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Competitiveness issues for Dutch aviation from EU ETS

Report

Delft, October 2008

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Publication Data

Bibliographical data:
Marc Davidson, Jasper Faber, Sander de Bruyn
Competitiveness issues for Dutch aviation from EU ETS
Delft, CE, 2008

Aviation / Competition (economical) / Emission rights / Tradable pollution permits / EC / Effects
FT: The Netherlands

Publication number: 08.7734.45

CE-publications are available from www.ce.nl

Commissioned by: Ministry of Transport.
Further information on this study can be obtained from the contact person Jasper Faber.

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Summary

In July 2008, the European Parliament voted in favour of a directive on the inclusion of aviation in the EU ETS. It is expected that the Council will follow in the autumn of 2008. Also in 2008, the Commission published a proposal to amend the EU ETS directive (2008(16)final). One of the major changes in design in the EU ETS as proposed by the Commission is that higher levels of allowances will be auctioned. In fact, for most sectors, auctioning will be gradually phased in and become the norm in 2020.

CE Delft has recently completed the study *Competitiveness issues for Dutch industry from EU ETS* (CE Delft, 2008). The aim of that study was to analyze the effects from the European Emission Trading Scheme (EU ETS) on industrial competitiveness, to identify economic activities where substantial impacts are likely to occur and to discuss several remedies (compensation mechanisms) that can reduce the impacts on competitiveness. As aviation was not considered there, the present study adds an analysis of impacts of auctioning in the EU ETS on competitiveness of the aviation sector.

The adopted position of the European Parliament has several design figures that are important to the competitive position of EU carriers:
- All flights to and from EU airports will be included in the EU ETS, regardless of the nationality of the carrier.
- The cap for aviation will be set at 97% of average 2004-2006 emissions in 2012, and 95% of these emissions from 2013.
- 15% of the aviation allowances will be auctioned.
- 82% of the aviation allowances will be allocated for free in proportion to the amount of goods and/or passengers transported (expressed in revenue ton kilometres or RTK) This benchmark will be updated every trading period. (The remaining 3% of allowances is set aside for new entrants or fast growing aircraft operators).

Because aviation's inclusion in the EU ETS is different than the inclusion of other sectors, some assumptions made in the first report have been altered in this one. The most important assumptions are:
- The emissions considered are not emissions by aircraft registered in the Netherlands, but emissions by aircraft flying to and from Dutch airports, regardless of their nationality.
- Instead of assuming a 20% reduction in 2005 emissions and a no-growth scenario, a growth scenario has been used together with an allocation of free allowances based on 2005 emissions.

The updated benchmark used to allocate free allowances is in fact a production subsidy. Therefore, aircraft operators have an incentive to increase production. As a result, there are opportunity benefits associated with production which offset

the opportunity costs of freely allocated emission allowances[1]. Therefore opportunity costs are not passed on to consumers and windfall profits are unlikely to occur. If, however, allowances are not allocated on the basis of regularly updated benchmarks, windfall profits may occur.

Since demand for aviation is forecasted to increase, even without auctioning the sector will face a cost increase because it has to buy allowances from other sectors to cover the difference between future emissions and average 2004-2006 emissions. Table 1 shows how total operating costs are affected under various emission prices and levels of auctioning.

Table 1 Potential cost price increases in 2020 (change of total operating costs per RTK)

	NL to and from EU airports	NL to and from non-EU airports
€ 20, 0% auctioning	+0.7%	+1.1%
€ 20, 10% auctioning	+0.8%	+1.2%
€ 20, 100% auctioning	+1.6%	+2.5%
€ 50, 0% auctioning	+1.9%	+2.9%
€ 50, 10% auctioning	+2.1%	+3.2%
€ 50, 100% auctioning	+4.1%	+6.4%

Source: AERO-MS.

In most aviation markets, cost price increases can be passed through. However, in some markets pass through will be limited due to the location of hubs (airports where passengers transfer flights) of non-EU carriers. On some long haul routes, passengers may choose to fly direct or transfer at a hub. Direct flights are generally both operated by EU carriers and non-EU carriers, flights via an EU hub generally with EU carriers and flights via non-EU hubs with non-EU carriers. As the latter flights only have one flight leg in the EU ETS, they will face a lower cost price increase than both direct flights and flights via EU hubs. As a result, flights via non-EU hubs (generally operated by non-EU carriers) will become more attractive and not all of the cost price increases in these markets may be passed through. The amount of pass through would probably be higher than 50% but lower than 100%. This report arbitrarily assumes that 50% of intercontinental flights from or via Dutch airports have an alternative route via a non-EU hub. It also assumes that additional demand can be accommodated at airports and in the airspace. Table 2 shows the net cost price increase on different routes and on the total network to and from Dutch airports under these assumptions.

[1] In the current legislative texts for the inclusion of aviation in the EU ETS, opportunity benefits would not completely offset opportunity costs. As the benefits are gained in future years, they should be discounted, making their net present value less than the opportunity costs.

Table 2 Net cost price increase without demand effects (€ 20, full auctioning)

	NL to and from EU	NL to and from non EU with potential hub effect	NL to and from non EU without potential hub effect	Total
Baseline RTK (billion)[a]	5.74	20.7	20.7	47.1
Baseline yield per RTK (€)[b]	0.1324	0.062	0.062	0.071
Total baseline turnover (€ bln)[c]	0.759976	1.2834	1.2834	3.33
Potential cost price increase [a]	+1.7%	+2.7%	+2.7%	+2.5%
Pass through[c]	100%	50-100%	100%	81-100%
Net cost price increase[c]	0%	0-1.4%	0%	0-0.5%

Note: [a] AERO MS; [b] AEA 2007; [c] this report.

Since indirect flights on long haul have lower emissions in total than direct long haul flights (at least for flights of 10,000 km), current high fuel prices may provide an additional incentive to fly indirectly rather than direct.

Because a relatively high share of passengers at Schiphol are transfer passengers, the hub effect could impact Dutch aviation more than aviation in some other Member States.

The impact on total turnover is not only affected by the net cost price increase, but also by the reduced demand. Note that reduced demand is one of the measures to reduce emissions and can thus be regarded as an intended effect of the EU ETS. In fact, the total change in turnover due to the inclusion of aviation in the EU ETS is the turnover gained due to the cost pass through (higher revenue per RTK) minus the turnover lost due to lower demand (fewer RTK). This change in turnover can be compared to the additional costs. Table 3 shows the impact on total turnover, taking demand effects into account. Here, total turnover without ETS is compared with total turnover with ETS and full auctioning. A comparison of Table 2 and Table 3 shows that the demand effect is approximately 2%. Because the reduction in demand is slightly smaller than the net increase in prices, turnover will increase slightly. Most probably, airlines would react to lower demand by reducing supply.

Table 3 Impact on turnover (€20, full auctioning)

	NL to and from EU	NL to and from non EU with potential hub effect	NL to and from non EU without potential hub effect	Total
CO_2 emissions (share of total)	17%	42%	42%	100%
Baseline RTK (billion)	5.74	20.7	20.7	47.1
Baseline yield per RTK (€)	0.1324	0.062	0.062	0.071 (average)
Total baseline turnover (€ bln)	0.75	1.28	1.28	3.33
Change in RTK	-1.6%	-2.0%	-2.0%	
Change in total operating costs (direct and indirect)	+1.7%	+2.7%	+2.7%	+2.5% (average)
Pass through	100%	50-100%	100%	81-100 %
Total turnover after cost pass through and change in demand (€ bln)	0.76	1.27-1.29	1.29	3.33-3.34

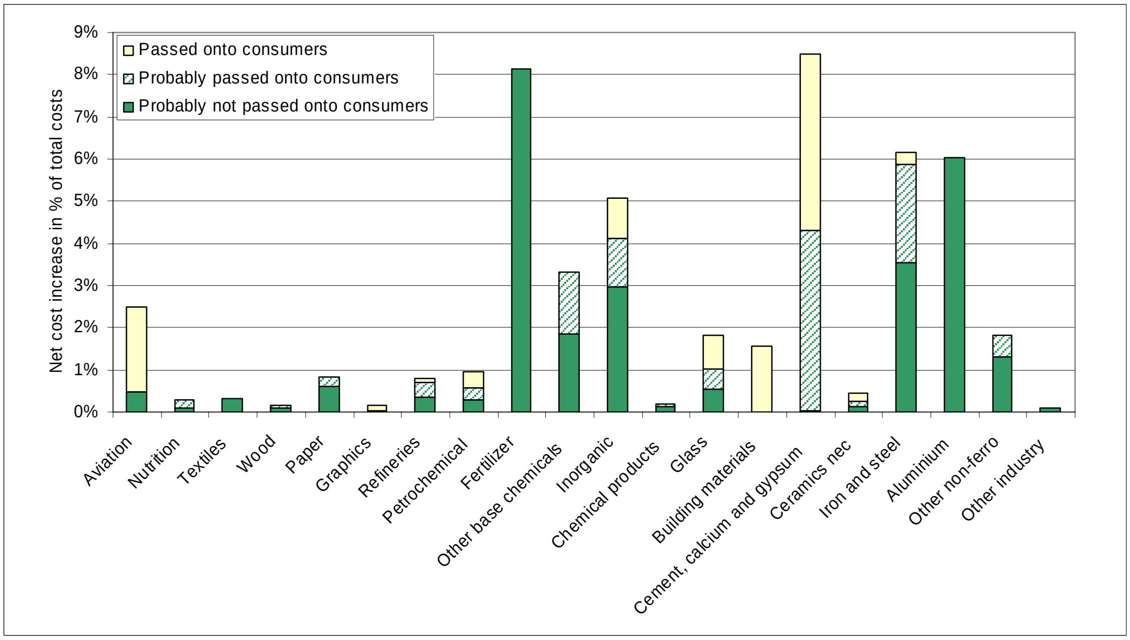
Source: CO_2 emissions: Eurocontrol; RTK and impact on total operating costs: AERO-MS; Yield per RTK: AEA 2007.

As the total cap of the EU ETS will be fixed, the level of auctioning for the aviation sector has no impact on CO_2 emissions under the cap. It may have an impact on aviation's non-CO_2 climate impacts, such as the indirect impacts from NO_x emissions and the impacts of contrail formation. A higher level of auctioning will result in a larger reduction of demand and thus a larger reduction of the non-CO_2 climate impacts.

The impacts on competitiveness could be mitigated either by free allocation or by recycling the revenues through lower airport fees. Other ways to mitigate the competitive impacts that are contemplated in other sectors cannot be applied in aviation, as they would often result in a transfer of funds from non-EU airlines to EU airlines.

Figure 1 compares the potential cost price increase of aviation with various industrial sectors and the possibilities to pass on the costs. Aviation has, in general, a relatively high potential cost price increase, albeit lower than some sectors in industry. However, aviation seems to be able to pass on the largest share of their costs in the higher product prices, where other industrial sectors, with the exception of cement, calcium and gypsum, is not able to do this. The reason for this is clear: because the emission rights of aviation are based on consumption of air transport they face less competition from non-EU suppliers than some industrial sectors where emission rights are based on production.

Figure 1 An estimation of the net cost price increase under full auctioning, emission price of € 20/ton CO_2



Source: This report and CE Delft (2008): *Competitiveness issues for Dutch industry from EU ETS.*

1 Introduction

1.1 Background

The European Commission brought forward a legislative proposal to include the climate impact of the aviation sector in the EU Emissions Trading Scheme (ETS) in 2006 (EC, 2006). In 2008, the Commission published a proposal to amend the EU ETS directive (2008(16)final). One of the major changes in design in the EU ETS as proposed by the Commission is that higher levels of allowances will be auctioned. In fact, for most sectors, auctioning will be gradually phased in and become the norm in 2020.

With regard to the proposal to include aviation in the EU ETS, both the European Parliament and the Council reached conclusions in the first reading and in July reached a common position, which at the time of writing has been adopted by the European Parliament (P6_TA-PROV(2008)0333)[2]. The main differences with the Commission Proposal are:
- All flights to and from EU airports will be included in the EU ETS from 2012[3].
- The cap for aviation emissions will be set at 97% of average 2004-2006 emissions in 2012, and at 95% of these emissions from 2013 onward, unless this cap is changed in the general review of the directive.
- 15% of the allowances will be auctioned in 2012, and at least 15% from 2013. this percentage may be increased in the general review of the directive.

CE Delft has recently completed the study *Competitiveness issues for Dutch industry from EU ETS* in commission of the Dutch Ministry of Finance (CE, 2008). The aim of that study was to analyze the effects from the European Emission Trading Scheme (EU ETS) on industrial competitiveness, to identify economic activities where substantial impacts are likely to occur and to discuss several remedies (compensation mechanisms) that can reduce the impacts on competitiveness. The present study adds an investigation of the EU ETS on competitiveness of the aviation sector, a sector which was not included in the earlier study.

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[2] European Parliament legislative resolution of 8 July 2008 on the Council common position for adopting a directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community (5058/2008 – C6-0177/2008 – 2006/0304(COD)).

[3] In fact, the directive probably would also apply to EEA airports, i.e. airports in Norway, Liechtenstein and Iceland. Throughout this report, the term EU can be considered to include the EEA countries.

1.2 What kind of impacts?

Apart from the environmental target objective – a reduction of CO_2 emissions – the EU ETS has economic impacts as well. First of all, any kind of environmental regulation adds costs to production or society in general. However, as such this loss of social welfare is not our main concern here. The focus is on the additional costs which may exist due to the fact that the EU ETS is a European and not a global scheme. Due to its regional nature, the EU ETS may affect the level playing field between companies, and thus the ability of firms to maintain their share of economic activities in certain markets, i.e. their *competitiveness*. From a broader, macro-economic point of view the question is how the EU ETS affects social welfare. Consequently, we shall describe the direct economic impacts of the EU ETS, but our main interest is whether additional impacts occur due to the fact that the EU ETS is not a global scheme. The definition of competitiveness and the methodology of this study is explained in more detail in the main study.

