would outweigh the environmental impact of growth. Sub-objectives were:

- including the air transport sector in efforts to mitigate climate change,
- better internalization of external costs of climate change and
- providing stronger incentives to air transport operators for reducing their impact on climate.

The 6th Environmental Action Plan identified reduction of greenhouse gas emissions from aviation as a priority action (European Parliament and Council, 2002).

Internalization of external costs

In general, the internalization of external costs by using market-based instruments is a long-standing EU policy objective, which was embedded in the European Sustainable Development Strategy. The objective can also be found at the 6th Environmental Action Plan (European Parliament and Council, 2002), the Common Transport Policy (CEC, 2001b) and in the most recent Integrated Policy Guidelines (CEC, 2005d), forming part of the Lisbon Strategy.

Avoiding distortion of the competitive position of different energy products
A proper functioning of the internal market is a key policy line in the EU. According to the Commission this requires minimum levels of taxation for energy products at Community level. The taxation of energy products and where appropriate, electricity, is one of the instruments available for achieving the Kyoto Protocol objectives. Differentiating taxes also avoids distortion of the competitive position of renewable energy compared to mineral oils.

4.2 EU Policy: progress with instruments

The three policy instruments discussed in the Commission's proposal (kerosene taxation, emission charging and emissions trading) are not new. A brief overview of progress with each of these instruments helps to complete the background of the Commission's proposal.

Kerosene taxation
The general progression in introducing a kerosene tax for aviation is slow (see box). According to Directive 2003/96/EC, the Council, in principle, allows *kerosene taxation* on national and intra-Community flights. But this has to be agreed on through bilateral Air Service Agreements (ASAs) between member states or through a unanimous decision by the Economic and Financial Affairs (ECOFIN) Council. Both processes are cumbersome, as are the attempts to allow kerosene taxation on flights between EU and non-EU countries. Kerosene taxation on flights between member states and third countries is also generally prohibited by ASAs between member states and third countries. It is important in this respect to note that in 2002 the European Court ruled that "the Community acquires an external competence by reason of the exercise of its internal competence" (CEC, 2002). As a result, member states are no longer allowed to make new or maintain existing bilateral open skies agreements. The Council has given the Commission the mandate for negotiating new agreements, a process that is currently ongoing. In principle, this re-negotiation process opens a window of opportunity to ensure that the clauses prohibiting kerosene taxation are removed from the ASAs.

Background to the excise duty on kerosene (kerosene tax)
In 1992, the Council adopted a directive for the harmonization of the excise duty on energy (92/81/EEC). Article 8 1(b) of this directive provides a compulsory exemption from this minimum excise tax for aviation. The directive also requires a review of this mandatory exemption, which the Commission carried out in 1996 (CEC, 1996). The Commission concluded that the exemption should be lifted as soon as it became possible to levy such a tax on all carriers, including non-EU carriers. The Commission's proposal for the replacement of Directive 92/81/EEC reflected that opinion. There was, however, much discussion in various Council working groups about this proposal, resulting in yet another request by the Council to the Commission to provide further information. This resulted in a recommendation to the Council to adopt a proposal permitting member states to levy tax on aviation fuels used on national flights, or by bilateral agreement, intra-Community movements (CEC, 2000). It also recommended intensified work with the ICAO on the subject of kerosene taxation. Through Directive 2003/96/EC, the Council finally allowed kerosene taxation on national and intra-community flights.

Emission charging
With respect to *environmental charges* to reduce the effect of aviation on climate change, no EU legislation is currently in place. However, Wit and Dings (2002) concluded that legal obstacles were non-existent. Indeed, in many EU countries and airports noise charges are

levied but only Switzerland, Sweden and the UK apply emission charges with respect to air pollutants (NO_x) (ANCAT, 2005).

Emissions trading scheme
Beginning its operation in January 2005, EU-ETS includes a major part of the EU's energy-intensive industrial installations. Not only can emission credits be traded between EU companies, but CDM credits from outside the EU can also be traded. The current first phase of the EU-ETS is generally regarded as a pilot phase to get acquainted with the system. Current emission caps do not yet form an impetus for CO_2 emission reductions.

