National Environmental Research Institute
Ministry of the Environment

Improving fuel statistics for Danish aviation

NERI Technical Report No. 387

National Environmental Research Institute
Ministry of the Environment

Improving fuel statistics for Danish aviation

NERI Technical Report No. 387
2001

Morten Winther
Department of Policy Analysis

Data sheet

Title: Improving fuel statistics for Danish aviation

Author: Morten Winther
Department: Department of Policy Analysis

Serial title and no.: NERI Technical Report No. 387

Publisher: Ministry of Environment
National Environmental Research Institute ©
URL: http://www.dmu.dk

Date of publication: December 2001

Referee: Helene Sneftrup Jensen, The Danish Energy Agency
Layout: Ann-Katrine Holme Christoffersen

Please cite as: Winther, M. 2001: Improving fuel statistics for Danish aviation. National Environmental Research Institute, Denmark. 56 p. – NERI Technical Report No. 387

Abstract: This report contains fuel use figures for Danish civil aviation broken down into domestic and international numbers from 1985 to 2000, using a refined fuel split procedure and official fuel sale totals. The results from two different models are used. The NERI (National Environmental Research Institute) model estimates the fuel use per flight for all flights leaving Danish airports in 1998, while the annual Danish CORINAIR inventories are based on improved LTO/aircraft type statistics. A time series of fuel use from 1985 to 2000 is also shown for flights between Denmark and Greenland/the Faroe Islands, obtained with the NERI model. In addition a complete overview of the aviation fuel use from the two latter areas is given, based on fuel sale information from Statistics Greenland and Statistics Faroe Islands, and fuel use data from airline companies. The fuel use figures are presented on a level, which facilitates the further summing of fuel according to different requirements. Methods on how to allocate the fuel use for passenger and cargo transportation are also discussed.

Keywords: Aircraft, Fuel use inventory, Energy statistics, Denmark, Greenland, the Faroe Islands, UNECE CLRTAP, UNFCCC, Passenger flights, Cargo flights.

Editing complete: December 2001

Financial support: The Danish Energy Agency

ISBN: 87-7772-655-3
ISSN (print): 0905-815x
ISSN (electronic): 1600-0048

Paper quality: Cyclus Office, 100 % recycled paper.
Printed by: Grønager's Grafisk Produktion A/S, Roskilde, Denmark
This publication is marked with the Nordic Environmental Label "Svanen".

Number of pages: 56
Circulation: 175
Price: DKK 75,- (incl. 25% VAT, excl. freight)

Internet version: The report is also available as a PDF-file from NERI's homepage
http://technical-reports.dmu.dk

For sale at:

Danish Environmental Research Institute
PO Box 358
Frederiksbogvej 399
DK-4000 Roskilde
Denmark
Tel.: +45 46 30 12 00
Fax: +45 46 30 11 14
e-mail: dmu@dmu.dk
www: www.dmu.dk

Miljøbutikken
Information and Books
Læderstræde 1
DK-1201 Copenhagen K
Denmark
Tel.: +45 33 95 40 00
Fax: +45 33 92 76 90
e-mail: butik@mem.dk
www.mem.dk/butik

Contents

Glossary and Terms

CAA-DK:	Civil Aviation Agency of Denmark.
Cargo flight:	Flight transporting cargo only. Can be regular or non-regular.
City-pair model/inventory:	Uses flight data with information on aircraft type and origin and destination airports.
CORINAIR:	Co-ordination Of Information On Air Emissions.
Cruise:	Part of the flight outside the LTO-cycle.
Charter flight:	Non-regular flight with a maximum take off weight exceeding 5700 kg.
EUROCONTROL:	The European Organisation for the Safety of Air Navigation.
Great Circle Distance:	The length of a natural curve between origin and destination airports.
ICAO:	International Civil Aviation Organisation.
IFR:	Instrumental Flight Rules (IFR) flights are made according to the instrumental flight rules. Typically flights are made with large aircraft, are commercial and controlled by air traffic control.
LTO:	Landing and Take-Off: A LTO cycle comprises the modes approach and landing from 3000 ft., taxi, take off and climb out to 3000 ft.
LTO/aircraft type statistics:	Information of the number of LTOs per aircraft type.
LTO times-in-modes:	Time durations of the four modes in a LTO cycle.
NERI:	National Environmental Research Institute of Denmark.
NM:	Nautical Miles. 1 NM = 1.852 km.
North-Atlantic flights:	Flights between Denmark, Greenland and the Faroe Islands, and reverse flights.
Scheduled flight:	Regular flight.
Taxi flight:	Non-regular flight with a maximum take off weight below 5700 kg.
UNECE CLRTAP:	United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution.
UNFCCC:	United Nations Framework Convention on Climate Change.

Preface

In Denmark there is a growing demand for consistent aviation fuel use statistics in order to meet specific requirements from different statistical bodies and to support emission inventories asked for by international conventions. Other urgent needs are valid fuel use data for monitoring work related to national target plans and to give proper advice on environmental matters. The Kingdom of Denmark includes Denmark, Greenland and the Faroe Islands. This special situation within the same country, characterised by long distances between the European continent and two North Atlantic island areas, makes specific statistical demands. In some situations the flights for Greenland and the Faroe Islands are regarded as domestic flights while in other cases the same flights must be classified as international flights. Therefore, depending on the recipient the fuel use information has different formats.

This report contains fuel use figures for Danish civil aviation broken down into domestic and international numbers from 1985 to 2000, using a refined fuel split procedure and official fuel sale totals. The total fuel sale figures for Greenland and the Faroe Islands are also divided into domestic and international numbers. In addition, simulated fuel use figures are given for flights between Denmark and Greenland/the Faroe Islands and reverse. All fuel use figures are reported on a level, which facilitates the further summing of fuel according to different requirements. Separately, methods of how to distinguish between the fuel use for passenger and cargo transport are also discussed in this report.