1.3 The Dutch aviation sector

The focus of this study is the impact of the EU ETS on the Dutch aviation sector. The sector is defined in two ways. First, the impact on the EU-based carriers is assessed relative to the non-EU carriers. Second, we broaden our scope to all flights arriving at or departing from Dutch airports, independent from the airline's nationality. The reason is that the contribution of aviation to Dutch welfare and employment is to a large extent independent of the nationality of the airline (note however the exception of the hub function below). Aviation contributes directly to those who make use of it and consequently a limitation on aviation may affect (potential) passenger's welfare. Furthermore, the accessibility of the Netherlands by air both in the number of direct destinations and the frequency of flights is often mentioned as an important consideration for multinationals to settle in the Netherlands (Nyfer, 2000). Please note that these observations do not tell anything about the desirability of such a limitation, since this depends upon a balancing of both benefits *and* costs!

Schiphol airport is a hub airport, meaning that Schiphol handles many transfer in addition to the passengers that either depart from or arrive at Schiphol. In 2007, 50.4 million passengers travelled from Schiphol airport and 1.61 Mtonne cargo. Although transfer passengers add little to the Dutch economy in a direct way, they largely benefit the economy *indirectly*. Because of the large number of transfer passengers the number of destinations directly accessible from Schiphol airport and the frequency of flights is much higher than it otherwise would have been. This better accessibility of the Netherlands contributes to Dutch welfare (see also CPB, 2002).

Schiphol's hub function is mainly the result of KLM's network, and in this aspect the nationality of the airline *does* matter. If KLM's competitiveness would be negatively affected, this could impact the hub function of Schiphol and thus the contribution of aviation to the Dutch economy.

1.4 Set up

The next chapter will discuss the design of the study taken here. Then, in Chapter 3, the economic impacts of including aviation in the EU ETS will be described. The fourth chapter contains an analysis into the wider effects of including aviation in the EU ETS system. Chapter 5, investigates possibilities to mitigate eventual impacts for the aviation sector.

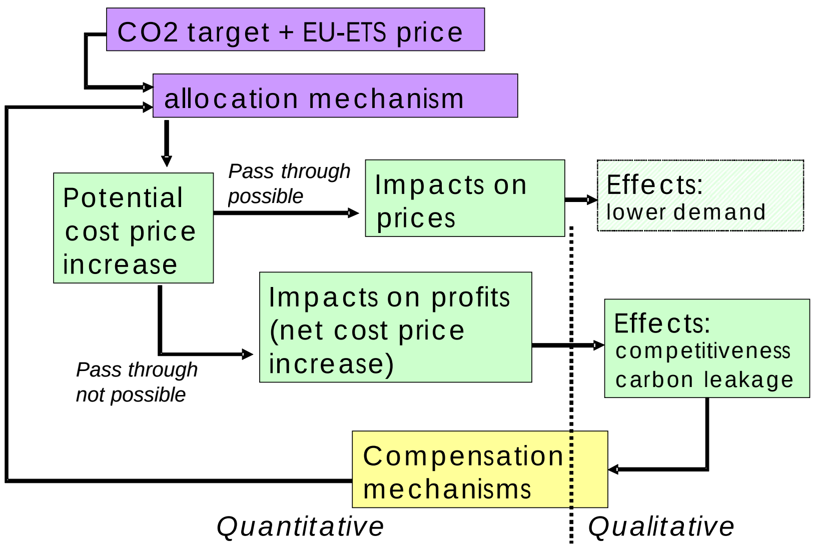
Please note that the results presented here are based on economic analysis assuming 'rational' and profit-maximizing behaviour. This is standard economic theory and has proven to be correct in many cases, at least on average and in the long run. In practice, companies may behave differently, particularly in the start-up phase of new regulation. Furthermore, companies may have strategic reasons – particularly in the short term – to deviate from price setting on the basis of marginal or average costs. And although companies cannot sell their products or services below costs for long, they can choose to do so in the short run. However, such price setting is strategic behaviour and cannot be predicted or modelled. Thus, it has not been investigated.

2 Study design and assumptions

2.1 Design of the study

Figure 2 gives a summary overview of how the issue of competitiveness is addressed in this study empirically.

Figure 2 Summary overview of approach chosen in this study, identified cost concepts and effects



Note: Boxes in purple are exogenous to this project, boxes in green are the calculated (or discussed) effects in this study, the yellow box indicates certain compensations mechanisms that have been investigated in this study and the white box are effects that are not taken into account in this study.

We assume in this analysis that the CO_2 targets, the associated EU ETS price and allocation mechanisms are given exogenously to our analysis (colour purple in case you have a colour print)[4]. We consider here the effects of three allocation mechanisms for the aviation sector:

a Full auctioning in which all the rights will be auctioned – both for the aviation and the refineries sector.
b Partial free allocation with 10% of the aviation allowances auctioned[5].
c Full free allocation for the aviation sector but full auctioning for the refineries sector.

[4] Of course, this is not the case in reality, but using various CO_2 prices and allocation mechanisms, one can gain insight into the potential effects that may occur (see also paragraph 2.3).

[5] Please note that the text recently adopted by the Parliament sets the level of auctoining at 15%. This was not known at the time when we ran the model.

The scenarios are equivalent to the previous study on competitiveness for industry: as the aviation sector hardly uses any electricity the partial grandfathering scenario is equivalent to a full grandfathering scenario.
The effects for the aviation sector from these two allocation scenarios are analyzed for an exogenously determined price for an emission allowance of € 20 per ton CO_2 and a reduction target of 0% by 2020 for the aviation sector and -20% for the industrial sectors. Both prices and targets are in line with most studies that have been investigating competitiveness effects for industry (e.g. Climate Strategies, 2007 and McKinsey/Ecofys, 2006) and these are, in turn, corresponding to what can be expected, according to various market analysts, of future prices if the EU ETS market is working efficiently.

EU ETS implies additional costs to the aviation sector as they have to buy allowances or invest in technologies to curb emissions downwards. These costs have been labeled in this study as the 'potential cost price increase'. Aviation companies will try to pass on these costs to their customers. However, if they are unable to do so they have to accept a loss in profits and bear the costs of EU ETS themselves.

If companies are able to pass on the costs to their customers, higher prices will induce lower demand. This will affect profitability as well. Such effects are included in the present study, but we should notice here that these follow directly from the *intended effects* from any climate change policy, i.e. to lower GHG emissions. After all, EU ETS must finally be translated into higher prices for consumers of carbon intensive products. However, if firms cannot pass on the costs to their customers, because of competition from non-EU carriers they will have to lower their profit margins which will have *unintended* side effects labeled as a loss in 'competitiveness'. These effects include 'carbon leakage' and losses in employment.

In order to derive at an indicator of the effect on profit margins we use here the concept 'net cost price increase' which is equivalent to the potential cost price increase minus the additional turnover by passing on (some of) the costs in the product prices. For companies that can pass all of its costs into higher prices the net cost price increase is zero.

Considerable net cost price increases may result in 'carbon leakage' and losses in employment. These effects will only be estimated qualitatively in this study as they step beyond the microeconomic framework applied in this study. However, by referring to the existing body of literature investigating these effects we hope to be able to shed some light on the question how severe these effects can be and what kind of implications they should have for policy.

The eventual *unintended* effects of EU ETS may be mitigated by several compensation mechanisms. In this study we solely focus on mitigating the effects from *auctioning*. One of the compensation mechanisms, considered by the Commission, is to give the allowances for free. However, many other options exist, including the recycling of revenues of auctioning to, for example, corporate taxes, or the installation of a system of border tax adjustments and export subsidies in order to correct for the loss of competitiveness of industry. Such compensation mechanisms will be considered in Chapter 5 in this study.

2.1.1 Definition and typology of costs

As can be seen from Figure 2, the potential cost price increase forms the starting point in our empirical analysis. The **potential cost price increase** is the increase that can be expected in the operational costs per unit of product[6]. Hence the potential cost price increase gives an indication of the additional costs sectors face for complying to EU ETS under the assumption that marginal costs are constant over the range of production levels considered. These costs correspond to the costs of buying allowances for their emissions. However, we also investigate the possibility when firms have a choice between buying allowances and investing in abatement technologies. Rational behaviour from the firm implies that only investment in abatement technologies will take place if the costs are lower than the price of an allowance. Hence, the actual cost price increases will be lower than the potential cost price increases.

The potential cost price increases may be (partially) shifted to the consumers through higher product prices. In this study we deserve the term **net cost increase** for the additional costs the sectors face when correcting the costs for the portion of potential cost increases that can be passed through to consumers. The net cost increase can be seen as the amount of money that will directly impact on the profits of the companies and is hence an important indicator for the effects on competitiveness[7].

Table 4 makes clear what costs are included in the three cost categories.

Table 4 Cost concepts and various cost categories used in this study

Cost concepts Categories	Potential cost price increase (maximum)	Potential cost price increase (actual)	Net cost increase
Direct costs of buying EU allowances			
Indirect costs of kerosene inputs			
Correction for costs of measures to reduce CO_2 emissions			
Correction for amount of costs that can be passed through			

One should notice that we distinguish in this table also **direct from indirect costs**. Direct costs are the costs of buying allowances or applying abatement technologies, indirect costs are cost price increases through price increases of

6 The costs in this study are all average costs for the sector, unless stated differently.

7 Due to issues relating to data availability we are not able here to directly estimate the impacts on profits and profit margins.

kerosene as refineries will also (partly) pass through the higher costs due to EU ETS into their inputs. Other inputs are not taken into account in this study[8].

2.1.2 More precise definition of competitiveness and carbon leakage

Competitiveness is, in line with the design of the study above, hence defined as the net cost price increase, the amount of costs that cannot be passed over to the consumers. This is a relative concept. No impact on competitiveness implies that market shares and profit margins remain unaltered due to EU ETS. Impacts on competitiveness imply that market shares or profit margins will be reduced due to EU ETS.

However, as EU ETS will in the end imply higher prices for carbon intensive products and services, total turnover or profits will be reduced by EU ETS even if no effects on competitiveness could be detected. However, since this reduction is divided equally among the various airline companies, there is no impact on competitiveness. The reduction of air transport due to higher prices is, in the end, an intended effect of EU ETS where carbon intensive products and services will contain a price for their carbon content.

Carbon leakage refers to the situation where activities that are currently under EU ETS are transferred to areas where they do not fall under climate change policies. In this way, global emissions will be higher than in the situation without carbon leakage. It is not necessary that the new installations will be less efficient. If steel manufacturing will be relocated from the Netherlands to India, this will always result in higher emissions worldwide, as the emission target for the Netherlands is still equivalent to -20% whereas the emission of India will now increase irrespective the efficiency of the new installation[9].

Carbon leakage could in principle occur in the aviation sector.

a Passengers on an indirect flight from one non EU airport to another non EU airport that currently decide to transfer in the EU could be incentivised to transfer outside the EU or take a direct flight. If the number of passengers changing their routes would be large enough to result in a reduction of frequencies or discontinuation of routes, the emissions under the EU ETS would be replaced by emissions outside the EU ETS.

b Passengers on flights from an EU airport to a non EU airport, either direct or with a transfer at an EU airport, could be incentivised to transfer at a non EU airport. Again, if the number of passengers doing so would be large enough this would result in emissions under the EU ETS being replaced by emissions outside the EU ETS.

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[8] Labour inputs could also increase if citizens try to pass through their higher costs of living due to EU ETS through wage demands.

[9] Notice that the Commission in their proposals states that carbon leakage only refers to the situation where the new installations are less efficient. So we take in this study another approach with respect to carbon leakage than the commission.

Since the aviation sector provides non-transportable goods, and since EU airlines and non-EU competitors are treated alike, criteria to define carbon leakage in manufacturing sectors may not always be applicable to the aviation sector. It would therefore be advisable to develop separate criteria for aviation.

This report does not quantify carbon leakage as it focuses on competitiveness impacts of the EU ETS.

2.1.3 Indicator issues

All the costs expressed here are the procentual cost price increases, where the cost price is determined by the average operational costs per RTK.

2.1.4 Unit of analysis and coverage of EU ETS

The unit of analysis is in this the aviation sector which consists of all flights from Dutch airports. This is due to the fact that no reliable data exist for airline companies with respect to their cost structure and CO_2 emissions. However, in some occasions, we will make reference to the situation for Dutch airline companies in this study.

2.1.5 Allocation mechanisms

As stated above two scenarios will be considered in this study with respect to the allocation of rights:

1 **Full auctioning:** 100% auctioning for all sectors.
2 **Partial auctioning:** 10% auctioning for aviation; 100% for all other sectors.
3 **Full benchmarking:** no auctioning for aviation; 100% for all other sectors.

For all scenarios, the amount of allowances allocated to the aviation sector (and either auctioned or allocated for free to aircraft operators) is assumed to be equal to the emission goal, i.e. the aviation sector gets an amount of allowances that equals its average 2004-2006 emission level[10].

ETS will have an impact on the barriers of entry or stimuli to exit the market. The analysis of these effects are not included here. They will depend on the rules for new entrants, which will have to be developed by the Commission according to the text adopted by the European Parliament (P6_TC2-COD(2006)0304).

2.1.6 Data requirements

The data that we have used in this study deal with sectoral data on:

a CO_2 emissions of the sector (from the AERO model).
b Kerosine used (from the AERO model).
c Total operational costs.
d Costs of abatement measures.

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[10] For the refineries sector a target of -20% is assumed, though, in accordance with the plans from the Commission.

e The origin of the flights from Dutch airports distinguished between EU and non-EU carriers.

As the sector hardly consumes any electricity, the calculations are in essence more straightforward than for industry. The main source of data used in this study is the AERO model. Annex B describes the AERO model in more detail.

