Analysis of European greenhouse gas inventories in the aviation sector

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1 Introduction

Parties included in Annex I to the United Nations Framework Convention on Climate Change (UNFCCC) have to report annual greenhouse gas inventory reports as part of their commitments under the Convention and its Kyoto Protocol. In addition, EU Member States have to submit national inventory reports under Decision 280/2004/EC to the European Commission. The European Community (EC) is a Party to the UNFCCC and its Kyoto Protocol and has to report an annual greenhouse gas inventory as well. The European Environment Agency annually compiles the EC inventory which is calculated as the sum of Member States' inventories; the EC inventory does not contain separate emission estimates using EU wide statistics to avoid discrepancies between Member States' and EC figures. Independent sources like Eurostat data is only used to fill gaps in Member State inventories and for quality assurance and quality control exercises; the mandatory reference approach which compares sectoral estimates for CO_2 emissions from energy use with the energy balance is an example where Eurostat data is used instead of Member States' reports.

Emissions from aviation are part of the reporting obligations and have to be reported separately for domestic and international flights. Only domestic aviation is part of the quantified emission reduction and limitation commitment under the Kyoto Protocol whereas emissions from international aviation are only reported as memo items.

Annex I Parties to the Protocol are obliged to set up a national system which ensures that national inventories are compiled according to the rules and procedures established by the SBSTA and COP/MOP. Part of the national system is a quality assurance and quality control (QA/QC) system to make sure that inventories are transparent, complete, consistent, comparable and accurate. The EC has implemented a quality assurance and quality control system which was adopted by the Climate Change Committee. The objectives of the EC QA/QC programme for the inventory of the European Community are the following:

(a) to provide an EC inventory of greenhouse gas emissions and removals that is the sum of the Member States' individual estimates of greenhouse gas emissions and removals,

(b) to contribute to the improvement of quality of Member States' inventories and

(c) to provide assistance for the implementation of national QA/QC programmes.

Greenhouse gas emissions from aviation are normally estimated based on fuel sales. Additional information on fuel supplied for domestic and international aviation, number of landings between airport pairs or similar information is used to determine the share of domestic and international aviation. Fuel sales are normally well known but the necessary data to determine the split between domestic and international emissions is often of

low quality or not available at all. An alternative approach towards estimating emissions is to use detailed models which calculate emissions for individual flights based on flight movement data. Differentiated fuel consumption and emission factors are used for different flight stages and aircraft types. The European Organisation for the Safety of Air Navigation (Eurocontrol) has implemented such a detailed model and provided estimates for fuel burn, CO_2 and NO_x emissions to the European Environment Agency (EEA) to support the EC and its Member States in their efforts to improve their inventories.

The purpose of this technical paper is to compare emissions reported by Member States with the modelling results provided by Eurocontrol. Both approaches to estimate the emissions use independent data sets and such a comparison is therefore a genuine quality assurance activity of the greenhouse gas inventories of Member States and the EC. Switzerland and Norway are members of both the EEA and Eurocontrol and are therefore included in this analysis. Member States might use the results of the analysis to review their national inventories. As the quality of the EC inventory depends largely on the quality of Member States' inventories this analysis might therefore also contribute to the improvement of the inventory of the European Community.

Chapter 2 of this report gives an overview on the methodologies used to estimate emissions from aviation and the data sources used for this technical paper. In chapter 3 the quality of the emission estimates is analysed; the actual comparison of country estimates with Eurocontrol calculations is included in chapter 4. Detailed information on the EU 15, EU 27, the 27 EU Member States as well as Norway and Switzerland is provided in the Annexes to this report.

2 Estimating emissions from aviation

Eurocontrol has only data on flights following instrumental flight rules which are under the supervision of air traffic control; general aviation (visual flight rules), e.g. small airplanes or helicopters, is not included. In general, flights under visual flight rules use aviation gasoline whereas larger aircraft burn jet kerosene. This comparison is therefore limited to fuel consumption and emission reported in CRF categories 1.A.3.a.i (Civil aviation – international aviation) and 1.A.3.a.ii (Civil aviation – domestic) (IPCC 1996).

2.1 Reporting requirements

2.1.1 Methodologies for estimating emissions

Annex I Parties under the UNFCCC have to use methodologies and guidance provided in the *1996 Revised IPCC Guidelines*, the *2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000 IPCC GPG)* and the *IPCC Good Practice Guidance for Land use, Land use Change and Forestry* in the preparation of their inventories. The use of the *2006 IPCC Guidelines* is not mandatory but if methodologies contained in the 2006 IPCC Guidelines are more accurate than those provided in earlier documents they may be used by Parties. The 2000 IPCC GPG

introduced one Tier 1 and two Tier 2 methodologies for estimating emissions; the 2006 IPCC Guidelines complemented these with two additional Tier 3 approaches.

In the simplest methodology (Tier 1) total fuel supplied to aircrafts is multiplied by emission factors for CO_2, SO_2 and NO_x (IPCC 2000). Emissions of CO_2 and SO_2 only depend on the carbon and sulphur content of the fuel and can be estimated accurately using this methodology assuming that the respective contents are known. NO_x emissions on the other hand vary between flight stages. More advanced methodologies take this into account and estimate emissions for landing and take-off cycles (LTO) separately from the cruise stage. Emissions and fuel consumption during LTO are estimated either based on total number of LTOs and emission factors for an average fleet (Tier 2a) or on the number of LTOs per aircraft type and respective emission factors (Tier 2b). The difference between total fuel sold and fuel use during LTO is used to estimate cruise emissions. The most detailed methodologies calculate fuel burn and emissions for all flight stages without needing fuel sale statistics. Calculations can either be based on information on generic aircraft type and origin and destination of each flight (Tier 3a) or on the actual route flown and detailed aircraft information (Tier 3b) (IPCC 2006).

Emissions for domestic and international aviation have to be calculated separately using one of the above methodologies. In general the quality of estimates for CO_2 and SO_2 will not improve with higher tiers as emissions only depend on the total fuel consumption and the carbon/ sulphur content of the fuel[1]. Even if emissions are calculated using models only (Tier 3) the results will be scaled to match national energy balances in most cases to ensure consistency with national statistics.

Emissions of methane (CH_4), nitrous dioxide (N_2O), nitrous oxides (NO_x), carbon monoxide (CO) and non-methane volatile compounds (NMVOC) on the other hand depend on many parameters, including the engine type and operating parameters. Higher tiers are expected to increase the accuracy of emission estimates for these gases as they allow applying different emission factors for different flight stages and aircraft or even engine types. In the simplest approach (Tier 1) all emissions are calculated by multiplying average emission factors with the fuel consumption. For some gases there are different average emission factors for domestic and international flights; the assumption is that domestic flights are shorter and emissions during the LTO cycle therefore have a larger impact on total emissions. The IPCC Tier 1default emission factors are listed in Table 1.

[1] The fraction of fuel oxidised in cases of incomplete combustion will have an effect on CO_2 emissions. Most inventory agency use an oxidation factors of one (complete combustion).

Table 1 *Net calorific value, emission factors and sulphur content of jet kerosene*

NCV	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
kJ/kg	kg/TJ						%
44 100	71 500	0.5	2	250	100	50	0.05

Source: *IPCC 1996, IPCC 2006*

2.1.2 Separating domestic and international aviation

The 2000 IPCC GPG provide a definition for the separation of domestic and international flights (Table 2). In general, flights which start and land in the same country are considered domestic flight whereas flights between countries are considered international. Whether flights with a stopover in the country of departure and/ or arrival are considered domestic or international flights depend on the type of stop made: if passengers are allowed to embark and disembark the domestic part of the flight is considered in the national total. If passengers are only allowed to do one of the two the whole flight is considered as an international flight. Many inventory agencies have no information on the type of stop made and are not able to apply the definition accurately. However, for most European countries this provision is of little relevance as there are only very few flights which have two stops within one country before departing on a long distance trip. In the 2006 IPCC Guidelines the differentiation has been simplified: all flights starting and landing in the same country are domestic independent of the nature of the stop. For the European Community, emissions from domestic aviation are defined as the sum of the domestic emissions of the individual Member States; intra-EU flights are recorded under international aviation. This is done to remain consistent with Member States inventories.

Table 2 *Definition of domestic and international aviation according to the IPCC Good Practice Guidance*

TABLE 2.9
DISTINCTION BETWEEN DOMESTIC AND INTERNATIONAL FLIGHTS

	Domestic	International
Depart and arrive in same country	Yes	No
Depart from one country and arrive in another	No	Yes
Depart in one country, stop in the same country without dropping or picking up any passengers or freight, then depart again to arrive in another country	No	Yes
Depart in one country, stop in the same country and drop and pick up passengers or freight, then depart finally arriving in another country	Domestic stage	International stage
Depart in one country, stop in the same country, only pick up more passengers or freight and then depart finally arriving in another country	No	Yes
Departs in one country with a destination in another country, and makes an intermediate stop in the destination country where no passengers or cargo are loaded.	No	Both segments international

Source: *IPCC 2000*

The main difficulty faced by Parties in reporting emissions from aviation is the separation between domestic and international aviation. National statistics might not differentiate between the two categories or use different definitions for the split than those required by the 2000 IPCC GPG. While this does not affect the total estimate of emissions from the sector it can lead to significant errors in the data given for domestic and international aviation. Several different approaches have been applied by Parties to determine the split between domestic and international:

- **Top down:** national fuel statistics or similar data sources are compiled using the split required by the good practice guidance. Parties can just use the fuel consumption as recorded in the statistics.
- **Bottom up:** based on the number of departures for domestic and international aviation, routes flown, types of aircraft and similar information the split between domestic and international aviation is calculated.
- **Small country:** Many small countries assume that there is no domestic aviation with aircrafts consuming jet kerosene.
- **Research projects:** the split is determined in research projects based on secondary data, e.g. passenger statistics or fuel supplied to national carriers. Often only single years are analysed.
- **Expert judgement:** one or several experts are asked to judge the split between domestic and international based on their experience and other information that might be available.

All of these approaches, if applied properly, can result in good estimates for the share of domestic aviation. A detailed analysis of methodologies applied and the results compared to Eurocontrol calculations is given in chapter 4.3.

2.2 Methodologies used by European countries

Table 3 provides an overview on the methodologies and parameters used by the 29 countries covered in this report. Twelve countries (41 %) calculate emissions using Tier 1; nine (31 %) use Tier 2 and only six (21 %) use Tier 3. Malta and Cyprus did not report on the methodology used. Ten Member States used bottom-up data to determine the share of domestic and international aviation; a further six applied the small country approach and included all fuel sales under international aviation. Top-down data and research projects are used by four countries each to separate the emissions. Only two countries rely on expert judgement. Austria changed the methodology from bottom-up data to top-down data in 2002; in Belgium different approaches are used by the different regions. The Czech Republic did not report the methodology to differentiate between domestic and international aviation.

Not surprisingly all countries that use bottom-up data to determine the split also use Tier 2 or Tier 3 methodologies to calculate the emissions; in these countries inventory agencies have access to sufficient data to apply higher tier methods. In contrast, the small country approach and expert judgement are only applied by countries which use Tier 1 for the calculation of the emissions. All EU 12 Member States which reported on their methodology use Tier 1 whereas all EU 15 Member States except Germany and Luxembourg apply higher Tiers. It has to be remembered that higher tiers do not provide greater accuracy for the estimation of CO_2 emissions; the driving factor is the quality of the fuel statistics and the accuracy of the split between domestic and international aviation.

Table 3 *Methods applied, separation between domestic and international aviation, net calorific value and emission factors used for the estimation of emissions from domestic aviation*

	Tier	Approaches to separate domestic and international aviation	NCV 2005 [TJ/ t fuel]	IEF 2005 [t CO_2/TJ]
Austria	3	1990 - 2001: bottum up; 2002 - 2005: top down	44.59	73.07
Belgium	2	bottom up and small country	43.12	68.62
Bulgaria	1	expert judgement	43.12	68.45
Cyprus	--	small country	44.59	70.80
Czech Republic*	1	--	44.59	71.20
Denmark*	3	bottum up	44.59	72.20
Estonia	1	top down	43.50	71.50
Finland	3	bottum up	43.30	71.20
France	3	bottum up	44.00	70.64
Germany	1	research project	43.00	70.65
Greece	2	bottum up	44.59	71.56
Hungary*	1	small country	44.59	70.79
Ireland	2	bottum up	44.10	70.58
Italy	2	research project	41.84	66.63
Latvia*	1	research project	44.59	72.27
Lithuania*	1	small country	44.59	74.79
Luxembourg	1	small country	43.00	69.41
Malta*	--	small country	44.59	70.62
The Netherlands*	2	research project	44.59	71.66
Norway	2	bottum up	43.10	71.21
Poland	1	top down	44.58	70.64
Portugal	2	bottum up	41.87	65.02
Romania*	1	expert judgement	44.59	--
Slovakia	1	top down	43.30	71.35
Slovenia	1	small country	43.50	71.60
Spain	2	top down	43.36	71.07
Sweden*	2	bottum up	44.59	73.17
Switzerland	3	bottum up	43.10	70.75
United Kingdom	3	bottum up	43.89	70.93

Notes: * NCV not reported; IPCC good practice guidance default value used
-- no value reported

Sources: *EEA 2007a, EEA 2007b, SHI 2007*

2.3 Methodologies used by Eurocontrol

The European Civil Aviation Conference (ECAC) recommended the use of the ANCAT methodologies to model fuel burn and emissions from aviation (ECAC 2003). ANCAT is based on the UNECE CORINAIR/EMEP Guidebook which includes three different approaches to modelling fuel burn and emissions. Eurocontrol implemented ANCAT 3 which is identical to the detailed CORINAIR/EMEP method (EEA 2006). Calculations are preformed for individual flights. The methodology provides emission and fuel burn factors for 19 generic aircraft models differentiated for different flight stages. A mapping table indicates the generic aircraft type which should be used for aircrafts not included in the model. Calculations of fuel burn and emissions are performed separately for landing and take-off (LTO) and cruise to take the different operating conditions between the two phases better into account. The cruise length is determined using the great circle distance between airports and adding a factor to take the difference between

real route and the optimal theoretical route into account. According to the definitions in the 2006 IPCC Guidelines ANCAT 3 is a Tier 3a methodology.

In addition to ANCAT 3 Eurocontrol has also implemented the Advanced Emission Model 3 (AEM 3). AEM 3 is a Tier 3b model which uses the actual flight path taken as recorded by the radar systems of the civil aviation authorities to calculate the emissions. In addition it differentiates between nine different flight stages and has more aviation types included in the model (Eurocontrol 2004). AEM 3 and the implementation at Eurocontrol are still undergoing validation and could not be used for this technical paper.

Eurocontrol has data on all flights which enter the air space of countries for which Eurocontrol is providing the central flow management function and which had at least one part of the flight under instrumental flight rules in general air traffic (IFR/GAT). With the exception of Estonia, Latvia and Lithuania all EU Member States as well as Norway and Switzerland requested Eurocontrol to provide the central flow management function in the years 2003 to 2006, for which Eurocontrol provided emission estimates to the EEA. For the Baltic States only flights going into the Eurocontrol area are included in the database. Not included are flights under visual flight rules (VFR) and some military flight from all countries. VFR apply mainly to small airplanes and helicopters; military flights which are not controlled by civil air traffic management for at least some part of a flight are also not available.

Emissions are computed by Eurocontrol's PAGODA facility using the ANCAT 3 methodology. Eurocontrol has adapted the ANCAT 3 methodology to include more different generic aircraft types for better accuracy.

2.4 Data sources

After a request by the EEA Eurocontrol Member States approved the provision of data for the comparison of results obtained from national emission estimates for aviation based mainly on fuel sales monitoring and from EUROCONTROL estimates based on flight data. Eurocontrol provided data on fuel burn in tonnes of kerosene, CO_2 and NO_x emissions for the years 2003 to 2006 for 29 countries in response to the request (Eurocontrol 2007). CO_2 emissions for EU 15 countries for the years 1996 to 2001 were taken from the documentation of the EEA workshop on emissions of greenhouse gases from aviation and navigation (ETC/ACC 2004). Fuel consumption for these years was calculated by dividing CO_2 emissions by 3.149 t CO_2/t fuel, the emission factor Eurocontrol used for the 2003-2006 data. According to Eurocontrol, the estimates for the years 1996 to 2001 have a higher uncertainty than the later figures.

All data for EU 27 Member States with the exception of Slovakia has been taken from the 2007 EC greenhouse gas inventory (EEA 2007a). After a presentation of preliminary results (ETC/ACC 2007) Slovakia submitted an updated inventory to the ETC/ACC and requested that this information should be used in this report (SHI 2007).

Data for Norway and Switzerland is taken from the 2007 EEA trends and projections report (EEA 2007b).

Some inventory submissions were incomplete but contained enough data to calculate the missing information (e.g. when only CO_2 emissions but no fuel burn is reported). In other cases wrong units were used. In these cases the missing data was calculated using default factors or the wrong units corrected. This was the case for Belgium (Annex 4), Malta (Annex 20) and Norway (Annex 22).

3 Quality of the emission estimates

3.1 Total fuel consumption

Several reasons exist why estimates for total emissions from aviation (domestic and international) might differ between Eurocontrol and its Member States. In the absence of further information a comparison between two distinct data sets can only identify areas where further research might be necessary. In the following some of the main reasons for different estimates are analysed.

3.1.1 Theoretical fuel burn versus fuel sales

Eurocontrol estimates the theoretical fuel burn for individual flights and calculates total national emissions as the sum of all flights from a country (bottom-up approach). In contrast, countries normally use the quantity of fuel sold to determine total national emissions (top-down). These two approaches only estimate the same parameter, if airplanes only load exactly the amount of fuel needed for the next leg of a flight. In practice this does not always happen. Differences in fuel prices make it economically more viable to refuel only in airports with lower prices. In addition, some airlines want to minimise the idle time of a plane at ground by refuelling only at every other stop to have higher turn-over rates.

3.1.2 Uncertainty of the estimation approaches

The uncertainty of total fuel supplied to airports is generally considered to be low. Only a limited number of fuel suppliers and a limited number of airports in a country facilitate the compilation process of national statistics. On the other hand, there are several reasons why theoretical fuel burn calculated using ANCAT 3 might differ from real fuel burn:

- **Load factors:** the take-off weight of an aircraft has a high influence on total fuel burn for a trip. The take-off weight depends on the actual number of passengers, their luggage and any cargo that might be transported as well. Fuel burn values in ANCAT 3 use typical load factors which might not fully reflect reality.
- **Route flown:** The implementation of ANCAT 3 at Eurocontrol uses typical flight routes based on the great circle distance between two airports. Due to atmospheric conditions, available air space and airport congestion actual routes might be longer or shorter than the typical distances used in the model.

- **Aircraft types:** To reduce the complexity of the data requirements only a limited number of different generic aircrafts are included in the model. All other aircrafts are grouped under the generic aircraft types. In reality, fuel burn does not only depend on the aircraft type but also on the engine which might be different between two aircrafts of the same type.
  Eurocontrol has included more aircraft types in the implementation of the ANCAT 3 model than included in the description of the methodology to reduce this error source.
- **Aircraft performance:** the age of an aircraft, maintenance standards and the actual operation all have an influence on fuel consumption. Again, these factors are only included as approximate values through average fuel consumption rates.

Eurocontrol received actual fuel consumption information for a selected number of flights through voluntary reporting by airlines to assess the uncertainty of their estimates. An analysis indicated that the uncertainty of the calculated fuel burn is around 10-12 %. Fuel statistics in countries with a well developed statistical system have a typical error of 3-5 % (IPCC 2001).

3.1.3 Completeness

Eurocontrol has data on flights that are operated entirely or in part in the European area in which Eurocontrol is providing the central flow management function with at least one part of the flight under IFR/GAT[2] rules. Not included are some military flights and flights using visual flight rules (VFR). This includes most small airplanes as well as helicopters. For this study only civil aircraft which burn kerosene have been included in the calculations of Eurocontrol to enable a better comparison with the data reported by Member States. Piston engines which use aviation gasoline have been excluded as Eurocontrol does not have complete data sets for these types of airplanes. Despite of this, there might be some completeness issues related to double counting or omissions. The same flight might be included more than once in the database if it passed through different national air traffic management authorities and the separate reports were not correctly linked to each other by Eurocontrol. The three Baltic States do not use Eurocontrol's central flow management function and only flights going to the west are recorded in the data warehouse. For flights that operate partially outside the Eurocontrol area only flight plan information is available for that part of the trip. There will always be some difference between flight plans and actual route flown which leads to additional uncertainties.

The data provided by Eurocontrol treated the ultra peripheral regions Azores and Madeira as integral part of Portugal, the Canaries as part of Spain and Martinique, Guadalupe, French Guyana and La Reunion as part of France. This means that flights between

[2] Instrumental flight rules in general air traffic

an ultra peripheral region and the respective parent state are included in the estimate for domestic aviation. This is consistent with the geographic scope of these countries under the Kyoto Protocol.

3.2 Share of domestic emissions

Most of the factors described above affect Eurocontrol estimates for domestic and international aviation similarly. If one only looks at the relationship between domestic and international aviation some of the errors are expected to cancel each other out. In contrast, many countries don't have adequate or reliable information to determine the split between domestic and international aviation correctly according to the IPCC good practice guidance. In these cases Eurocontrol estimates will be of much higher quality than estimates by countries. Only in countries where fuel statistics differentiate in accordance with the reporting requirements or which use detailed Tier 3 methodologies, national estimates are expected to be of higher accuracy.

3.3 Interpretation of the comparison results

Overall it can be concluded that differences up to 15 % for the total fuel consumption are well within the combined uncertainty margin of the two estimates. Even differences of 20 % do not necessarily indicate that the estimate by the country is wrong. Despite this, the trend of the fuel consumption is expected to follow similar patterns for the two independent estimates. If not, it might indicate that either dataset has a problem which should be further investigated.

In general it can be assumed that the share of domestic aviation provided by Eurocontrol is a good estimate for all countries except the Baltic States (chapter 2.3). Large differences between national and Eurocontrol estimates or different trends should be carefully assessed by countries. An error in the share of domestic aviation will have a higher impact on the emissions covered under the Kyoto Protocol than an error of identical magnitude for total emissions from aviation.

4 Comparison of country estimates with Eurocontrol data

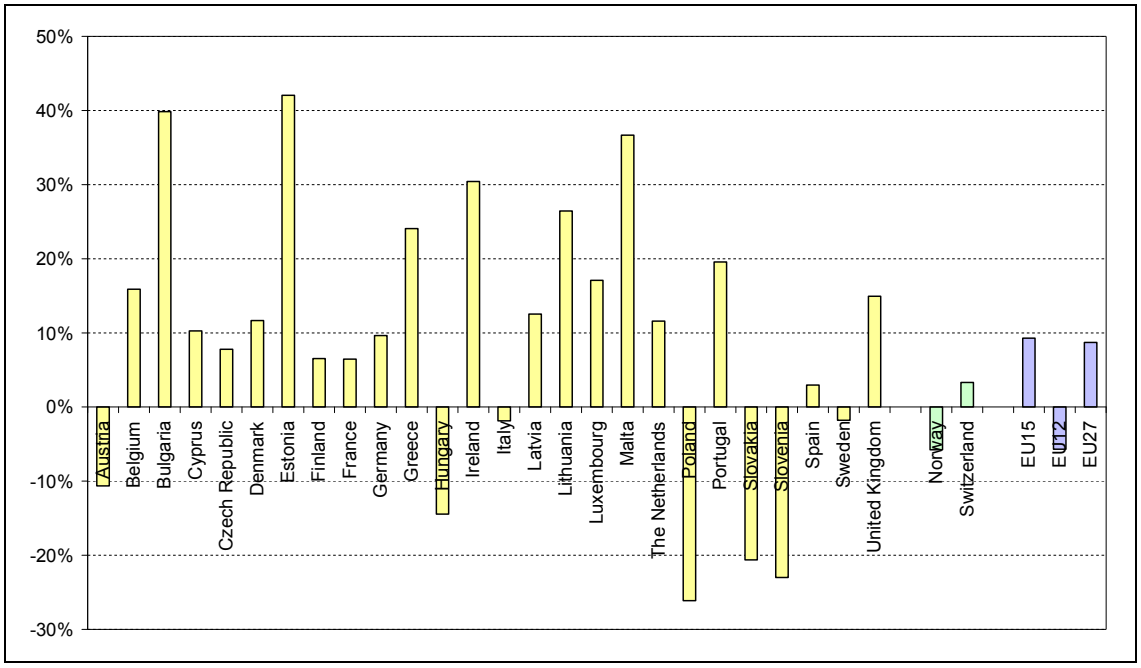
In the following the results of EU wide analysis are presented. More detailed information on the EU 15, EU 27, the 27 EU Member Stats as well as Norway and Switzerland is included in Annex 1 to Annex 31.

4.1 Total CO_2 emissions

The differences in the figures reported in national inventories and by Eurocontrol in Austria, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Latvia, Netherlands, Spain, Sweden, United Kingdom, Norway, Switzerland as well as the aggregate EU15, EU12, EU27 figures are below 15 %; for these countries and areas Eurocontrol estimates are consistent with national statistics taking the error margin of the ANCAT 3 model which is around 15 % (chapter 3.3) into account. National estimates for total CO_2 emissions are more than 20 % higher/ lower than Eurocontrol calculations in Bulgaria, Estonia, Greece, Ireland, Lithuania, Malta, Poland, Slovakia and

Slovenia (Figure 1). The higher national estimates in Estonia (+42 %) and Lithuania (+26 %) are not surprising as Eurocontrol has only partial data for the Baltic States. The large differences for some other countries are not so easily explained. Overall, countries tend to report higher fuel consumption than the fuel burn calculated by Eurocontrol; this is especially true for EU 15.

Figure 1 *Total CO_2 emissions 2005: differences between country estimates and Eurocontrol*



Notes: *Romania does not report CO_2 emissions from international aviation and is not included.*

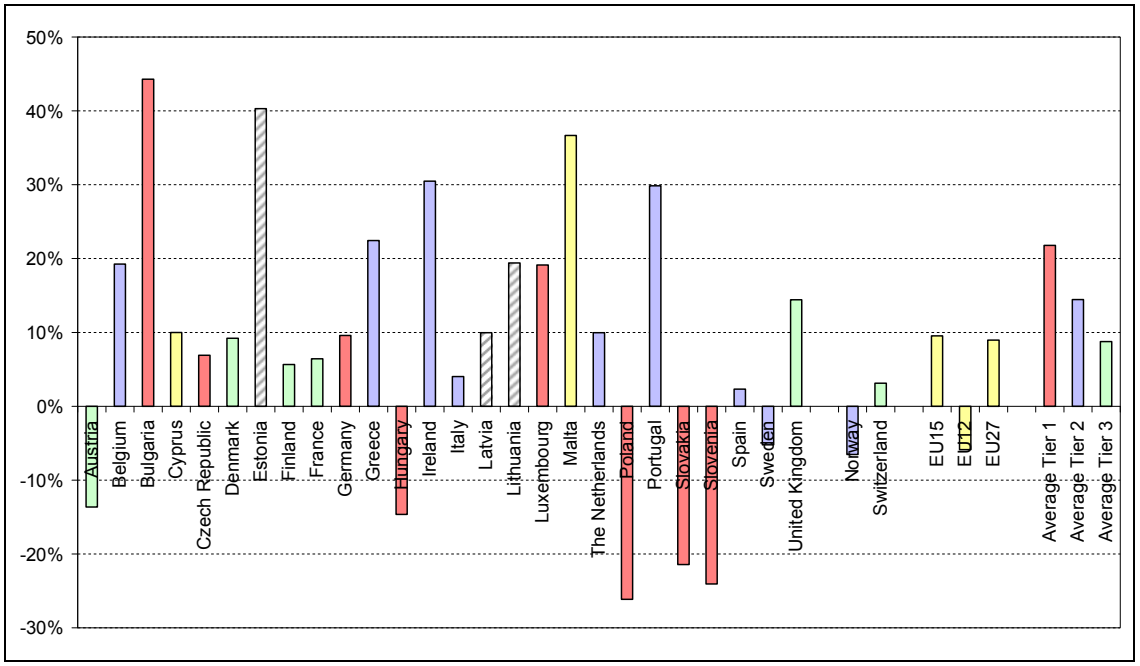
Source *EEA 2007a, EEA 2007b, Eurocontrol 2007, SHI 2007, own calculations*

4.2 Total fuel consumption

Jet kerosene is a homogenous product which only shows slight variation across countries. The difference between the highest and lowest net calorific value reported by an European country is 4.5 %. Consequently, the picture for total fuel consumption as reported by countries compared to Eurocontrol estimates is very similar to the differences in total CO_2 emissions (Figure 2). In theory the quality of the estimate for fuel consumption should not depend on the tier applied by a country as fuel consumption normally only depends on the energy balance. Despite this there is a clear difference in the average difference by tier: countries using Tier 1 have, on average, a 22 % higher estimate for fuel consumption than Eurocontrol; for countries using Tier 2 the difference decreases to 14 % and for countries applying Tier 3 it is only 9 %. There are several reasons which might explain this trend:

- Applying higher tiers requires a large amount of detailed data. Countries which collect this data might, on average, have better developed statistics which is also reflected in estimates for total fuel consumption.
- Some countries which applied Tier 3 might not have scaled the model results with their national energy balance. In these cases Eurocontrol and country estimates use the same or similar models and the same or similar data sets. Results therefore show a higher consistency than in cases where independent data has been used.
- The differences reflect the difference between fuel sales and fuel consumption and the different coverage of the sector (chapter 3). The correlation between tier applied and difference to Eurocontrol estimates is merely coincidence.

Figure 2 *Total fuel combustion 2005: differences between country estimates and Eurocontrol by tier*



Notes: *Yellow bars: no tier reported or not applicable.*
Eurocontrol has only incomplete data for Estonia, Latvia and Lithuania.

Source *EEA 2007a, EEA 2007b, Eurocontrol 2007, SHI 2007, own calculations*

4.3 Split domestic/ international and domestic fuel consumption

The most difficult aspect in the aviation inventory preparation for most countries is the calculation of the correct split between domestic and international aviation. Eurocontrol data might be able to support countries in their work; together with the national energy balance countries could use a Tier 3 methodology without needing to implement a de-

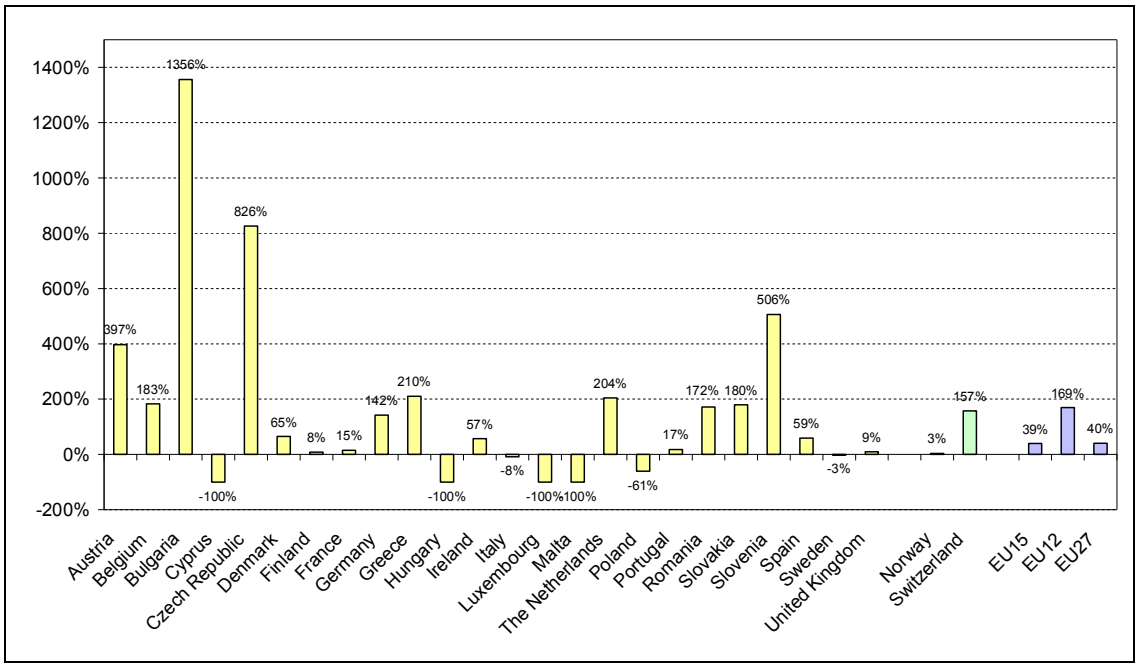
tailed model themselves. The main difficulty in such an approach is the calculation of a consistent time series: in the best case Eurocontrol data is available as of 1996.

Six European countries (Austria, Bulgaria, Czech Republic, Greece, Netherlands and Slovenia) report more than twice as many CO_2 emissions from domestic aviation than Eurocontrol. For the EU 15 the difference is 39 % or 6.7 Mt CO_2/yr on average in the period 2003 to 2005.