The project was funded by the Danish Energy Agency (DEA). The steering group consisted of Helene S. Jensen and Peter Dal, both DEA, and Morten Winther, National Environmental Research Institute (NERI).

Many thanks should be given to Lars H. Hansen, Copenhagen Airport, Jette Giørtz and Ronny Lilienvald, Billund Airport, Thomas Sigvardt, Århus Airport, and Torfinn Jacobsen, Vagar Airport, for flight data used in the calculations. Also special thanks to the following people providing fuel use data for flights in Greenland: Gary Plexman, First Air, Inge Merete Friis, Alpha Air, Thomas Leth Jørgensen and Hanne Bertels, both Greenlandair. Thanks should also be given to Andreas Vedel, Statistics Greenland, for improving the overview of aviation fuel uplift in airports in Greenland, and to Henrik Gravesen, CAA-DK, for fruitful discussions on the cargo fuel use inventory part. Lastly, thanks to Helene Sneftrup Jensen, DEA, for technical comments and to Joshua Nash for English proofreading.

Summary

Objectives
In Denmark there is a growing demand for more detailed aviation fuel use statistics in order to meet specific requirements from different statistical bodies and to support emission inventories requested by international conventions. The Kingdom of Denmark includes Denmark, Greenland and the Faroe Islands. Depending on the recipient the flights for Greenland and the Faroe Islands are regarded as either domestic or international flights.

The primary objectives of this project are to 1) develop a method to divide the total civil aviation fuel sold in Denmark into domestic and international aviation fuel sale figures from 1985 to 2000, and 2) estimate the fuel used by flights between Denmark and Greenland/the Faroe Islands, and domestic and international fuel use from the two latter areas for the same time period. Both methods under 1) and 2) should be used in the future as input to the yearly Danish fuel use statistics. The last objective is to develop a method, which allocates domestic and international fuel use into fuel figures for passenger and cargo.

Danish Energy Statistics
The Danish Energy Agency (DEA) has made a split of the total fuel sale into domestic and international shares with the DEA model; a model developed by the Ministry of Transport. Using information on aircraft type and origin and destination airports for domestic flights (city-pair data) the DEA model gives fairly accurate domestic fuel estimates. However, the model cannot distinguish between fuel use for LTO (Landing and Take Off, < 3000 ft) and cruise (> 3000 ft). This grouping is essential for fuel use and emission inventories in the European-wide CORINAIR (COoRdination of INformation on AIR emissions) emission inventory system.

To obtain the fuel split as required by CORINAIR, instead the NERI model has been used together with the annual Danish CORINAIR inventories. The latter estimates are based on improved LTO/aircraft type statistics, while the NERI model (a city-pair model) computes the fuel use for 1998 in CORINAIR categories. As a starting point the domestic and international cruise fuel use shares from the NERI model are regarded as precisely enough for 1998 along with each year's Danish LTO estimates.

In 1998 the Danish fuel sale total minus the total LTO estimate gives the total cruise fuel use. This total and the shares from the NERI model gives absolute values for domestic and international cruise fuel use. To find the cruise figures for other years, firstly the cruise fuel use figures obtained for 1998 are scaled with the yearly LTO fuel use development related to 1998. From these cruise figures the domestic and international shares are derived for each year. Finally, these shares are used to make a split in the real cruise fuel use total

for 1985-2000. This total is known as the difference between each year's fuel sale and LTO fuel sum.

Fuel use for flights between Denmark, Greenland/the Faroe Islands and domestic Greenland/Faroe flights
For flights between Denmark and Greenland/the Faroe Islands (North Atlantic flights) the time series of fuel use in 1985-2000 have been calculated with the NERI model. Data was limited to 1999 and 2000 for flights leaving the Faroe Islands and no flight data was available from Greenland for this study. In these situations the fuel results for Danish return flights were used. Since almost all the North Atlantic flights are return flights the total fuel use estimate (per round trip) is fairly precise. However, precautions must be taken in terms of fuel allocation. Due to fuel price differences most of the fuel is being lifted up in Denmark.

Fuel use for international flights from the Faroe Islands and domestic flights are also simulated with the NERI model for 1999 and 2000. Approximations are made for previous years on the basis of the air traffic development. Because of the high fuel prices in the Faroe Islands, the statistical fuel sale figures are much smaller than calculated results for the actual flight. However, by making proper assumptions the fuel sale figures are summarised according to domestic, Danish and other international flights.

This distinction is also made for Greenland. Information on the total fuel sale is available and fuel use data has been gathered for international flights. Fuel use figures for the reverse flight are used to estimate the fuel used by Danish flights. For domestic flying the fuel use is calculated as total fuel sale minus fuel used by Danish and other international flights.

Fuel use data for the Kingdom of Denmark in convention formats
Based on the previously derived results a 1985-2000 times series of fuel use is produced according to the different formats of the UNFCCC (United Nations Framework Convention on Climate Change) and UNECE CLRTAP (United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution) conventions. The data serve as input data for emission estimates as required by the two conventions.

Dividing fuel use by passenger and freight
In this study three methods to divide the fuel use by passenger and freight are discussed with an increased level of detail. A basic approach is to simulate the fuel use for sole cargo flights. This has already been done for domestic flights from 1991 to 1999 as a part of the DEA model. If flight data for 2000 is obtained both for domestic and international flights, a 1991-2000 fuel use inventory can be made with the NERI model. For years prior to 2000 more rough international estimates can be made using LTO/aircraft type statistics already available.

Ideally an approximation of the fuel used for cargo transportation on passenger flights can be made using the sole cargo results. This extra fuel calculation is the product of the cargo weight ratio for passenger-cargo flights and the fuel use for sole cargo flights. Thus data is required for the total handled cargo weight and the cargo weight for sole cargo flights. The most detailed approach is to use city-pair flight data with number of passengers (with an average weight per passenger) and cargo weight. The fuel use per flight can be estimated with the NERI model and subsequently split into shares for passenger and cargo.

