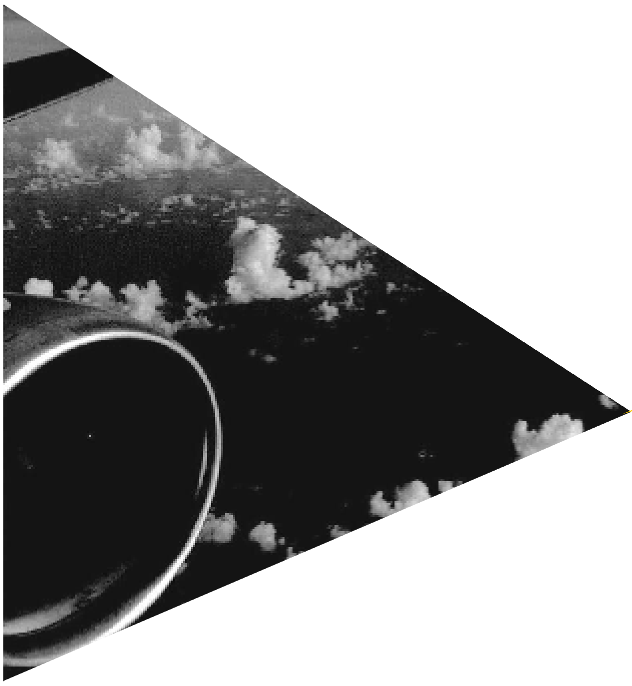

Inclusion of Aviation in the EU ETS: Cases for Carbon Leakage

Executive Summary

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ERNST & YOUNG
Quality In Everything We Do

York Aviation

This Study has been conducted at the request of:

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Association of European Airlines
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ECA
European Cargo Alliance
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ERA
European Regions Airline Association
www.eraa.org

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This study has been performed by Ernst & Young and York Aviation on the basis of the June 2007 impact study. The theoretical background was reviewed by Professor Jan Keppler (Paris Dauphine University) and Michel Cruciani (Paris Dauphine University); Professor Jean-Charles Hourcade (CIRED – Centre International de Recherche sur l'Environnement et le Développement) and Stéphanie Monjon (CIRED) were associated with the methodology regarding carbon leakage

EXECUTIVE SUMMARY

1. BACKGROUND

1.1 In January 2008, in the context of the 'Second Package on Energy and Climate', the European Commission published its proposed Directive to improve and extend the EU ETS. It acknowledged that certain sectors could be exposed to a loss of market share and competitive disadvantage leading to carbon leakage.

1.2 In an effort to identify those sectors at risk of carbon leakage, a questionnaire has been sent to all ground sources covered by the EU ETS. On the basis of the replies received, the Commission will determine which sectors qualify for a special regime (from 0% up to 100% of auctioning). The results will be announced in June 2010.

1.3 In May 2008 the aviation sector received the same questionnaire, to which it replied in August 2008. However, some decisions have already been made for the sector. Indeed, the new aviation legislation stipulates that "*from 1 January 2013 15% of allowances shall be auctioned. **This percentage may be increased as part of the general review of this Directive***".

1.4 The aviation industry has substantial concerns about the design of the scheme in general and about the level of auctioning in particular, since it is proposed to increase progressively to 100% by 2020.

1.5 **The aviation sector has commissioned this study to assess the impact of high levels of auctioning on the costs of the industry and whether it will become subject to significant carbon leakage.**

2. OBJECTIVE OF THE STUDY

2.1 The primary objective of the study is to examine the extent to which the airline sector may be subject to carbon leakage under the combined effects of ETS costs and high levels of auctioning.

2.2 In considering the airline sector's potential exposure to carbon leakage as a result of high levels of auctioning, we have adopted the approach developed by the Climate Strategies Report[1] which addressed four key questions.

1. ***Would auctioning lead to a substantial increase in production costs for the airline sector and would it have an impact on profitability?***
2. ***How will the EU ETS impact the market, price and demand?***
3. ***What is the risk of transfer of activities to non-EU operators or to routes not covered by the EU-ETS?***
4. ***To what extent would the sector be able to reduce emissions levels, for instance through more efficient technology?***

2.3 The study also investigates the impact of ETS and increasing levels of auctioning on the wider EU economy.

1 Climate Strategies (2007): J.C. Hourcade, K. Neuhoff, D. Demailly and M. Sato, Differentiation and dynamics of EU ETS industrial competitiveness impacts