2.1.7 Assumptions related to the time dimension in this study

All the calculations that are performed in this study are for the EU ETS system in the year 2020. However, the final outcome will be highly dependent on two developments:
1 The structure and size of aviation in the year 2020.
2 The development of international climate policy in 2020 and the years after.

The **structure and size** of the aviation sector in the year 2020 matters for the analysis conducted here. The AERO model uses demand assumptions made in FESG forecasts as a basis for this.

The **development of international climate policy** matters as the analysis in this study largely depends on the assumption that there will be no progress in international climate policy. Hence this study assumes that like in the Kyoto Protocol, aviation will not be included in national targets nor be given a emission target of its own. Only the EU will implement a policy instrument to reduce the climate impact of aviation while all other countries will not. Only under these circumstances price differentials are sustained between countries that adhere to climate change policy goals and countries that do not have any type of climate change policies. Therefore the results from this study typically are only valid if international climate policies will completely fail.

3 Economic impacts

3.1 Introduction

In this chapter we identify the potential and net cost price increases for the aviation sector. First, in Section 3.2, we will determine the potential cost price increases for the sector. Then, in Section 3.3. we will investigate the possibilities for the sector to pass on the additional costs of EU-ETS to their customers. Section 3.4 estimates the net cost price increase. Finally, Section 3.5 analyses the economic consequences of benchmarking.

3.2 Potential cost price increase

3.2.1 Potential direct cost price increase

In this study, the allowance price is assumed exogenous as either € 20 or € 50 per ton CO_2. Table 5 shows the impact on costs for three auctioning levels (see Appendix A for more details).

Table 5 Potential cost price increases (change of total operating costs per RTK)

	NL to and from EU airports	NL to and from non-EU airports
€ 20, 0% auctioning	+0.7%	+1.1%
€ 20, 10% auctioning	+0.8%	+1.2%
€ 20, 100% auctioning	+1.6%	+2.5%
€ 50, 0% auctioning	+1.9%	+2.9%
€ 50, 10% auctioning	+2.1%	+3.2%
€ 50, 100% auctioning	+4.1%	+6.4%

Source: AERO-MS.

Potential cost price increases are higher for long haul flights, as the CO_2 emissions per unit of costs of these flights is higher than for short haul flights. As expected, the cost price increase is higher for higher levels of auctioning and for higher allowances prices.

3.2.2 Potential indirect cost price increase

Climate policy will result in a lower demand for fossil fuel and thus a lower fuel price relative to the baseline. This effect has not been taken into account in this study.

Under the EU ETS refineries face higher costs for kerosene production. Therefore, kerosene prices will rise as well. From the study on competitiveness of industry, we calculated that refineries, for an emission price of € 20/ton CO_2, would face a potential cost price increase of 0,2% in the case the rights would be partially grandfathered, to 0,8% in the case the rights would be auctioned. Based on a literature review, we suggested in the other study that refineries could pass on 25-75% of the additional costs of EU ETS to their customers. If we would take here the more pessimistic scenario of 75%, this would imply that the net cost price increase is equivalent to 0,15% in the case of (partial) grandfathering, and 0,6% in the case of auctioning.

We would suggest to take in this study the figure of 0,6%. Even if rights would be grandfathered, refineries could make windfall profits by still passing on (a large share) of the costs. Given the fact that current market capacity is rather tight, we suggest that a cost-pass-through of 75% seems realistic, though being rather pessimistic on the possibility to relieve the current market stress by 2020. It seems to be logical to assume that worldwide capacity is less tight in 2020 than at present as new refineries are built. The figure of 0,6% should hence be perceived as a 'worst case scenario' in which the rights are either fully auctioned, or grandfathered under the situation that worldwide capacity remains tight until 2020.

One final question deals with the fact if the cost price increase will be similar for all output of refineries. We assumed in this study that this is the case as there exists no empirical investigation on the cost division and cost-pass through rates from individual products of refineries. Hence we would assume that the additional cost price increase for kerosene is 0,6% due to EU ETS (in terms of the price level of 2005). AERO calculations show that at a fuel price of US$ 100 per barrel, the potential indirect cost price increase would be 0.1 percentage points for intra-EU flights and 0.2 percentage points for flights to and from non-EU airports.

Air line companies have various ways to deal with these price increases. If prices are increased, this will give airlines an incentive to take in more kerosene outside the EU, however the scope for doing so would be limited and current high fuel prices make this option even less attractive. Furthermore, an increase in kerosene prices may intensify the hub-effect. This will be discussed in Section 3.3.

3.2.3 Total potential cost increase

Combining both the direct and indirect cost price increases results in the insight that the total potential cost price increases for the aviation sector equal 1.7% for flights from the Netherlands to EU airports and 2.7% for flights to non-EU airports assuming full auctioning and an allowance price of €20 per EUA.

If the price of allowances would rise to € 50 per tonne, the potential direct plus indirect cost price increases would equal 4.2% for flights from the Netherlands to EU airports and 6.6% for flights to non-EU airports, again assuming full auctioning.

3.3 Cost pass through

The question is now how much of these costs can be passed onto the consumers. After a general analysis of impacts on competitiveness (Section 3.3.1), we distinguish between the intra-EU market (Section 3.3.2) and the intercontinental market (Section 3.3.4).

Please note that this analysis is based on the assumption that on average and in the long run, prices are set by marginal costs. In other words, airlines will not operate on routes where they are not able to recover their costs. Please note that a route may involve more than one flight so that an airline can for example experience losses on feeder flights which are compensated on long haul flights without being at odds with this assumption. We acknowledge that prices for individual tickets need not reflect marginal costs. Furthermore, this assumption does not deny that airlines may experience temporary losses on some of all of their routes because of unanticipated changes in the market.

3.3.1 General impacts on competitiveness

In the main study, several economic activities have been analyzed whereby firms in the EU are being faced with higher costs due to the EU ETS, which may harm their export position and foster import substitution from non-EU countries where carbon has no price. Under the EU ETS European firms face higher costs - whether it be on European or non-European markets - than their non-EU counterparts. Therefore, there are obvious issues of competitive power involved and companies are limited in the amount of costs that can be passed through to their customers.

However, with respect to aviation the EU ETS has been designed radically different. In the case of aviation, the point of grip of the EU ETS is not European installations, but European markets, i.e. lines between European airports and other European or non-EU airports. At each of these specific markets or lines all airlines are treated equally. For example, to fly between Schiphol Airport and New York, American and European airlines equally require emission rights. This is a radical other situation than, for example, in the case of steel production, where a non-EU firm can produce for the Dutch market without the necessity to buy emission allowances while a Dutch company does in fact needs such allowances.

When all airlines face the same (kind of) cost increase, it is expected that airlines can and will fully pass on the price of emissions allowances in the ticket prices (the net cost price increase is zero). As long as there is no competition from airlines that face no costs from buying EUAs, this will have no spill over effects or loss of competitiveness. Therefore, there will be no loss of profit per transported passenger or cargo. Nor will there be an adverse effect on the ability of European airlines to maintain their share of economic activities in their markets. This is not to say that there will be no effect on total demand of airline companies or profit as the higher prices will reduce demand. However, this effect is independent from the regional nature of the EU ETS and will be discussed later.

3.3.2 Intra-EU market: full cost pass through[11]

Allowances that are auctioned or purchased on the market have a similar economic impact as does for example an increase in kerosene prices. We will discuss the impact of such price in-creases to analyse the expected impact of increases expenses on emission allowances.

In general, the costs of kerosene are part of the production costs for airlines, and it is very likely that these costs will be reflected in ticket prices. Kerosene prices are part of the marginal costs, and may make up to 50% of the direct operating costs on intercontinental flights. Airlines that do not reflect these costs in ticket prices will go bankrupt without long.

However, kerosene prices are unpredictable and may fluctuate substantially over time. These fluctuations are not always reflected in ticket prices for two reasons. First of all, airlines apply fuel hedging so to lessen their exposure to fluctuations on the oil market. Second, there are so-called menu costs associated with changing product (i.e. ticket) prices. For these reasons, it may take some time before enduring changes in kerosene prices are reflected in ticket prices.

This is precisely the outcome of research by Price Waterhouse Coopers (2005: 43). PWC regressed changes in annual kerosene prices (with a one period lag) on changes in an annual air travel price index for the UK. The result was calibrated for full service and low cost airlines and confirmed pass through rates that are not significantly different from 100% for both types of carriers. Figure 3 reproduces the results. For full service carriers the level of pass through is estimated at 105%, with the confidence interval ranging from 44 to 156%. For low cost airlines the point estimate is slightly lower, 90%, with the confidence interval ranging from 46 to 133%. The analysis suggested that it takes up to two years for the full impact to become apparent. This may partly be the result of strategic pricing as mentioned in the introduction.

Table 6 Regression results on pass through of fuel price increases

	Regression result	Lower bound	Upper bound
Coefficient	4.12	2.13	6.11
Full service pass through	105%	44%	156%
Low cost pass through	90%	46%	133%

Source: PWC, 2005.

Ernst & Young (2007) take a different view on the pass through of costs. They claim that because most routes are monopoly or oligopoly routes, airlines cannot pass through the costs. However, to arrive at this conclusion Ernst & Young have to assume (without justification) that the oligopolies are so-called Cournot oligopolies, in which oligopolists are able to extract oligopolist rents and thus

[11] On the basis of CE, 2007.

make supranormal profits. In a Cournot oligopoly airlines would not pass through cost increases because they are able to absorb them in their supranormal profits. However, the profit margins at which airlines operate hardly support the assumption that they are making oligopolistic profits.

The alternative, that airlines operate in so-called Bertrand oligopolies, where normal profits are made, is not discussed by Ernst & Young. In a Bertrand oligopoly, prices are set at marginal costs so operators will pass through cost increases (CE, 2007).

3.3.3 Intra-EU: also full cost pass through at congested airports[12]

There is a situation in which one may doubt full cost pass through. Generally, if there is no full competition, possibly because of production capacity constraints, prices may not reflect marginal costs. For example, in the case of congested airports there may be constraints to the number of airplanes which can arrive or depart either by limited slot availability or noise regulation. In such capacity constrained markets, the product price is not determined by the marginal costs of production, but simply set at the level which clears the demand at the given supply (OXERA, 2003). This clearing price is higher than the marginal costs of production at the given supply. The difference is the so-called scarcity rent. Similarly, if there is a monopoly, such as up to recently on the route Amsterdam - Paris Charles de Gaulle, price setting is not based on marginal producer costs. In such situations, cost increases may not be passed through to the client, but may instead decrease the profit (margin) of the operator on the applicable routes (see e.g. E&Y, 2007).

However, while some airports such as Schiphol may be congested with respect to the number of aircraft which can be handled, this does not automatically imply congestion with respect to the number of passengers which can be handled. More passengers can be handled with same number of aircraft, for example, by increasing the load factor or exchanging smaller by larger aircraft. This would imply that whereas airports would without regulation be able to extract monopoly rents from airlines, airlines cannot extract them from their passengers as the number of passengers is not restricted by congestion. This support PWC's (2005) finding of pass through close to 100%, also at congested airports.

PWC's view coincides with the opinion expressed by the Competition Commission (2002) in response to a report by the Civil Aviation Authority. According to the Competition Commission, 'The argument that there are significant rents to airlines at Heathrow sits oddly with the lack of profitability of Heathrow airlines. Almost all are currently making little or no profit' (2002: 53). Furthermore, according to the Competition Commission airlines as well strongly disputed the existence of scarcity rents that would allow them to absorb any increase in costs (2002: 53). Therefore, the Competition Commission concluded that the very strong probability is that fares will rise generally across many, if not most, routes if airport charges or air passenger duties are increased.

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12 On the basis of CE, 2007.

We therefore assume a full cost pass through in spite of Schiphol Airport being congested for flights.

3.3.4 Intercontinental market: cost pass through limited due to hub location[13]

Although the EU ETS is designed in such a manner that the competitive power of airlines is not directly affected, on intercontinental flights the impact of the ETS on EU carriers and (some) non-EU carriers will nonetheless be different, because of the location of their hub airports. For most major city-pairs there are direct flights, typically operated in competition between carriers based at the two cities concerned. Other carriers, however, will offer alternative routings via their own hubs, where passengers must transfer (interchange) between flights. This is usually at a lower fare than for the direct flights, to compensate for the additional time and inconvenience of the indirect journey.

Consequently, passengers between major cities typically have a choice between direct flights, or transferring at an EU hub, or transferring at a non-EU hub. Other passengers may not have direct flights, and will always need to transfer at a hub. There may still be choices, however, between transferring at EU or non-EU hubs. Figure 3 presents an example of a route (Amsterdam - Los Angeles in this case) that can be either direct, indirect via an EU hub (Madrid in this case)[14] or indirect via a non-EU hub (New York in this case).

[13] On the basis of CE & MVA Consultancy, 2007.

[14] In reality, there are no competitive routes via Madrid. However, there are routes via other hubs such as London Heathrow or Frankfurt. Madrid has the advantage that it shows clearly on the map.

Figure 3 Example of a direct and two indirect flights from Amsterdam to Los Angeles

The importance of hub location is this. For passengers who transfer at an EU hub (Madrid in Figure 3), both the flights that they use will be subject to the ETS. A direct flight will also be totally included in the EU ETS. In contrast, only one of the flights used by passengers who transfer at a non-EU hub (New York in Figure 3) will be subject to the ETS.

Moreover, if the carrier passes on the ETS cost to passengers in relation to the fuel consumed on flights that are subject to the ETS, the indirect routing of a journey via an EU hub will involve an ETS-based fare increase that is higher than that for a direct flight. Routing via a non-EU hub, on the other hand, may reduce the distance on flights that are subject to the ETS, when com-pared to using the direct flights.