Conclusion

In this study a method has been developed to give a consistent split of Danish fuel sale totals into domestic and international jet fuel use in a time series from 1985 to 2000, further broken down into fuel used for LTO (< 3000 ft) and cruise (>3000 ft). The method is using precise domestic and international LTO/aircraft type information from Copenhagen Airport. More accurate cruise fuel use estimates have been calculated based on model results from the detailed NERI model. A good relationship exists between this study and the current split made with the DEA model for domestic flights; the result deviate between + 7 % and –2%.

The present report gives a good overview of the fuel used by flights between Denmark and Greenland/the Faroe Islands, and the fuel use by the remaining North Atlantic flights. This yields a precise fuel grouping for the UNFCCC and UNECE conventions. Unrealistic deviations in fuel sale totals suggest that the statistics for Greenland needs further elaboration.

It is possible to make a fuel use inventory for sole cargo flights. In terms of a fuel use approximation for cargo on passenger flights, the cargo weight data available are still scarce and uncertain. If data are to be included they must refer to flights leaving Danish airports. Moreover an actual problem is that a bias is introduced in the calculations. A part of the statistical figures cover goods being transported by trucks to airports in other countries from where it is flown out. The prospects of making a detailed and complete cargo fuel use inventory will become increasingly better. From 2001 and onwards the flight statistics will presumably contain data for number of passengers and cargo weight for each flight leaving a large Danish airport.

Sammendrag

Formål
I Danmark er der et stigende behov for mere detaljerede opgørelser om flys energiforbrug, dels til brug for diverse statistiske indberetninger og dels som baggrundsdata til emissionsopgørelser iht. internationale konventioner. Kongeriget Danmark omfatter både Danmark, Grønland og Færøerne og afhængig af fra hvilken side der forespørges om energitotaler, betragtes flyturene til Grønland og Færøerne enten som indenrigs- eller udenrigsflyvninger.

Hovedformålet med dette projekt er 1) at udvikle en model der fordeler det samlede civile jetbrændstofsalg i et indenrigs- og udenrigsforbrug for årene 1985-2000, og 2) at opgøre brændstofforbruget i samme periode for flyvninger mellem Danmark og Grønland/Færøerne samt indenrigs- og udenrigsforbruget for de to sidste områder. De to metoder bestemt i 1) og 2) skal bruges i fremtiden som input til den årlige danske energistatistik. Projektets sidste formål er at udvikle en metode der fordeler indenrigs- og udenrigsforbruget i tal for passager- og godstransport.

Den danske energistatistik
Energistyrelsen (ENS) har fordelt det samlede brændstofsalg i indenrigs- og udenrigsforbrug med ENS-modellen der er udviklet af Trafikministeriet. Ud fra oplysninger om flytype og start- og ankomstlufthavn (city-pair data) for hver enkelt flyvning kan modellen beregne indenrigsforbruget rimeligt præcist. Modellen kan ikke opdele energiforbruget i LTO (Landing and Take Off, < 3000 ft) og cruise (> 3000 ft). Opdelingen er nødvendig når brændstof- og emissionsopgørelser skal beregnes i det fælleseuropæiske CORINAIR (COoRdination of INformation on AIR emissions) system.

For at fremskaffe den opdeling af brændstofforbruget som CORINAIR foreskriver, bruges DMU-modellen i stedet sammen med de årlige danske CORINAIR opgørelser. De sidstnævnte opgørelser er baseret på en forbedret LTO/flytype statistik mens DMU-modellen (en city-pair model) kan beregne brændstofforbruget for 1998 efter CORINAIRs opdeling. Som udgangspunkt antages at DMU-modellens procentandele for cruise brændstofforbruget i 1998 er præcise nok. Det samme antages at gælde for de årlige CORINAIR LTO opgørelser.

I 1998 beregnedes det totale cruiseforbrug som det totale salg minus den beregnede mængde for LTO. Cruisetotalen og procentandelene fra DMU-modellen gav absolutte værdier for indenrigs og udenrigs cruiseforbruget. Til bestemmelse af andre års cruiseforbrug skaleredes de absolutte cruiseværdier for 1998 med udviklingen i brændstofforbruget for LTO set i forhold til 1998. Med de herved beregnede cruiseværdier opstilles indenrigs og udenrigs procentandelene for 1985-2000. Endeligt bruges procentandelene til at opdele årenes virkelige cruiseforbrug. Dette forbrug er forskellen mellem salget og den beregnede mængde for LTO.

Brændstofforbrug for flyvninger mellem Danmark, Grønland/Færøerne og indenrigs flyvninger på Grønland og Færøerne
En tidsserie for brændstofforbruget i 1985-2000 beregnes med DMU-modellen for flyvninger mellem Danmark og Grønland/Færøerne (Nord-Atlantiske flyvninger). For flyvninger fra Færøerne er data begrænset til 1999 og 2000 mens ingen data har kunnet fremskaffes for grønlandske starter. I situationer med datamangel bruges resultaterne for flyvningerne fra Danmark. Da næsten alle de Nord-Atlantiske flyvninger er returflyvninger er den samlede total (pr. returflyvning) rimelig præcis. Der skal dog tages et vist forbehold med hensyn til fordelingen. På grund af prisforskelle bliver størstedelen af brændstoffet tanket i Danmark.

For 1999 og 2000 bruges DMU-modellen også for Færøerne til at beregne både indenrigsforbruget og de internationale flyvningers forbrug. Tilnærmede tal for tidligere år er bestemt ud fra udviklingen i flytrafikken. På grund af de høje brændstofpriser på Færøerne er brændstofsalget meget mindre end det beregnede forbrug for den virkelige flyvning. Med diverse tillempelser kan det dog lade sig gøre at gruppere brændstofsalget efter indenrigs, danske og andre internationale flyvninger.