The 2006 review of the EU-ETS will prepare the trade market for the 2008-2012 period. The review concerns changes in the national allocation of CO_2 allowances and increases in the percentage allowances (10%) that can be allocated through auctioning, expansion of ETS to non-CO_2 greenhouse gases and expansion by including other sectors, such as aviation.

4.3 Dutch policy goals

Climate policy
Ever since the first National Environmental Policy Plan (NEPP, 1989), climate change has been a priority issue in environmental policy in the Netherlands. In the 1990s the Dutch were very active in setting up policy goals at European and global level. Currently, Dutch climate policy is short term, focused on attaining the Kyoto targets (6% CO_2 reduction in the 2008-2012 period compared to 1990). Dutch policies for the long term aim at a transition to a sustainable energy system where CO_2 emissions are low (NEPP4, 2001). The 4th NEPP has also adopted the UN goal of avoiding a 2 ^{o}C temperature change.

Climate policy for aviation
Abating climate impacts of aviation is a fairly new subject on the Dutch policy agenda. The first memorandum appeared in 1995 (Nota luchtvaart en luchtverontreininging, 1995). This memorandum and the more recent National Environmental Policy Plan (NEPP4, 2001), the Memorandum on traffic emissions (Beleidsnota Verkeersemissies, 2004) and the Dutch Mobility Plan (Nota Mobiliteit, 2004) all call for *international* action to reduce climate impact from aviation.

Indeed, there is little or no *national* policy pressure to reduce climate-related emissions (CO_2, NO_x) from aviation, as (most) CO_2 from aviation forms no part of the Kyoto agreements, and local air quality around Schiphol airport (NO_2) is expected to comply with EU standards. However, the Netherlands has been the first EU country to introduce a kerosene tax on domestic flights.

The Dutch government prefers the introduction of market-based instruments for international aviation to take place through the ICAO. But since action at ICAO is slow, the Dutch government would like to see the European Community introduce market-based measures, such as emission charging, emissions trading or kerosene taxation (Beleidsnota Verkeersemissies, 2004).

Internalizing external costs
Internalizing environmental costs in prices, seen as essential for environmental policy, is one of key points in the 4th NEPP. Taxes, charges and emissions trading are also seen as vital

instruments for realizing emission reductions. Furthermore, current Dutch tax policies aim at greening of the tax system (Ministerie van Financiën, 2005).

Avoiding distortion of the competitive position of different energy products
This is not a special Dutch policy line.

Other specific Dutch policy lines related to aviation
Important policy lines in the Dutch Mobility Plan are to strengthen both the added value of Dutch airports for the Dutch economy and the international competitive position of Amsterdam Airport Schiphol. The Dutch Mobility Plan also expresses the ambition to reduce financial consequences of government measures for the aviation sector.

5 Evaluation of three possible instruments

Common to the three options proposed by the Commission are that they will all likely result in higher operating costs which will stimulate efficiency improvements. Sometimes increased fuel prices –either through a tax or carbon price or en-route and/or landing and take-off charges through emission charging– cannot be compensated for by efficiency improvements. Considering the long lifetimes of aircraft and the generally considered high costs of efficiency improvements, reductions in fuel consumption and emission improvements might take a while to materialize.

In the internally highly competitive aviation sector extra costs are likely to be transferred to customers through ticket price increases, which could reduce air transport demand and CO_2 emissions. The magnitude of such reductions is uncertain and depends, among other aspects, on the extent of price increases and the price elasticity of air transport demand. Obviously, there are other effects of the proposed instruments. See below for a summary of the pros and cons of the instruments seen in the light of the overall policy objectives mentioned in the previous chapter.

5.1 Including aviation in the EU emissions trading scheme

This option is considered to be the most cost-efficient of the three options to reduce CO_2 emissions, as the trade market will ensure reductions take place where it is the least expensive, and to let aviation share in the costs of emission reduction. The option is therefore in line with overall climate policy and with the desire to internalize external costs. A distinguishing feature of emissions trading is that the environmental gains in terms of CO_2 emission reductions are known in advance, because of the cap imposed on the sector (provided the system works in practice as it supposed to). Unknown in advance are the CO_2 prices.