If carriers pass on their ETS costs as increases in their fares, there will be an overall reduction in the total number of passengers travelling between each pair of EU and non-EU cities. In view of the previous discussion, it can be expected that transfers at EU hubs will fall more than proportionately, and passengers on direct flights less than proportionately. It is also possible that transfers at some non-EU hubs will fall less than proportionately, or even increase, if the reduction in exposure to the ETS (compared to using direct flights) more than compensates for the additional time and inconvenience of using an indirect route.

Because of the hub effect, indirect flights via EU hubs will become less attractive relative to direct flights and indirect flights via a non EU hub. Direct flights will become more attractive than indirect flights via an EU hub, but less attractive than indirect flights via a non EU hub.

Since transfers at EU hubs are overwhelmingly with EU carriers, and those at non-EU hubs are almost entirely with non-EU carriers, it can be seen that the hub location can benefit non-EU carriers. Expert opinion is of the view that EU carriers will be unlikely to re-locate hub activities to non-EU airports (CE and MVA, 2007).

Table 7 Estimated reductions in passenger numbers on the basis of an illustrative ETS allowance price of € 30/ton of CO_2 on selected routes to and from Amsterdam and Istanbul

	All carriers	EU carriers			Non-EU carriers		
Cities	Total	Total	Direct	Transfer	Total	Direct	Transfer
Nth America	-4.7%	-5.0%	-4.3%	-10.5%	-4.4%	-4.2%	-5.8%
Asia/Pacific	-5.1%	-5.0%	-3.8%	-8.4%	-5.2%	-3.9%	-10.0%

Source: CE and MVA (2007). Note that flights to Asia/Pacific on the selected routes to which this table applies are not affected by the hub effect as some of the major Asian hubs are at a greater distance from Amsterdam than the final destinations

An airport that is a hub airport can also be affected by the hub effect. In the example in Figure 4, a flight from Stockholm to New Delhi, the flight via Amsterdam would become less attractive, the direct flight slightly more attractive and the flight via a non-EU hub much more attractive. This implies that EU hubs could be more affected by the hub effect than EU airports that have no hub function.

Figure 4 Example of routes from Stockholm to New Delhi with possible transfers at Amsterdam and Istanbul

The hub effect has the largest impact on flights from EU airports to non EU airports via an EU hub. The larger the share of these transfers at an EU hub, the more it will be affected by the hub effect. Likewise, the more intercontinental passengers of an airline transfer at its EU hub, the more it will be affected. Although we do not have access to data that would enable to estimate the share of intercontinental passengers transferring at Dutch airports and other EU hubs, Table 8 indicates that Schiphol has a relatively high share of transfer passengers. It is likely that KLM carries more transfer passengers than the home carriers of Paris Charles de Gaulle, Heathrow and Munich (but less than the home carrier of Frankfurt which confusingly is the same carrier as Munich). If these passengers are on intercontinental routes which are subject to a hub effect, Schiphol could be harder hit than other airports.

Table 8 Transfer passengers as a percentage of all passengers handled

	2000	2001	2002	2003	2004
London Heathrow	29.00				
Paris Charles de Gaulle	34.00	33.00	34.00	34.00	33.00
Frankfurt	50.00	51.00	53.00	54.00	53.00
Amsterdam Schiphol		41.00	42.00	41.00	42.00
Munich	27.00	29.00	31.00	31.00	33.00

Source: SEO, 2005.

3.3.5 Intercontinental market: no significant additional cross-subsidization[15]

Another possibility that has been suggested for non-EU carriers to gain competitive advantage is the scope for additional cross-subsidization, i.e. non-EU carriers allocating the ETS costs to their non-EU markets, reducing fares in the geographical scope of the EU ETS and thereby gaining market share from EU carriers. (Please note that *additional* cross-subsidisation refers to cross-subsidisation caused directly by the inclusion of aviation in the EU ETS. We do not deny that cross-subsidisation may be taking place in the aviation industry). We do not expect such cross-subsidization to occur, however.

If non-EU carriers would cross-subsidize, they would allocate some or all of the ETS costs to their non-ETS markets. To recoup the ETS costs in those markets, they would need to raise fares there. But basic economic reasoning is that, as prices go up, demand goes down, and if prices of one firm in a market go up, demand shifts to other firms. It implies that, under normal market conditions, it would not be possible for airlines to generate additional profits in non-ETS markets that could be used to offset ETS costs. On the contrary, raising fares in non-ETS markets would more probably reduce profits in them.

A possible exception to this general finding applies to markets that are regulated in such a way that airlines are able to make supra-normal profits, for example markets where capacity is restricted but fares are free. To the extent that such markets exist, and to the extent that capacity in them is regulated below free-market demand, airlines operating in these markets could have the possibility to make supra-normal profits. Non-EU carriers in this position in non-ETS markets might then engage in strategic pricing on routes to/from the EU, by not passing through their ETS costs to fares on these routes, and financing the ETS costs from their supra-normal profits. The reason behind this behaviour would be that they perceived that it conferred strategic advantage to them (e.g. pressure on EU carriers' fare levels) on to/from EU routes.

The opportunities for exercising such strategic behaviour depend upon the extent of markets where supra-normal profits can be achieved. These are limited. For example, the UK CAA has recently decided to remove all fares regulation from routes between the UK and points outside the EU, on the ground that competition is sufficient to avoid exploitation of market power ('CAA Air Fares Policy: Removing Regulation', November 2006). This will continue globally as aviation markets become increasingly liberalized.

If airlines operate on markets where they can make supra-normal profits, they can use them to gain market share even prior to the inclusion of aviation in the EU ETS. However, ETS may be perceived as a shock to the market which these airlines may want to exploit strategically. It is therefore questionable whether this type of cross-subsidization is caused by ETS.

15 On the basis of CE & MVA Consultancy, 2007.

In summary, whether non-EU carriers could engage in cross-subsidization of their routes to/from the EU depends upon whether they also operate in markets where they can earn supra-normal profits. These opportunities are limited. And this type of strategic behaviour is not necessarily the result of inclusion of aviation in the ETS.

3.4 An estimation of the net cost price increase

3.4.1 Quantification of the amount of cost pass through

We have seen above that companies face full cost pass through in the intra-EU market, but may not be able to pass through all the costs in the intercontinental market due to the hub-effect.

In order to quantify the total impacts on the cost-pass through some strong assumptions must be made for the magnitude and impact of the hub-effect. One may quantify this under the following assumptions:

a For flights within the EU the cost-pass through will be 100% as the hub-effect is not relevant here and cross subsidization is unlikely, as indicated above.
b For some flights from the EU to a non-EU country and vice versa, the cost pass through may not be 100% as there are alternative routes via a non-EU hub.
c For other flights from the EU to a non-EU country and vice versa, i.e. flights without an alternative via a non-EU hub, the cost pass through will be 100%. On these routes, all carriers will face the same cost price increase and additional cross-subsidisation is not possible or will not have a significant effect.

Flights to the east coast of North America, to North Africa, western Russia, the Middle East, as well as a large part of South America would not be subject to a hub effect, as there are not many hubs between the EU and these regions and the costs in time and extra fuel would be prohibitive. In contrast, flights to South East Asia and East Asia, to Sub Sahara Africa, the west coast of North America, Middle America and eastern Russia could be affected by the hub effect. We assume that the latter account for half of the CO_2 emissions on intercontinental flights.

In order to accurately estimate the size of the hub effect, one would need a network model. We do not have such a model[16]. However, it is possible to estimate the cost pass through on routes from EU airports to non EU airports in another way, viz. by estimating the cost increase on the direct route and the cost increase on the indirect route. NLR calculations show that a direct flight from

[16] Such a model is applied in MVA, CE, 2007. It shows that the total reduction on traffic on routes from EU airports to non-EU airports would amount to 2.3% at a price of € 30 per tonne of CO_2. Assuming a linear reaction, € 20 per tonne would yield a reduction in traffic of 1.5%. Direct routes are slightly less affected (-1.4%), as are routes via non EU hubs (-0.6%), whereas routes via EU hubs would sea a decrease in passenger numbers of 2.5%.

Amsterdam to Singapore on a B747-400 with CF6-80C2B1F engines emits 0.46 Mt of CO_2 flying the same route with a stop in New Delhi would reduce total emissions to 0.42 Mt of CO_2, of which 0.26 Mt would be emitted in the first leg of the flight and thus be under ETS (Appendix B). Consequently, the cost increase of the indirect flight would be 0.26/0.46 = 56% of the cost increase on the direct flight. On top of this, an indirect flight would have lower fuel costs.

Of course, this is just one example. Table 9 shows a couple of other examples, calculated with the KLM emission calculator and therefore showing slightly different figures than cited above. A flight to Singapore via Dubai instead of New Delhi would have a smaller share of emissions under the EU ETS (but it would involve a larger detour). A flight to the US west coast via an east coast hub would have a slightly larger share of emissions under the EU ETS.

Table 9 Share of CO_2 emissions under ETS on three exemplary flights

	Distance (km)	CO_2 emissions per pax	% of emissions of direct flights under ETS
AMS - LAX	8,977	776.50	100%
AMS - JFK	5,863	506.99	65%
JFK - LAX	3,983	344.65	
AMS - SIN	10,517	911.51	100%
AMS - DEL	6,375	551.77	61%
DEL - SIN	5,142	-	
AMS - DXB	5,174	448.16	49%
DXB - SIN	5,847	506.82	

Source: KLM emissions calculator, all flights on a B747-400 passenger (http://www.klm.com/travel/corporate_en/images/Emission%20calculator_tcm172-24373.xls).

On the basis of these examples, we assume that the cost increase via a non-EU hub would be half the cost increase on a direct flight.

On the basis of these assumptions, one can conclude that on routes where a hub effect decreases the cost pass through rate, at least half of the costs can still be passed through as the competing carriers face this cost increase and will pass it through. For the remaining half of the increase, EU carriers face different options: they can absorb these costs in their profits and maintain their market share, or they may give up market share but increase the prices more than their competitors do. In the worst case, they can only pass on half of the cost increase. Air-lines would do so if the cross-elasticity between direct and indirect flights is high. In the best case, if cross-elasticity would be very small, airlines can pass on most of the cost increase. Cross-elasticities between direct and indirect are not known to us, therefore, we assume that in the worst case 50% can be passed through and in the best case 100%.

3.4.2 Net cost price increase

In the main report, the net cost price increase is defined as the potential cost price increase minus the costs that can be passed on to the customers (see Section 2.1). Since AERO has no accurate information on turnover, we have estimated turnover by multiplying RTKs with yield per RTK. For the latter, we have used the yields per RTK as reported by AEA (AEA, 2007). Since these are the yields mainly of network carriers, they may be considered a high estimate; low cost carriers and charter carriers may have lower yield per RTK.

Table 10 Net cost price increase without demand effects (€ 20, full auctioning)

	NL to and from EU	NL to and from non EU with potential hub effect	NL to and from non EU without potential hub effect	Total
Baseline RTK (billion)[a]	5.74	20.7	20.7	47.1
Baseline yield per RTK (€)[b]	0.1324	0.062	0.062	0.071
Total baseline turnover (€ bln)[c]	0.759976	1.2834	1.2834	3.33
Potential cost price increase [a]	+1.7%	+2.7%	+2.7%	+2.5%
Pass through[c]	100%	50% – 100%	100%	81% - 100%
Net cost price increase[c]	0%	0% - 1.4%	0%	0% - 0.5%

Note: [a] AERO MS; [b] AEA 2007; [c] this report.

Table 10 shows that the net cost price increase in aviation according to the standard definition is 0 to 0.5% of total operating costs, depending on the rate of pass through at routes where a hub effect may be expected.

The impact on total turnover is not only affected by the net cost price increase, but also by the reduced demand. Note that reduced demand is one of the measures to reduce emissions and can thus be regarded as an intended effect of the EU ETS. In fact, the total change in turnover due to the inclusion of aviation in the EU ETS is the turnover gained due to the cost pass through minus the turnover lost due to lower demand. This change in turnover can be compared to the additional costs. Table 11 shows the impact on total turnover, taking demand effects into account. Here, total turnover without ETS is compared with total turnover with ETS and full auctioning. A comparison of Table 10 and Table 11 shows that the demand effect is approximately 2%. Because the reduction in demand is slightly smaller than the net increase in prices, turnover will increase slightly. Most probably, airlines would react to lower demand by reducing supply.

Table 11 Impact on turnover (€ 20, full auctioning)

	NL to and from EU	NL to and from non EU with potential hub effect	NL to and from non EU without potential hub effect	Total
CO_2 emissions (share of total)	17%	42%	42%	100%
Baseline RTK (billion)	5.74	20.7	20.7	46.3
Baseline yield per RTK (€)	0.1324	0.062	0.062	0.071 (average)
Total baseline turnover (€ bln.)	0.75	1.28	1.28	3.33
Change in RTK	-1.6%	-2.0%	-2.0%	
Change in total operating costs (direct and indirect)	+1.7%	+2.7%	+2.7%	+2.5% (average)
Pass through	100%	50-100%	100%	81-100 %
Total turnover after cost pass through and change in demand (€ bln.)	0.76	1.27-1.29	1.29	3.33-3.34

Source: CO_2 emissions: Eurocontrol; RTK and impact on total operating costs: AERO-MS; Yield per RTK: AEA, 2007.

3.4.3 Actual cost price increase

The above identified net cost price increase can be lowered if the aviation sector could take cheaper options to reduce CO_2 emissions. The palette of measures to reduce emissions does not only include investment in low carbon and energy efficiency technologies, but also other measures such as more efficient operation and demand reduction. In the case of aviation, air-craft operators can reduce their emissions in the following ways:

1 Technical measures:
   - To existing aircraft (short term), such as retrofitting of winglets, riblets and possibly engines.
   - To new aircraft (long term), such as replacement of old aircraft by newer, more fuel-efficient aircraft.