Denne opdeling er også gjort i Grønlands tilfælde. Den totale salgsstatistik er tilgængelig og forbrugsdata er blevet oplyst for internationale flyvninger. Forbrugstal for de omvendte flyvninger bruges til at opgøre forbruget for flyvninger til Danmark. Indenrigsforbruget beregnes som totalsalget minus de danske og internationale flyvningers forbrug.

Forbrugsdata for Kongeriget Danmark ifølge konventionskrav
Ud fra projektets resultater opstilles en tidsserie for årene 1985-2000 i formaterne for de to konventioner UNFCCC (United Nations Framework Convention on Climate Change) og UNECE CLRTAP (United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution). Forbrugstallene bruges som input til de videre emissionsberegninger for de to konventioner.

Opdeling af brændstofforbruget efter passager og gods
I nærværende projekt skitseres tre metoder til at opdele flys brændstofforbrug efter passager- og gods med en stigende detaljeringsgrad. En standardmetode er at beregne forbruget for rene godsfly. Dette er allerede gjort med ENS-modellen for indenrigsflyvninger og årene 1991-1999. Hvis indenrigs- og udenrigsflydata kan fremskaffes for 2000, kan en opgørelse laves for 1991-2000 med DMU-modellen. For årene før 2000 kan tillempede opgørelser laves for udenrigsflyvningerne ud fra den allerede tilgængelige LTO/flytype statistik.

Ideelt set kan man lave et skøn over forbruget ved godstransport med passagerflyvninger ud fra de rene godsflys resultater. Denne ekstra brændstofmængde beregnes som produktet af det totale godsforhold for passager-/godsflyvninger og rene godsflyvningers brændstofforbrug. Der er brug for data for den totale godsmængde og godsmængden ombord på rene godsfly. Den mest detaljerede metode er at bruge city-pair flydata hvor også antallet af passagerer (med en gennemsnitlig vægt pr. passager) og godsvægten oplyses. Forbruget pr. flyvning kan beregnes med DMU-modellen, og i næste trin fordeles i et forbrug for passager og gods.

Konklusion
I denne undersøgelse er der udviklet en konsistent metode til at opdele den totalt solgte mængde af flybrændstof i Danmark i et indenrigs- og udenrigsforbrug. Opdelingen er gjort for årene 1985-2000 og er yderligere grupperet efter LTO (< 3000 ft) og cruise (>3000 ft). Metoden bruger præcise oplysninger om indenrigs og udenrigs LTO/flytypefordelingen fra Københavns Lufthavn. Mere præcise cruiseforbrug er beregnet på basis af DMU modellens resultater. Der er en god overensstemmelse mellem denne undersøgelses og ENS-modellens resultater for indenrigsforbruget; forskellene ligger mellem + 7 % og –2%.

Denne rapport giver et godt overblik over brændstofforbruget for flyvninger mellem Danmark og Grønland/Færøerne og de øvrige Nord Atlantiske flyvninger. Resultaterne kan grupperes præcist som UNFCCC og UNECE konventionerne foreskriver. Urealistiske udsving i totalsalget tyder på at Grønlands brændstofstatistik kræver yderligere arbejde.

En brændstofopgørelse kan godt laves for rene godsfly. Data for godsmængder er stadig mangelfulde og usikre når et skøn skal laves over forbruget henført til gods med passagerfly. Skal data bruges, må de gælde for flystarter i danske lufthavne. Et reelt problem er yderligere, at der indføres en systematisk fejl i beregningen. En del af godsmængderne dækker over varer der transporteres ad landevejen til lufthavne i andre lande, hvorfra de flyves ud. Udsigterne til en komplet og detaljeret opgørelse for godsflyvningernes brændstofforbrug bliver stadigt bedre. Efter alt og dømme vil flystatistikken fra 2001 rumme oplysninger om passagerantal og godsmængde for hver flyvning der starter fra store danske lufthavne.

1 Introduction

In the Danish energy statistics fuel used by flights from Denmark to Greenland and the Faroe Islands are reported as international fuel use. This definition is in line with the requirements from the UNECE CLRTAP (United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution) convention. However, the UNFCCC (United Nations Framework Convention on Climate Change) convention prescribe this fuel use to be reported as a part of the Danish domestic fuel use, together with the fuel used by reverse flights and the fuel used in Greenland and the Faroe Islands for domestic flights.

This project aims to:

1) develop a method to divide total civil aviation fuel sold in Denmark into domestic and international aviation fuel sale figures from 1985 to 2000;

2) estimate the fuel used by flights between Denmark and Greenland/the Faroe Islands, and domestic and international fuel use for the two latter areas within the same time period;

3) develop a method which allocates domestic and international fuel use into figures for passenger and cargo.

Both methods under 1) and 2) should be used in the future to ensure consistent fuel use statistics.

In this study a consistent time series of fuel use for domestic and international flights from Danish airports is produced by combining the results from two different models. The NERI (National Environmental Research Institute) model estimates the fuel use per flight for all flights leaving Danish airports in 1998, while the annual Danish CORINAIR inventories are based on improved LTO/aircraft type statistics.

The NERI model will also be used to obtain fuel use results for flights between Denmark and Greenland/the Faroe Islands. To gain a complete overview of the aviation fuel use from the two latter areas, additional fuel sale information are gathered from Statistics Greenland and Statistics Faroe Islands together with fuel use data from airline companies.

In chapter 2 it is explained how to improve the split between domestic and international aviation fuel sold in Denmark from 1985 to 2000. For the same time period chapter 3 describes how to simulate the fuel use for flights between Denmark and Greenland/the Faroe Islands. As regards Greenland and the Faroe Islands chapter 3 also explains how to make a division in the fuel statistics between domestic and international fuel sold. The fuel use results given in chapter 2 and 3 are used in chapter 4 to present fuel use totals according to the UNECE and UNFCCC conventions. Methods of how to distinguish between the fuel use for passenger and cargo transport are presented in chapter 5.