3. FIRST FINDING

Auctioning will lead to a substantial increase in production costs for the airline sector and will affect the profitability of the sector

3.1 4 scenarios have been set out based on 2 different levels of CO_2 costs combined with 2 auctioning options:

- Scenario 1: CO_2 at €30/t with a flat rate of auctioning of 15% from 2012 to 2020
- Scenario 2: CO_2 at €30/t with an auctioning rate increasing from 15% in 2012 to 100% in 2020
- Scenario 3: CO_2 at €50/t with a flat rate of auctioning of 15% from 2012 to 2020
- Scenario 4: CO_2 at €50/t with an auctioning rate increasing from 15% in 2012 to 100% in 2020

3.2 Over the trading period 2012-2020, the costs by scenario are as follows:

Period 2012 - 2020	Scenario 1 €30/t CO_2 auctioning 15% 2012 - 2020	Scenario 2 €30/t CO_2 auctioning 15% 2012 to 100% 2020	Scenario 3 €50/t CO_2 auctioning 15% 2012 - 2020	Scenario 4 €50/t CO_2 auctioning 15% 2012 to 100% 2020
Cost – Purchasing	€31.4 billion	€30.7 billion	€51.0 billion	€49.1 billion
Costs - Auctioning	€8.4 billion	€32.2 billion	€14.0 billion	€53.7 billion
Total costs	€39.8 billion	€62.9 billion	€65.0 billion	€102.8 billion

3.3 The table above gives rise to the following remarks:

- The difference between the total cost in Scenarios 3 and 4 is €37.8 billion, which represents an increase of **58%.**
- In Scenario 3, auctioning represents **21.5%** of the total cost of ETS whereas in Scenario 4 it represents **52%** of the total and is evidently the main cost component.

In order to highlight the importance of the ETS impact, it seems appropriate to compare its cost to the airline industry's operating profits and investments in fleet renewal.

3.4 The prospects of air transport returning to 'normal business profitability', i.e. earning a consistent average operating margin of 4%, during the next 5-6 years is greatly over-optimistic.

Worldwide airline results during the period 2001-2006 (since the tragic events of '9/11') recorded losses in each year, aggregating to a loss for the entire period of USD42 billion. IATA estimates results for 2007, 2008 and 2009 to be a profit of USD5.6 billion and losses of USD 5.2 billion and USD4.1 billion respectively. Most industry analysts believe that the effects of the worldwide economic downturn will last longer and be more far-reaching than the more transitory effects of '9/11'.

However, even though the current financial crisis and the continuation of an economic downturn means that an assumption of an operating margin of 4% for network airlines is over-optimistic, this study uses it in order to be consistent with the previous 2007 study. In order to calculate these operating profits it has been assumed that:

- Operating profit is the profit made on all flights arriving at or departing from an EU airport, regardless of the nationality of the operator.
- Profitability on these routes reflects the overall profitability of airlines across all their operations.
- A "business as usual" operating margin for network airlines is 4%, for leading low fares airlines 14%, for other low fares/leisure airlines 2% and for cargo airlines 4%.

3.5 On this basis, we estimate that the projected operating profit of the airline industry during the period 2012-2020 would amount to €106.4 billion, namely **€12 billion per year.** Even this over-estimated operating profit would practically disappear in Scenario 4, simply due to the high level of auctioning.
We have calculated the amount of investment to be made by airlines to renew their fleet based on ICAO FESG (Forecast and Economic Analysis Support Group) data and more particularly on the fleet renewal forecast at 2006 prices in the 15-year period 2006-2020. Airlines operating to/from Europe are expected to spend **€525 billion** on fleet renewal during the period 2006-2020, namely **€35 billion per year**.

3.6 As shown in the Table below, aviation's inclusion in the EU ETS will have a significant financial and economic impact on airlines' profit and investments. The EU-based carriers will be more affected as the totality of their traffic will be covered by the ETS.

	ETS TOTAL COSTS 2012 - 2020	ETS ANNUAL AVERAGE COSTS	% ANNUAL AVERAGE PROFITS €12 billion	% ANNUAL AVERAGE FLEET INVESTMENTS €35 billion
Scenario 3 €50 with auctioning at 15%	€65.0 billion	€7 billion	60%	21%
Scenario 4 €50 with auctioning at 15% -100%	€102.8 billion	€11 billion	95%	33%

- In Scenario 3, the annual cost of ETS will be **€7 billion** and will represent **60%** of the airline industry's annual profits and **21% (i.e one fifth)** of its annual fleet investment.
- In Scenario 4, the annual cost of ETS will be **€11 billion** and will represent **95%** of the airline industry's annual profits and **33%** of its annual fleet investment.