2 Operational measures:
   - At individual flight level (changes of flight path, reduction of empty weight).
   - At network level (such as increases in load factor).

3 Volume measures:
   - Reducing the amount of transported ton-kilometres.

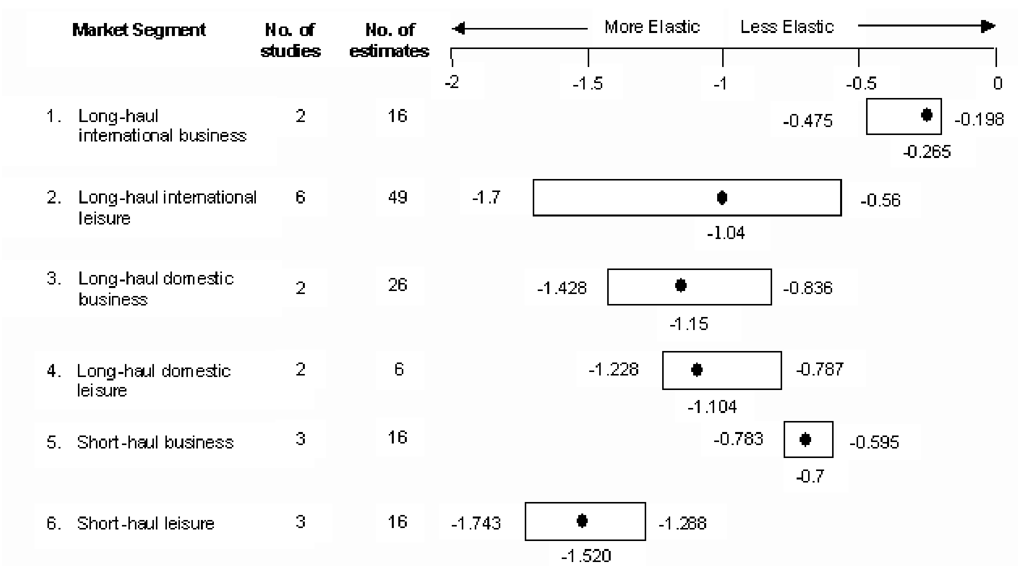
Technical measures in the aviation sector are more expensive than in many other sectors (CE et al., 2002). As a result, the lion share of cost-effective emission reduction in aviation is not achieved through technical measures, but foremost through volume measures: an increase in ticket prices due to the EU ETS results in air transport being cancelled of which the (social) benefits were only marginal. In other words, cancelling this marginal part of transport is cheaper than reducing emissions by implementing technical measures. According to calculations with the AERO model, about 70% of cost-effective emission reduction is achieved through a lowering of demand. (In addition, aviation will buy allowances from other sectors thus financing emission reduction in these sectors).

We assume here that the remaining reduction will be taken by buying EUAs instead of taking technical measures. Therefore, the net cost price increases will not be lower if companies can take technical measures.

3.4.4 Impacts on demand

The impact of ticket price increase on demand is determined by the own-price elasticity. In the literature a wide range of values can be found for the own-price elasticity of demand (see e.g. Oum et al., 1992; Wohlgemuth, 1997; Brons et al., 2001) and the travel cost elasticity (see e.g. Witt and Witt, 1995; Crouch, 1995), which is a proxy for the former. The results of a (relatively) recent meta-analysis by Gillen et al. (2003) are shown in Figure 5. These results are used in the AERO-model as well.

Figure 5 Own-price elasticities on demand (Gillen et al., 2003)



3.4.5 Demand effects and impact on profits

On many routes, costs are passed through completely, while on other routes, a share of the costs can be passed through. As a result, the revenue and the costs per RTK will increase. This will also trigger a reduction in demand. Table 11 shows that the cost increase is almost completely offset by the reduction in demand so that the turnover is not affected. Higher costs and constant turnover combine into reduced profits for airlines.

Turnover and profit of the Schiphol Group in 2006-2007 were 1.146 billion Euro and 420 million Euro, respectively. If we assume a doubling of these figures in

2020 (on the basis of a yearly growth of 5%), the loss of turnover will be about 36 to 94 million Euro, at an allowance price of 20 and 50 €/ton, respectively. Profit of the Schiphol Group will be about 14 to 34 million Euro less.

3.5 Economic consequences of benchmarking

3.5.1 Reduced potential cost price increase

Under the present EU proposal, the total number of allowances to be allocated to the aviation sector will be set equal to the average emissions from aviation in the years 2004-2006, i.e. 218 Mton (CE, 2007). Emissions are expected to grow, however, in a business-as-usual scenario to 401 Mton in 2020 (CE, 2007). Consequently, if emission reduction by the aviation sector itself is neglected (see next chapter), aviation will have to pay for a substantial emission reduction by other sectors so to make room for the growth in aviation emissions independent from any free allocation of allowances to the aviation sector.

In the Directive recently adopted by the European Parliament, the level of auctioning in 2012 is set at 15% of the total amount of allowances available to the aviation sector.

The result of the proposed updated benchmarking is that the (marginal or average) cost in-crease, which results in the case of full auctioning, is partly undone. The reason is that in the case of updated benchmarking emission allowances can be earned for future periods on the basis of present performance. In other words, updated benchmarking creates opportunity benefits, which partly cancel the opportunity costs of the allowances one requires for performing a flight. If as many allowances could be earned as one requires for performing a flight, there would be no price increase whatsoever.

However, due to the fact that aviation emissions are expected to grow in a business-as-usual scenario to 401 Mton in 2020, and that somewhat less than 218 Mton will be allocated free of charge on the basis of a benchmark, the opportunity benefits of a flight are only about half of the opportunity costs of the allowances one requires. Consequently, the (marginal or average) cost and price increase is about half. Therefore, we assume that the impacts in the case of free allocation on the basis of a benchmark as proposed by the EU are simply half the economic impacts which have been discussed before for the case of full auctioning.

It should be noted, though, that the Commission has recently proposed to stop updated bench-marking in the year 2020 : ‘Aviation should be treated as other industries which receive transitional free allocation rather than as electricity generators, which means that from 2013 onwards, 80% of allowances should be allocated for free in 2013, and thereafter the free allocation to aviation should decrease each year by equal amounts resulting in no free allocation in 2020’. In that case, updated benchmarking would lose its importance for this study which has the year 2020 as point of reference. Nevertheless, we have performed calculations on the basis of a continuation of benchmarking to show its potential effects.

3.5.2 No windfall profits

In the case of free allocation of allowances on the basis of performance in the past ('grand-fathering') windfall profits can be obtained. Although the emission allowances are obtained for free, they represent opportunity costs and are thus passed through in prices. After all, the allowances could also be sold against the market price.

In the case of (updated) benchmarking no such windfall profits occur. In that case, there are not only opportunity costs of the emission allowances one already owns, but also opportunity benefits of the allowances one can earn by production. While the opportunity costs are reason to in-crease prices, the opportunity benefits are reason to lower prices. That means that free emission rights, which are received on the basis of performance in the future, do not lead to price increases and windfall profits.

Since there may be a time lag between the moment that emission allowances can be earned and the moment that allowances are required for flights, there may be some price distortion. In principle, it is rational to lower ticket prices during the years, which are used for the benchmark, and increase ticket prices in the years that the allowances are used. Apart from the time lag, the resulting gains and losses cancel each other. However, we shall assume a 'steady state', in which in the same year allowances are used which were received for free in the past, while the same amount of allowances are earned for next periods.

Please note that the fact that the free allocation of allowances on the basis of a benchmarking is cut back until the year 2020 (see previous section) does not alter this analysis. Any single allowance which can be obtained for free on the basis of future performance does not lead to windfall profits. If, however, the free allowances are received in the last period on the basis of performance in the past, then such windfall profits will be obtained indeed.

3.5.3 Criteria for free allocation

In its proposal to amend the ETS directive (COM(2008)16), the European Commission sets out the following criteria for sectors to be eligible for free allocation of allowances. First, in the proposed article 10a, the Commission seems to take a narrow definition of carbon leakage, viz. 'a loss of market share to less carbon efficient installations outside the Community'. It is very unlikely that aviation would be able to meet this criteria, as the EU carriers generally operate modern and thus fuel efficient aircraft types. In addition, the Commission proposes to take the following into account:

a 'The extent to which auctioning would lead to a substantial increase in production cost.

b The extent to which it is possible for individual installations in the sector concerned to reduce emission levels for instance on the basis of the most efficient techniques.
c Market structure, relevant geographic and product market, the exposure of the sectors to international competition.
d The effect of climate change and energy policies implemented, or expected to be implemented outside the EU in the sectors concerned.'

The increase in production costs in aviation is estimated to be 0.7 to 2.5% which is lower than the worst affected sectors but higher than some other sectors. The second criteria may be applicable to aviation. Especially for long haul flights, new aircraft types are being introduced that are more fuel efficient than the aircraft types they replace. The third criteria may need to be altered to allow it to be applied to aviation, since in aviation markets (i.e. city pairs) are included in the EU ETS, either wholly or partially in the case when it is possible to transfer at a non EU hub. On these markets, both domestic and foreign operators are affected by EU ETS. As explained in Chapter 3, the relevant issue in aviation is not whether there is competition from non-EU operators, but whether the competition is able to operate at lower costs. This is argued to be the case if the operators have a hub just outside the EU, e.g. in the Middle East for the South-East Asian destinations and on the North American east coast for destinations in Middle America and on the North American west coast. The fourth criteria does not apply currently to aviation, as to out knowledge states outside the EU have not yet adopted climate policy instruments that apply to international aviation.

4 Wider impacts

4.1 Introduction

In this chapter, we discuss the wider economic and environmental impacts of including aviation in the EU ETS.

4.2 Impacts on the emission trading price

4.2.1 Competitive impacts on other sectors

In this study, the allowance price is assumed exogenous as either € 20 or € 50 per ton CO_2. It should be noted though that inclusion of aviation in the EU ETS will lead to some increase in allowance prices. The total number of allowances to be allocated to the aviation sector will be set equal to the average emissions from aviation in the years 2004-2006. Aviation emissions are expected to double, however, between 2005 and 2020 (CE, 2007). Inclusion of aviation in the EU ETS will hardly curb this growth in emissions. Consequently, aviation will be a large net buyer of emission allowances and allowance prices will somewhat rise in comparison to the situation that aviation is not included in the EU ETS. This increase in allowance price will somewhat enhance the impacts on competitive power investigated in the main study. It could also be argued, however, that the assumed allowance prices in the main study already include this effect.

Furthermore, even if a price increase of aviation would not affect the competitive position of European airlines, it could still affect the competitive position of some companies which make use of air transport to reach global markets. So while aviation may be able to fully pass on the costs of allowances to prices (net cost price increase is zero), this does not have to be so for all aviation's clients (net cost price increase is equal to the potential cost increase). This effect is not quantified here, however.

4.3 Main emission reduction by other sectors

Emissions from flights departing from the Netherlands are expected to grow between 2004 and 2020 in a business-as-usual scenario from 9.6 Mton to about 18 Mton CO_2. As can be seen in Table 12, the emission reduction within the aviation sector is at maximum about 1.0 Mton.

However, the total number of allowances to be allocated to the aviation sector will be set equal to the average emissions from aviation in the years 2004-2006. Consequently, the emission reduction within the aviation sector due to inclusion in the EU ETS is small in comparison to the additional emission reduction within other sectors of about 7-8 Mton CO_2.

Therefore, by far the largest environmental effect of inclusion of aviation in the EU ETS is an effective tightening of the cap for other sectors.

4.4 Emission reductions in the aviation sector

Including aviation in the EU ETS will cap the total emissions under the system. However, higher prices for emission allowances or higher shares of auctioning would result in a higher reduction of emissions in the aviation sector. This would result in a smaller demand from aviation for allowances from other sectors.

As calculated in the previous chapter, demand and thus CO_2 emissions will decrease by 1.6% and 4.1% at an allowance price of 20 and 50 €/ton, respectively and full auctioning. In the case of the EU proposal (benchmarking), these numbers are about half their size: 0.6% and 2.0% respectively.

In Table 12 the expected emission reduction is given, based upon the expected emissions from flights departing from the Netherlands in 2020 of about 18 Mton CO_2 (AERO-model).

Table 12 Emission reduction in the aviation sector under different scenario's

	20 Euro/ton CO_2		50 Euro/ton CO_2	
	Full auctioning	Benchmark	Full auctioning	Benchmark
Volume effect	0.3 Mton CO_2	0.15 Mton CO_2	0.7 Mton CO_2	0.35 Mton CO_2
Operational and technical measures	0.12 Mton CO_2	0.12 Mton CO_2	0.3 Mton CO_2	0.3 Mton CO_2
Total reduction	0.4 Mton CO_2	0.3 Mton CO_2	1.0 Mton CO_2	0.7 Mton CO_2

Please note that the total emission reduction achieved by the EU ETS remains the same in all scenario's. However, the emission reduction which is required in other sectors does indeed differ. If cost-effective measures are left unused within the aviation sector, for example, then more allowances will be bought from other sectors.

4.5 Environmental effects other than CO_2

Including aviation in the EU ETS not only reduces CO_2 emissions, but other pollutants as well. Of particular interest here are NO_x, SO_2 and volatile organic compounds (VOC). Anticipating more detailed analysis on the basis of the AERO-model, we here assume that these emissions are reduced proportionally to CO_2 emissions. In Table 13, the emissions in a business-as-usual scenario are given.

Table 13 Business-as-usual emissions (in Kton) during landing and takeoff in 2020 in the Netherlands

NO_x	6,214
SO_2	420
VOS	632

Source: AERO-model.