Cyprus, Hungary, Luxembourg, Malta and Slovenia use the small country approach to separate domestic and international aviation: it is assumed that all jet kerosene is burned in international flights. Four of these countries underestimate domestic emissions by 100 % compared to Eurocontrol. The reason for this is that even in countries with only one airport there might be 'domestic' flights, i.e. flights which depart and land at the same airport, e.g. due to technical problems. Eurocontrol has information on these flights and calculates domestic emissions for these countries. In absolute terms the error is marginal: Cyprus has, with 11 kt CO_2/yr, the highest difference out of these countries. Slovenia reports in the national inventory that all jet kerosene is consumed in international aviation. Despite this Slovenia reports minor quantities (2 kt CO_2/yr) which are still considerably higher than Eurocontrol estimates.

With the exception of very few countries there are major differences between national estimates for CO_2 emissions from domestic aviation and Eurocontrol estimates. Figure 3 compares absolute emissions and therefore depends on the completeness of Eurocontrol data and the overall quality of emission calculations. A better indicator to assess the split between domestic and international aviation is the share of domestic aviation compared to overall emissions. Under the assumption that completeness errors affect domestic and international flights in the same way and that the error in the fuel consumption is consistent between domestic and international aviation, the share for domestic emissions as calculated by Eurocontrol should be of higher quality than estimates for absolute emissions by Eurocontrol; consistent errors in the estimates for absolute emissions from international and domestic aviation should cancel each other out when calculating the share of domestic aviation. In Figure 4 the share of domestic aviation is shown as calculated by the country and Eurocontrol. In addition the figure contains information on the methodology used to separate domestic and international aviation. In general, countries tend to overestimate domestic emissions. For the EU 15, the difference is 3.8 percentage points or 5.5 Mt CO_2/yr using the fuel consumption reported by countries.

Figure 3 *Domestic CO_2 emissions: average differences between country estimates and Eurocontrol 2003-2005*



Notes: *Eurocontrol has no data for domestic emissions in Estonia, Latvia and Lithuania.*

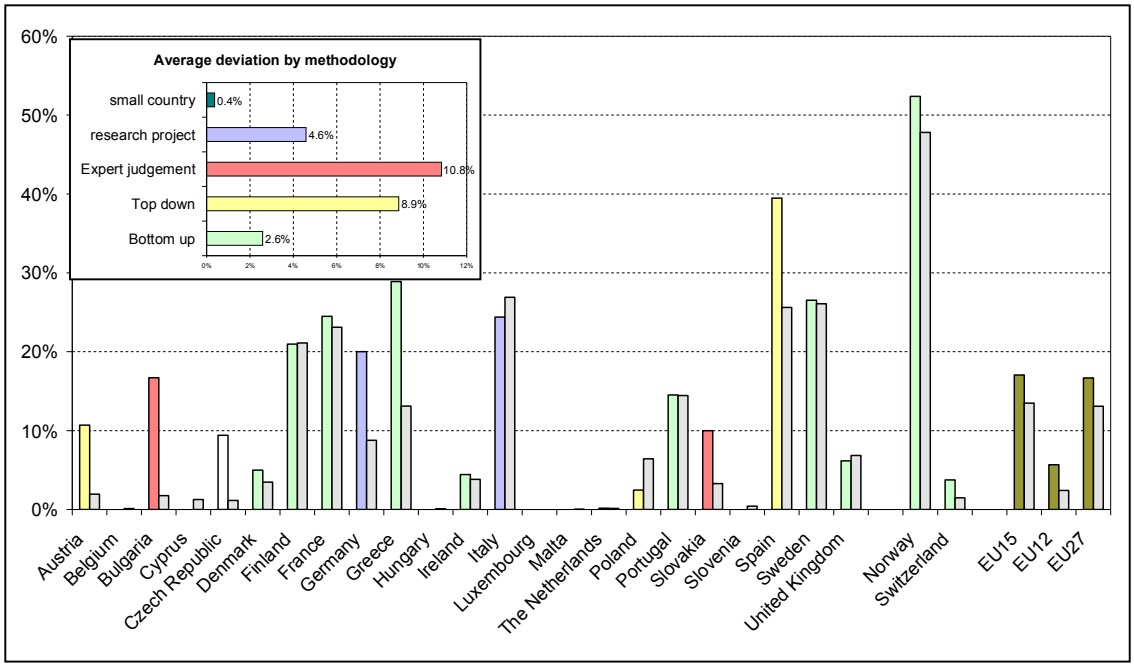
Source *EEA 2007a, EEA 2007b, Eurocontrol 2007, SHI 2007, own calculations*

The analysis shows that there are clear differences in the consistency between country estimates and Eurocontrol figures depending on the methodology used to calculate the split:

- The difference is 0.4 % for countries applying the small country approach.
- The difference is highest for countries which have to rely on expert judgement or top-down approaches. Both methods are commonly used by countries which do not have good data available.
- Bottom-up approaches show a high consistency with Eurocontrol with only one country having significantly different results. This is understandable as Eurocontrol is applying a bottom-up approach as well; similar methodologies should result in similar results.
- Research projects can lead to good estimates of the split between domestic and international but this is not true in all cases.

The tendency to overestimate domestic emissions ensures that countries report conservatively as only this share is included in the national totals. On the other hand, overestimating domestic emissions will make it harder for countries and the EU to reach their Kyoto targets.

Figure 4 *Domestic CO_2 emissions: average differences between country estimates and Eurocontrol 2003-2005 by methodology*



Notes: *Eurocontrol has no data for domestic emissions in Estonia, Latvia and Lithuania.*

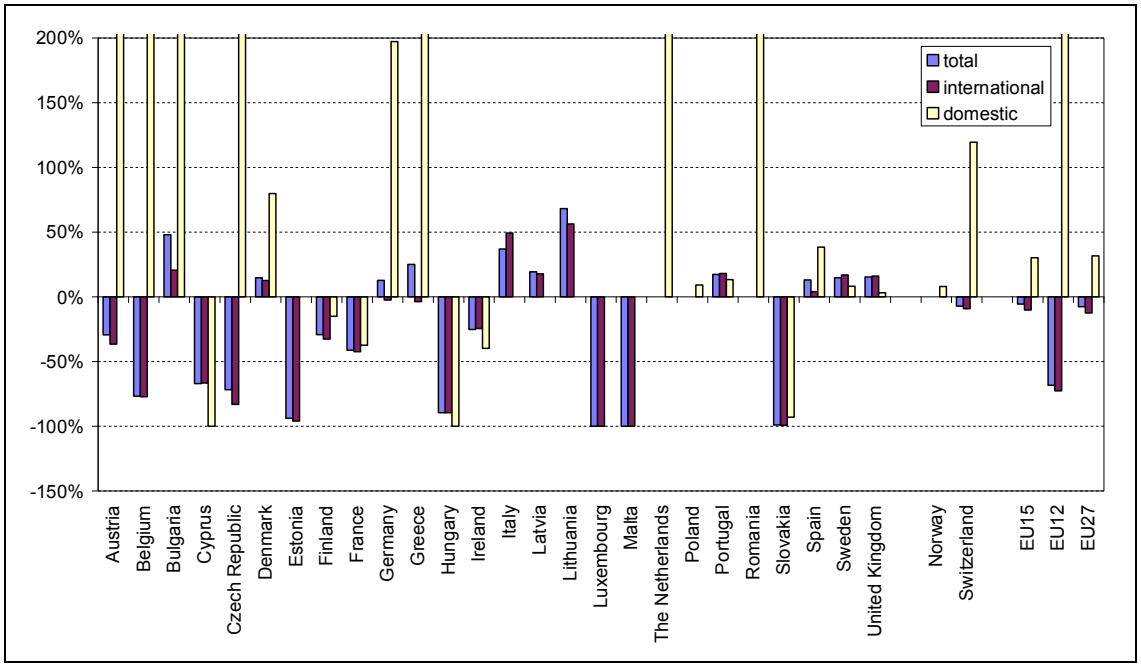
Source *EEA 2007a, EEA 2007b, Eurocontrol 2007, SHI 2007, own calculations*

4.4 NO_x emissions

Emissions from nitrous oxides depend on the technology used and operation conditions. Countries which apply simple Tier 1 methods will not be able to reflect these parameters correctly and can only calculate rough estimates. On the other hand emission factors for NO_x show high uncertainties and higher tiers will not necessarily lead to higher accuracy (IPCC 2001). Figure 5 shows that countries tend to overestimate NO_x emissions from domestic aviation and underestimate NO_x emissions from international aviation compared to Eurocontrol estimates. Overall for the EU 15 and EU 27 the total NO_x emissions are close between the two independent data sets.

An analysis by tier leads to no conclusive results (Table 4). In the data set analysed for this study countries applying Tier 2 methodologies have the highest consistency with total NO_x emissions calculated by Eurocontrol. For international aviation countries using detailed models show the smallest difference although the difference is still over 90 %. Overall the comparison mainly highlights the large uncertainties for estimating nitrous oxide emissions from aviation. Variations between the tiers might be due to substance but could also be a coincidence. The latter seems likely, especially because the sample is not very large for each tier.

Figure 5 *NO_x emissions in 2005: differences between country estimates and Eurocontrol*



Notes: *Eurocontrol has only incomplete data for Estonia, Latvia and Lithuania.*

Source *EEA 2007a, EEA 2007b, Eurocontrol 2007, SHI 2007, own calculations*

Table 4 *NO_x emissions in 2005: difference between country estimates and Eurocontrol by tier*

	Total		Domestic		International	
	Number of estimats	Average deviation	Number of estimats	Average deviation	Number of estimats	Average deviation
Tier 1	9	-34.0%	9	-41.7%	7	399.2%
Tier 2	7	0.7%	7	-2.4%	9	703.0%
Tier 3	6	-12.8%	6	-15.3%	6	91.8%
Tier unknown	2	-83.6%	2	-83.3%	1	-100.0%

Sources: *EEA 2007a, EEA 2007b, SHI 2007, SHI 2007, own calculations*

5 Conclusions

Comparing country estimates for fuel burn, CO_2 emissions and NO_x with Eurocontrol calculations is a genuine quality assurance exercise which can help both sides in improving their data. Despite significant uncertainties in the estimates the comparison was able to identify countries for which the differences could not be easily explained and where countries as well as Eurocontrol might need to do further analysis. Especially for the share of domestic aviation Eurocontrol data might be of use to several countries in the future.

The analysis showed that although in theory CO_2 estimates from aviation do not depend on the tier chosen, in practice countries applying higher tiers also had more consistent carbon dioxide emission estimates. One of the reasons might be that the application of higher tiers requires detailed statistics in the aviation sector which might also be reflected in the fuel sale estimates.

The use of bottom-up data for the determination of the split between domestic and international aviation could improve the accuracy. The small country approach is a good and very easy methodology for countries without domestic IFR/GAT aviation; research projects can produce good estimates for the share of domestic emissions. Out of the 29 countries assessed for this technical paper, those applying expert judgement or top-down data had the highest discrepancies compared to Eurocontrol.

In general, the European countries tend to overestimate domestic emissions. This is a conservative approach as it increases the emissions included in the emission reduction commitment under the Kyoto Protocol. For the same reason it would be in the interest of the concerned countries to improve their estimates: greenhouse gas emissions from aviation have increased substantially since 1990 (ETC/ACC 2006) and overestimating the domestic share will exacerbate the efforts for reaching the national targets. Applying the share of domestic aviation as calculated by Eurocontrol to total fuel consumption in the EU 15 leads to an overestimation of domestic emissions from aviation by 6.2 Mt CO_2 in 2005. An assessment by country is included in the Annex to this report.

In theory, Eurocontrol data could be used to compile national inventory reports for its Member States. The data has several advantages, most importantly the timely preparation and estimation of emissions using a Tier 3 methodology without additional resource requirements for inventory agencies. However, several issues need to be solved before Eurocontrol data can be used:

- **Consistent time series**: Eurocontrol has no data for the years 1990 – 1995 and only limited information for 1996 – 2002. Additional information will be necessary to compile a consistent time series.
- **Consistency with national statistics**: National statistics could be used to complement the modelled data to ensure consistency and completeness with the reference approach. In addition, energy statistics often have a lower uncertainty than the fuel consumption data calculated with ANCAT 3.
- **Completeness**: Eurocontrol only covers certain geographic areas and certain types of flights. Inventory agencies will need to ensure that all emissions are covered in the national inventory report independent of the coverage of Eurocontrol.

Once the AEM model is fully operational at Eurocontrol (chapter 2.3) it might be interesting to update this study. Using a different model might help identifying the sources for the discrepancies between Eurocontrol and some Member States. In addition AEM 3 can be used to compile inventories for other pollutants like CO and N_2O as well.

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Annex 1: EU 15

The inventory of the European Community is the sum of the Member States' inventories. As it is not compiled independently there is no own methodology which is applied by the European Community.

Total fuel consumption and CO_2 emissions are well within the uncertainty of the ANCAT 3 model. Domestic CO_2 emissions and the share of domestic emissions on the other hand are significantly higher than the values calculated by Eurocontrol. The trend of the last years indicates that the gap will increase in the future. There might be a need for the 15 Member States for which the European Community compiles its inventory to assess their estimates and correct it if necessary. NO_x emissions are relatively close to Eurocontrol estimates.

Table A 1 Fuel consumption and CO_2-Emissions EU 15

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	32,388	31,678	2	101,904	99,755	2	19,307	18,416	5	18.9	18.5	3
1997	33,988	33,180	2	107,028	104,484	2	20,052	19,240	4	18.7	18.4	2
1998	36,596	35,639	3	115,160	112,229	3	21,394	19,731	8	18.6	17.6	5
1999	39,379	38,080	3	123,873	119,914	3	22,612	20,653	9	18.3	17.2	6
2000	41,674	39,121	6	130,890	123,193	6	23,981	21,207	12	18.3	17.2	6
2001	40,556	35,817	12	127,615	112,787	12	23,078	19,277	16	18.1	17.1	5
2002	41,296			129,905			22,413			17.3		
2003	40,879	37,451	8	128,506	117,934	8	22,385	16,505	26	17.4	14.0	20
2004	43,642	40,123	8	137,231	126,347	8	23,370	16,987	27	17.0	13.4	21
2005	46,016	42,043	9	144,688	132,393	8	25,063	17,274	31	17.3	13.0	25
2006		43,484			136,930			17,382			12.7	

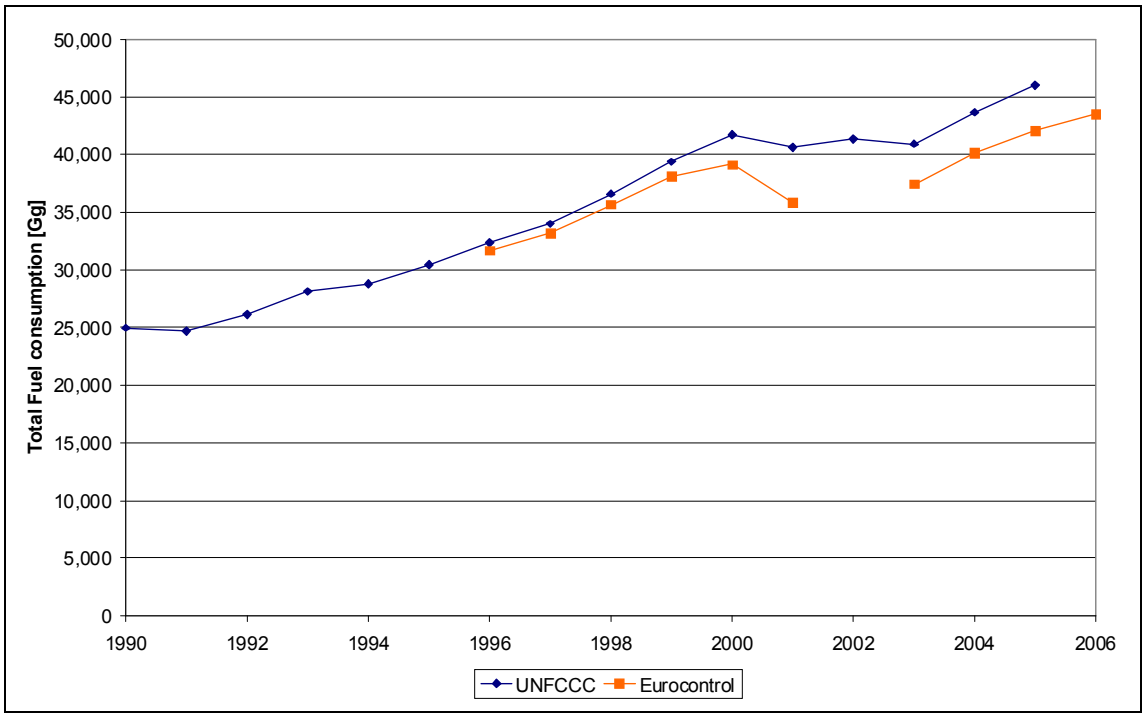
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 2 NO_x-Emissions EU 15

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	475.0	506.8	-7	82.7	68.9	17	395.4	437.9	-11	11.62	13.53	-16
2004	511.6	543.4	-6	86.9	71.4	18	428.0	472.0	-10	11.72	13.54	-16
2005	537.4	569.0	-6	94.1	72.2	23	446.2	496.8	-11	11.68	13.53	-16
2006		587.3			72.4			514.9			13.51	

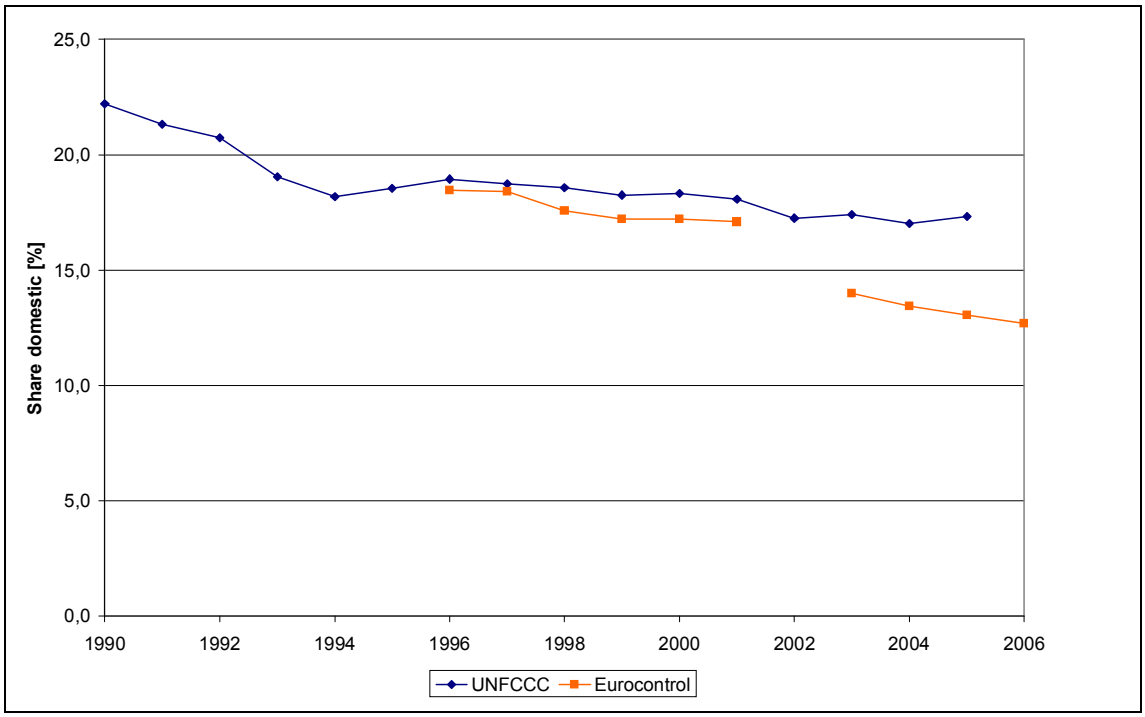
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 1 Total fuel consumption EU 15



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 2 Share domestic EU 15



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 2: EU 27

The inventory of the EU 27 is the sum of the Member States' inventories. As it is not compiled independently there is no methodology which is applied by the European Union.

Total fuel consumption and CO_2 emissions are well within the uncertainty of the ANCAT 3 model. Domestic CO_2 emissions and the share of domestic emissions on the other hand are significantly higher than the values calculated by Eurocontrol. There might be a need for the 27 Member States for which the European Union compiles its inventory to assess their estimates and correct it if necessary. The EU 15 countries dominate the EU 27 aviation emissions making an improvement of the estimates by EU 15 Member States more urgent.

Table A 3 Fuel consumption and CO_2-Emissions EU 27

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Eurocontrol	Deviation	NIR	Eurocontrol	Deviation	NIR	Eurocontrol	Deviation	NIR	Eurocontrol	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	33,732			106,151			19,810			18.7		
1997	35,274			111,088			20,543			18.5		
1998	37,784			118,902			21,733			18.3		
1999	40,584			127,669			22,883			17.9		
2000	42,885			134,716			24,268			18.0		
2001	41,837			131,728			23,379			17.7		
2002	42,583			134,016			22,683			16.9		
2003	42,299	38,658	9	133,016	121,733	8	22,634	16,606	27	17.0	13.6	20
2004	45,090	41,538	8	141,870	130,803	8	23,662	17,098	28	16.7	13.1	22
2005	47,568	43,691	8	149,584	137,583	8	25,396	17,387	32	17.0	12.6	26
2006		45,324			142,727			17,511			12.3	

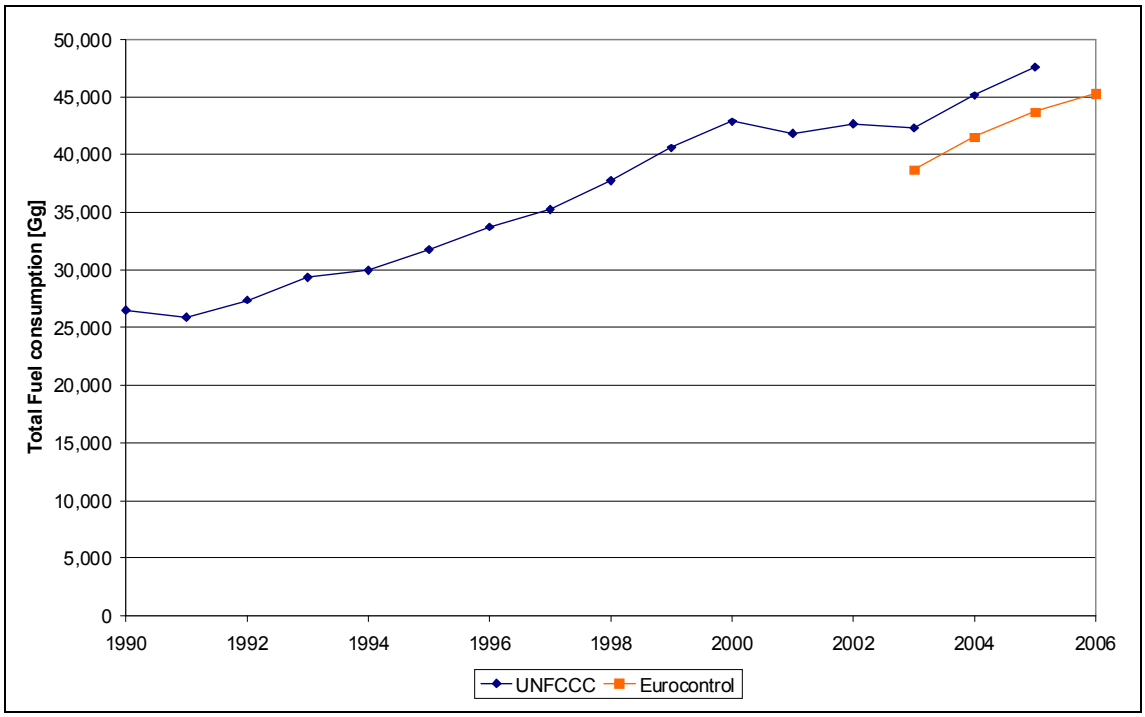
Source: EEA 2007a, Eurocontrol 2007, SHM 2007, own calculations

Table A 4 NO_x-Emissions EU 27

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Eurocontrol	Deviation	NIR	Eurocontrol	Deviation	NIR	Eurocontrol	Deviation	NIR	Eurocontrol	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	481.8	520.8	-8	83.3	69.3	17	402.0	451.5	-12	11.39	13.47	-18
2004	517.1	559.6	-8	87.8	71.8	18	433.1	487.8	-13	11.47	13.47	-17
2005	543.4	587.8	-8	95.6	72.6	24	451.3	515.2	-14	11.42	13.45	-18
2006		608.3			72.9			535.4			13.42	

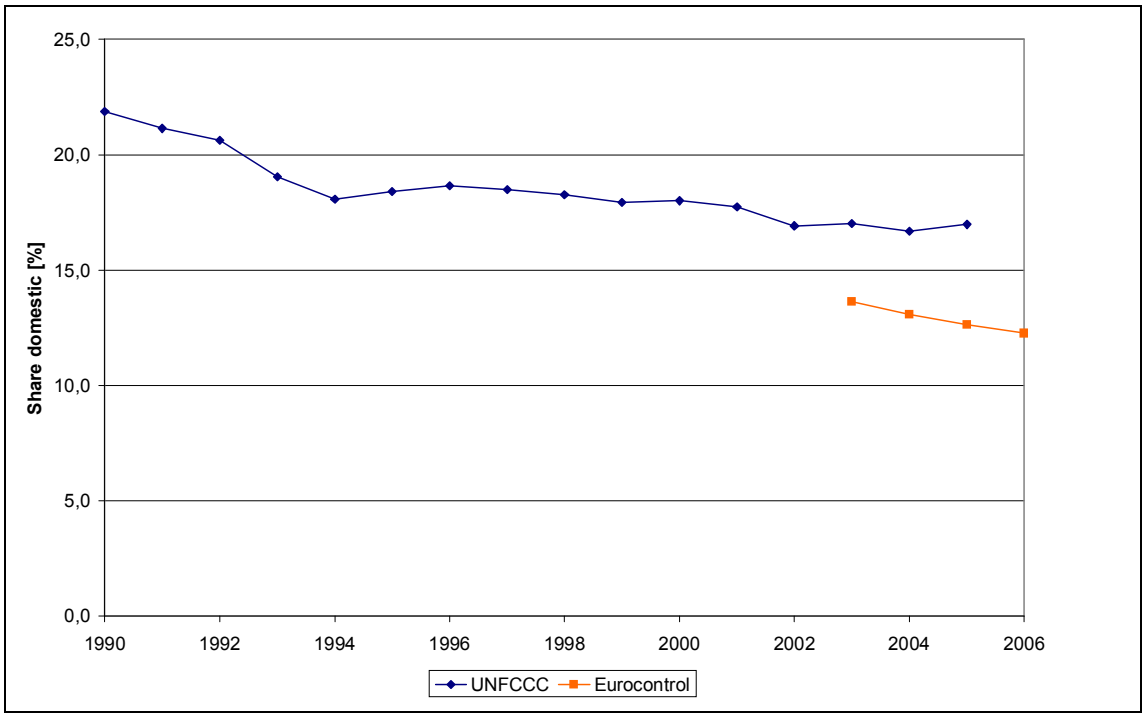
Source: EEA 2007a, Eurocontrol 2007, SHM 2007, own calculations

Figure A 3 Total fuel consumption EU 27



Source: EEA 2007a, Eurocontrol 2007, SHM 2007, own calculations

Figure A 4 Share domestic EU 27



Source: EEA 2007a, Eurocontrol 2007, SHM 2007, own calculations

Annex 3: Austria

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Austria	3	1990 - 2001: bottum up; 2002 - 2005: top down	3.258	44.59

Austria is estimating emissions from aviation using a Tier 3 approach. Up to the year 2001 the split between domestic and international aviation was calculated using bottom-up data; since 2002 top-down figures are used.

The comparison shows that the share of domestic emissions has risen sharply after the change of methodology. At the same time the share according to Eurocontrol has declined significantly. The relatively low deviation for the years 1996 to 2001 rises to over 80 % for the subsequent years as a result of this. If possible it might be useful to calculate the split based on bottom-up data as has been done in the past. NO_x emissions deviate between -40 % and +80 %, depending on the parameter and the year.

Table A 5 Fuel consumption and CO_2-Emissions Austria

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	470	480	-2	1,530	1,513	1	63	62	2	4.2	4.1	1
1997	491	497	-1	1,596	1,566	2	71	65	7	4.4	4.2	5
1998	509	549	-8	1,655	1,728	-4	77	73	6	4.7	4.2	9
1999	498	552	-11	1,623	1,738	-7	81	69	14	5.0	4.0	20
2000	540	557	-3	1,757	1,754	0	82	80	3	4.7	4.6	2
2001	524	447	15	1,707	1,407	18	78	68	13	4.6	4.9	-6
2002	492			1,604			78			4.9		
2003	450	547	-22	1,467	1,721	-17	162	38	77	11.1	2.2	80
2004	529	645	-22	1,724	2,031	-18	192	38	80	11.1	1.9	83
2005	598	692	-16	1,948	2,180	-12	217	39	82	11.2	1.8	84
2006		695			2,189			41			1.9	

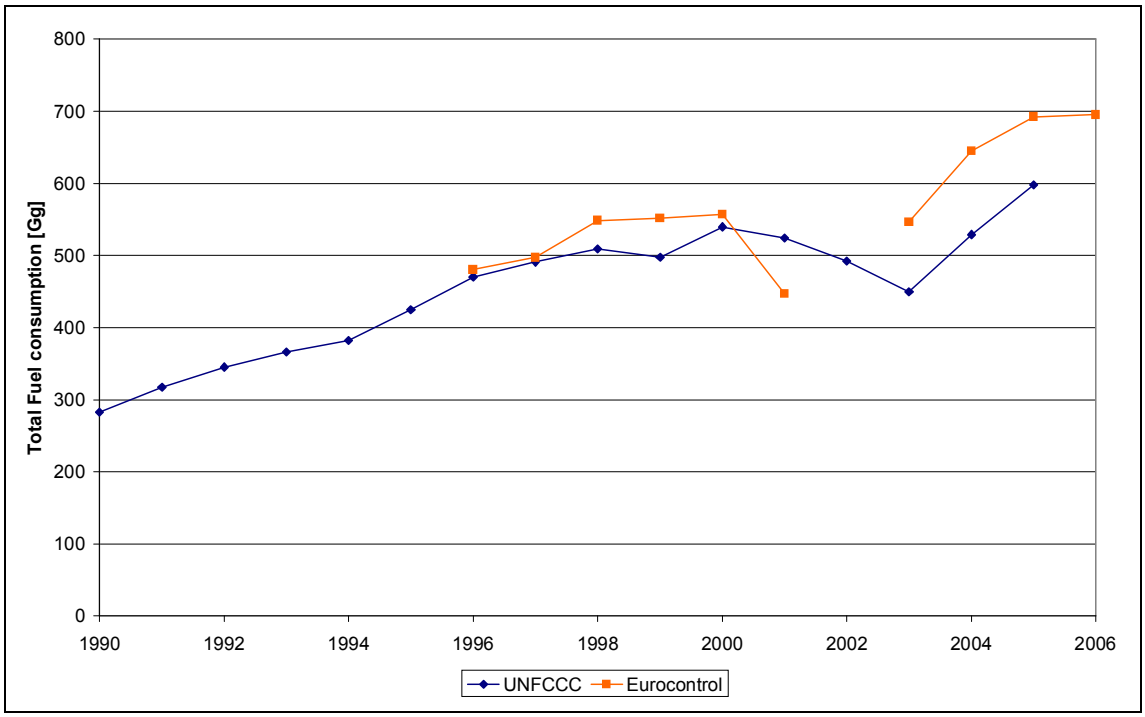
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 6 NO_x-Emissions Austria

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	4.7	7.0	-49	0.5	0.1	75	4.2	6.9	-65	10.47	12.85	-23
2004	5.5	8.3	-50	0.6	0.1	78	4.9	8.2	-67	10.47	12.88	-23
2005	6.3	8.9	-42	0.7	0.1	80	5.5	8.7	-57	10.47	12.80	-22
2006		8.8			0.2			8.6			12.60	

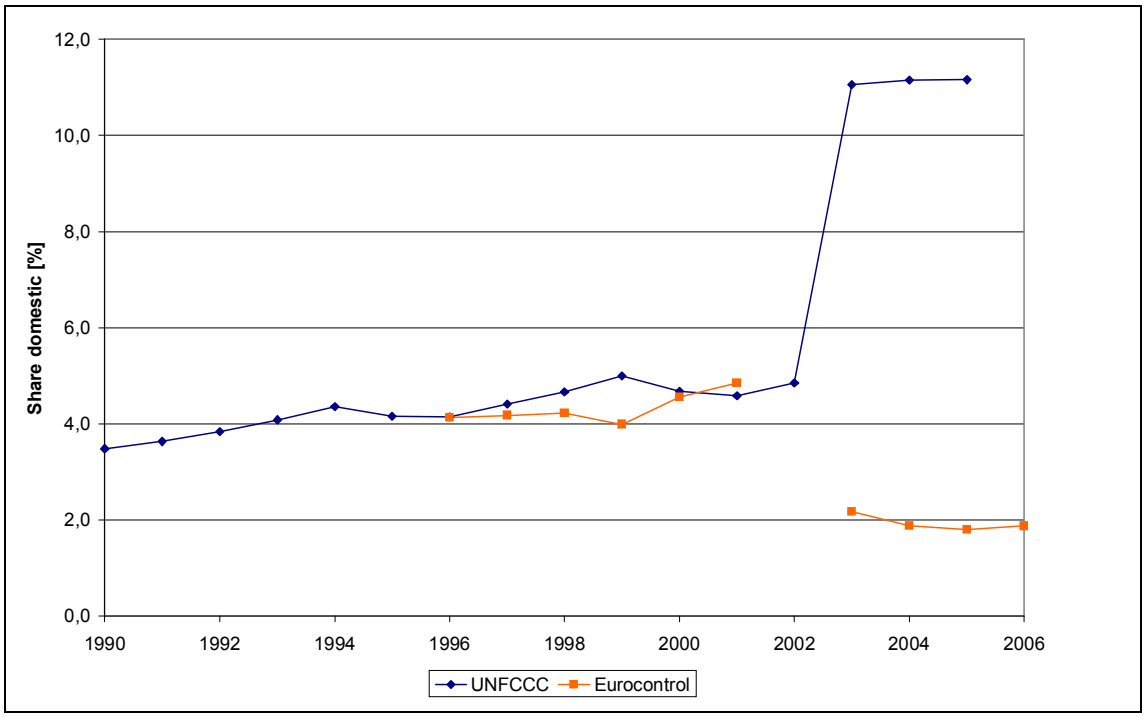
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 5 Total fuel consumption Austria



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 6 Share domestic Austria



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 4: Belgium

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Belgium	2	bottom up and small country	3.157	43.12

Belgium is using Tier 2 to estimate emissions. The split between domestic and international is calculated differently in the two regions: in Flanders the small country approach is followed, in Wallonia bottom-up data from the airports is available. Several errors in the inventory tables were corrected for this comparison (see footnote c in table below).