2 Danish energy statistics

The Danish Energy Agency (DEA, 2000) aggregates information from all seven oil companies selling fuel to Danish airports. Every year DEA receives information from each oil company on a specific reporting scheme. All schemes are summarised for each individual fuel type to give the overall Danish total for fuel used for civil purposes in national airports.

Table 1. Total end-use of energy in Danish airports in 1999 (DEA, 2000)

End-use information 1999	International [m^3]	Domestic [m^3]	Military [m^3]	International [TJ]	Domestic [TJ]	Military [TJ]
Jetpetrol/JP1	834,295	145,893	42,350	29,033	5,077	1,474
Aviation gasoline	125	3,471	195	4	108	6
Motor gasoline		594	995		20	33
Env. gas/diesel		2,325	4,626		83	166
Diesel		150	1,253		5	45
Heating oil		1,420	280		51	10
Other gas/diesel		0	21,785		0	781
Other Kerosene		2,045	0		71	0
LPG			27			1

In Denmark the fuel used for different purposes are well defined (BKL I/S, the fuel depot at Copenhagen Airport, 2000). In this way JP1 is used by aircraft jet engines, while aviation gasoline is used for small piston engined aircraft. Motor gasoline and Environmental gas/diesel (very low sulphur content) and diesel oil are used by ground handling vehicles. Heating oil is used for special purposes like the pre-heating of aircraft and for heat generation in working areas. The other kerosene fuel type is also used for heating purposes.

However, large uncertainties are associated with the fuel split (jet petrol and aviation gasoline) used for domestic and international flights. Although oil companies make this information available, they do concede, however, that this fuel split is an unreliable measure.

2.1 Domestic/international split made by DEA

The fuel split is made by the DEA by using flight data from Copenhagen Airport for domestic flights. The DEA model is a city-pair model. It uses information of aircraft type and destination airport for each flight (Ministry of Transport, 2000a). The model assumes that all flights are return flights. To facilitate the actual calculations, all aircraft types are classified according to 10 representative aircraft types. The fuel data are obtained from the Danish TEMA2000 model (see Ministry of Transport, 2000b) and for smaller aircraft types as information from airline companies. The fuel used for international flights is subsequently estimated as the difference between the total fuel sale figure and the domestic fuel result. Flights for Greenland and the Faroe Islands are regarded as international flights. Table 2 shows the fuel use from 1988 to 1999 estimated with the DEA existing method.

Table 2. Danish 1988-1999 domestic/international jet fuel use (DEA, 2000)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]
Domestic	2,464	2,558	2,444	2,262	2,226	2,227	2,239	2,299	2,510	2,562	2,279	1,979
International	25,093	26,045	24,887	23,031	23,838	23,318	25,598	26,244	27,579	28,177	30,282	32,132
Total	27,557	28,603	27,331	25,293	26,064	25,545	27,837	28,543	30,089	30,739	32,561	34,111

2.2 Refinement of DEA domestic/international jet fuel split

The DEA approach does not take into account the division in fuel use between LTO[1] (Landing and Take Off, < 3000 feet) and cruise (> 3000 feet) for domestic and international flights. This division of fuel use is necessary for the European-wide CORINAIR (COoRdination of INformation on AIR emissions) emission inventory system. In CORINAIR country-specific fuel use and emission data are gathered and the emissions are summarised and further reported to international conventions such as the United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution (UNECE CLRTAP).

All Danish environmental data (and underlying fuel use numbers) are organised in CORINAIR and a split in aviation fuel must therefore be made according to the CORINAIR definitions. This yields a consistency between the Danish aviation fuel statistics and the Danish obligations in relation to international conventions and forums. In order to make this split of fuel into LTO (<3000 ft) and cruise (>3000 ft) the results from two different models are combined. The two models are described in section 2.2.1 and 2.2.2.

2.2.1 The NERI model

In 1998, a detailed city-pair fuel use analysis was made at the National Environmental Research Institute (NERI) for all IFR (Instrumental Flight Rules) flights leaving Danish airports (Winther, 2000 and 2001). The NERI model is based on the new detailed CORINAIR calculation principle (CORINAIR, 1999). Air traffic data was provided by EUROCONTROL (The European Organisation for the Safety of Air Navigation) and information on aircraft types and air-

[1] A LTO cycle refers to the aircraft activity in four modes from 3000 ft during 1) descent/landing, 2) airport taxi in/out, 3) take off and 4) climb out to a level of 3000 ft.

port codes was obtained from ICAO (International Civil Aviation Organization), see ICAO (1998, 1999). Flights to Greenland and the Faroe Islands were classified as international flights. All aircrafts were grouped into 24 representative aircraft types for which fuel use and emission data were available in the CORINAIR databank (www.eea.int/aegb/) per LTO and for distance classes. Cruise results were estimated for each flight by adjusting for the given flight length.

Table 3. Cruise fuel use shares per airport and domestic/international from the Danish 1998 study

Airport	Domestic [%]	International [%]
Copenhagen	2.5	84.5
Other airports	2.5	10.5
Sum	5.0	95.0

An adjustment of the domestic cruise fuel use in other airports was made to take into account different numbers of flights from EURO-CONTROL in the NERI model and the national estimates from the current CORINAIR model, which uses take off numbers provided by the Civil Aviation Agency of Denmark (CAA-DK).

2.2.2 Annual Danish CORINAIR inventories

At present no time series of city-pair flight data, with information about each flight's departure and destination airport, are available to support the current Danish aviation fuel use inventory work. So far this information is only available for the year 1998 provided by EUROCONTROL and used in the NERI study described in 2.2.1.