Table 14 Emission reduction (in Kton) under different scenario's

	20 Euro/ton CO_2		50 Euro/ton CO_2	
	Full auctioning	Benchmark	Full auctioning	Benchmark
NO_x	143	106	367	242
SO_2	10	7	25	16
VOS	15	11	37	25

5 Compensation mechanisms

5.1 Introduction

The European Commission proposes to auction allowances as the principle mechanism for initial allocation instead of allocating them for free. The main advantage of auctioning is that emission reduction can be achieved against lower costs than in the case of (certain types of) free allocation. A related advantage is that eventual windfall profits, which imply a transfer of money from citizens to industry, are skimmed off. However, as many non-EU countries do not have emission reduction targets (yet), these advantages come at a price. Installations and aircraft operators in the EU might lose competitiveness relative to their competitors in non-EU countries, as the former see their costs rise whereas the others do not.

The loss of competitiveness can be remedied by several means. This section explores the ad-vantages and disadvantages of three options:
1. Free allocation based on a benchmark - the remedy proposed by the Commission.
2. Border tax adjustment - a solution advocated amongst others by the French government. And ,
3. Recycling of the revenues back to the industry.

Each of these options is described in a separate section below. The effect of recycling of revenues back to the industry through various schemes will also be empirically estimated in paragraph 5.4.

5.2 Free allocation on the basis of a benchmark

The proposal for the inclusion of aviation in the EU ETS encompasses the free allocation of allowances based on a benchmark (COM(2006)818). The proposed benchmark is RTK. Each air-craft operator would receive a share of the total amount of allowances allocated for free equal to the share of RTKs produced in a reference year.

Free allocation in the basis of a benchmark would lower the potential direct cost price increase as shown in Section 3.2.1. It would not eliminate the increase, as aviation is expected to grow and will have to buy allowances from other sectors to make this growth possible.

The European Commission proposes to maintain free allocation of allowances after 2013 (COM(2006)818). So the benchmark would be updated repeatedly. This would eliminate the possibility of windfall profits (Section 3.5.2) but it would also reduce the price increase and thus the impact on demand for aviation. As a result, the demand from the aviation sector for emission allowances will increase. This may result in a higher price of allowances.

5.3 Border tax adjustments

The concept of a border tax adjustment is to levy a charge on the CO_2 content of imported goods. This would ensure that external costs of CO_2 are reflected in the product price, regard-less of whether the goods have been manufactured in the EU ETS or in countries without climate policies for industry.

The equivalent of a border tax adjustment in aviation would be a charge on flights to non-EU destinations via a non-EU hub. Such a charge would eliminate the hub effect. However, as such a charge would be levied almost exclusively on non-EU airlines, it is likely to violate the non-discrimination principle enshrined in the Chicago Convention and in bilateral air service agreements. Consequently, the implementation of such a charge is unlikely.

5.4 Recycling of revenues

Recycling of revenues may be done in a number of ways: through lower social security contributions, through lower corporate taxes, through subsidies for energy-saving measures and R&D or, in the case of aviation, through lower landing fees. In contrast to the other sectors, the first two options could be considered unequitable in aviation. After all, only Dutch carriers pay social security contributions or corporate taxes in the Netherlands, whereas the auctioning revenue would accrue from all airlines administered by the Netherlands. As some of these airlines may be foreign, these options could imply a transfer of funds from foreign airlines to Dutch airlines. Subsidies for energy-saving measures could also be considered unequitable for the same reasons. Therefore, this report has only considered the option of recycling the revenue through lower landing fees. It has not considered the exact design of this option nor its legal feasibility.

Table 15 shows the impacts of recycling on the total operating costs. We have identified two situations, one in which only the Netherlands would lower landing fees, and one in which all EU states would lower landing fees. As can be seen from Table 15, both have a considerable impact on the potential cost price increase.

Table 15 Impacts of recycling on total operating costs (€ 20 per tonne, full auctioning)

	NL to and from EU	NL to and from non EU
No recycling	+1.6%	+2.5%
Recycling - all airports	+0.7%	+1.4%
Recycling - Dutch airports only	+0.9%	+1.1%

Source: Appendix A.

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Competitiveness issues for Dutch aviation from EU ETS

Annexes

Report

Delft, October 2008

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A AERO results

Study: Competitiveness issues for Dutch aviation from EU ETS
Subject: Results AERO computation
To: CE Delft
From: André van Velzen
Date: 1 July 2008

1 This memo contains the results of computations with the AERO model for the above mentioned study. Computations are made for various levels of auctioning of the allowances initially allocated to the aviation sector (AAIAA). The total amount of AAIAA is assumed to be equal to the 2005 aviation CO_2 emissions on the routes under emission trading (i.e. all de-parting and arriving flights from EU airports). After consultation with CE, effects for the following policy options have been computed:
   1 EU ETS with no auctioning of AAIAA - allowance price € 20 per ton CO_2.
   2 EU ETS with 10% auctioning of AAIAA - allowance price € 20 per tonCO_2.
   3 EU ETS with 100% auctioning of AAIAA - allowance price € 20 per ton CO_2.
   4 EU ETS with no auctioning of AAIAA - allowance price € 50 per ton CO_2.
   5 EU ETS with 10% auctioning of AAIAA - allowance price € 50 per ton CO_2.
   6 EU ETS with 100% auctioning of AAIAA - allowance price € 50 per ton CO_2.
   7 EU ETS with 100% auctioning of AAIAA - allowance price € 20 per ton CO_2 plus the indirect effect of the EU ETS for the aviation industry (i.e. 0.6% increase of fuel price).
   8 EU ETS with 100% auctioning of AAIAA - allowance price € 20 per ton CO_2 plus re-channeling of auction revenues by all EU countries.
   9 EU ETS with 100% auctioning of AAIAA - allowance price € 20 per ton CO_2 plus re-channeling of auction revenues by the Netherlands only.

2 The following effects are computed for the Netherlands aviation sector:
   - % effect on RTK.
   - % effect on direct operating costs (DOC) of airlines.
   - % effect on total operating costs (TOC) of airlines.
   - % effect on DOC/RTK.
   - % effect on TOC/RTK.

Effects are computed as a % effect relative to the BaU scenario with no policy measures in 2020. Direct operating costs of airlines include: i) en route en landing charges; ii) fuel costs; iii) flight and cabin crew costs; iv) aircraft maintenance costs. Effects are separately presented for:
   - Routes between NL and other EU countries;
   - Routes between NL and non-EU countries.

It is assumed that airlines do not pass on the opportunity costs of grandfathered allowances to consumers.

3 This memo contains the following tables:
- Table 1. CO_2 aviation emissions in 2005 for flights to and from the Netherlands.
- Table 2. Auction revenues for the Netherlands for various EU ETS policy options (in M€).
- Table 3. Percentage effects of various policy options for EU ETS (effects relative to BaU scenario in 2020).

4 The 2005 CO_2 emissions for flights to and from the Netherlands presented in Table 1 are based on EUROCONTROL data. Emission data have been made available by EUROCONTROL for 2004, and were adjusted based on an assumed 4% growth of CO_2 emissions in 2005.

5 Table 2 presents the auction revenues for the Netherlands government for policy options 2, 3, 5 and 6 presented above (i.e. in policy options 1 and 4 there are no auction revenues). Hereby it is assumed that:
- Auction revenues related to flights from the NL to other EU countries accrue to the Netherlands government (i.e. the revenues from flights to the NL from other EU countries accrue to the departure countries of these flights).
- Auction revenues related to all flights between the NL and non-EU countries accrue to the Netherlands government.

The auction revenues for the policy option with 100% auctioning (and allowance price € 20 per ton CO_2) are assumed to be re-channeled to the flights to and from the Netherlands in policy options 8 and 9. The difference between these options is that in option 8 it is assumed that all EU countries re-channel their auction revenues, whereas in policy option 9 it is assumed that only the Netherlands would do so. Auction revenues are assumed to be re-channeled by a reduction of en route charges.

6 With respect to the effects of policy options 8 and 9 computed by AERO (see lower part Table 3) the following observations can be made:
- If auction revenues are re-channeled by all EU countries (policy option 8) the effects for the Netherlands aviation industry are very comparable to the situation where there is no auctioning (policy option 1). For both options, the policy-induced cost increases and demand effects relate to the costs airlines make to acquire allowances from other economic sectors to cover the growth in CO_2 aviation emissions over the period 2005-2020 (i.e. for these emissions no allowances are initially allocated).
- If auction revenues are re-channeled by the Netherlands only (policy option 9) the effect on RTK for the Netherlands aviation industry is more limited compared to policy option 8. The effects on costs for the Netherlands related flights (f.e. effects on DOC/RTK) how-ever are comparable between policy options 8 and 9. In case however only the Nether-lands would re-channel auction revenues the cost increase per RTK for Netherlands related flights is lower compared the cost increase

per RTK in neighboring countries. Hence a small shift of demand will take place from these neighboring countries to the Netherlands, limiting the decrease of demand for flights to and from the Netherlands.

7 For the route groups considered in table 3, the absolute number of RTKs in 2020 (for the BaU scenario) are:
- NL to EU 2.80 billion
- EU to NL 2.94 billion
- **Total NL to EU/EU to NL 5.74 billion**
- NL to non EU 20.85 billion
- Non EU to NL 20.45 billion
- **Total NL to non EU/non EU to NL 41.30 billion**

Table 1 CO_2 aviation emissions in 2005 for flights to and from the Netherlands

Route group	CO_2 emissions (Kton)
From NL to EU countries	1,609
From NL to non-EU countries	8,431
From EU countries to NL	1,692
From non-EU countries to NL	8,268
Total	20,000

Table 2 Auction revenues for the Netherlands for various EU ETS policy options (in M€)

Policy option	Route group			Total
	NL to EU	NL to non-EU	Non-EU to NL	
Allowance price € 20 per ton CO_2				
10% auctioning	3.2	16.9	16.5	36.6
100% auctioning	32.2	168.6	165.4	366.2
Allowance price € 50 per ton CO_2				
10% auctioning	8.0	42.2	41.3	91.5
100% auctioning	80.5	421.5	413.4	915.4

Table 3 Percentage effects of various policy options for EU ETS (effects relative to BaU scenario in 2020)

Scenario/effect	Route groups	
	NL to EU / EU to NL	NL to non EU / non EU to NL
1 Allowance price € 20 per ton CO_2; 0% auctioning		
RTK	-0.7%	-0.9%
Direct operating costs (DOC)	0.5%	0.8%
Total operating costs (TOC)	0.1%	0.2%
DOC/RTK	1.1%	1.7%
TOC/RTK	0.7%	1.1%
2 Allowance price € 20 per ton CO_2; 10% auctioning		
RTK	-0.8%	-1.0%
Direct operating costs (DOC)	0.5%	0.9%
Total operating costs (TOC)	0.1%	0.2%
DOC/RTK	1.3%	1.9%
TOC/RTK	0.8%	1.2%
3 Allowance price € 20 per ton CO_2; 100% auctioning		
RTK	-1.5%	-1.9%
Direct operating costs (DOC)	1.0%	1.8%
Total operating costs (TOC)	0.1%	0.5%
DOC/RTK	2.5%	3.8%
TOC/RTK	1.6%	2.5%
4 Allowance price € 50 per ton CO_2; 0% auctioning		
RTK	-1.7%	-2.2%
Direct operating costs (DOC)	1.2%	2.1%
Total operating costs (TOC)	0.2%	0.6%
DOC/RTK	2.9%	4.4%
TOC/RTK	1.9%	2.9%
5 Allowance price € 50 per ton CO_2; 10% auctioning		
RTK	-1.9%	-2.4%
Direct operating costs (DOC)	1.3%	2.4%
Total operating costs (TOC)	0.2%	0.7%
DOC/RTK	3.2%	5.0%
TOC/RTK	2.1%	3.2%
6 Allowance price € 50 per ton CO_2; 100% auctioning		
RTK	-3.6%	-4.6%
Direct operating costs (DOC)	2.5%	4.7%
Total operating costs (TOC)	0.4%	1.5%
DOC/RTK	6.3%	9.8%
TOC/RTK	4.1%	6.4%
7 Allowance price € 20 per ton CO_2; 100% auctioning plus the indirect effect of EU ETS for the aviation industry		
RTK	-1.6%	-2.0%
Direct operating costs (DOC)	1.1%	2.0%
Total operating costs (TOC)	0.1%	0.6%
DOC/RTK	2.7%	4.1%
TOC/RTK	1.7%	2.7%
8 Allowance price € 20 per ton CO_2; 100% auctioning plus re-channeling of auction revenues by all EU countries		
RTK	-0.6%	-1.2%
Direct operating costs (DOC)	0.5%	0.7%
Total operating costs (TOC)	0.1%	0.2%
DOC/RTK	1.1%	1.9%
TOC/RTK	0.7%	1.4%
9 Allowance price € 20 per ton CO_2; 100% auctioning plus re-channeling of auction revenues by NL only		
RTK	-0.1%	-0.2%
Direct operating costs (DOC)	1.0%	1.0%
Total operating costs (TOC)	0.8%	0.9%
DOC/RTK	1.2%	1.3%
TOC/RTK	0.9%	1.1%

B Emissions on individual flights

Effecten van EU ETS voor aantal retourvluchten vanuit Amsterdam
In opdracht van DGTL
André van Velzen (Vital Link Beleidsanalyse)
26 juni 2008

In opdracht van DGTL is een eenvoudige spreadsheet ontwikkeld waarmee een aantal effecten van het opnemen van de luchtvaart in het bestaande Europese systeem voor emissiehandel (EU ETS) worden bepaald voor een aantal retourvluchten vanuit Amsterdam. Het gaat om de volgende vluchten:

1 Amsterdam - Zurich uitgevoerd met een 737-400;
2 Amsterdam - Zurich uitgevoerd met een 737-800;
3 Amsterdam - Zurich uitgevoerd met een Fokker 100;
4 Amsterdam - Madrid uitgevoerd met een 737-400;
5 Amsterdam - Madrid uitgevoerd met een 737-800;
6 Amsterdam - San Francisco uitgevoerd met een 777-200ER;
7 Amsterdam - San Francisco uitgevoerd met een A330-200;
8 Amsterdam - San Francisco uitgevoerd met een MD11;
9 Amsterdam - Singapore uitgevoerd met een 747-400 (zonder tussenlanding);
10 Amsterdam - Singapore uitgevoerd met een 747-400 (met tussenlanding in New Delhi).