The relative deviation for domestic aviation emissions is large but does not influence the overall inventory as total emissions from domestic aviation are very low. The differences between Eurocontrol and the Belgium inventory for total fuel consumption are within the uncertainties for most years. Estimates for NO_x are much lower than those prepared by Eurocontrol.

Table A 7 Fuel consumption and CO_2-Emissions Belgium

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR [c]	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996 [a]	1,094	963	12	3,348	3,033	9	9	8	14	0.3	0.3	5
1997	1,179	1,041	12	3,608	3,278	9	8	9	-5	0.2	0.3	-15
1998	1,332	1,146	14	4,074	3,608	11	9	9	2	0.2	0.2	-11
1999	1,484	1,243	16	4,541	3,915	14	12	8	31	0.3	0.2	20
2000	1,525	1,180	23	4,665	3,715	20	12	6	46	0.3	0.2	32
2001 [b]	1,337	903	32	4,221	2,842	33	12	6	52	0.3	0.2	29
2002	2,610			8,233			15			0.2		
2003	1,211	1,004	17	3,828	3,160	17	14	3	75	0.4	0.1	69
2004	1,181	1,016	14	3,727	3,198	14	8	4	54	0.2	0.1	47
2005	1,132	980	13	3,574	3,085	14	9	4	59	0.3	0.1	52
2006		1,019			3,210			5			0.1	

a) For 1995-2005 total fuel consumption is only international fuel consumption; domestic is reported as "IE"
b) From the year 2000 on most or all consumption for aviation bunkers has been reported under "Gasoline"
c) International fuel consumption 1991-1993 has been multiplied with 1000 due to an error in units. For 2001-2005 activity data was not correct or lacking; it has been recalculated using the EF for 2000

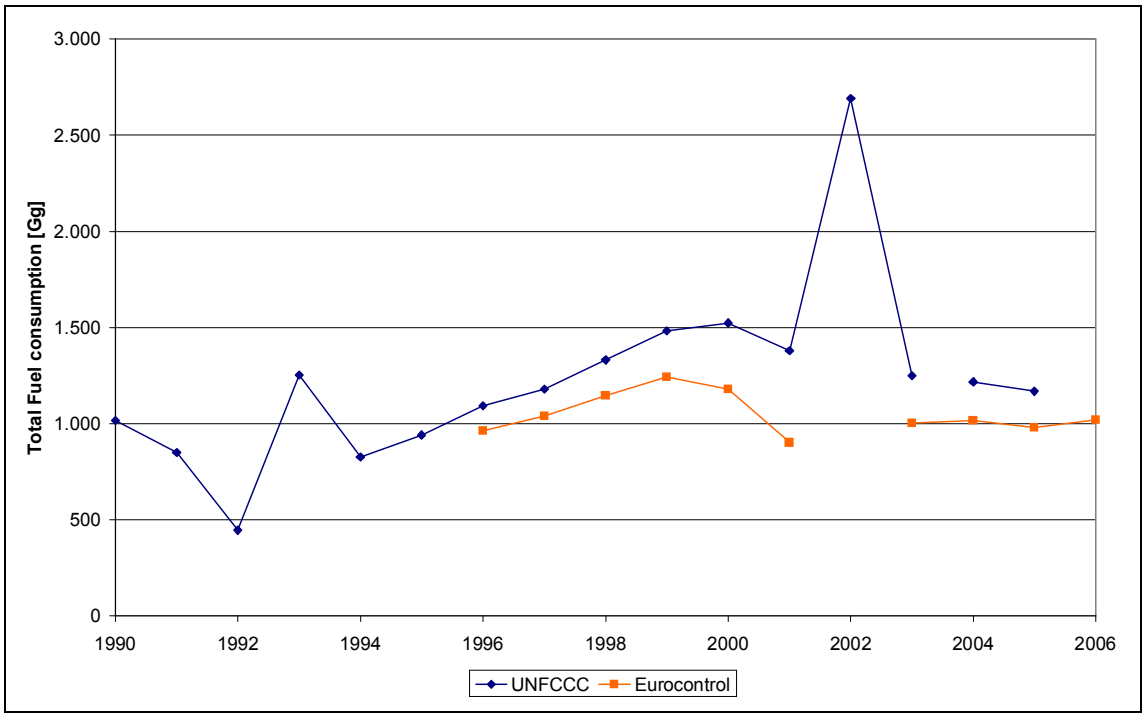
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 8 NO_x-Emissions Belgium

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	3.6	13.3	-265	0.1	0.0	75	3.6	13.3	-271	3.00	13.22	-340
2004	3.7	13.4	-266	0.1	0.0	70	3.6	13.4	-270	3.10	13.19	-325
2005	3.0	12.9	-332	0.1	0.0	69	2.9	12.8	-339	2.63	13.13	-399
2006		13.5			0.0			13.5			13.21	

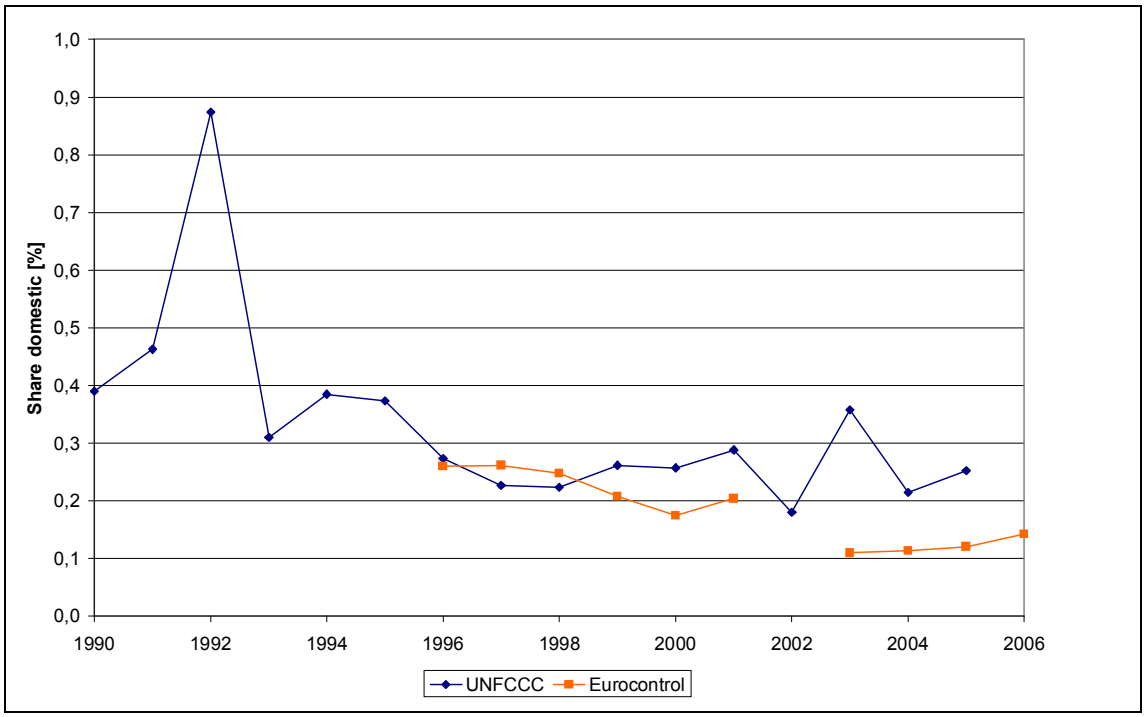
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 7 Total fuel consumption Belgium



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 8 Share domestic Belgium



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 5: Bulgaria

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Bulgaria	1	expert judgement	3.052	43.12

Bulgaria is using a Tier 1 approach and expert judgement to estimate emissions from aviation. Total fuel consumption as well as the share of domestic emissions and NO_x emissions is quite different from Eurocontrol estimates. These discrepancies indicate incomplete data at Eurocontrol or errors in the Bulgarian energy statistic.

Table A 9 Fuel consumption and CO_2-Emissions Bulgaria

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	225			686			214			31.2		
1997	200			611			183			30.0		
1998	199			610			120			19.7		
1999	117			355			35			10.0		
2000	98			302			32			10.6		
2001	144			440			46			10.5		
2002	146			447			48			10.7		
2003	177	96	46	541	304	44	56	4	93	10.4	1.4	87
2004	166	116	30	509	366	28	104	7	94	20.4	1.8	91
2005	194	135	31	592	424	28	120	9	93	20.2	2.0	90
2006		159			499			11			2.2	

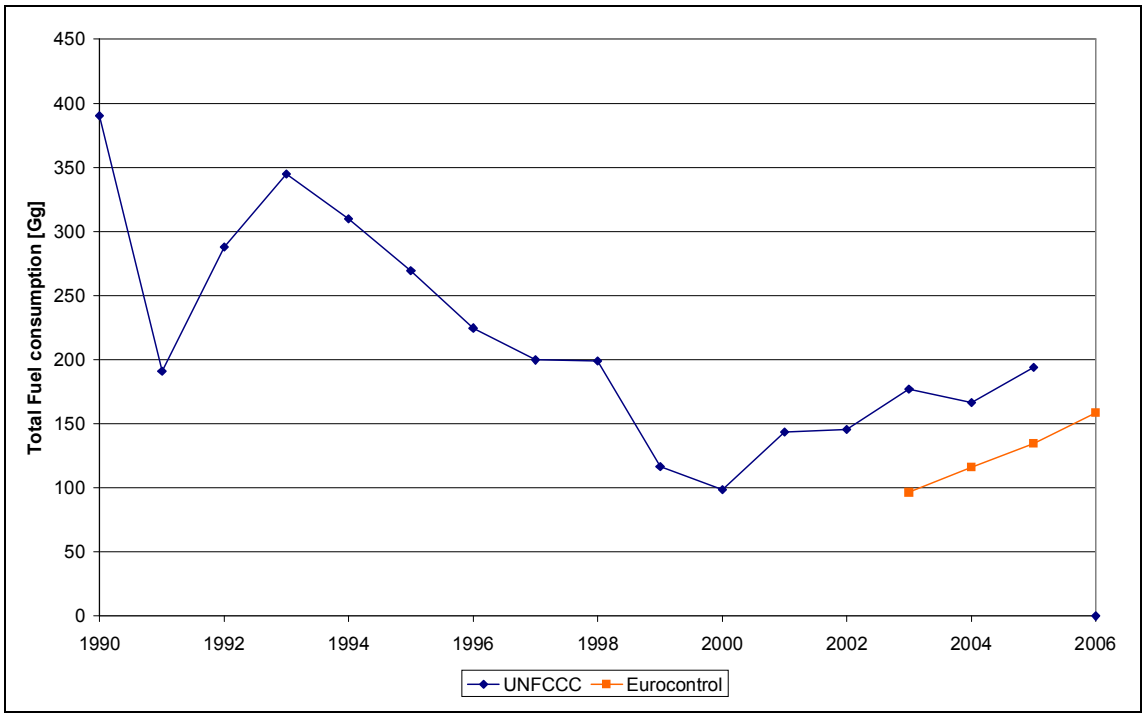
Source: EEA 2007a, Eurocontrol 2007, own calculations

Table A 10 NO_x-Emissions Bulgaria

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	2.2	1.2	45	0.2	0.0	93	1.9	1.2	39	12.22	12.38	-1
2004	2.0	1.4	31	0.4	0.0	94	1.6	1.4	15	12.22	12.14	1
2005	2.4	1.6	32	0.5	0.0	93	1.9	1.6	17	12.21	11.90	3
2006		1.8			0.0			1.8			11.58	

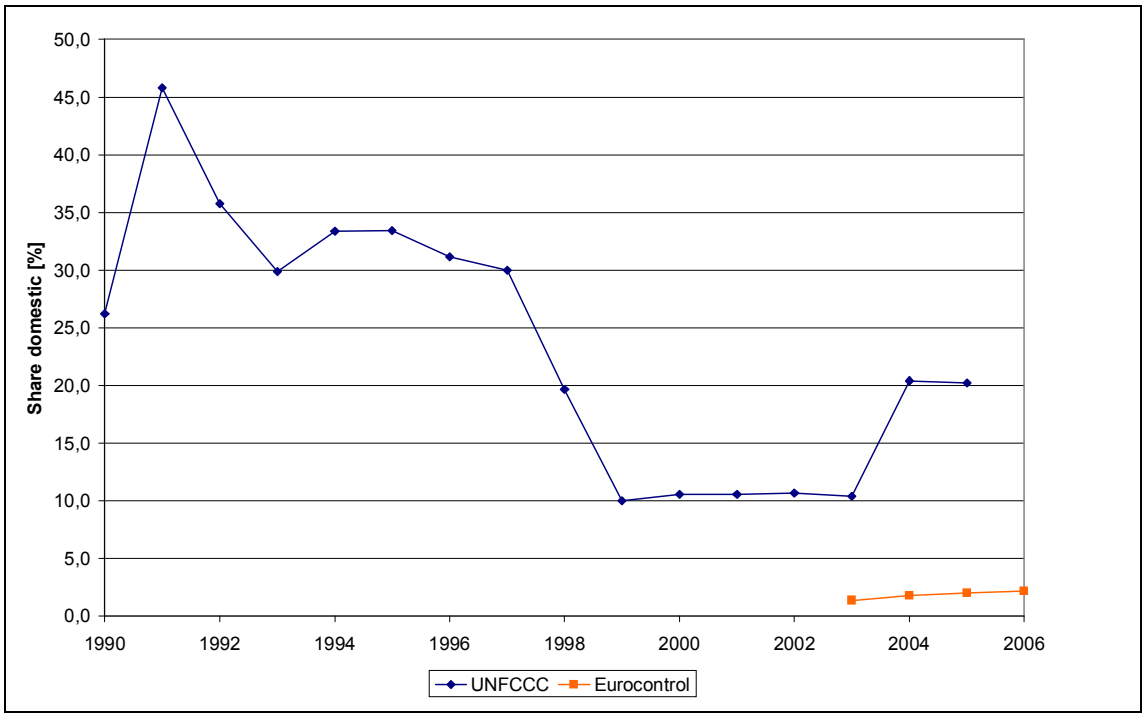
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 9 Total fuel consumption Bulgaria



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 10 Share domestic Bulgaria



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 6: Cyprus

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Cyprus	--	small country	3.157	44.59

Cyprus did not report on the methodology used to estimate emissions. The split between domestic and international aviation has been done according to the small country approach.

Total fuel consumption matches Eurocontrol estimates reasonably well. According to Eurocontrol about 1 % of total jet kerosene consumption should be included under domestic aviation; in absolute terms this affects about 10 kt CO_2/yr.

Table A 11 Fuel consumption and CO_2-Emissions Cyprus

	Total fuel consumption [a]			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	249			786								
1997	245			775								
1998	253			800								
1999	263			829								
2000	287			907								
2001	314			990								
2002	302			954								
2003	332	273	18	1,047	858	18		12			1.4	
2004	295	251	15	930	789	15		11			1.3	
2005	291	265	9	920	834	9		9			1.1	
2006		267			840			9			1.0	
a) Total fuel consumption comprises only international fuel consumption, domestic is reported as "NA"												

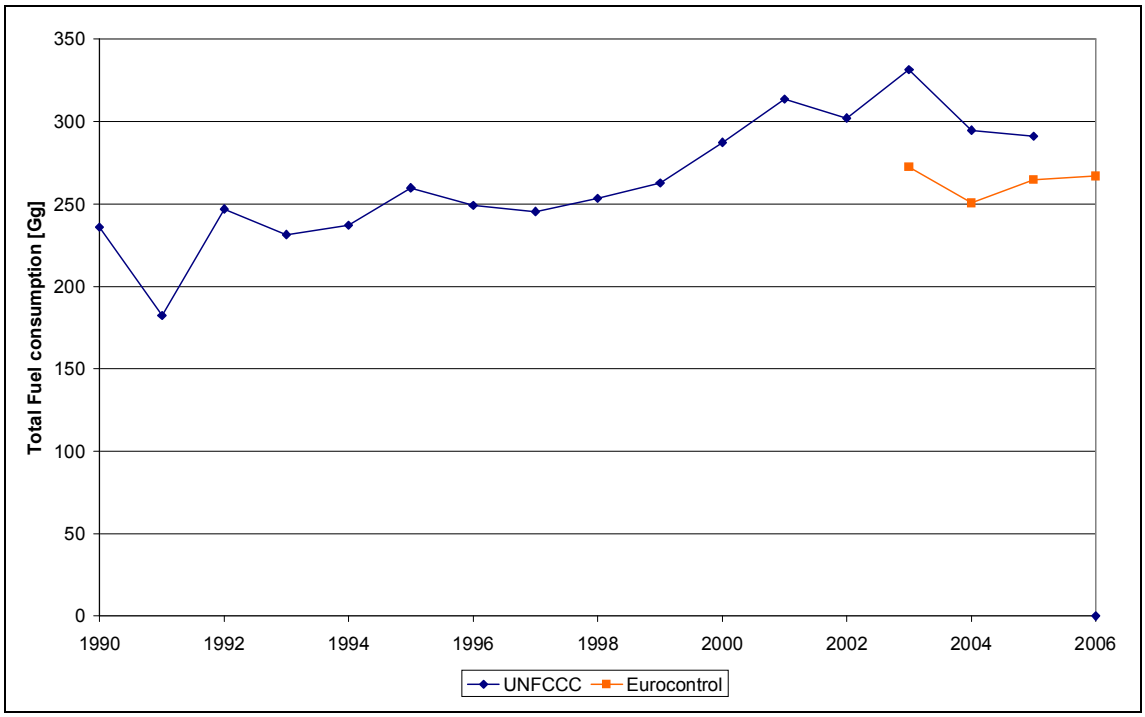
Source: EEA 2007a, Eurocontrol 2007, own calculations

Table A 12 NO_x-Emissions Cyprus

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	3.5	3.6	-1		0.06		3.5	3.5	0.4	10.67	13.17	-23
2004	1.0	3.2	-225		0.06		1.0	3.1	-219	3.29	12.58	-282
2005	1.1	3.3	-204		0.05		1.1	3.3	-200	3.74	12.52	-234
2006		3.4			0.05			3.3			12.58	

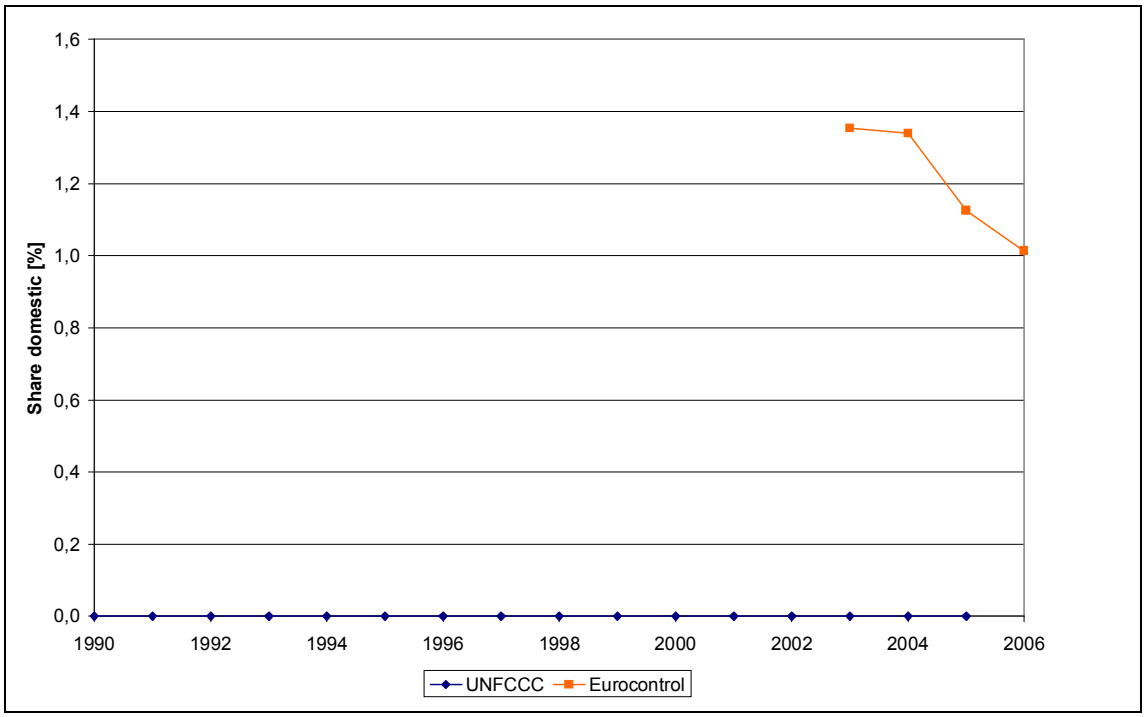
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 11 Total fuel consumption Cyprus



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 12 Share domestic Cyprus



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 7: Czech Republic

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Czech Republic	1	–	3.175	44.59

Emissions from aviation are calculated using Tier 1 in the Czech Republic; the national inventory report 2007 does not contain information on the methodology applied to determine the split between domestic and international aviation.

Total fuel consumption and total CO_2 emissions agree very well between Eurocontrol and the Czech estimates. Domestic CO_2 emissions are overestimated by approximately 90 % according to Eurocontrol estimates. This amounts to about 80 kt CO_2/yr which should not be included in the national inventory but reported as memo item. Estimates for NO_x emissions from international aviation are much lower than those prepared by Eurocontrol.

Table A 13 Fuel consumption and CO_2-Emissions Czech Republic

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	170			556			141			25.4		
1997	170			550			164			29.9		
1998	98			310			85			27.4		
1999	197			623			84			13.5		
2000	139			447			104			23.3		
2001	193			615			131			21.3		
2002	192			612			115			18.9		
2003	216	209	3	690	657	5	93	8	92	13.5	1.2	91
2004	279	277	1	889	871	2	82	12	86	9.2	1.3	85
2005	322	302	6	1,024	950	7	91	9	90	8.9	1.0	89
2006		310			976			11			1.1	

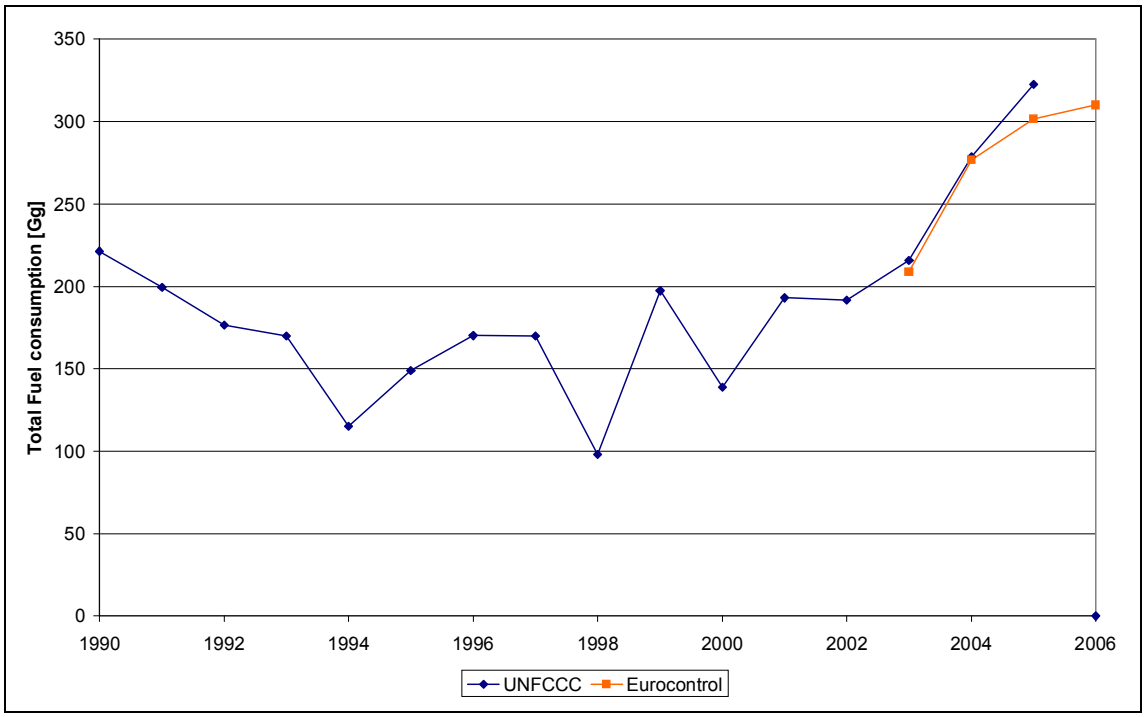
Source: EEA 2007a, Eurocontrol 2007, own calculations

Table A 14 NO_x-Emissions Czech Republic

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003		2.3		0.02	0.0	-10	NE	2.2			10.79	
2004	1.02	3.0	-195	0.03	0.0	-49	1.0	3.0	-198	3.66	10.86	-197
2005	0.94	3.3	-254	0.38	0.0	91	0.6	3.3	-491	2.91	11.02	-279
2006		3.5			0.0			3.5			11.27	

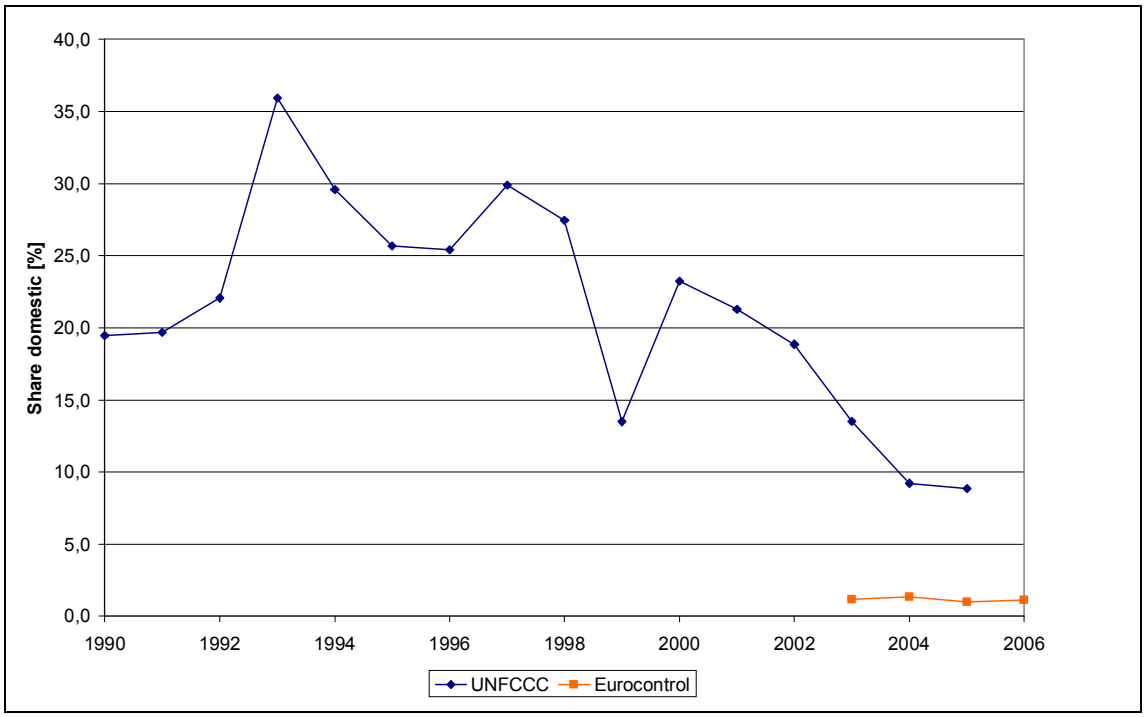
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 13 Total fuel consumption Czech Republic



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 14 Share domestic Czech Republic



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 8: Denmark

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Denmark	3	bottum up	3.220	44.59

Denmark is applying Tier 3 methodologies and bottom-up data to estimate emissions from aviation and to separate domestic and international aviation.

Total fuel consumption and CO_2 emissions are very similar for the entire time series. The share of domestic emissions shows a higher difference but, judging by the graph, it might also be that the Eurocontrol estimates are not consistent over the entire time series. NO_x emissions match those by Eurocontrol very well.