It should be noted that only a small part of the CO_2 emission reduction is expected to take place in the aviation sector; the rest will be purchased in other sectors. The main reason for this is that aviation is generally considered to have fewer and more expensive options to reduce emissions than other sectors. Moreover, when the prices of emission allowances are pushed up to meet aviation's demand, this could lead to higher prices in other sectors. In this case, non-flyers would also be paying for aviation's CO_2 emissions.

Currently, the EU-ETS only covers CO_2 emissions. When only CO_2 aviation emissions become part of the EU-ETS and measures to reduce CO_2 are taken outside the aviation sector, no impetus will be given to reduce the non-CO_2 effects (e.g. for NO_x) in the aviation sector. This will reduce the ability of policy to address the full impact of aviation on climate change and will therefore lessen the extent to which external costs of the aviation sector will be internalized. Non-CO_2 emission could be taken up in to the ETS system by multiplying CO_2 emissions by a certain factor. In principle, this is allowed by the EU-ETS review planned for 2006. Another way to cover non-CO_2 emission could be to introduce emission charges (see below).

Politically, an advantage of emissions trading is that it is an acceptable instrument at various levels (countries, EU, ICAO).

5.2 Introduction of a fuel (kerosene) tax

Contrary to emissions trading, the effects of fuel taxation on CO_2 emission reduction are not known in advance, while the costs are. With the appropriate fuel tax rate and revenues earmarked for CO_2 and non-CO_2 emission reductions, this instrument could, in principle, have the same effect as emissions trading. The difference lies in the government determining the tax rates rather than trade determining the carbon price, and the government intervention needed to distribute tax revenues to emission reduction programmes, rather than having the emissions trading market taking care of it. Fuel taxes are considered as a relatively simple instrument to internalize the costs of CO_2 emissions in the price of fuels (CEC, 2001b; ECMT, 2003). However, as with emissions trading, fuel taxes do not guarantee CO_2 emission reductions in the aviation sector per se. They do, however, guarantee that only those using air transport will pay. In addition, kerosene taxation will be in line with the EU's objective of reducing distortions in competition between different energy products.

A disadvantage of fuel tax is that it will not lead to CO_2 emission reductions in the most cost-efficient way, as reductions will be made in the sector itself (as a response to higher fuel costs), even though these are considered expensive. Reductions could also take place elsewhere by using tax revenues for emission reduction programmes, in which case the government needs to intervene (less efficient than trade). However, tax revenues are usually not earmarked. Note that there is a possible negative side-effect of introducing fuel taxation only in the EU. This could lead to aircraft taking extra fuel aboard outside the EU (tankering). The effects of tankering are expected to be small but significant.

A disadvantage of a fuel tax is its political sensitivity and its impopularity within such institutions as ICAO.

5.3 Introduction of an emission charge

Emission charges differentiated to environmental efficiency of an aircraft can be applied to CO_2 and non-CO_2 emissions for landing and take-off and/or for each mile flown (en-route charging). When applied to CO_2 only, the instrument is quite similar to fuel taxation. When applied to CO_2 and non-CO_2 the instrument becomes more fine-tuned and capable of addressing the full climate impact of aviations. As with fuel taxes, the effects of emission charging on CO_2 emission reduction are not known in advance, while the costs are. But again, with appropriate charge rates and revenues earmarked for CO_2 and non-CO_2 emission reductions, this instrument could, in principle, have the same effect as emissions trading. Emission charging, as fuel taxation, will also ensure that only those using air transport will carry the burden of emission abatement by the sector, which is in line with the polluter pays principle.

Emission charging could also be introduced as a flanking measure alongside emissions trading, when this emissions trading system only accounts for CO_2

emissions. Such a flanking measure could avoid the difficulties in adding non-CO_2 emissions in the EU-ETS, while at the same time account for the full climate impact of aviation.

Emission standards
Setting emission standards is yet another option to reduce emissions from aircraft. ICAO has already set NO_x emission standards, although progress in this area is slow and according to some not "technology forcing" enough. This is because current NO_x standards do not off set NO_x emission increases due to volume growth. This is in strong contrast with NO_x emission standards in European road transport and industrial installations, which have enforced absolute decoupling volume growth and NO_x emission.