Voor de laatste vlucht geldt dat de kostenstijging als gevolg van emissiehandel alleen betrekking heeft op het deel Amsterdam-Delhi-Amsterdam. Het overige deel (Delhi-Singapore-Delhi) zal niet onder het EU ETS komen te vallen.

De effecten die voor de betreffende vluchten worden bepaald hebben betrekking op:

- karakteristieken van de vlucht;
- brandstofgebruik en CO_2-emissies;
- kosten voor brandstof en aankoop emissierechten.

Bij het bepalen van de effecten zijn de volgende aannames gedaan:

1 Op grond van gebruikersspecificaties wordt in de spreadsheet een verhouding vastgesteld tussen het aantal emissierechten waarvoor moet worden betaald (geveilde rechten of rechten gekocht op de emissiemarkt) en rechten die gratis worden verkregen ('grandfathering'). Deze verhouding is van toepassing op alle beschouwde vluchten voor het bepalen van de kostenstijging als gevolg van emissiehandel.
2 De 'opportunity costs' van gratis gealloceerde emissierechten worden niet meegenomen. De kosten voor de aankoop van emissierechten hebben dus alleen betrekking op geveilde rechten en op de rechten die gekocht moeten worden om de groei van de luchtvaartemissies vanaf het basisjaar mee af te dekken.
3 De effecten die worden bepaald zijn eerste orde effecten. Zo wordt geen rekening gehouden met het effect op de vraag als gevolg van de met emissiehandel samenhangende kostenstijging. Ook wordt geen rekening

gehouden met eventuele ‘supply side’-effecten. Het zou daarbij, als reactie op de introductie van emissiehandel, bijvoorbeeld kunnen gaan om het aanbrengen van aanpassingen aan bestaande vliegtuigen zodat de CO_2-emissies van een vlucht worden verlaagd.

4 De kosten voor het verkrijgen van emissierechten worden o.a. uitgedrukt in termen van een kostenstijging per passagier. Hierbij is geen rekening gehouden met de mogelijkheid dat een deel van de kostenstijging wordt afgewenteld op eventuele betaalde vracht die op een vlucht wordt vervoerd. Verder wordt de kostenstijging uitgedrukt als een gemiddelde kostenstijging per passagier. Geen uitspraak wordt gedaan over de wijze waarop deze kostenstijging zou worden doorberekend naar de verschillende passagierssegmenten (economy, business).

5 Het brandstofgebruik van de beschouwde vluchten is bepaald door het NLR met het zogenaamde gate-to-gate model. Hierbij is voor alle vluchten een bezettingsgraad van 80% aangehouden. Dit is gelijk aan de gemiddelde bezettingsgraad van de Air France-KLM groep in 2007.

6 Het aantal stoelen per vliegtuigtype is gebaseerd op informatie van de KLM site:
(http://www.klm.com/travel/corporate_nl/images/Fleet_tcm173-119515.pdf).

Met gebruikmaking van de ontwikkelde spreadsheet zijn de effecten bepaald voor de volgend situatie:

1 100% van de initieel gealloceerde CO_2-emissies van de luchtvaartsector wordt geveild;
2 10% van de initieel gealloceerde CO_2-emissies van de luchtvaartsector wordt geveild;
3 0% van de initieel gealloceerde CO_2-emissies van de luchtvaartsector wordt geveild.

De effecten zijn bepaald voor het jaar 2020 (aangeduid als zichtjaar) voor prijzen van resp. € 20 en € 50 per ton CO_2. Dit leidt dus tot zes verschillende berekeningen waarvan de resultaten onderstaand zijn gepresenteerd in Tabel 1 tot en met 6. Aan de berekeningen liggen verder de volgende specificaties ten grondslag (i.e. deze specificaties kunnen in de spreadsheet desgewenst worden gewijzigd):

– De prijs van brandstof bedraagt 4 US$ per gallon.
– Als detour factor is voor Intra EU vluchten (bovenstaande vluchten 1 t/m 5) 1.15 aangehouden. Voor intercontinentale vluchten is 1.1 aangehouden (bovenstaande vluchten 6 t/m 10).
– Voor de periode tussen het basisjaar (standaard 2005) en het zichtjaar (2012 of 2020) is aangehouden dat CO_2-emissies toenemen met 4% per jaar. Op grond van dit groeipercentage wordt de verhouding vastgesteld tussen het aantal initieel gealloceerde emissies van de luchtvaartsector (gebaseerd op de emissies in het basisjaar) en de toename van emissies tussen 2005 en het zichtjaar. De toename van emissies in deze periode kan alleen plaatsvinden indien daarvoor rechten op de emissiemarkt (tegen de aangenomen prijs van emissierechten) worden gekocht.

Tabel 1 Effecten in 2020 van EU ETS voor aantal vluchten vanuit Amsterdam - 100% veiling van initieel gealloceerde emissierechten (prijs emissierechten is € 20 per ton CO_2

								Prijs CO_2-emissierecht:			€ 20
								Zichtjaar:			2020
								Percentage veilen:			100%
Effect	**Eenheid**				**Verschillende retourvluchten vanuit Amsterdam**						
Karakteristieken van de vlucht											
Retourvlucht vanuit Amsterdam met	--	Zurich	Zurich	Zurich	Madrid	Madrid	San Francisco	San Francisco	San Francisco	Singapore	Singapore (via Delhi)
Vliegtuigtype	-	B737-400	B737-800	Fokker100	B737-400	B737-800	B777-200ER	A330-200	MD-11	B747-400	B747-400
Motortype	-	CFM56-3B2	CFM56-7B24	TAYMK.62015	CFM56-3B2	CFM56-7B24	GE90-94B	CF6-80E1A3	CF680C2D1F	CF680C2B1F	CF680C2B1F
Vliegafstand	Km	1,382	1,382	1,382	3,358	3,358	19,316	19,316	19,316	23,100	23,100
Aantal passagiers	Pax	118	137	82	118	137	262	201	235	342	342
Passagier-km	1.000 pax-km	163.1	189.4	113.3	396.2	460.0	5,060.8	3,882.5	4,539.3	7,900.2	7,900.2
Brandstofgebruik en CO_2-emissies											
Brandstofgebruik LTO	1.000 kg	1.68	1.65	1.37	1.68	1.65	4.81	3.90	5.26	6.64	13.28
Brandstofgebruik kruisgedeelte vlucht	1.000 kg	3.21	3.47	3.39	7.26	7.56	104.40	89.22	161.86	282.07	251.97
Totale brandstofgebruik	1.000 kg	4.90	5.12	4.75	8.95	9.21	109.21	93.12	167.12	288.71	265.24
Totale CO_2-emissies	1.000 kg	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	837.38
Aantal benodigde CO_2-emissierechten	Emissie-rechten	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	511.96
Brandstofgebruik per km	kg/km	3.5	3.7	3.4	2.7	2.7	5.7	4.8	8.7	12.5	11.5
Brandstofgebruik per passagier	kg/pax	41.5	37.4	58.0	75.8	67.2	416.8	463.3	711.1	844.2	775.6
Brandstofgebruik per passagier-km	Gram/pax-km	30	27	42	23	20	22	24	37	37	34
Kosten voor brandstof en aankoop emissierechten											
Brandstofkosten	€	€ 4,070	€ 4,255	€ 3,951	€ 7,438	€ 7,655	€ 90,800	€ 77,422	€ 138,945	€ 240,032	€ 220,526
Brandstofkosten per passagier	€	€ 34	€ 31	€ 48	€ 63	€ 56	€ 347	€ 385	€ 591	€ 702	€ 645
Brandstofkosten per 1.000 passagier-km	€	€ 25	€ 22	€ 35	€ 19	€ 17	€ 18	€ 20	€ 31	€ 30	€ 28
Kosten voor aankoop emissierechten	€	€ 309	€ 323	€ 300	€ 565	€ 581	€ 6,896	€ 5,880	€ 10,552	€ 18,229	€ 10,239
Kosten emissierechten per passagier	€	€ 3	€ 2	€ 4	€ 5	€ 4	€ 26	€ 29	€ 45	€ 53	€ 30
Kosten emissierechten per 1.000 passagier-km	€	€ 1.89	€ 1.71	€ 2.65	€ 1.43	€ 1.26	€ 1.36	€ 1.51	€ 2.32	€ 2.31	€ 1.30
Kosten emissierechten als % van brandstofkosten	%	8%	8%	8%	8%	8%	8%	8%	8%	8%	5%

Tabel 2 Effecten in 2020 van EU ETS voor aantal vluchten vanuit Amsterdam - 10% veiling van initieel gealloceerde emissierechten (prijs emissierechten is € 20 per ton CO_2)

									Prijs CO_2-emissierecht:		€ 20
									Zichtjaar:		2020
									Percentage veilen:		10%
Effect	**Eenheid**	**Verschillende retourvluchten vanuit Amsterdam**									
Karakteristieken van de vlucht											
Retourvlucht vanuit Amsterdam met	--	Zurich	Zurich	Zurich	Madrid	Madrid	San Francisco	San Francisco	San Francisco	Singapore	Singapore (via Delhi)
Vliegtuigtype	--	B737-400	B737-800	Fokker100	B737-400	B737-800	B777-200ER	A330-200	MD-11	B747-400	B747-400
Motortype	--	CFM56-3B2	CFM56-7B24	TAYMK.620-15	CFM56-3B2	CFM56-7B24	GE90-94B	CF6-80E1A3	CF6-80C2D1F	CF6-80C2B1F	CF6-80C2B1F
Vliegafstand	km	1,382	1,382	1,382	3,358	3,358	19,316	19,316	19,316	23,100	23,100
Aantal passagiers	pax	118	137	82	118	137	262	201	235	342	342
Passagier-km	1000 pax-km	163.1	189.4	113.3	396.2	460.0	5,060.8	3,882.5	4,539.3	7,900.2	7,900.2
Brandstofgebruik en CO_2-emissies											
Brandstofgebruik LTO	1.000 kg	1.68	1.65	1.37	1.68	1.65	4.81	3.90	5.26	6.64	13.28
Brandstofgebruik kruisgedeelte vlucht	1.000 kg	3.21	3.47	3.39	7.26	7.56	104.40	89.22	161.86	282.07	251.97
Totale brandstofgebruik	1.000 kg	4.90	5.12	4.75	8.95	9.21	109.21	93.12	167.12	288.71	265.24
Totale CO_2-emissies	1.000 kg	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	837.38
Aantal benodigde CO_2-emissierechten	Emissierechten	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	511.96
Brandstofgebruik per km	kg/km	3.5	3.7	3.4	2.7	2.7	5.7	4.8	8.7	12.5	11.5
Brandstofgebruik per passagier	kg/pax	41.5	37.4	58.0	75.8	67.2	416.8	463.3	711.1	844.2	775.6
Brandstofgebruik per passagier-km	gram/pax-km	30	27	42	23	20	22	24	37	37	34
Kosten voor brandstof en aankoop emissierechten											
Brandstofkosten	€	€ 4,070	€ 4,255	€ 3,951	€ 7,438	€ 7,655	€ 90,800	€ 77,422	€ 138,945	€ 240,032	€ 220,526
Brandstofkosten per passagier	€	€ 34	€ 31	€ 48	€ 63	€ 56	€ 347	€ 385	€ 591	€ 702	€ 645
Brandstofkosten per 1.000 passagier-km	€	€ 25	€ 22	€ 35	€ 19	€ 17	€ 18	€ 20	€ 31	€ 30	€ 28
Kosten voor aankoop emissierechten	€	€ 155	€ 162	€ 150	€ 283	€ 291	€ 3,450	€ 2,941	€ 5,279	€ 9,119	€ 5,122
Kosten emissierechten per passagier	€	€ 1	€ 1	€ 2	€ 2	€ 2	€ 13	€ 15	€ 22	€ 27	€ 15
Kosten emissierechten per 1.000 passagier-km	€	€ 0.95	€ 0.85	€ 1.32	€ 0.71	€ 0.63	€ 0.68	€ 0.76	€ 1.16	€ 1.15	€ 0.65
Kosten emissierechten als % van brandstofkosten	%	4%	4%	4%	4%	4%	4%	4%	4%	4%	2%

Tabel 3 Effecten in 2020 van EU ETS voor aantal vluchten vanuit Amsterdam - 0% veiling van initieel gealloceerde emissierechten (prijs emissierechten is € 20 per ton CO_2)