Table A 15 Fuel consumption and CO_2-Emissions Denmark

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	675	651	3	2,176	2,051	6	205	206	0	9.4	10.0	-7
1997	689	681	1	2,222	2,144	4	212	209	1	9.5	9.8	-2
1998	730	701	4	2,353	2,209	6	194	217	-12	8.2	9.8	-19
1999	765	756	1	2,464	2,379	3	174	196	-12	7.1	8.2	-16
2000	777	784	-1	2,504	2,468	1	154	178	-16	6.2	7.2	-17
2001	791	735	7	2,546	2,314	9	161	174	-8	6.3	7.5	-18
2002	683			2,199			140			6.4		
2003	707	680	4	2,279	2,142	6	137	90	34	6.0	4.2	30
2004	800	741	7	2,575	2,332	9	127	74	42	4.9	3.2	36
2005	841	770	8	2,709	2,426	10	133	77	43	4.9	3.2	36
2006		769			2,421			78			3.2	

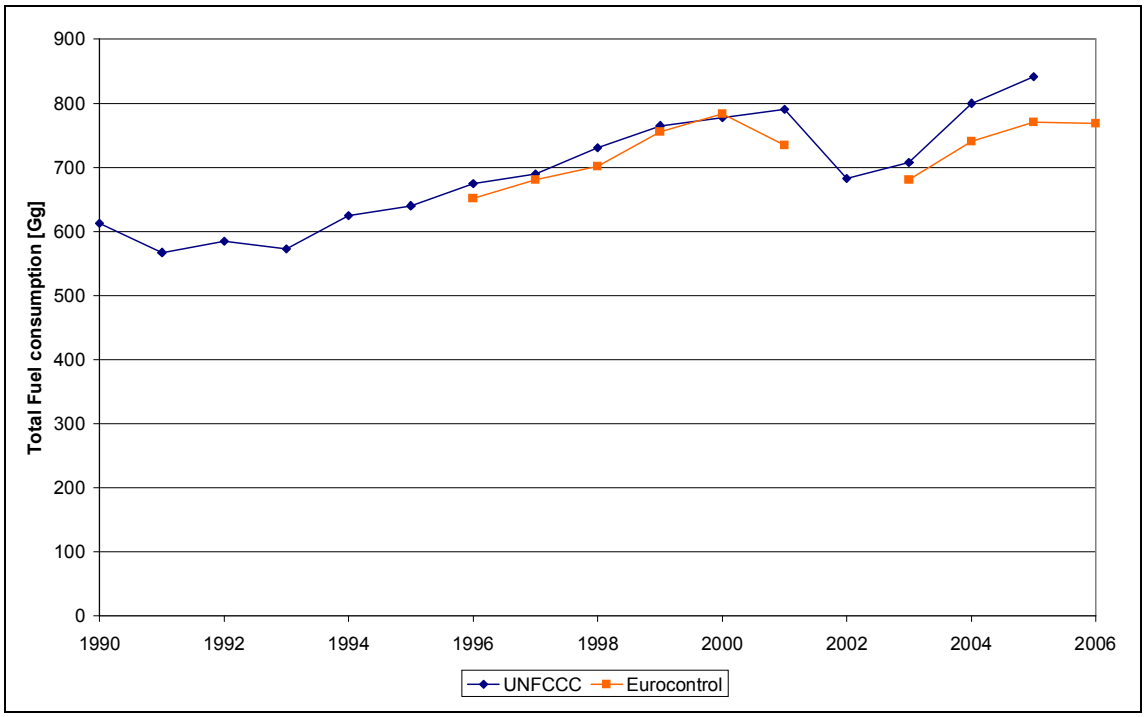
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 16 NO_x-Emissions Denmark

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	9.7	8.9	8	0.6	0.4	37	9.1	8.5	6	13.69	13.05	5
2004	11.0	9.8	12	0.5	0.3	44	10.5	9.5	10	13.79	13.17	4
2005	11.6	10.1	13	0.6	0.3	44	11.0	9.8	11	13.81	13.14	5
2006		10.2			0.3			9.9			13.27	

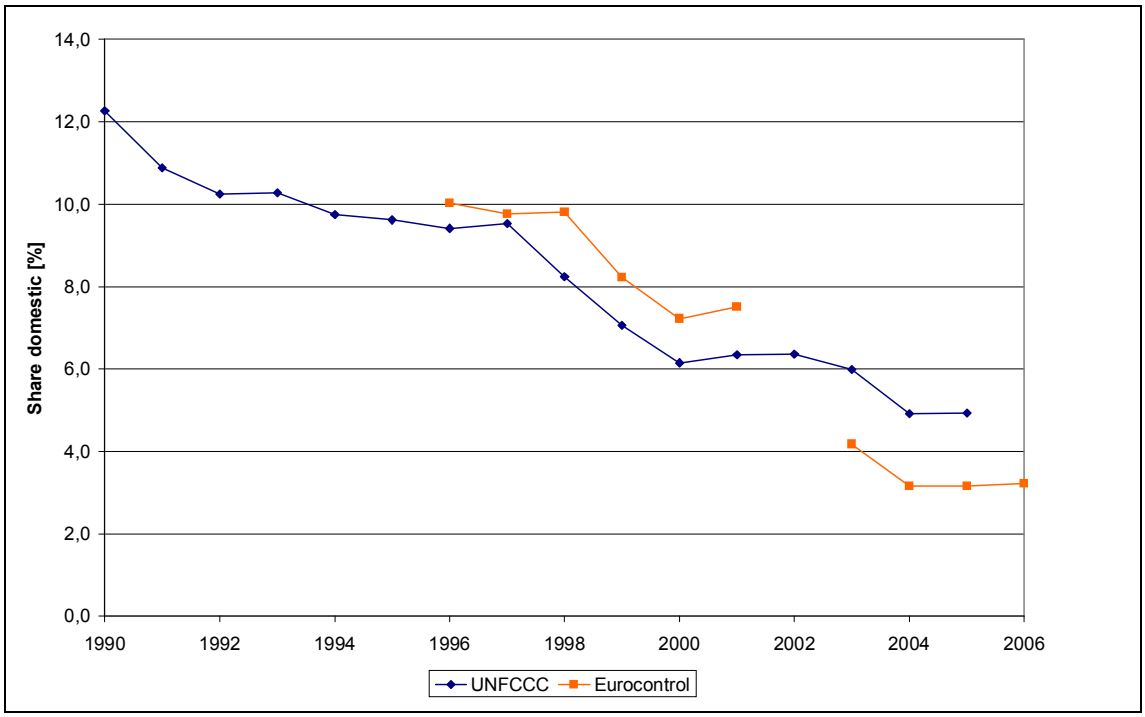
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 15 Total fuel consumption Denmark



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 16 Share domestic Denmark



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 9: Estonia

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Estonia	1	top down	3.188	43.50

In Estonia emissions from aviation are calculated using Tier 1 and top-down data to estimate the split between domestic and international aviation. Eurocontrol is not providing central flow management to the Baltic States and the database only includes flights leaving these countries and going to the west. Taking this into account it is surprising how well the total fuel consumption matches between the two data sets. NO_x estimates show very high differences between the two data sets.

Table A 17 Fuel consumption and CO_2-Emissions Estonia

	Total fuel consumption [a]			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	NE			NE			48					
1997	22			71			6			8.9		
1998	16			50			8			16.8		
1999	22			70			15			21.4		
2000	21			68			7			9.6		
2001	16			52			1			1.1		
2002	19			59			2			4.2		
2003	18	16	12	59	51	13	1	0	97	1.7	0.059	97
2004	29	23	20	92	73	21	2	0	100	2.4	0.004	100
2005	47	34	29	150	106	30	2			1.1		100
2006		37			116			0			0.014	
a) Total fuel consumption and CO_2 emissions 1990-1996 comprise only domestic data (international has not been reported)												

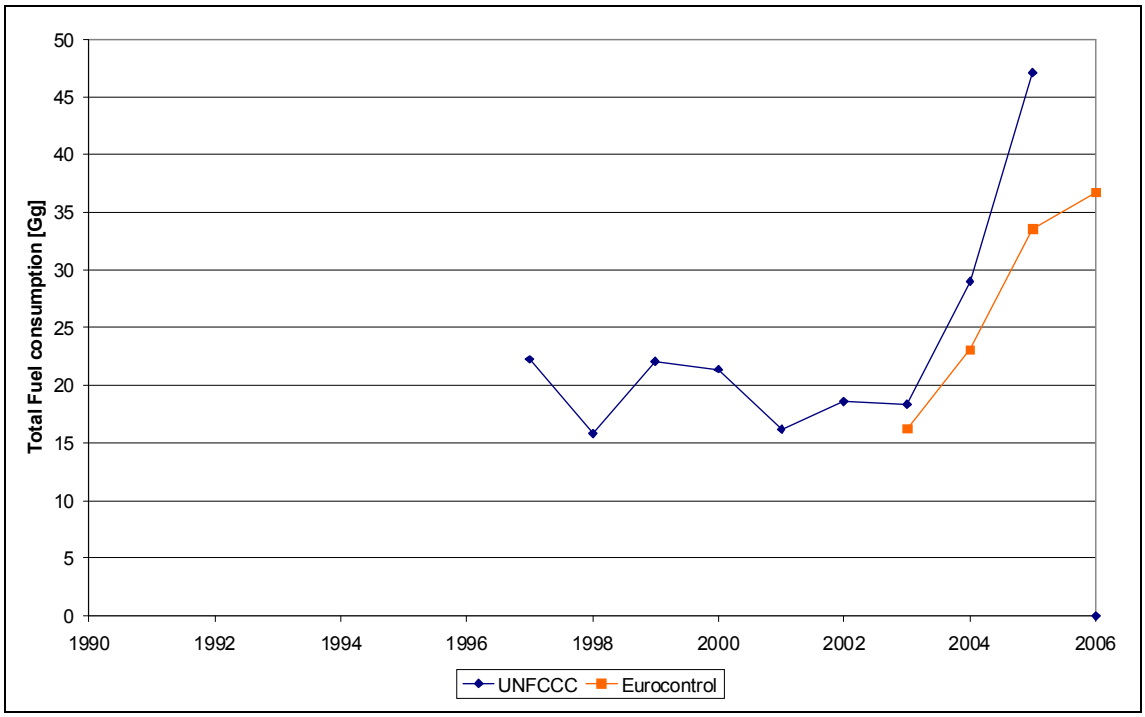
Source: EEA 2007a, Eurocontrol 2007, own calculations

Table A 18 NO_x-Emissions Estonia

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	0.01	0.2	-1,565	0.004			0.01	0.2	-2,904	0.52	9.73	-1,784
2004	0.02	0.2	-1,163	0.009			0.01	0.2	-2,580	0.60	9.58	-1,488
2005	0.02	0.3	-1,508	0.007			0.01	0.3	-2,354	0.44	9.92	-2,156
2006		0.4						0.4			9.94	

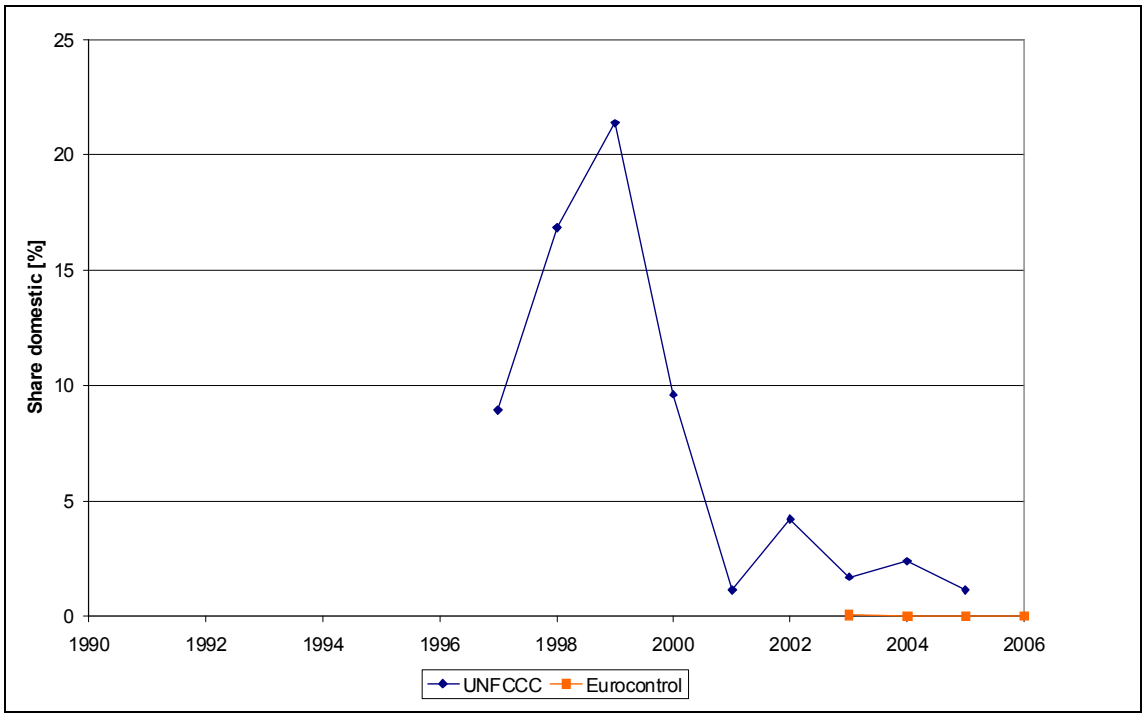
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 17 Total fuel consumption Estonia



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 18 Share domestic Estonia



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 10: Finland

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Finland	3	bottum up	3.175	43.30

Finland is using Tier 3 to estimate aviation fuel consumption and emissions; bottom-up data is applied to separate domestic from international aviation. The results are very consistent with Eurocontrol estimates; one of the reasons might be that Finland already did some quality checks together with Eurocontrol in the past. However estimates for NO_x emissions from international aviation are much lower than those prepared by Eurocontrol.

Table A 19 Fuel consumption and CO_2-Emissions Finland

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	397	370	7	1,265	1,167	8	305	322	-5	24.1	27.6	-14
1997	420	400	5	1,337	1,259	6	339	357	-5	25.4	28.4	-12
1998	443	455	-3	1,409	1,434	-2	387	410	-6	27.5	28.6	-4
1999	465	466	0	1,477	1,468	1	383	404	-5	25.9	27.5	-6
2000	453	476	-5	1,443	1,499	-4	380	413	-9	26.3	27.6	-5
2001	460	423	8	1,462	1,332	9	372	318	15	25.5	23.8	6
2002	441			1,401			323			23.1		
2003	453	421	7	1,440	1,326	8	327	312	5	22.7	23.5	-4
2004	508	472	7	1,614	1,487	8	332	308	7	20.6	20.8	-1
2005	510	483	5	1,619	1,520	6	329	295	10	20.3	19.4	4
2006		510			1,607			266			16.5	

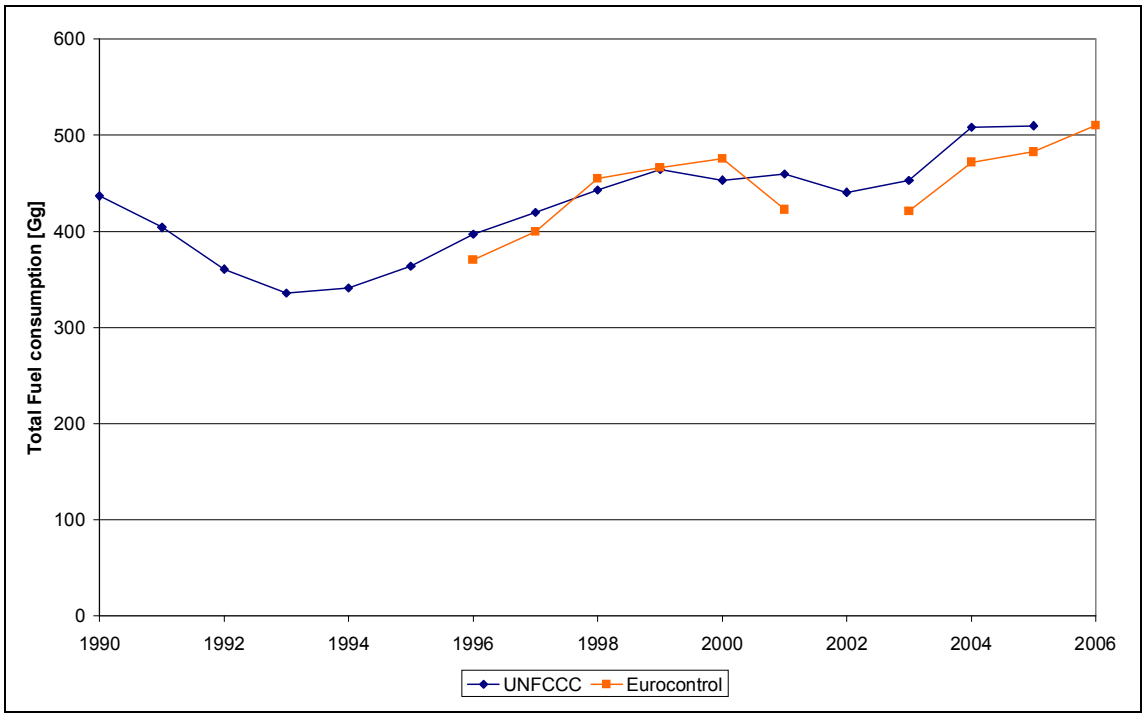
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 20 NO_x-Emissions Finland

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	4.1	5.6	-34	1.2	1.3	-13	3.0	4.2	-43	9.12	13.20	-45
2004	4.5	6.3	-40	1.2	1.3	-12	3.3	5.0	-50	8.86	13.32	-50
2005	4.6	6.5	-41	1.1	1.3	-18	3.5	5.2	-49	8.96	13.37	-49
2006		6.8			1.2			5.7			13.34	

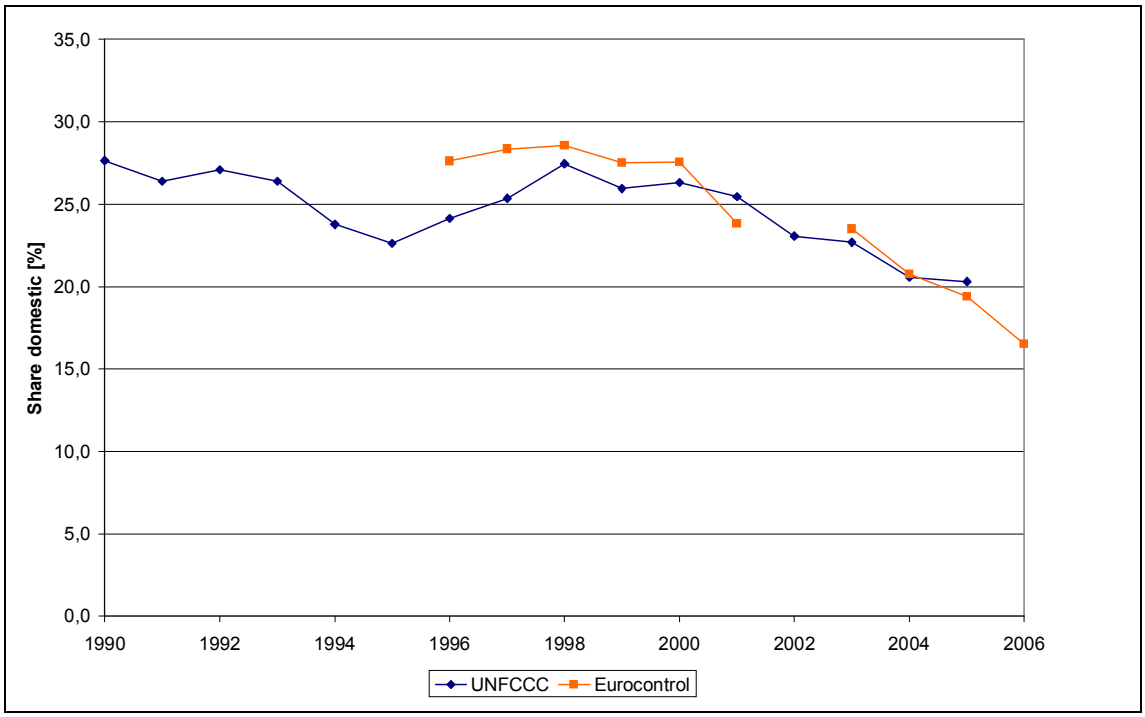
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 19 Total fuel consumption Finland



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 20 Share domestic Finland



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 11: France

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
France	3	bottum up	3.150	44.00

France is using Tier 3 to estimate aviation fuel consumption and emissions; bottom up data is applied to separate domestic from international aviation. The results for total consumption and CO_2 emissions as well as for the domestic share are very consistent with Eurocontrol estimates. Estimates for NO_x emissions are much lower than those prepared by Eurocontrol.

Table A 21 Fuel consumption and CO_2-Emissions France

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	5,306	5,138	3	16,714	16,180	3	5,671	5,761	-2	33.9	35.6	-5
1997	5,446	5,344	2	17,156	16,829	2	5,713	6,004	-5	33.3	35.7	-7
1998	5,789	5,714	1	18,234	17,993	1	6,011	6,227	-4	33.0	34.6	-5
1999	6,245	6,029	3	19,671	18,986	3	5,980	6,285	-5	30.4	33.1	-9
2000	6,449	6,274	3	20,314	19,757	3	6,093	6,603	-8	30.0	33.4	-11
2001	6,298	5,665	10	19,839	17,838	10	5,590	5,937	-6	28.2	33.3	-18
2002	6,270			19,751			5,421			27.4		
2003	6,151	5,615	9	19,376	17,682	9	4,952	4,288	13	25.6	24.2	5
2004	6,469	5,968	8	20,376	18,793	8	4,964	4,364	12	24.4	23.2	5
2005	6,497	6,104	6	20,466	19,223	6	4,830	4,213	13	23.6	21.9	7
2006		6,270			19,743			4,125			20.9	

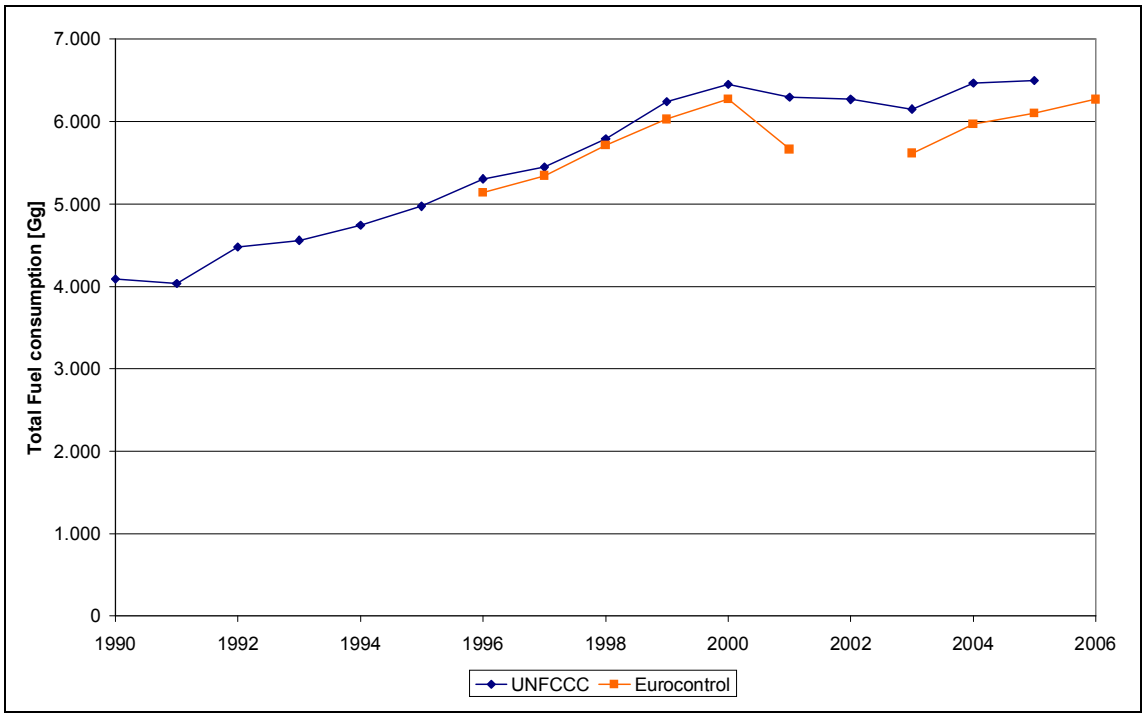
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 22 NO_x-Emissions France

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	47.3	78.7	-67	11.9	19.2	-61	35.4	59.5	-68	7.68	14.02	-82
2004	50.1	83.9	-68	12.1	19.8	-63	37.9	64.1	-69	7.74	14.06	-82
2005	50.4	85.8	-70	11.8	18.8	-60	38.6	67.0	-74	7.76	14.06	-81
2006		87.9			18.3			69.6			14.02	

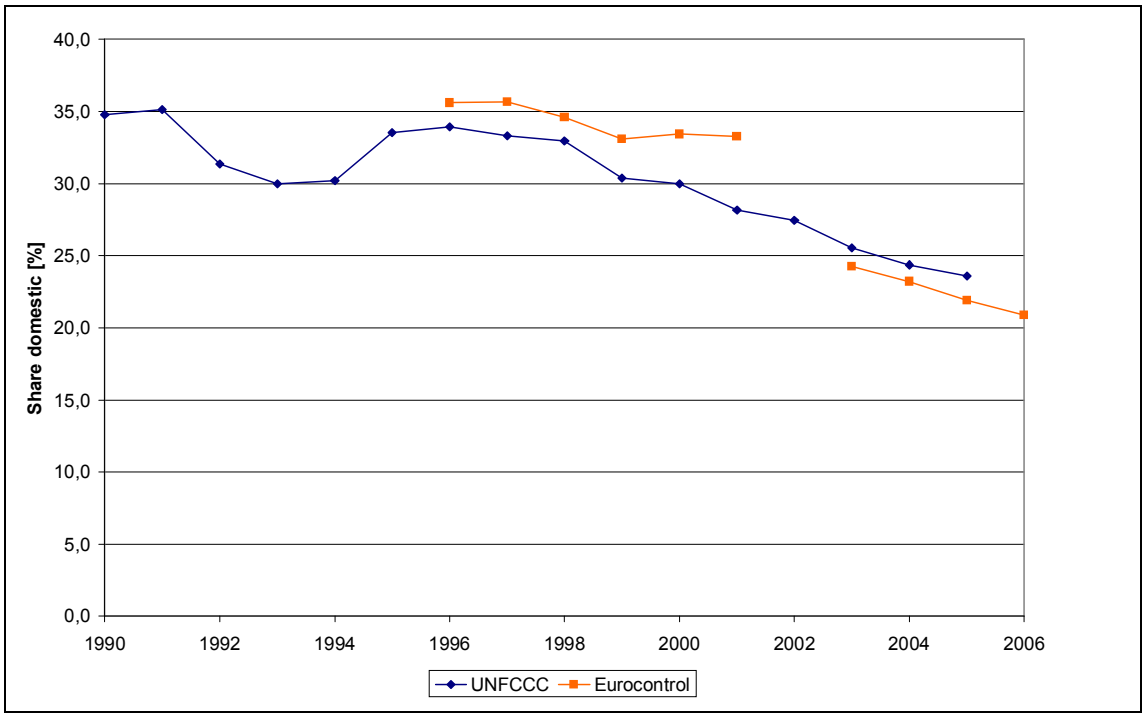
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 21 Total fuel consumption France



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 22 Share domestic France



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 12: Germany

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Germany	1	research project	3.150	43.00

Germany used Tier 1 estimates and results of research projects to estimate emissions from aviation. The research projects were undertaken because the inventory had no access to data that could be used to calculate the split between domestic and international aviation. The research project used passenger numbers in the early 1990s to calculate the split; since then the ratio has remained constant in the inventory.

With the exception of 2001 Eurocontrol estimates are close to German figures for total fuel consumption and CO_2 emissions. The 20 % share for domestic emissions is overestimating domestic emissions by over 3 Mt CO_2 in 2005, almost half of the error of the EU 15 inventory. Germany is working together with Eurocontrol to improve the German greenhouse gas inventory and will update the figures in one of the next inventories (Öko-Institut 2007).

NOx emissions from international aviation match Eurocontrol estimates quite well.

Table A 23 Fuel consumption and CO_2-Emissions Germany

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	5,711	5,578	2	18,171	17,566	3	3,634	2,307	37	20.0	13.1	34
1997	5,930	5,719	4	18,871	18,010	5	3,774	2,439	35	20.0	13.5	32
1998	6,098	5,965	2	19,404	18,783	3	3,881	2,487	36	20.0	13.2	34
1999	6,543	6,307	4	20,820	19,860	5	4,164	2,516	40	20.0	12.7	37
2000	6,939	6,523	6	21,861	20,540	6	4,372	2,610	40	20.0	12.7	36
2001	6,762	5,769	15	21,303	18,166	15	4,261	2,419	43	20.0	13.3	33
2002	6,702			21,114			4,223			20.0		
2003	6,805	6,337	7	21,438	19,956	7	4,288	1,887	56	20.0	9.5	53
2004	6,996	6,886	2	22,040	21,684	2	4,408	1,868	58	20.0	8.6	57
2005	8,049	7,345	9	25,358	23,131	9	5,072	1,929	62	20.0	8.3	58
2006		7,588			23,895			2,012			8.4	

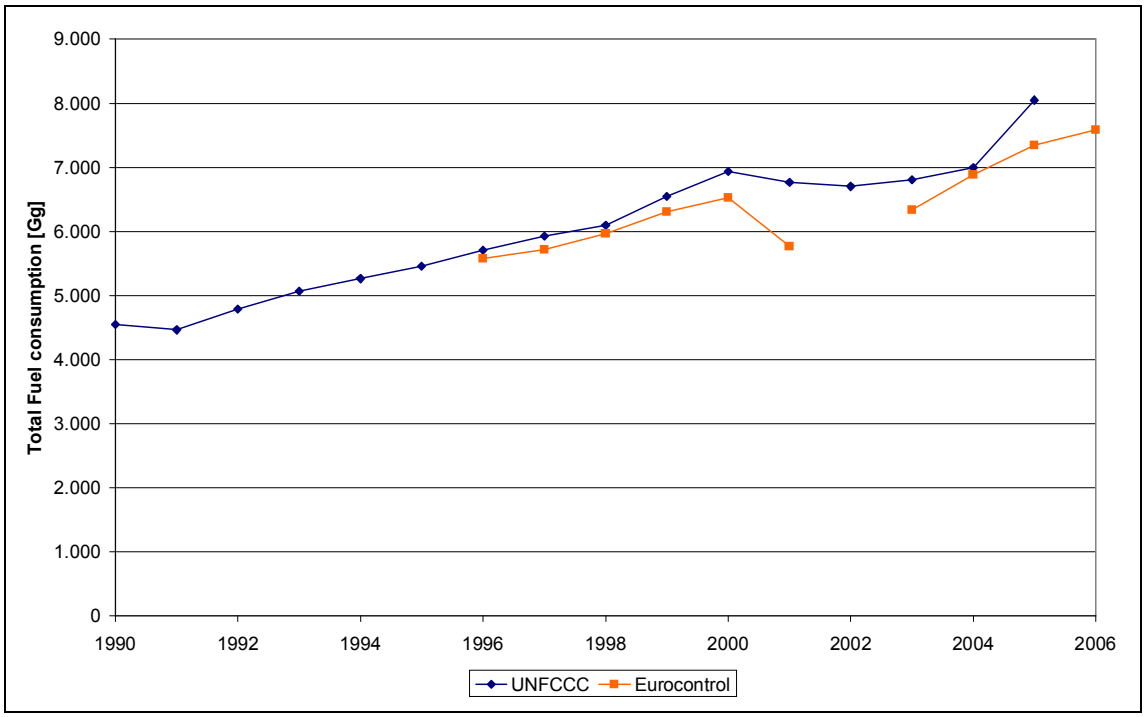
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 24 NO_x-Emissions Germany

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	95.3	85.7	10	19.1	7.5	61	76.2	78.2	-3	14.00	13.53	3
2004	97.9	93.5	5	19.6	7.4	62	78.4	86.1	-10	14.00	13.58	3
2005	112.7	99.9	11	22.5	7.6	66	90.1	92.4	-2	14.00	13.61	3
2006		103.1			7.9			95.2			13.58	

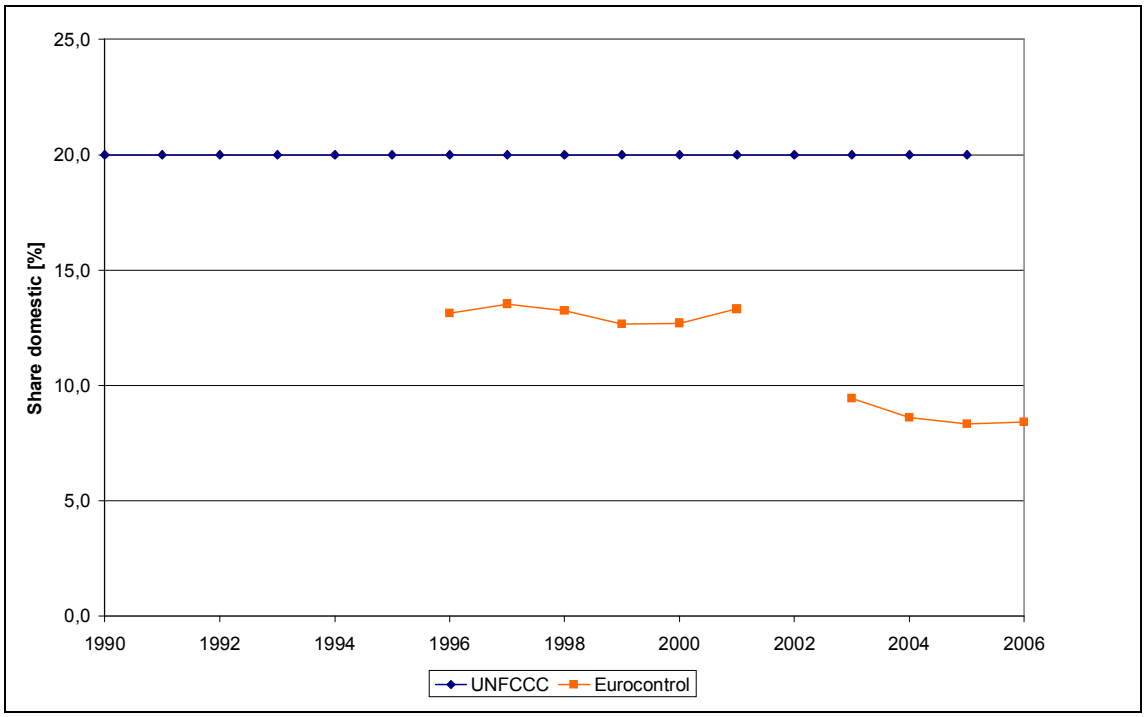
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 23 Total fuel consumption Germany



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 24 Share domestic Germany



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 13: Greece

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Greece	2	bottum up	3.191	44.59

Greece is applying Tier 2 and bottom-up data to estimate and separate emissions from aviation. The deviation for total fuel consumption is higher than should be expected; Greece statistics show a 20 % to 30 % higher fuel consumption than Eurocontrol estimates. Greece domestic emissions emissions are significantly higher; Eurocontrol calculates less than half of the Greece estimates. This results in approximately 800 kt CO_2/yr which are included in the national inventory but should have been reported under memo items if Eurocontrol estimates are correct.

According to NO_x emissions are in general higher than those of Eurocontrol in accordance with the higher Greek fuel consumption estimates; only the estimate for NO_x emissions from international aviation in 2005 is hardly explainable.