5.4 Specific impacts for the Netherlands for each policy option

The pros and cons for Europe of each policy option, as described above, are not significantly different for the Netherlands. It should be noted that the Netherlands has already introduced a NO_x emissions trading scheme for industrial installations and a kerosene tax for domestic flights. The Netherlands has also accumulated experience with (noise) emission charging and earmarking revenues, for example, by using noise charges at Schiphol Airport for local insulation programmes. The Netherlands therefore has had experience with each instrument discussed in the Commission's proposal.

5.5 Conclusion

The inclusion of aviation in the EU emissions trading scheme is a first step toward incorporating the aviation sector in climate policy in the short term, and toward reducing CO_2 emissions in the most cost-efficient way for society. To address the full impact of aviation on climate change, the ETS should also cover non-CO_2 emissions or be flanked with measures aimed at reducing non-CO_2 emissions from the sector.

A kerosene tax and emission charging, with revenues earmarked for climate policy, are straightforward instruments for internalising external costs and for stimulating (fuel) efficiency improvements and CO_2 emission reduction from the aviation sector. A tax is also in line with Europe's goal to reduce distortions in competition between different energy products as well as with Dutch policies for greening the tax system. A charge could furthermore be used to address the non-CO_2 emissions, such as NO_x emissions, possibly complementing fuel taxes and/or CO_2 emissions trading.

Table 1: Contribution of three policy instruments to overarching policy objectives

Instrument **Policy objective**	**Emissions trading scheme**		**Kerosene taxation**		**Emission charging**			
	CO_2	*CO_2 + non-CO_2*	*Revenues not earmarked*	*Revenues earmarked *)*	*CO_2: revenues not earmarked*	*CO_2: revenues earmarked *)*	*CO_2 + non-CO_2: revenues not earmarked*	*CO_2 + non-CO_2: revenues earmarked *)*
To limit climate change	✓✓	✓✓ ✓	✓	✓✓	✓	✓✓	✓✓	✓✓✓
To limit aviation's contribution to climate change	✓	✓✓	✓	✓✓	✓	✓✓	✓✓	✓✓✓
To internalise external costs	✓✓	✓✓ ✓	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓
To reduce distortion in competition between mineral oils and other energy products	–	–	✓✓	✓✓	–	–	–	–

*) revenues are earmarked to lessen aviation's CO_2 and non-CO_2 climate impact.

6 Environmental and economic impacts of including aviation in the EU-ETS

Many of the economic and environmental impacts of including aviation in EU-ETS will depend on the future design of the system. Here we describe expected short-term impacts, possible longer term impacts and crucial design parameters for aviation in EU-ETS.

6.1 Short term: price of CO2 allowances

Adding the aviation sector to the EU-ETS is expected to only slightly increase the price of CO_2 allowances on the ETS market in 2008-2012. This is because the aviation sector will have to buy only a small fraction of the total allowances in the EU-ETS system. Wit et al. (2005) estimated this fraction at 0.8–1.1% of total allowances in the EU-ETS system. Such a change in demand will have a small impact on CO_2 prices. These estimations assume a growth of CO_2 emissions from the aviation sector of 4% per year over the 2008–2012 period.

6.2 Short term: ticket prices

Wit et al. (2005) calculated different scenarios for the 2008-2012 period estimating the possible increase of ticket prices of an average round trip. According to the calculations the price increase would be between €0.20 and €19.80, depending on the chosen design option and whether opportunity costs are fully passed on in the ticket price or not. The most significant parameters having an effect on the ticket prices appear to be:

1. the allowance allocation (operators pay for the entire budget of allowances through auctioning or get them free),
2. the opportunity costs (see textbox),
3. the multiplier applied (CO_2 only is subject to the system, or a multiplier is used to account for non-CO_2 climate effects).

According to the scenarios of Wit et al. (2005), the expected ticket price increase without auctioning will come to a maximum of €2.90. The high-end outcome of a system with auctioning will lead to a price increase of €9. A price increase of €19.80 is projected for the situation where opportunity costs are fully passed on, and where the system is applied to all flights departing from the EU and where no multiplier is used. This outcome could be 2 to 4 times higher when a multiplier of 2 to 4 is applied to compensate for non-CO_2 effects.