With a high level of auctioning, even taking a largely overestimated profit assumption, ETS would practically remove the industry's overall profits and would deprive the sector of one third of its financial capacity to invest in new technologies.

3.7 As shown in the Table below, the importance of the financial and economic impact is strongly related to the level of auctioning applied to the sector.

	AUCTIONING COSTS ALONE 2012 - 2020	AUCTIONING ANNUAL AVERAGE COSTS	% ANNUAL AVERAGE PROFITS €12 billion	% ANNUAL AVERAGE FLEET INVESTMENTS €35 billion
Scenario 3 €50 with auctioning at 15%	€14.0 billion	€2 billion	13%	4%
Scenario 4 €50 with auctioning at 15% -100%	€53.7 billion	€6 billion	50%	17%
Scenario 3 versus 4	€39.6 billion	€4 billion	37%	13%

- In Scenario 3, the annual cost of auctioning alone will be **€2 billion,** representing **13%** of the airline industry's annual profits and **4%** of its annual fleet investment.
- In Scenario 4, the cost of auctioning alone will be **€6 billion,** representing **50%** of the airline industry's annual profits and 1**7%** of its annual fleet investment.
- The difference in monetary terms between the moderate and high levels of auctioning is **€39.7 billion, namely €4 billion per year.** This represents an increase of **284%** between the two levels.

Auctioning is the driving factor for cost increases arising from ETS. If set at a high level, auctioning alone will remove half of the industry's overall profits and will deprive the airline industry of 17% of its financial capacity to invest in new technologies.

4. SECOND FINDING

The EU ETS will significantly impact the market

4.1 In order to determine the impact of the EU ETS on the market, and more particularly on price and demand, the theoretical assumptions which were used in the previous study published in June 2007 have been revisited. A detailed analysis of these theoretical assumptions and demonstrations on cost pass through and windfall profits can be found in Section II of this study.

The level of auctioning has a significant impact on operating profits. The study estimates that, all other things being equal, for the period 2012 to 2020 :

- **Network airlines** would experience a decline globally from the assumed operating margin of 4% to between **2.4% and -1.2%;**
- **Low fares/leisure airlines**: the market leaders would see a decline from the assumed operating margin of 14% to between **12.9% and 9.5%**. For other low fares/leisure airlines, there would be a decline from the assumed operating margin of 2% to between **0.9% and -2.4%.**
- **Cargo airlines** would face a decline from the assumed operating margin of 4% to between **-0.8% and -9.1%.**

4.2 It should be underlined that this is an overall assessment for the whole industry. The reaction and adaptation to market changes depend on the financial situation of individual airlines, their exposure to competition and on cost pass through and price elasticity over time. If the level of auctioning increases, it becomes harder for airlines to assimilate the associated costs. Ultimately, this results in significant losses or even a total erosion of operating margins.

In the short/medium term, there will be capacity reduction in Europe. In the longer term, this is likely to affect EU operators' ability to invest in new technologies and fleet renewal. Furthermore, as EU-based airlines will be more affected than non-EU based carriers this would result in competitive imbalances.

4.3 The economic and financial impact as described in Paragraphs 3.6 and 3.7 will result in a loss of traffic, with differentiated effects on routes and markets:

- we estimate that with Scenario 3, the number of passengers lost would range from 11 million in 2012 to 22 million in 2020, an average annual loss of 18 million.

- in Scenario 4, the range would be between 11 million in 2012 and 47 million in 2020, an average annual loss of 29 million.

Although these numbers seem relatively low (between 1% and 4% of total traffic), the impact on specific markets could be severe. Some routes may become unviable and could be withdrawn, with major economic and social consequences on regional connectivity and local employment.

5. THIRD FINDING

There is a risk of transfer of activities to non-EU operators or to routes not covered by the EU ETS

5.1 For ground based sectors the concept of carbon leakage covers two types of situation: either the EU manufacturer moves its activities outside the EU to avoid EU ETS costs (**supply driven carbon leakage**) or it loses its market share/competitiveness due to high EU ETS costs and demand then shifts to a non-EU manufacturer (**demand driven carbon leakage**). In both cases, greenhouse gases will continue to be emitted into the atmosphere by operators not covered by the EU ETS.