The official Danish CORINAIR estimates are based on the number of domestic and international LTOs per aircraft type (LTO/aircraft type statistics) and their respective LTO times-in-mode. The most detailed data are available for Copenhagen Airport, see Copenhagen Airport (1998 and 2001), where an Environmental Impact Assessment (EIA) has proposed 20 aircraft types to represent all aircraft and as a part of this made a survey to determine the most frequently used engine in these 20 representative aircraft types (Copenhagen Airport, 1996). Other Danish airports only submit their statistics for domestic and international LTOs for large and small aircraft (Statistics Denmark; 1986, 1989-1999 and CAA-DK, 2000, 2001a). Flights to Greenland and the Faroe Islands are regarded as international flights.

2.3 Refinement procedure for domestic/international fuel split

The Danish CORINAIR inventories can be improved both for LTO and cruise. Previously (until 2000) information about the total number of LTOs per aircraft type was obtained from Copenhagen Airport and subsequently NERI made an estimate of the split between domestic and international fuel use.

Now the distinction between domestic and international LTOs can be made directly (since 2000) using new flight information from Copenhagen Airport for the years 1991-2000, which improves the precision of the final LTO results. For cruise the estimates also become more accurate by using both the improved LTO results, and in particular the cruise results from the detailed 1998 study.

The improvement of LTO fuel use is described in section 2.3.1 and the improvement of cruise fuel use in section 2.3.2.

2.3.1 Refining LTO fuel use

From LTO times-in-modes (approach/landing, taxiing, take off and climb out), the fuel use factors are computed for Copenhagen Airport by using engine specific fuel flow indices from the ICAO engine exhaust emission data bank (see ICAO, 1995) for the representative aircraft types:

$$FC^{i}_{LTO} = \sum_{m=1}^{4} t_m \cdot ff_m \quad (1)$$

Where

FC_{LTO}^{i} = Fuel Consumption per LTO for aircraft type i (in kg)
t_m = The time duration of LTO-mode m in seconds
ff_m =Fuel flow for mode m (kg per second)
m = mode (1= approach/landing, 2= airport taxi, 3= take off, 4= climb out to 3000 ft)
i = aircraft type (i=1,2,....,20).

Other airports are treated in the model as one, and for domestic flying aggregated LTO data for Copenhagen Airport is used slightly modified for lower taxi-times. This assumption can be made since almost all domestic trips (scheduled and charter) are made via Copenhagen Airport.

Now it is possible to calculate the total LTO fuel use for each airport by using fuel use per LTO and aircraft type, i, (FC_{LTO}^{i}) in combination with the number of LTOs per aircraft type i:

$$\sum_{i=1}^{20} FC^{i}_{LTO} = N^{i}_{LTO} \cdot FC^{i}_{LTO} \quad (2)$$

Where
N_{LTO}^{i} = Number of LTOs made with aircraft type i.

Appendix 1 and 2 show the fuel use factors per LTO and aircraft type and the number of LTOs per representative aircraft type in different airports for the years 1985-2000. Based on numbers from appendix 1 and 2 the following example illustrates the method:

The fuel use factor (FC_{LTO}^{i}) for the aircraft type B737 in Copenhagen Airport is calculated using formula (1) and the fuel use for the four LTO modes given in appendix 1:

144.9 kg + 153.8 kg + 124.8 + 57.8 kg = 481,3 kg JP1 (3) which can be converted into 20.9 GJ by using a calorific value of 43.5 GJ/ton of JP1.

In 2000 the aircraft type B737 made 27,100 LTOs in Copenhagen airport with international destination (N_{Lto}^{i}) as can be seen in appendix 2. Thus the total fuel use by aircraft B737 in Copenhagen airport in the year 2000 is calculated as 20.9 GJ per LTO times 27,100 LTOs; this gives a fuel use of 566 TJ.

To end up with total LTO figures the calculations in (2) is repeated for all aircraft types and summed up separately for Copenhagen Airport and other airports, and for domestic and international LTOs. Appendix 3 shows each year's LTO fuel use results per aircraft type in Copenhagen Airport and as totals for other airports with a distinction between domestic and international.

2.3.2 Refining cruise fuel use

The total cruise fuel use is estimated as the difference between the total aviation fuel use from DEAs sale statistics and the total LTO fuel use from above. The split of total cruise fuel use into airports and domestic/international flights is based on the findings from the 1998-NERI study (table 3 in section 2.2.1).

The amount of cruise fuel allocated to Copenhagen/Other airports, for domestic and international flights in 1998 then becomes:

$$FC_{CR}^{j}(1998) = \%FC_{CR}^{j}(1998, NERI) \cdot FC_{CR}(1998) \quad (4)$$

Where

FC_{CR}^{j} = Fuel consumption for cruise by flights from j

j = 1=Copenhagen airport, domestic, 2=Other airports, domestic, 3= Copenhagen airport, international, 4= other airports, international

$\%FC_{CR}^{j}$ (1998,NERI) = Share of fuel use by flights from j based on the NERI study from 1998.

FC_{CR} (1998) = Total cruise fuel use (based on total sold aviation fuel minus LTO fuel use)

The split in cruise fuel use between Copenhagen/Other airports, for domestic and international flights for a given year, X, is calculated in two steps. The first step estimates the shares in table 3 for the given year X. In the second step these estimated shares are used to distribute the total cruise fuel use in year X, since the cruise total is a known actual figure based on the sales figures for total aviation fuel minus the total LTO fuel use in year X. In the first step the estimated cruise share is assumed to develop like the LTO fuel use over time. From formula (4) it is seen that if LTO fuel use in year X for flights from j accounts for 80 % of LTO use in 1998 for flights from j, then the cruise fuel use in year X for flights from j is also assumed to account to 80 % of the corresponding fuel use in 1998:

$$FC_{CR}^{j}(X) = FC_{CR}^{j}(1998) \cdot \frac{FC_{LTO}^{j}(X)}{FC_{LTO}^{j}(1998)}, \text{ where j=1,..4} \quad (5)$$

The sum of fuel used for cruise flying is a sum of the four cruise fuel contributions:

$$FC_{CR}(X) = \sum_{j=1}^{4} FC_{CR}^{j}(1998) \cdot \frac{FC_{LTO}^{j}(X)}{FC_{LTO}^{j}(1998)} \quad (6)$$

The cruise sub-totals and total cruise fuel use found in (5) and (6) take into account the changes in LTO fuel use from the baseline year 1998. This correction expresses the change in aircraft types and number of operations. However, variations in the flight length distribution over the years are not compensated for since no aircraft/city-pair information is available for each calculation year to refine this study. Instead (5) and (6) can be transformed in a second step which as an end result gives the true cruise fuel use sum.