Table A 25 Fuel consumption and CO_2-Emissions Greece

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	1,180	929	21	3,772	2,924	22	1,274	429	66	33.8	14.7	57
1997	1,135	919	19	3,640	2,893	21	1,224	407	67	33.6	14.1	58
1998	1,149	948	17	3,681	2,986	19	1,145	361	68	31.1	12.1	61
1999	1,243	1,066	14	3,937	3,356	15	1,089	504	54	27.7	15.0	46
2000	1,273	1,070	16	4,062	3,368	17	1,564	501	68	38.5	14.9	61
2001	1,141	639	44	3,653	2,011	45	1,331	143	89	36.4	7.1	81
2002	1,106			3,539			1,218			34.4		
2003	1,309	938	28	4,186	2,953	29	1,164	355	69	27.8	12.0	57
2004	1,356	966	29	4,333	3,042	30	1,227	429	65	28.3	14.1	50
2005	1,136	928	18	3,626	2,922	19	1,238	385	69	34.2	13.2	61
2006		1,006			3,168			396			12.5	

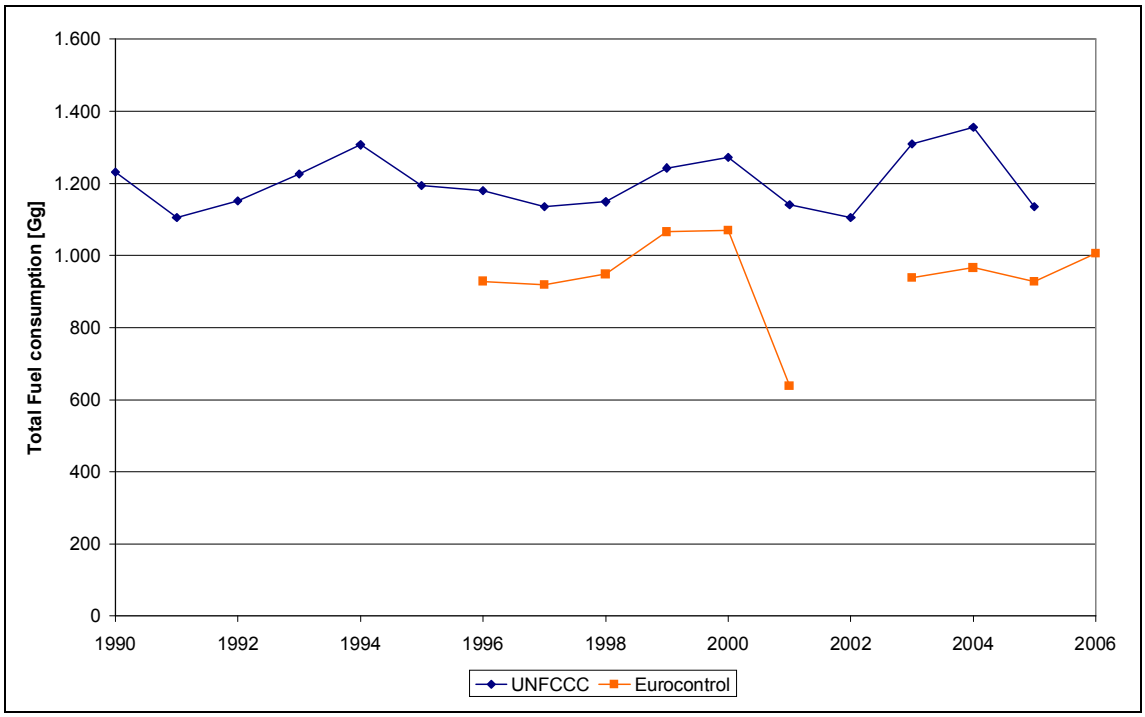
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 26 NO_x-Emissions Greece

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	21.4	11.4	47	3.5	1.2	65	17.9	10.2	43	16.32	12.16	25
2004	22.1	11.7	47	3.7	1.5	60	18.4	10.2	45	16.26	12.06	26
2005	14.1	11.3	20	4.5	1.3	71	9.6	10.0	-4	12.40	12.14	2
2006		12.2			1.3			10.9			12.14	

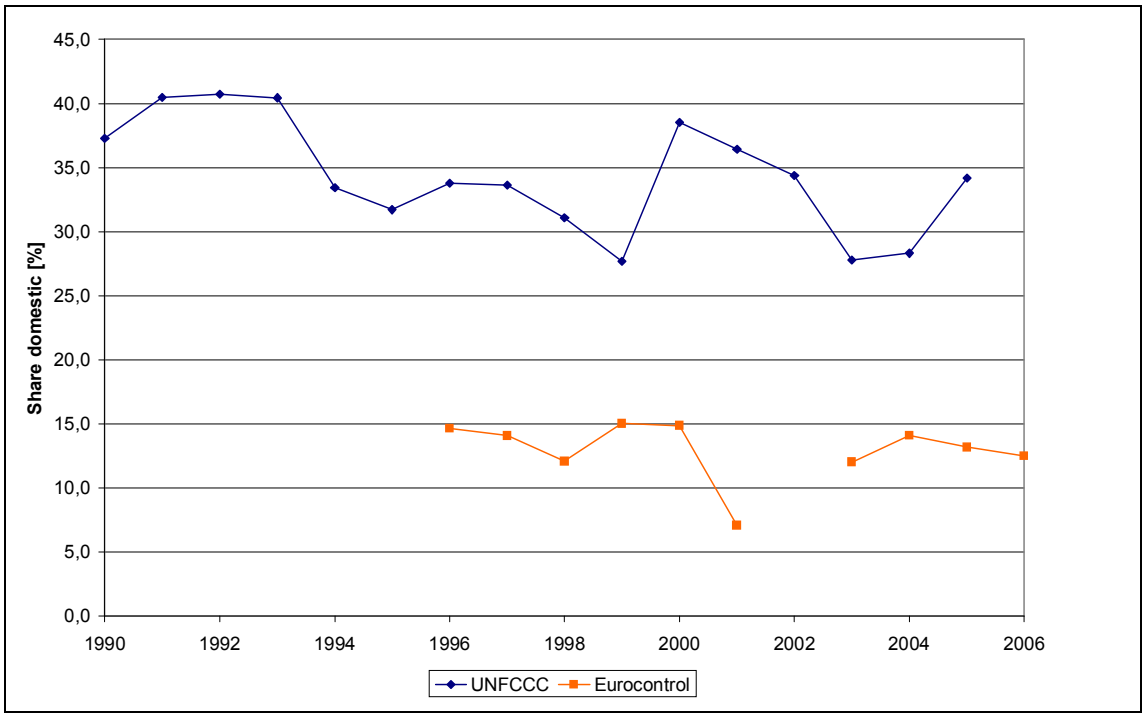
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 25 Total fuel consumption Greece



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 26 Share domestic Greece



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 14: Hungary

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Hungary	1	small country	3.156	44.59

Emissions and fuel burn from aviation are calculated using Tier 1; Hungary applies the small country approach to separate domestic and international aviation. Total fuel burn and CO_2 emissions are just within the uncertainty range. According to Eurocontrol domestic emissions are approximately 1 kt CO_2/yr, a value which justifies the small country approach. Differences in the NO_x estimates are well above 500 %. The deviation of NO_x emissions is very high.

Table A 27 Fuel consumption and CO_2-Emissions Hungary

	Total fuel consumption [a]			CO_2 emissions [a]						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	177			560			IE,NO					
1997	168			531			IE,NO					
1998	176			556			IE,NO					
1999	189			596			IE,NO					
2000	201			641			7			1.2		
2001	170			545			6			1.2		
2002	183			577			IE,NO					
2003	187	161	14	592	506	15	IE,NO	0			0.1	
2004	193	207	-7	609	652	-7	IE,NO	1			0.1	
2005	210	246	-17	663	775	-17	IE,NO	1			0.1	
2006		255			803			2			0.2	

a) Total fuel consumption (1990-2005) and CO_2 emissions (1990-99 and 2002-2005) only include international emissions

Source: EEA 2007a, Eurocontrol 2007, own calculations

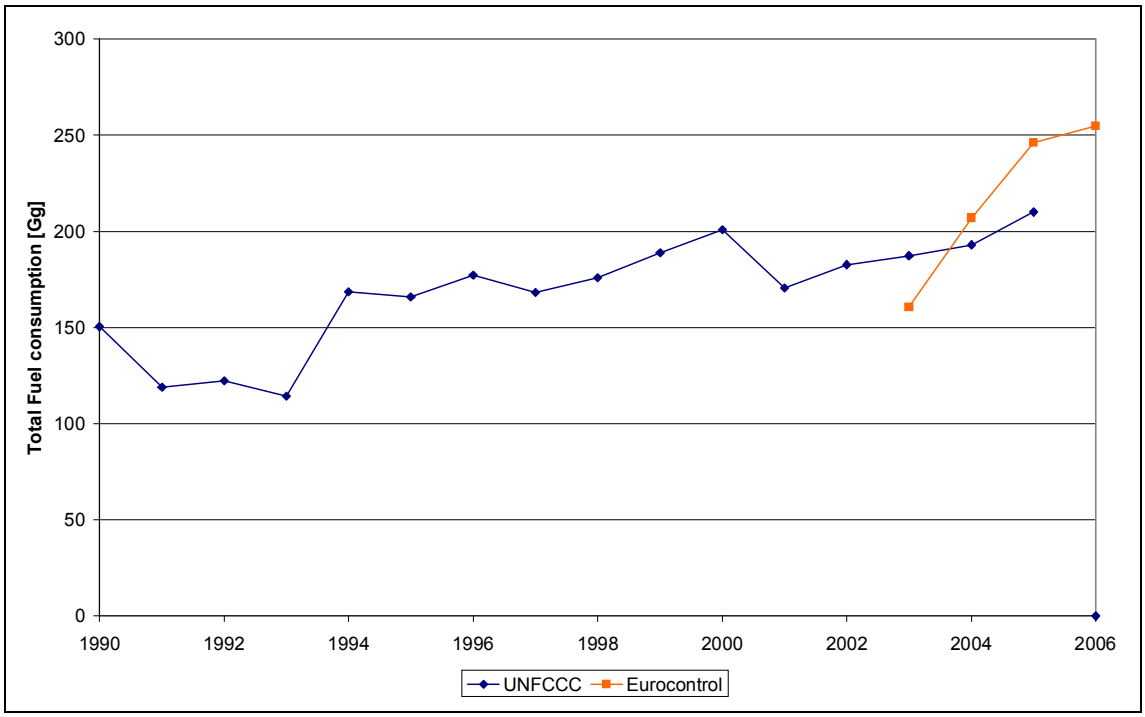
Table A 28 NO_x-Emissions Hungary

	NO_x Emissions									Implied Emission Factor NO_x		
	Total [a]			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	0.3	1.8	-588	IE	0.002		0.3	1.8	-588	1.38	11.10	-703
2004	0.3	2.3	-769	IE	0.002		0.3	2.3	-768	1.38	11.19	-710
2005	0.3	2.8	-853	IE	0.003		0.3	2.8	-852	1.38	11.25	-714
2006		2.9			0.005			2.9			11.33	

a) Total NO_x emissions only include international emissions

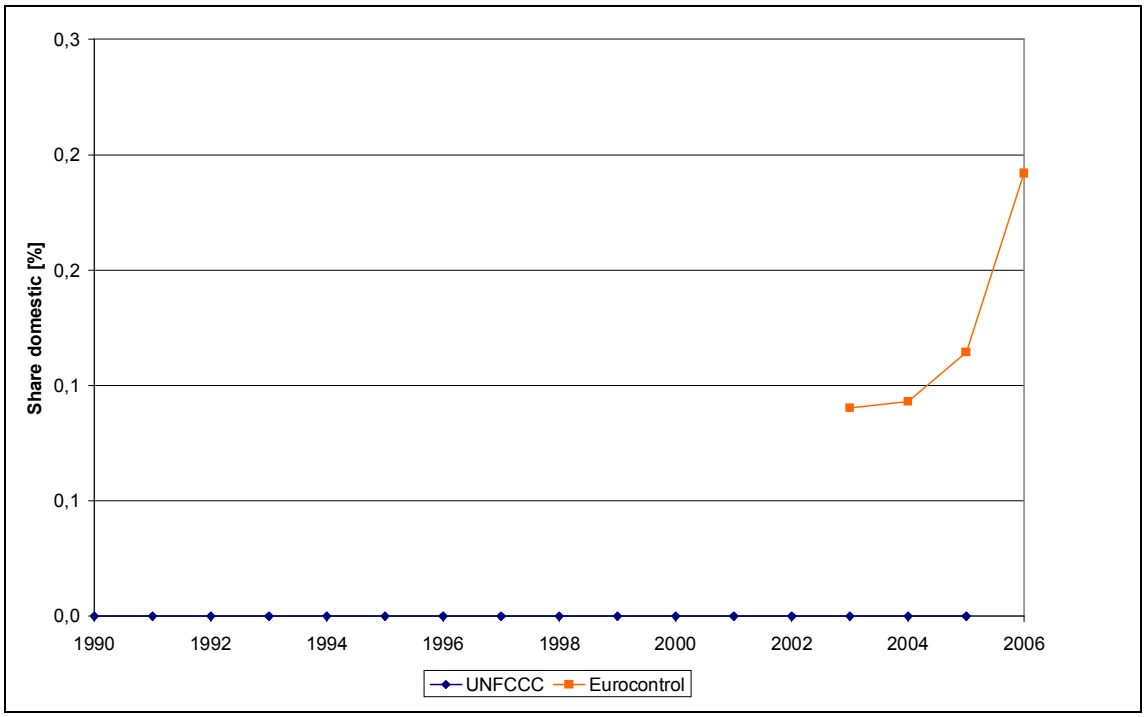
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 27 Total fuel consumption Hungary



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 28 Share domestic Hungary



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 15: Ireland

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Ireland	2	bottum up	3.147	44.10

Ireland uses Tier 2 and bottom-up data to calculate the emissions. Emissions for the years 1996 – 2000 are closer to Eurocontrol estimates than for the other years. The value for 2001 shows the largest difference; this can also be observed in other countries (e.g. Germany and Greece) and seems to be a problem with the Eurocontrol estimates. It has to be remembered that Eurocontrol is not confident about the quality of the estimates for the years before 2003 anymore. With a few exceptions the share of domestic emissions is quite similar in both estimates. Compared to other countries the difference between the Irish and the European wide NO_x estimates is relatively small and 'just' at 25 % to 75 %.

Table A 29 Fuel consumption and CO_2-Emissions Ireland

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	351	407	-16	1,107	1,283	-16	67	51	25	6.1	4.0	35
1997	422	430	-2	1,331	1,354	-2	72	66	9	5.4	4.8	11
1998	436	473	-8	1,375	1,489	-8	83	84	-2	6.0	5.7	6
1999	515	567	-10	1,624	1,786	-10	88	94	-7	5.4	5.3	2
2000	597	557	7	1,882	1,754	7	99	100	-1	5.3	5.7	-9
2001	717	485	32	2,260	1,528	32	112	74	34	5.0	4.8	3
2002	761			2,398			108			4.5		
2003	744	536	28	2,345	1,689	28	106	68	35	4.5	4.0	10
2004	705	543	23	2,222	1,710	23	108	66	39	4.9	3.9	20
2005	814	624	23	2,562	1,964	23	108	70	35	4.2	3.6	15
2006		706			2,223			83			3.8	

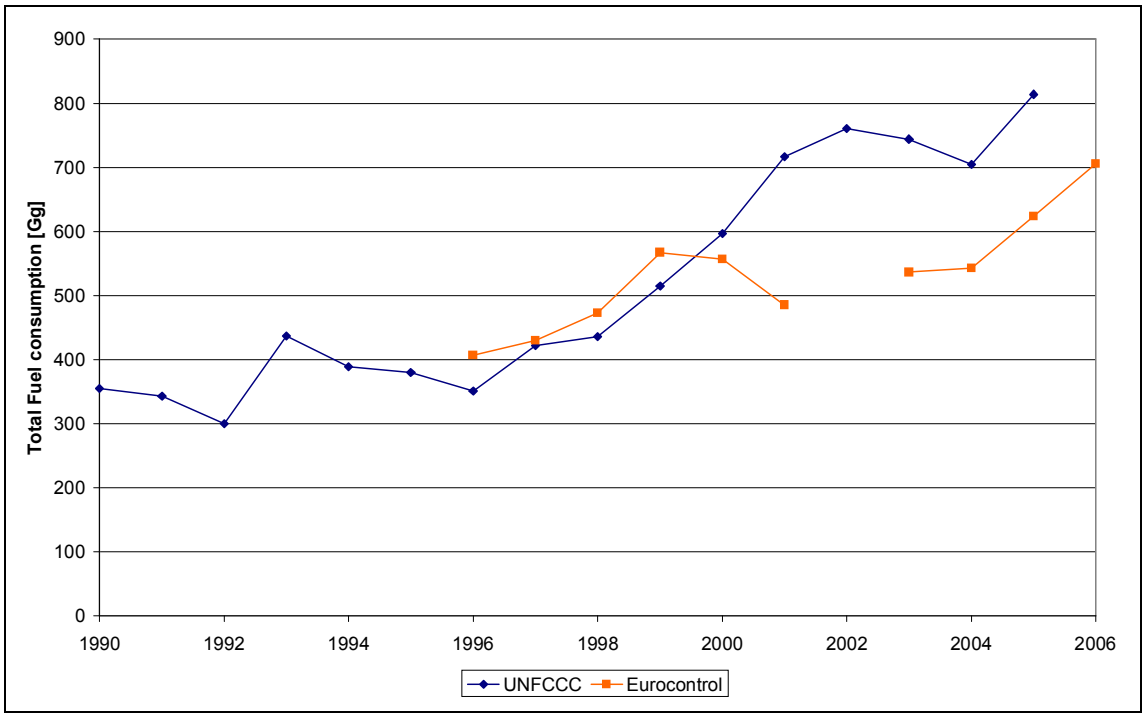
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 30 NO_x-Emissions Ireland

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	5.3	6.6	-24	0.2	0.4	-59	5.1	6.3	-23	7.18	12.36	-72
2004	5.2	6.7	-29	0.2	0.4	-57	5.0	6.3	-28	7.35	12.34	-68
2005	5.8	7.8	-34	0.2	0.4	-66	5.6	7.4	-32	7.18	12.53	-75
2006		8.9			0.4			8.4			12.54	

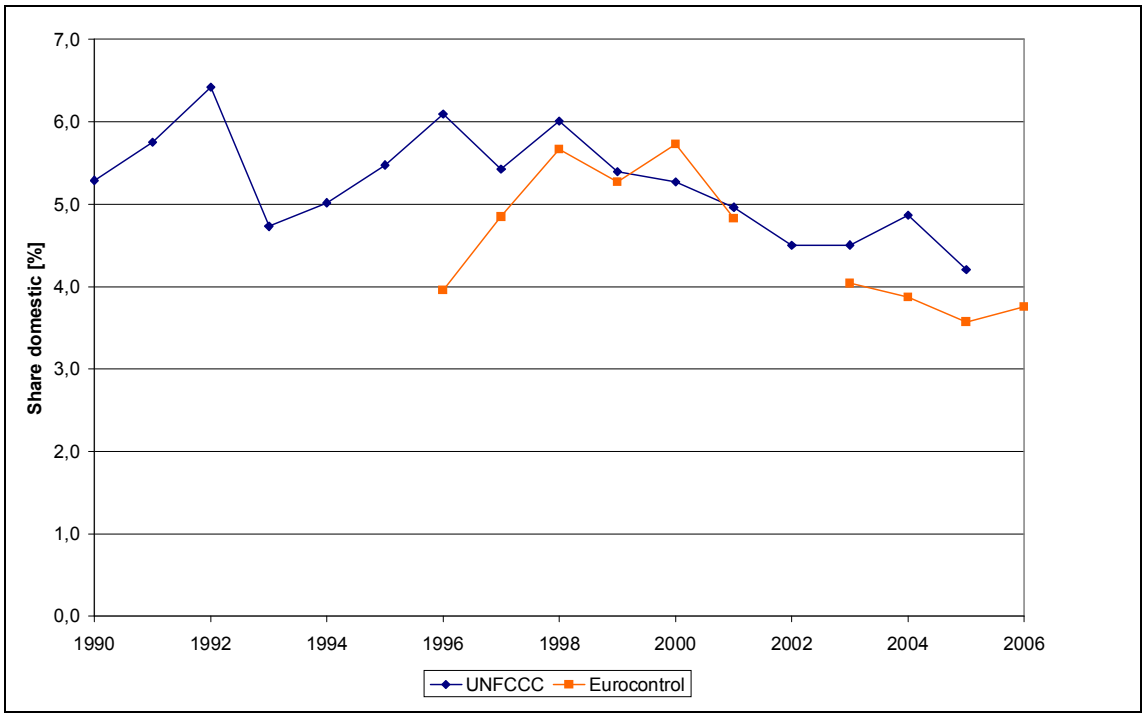
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 29 Total fuel consumption Ireland



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 30 Share domestic Ireland



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 16: Italy

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Italy	2	research project	2.971	41.84

Italy calculates emissions from aviation using the Tier 2 approach; a research project has been used to determine the split between domestic and international aviation.

The trend for total fuel consumption, total CO_2 emissions as well as for the share of domestic aviation follows the same pattern in both data sets. Italy uses a very low heat value compared to other countries; this helps to reduce the gap of approximately 9 % in the total fuel burn to approximately 3 % for the total CO_2 emissions. Eurocontrol consistently calculates an approximately 9 % higher share of domestic aviation. The estimates for NO_x are quite consistent.

Table A 31 Fuel consumption and CO_2-Emissions Italy

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	2,667	2,444	8	7,910	7,696	3	1,894	2,105	-11	23.9	27.4	-14
1997	2,758	2,516	9	8,181	7,923	3	2,047	2,192	-7	25.0	27.7	-11
1998	2,998	2,677	11	8,894	8,431	5	2,228	2,279	-2	25.1	27.0	-8
1999	3,330	2,972	11	9,884	9,358	5	2,570	2,580	0	26.0	27.6	-6
2000	3,554	3,188	10	10,551	10,038	5	2,716	2,810	-3	25.7	28.0	-9
2001	3,243	2,937	9	9,634	9,249	4	2,580	2,695	-4	26.8	29.1	-9
2002	3,243			9,634			2,677			27.8		
2003	3,642	3,329	9	10,826	10,482	3	2,772	3,046	-10	25.6	29.1	-13
2004	3,613	3,462	4	10,736	10,901	-2	2,668	2,909	-9	24.9	26.7	-7
2005	3,768	3,622	4	11,195	11,407	-2	2,652	2,866	-8	23.7	25.1	-6
2006		3,783			11,912			2,970			24.9	

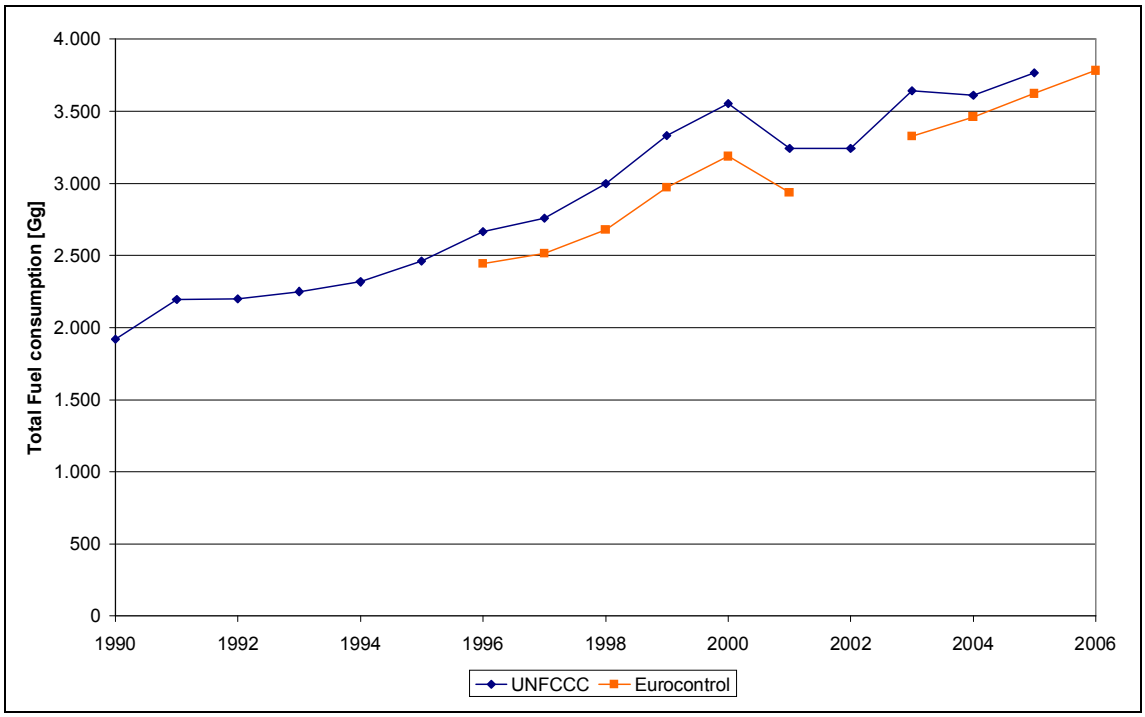
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 32 NO_x-Emissions Italy

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	59.9	43.7	27	12.5	12.7	-2	47.5	31.0	35	16.46	13.13	20
2004	62.0	45.4	27	12.0	12.2	-1	50.0	33.3	33	17.16	13.13	23
2005	64.9	47.4	27	11.9	11.9	0	52.9	35.4	33	17.21	13.08	24
2006		49.4			12.3			37.1			13.06	

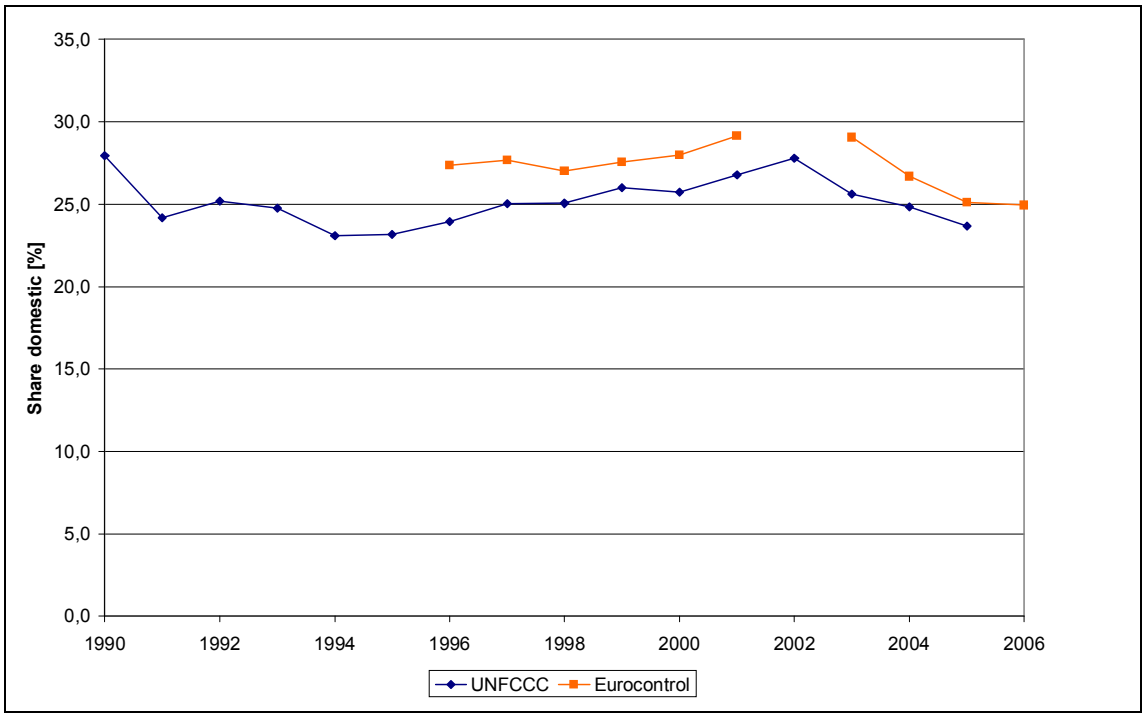
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 31 Total fuel consumption Italy



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 32 Share domestic Italy



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 17: Latvia

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Latvia	1	research project	3.222	44.59

In Latvia emissions from aviation are calculated using Tier 1; a research project has been undertaken to determine the split between domestic and international aviation. Eurocontrol is not providing central flow management to the Baltic States and the database only includes flights leaving these countries and going to the west. This explains that Latvian estimates for the years 2003 to 2005 are considerably higher than Eurocontrol calculations. NO_x estimates show very high differences between the two data sets.

Table A 33 Fuel consumption and CO_2-Emissions Latvia

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	31			100			1			0.7		
1997	31			101			1			0.9		
1998	28			91			1			1.3		
1999	28			92			1			1.5		
2000	26			83			2			2.0		
2001	26			83			2			2.3		
2002	27			86			2			2.4		
2003	38	17	56	124	54	57	2	0	100	1.8	0.00	100
2004	46	30	35	149	94	37	2	0	100	1.6	0.00	100
2005	56	51	9	180	160	11	2	0	100	1.4	0.00	100
2006		63			198			0			0.01	

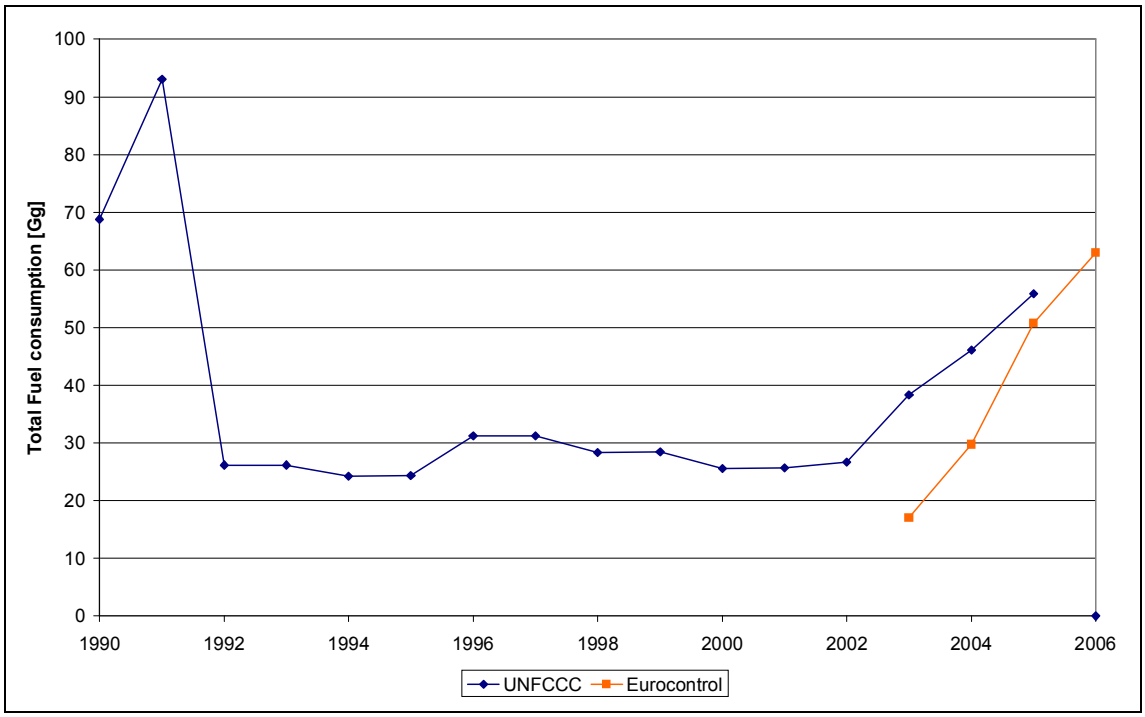
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 34 NO_x-Emissions Latvia

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	0.4	0.2	56	0.01			0.4	0.2	55	11.18	11.05	1
2004	0.5	0.3	40	0.01			0.5	0.3	39	11.18	10.42	7
2005	0.6	0.5	16	0.01			0.6	0.5	15	11.18	10.30	8
2006		0.6						0.6			10.27	

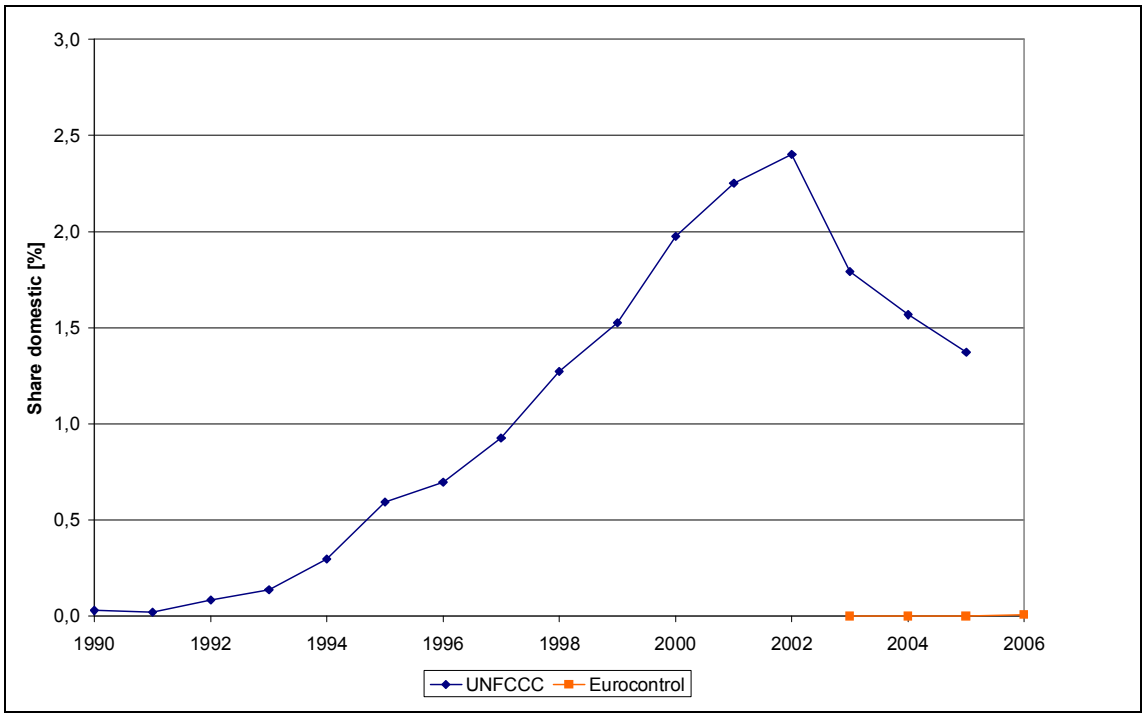
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 33 Total fuel consumption Latvia



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 34 Share domestic Latvia



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 18: Lithuania

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Lithuania	1	small country	3.335	44.59

In Lithuania emissions from aviation are calculated using Tier 1; according to the small country approach most emissions are included in the international aviation sector. Eurocontrol is not providing central flow management to the Baltic States and the database only includes flights leaving these countries and going to the west. Taking this into account it is surprising that Eurocontrol estimates are twice as high as Lithuanian calculations in 2004. The consistency in 2003 and 2005 is quite good and the 2004 value might be due to an error in the calculations or statistics either at Eurocontrol or in Lithuania.