5.2 There are important differences between aviation and ground based sectors:

- Aviation, as a mobile source, emits CO_2 all along the air route, crossing national borders and different geographical regions. This international dimension is its main feature;
- Aviation provides a service and does not manufacture a product. Its product (a seat offered on a given flight) cannot be stocked. An unsold seat is definitively lost;
- Given the existing constraints of the bilateral traffic rights system and national ownership restrictions, EU carriers cannot realistically switch their activities away from the EU and move their fleet (centre of production) outside the EU;
- However, there is nothing to stop passengers from changing their behaviour, shifting to non-EU carriers or using alternative routings.

In contrast to ground sources, carbon leakage in aviation is linked neither to a product nor to the place of production. Carbon leakage for airlines is better defined as the risk of traffic being deviated from EU operators to the benefit of non-EU operators. In other words, it is not the production facilities (supply driven carbon leakage) but demand (i.e. passengers and goods) that generates carbon leakage.

5.3 The study has identified the following main channels for carbon leakage:

- Case study 1: In intercontinental markets between two non-EU airports: 8%[2] of passenger traffic arriving at EU airports from non-EU origins is connecting to non-EU destinations. Those passengers (and possibly some cargo traffic) could bypass the EU and fly to their final destination via a non-EU hub, located for example in the Middle East, which faces no EU ETS costs. The result would be less activity for European carriers and their home airports but an increase in unregulated emissions around the world;

- Case study 2 and 3: In intercontinental markets between EU and non-EU airports: passenger or cargo traffic could be lost, to the benefit of operators offering connections at hubs close to the borders of the EU and which face lower ETS costs. In such a scenario, there will be increased competition between direct long-haul routes and indirect services. Therefore, the competitive balance will shift in favour of operations that are less affected by ETS costs, namely indirect routes via a hub outside the EU;

- Case study 4: In intercontinental markets between EU and non-EU airports where no direct flight is available. Those passengers do not have the option to choose a direct long haul flight from their departure airport and will have to hub either at an EU or a non-EU airport to reach their non-EU destination. Since these passengers care little about their connection points, unless it adds significant time to the journey, they will be highly sensitive to price and could easily switch to non-EU connecting hubs. The potential risk for traffic to be diverted to non-EU hubs is high.

- Case study 5: Cargo airlines could choose to add a stopover outside the EU in order to reduce the distance covered by the EU ETS. The possibilities on routes from Asia, South America and Africa are greater than on services between North and Central America and Europe. Russia, non-EU countries in Eastern Europe, Central Asia, the Middle East and North Africa could become potential stops.

2 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)

In some cases these points may be on the great circle route, but in other cases they may represent a diversion from the great circle route and, consequently, may generate higher emissions than a direct route.

- Around 25%[3] of passenger traffic at EU airports is generated by non-EU residents travelling into the EU for leisure. Rising prices caused by the EU ETS could result in some of these inbound tourists being diverted to non-EU destinations, thereby causing carbon leakage. The likelihood of this type of carbon leakage occurring is particularly high considering the sensitivity to price of this segment of the market;

- Case study 6 and 7: For intra-EU markets, increased carbon emissions will be caused by the diversion of short-haul air passengers to surface transport modes which are not subject to the EU ETS or not covered by other restrictions on carbon emissions. This channel for leakage will particularly affect regional routes where prices rises will lead to passengers to switching to car. In some cases, where services remain viable, additional journeys by car will simply result in additional carbon emissions. Alternatively, where the EU ETS undermines the viability of a service, it could stop operating and its passengers would in the main still travel. In these circumstances, on some routes, the additional car journeys involved would create carbon emissions over and above those created by the flight. The examples show that on a typical route, the loss of an air service could lead to a 47% increase in CO_2 emissions compared to keeping the air route in order to satisfy travel demand.

5.4 The Table below analyses the risk of carbon leakage on the types of routes described above. It shows that there is a high risk within a number of markets, and that non-EU carriers are likely to enjoy a competitive advantage as a result of this leakage. However, the importance of these markets to the airlines concerned needs to be considered. In many cases, carbon leakage centres on long-haul movement of either passengers or freight, which are among the most profitable activities for the operating carriers. Therefore, EU carriers' potential loss of market share to non-EU carriers is not just about erosion of volumes; it is about erosion of volumes on their most profitable routes.