Opportunity costs
CO_2 allowances have a market value in the EU-ETS. These allowances can be surrendered when CO_2 is emitted, but can also be sold on the emissions trading market. The allowances used for covering emissions can no longer be sold on the market. This missed income can be seen as "opportunity costs". These opportunity costs do not always reflect real operational costs, in particular, when a sector gets the allowances for free (e.g. through grandfathering). Opportunity costs may be passed on to customers. Recent evidence for the Netherlands suggests that electricity companies do indeed transfer the opportunity costs of (freely obtained) CO_2 allowances to their customers (Sijm et al., 2005).

Figure 1 indicatively shows the breakdown of ticket prices, their long-term dynamics and the short-term cost estimates of including aviation in EU-ETS.

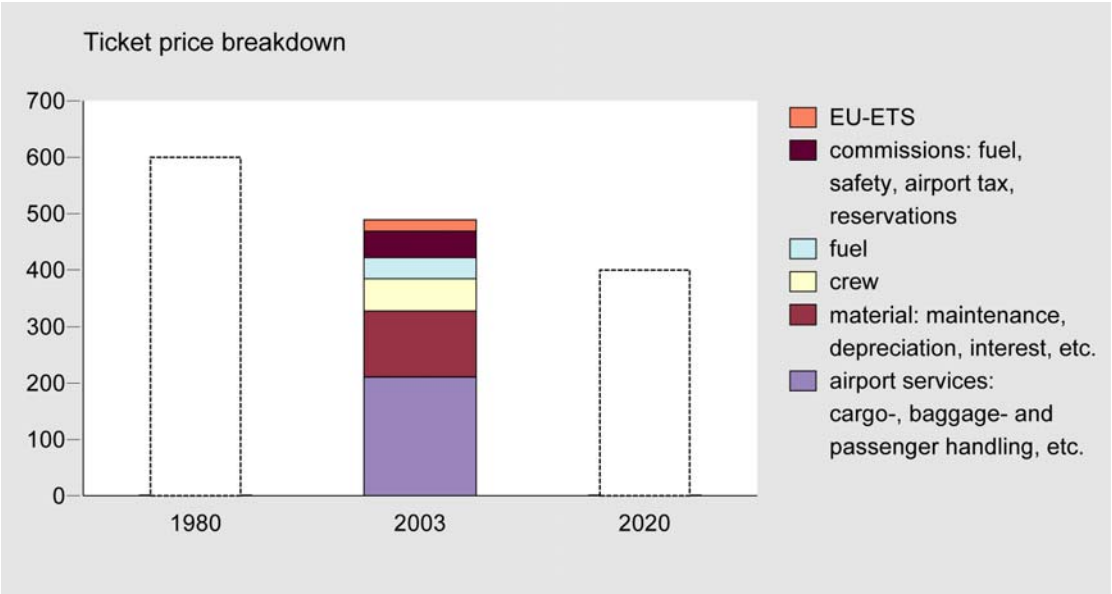

Figure 1: Breakdown of ticket prices, their long-term dynamics and the short- term cost estimates of including aviation in EU-ETS. The €469 value is an average ticket price (including short and long distances & business and economy) for tickets sold by Dutch travel agencies in 2004 (ANVR, 2005). Dotted bars indicate the long term trend of 1% per year ticket price reduction (Russo, 1997)

6.3 Environmental effects

It is not (yet) possible to quantify the real environmental impact of introducing European aviation into ETS. This impact will depend on the geographical scope of the system, the inclusion (or not) of non-CO_2 emissions in the system and the number of CO_2 allowances to be allocated to the aviation sector when compared to the sectors' business-as-usual scenario (i.e. the "cap"). As an example we will discuss the allocation of allowances and the geographical scope of the system a bit further.

Possible longer term secondary effects

Economic and environmental effects in other sectors
In a scenario with a growing contribution of aviation to EU-ETS and gradually tightened-up CO_2 caps, the sector may increasingly buy CO_2 credits supplied by the electricity sector (part of EU-ETS), where CO_2 reductions are relatively cheap. Measures in the electricity sector may include a further shift from high-CO_2 coal to lower-CO_2 gas firing. Such a shift will cost-effectively contribute to a decrease in European air pollution (NO_x, SO_2, PM_{10}). In a similar scenario, however, EU-ETS participants may also obtain relatively cheap CO_2 credits from outside the EU, via the so-called linking directive. The environmental revenues of such credits are currently still a subject of study.