Table A 35 Fuel consumption and CO_2-Emissions Lithuania

	Total fuel consumption [a]			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	32			107			1			0.6		
1997	32			107			1			0.9		
1998	27			90			1			1.3		
1999	24			82			1			1.2		
2000	24			81			1			1.2		
2001	11			106			2			1.5		
2002	14			94			2			1.7		
2003	22	22	-1	101	69	32	2	0	100	1.6	0.0	100
2004	14	30	-107	120	94	22	2	0	100	1.3	0.0	100
2005	47	39	16	157	124	21	1	0	100	0.9	0.0	100
2006		49			154			1			0.5	

a) Total fuel consumption only include international emissions

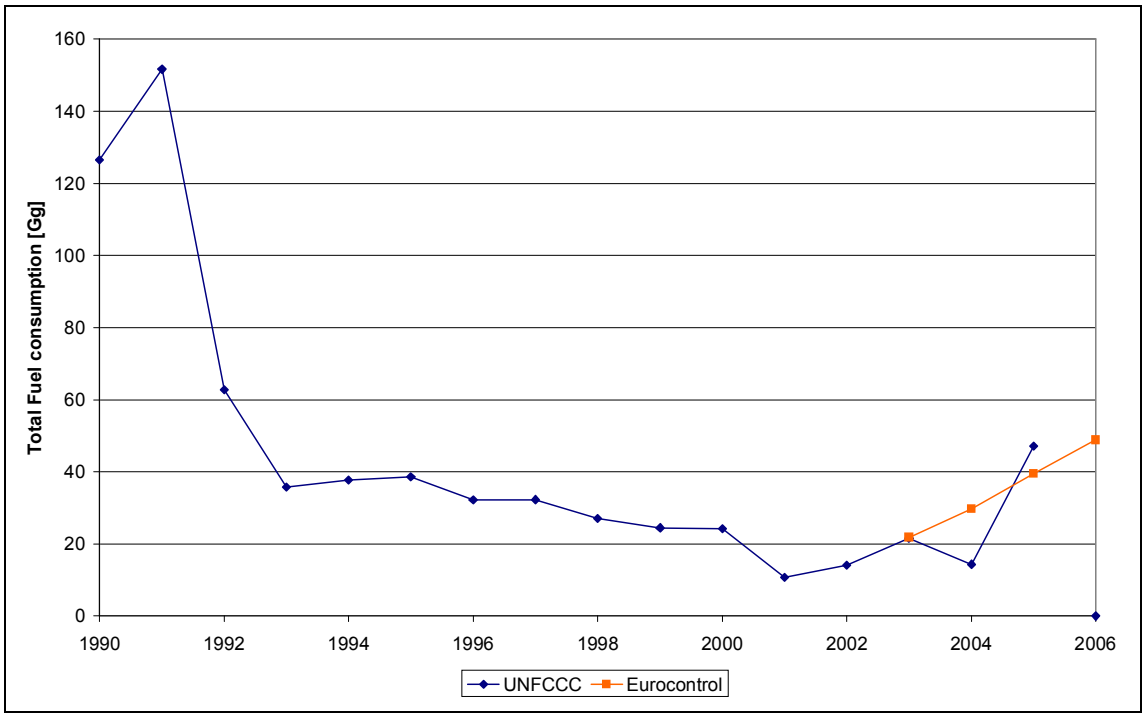
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 36 NO_x-Emissions Lithuania

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	0.4	0.2	44	0.0			0.4	0.2	44	18.76	10.31	45
2004	0.7	0.3	60	0.0			0.7	0.3	60	51.06	9.80	81
2005	0.6	0.4	41	0.0			0.6	0.4	36	13.32	9.46	29
2006		0.5			0.002			0.5			9.81	

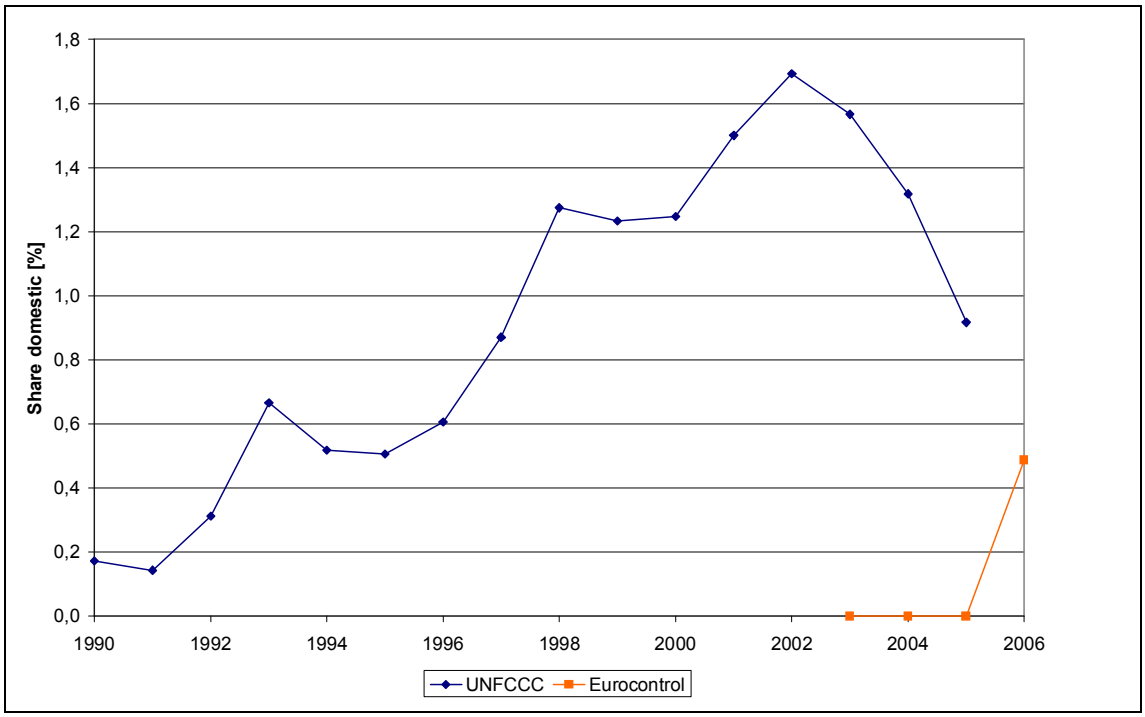
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 35 Total fuel consumption Lithuania



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 36 Share domestic Lithuania



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 19: Luxembourg

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Luxembourg	1	small country	3.095	43.00

In Luxembourg emissions from aviation are calculated using Tier 1; according to the small country approach all emissions are included under international aviation. The consistency between Eurocontrol and national numbers is higher for the early years; according to Eurocontrol emissions have stabilized after 2000 whereas figures from Luxembourg continue to show a rising trend. The results of Eurocontrol show that the error because of the disregard of the differentiation between domestic and international aviation is marginal. Luxembourg does not estimate NO_x emissions.

Table A 37 Fuel consumption and CO_2-Emissions Luxembourg

	Total fuel consumption [a]			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	201	231	-15	624	728	-17	NE,NO	2			0.289	
1997	231	251	-9	746	790	-6	NE,NO	2			0.314	
1998	292	288	1	904	907	0	NE,NO	2			0.267	
1999	329	345	-5	1,020	1,087	-7	NE,NO	2			0.223	
2000	314	328	-4	972	1,031	-6	NE,NO	2			0.159	
2001	339	352	-4	1,051	1,108	-5	NE,NO	2			0.144	
2002	368			1,139			NE,NO					
2003	383	314	18	1,187	987	17	NE,NO	0			0.001	
2004	417	347	17	1,290	1,094	15	NE,NO	0			0.013	
2005	424	356	16	1,311	1,119	15	NE,NO	0			0.003	
2006		341			1,075			0			0.002	

a) Total fuel consumption and total CO_2 emissions only include international emissions

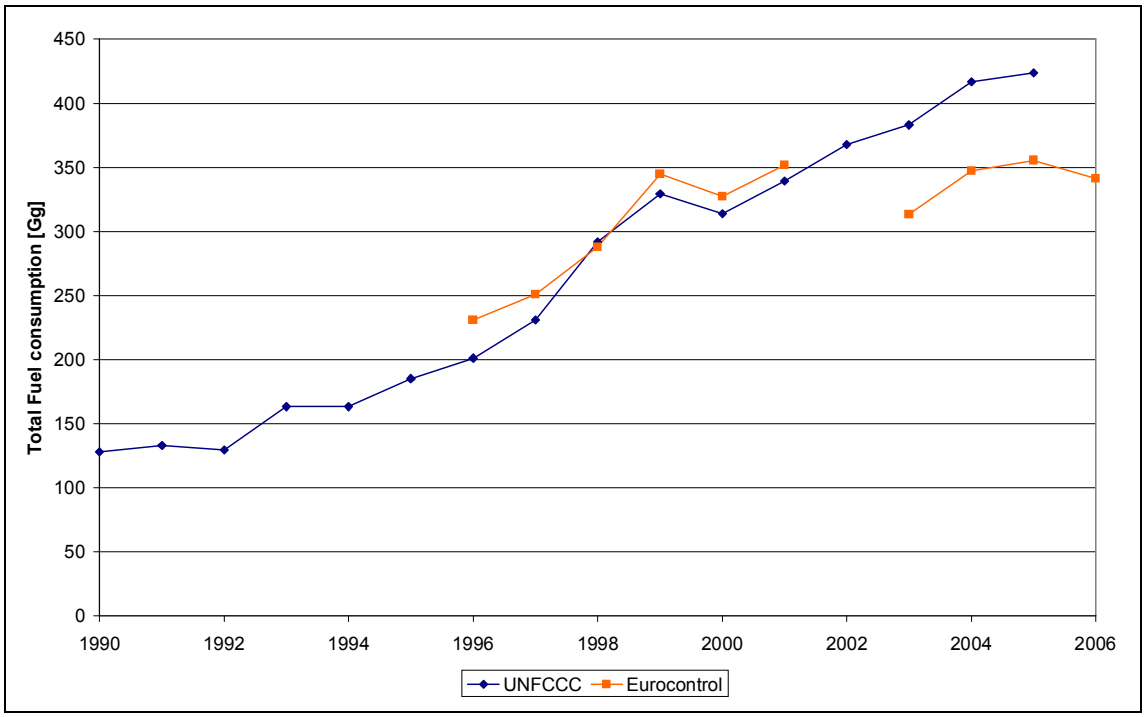
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 38 NO_x-Emissions Luxembourg

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	NE	4.5		NE	0.000		NE	4.5			14.36	
2004	NE	5.0		NE	0.001		NE	5.0			14.45	
2005	NE	5.2		NE	0.000		NE	5.2			14.50	
2006		4.9						4.9			14.33	

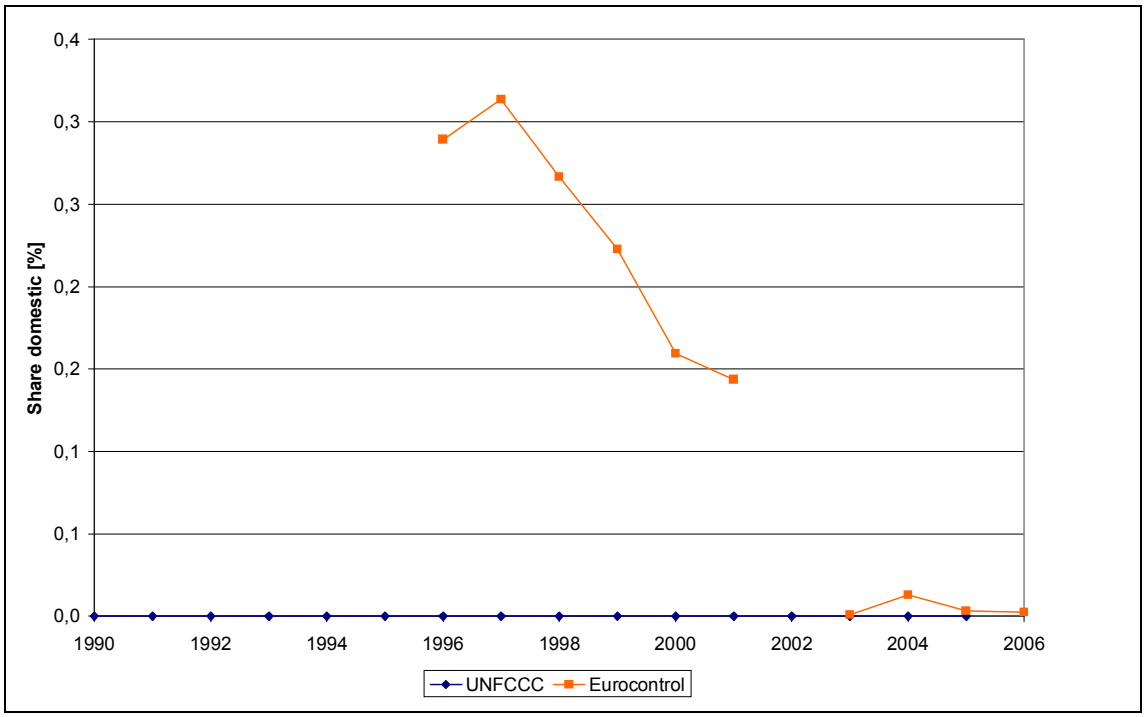
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 37 Total fuel consumption Luxembourg



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 38 Share domestic Luxembourg



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 20: Malta

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Malta	--	small country	3.149	44.59

Malta did not report on the methodology used to estimate emissions. The split between domestic and international aviation has been done according to the small country approach. Malta did not report activity data, i.e. fuel consumption, in its inventory submission. Fuel consumption has been calculated from the CO_2 emissions using a default emission factor.

Total fuel consumption and CO_2 emissions are 30 % higher than the figures reported by Eurocontrol. In absolute terms Eurocontrol calculates emissions of about 40 kt CO_2/yr for domestic aviation. Malta does not estimate NO_x emissions.

Table A 39 Fuel consumption and CO_2-Emissions Malta

	Total fuel consumption [a]			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	107			337			0.00			0.0		
1997	112			352			0.00			0.0		
1998	107			338			0.00			0.0		
1999	111			350			0.00			0.0		
2000	107			335			0.00			0.0		
2001	105			330			0.00			0.0		
2002	110			345			0.00			0.0		
2003	109	75	31	343	235	31	0.00	0		0.0	0.0	
2004	109	77	29	343	243	29	0.00	0		0.0	0.0	
2005	109	80	27	344	251	27	0.00	0		0.0	0.0	
2006		78			244			0			0.0	

a) MT did not report AD, emissions only. Default Eurocontrol EF (3.149 t CO2/t fuel) used to calculate total fuel consumption

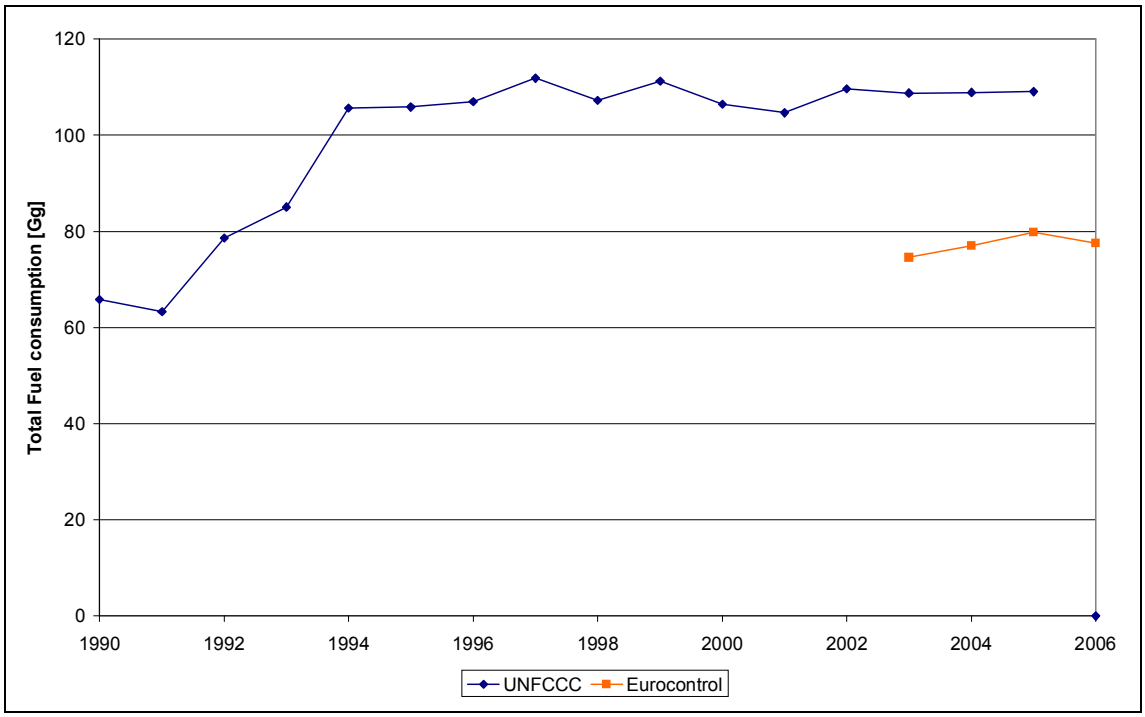
Source: EEA 2007a, Eurocontrol 2007, own calculations

Table A 40 NO_x-Emissions Malta

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	0.0	0.9		0.0	0.0		0.0	0.9		0.00	11.53	
2004	0.0	0.9		0.0	0.0		0.0	0.9		0.00	12.00	
2005	0.0	1.0		0.0	0.0		0.0	1.0		0.00	12.36	
2006		1.0			0.000			1.0			12.71	

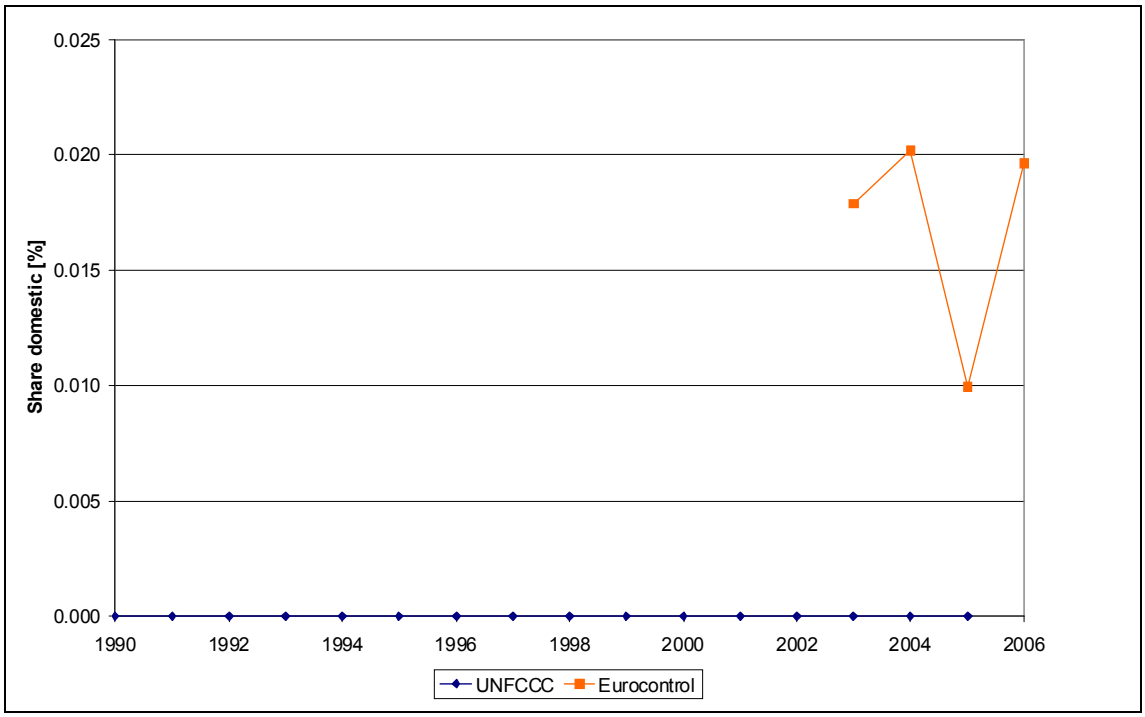
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 39 Total fuel consumption Malta



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 40 Share domestic Malta



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 21: The Netherlands

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
The Netherlands	2	research project	3.195	44.59

In the Netherlands emissions from aviation are calculated using a Tier 2 approach. A research project has been undertaken to determine the share of domestic emissions. Eurocontrol estimates for total fuel burn and CO_2 emissions are lower but consistent within the uncertainty range of the model. According to Eurocontrol the share of domestic emissions should be twice as high as reported by the Netherlands. The error in absolute terms is once again negligible (10 to 14 kt CO_2/year). No estimates for NO_x emissions from international aviation are included in the Dutch aviation inventory.

Table A 41 Fuel consumption and CO_2-Emissions Netherlands

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	2,539	2,177	14	8,121	6,857	16	41	53	-29	0.5	0.8	-53
1997	2,746	2,281	17	8,781	7,184	18	41	53	-29	0.5	0.7	-58
1998	3,004	2,431	19	9,601	7,654	20	41	56	-36	0.4	0.7	-71
1999	3,089	2,519	18	9,873	7,932	20	41	45	-10	0.4	0.6	-37
2000	3,063	2,616	15	9,790	8,239	16	41	41	1	0.4	0.5	-17
2001	2,997	2,675	11	9,580	8,423	12	41	37	10	0.4	0.4	-2
2002	3,136			10,023			41			0.4		
2003	3,084	2,836	8	9,858	8,931	9	41	14	65	0.4	0.2	62
2004	3,300	2,986	10	10,544	9,403	11	41	14	65	0.4	0.2	61
2005	3,416	3,107	9	10,917	9,783	10	41	12	71	0.4	0.1	67
2006		3,119			9,821			10			0.1	

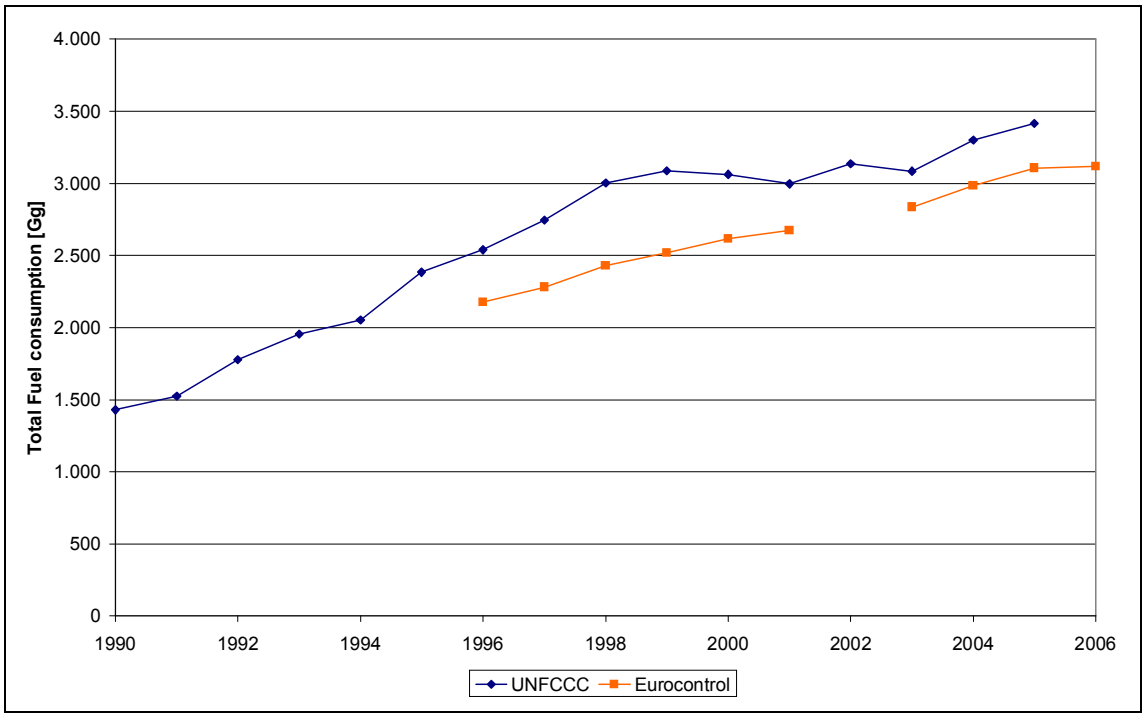
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 42 NO_x-Emissions Netherlands

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003		39.6		3.1	0.1	98	NE	39.5			13.96	
2004		41.6		3.3	0.1	98	NE	41.5			13.93	
2005		43.1		2.8	0.0	98	NE	43.1			13.88	
2006		42.8			0.0			42.7			13.71	

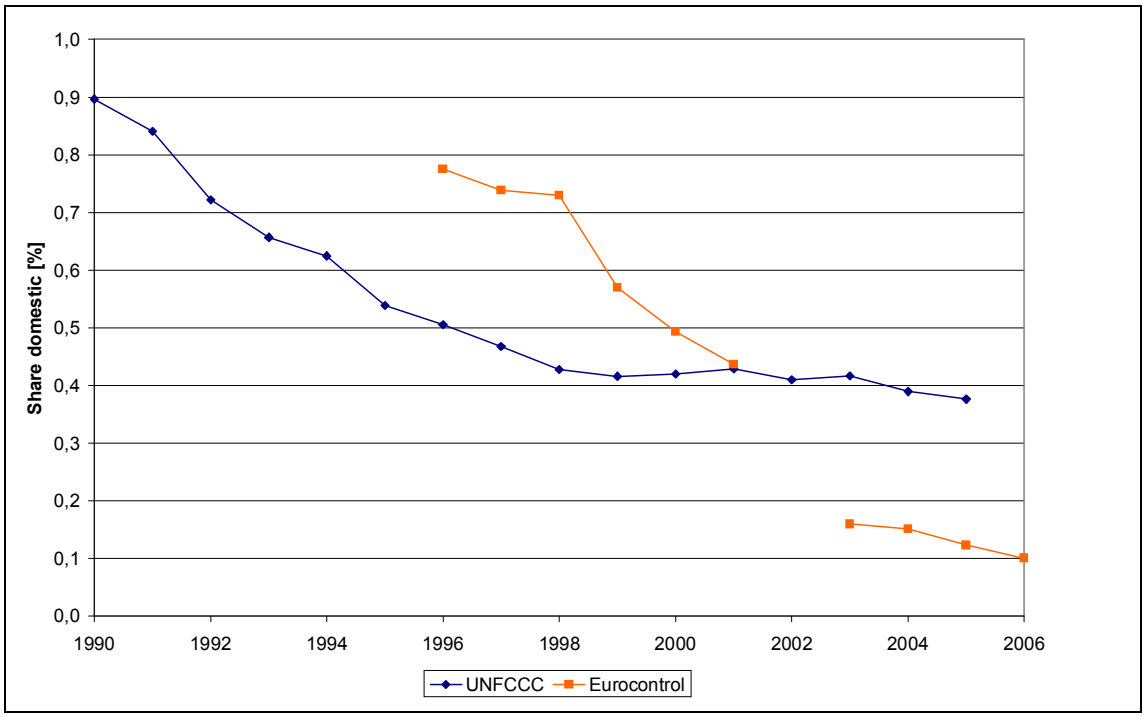
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 41 Total fuel consumption Netherlands



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 42 Share domestic Netherlands



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 22: Norway

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Norway	2	bottum up	3.175	43.10

Norway uses Tier 2 and bottom up data to calculate the emissions from aviation. For international aviation Norway only reports fuel consumption but uses the notation key 'not occurring' for CO_2 emissions. For this comparison the CO_2 emission factor applied by Norway for domestic aviation has been used to calculate the international CO_2 emissions.

Eurocontrol's and Norway's estimates are very close to each other and show the same trend over the three years for which both sides reported data. For domestic NO_x emissions the same picture applies; Norway does not estimate NO_x emissions from international aviation.

Table A 43 Fuel consumption and CO_2-Emissions Norway

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total [a]			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	520			1,652			955			57.8		
1997	554			1,759			982			55.8		
1998	578			1,832			1,005			54.9		
1999	663			2,103			1,155			54.9		
2000	623			1,976			1,057			53.5		
2001	600			1,905			1,063			55.8		
2002	521			1,663			913			54.9		
2003	537	578	-8	1,710	1,819	-6	954	919	4	55.8	50.5	10
2004	565	604	-7	1,804	1,902	-5	945	903	4	52.4	47.5	9
2005	593	634	-7	1,883	1,998	-6	928	913	2	49.3	45.7	7
2006		693			2,182			968			44.4	

a) International CO_2 emissions have been calculated with IEF CO_2 domestic.