Types of Flights / Types of Diversion	Flights between 2 non-EU points – Direct or indirect	Flights between EU and non-EU points – Direct or indirect	Intra-EU flights
Connecting at a non-EU airport	**Leakage (bypassing the EU)** (Case study 1)	**Leakage** (Case studies 2, 3 & 4)	No leakage
Additional intermediate stop outside the EU	No Leakage	**Leakage for cargo** (Case study 5)	Not leakage
Switch to ground transport modes	No Leakage	No Leakage	**Leakage** (Case studies 6 & 7)
Tourism diverted from the EU	**Small Leakage**	**Leakage**	**Leakage**

5.5 In order to illustrate the different types of carbon leakage we have detailed a number of case studies which are described hereafter.

3 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)

6. FOURTH FINDING

Fleet renewal remains the most efficient way to reduce emissions. It depends on airlines' financial capacity, on manufacturers' industrial capability to construct aircraft in sufficient numbers and on manufacturers' ability to produce steady technological improvements.

6.1 Aviation's abatement opportunities are very limited as the sector is heavily reliant on a single fuel source, with little prospect of technological change in the short to medium term. Improvements to existing aircraft through retrofits, engine upgrades and the use of alternative ground power sources do offer a few opportunities for airlines to reduce their emissions and hence to limit the costs associated with the EU ETS.

6.2 The primary avenue for abatement remains fleet renewal and the introduction of more efficient aircraft or technology - but this will take time and require investment. The imposition of major additional costs through high levels of auctioning will further limit the industry's ability to invest in new technology. The sector has already achieved the quickest renewal that the manufacturers can provide and the fleet operated by European carriers is on average young, relatively modern and efficient compared to what the manufacturers can offer for replacement. This means that the sector has limited technological means to further limit its emissions' growth in the short to medium-term.

6.3 Research into alternative fuel sources is ongoing and involves a number of leading airlines. Central to the success of the strategy will be the development of 'drop in' replacement fuels that can be used with existing aircraft, engines and distribution and storage systems. However, it will be some time before the products resulting from this research can be brought to the market.

6.4 Improvements to air traffic management (ATM) are also expected to bring emissions savings. This is particularly valid for the Single European Sky policy, the implementation of which is outside the control of air carriers. Here again, it will be some time before any tangible results can be achieved. It has been estimated that an efficient ATM system could lead to a 12% reduction in CO_2 emissions. ATM improvements will require significant investment in new airborne and ground technologies. Similarly to fleet investment the additional costs associated with increased levels of auctioning will limit the industry's ability to invest in this area.

7. FIFTH FINDING

The implementation of ETS and, in particular, an increased level of auctioning will impact the competitiveness of the EU, tourism and social mobility.

7.1 As aviation will be the first transport sector to be included in the EU ETS, the impacts will not only affect airlines but will have far-reaching consequences for the wider EU economy. Indeed, by their very nature transport services are inextricably linked to the wider economy and even to society as a whole.

7.2 In this respect we estimate that damage to the air transport industry will directly affect:

- the EU's single market goals, EU cohesion and social mobility;
- the global competitiveness and attractiveness of key centres and regions;
- tourism, where falls in demand are likely to endanger the economic prosperity of regions that are either highly tourism intensive or that have nascent tourism products built around the recent rapid expansion of connectivity within Europe;
- high value added sectors throughout Europe that rely on air connections to enable them to access markets, to source the best and most cost effective components, to interact with other parts of their organisations and extend their presence in the global economy.

8. CONCLUSION

Our analysis shows that:

1. **Aviation's inclusion in the EU ETS will have a significant financial and economic impact on airlines and particularly on EU-based carriers.**
2. **The importance of the financial and economic impact is strongly related to the level of auctioning applied to the sector.**
3. **The economic and financial impact would result in a loss of traffic, with differentiated effects on routes and markets.**
4. **High levels of auctioning combined with international competition would entail risks of carbon leakage and would result in demand (passenger or cargo) shifting to non-EU carriers or alternative routes without necessarily reducing carbon emissions, or even leading to an increase in global CO_2 emissions (see case studies).**

CASE STUDIES

Case Study 1: Bypassing EU on international long-haul flights between non-EU cities

The example relates to a one-way flight from New York (JFK) to Bombay (BOM) either via Amsterdam (AMS, option A) or via Dubai (DXB, option B).

For the purposes of this analysis we have not included the difference in fuel and landing costs associated with each routing, assuming that the networks that bypass Europe are already developed (e.g. Middle East) and that the change in the system will give these carriers an additional pricing advantage. We have also assumed a 100% auctioning rate.