The true total for cruise fuel use in a given year, $FC_{CR,TRUE}(X)$ is known as the difference between total aviation fuel use and total LTO fuel use. The difference between this total and the total found in step 1 must be distributed into the four cruise parts to end up with correct numbers. The distribution is made on the basis of the cruise fuel use amount for each sector found in (4). The true amounts become:

$$FC_{CR,TRUE}^{j}(X) = FC_{CR,TRUE}(X) \frac{FC_{CR}^{j}(X)}{FC_{CR}(X)} \quad (7)$$

Finally the true cruise total is found as:

$$FC_{CR,TRUE}(X) = \sum_{j=1}^{4} FC_{CR,TRUE}(X) \frac{FC_{CR}^{j}(X)}{FC_{CR}(X)} \quad (8)$$

Based on the LTO fuel use results from appendix 3 and fuel sale figures for JP1 in 1998 (table 2) the following example for 1999 illustrates the method. Equation (4) yields the cruise fuel use in step 1 for each airport and domestic/international:

$$FC_{CR}^{1}(1999) = FC_{CR}^{1}(1998) \cdot \frac{FC_{LTO}^{1}(1999)}{FC_{LTO}^{1}(1998)} = (32{,}561TJ - 3{,}650TJ) \cdot 2.5\% \cdot \frac{383TJ}{420TJ} = 663TJ \quad (9)$$

$$FC_{CR}^{2}(1999) = FC_{CR}^{2}(1998) \cdot \frac{FC_{LTO}^{2}(1999)}{FC_{LTO}^{2}(1998)} = (32{,}561TJ - 3{,}650TJ) \cdot 2.5\% \cdot \frac{320TJ}{347TJ} = 674TJ \quad (10)$$

$$FC_{CR}^{3}(1999) = FC_{CR}^{3}(1998) \cdot \frac{FC_{LTO}^{3}(1999)}{FC_{LTO}^{3}(1998)} = (32{,}561TJ - 3{,}650TJ) \cdot 84.5\% \cdot \frac{2{,}728TJ}{2{,}587TJ} = 25{,}756TJ \quad (11)$$

$$FC_{CR}^{4}(1999) = FC_{CR}^{4}(1998) \cdot \frac{FC_{LTO}^{4}(1999)}{FC_{LTO}^{4}(1998)} = (32{,}561TJ - 3{,}650TJ) \cdot 10.5\% \cdot \frac{276TJ}{296TJ} = 2{,}823TJ \quad (12)$$

Equation (5) gives the total cruise fuel use in 1999 calculated in step 1:

$$FC_{CR}(1999) = \sum_{j=1}^{4} FC_{CR}^{j}(1999) = 29{,}917TJ \quad (13)$$

Now the true domestic/international cruise fuel use is found for each airport using equation (6):

$$FC_{CR,TRUE}^{1}(1999) = FC_{CR,TRUE}(1999) \cdot \frac{FC_{CR}^{1}(1999)}{FC_{CR}(1999)} = (34{,}111TJ - 3{,}707TJ) \cdot \frac{663TJ}{29{,}917TJ} = 674TJ \quad (14)$$

$$FC_{CR,TRUE}^{2}(1999) = FC_{CR,TRUE}(1999) \cdot \frac{FC_{CR}^{2}(1999)}{FC_{CR}(1999)} = (34{,}111TJ - 3{,}707TJ) \cdot \frac{674TJ}{29{,}917TJ} = 685TJ \quad (15)$$

$$FC_{CR,TRUE}^{3}(1999) = FC_{CR,TRUE}(1999) \cdot \frac{FC_{CR}^{3}(1999)}{FC_{CR}(1999)} = (34{,}111TJ - 3{,}707TJ) \cdot \frac{25{,}756TJ}{29{,}917TJ} = 26{,}175TJ \quad (16)$$

$$FC_{CR,TRUE}^{4}(1999) = FC_{CR,TRUE}(1999) \cdot \frac{FC_{CR}^{4}(1999)}{FC_{CR}(1999)} = (34{,}111TJ - 3{,}707TJ) \cdot \frac{2{,}823TJ}{29{,}917TJ} = 2{,}869TJ \quad (17)$$

Table 4 shows the fuel use results based on the new refined methods dividing aviation into LTO fuel (use < 3000 ft) and cruise (> 3000 ft), as described above.