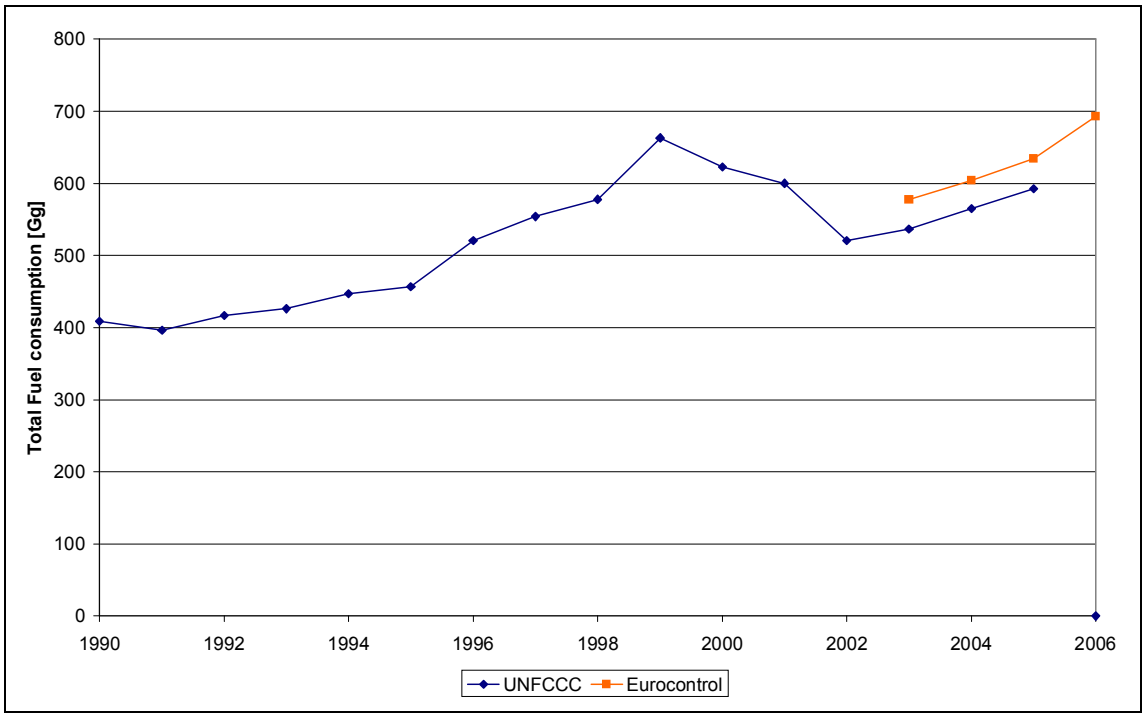
Source: EEA 2007b, Eurocontrol 2007, own calculations

Table A 44 NO_x-Emissions Norway

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003		6.4		3.2	3.1	3	NO	3.3			11.05	
2004		6.5		3.2	2.9	9	NO	3.6			10.77	
2005		6.8		3.1	2.9	7	NO	3.9			10.67	
2006		7.4			3.1			4.3			10.65	

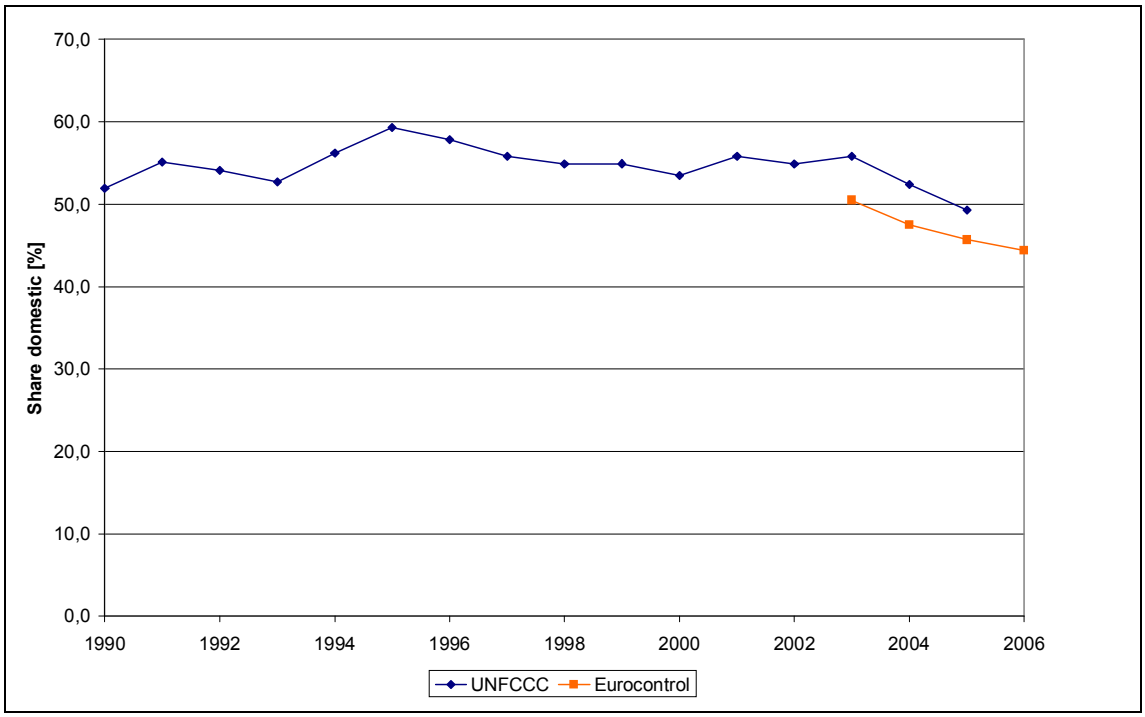
Source: EEA 2007b, Eurocontrol 2007, own calculations

Figure A 43 Total fuel consumption Norway



Source: EEA 2007b, Eurocontrol 2007, own calculations

Figure A 44 Share domestic Norway



Source: EEA 2007b, Eurocontrol 2007, own calculations

Annex 23: Poland

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Poland	1	top down	3.150	44.58

Poland uses Tier 1 and top down data to calculate the emissions from aviation. No correlation can be seen between the two data sets for total fuel consumption and total CO_2 emissions. Poland underestimates domestic emissions significantly: domestic CO_2 emissions from Eurocontrol are two to three times higher.

From the year 2004 on NO_x emissions from domestic aviation have been estimated for the Polish aviation inventory, which match Eurocontrol estimates very well. This implicates an Implied Emission Factor which is twice as high than the one from Eurocontrol.

Table A 45 Fuel consumption and CO_2-Emissions Poland

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	317			999			29			2.9		
1997	270			851			24			2.9		
1998	252			793			21			2.7		
1999	218			685			17			2.6		
2000	266			837			22			2.6		
2001	262			825			22			2.6		
2002	255			803			21			2.7		
2003	276	205	26	868	644	26	23	48	-114	2.6	7.5	-189
2004	269	245	9	847	772	9	21	54	-158	2.5	7.0	-183
2005	222	300	-35	699	946	-35	16	50	-207	2.3	5.3	-127
2006		389			1,225			53			4.4	

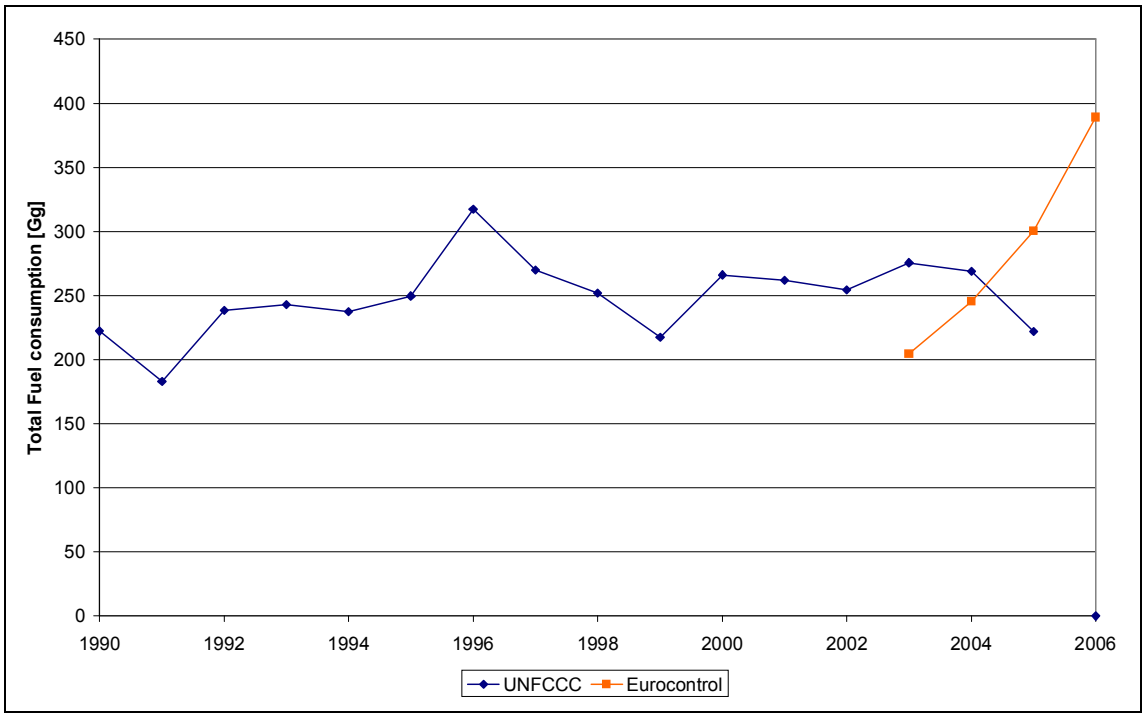
Source: EEA 2007a, Eurocontrol 2007, own calculations

Table A 46 NO_x-Emissions Poland

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	NE	2.3		NE	0.2		NE	2.1			11.12	
2004	NE	2.8		0.2	0.2	5	NE	2.6			11.36	
2005	NE	3.5		0.2	0.2	8	NE	3.3			11.53	
2006		4.5			0.2			4.3			11.45	

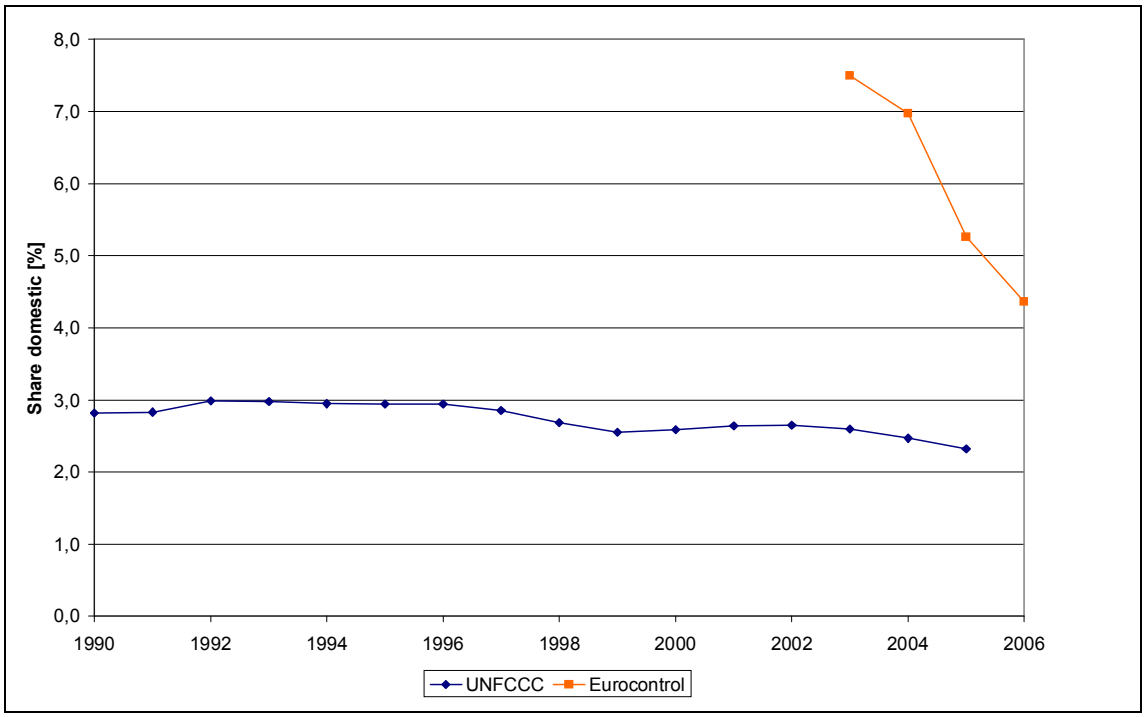
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 45 Total fuel consumption Poland



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 46 Share domestic Poland



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 24: Portugal

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Portugal	2	bottum up	2.899	41.87

Portugal calculates emissions from aviation using the Tier 2 approach and a bottom up methodology to determine the split between domestic and international aviation.

All estimates considered agree quite well between Eurocontrol and the Portuguese estimates. The differences show an increasing trend with the exception of the domestic split, which matches best in last years. Portugal uses a very low heat value compared to other countries.

Table A 47 Fuel consumption and CO_2-Emissions Portugal

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	659	620	6	1,914	1,953	-2	266	313	-18	13.9	16.0	-15
1997	672	624	7	1,954	1,964	0	276	336	-22	14.1	17.1	-21
1998	740	699	6	2,151	2,202	-2	325	362	-11	15.1	16.4	-9
1999	754	757	0	2,192	2,385	-9	345	370	-7	15.7	15.5	1
2000	858	769	10	2,495	2,423	3	364	347	5	14.6	14.3	2
2001	816	652	20	2,373	2,052	14	384	243	37	16.2	11.9	27
2002	829			2,409			406			16.9		
2003	854	701	18	2,481	2,207	11	387	340	12	15.6	15.4	1
2004	957	750	22	2,775	2,363	15	401	338	16	14.4	14.3	1
2005	1,003	772	23	2,909	2,433	16	401	335	16	13.8	13.8	0
2006		833			2,622			333			12.7	

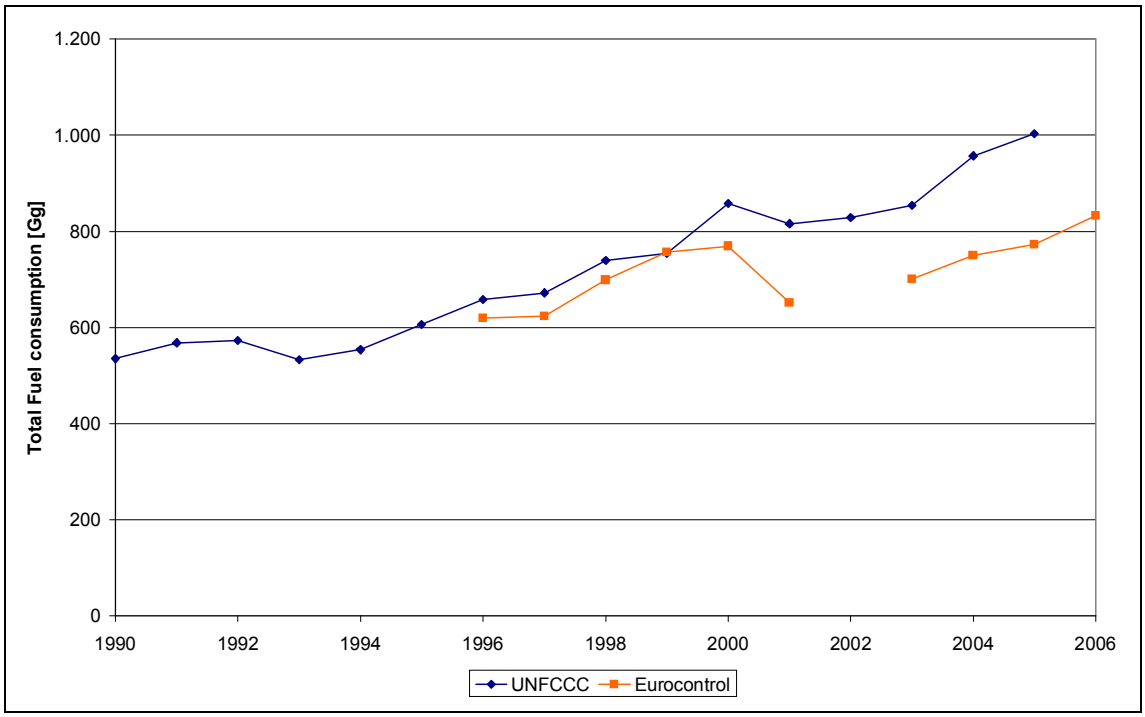
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 48 NO_x-Emissions Portugal

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	10.5	9.2	12	1.7	1.5	12	8.8	7.7	12	12.27	13.18	-7
2004	11.4	9.8	14	1.7	1.5	13	9.7	8.4	14	11.90	13.12	-10
2005	12.0	10.2	15	1.7	1.5	12	10.2	8.7	15	11.91	13.19	-11
2006		10.9			1.5			9.4			13.07	

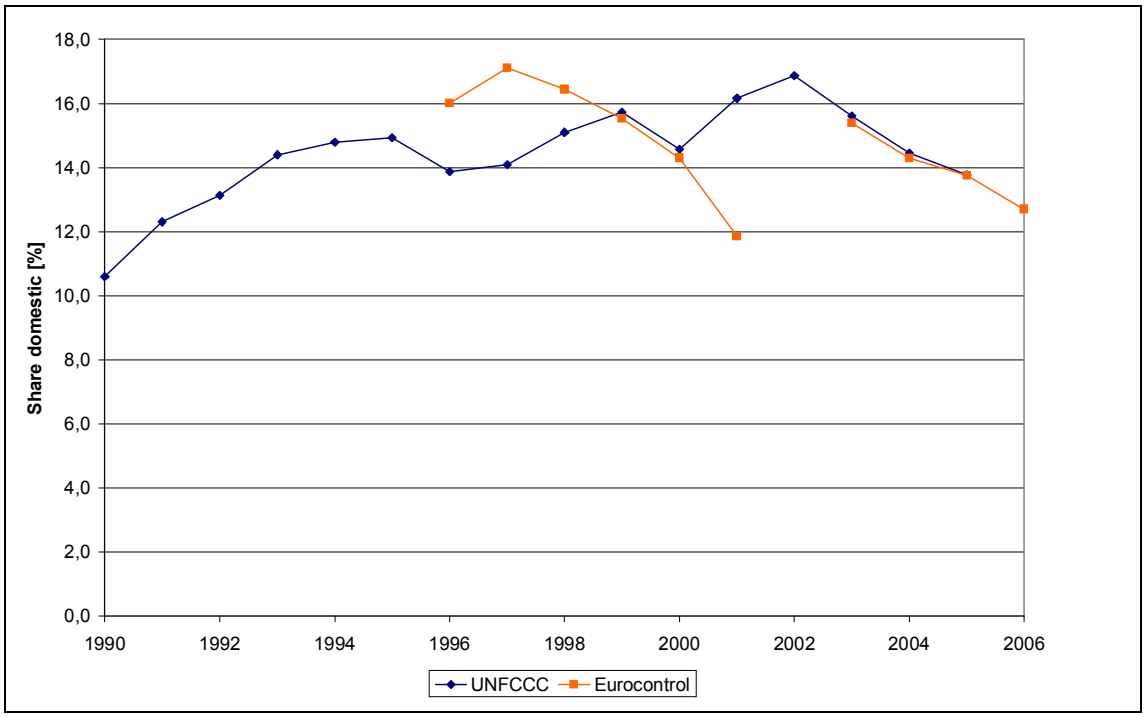
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 47 Total fuel consumption Portugal



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 48 Share domestic Portugal



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 25: Romania

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Romania	1	expert judgement	4.971	44.59

Emissions and fuel consumption from aviation are calculated using Tier 1 and expert judgement. Romania estimates only domestic fuel consumption and CO_2 Emissions.

Domestic CO_2 emissions in the Romanian inventory are two to three times higher than Eurocontrol estimates, the same applies for NO_x emissions.

Table A 49 Fuel consumption and CO_2-Emissions Romania

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	NE			NE			60					
1997	NE			NE			103					
1998	NE			NE			94					
1999	NE			NE			109					
2000	NE			NE			105					
2001	NE			NE			83					
2002	NE			NE			72					
2003	NE	94		NE	296		62	26	58		8.8	
2004	NE	102		NE	322		68	25	63		7.7	
2005	NE	130		NE	408		89	30	67		7.3	
2006		154			484			35			7.2	

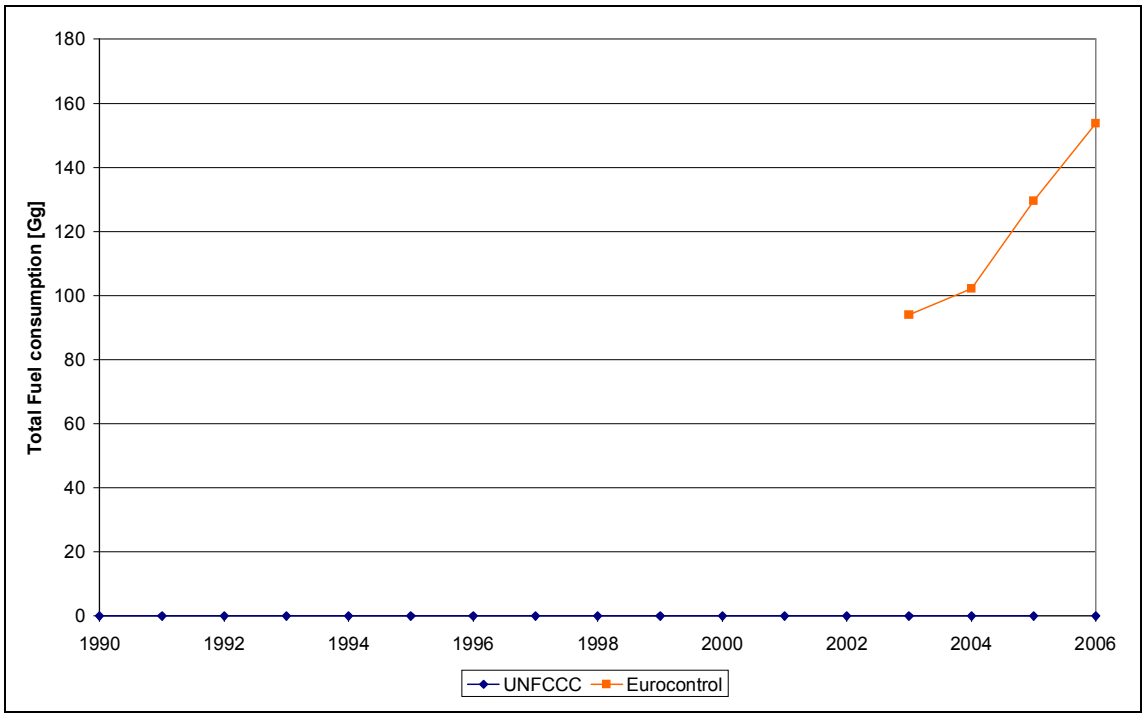
Source: EEA 2007a, Eurocontrol 2007, own calculations

Table A 50 NO_x-Emissions Romania

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	NE	1.0		0.3	0.1	66	NE	1.0			11.09	
2004	NE	1.1		0.3	0.1	72	NE	1.0			10.65	
2005	NE	1.4		0.4	0.1	75	NE	1.3			10.50	
2006		1.6			0.1			1.5			10.60	

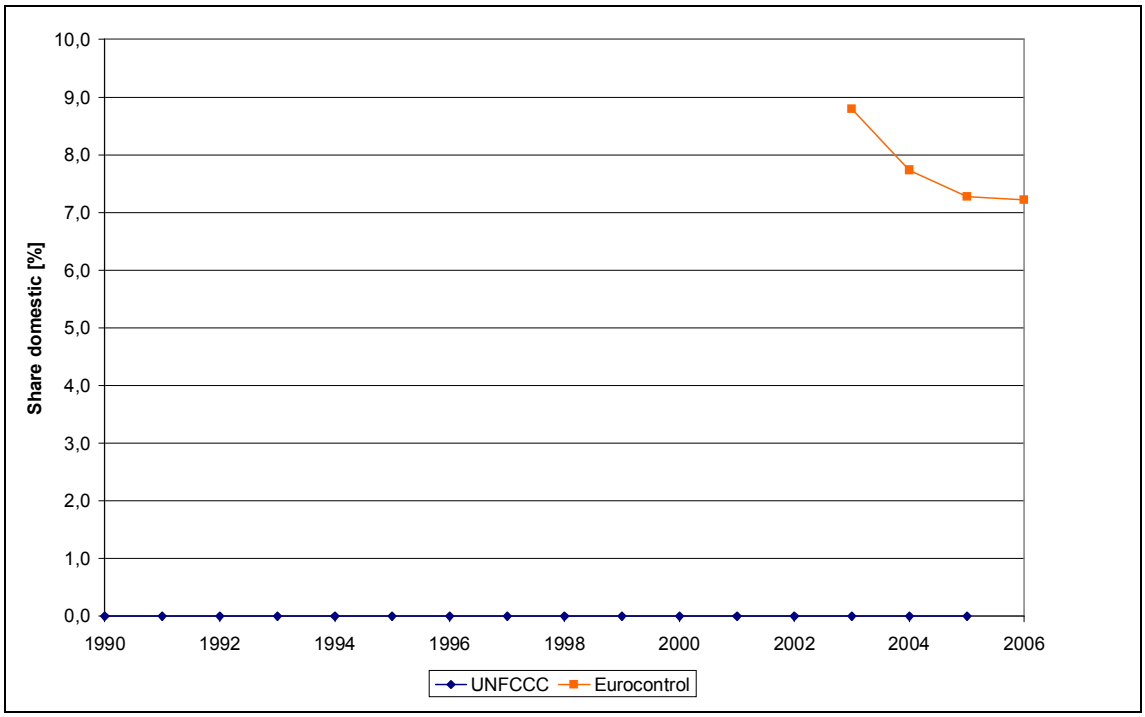
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 49 Total fuel consumption Romania



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 50 Share domestic Romania



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 26: Slovakia

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Slovakia	1	expert judgement	3.182	43.30

Slovakia is using a Tier 1 approach and expert judgement to estimate emissions from aviation. The numbers reported in the national inventory report submitted in April 2007 had a large error and were corrected after an in-country review of the inventory. After the presentation of preliminary results during a workshop on methodological issues related to estimating emissions from international aviation and maritime transport (ETC/ACC 2007) Slovakia submitted the corrected inventory for use in this report.

Total fuel consumption and CO_2 emissions show a difference of 10 % to almost 30 % in 2003 to 2005. The share of domestic aviation is three times higher than the number calculated by Eurocontrol. The deviation of NO_x emissions from aviation is very high.

Table A 51 Fuel consumption and CO_2-Emissions Slovakia

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	18			60			6			10.8		
1997	17			53			6			10.8		
1998	15			49			5			10.8		
1999	16			49			5			10.8		
2000	18			50			5			11.0		
2001	15			47			5			11.1		
2002	15			49			5			11.1		
2003	20	18	9	64	58	10	7	2	69	10.8	3.8	65
2004	27	33	-22	87	105	-21	9	2	74	10.5	2.2	79
2005	32	40	-27	101	127	-26	11	5	53	10.5	3.9	62
2006		52			162			8			4.9	

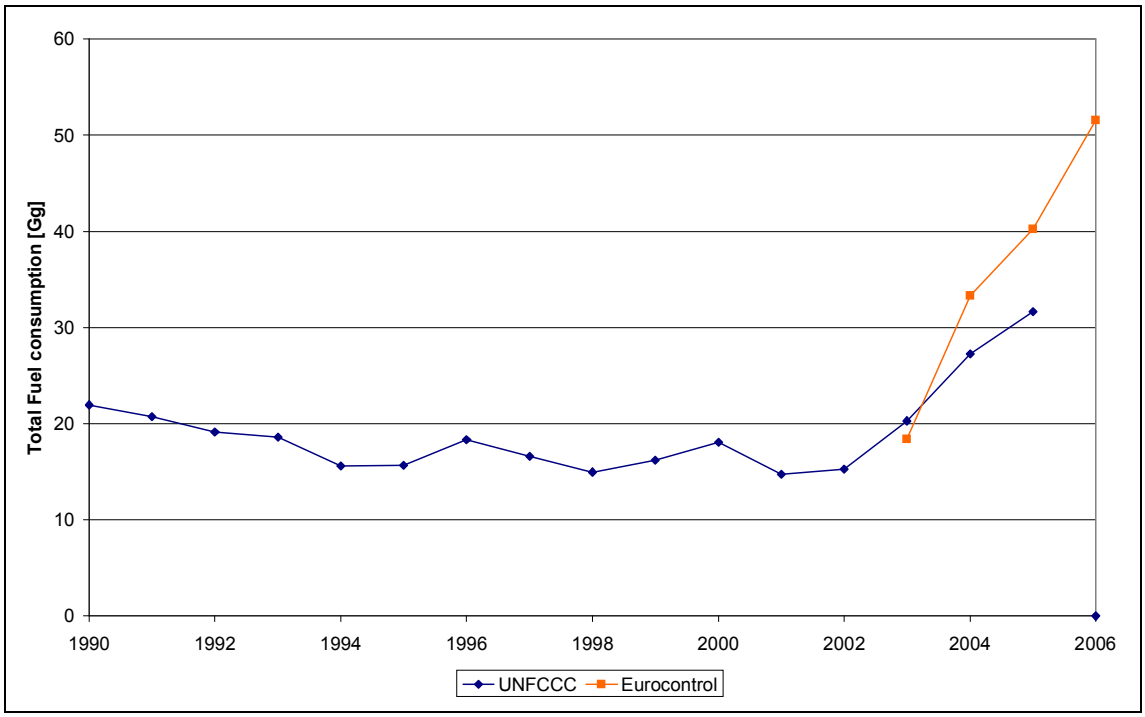
Source: SHI 2007, Eurocontrol 2007, own calculations

Table A 52 NO_x-Emissions Slovakia

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	0.003	0.2	-8,053	0.001	0.01	-999	0.002	0.2	-10,760	0.13	11.62	-8,885
2004	0.004	0.4	-9,965	0.001	0.01	-825	0.003	0.3	-13,430	0.13	10.69	-8,137
2005	0.004	0.4	-10,059	0.001	0.02	-1,317	0.003	0.4	-13,374	0.13	10.35	-7,882
2006		0.5			0.03			0.5			10.22	

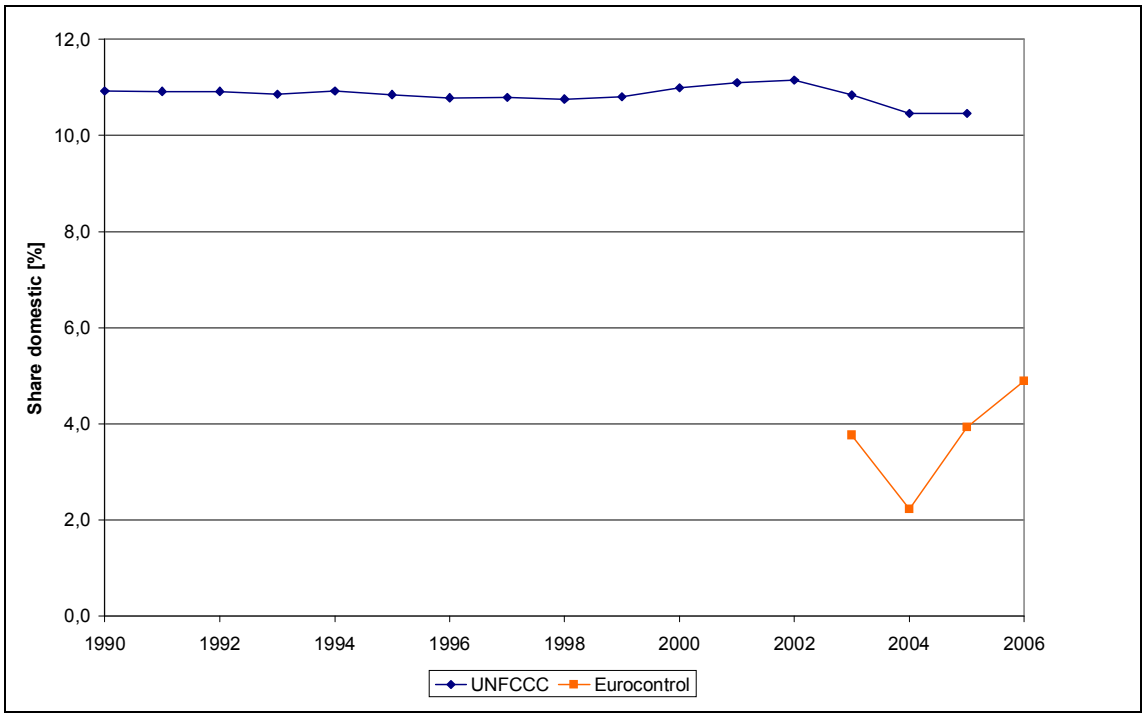
Source: SHI 2007, Eurocontrol 2007, own calculations

Figure A 51 Total fuel consumption Slovakia



Source: SHI 2007, Eurocontrol 2007, own calculations

Figure A 52 Share domestic Slovakia



Source: SHI 2007, Eurocontrol 2007, own calculations

Annex 27: Slovenia

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Slovenia	1	small country	3.192	43.50

In Slovenia emissions from aviation are calculated using Tier 1. The split between domestic and international aviation has been done according to the small country approach. Nevertheless Slovenia reported CO_2 emissions from domestic aviation, which are much higher than Eurocontrol estimates. Slovenia did not estimate NO_x emissions.