	Length (km)	kg CO_2 per passenger	EUETS Cost (100% auctioning - €30/tCO_2 per passenger)
Option A: JFK ➔ AMS	5 845	408	€ 12
Option A: AMS ➔ BOM	6 854	441	€ 13
Option B: JFK ➔ DXB	10 992	817	€ 0
Option B: DXB ➔ BOM	1 928	144	€ 0
Option A	12 699	849	€ 25
Option B	12 920	961	€ 0
Difference B-A	**+221**	**+112**	**-€ 25**

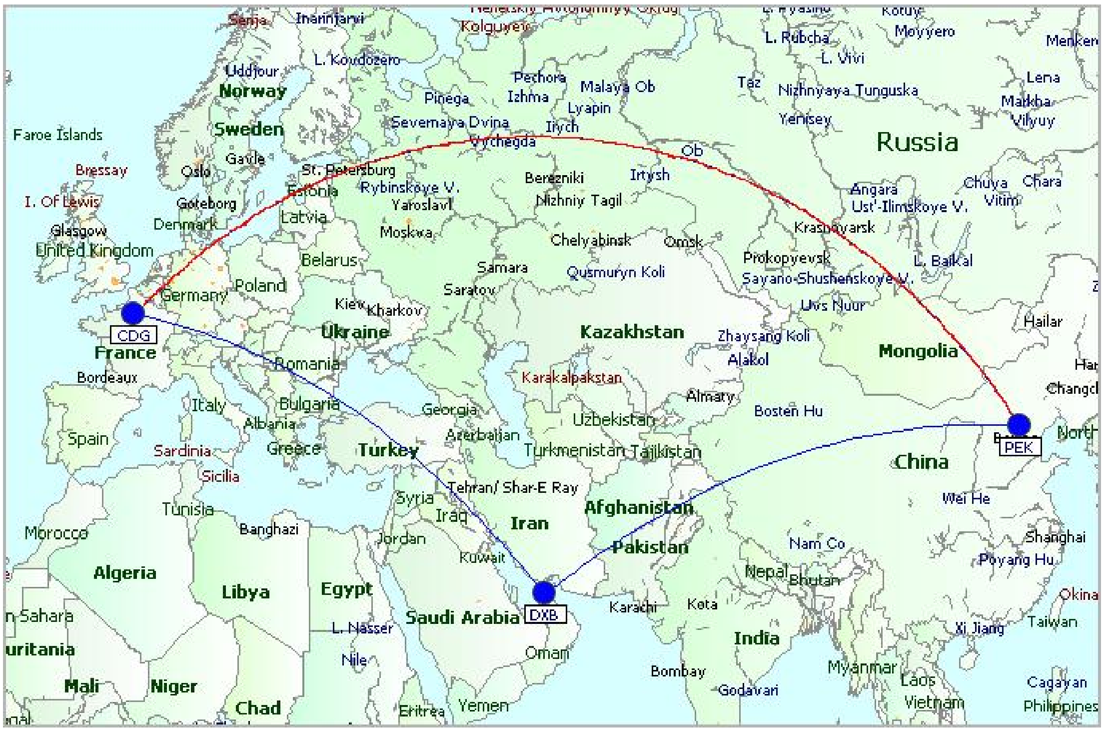
Source for distances and carbon emissions: ICAO Calculator

This type of traffic deviation/leakage affects the intercontinental market for passengers flying between two cities located outside the EU. These journeys could be made either via an EU or a non-EU hub. Any rise in price due to high levels of auctioning will diminish the attractiveness of the EU routing and will encourage passengers/cargo to simply bypass the EU. They may either use a direct flight, if any, or go via a non-EU hub. As illustrated in our case study the intermediate point is of little consequence to the vast majority of passengers. Hence, there is likely to be little consumer 'loyalty' to the EU routing.

The traffic deviation/carbon leakage via a non-EU hub will result in additional CO_2 emissions of 112 kg par passenger. This represents an additional 13% CO_2 per passenger compared to the flight via AMS. This type of traffic deviation/carbon leakage is not only environmentally harmful but also economically detrimental. In reality, these markets are particularly important for the EU carriers as they are key drivers of profitability and are also central to their networks, which concentrate and consolidate intercontinental demand at their European home base hubs.

Case Study 2: Direct vs indirect routes on international long-haul flights between EU and non-EU cities: passengers

The example relates to a one-way flight from Paris (CDG) to Beijing (PEK) either direct (CDG, option A) or via Dubai (DXB, option B).



Again, for the purposes of this analysis we have not included the difference in fuel and landing costs associated with each routing, assuming that the networks that bypass Europe are already developed (e.g. Middle East) and that the change in the system will give these carriers an additional pricing advantage. We have also assumed a 100% auctioning rate.