										Prijs CO_2-emissierecht:	€ 20
										Zichtjaar:	2020
										Percentage veilen:	0%
Effect	**Eenheid**	**Verschillende retourvluchten vanuit Amsterdam**									
Karakteristieken van de vlucht											
Retourvlucht vanuit Amsterdam met	--	Zurich	Zurich	Zurich	Madrid	Madrid	San Francisco	San Francisco	San Francisco	Singapore	Singapore (via Delhi)
Vliegtuigtype	--	B737-400	B737-800	Fokker100	B737-400	B737-800	B777-200ER	A330-200	MD-11	B747-400	B747-400
Motortype	--	CFM56-3B2	CFM56-7B24	TAYMK.620-15	CFM56-3B2	CFM56-7B24	GE90-94B	CF6-80E1A3	CF6-80C2D1F	CF6-80C2B1F	CF6-80C2B1F
Vliegafstand	km	1,382	1,382	1,382	3,358	3,358	19,316	19,316	19,316	23,100	23,100
Aantal passagiers	pax	118	137	82	118	137	262	201	235	342	342
Passagier-km	1.000 pax-km	163.1	189.4	113.3	396.2	460.0	5,060.8	3,882.5	4,539.3	7,900.2	7,900.2
Brandstofgebruik en CO_2-emissies											
Brandstofgebruik LTO	1.000 kg	1.68	1.65	1.37	1.68	1.65	4.81	3.90	5.26	6.64	13.28
Brandstofgebruik kruisgedeelte vlucht	1.000 kg	3.21	3.47	3.39	7.26	7.56	104.40	89.22	161.86	282.07	251.97
Totale brandstofgebruik	1.000 kg	4.90	5.12	4.75	8.95	9.21	109.21	93.12	167.12	288.71	265.24
Totale CO_2-emissies	1.000 kg	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	837.38
Aantal benodigde CO_2-emissierechten	Emissierechten	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	511.96
Brandstofgebruik per km	kg/km	3.5	3.7	3.4	2.7	2.7	5.7	4.8	8.7	12.5	11.5
Brandstofgebruik per passagier	kg/pax	41.5	37.4	58.0	75.8	67.2	416.8	463.3	711.1	844.2	775.6
Brandstofgebruik per passagier-km	gram/pax-km	30	27	42	23	20	22	24	37	37	34
Kosten voor brandstof en aankoop emissierechten											
Brandstofkosten	€	€ 4,070	€ 4,255	€ 3,951	€ 7,438	€ 7,655	€ 90,800	€ 77,422	€ 138,945	€ 240,032	€ 220,526
Brandstofkosten per passagier	€	€ 34	€ 31	€ 48	€ 63	€ 56	€ 347	€ 385	€ 591	€ 702	€ 645
Brandstofkosten per 1.000 passagier-km	€	€ 25	€ 22	€ 35	€ 19	€ 17	€ 18	€ 20	€ 31	€ 30	€ 28
Kosten voor aankoop emissierechten	€	€ 137	€ 144	€ 133	€ 251	€ 259	€ 3,067	€ 2,615	€ 4,693	€ 8,107	€ 4,554
Kosten emissierechten per passagier	€	€ 1	€ 1	€ 2	€ 2	€ 2	€ 12	€ 13	€ 20	€ 24	€ 13
Kosten emissierechten per 1.000 passagier-km	€	€ 0.84	€ 0.76	€ 1.18	€ 0.63	€ 0.56	€ 0.61	€ 0.67	€ 1.03	€ 1.03	€ 0.58
Kosten emissierechten als % van brandstofkosten	%	3%	3%	3%	3%	3%	3%	3%	3%	3%	2%

Tabel 4 Effecten in 2020 van EU ETS voor aantal vluchten vanuit Amsterdam - 100% veiling van initieel gealloceerde emissierechten (prijs emissierechten is € 50 per ton CO_2)

Prijs CO_2-emissierecht:	€ 50
Zichtjaar:	2020
Percentage veilen:	100%

Effect	Eenheid	Verschillende retourvluchten vanuit Amsterdam									
Karakteristieken van de vlucht											
Retourvlucht vanuit Amsterdam met	--	Zurich	Zurich	Zurich	Madrid	Madrid	San Francisco	San Francisco	San Francisco	Singapore	Singapore (via Delhi)
Vliegtuigtype	--	B737-400	B737-800	Fokker100	B737-400	B737-800	B777-200ER	A330-200	MD-11	B747-400	B747-400
Motortype	--	CFM56-3B2	CFM56-7B24	TAYMK.620-15	CFM56-3B2	CFM56-7B24	GE90-94B	CF6-80E1A3	CF6-80C2D1F	CF6-80C2B1F	CF6-80C2B1F
Vliegafstand	km	1,382	1,382	1,382	3,358	3,358	19,316	19,316	19,316	23,100	23,100
Aantal passagiers	pax	118	137	82	118	137	262	201	235	342	342
Passagier-km	1.000 pax-km	163.1	189.4	113.3	396.2	460.0	5,060.8	3,882.5	4,539.3	7,900.2	7,900.2
Brandstofgebruik en CO_2-emissies											
Brandstofgebruik LTO	1.000 kg	1.68	1.65	1.37	1.68	1.65	4.81	3.90	5.26	6.64	13.28
Brandstofgebruik kruisgedeelte vlucht	1.000 kg	3.21	3.47	3.39	7.26	7.56	104.40	89.22	161.86	282.07	251.97
Totale brandstofgebruik	1.000 kg	4.90	5.12	4.75	8.95	9.21	109.21	93.12	167.12	288.71	265.24
Totale CO_2-emissies	1.000 kg	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	837.38
Aantal benodigde CO_2-emissierechten	Emissierechten	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	511.96
Brandstofgebruik per km	kg/km	3.5	3.7	3.4	2.7	2.7	5.7	4.8	8.7	12.5	11.5
Brandstofgebruik per passagier	kg/pax	41.5	37.4	58.0	75.8	67.2	416.8	463.3	711.1	844.2	775.6
Brandstofgebruik per passagier-km	gram/pax-km	30	27	42	23	20	22	24	37	37	34
Kosten voor brandstof en aankoop emissierechten											
Brandstofkosten	€	€ 4,070	€ 4,255	€ 3,951	€ 7,438	€ 7,655	€ 90,800	€ 77,422	€ 138,945	€ 240,032	€ 220,526
Brandstofkosten per passagier	€	€ 34	€ 31	€ 48	€ 63	€ 56	€ 347	€ 385	€ 591	€ 702	€ 645
Brandstofkosten per 1.000 passagier-km	€	€ 25	€ 22	€ 35	€ 19	€ 17	€ 18	€ 20	€ 31	€ 30	€ 28
Kosten voor aankoop emissierechten	€	€ 773	€ 808	€ 750	€ 1,412	€ 1,453	€ 17,239	€ 14,699	€ 26,380	€ 45,572	€ 25,598
Kosten emissierechten per passagier	€	€ 7	€ 6	€ 9	€ 12	€ 11	€ 66	€ 73	€ 112	€ 133	€ 75
Kosten emissierechten per 1.000 passagier-km	€	€ 4.74	€ 4.27	€ 6.62	€ 3.56	€ 3.16	€ 3.41	€ 3.79	€ 5.81	€ 5.77	€ 3.24
Kosten emissierechten als % van brandstofkosten	%	19%	19%	19%	19%	19%	19%	19%	19%	19%	12%

Tabel 5 Effecten in 2020 van EU ETS voor aantal vluchten vanuit Amsterdam - 10% veiling van initieel gealloceerde emissierechten (prijs emissierechten is € 50 per ton CO_2)

										Prijs CO_2-emissierecht:	€ 50
										Zichtjaar:	2020
										Percentage veilen:	10%
Effect	**Eenheid**	**Verschillende retourvluchten vanuit Amsterdam**									
Karakteristieken van de vlucht											
Retourvlucht vanuit Amsterdam met	--	Zurich	Zurich	Zurich	Madrid	Madrid	San Francisco	San Francisco	San Francisco	Singapore	Singapore (via Delhi)
Vliegtuigtype	--	B737-400	B737-800	Fokker100	B737-400	B737-800	B777-200ER	A330-200	MD-11	B747-400	B747-400
Motortype	--	CFM56-3B2	CFM56-7B24	TAYMK.620-15	CFM56-3B2	CFM56-7B24	GE90-94B	CF6-80E1A3	CF6-80C2D1F	CF6-80C2B1F	CF6-80C2B1F
Vliegafstand	km	1,382	1,382	1,382	3,358	3,358	19,316	19,316	19,316	23,100	23,100
Aantal passagiers	pax	118	137	82	118	137	262	201	235	342	342
Passagier-km	1.000 pax-km	163.1	189.4	113.3	396.2	460.0	5,060.8	3,882.5	4,539.3	7,900.2	7,900.2
Brandstofgebruik en CO_2-emissies											
Brandstofgebruik LTO	1.000 kg	1.68	1.65	1.37	1.68	1.65	4.81	3.90	5.26	6.64	13.28
Brandstofgebruik kruisgedeelte vlucht	1.000 kg	3.21	3.47	3.39	7.26	7.56	104.40	89.22	161.86	282.07	251.97
Totale brandstofgebruik	1.000 kg	4.90	5.12	4.75	8.95	9.21	109.21	93.12	167.12	288.71	265.24
Totale CO_2-emissies	1.000 kg	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	837.38
Aantal benodigde CO_2-emissierechten	Emissierechten	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	511.96
Brandstofgebruik per km	kg/km	3.5	3.7	3.4	2.7	2.7	5.7	4.8	8.7	12.5	11.5
Brandstofgebruik per passagier	kg/pax	41.5	37.4	58.0	75.8	67.2	416.8	463.3	711.1	844.2	775.6
Brandstofgebruik per passagier-km	gram/pax-km	30	27	42	23	20	22	24	37	37	34
Kosten voor brandstof en aankoop emissierechten											
Brandstofkosten	€	€ 4,070	€ 4,255	€ 3,951	€ 7,438	€ 7,655	€ 90,800	€ 77,422	€ 138,945	€ 240,032	€ 220,526
Brandstofkosten per passagier	€	€ 34	€ 31	€ 48	€ 63	€ 56	€ 347	€ 385	€ 591	€ 702	€ 645
Brandstofkosten per 1.000 passagier-km	€	€ 25	€ 22	€ 35	€ 19	€ 17	€ 18	€ 20	€ 31	€ 30	€ 28
Kosten voor aankoop emissierechten	€	€ 387	€ 404	€ 375	€ 706	€ 727	€ 8,624	€ 7,353	€ 13,197	€ 22,798	€ 12,806
Kosten emissierechten per passagier	€	€ 3	€ 3	€ 5	€ 6	€ 5	€ 33	€ 37	€ 56	€ 67	€ 37
Kosten emissierechten per 1.000 passagier-km	€	€ 2.37	€ 2.13	€ 3.31	€ 1.78	€ 1.58	€ 1.70	€ 1.89	€ 2.91	€ 2.89	€ 1.62
Kosten emissierechten als % van brandstofkosten	%	9%	9%	9%	9%	9%	9%	9%	9%	9%	6%

Tabel 6 Effecten in 2020 van EU ETS voor aantal vluchten vanuit Amsterdam - 0% veiling van initieel gealloceerde emissierechten (prijs emissierechten is € 50 per ton CO_2)

										Prijs CO_2-emissierecht:	€ 50
										Zichtjaar:	2020
										Percentage veilen:	0%
Effect	**Eenheid**	**Verschillende retourvluchten vanuit Amsterdam**									
Karakteristieken van de vlucht											
Retourvlucht vanuit Amsterdam met	--	Zurich	Zurich	Zurich	Madrid	Madrid	San Francisco	San Francisco	San Francisco	Singapore	Singapore (via Delhi)
Vliegtuigtype	--	B737-400	B737-800	Fokker100	B737-400	B737-800	B777-200ER	A330-200	MD-11	B747-400	B747-400
Motortype	--	CFM56-3B2	CFM56-7B24	TAYMK.620-15	CFM56-3B2	CFM56-7B24	GE90-94B	CF6-80E1A3	CF6-80C2D1F	CF6-80C2B1F	CF6-80C2B1F
Vliegafstand	km	1,382	1,382	1,382	3,358	3,358	19,316	19,316	19,316	23,100	23,100
Aantal passagiers	pax	118	137	82	118	137	262	201	235	342	342
Passagier-km	1.000 pax-km	163.1	189.4	113.3	396.2	460.0	5,060.8	3,882.5	4,539.3	7,900.2	7,900.2
Brandstofgebruik en CO_2-emissies											
Brandstofgebruik LTO	1.000 kg	1.68	1.65	1.37	1.68	1.65	4.81	3.90	5.26	6.64	13.28
Brandstofgebruik kruisgedeelte vlucht	1.000 kg	3.21	3.47	3.39	7.26	7.56	104.40	89.22	161.86	282.07	251.97
Totale brandstofgebruik	1.000 kg	4.90	5.12	4.75	8.95	9.21	109.21	93.12	167.12	288.71	265.24
Totale CO_2-emissies	1.000 kg	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	837.38
Aantal benodigde CO_2-emissierechten	Emissierechten	15.45	16.16	15.00	28.24	29.07	344.78	293.98	527.60	911.44	511.96
Brandstofgebruik per km	kg/km	3.5	3.7	3.4	2.7	2.7	5.7	4.8	8.7	12.5	11.5
Brandstofgebruik per passagier	kg/pax	41.5	37.4	58.0	75.8	67.2	416.8	463.3	711.1	844.2	775.6
Brandstofgebruik per passagier-km	gram/pax-km	30	27	42	23	20	22	24	37	37	34
Kosten voor brandstof en aankoop emissierechten											
Brandstofkosten	€	€ 4,070	€ 4,255	€ 3,951	€ 7,438	€ 7,655	€ 90,800	€ 77,422	€ 138,945	€ 240,032	€ 220,526
Brandstofkosten per passagier	€	€ 34	€ 31	€ 48	€ 63	€ 56	€ 347	€ 385	€ 591	€ 702	€ 645
Brandstofkosten per 1.000 passagier-km	€	€ 25	€ 22	€ 35	€ 19	€ 17	€ 18	€ 20	€ 31	€ 30	€ 28
Kosten voor aankoop emissierechten	€	€ 344	€ 359	€ 334	€ 628	€ 646	€ 7,667	€ 6,537	€ 11,732	€ 20,268	€ 11,384
Kosten emissierechten per passagier	€	€ 3	€ 3	€ 4	€ 5	€ 5	€ 29	€ 33	€ 50	€ 59	€ 33
Kosten emissierechten per 1.000 passagier-km	€	€ 2.11	€ 1.90	€ 2.94	€ 1.58	€ 1.40	€ 1.51	€ 1.68	€ 2.58	€ 2.57	€ 1.44
Kosten emissierechten als % van brandstofkosten	%	8%	8%	8%	8%	8%	8%	8%	8%	8%	5%