Longer term economic impacts
The EU-ETS is expected to keep costs to society low in the short term, but this does not guarantee that these costs will remain low over the longer term, in particular, if the overall climate objective is to be taken seriously. Recent research suggests that a 65–85% reduction in CO_2 emissions in Europe by 2050 is needed to contribute to the target of limiting global warming to a maximum of 2 ^oC (Den Elzen and Meinshausen, 2005). The emissions trading scheme is designed to contribute to this overall long-term climate goal in a cost-effective and economically efficient manner (Directive 2003/87/EC). Emissions trading schemes will indeed stimulate the most cost-effective emission reduction measures to be taken in the short term, and will postpone taking more expensive emission reduction measures. Technological innovation could, in the long term, make the currently still rather expensive emission reduction measures cost-effective, which, even over the long term, will make the system economically efficient. There is, however, a risk that efficient reduction technologies will not sufficiently materialize, which then results in high costs to further reduce emissions in the future.

There are many more uncertainties associated with the long-term effects of including aviation in the EU ETS. Examples are the relation with CDM and JI and effects on prices in other sectors, all of which depend on the design of the system and the reactions of actors involved. It will be worthwhile to examine those further.

6.4 Design parameter: allocation of allowances

The allocation of emission rights determines the financial burden to be borne by the sector and therefore is a highly sensitive design issue. Wit et al. (2005) discuss and evaluate several allocation options, three of which are grandfathering, benchmarking and auctioning. In the *grandfathering* approach, emission rights are allocated free of charge on the basis of past emissions. This approach fundamentally contradicts the polluter-pays principle. In general, airlines using relatively old and polluting technologies will be relatively better off than operators that have already invested in cleaner technology. In the *benchmarking* approach, emission allowances are distributed free of charge but on the basis of benchmarks relating to a typical output factor of a sector, for example, emissions per unit output. In this case operators with new and low-emission aircrafts are favoured. The benchmark can provide strong incentives for investments in new technologies. *Auctioning* appears to be the most attractive option for allocation. From an economic angle it is considered to be the

most efficient option. Permits are allocated on a non-discriminatory basis that also extends to new entrants. The revenue raised by auctioning could be substantial. These revenues could, in principle, be used to reduce taxes elsewhere or to finance other climate control measures.

6.5 Design parameter: geographical scope of the system

The geographical scope of aviation in the ETS is an important design parameter, especially when considering whether or not to include flights coming in or departing from the EU (inter-EU flights) in the ETS system. Some pros and cons:

- Including inter- and intra-EU flights in ETS will enlarge the coalition size of the ETS system, which, in turn, will increase the effectiveness of the EU climate policy to meet the requirements of the 2 ^{o}C climate objective (Bollen et al., 2005).
- CO_2 from international (inter- as well as intra-EU) flights are still in a policy vacuum as these emissions are not allocated to either countries or sectors and form no part of the Kyoto agreements. Involving intra-EU flights in the ETS system is an opportunity to release this vacuum.
- Introducing CO_2 trade for intra-EU flights only will increase the operation costs for airlines specialized in intra-EU aviation and thus result in a comparative advantage for those airlines operating more on inter-EU flights. Including intra- *and* inter-EU flights in ETS will retain the level playing field amongst EU companies.
- Including inter-EU flights could affect air transport volumes from and to the EU and might also cause re-routing of trade and passenger flows e.g. by using non-EU hubs for transatlantic flights (e.g. through Geneva and other hubs close to the EU). The potential size of such impacts on European airlines and the economy will require further research.

6.6 Needs for further research

Further research is needed to quantify the environmental and economic impact of various options to introduce European aviation into ETS. Subjects for further research include the geographical scope of the system, the inclusion (or not) of non-CO_2 emissions in the system and the number of CO_2 allowances to be allocated to the aviation sector when compared to the sectors' business-as-usual scenario (i.e. the "cap").

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