	Length (km)	kg CO_2 per passenger	EUETS Cost (100% auctioning €30/tCO_2 per passenger)
Option A: PAR ➔ PEK	8 185	572	€ 17
Option B: PAR ➔ DXB	5 232	371	€ 11
Option B: DXB ➔ PEK	5 843	416	€ 0
Option A	8 185	572	€ 17
Option B	11 075	787	€ 11
Difference B-A	**+2 890**	**+215**	**-€ 6**

Source for distances and carbon emissions: ICAO Calculator

This type of traffic deviation/leakage affects the intercontinental market for passengers flying between two cities, one located within and the other outside the EU. These journeys could be made either directly or via a non-EU hub. The direct flight will incur additional costs of €6 per passenger but the indirect route via Dubai will result in an additional 215 kgCO_2 per passenger being emitted. This represents an additional 38% CO_2 per passenger compared to the direct flight. It is obvious that in this case there will be no environmental benefit.

Case Study 3: Direct vs indirect routes on international long-haul flights between EU and non-EU cities : Cargo

The example mentioned above is also bound to occur on some cargo routes. Cargo traffic could be diverted to indirect routes that would become cheaper for Cargo clients. We have set out the case of a one-way flight from Delhi (DEL) to Brussels (BRU, option A) direct or via Istanbul (IST, option B).

Again, for the purposes of this analysis we have not included the change in fuel and landing costs associated with each routing, assuming that the networks that bypass Europe are already developed (e.g. Middle East) and that the change in the system will give these carriers an additional pricing advantage. We have also assumed a 100% auctioning rate.

	Length (km)	CO_2 emissions (t CO_2)	Costs of CO_2 emissions under EU ETS (hyp.: €30/tCO_2)	Payload (tonnes)	Cost of CO_2/tonne transported
Option A: DEL - BRU	6 482	277	€ 8 310	119.3	€ 70
Option B: DEL - IST	4 663	201	€ 0	119.3	€ 0
Option B: IST - BRU	2 208	94	€ 2 817	119.3	€ 24
Option A	6 482	277	€ 8 310	119.3	€ 70
Option B	6 871	295	€ 2 817	119.3	€ 24
Difference B-A	**+ 389**	**+ 18**	**- € 5 493**	**0**	**- € 46**

Source: EEA (European Express Association)

In the example quoted, the indirect route will cost € 46/tonne less than the direct one, although it will emit an additional 18tCO_2 (i.e. 6% of the CO_2 emissions of the direct flight).

Case Study 4 : **Intercontinental flights between EU and non-EU airports where no direct flight is available.**

The example relates to a one-way flight from Nice (NCE) to Tokyo (NRT) either via Frankfurt (FRA option A) or via Istanbul (IST, option B).

Again, for the purposes of this analysis we have not included the difference in fuel and landing costs associated with each routing, assuming that the networks that bypass Europe are already developed (e.g. Middle East) and that the change in the system will give these carriers an additional pricing advantage. We have also assumed a 100% auctioning rate.

	Length (km)	kg CO_2 per passenger	EUETS Cost (100% auctioning €30/tCO_2 per passenger)
Option A: NCE ➔ FRA	715	93	€ 3
Option A: FRA ➔ NRT	9 356	623	€ 19
Option B: NCE ➔ IST	1 794	193	€ 6
Option B: IST ➔ NRT	8 985	695	€ 0
Option A	10 071	716	€ 21
Option B	10 779	888	€ 6
Difference B-A	**+708**	**+172**	**-€15**

Source for distances and carbon emissions: ICAO Calculator

The flight with a stop in Frankfurt will cost €15 per passenger more than the one through Istanbul. Any increase in the ticket price resulting from this increase in costs will lead some passengers to switch from the routing via FRA to the routing via IST. However, this alternate routing will result in 172 kgCO_2. This represents an additional 24% CO_2 per passenger compared to the flight via FRA.

Case Study 5: Addition of an intermediate stop outside the EU on international long-haul flights to/from the EU

For cargo airlines, there is a further possibility that is worth mentioning at this stage. Indeed, for cargo airlines, in certain circumstances it would be rational to avoid part of the cost of the EU ETS by adding an intermediate stop to existing long-haul routes.

We have set out the case of a one-way flight from Shanghai (PVG) to Frankfurt (FRA, option A) direct or via Moscow (SVO, option B).