Table A 53 Fuel consumption and CO_2-Emissions Slovenia

	Total fuel consumption [a]			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	17			56			2			4.0		
1997	18			59			2			4.1		
1998	17			55			3			5.4		
1999	20			65			3			4.4		
2000	23			74			3			3.9		
2001	26			83			2			2.8		
2002	27			85			2			2.8		
2003	25	21	16	81	67	18	2	0	88	3.0	0.4	85
2004	19	24	-25	62	76	-22	2	0	77	3.0	0.6	81
2005	21	27	-32	66	86	-30	2	0	85	2.5	0.3	88
2006		30			95			0			0.2	

a) Total fuel consumption only includes international emissions

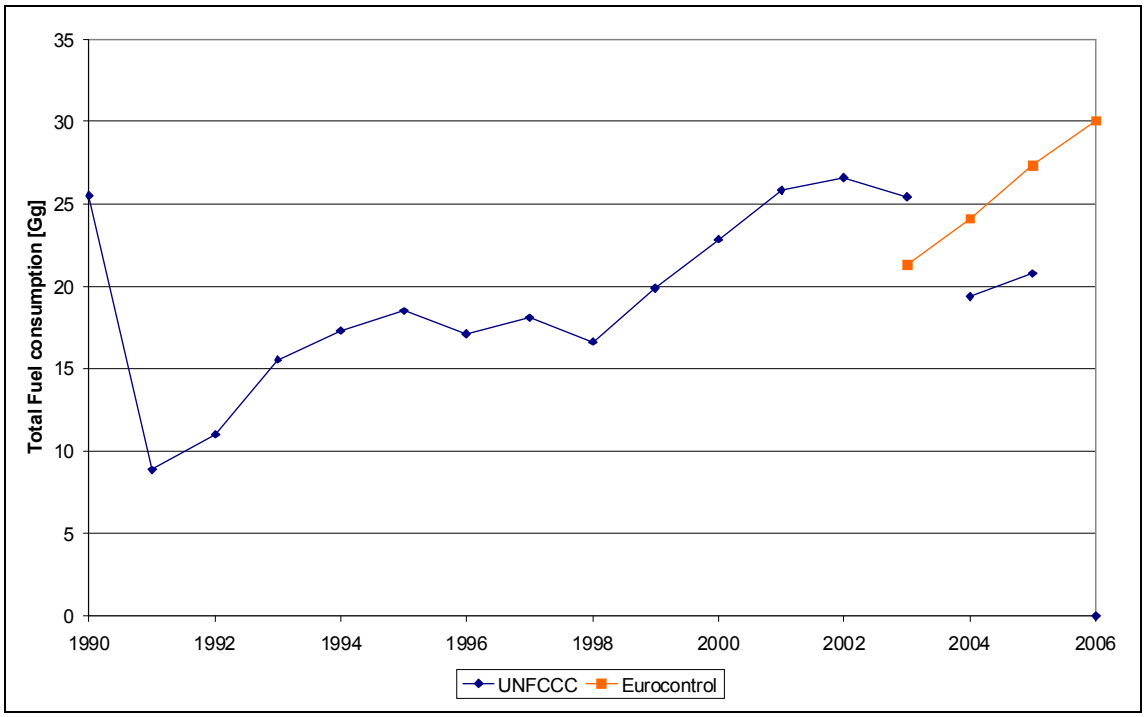
Source: EEA 2007a, Eurocontrol 2007, own calculations

Table A 54 NO_x-Emissions Slovenia

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	NE	0.3		IE	0.0		NE	0.3			12.94	
2004	NE	0.3		IE	0.0		NE	0.3			12.57	
2005	NE	0.3		IE	0.0		NE	0.3			12.36	
2006		0.4			0.0			0.4			11.74	

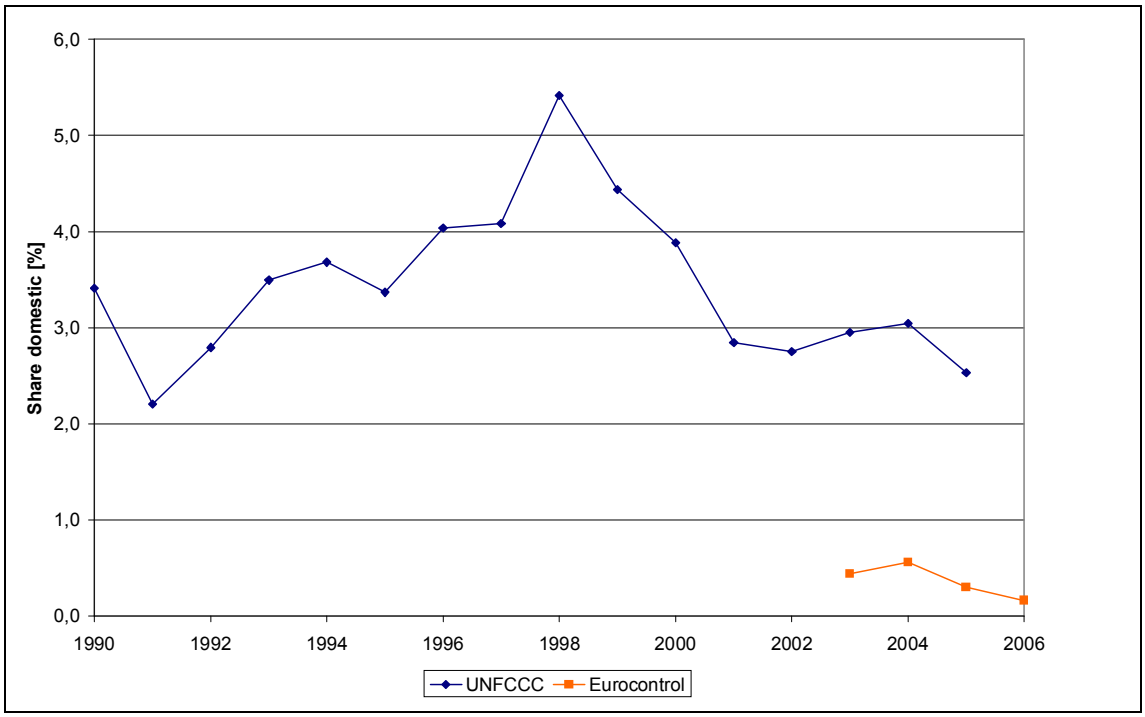
Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 53 Total fuel consumption Slovenia



Source: EEA 2007a, Eurocontrol 2007, own calculations

Figure A 54 Share domestic Slovenia



Source: EEA 2007a, Eurocontrol 2007, own calculations

Annex 28: Spain

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Spain	2	top down	3.169	43.36

Spain uses Tier 2 to calculate the emissions from aviation and top down data is applied to separate domestic from international aviation. Spanish estimates for total fuel burn, CO_2 emissions and NO_x emissions are generally in the uncertainty range, but until 2001 lower and in the last three years higher than Eurocontrol estimates. The share of domestic emissions reported for the Spanish inventory is significantly higher than the one reported by Eurocontrol.

Table A 55 Fuel consumption and CO_2-Emissions Spain

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	3,297	3,849	-17	10,386	12,121	-17	3,831	3,814	0	36.9	31.5	15
1997	3,543	4,019	-13	11,199	12,656	-13	4,128	3,987	3	36.9	31.5	15
1998	3,858	4,288	-11	12,200	13,504	-11	4,722	3,876	18	38.7	28.7	26
1999	4,087	4,694	-15	12,924	14,781	-14	5,188	4,151	20	40.1	28.1	30
2000	4,368	4,767	-9	13,811	15,011	-9	5,497	4,138	25	39.8	27.6	31
2001	4,407	4,716	-7	13,943	14,850	-7	5,470	3,948	28	39.2	26.6	32
2002	4,181			13,243			5,091			38.4		
2003	4,387	4,392	0	13,892	13,829	0	5,340	3,502	34	38.4	25.3	34
2004	4,864	4,715	3	15,409	14,848	4	5,925	3,793	36	38.4	25.5	34
2005	5,183	5,065	2	16,424	15,950	3	6,905	4,136	40	42.0	25.9	38
2006		5,288			16,652			4,245			25.5	

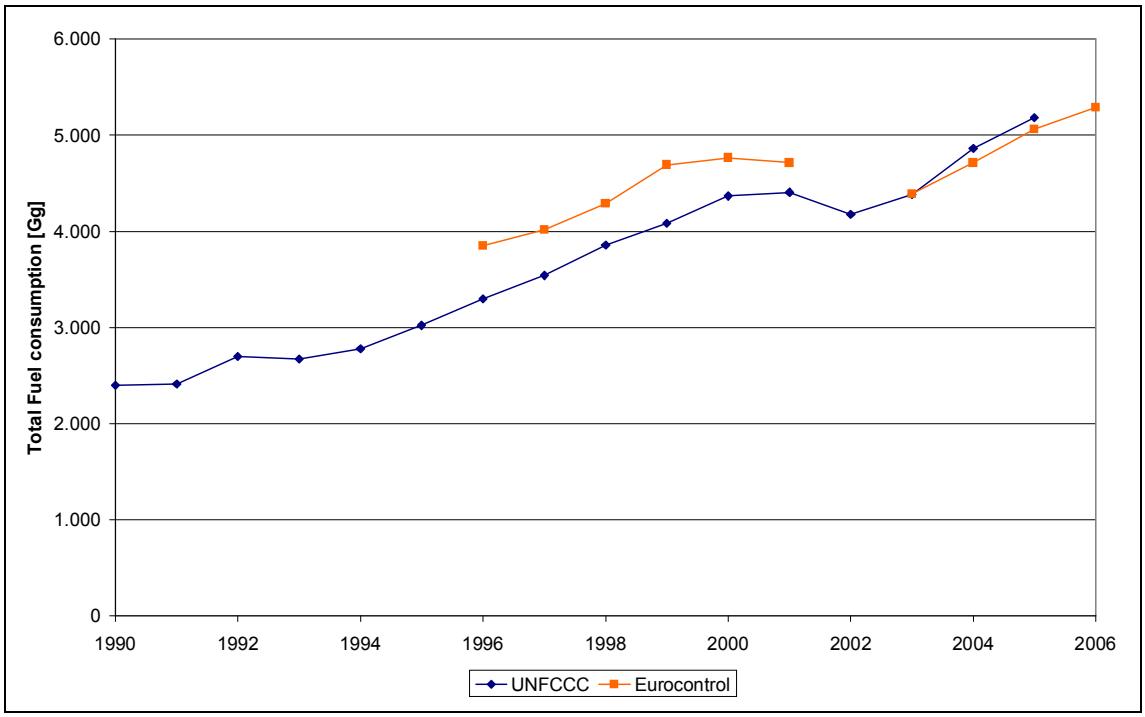
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 56 NO_x-Emissions Spain

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	64.2	58.0	10	18.7	15.1	19	45.5	42.9	6	14.65	13.21	10
2004	71.3	61.9	13	20.8	16.2	22	50.5	45.7	10	14.66	13.14	10
2005	74.9	66.2	12	24.2	17.5	28	50.7	48.7	4	14.44	13.07	10
2006		69.1			17.8			51.2			13.06	

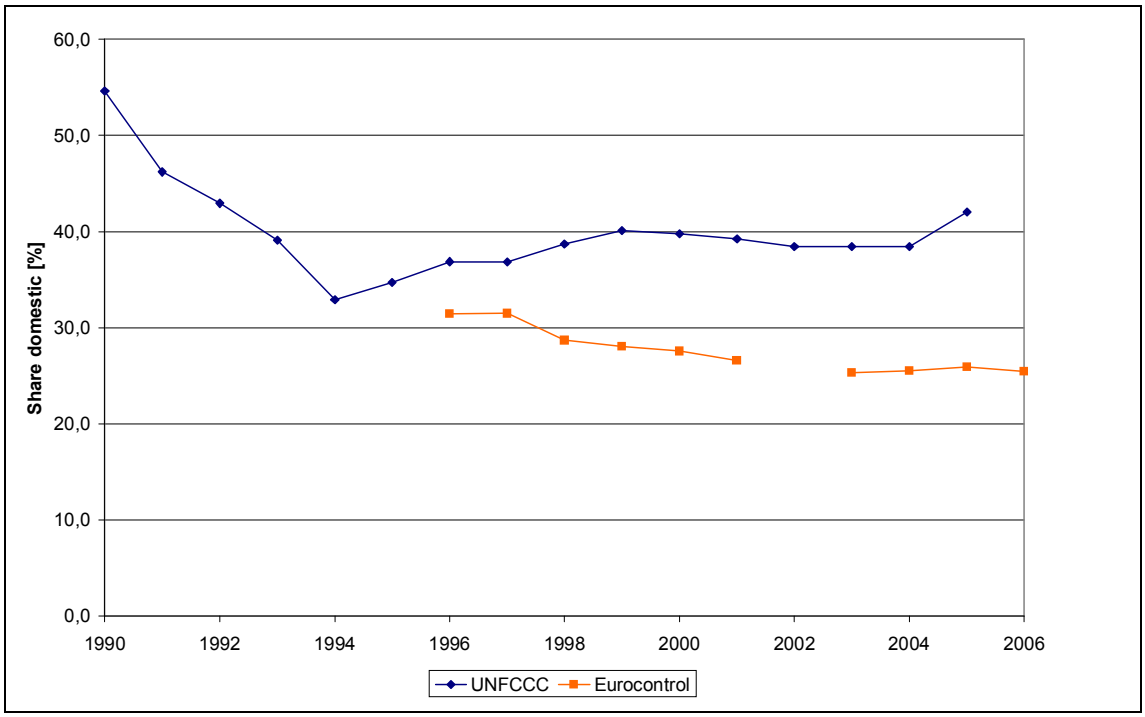
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 55 Total fuel consumption Spain



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 56 Share domestic Spain



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 29: Sweden

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Sweden	2	bottum up	3.263	44.59

Sweden calculates emissions from aviation using the Tier 2 approach; a bottom up approach has been used to determine the split between domestic and international aviation.

The trend for total fuel consumption, total CO_2 emissions as well as for the share of domestic aviation follows the same pattern in both data sets with decreasing differences. Especially from the year 2003 on Eurocontrol estimates match very well with very low differences, the same applies to NO_x emissions.

Table A 57 Fuel consumption and CO_2-Emissions Sweden

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	637	802	-26	2,080	2,526	-21	604	929	-54	29.1	36.8	-26
1997	678	862	-27	2,215	2,715	-23	654	963	-47	29.5	35.5	-20
1998	717	939	-31	2,340	2,956	-26	667	973	-46	28.5	32.9	-15
1999	790	987	-25	2,578	3,107	-21	699	994	-42	27.1	32.0	-18
2000	787	985	-25	2,570	3,101	-21	644	945	-47	25.1	30.5	-22
2001	765	872	-14	2,496	2,746	-10	625	840	-34	25.1	30.6	-22
2002	678			2,212			601			27.2		
2003	658	734	-11	2,149	2,311	-8	582	614	-5	27.1	26.6	2
2004	747	819	-10	2,439	2,580	-6	667	686	-3	27.4	26.6	3
2005	796	840	-5	2,598	2,646	-2	663	665	0	25.5	25.1	2
2006		856			2,697			617			22.9	

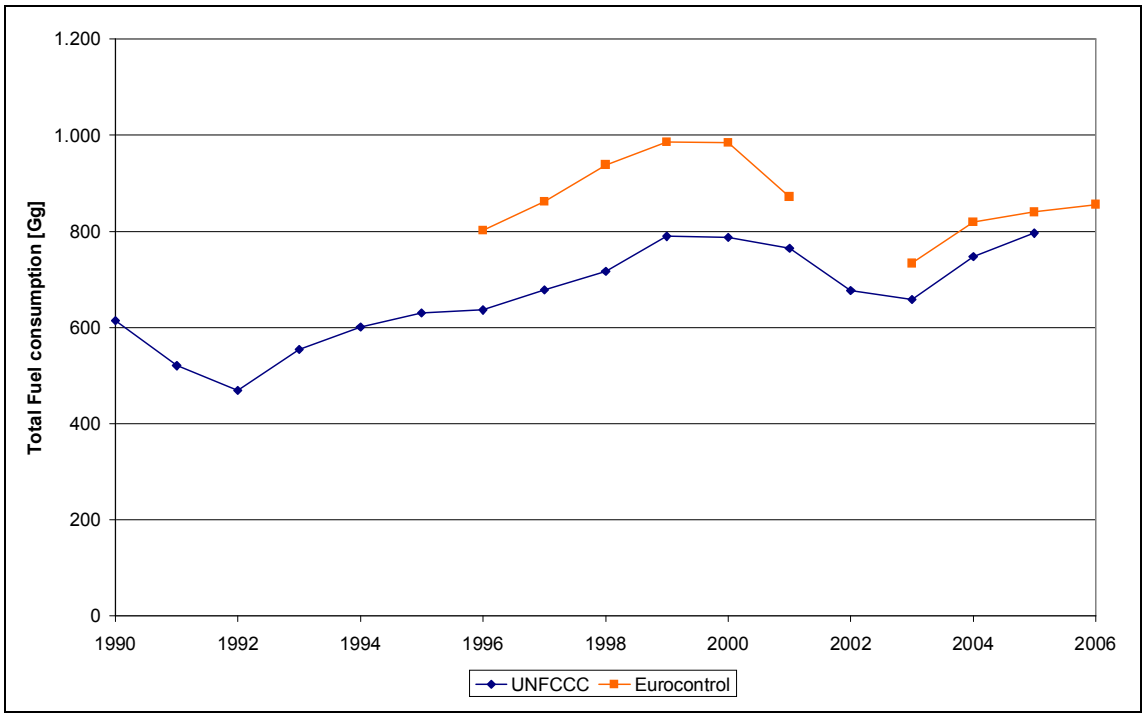
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 58 NO_x-Emissions Sweden

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	9.3	8.7	7	2.2	2.2	3	7.1	6.5	8	14.11	11.82	16
2004	10.8	9.9	9	2.7	2.6	5	8.1	7.3	10	14.52	12.09	17
2005	11.9	10.3	13	2.8	2.6	8	9.1	7.8	14	14.90	12.31	17
2006		10.5			2.3			8.2			12.31	

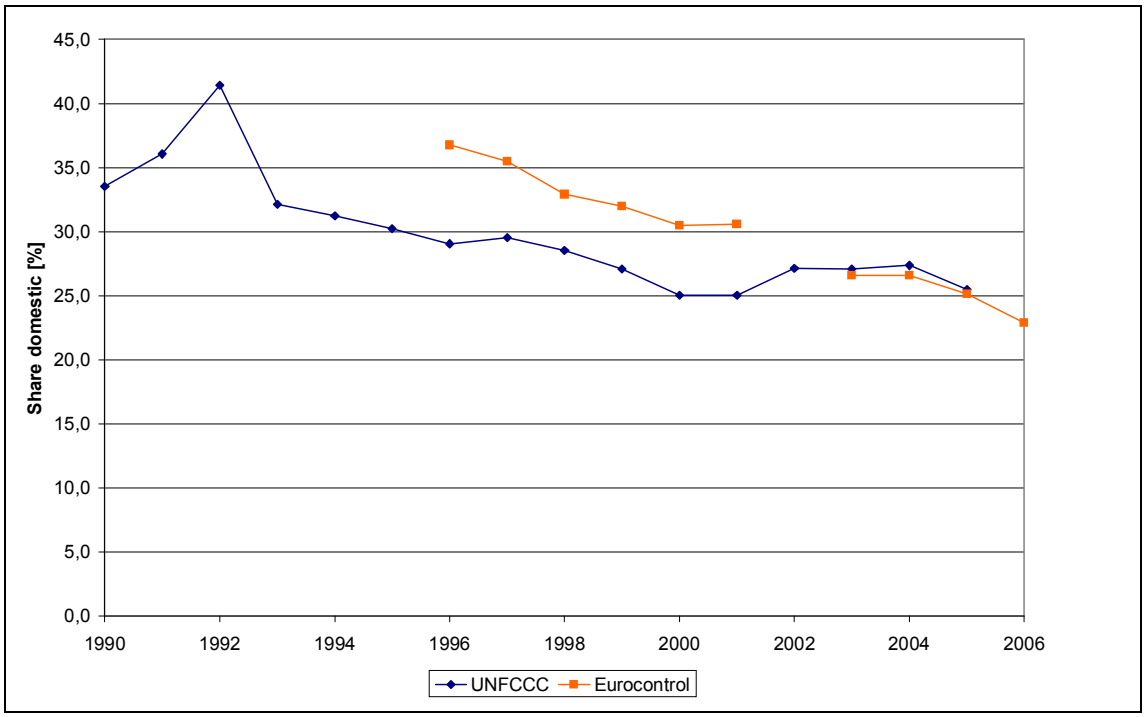
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 57 Total fuel consumption Sweden



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 58 Share domestic Sweden



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Annex 30: Switzerland

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
Switzerland	3	bottum up	3.155	43.10

Switzerland calculates emissions from aviation using the Tier 3 approach and a bottom up methodology to determine the split between domestic and international aviation.

Total fuel consumption, total CO_2 and NO_x emissions match Eurocontrol estimates very well. The share of domestic aviation is more than twice as high as the number calculated by Eurocontrol.

Table A 59 Fuel consumption and CO_2-Emissions Switzerland

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[%]		
1996	1,275			4,023			218			5.4		
1997	1,319			4,161			209			5.0		
1998	1,377			4,344			201			4.6		
1999	1,473			4,648			196			4.2		
2000	1,537			4,848			186			3.8		
2001	1,448			4,568			168			3.7		
2002	1,334			4,209			148			3.5		
2003	1,200	1,178	2	3,786	3,711	2	143	61	58	3.8	1.6	57
2004	1,134	1,118	1	3,577	3,521	2	144	50	66	4.0	1.4	65
2005	1,146	1,111	3	3,614	3,499	3	124	49	60	3.4	1.4	59
2006		1,151			3,624			50			1.4	

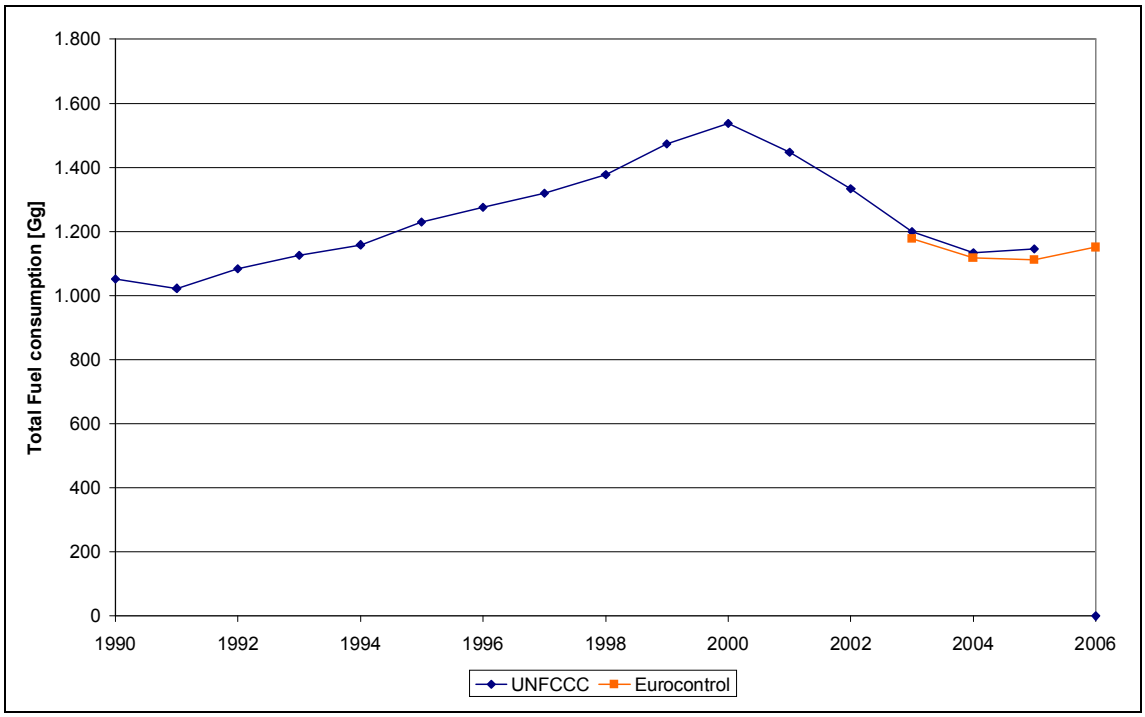
Source: EEA 2007b, Eurocontrol 2007, own calculations

Table A 60 NO_x-Emissions Switzerland

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	14.5	15.6	-8	0.6	0.3	50	13.9	15.3	-10	12.06	13.26	-10
2004	13.7	15.0	-10	0.6	0.2	60	13.1	14.8	-13	12.08	13.44	-11
2005	13.9	15.0	-8	0.5	0.2	54	13.4	14.8	-10	12.14	13.48	-11
2006		15.6			0.2			15.3			13.54	

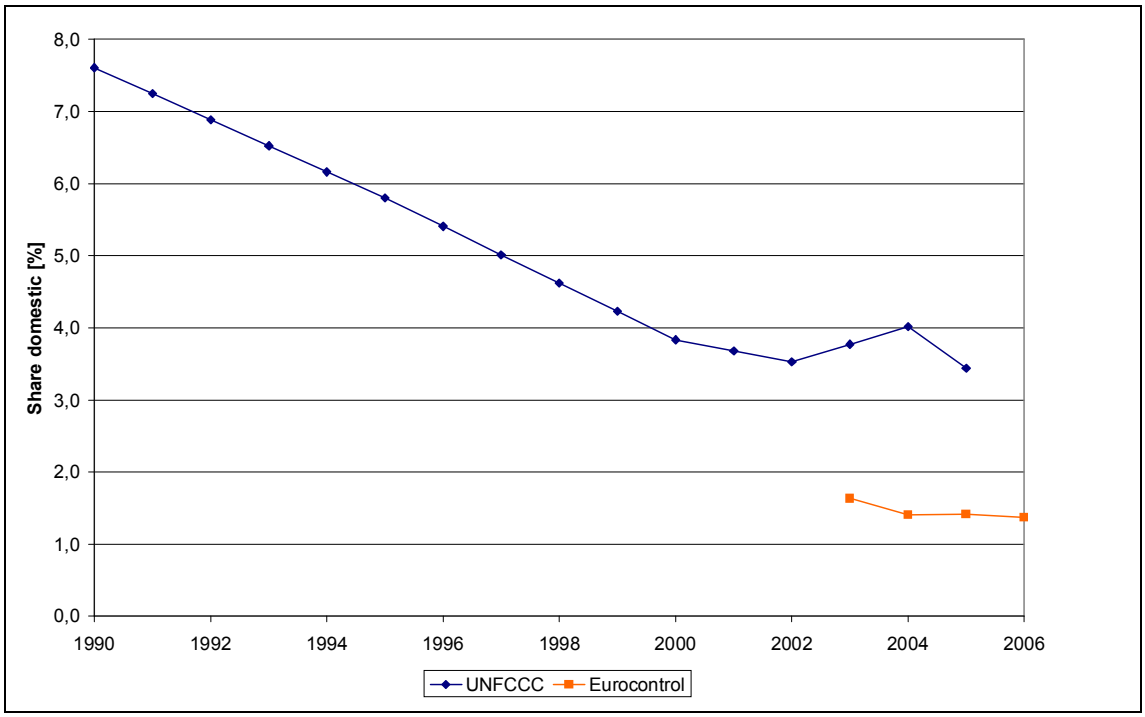
Source: EEA 2007b, Eurocontrol 2007, own calculations

Figure A 59 Total fuel consumption Switzerland



Source: EEA 2007b, Eurocontrol 2007, own calculations

Figure A 60 Share domestic Switzerland



Source: EEA 2007b, Eurocontrol 2007, own calculations

Annex 31: United Kingdom

	Methodology for estimating emissions	Methodology for separating domestic and int. aviation	Emission factor CO_2 [t CO_2 / t fuel]	Net calorific value [GJ / t]
United Kingdom	3	bottum up	3.163	43.89

United Kingdom is applying Tier 3 methodologies and bottom-up data to estimate emissions from aviation and to separate domestic and international aviation.

Data reported in inventories are consistent with Eurocontrol estimates, although the difference between the data sets regarding total fuel consumption and total CO_2 emissions has risen. On the other hand the share of domestic aviation matches Eurocontrol estimates very well from the year 2003 on. NO_x emissions from inventories are well in the uncertainty range of the ANCAT 3 model, too.

Table A 61 Fuel consumption and CO_2-Emissions United Kingdom

	Total fuel consumption			CO_2 emissions						Share domestic		
				Total			Domestic					
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]		[%]	
1996	7,204	7,037	2	22,787	22,160	3	1,440	2,055	-43	6.3	9.3	-47
1997	7,646	7,596	1	24,192	23,918	1	1,494	2,151	-44	6.2	9.0	-46
1998	8,502	8,366	2	26,885	26,346	2	1,624	2,316	-43	6.0	8.8	-45
1999	9,242	8,821	5	29,245	27,777	5	1,798	2,432	-35	6.1	8.8	-42
2000	10,177	9,049	11	32,212	28,494	12	1,963	2,434	-24	6.1	8.5	-40
2001	9,959	8,549	14	31,546	26,920	15	2,060	2,375	-15	6.5	8.8	-35
2002	9,797			31,006			2,072			6.7		
2003	10,039	9,069	10	31,754	28,557	10	2,114	1,949	8	6.7	6.8	-3
2004	11,201	9,807	12	35,426	30,882	13	2,302	2,096	9	6.5	6.8	-4
2005	11,848	10,354	13	37,473	32,604	13	2,465	2,249	9	6.6	6.9	-5
2006		10,700			33,695			2,200			6.5	

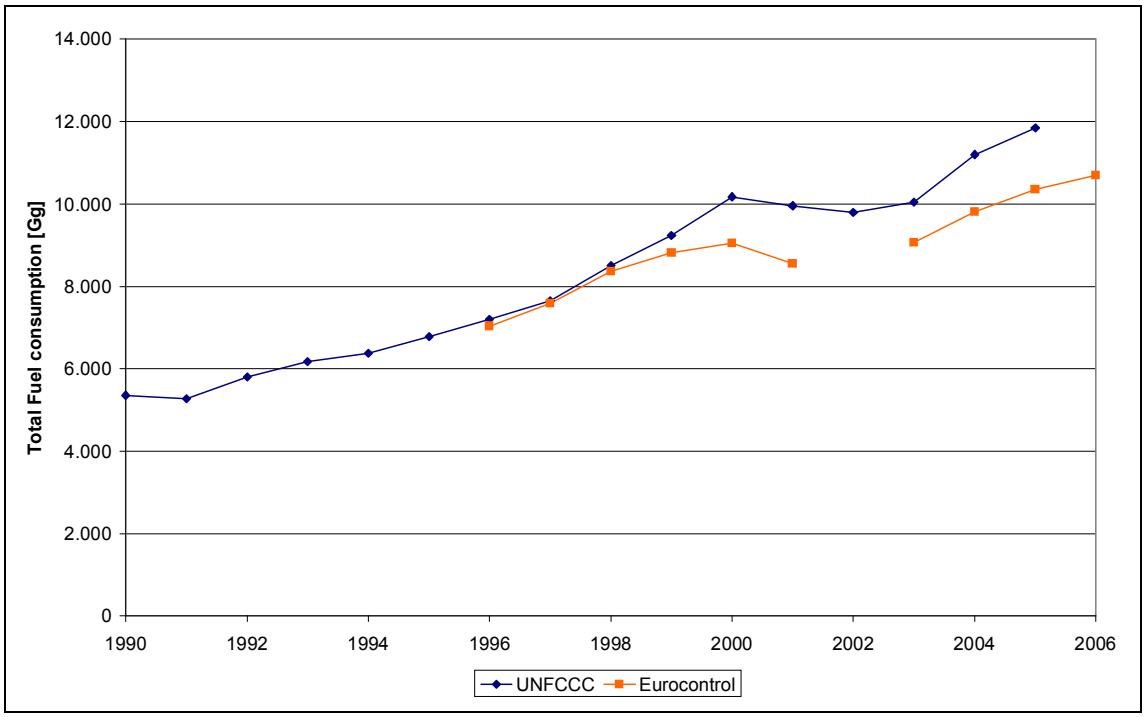
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Table A 62 NO_x-Emissions United Kingdom

	NO_x Emissions									Implied Emission Factor NO_x		
	Total			Domestic			International			Total		
	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation	NIR	Euro-control	Deviation
	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[Gg]	[Gg]	[%]	[g/kg]	[g/kg]	[%]
2003	139.7	125.9	10	7.5	7.3	2	132.2	118.5	10	13.91	13.88	0
2004	156.1	136.2	13	8.4	8.1	3	147.7	128.1	13	13.93	13.89	0
2005	165.5	143.5	13	9.1	8.9	3	156.3	134.7	14	13.97	13.86	1
2006		148.5			8.8			139.7			13.88	

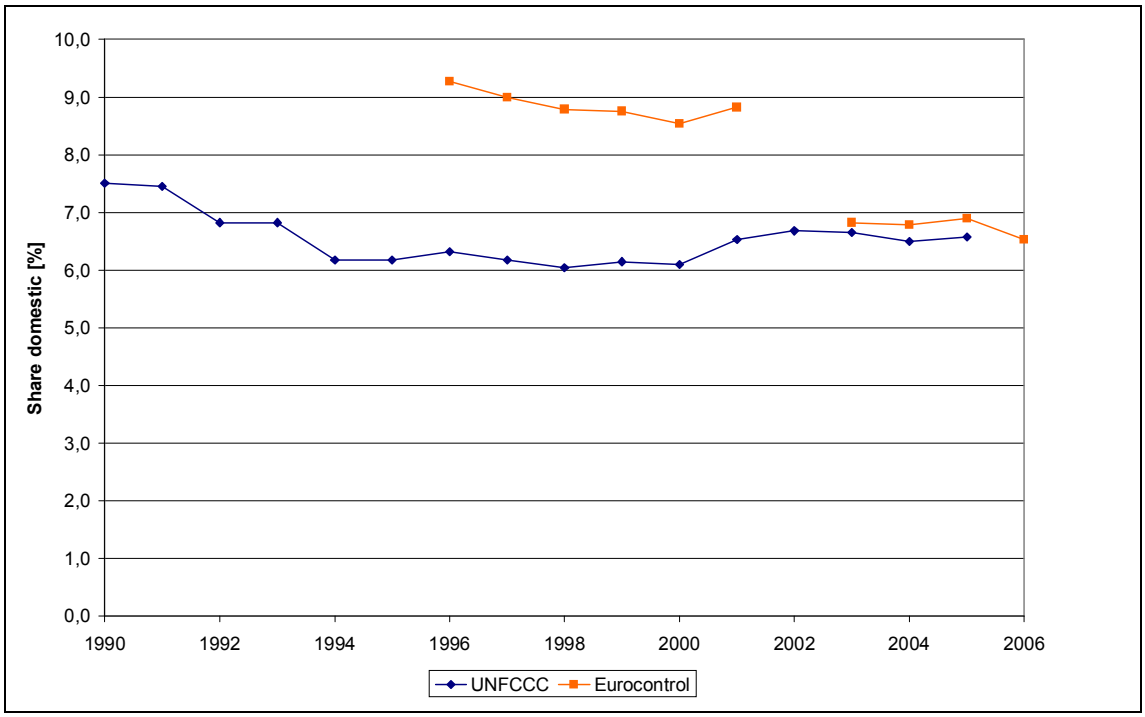
Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 61 Total fuel consumption United Kingdom



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations

Figure A 62 Share domestic United Kingdom



Source: EEA 2007a, ETC/ACC 2004, Eurocontrol 2007, own calculations