In this case fuel and landing costs are relevant and have been included in the analysis. Cargo carriers are able to sensibly add a stop to their existing schedules where passenger airlines cannot since this would impact customer service. We have assume a 100% auctioning rate.

	Length (km)	CO_2 emissions (t CO_2)	Landing charges	Cost of Fuel	Costs of CO_2 emissions under EU ETS (hyp.: €30/tCO_2)	Total cost
Option A: PVG - FRA	9 034	380	€ 1 632	€ 77 371	€ 11 413	€ 90 415
Option B: PVG - SVO	7 091	304	€ 3 610	€ 61 818	€ 0	€ 65 429
Option B: SVO - FRA	2 069	88	€ 1 632	€ 17 809	€ 2 627	€ 22 067
Option A	9 034	380	€ 1 632	€ 77 371	€ 11 413	€ 90 415
Option B	9 160	392	€ 5 242	€ 79 627	€ 2 627	€ 87 496
Difference B-A	**126**	**12**	**€ 3 610**	**€ 2 256**	**€ 8 786**	**€ -2 919**

Source: EEA (European Express Association)

In the example quoted, the flight with a stopover will cost 3% less than the direct one, although it will emit an additional 12tCO_2 (i.e. 3% of the CO_2 emissions of the direct flight). This suggests that such an indirect routing could make operational sense for a cargo carrier.

Case Studies 6 & 7: Carbon leakage to car

Below, we consider two cases whereby aviation's entry into the EU ETS leads to an increase in CO_2 emissions as passengers are forced to switch modes to car travel. In each case, we have considered two scenarios:

- First, a situation in which price increases stemming from ETS lead to reduced passenger numbers on an air service that stills flies, where the displaced passengers then travel to their destination by car;
- Second, a scenario whereby the costs of ETS undermine route viability to such an extent that the service no longer flies and its passengers therefore have to travel to their destination by car.

In each case, we have assumed that:

- Purpose of travel for passengers reflects domestic air traffic in the UK and this purpose determines the number of passengers per car;
- Car journeys are made using a typical family car emitting 185g of CO_2/Km;
- Cost pass-through assumptions, price elasticity, load factor and yield are in line with those for domestic flights set out in Chapter 3 of the main report.

In the Table below we have examined a domestic route operating between Aberdeen and Teeside operated by a Jetstream 41.

	Aberdeen to Teeside	**Aircraft**	**Car**	**Total**	**% Change**
	Journey Distance (km)	304	469		
Scenario 1	Passengers without ETS	19.5	0.0	19.5	
	Emissions without ETS (CO_2 tonnes)	0.89	0.00	0.89	
	Passengers with ETS	19.1	0.4	19.5	
	Emissions with ETS (CO_2 tonnes)	0.89	0.02	0.91	**2%**
Scenario 2	Passengers without ETS	19.5	0.0	19.5	
	Emissions without ETS (CO_2 tonnes)	0.89	0.00	0.89	
	Passengers with ETS	0.0	19.5	19.5	
	Emissions with ETS (CO_2 tonnes)	0.00	1.32	1.32	**47%**

Source: York Aviation

This demonstrates that, if the service continues to fly, the rise in price resulting from the EU ETS will result in an increase in total carbon emissions of around 2%. If, however, the service becomes unviable and passengers are forced to make their journeys by car, total emissions could increase by as much as 47%.

The following Table shows a further example of this type of leakage on a route between Leeds and Southampton operated by a Dash 8 Q400.

	Leeds to Southampton	**Aircraft**	**Car**	**Total**	**% Change**
	Journey Distance (km)	325	379		
Scenario 1	Passengers without ETS	50.4	0.0	50.4	
	Emissions without ETS (CO_2 tonnes)	2.34	0.00	2.34	
	Passengers with ETS	49.5	0.9	50.4	
	Emissions with ETS (CO_2 tonnes)	2.34	0.04	2.38	**2%**
Scenario 2	Passengers without ETS	50.4	0.0	50.4	
	Emissions without ETS (CO_2 tonnes)	2.34	0.00	2.34	
	Passengers with ETS	0.0	50.4	50.4	
	Emissions with ETS (CO_2 tonnes)	0.00	2.76	2.76	**18%**

Source: York Aviation

This demonstrates, again, that if the service still operates there is an increase of around 2% in carbon emissions with aviation's introduction into the EU ETS as some passengers shift to car. If, however, the service becomes unviable and passengers are forced to make their journeys by car, total emissions could increase by as much as 18%.

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