Table 4. Refined 1985-2000 fuel results for JP1 in Denmark

Airport	Category	1985 [TJ]	1986 [TJ]	1987 [TJ]	1988 [TJ]	1989 [TJ]	1990 [TJ]	1991 [TJ]	1992 [TJ]	1993 [TJ]	1994 [TJ]	1995 [TJ]	1996 [TJ]	1997 [TJ]	1998 [TJ]	1999 [TJ]	2000 [TJ]
CPH	Dom. LTO	350	377	402	424	453	445	407	426	413	413	450	474	495	420	383	337
Other	Dom. LTO	322	340	356	372	392	368	354	360	347	336	365	392	406	347	320	281
All s	Dom. LTO	672	717	758	796	844	814	760	785	760	749	815	866	901	767	703	618
CPH	Int. LTO	1,678	1,726	1,825	1,908	1,988	1,974	1,865	2,004	2,034	2,093	2,187	2,339	2,514	2,587	2,728	2,756
Other	Int. LTO	75	80	86	92	133	171	138	149	168	175	202	287	296	296	276	281
All	Int. LTO	1,752	1,806	1,911	1,999	2,121	2,145	2,003	2,153	2,202	2,267	2,389	2,626	2,811	2,883	3,004	3,037
CPH	Dom. cruise	687	760	829	889	924	857	775	777	722	773	814	818	814	727	674	603
Other	Dom. cruise	770	835	895	948	974	863	820	799	739	765	804	824	811	731	685	610
All	Dom. cruise	1,457	1,595	1,724	1,837	1,898	1,720	1,595	1,576	1,461	1,538	1,617	1,642	1,625	1,458	1,359	1,213
CPH	Int. cruise	17,966	18,983	20,538	21,789	22,130	20,705	19,379	19,942	19,381	21,350	21,560	22,023	22,522	24,426	26,175	26,827
Other	Int. cruise	867	959	1,050	1,136	1,609	1,947	1,555	1,608	1,740	1,933	2,161	2,932	2,880	3,028	2,869	2,969
All	Int. cruise	18,833	19,942	21,589	22,925	23,740	22,653	20,934	21,550	21,122	23,283	23,721	24,955	25,402	27,454	29,045	29,796
All	Cruise Sum	20,291	21,537	23,313	24,762	25,637	24,372	22,530	23,126	22,582	24,821	25,338	26,597	27,027	28,912	30,404	31,009
Total		22,715	24,059	25,981	27,557	28,603	27,331	25,293	26,064	25,545	27,837	28,543	30,089	30,739	32,561	34,111	34,664

2.3.3 Differences between DEA and refined fuel results

Table 5 shows the results from the new method and the results from the existing DEA method. The last rows in table 5 include an index showing the deviation between the two methods. A good relationship exists between the DEAs current method for domestic fuel use and this study's refined method for domestic jet fuel figures, with the index showing a difference from –2 % to + 7 %. This corresponds to 184 TJ more domestic fuel use in 1989 and 54 TJ less in 1998.

Table 5. Refined Danish jet fuel statistics and percentage of DEA figures

		1985 [TJ]	1986 [TJ]	1987 [TJ]	1988 [TJ]	1989 [TJ]	1990 [TJ]	1991 [TJ]	1992 [TJ]	1993 [TJ]	1994 [TJ]	1995 [TJ]	1996 [TJ]	1997 [TJ]	1998 [TJ]	1999 [TJ]	2000 [TJ]
New	Dom.	2,129	2,311	2,482	2,633	2,742	2,533	2,355	2,361	2,221	2,287	2,433	2,508	2,526	2,225	2,062	1,831
refined	Int.	20,586	21,748	23,499	24,924	25,861	24,798	22,938	23,703	23,324	25,550	26,110	27,581	28,213	30,337	32,049	32,832
method	Total	22,715	24,059	25,981	27,557	28,603	27,331	25,293	26,064	25,545	27,837	28,543	30,089	30,739	32,561	34,111	34,664
DEA	Dom.	2,031	2,152	2,324	2,464	2,558	2,444	2,262	2,226	2,227	2,239	2,299	2,510	2,562	2,279	1,979	-
Existing	Int.	20,684	21,908	23,658	25,093	26,045	24,887	23,031	23,838	23,318	25,598	26,244	27,579	28,177	30,282	32,132	-
method	Total	22,715	24,059	25,981	27,557	28,603	27,331	25,293	26,064	25,545	27,837	28,543	30,089	30,739	32,561	34,111	-
Differ-ence	Dom.	105	107	107	107	107	104	104	106	100	102	106	100	99	98	104	-
	Int.	100	99	99	99	99	100	100	99	100	100	99	100	100	100	100	-
	Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-

2.4 Conclusion

Fossil fuel products used for different purposes are well defined in Danish airports. In this study a consistent split in jet fuel for domestic and international use has been achieved in a time series from 1985 to 2000. The approach has been to develop a method that gives the necessary fuel split to support the calculation of Danish aviation emissions in the CORINAIR emission inventory system. In this way the total fuel use is broken down into fuel used for domestic and international LTO (< 3000 ft) and cruise (>3000 ft). Two major improvements have been achieved:

1) It is now possible to distinguish directly between domestic and international flights from Copenhagen Airport. The improved LTO/aircraft type data is provided by the airport itself and the overall national LTO numbers come from CAA-DK.

2) More accurate cruise fuel use estimates have been calculated based on model results from the detailed NERI model. The NERI model uses detailed city-pair flight information for the year 1998.

In both models flights for Greenland and the Faroe Islands are regarded as international flights.

A correspondence exists between the new fuel use split and the current split made with the DEA city-pair model for domestic flights; result deviations are between + 7 % and –2%.

To make the split in domestic and international fuel use in the future four kinds of information is needed:

1) The total JP1-fuel sale figure for aviation.

2) Information about LTOs for each aircraft type and divided between international and domestic LTOs from Copenhagen Airport (see appendix 2).

3) The official Danish LTO numbers from CAA-DK. (see appendix 2).

4) Fuel use factors per aircraft type according to local airport LTO times-in-modes (see appendix 1).

3 Fuel use for flights between Denmark, Greenland/the Faroe Islands and domestic Greenland/Faroe flights

3.1 Fuel use for flights between Denmark, Greenland and the Faroe Islands

In chapter 2 it was explained how to divide all sold Danish jet petrol into domestic and international use for the years 1985 to 2000. The underlying flight data was official Danish take off numbers (from CAA-DK) and take off numbers from Copenhagen Airport, and EUROCONTROL city-pair flight data used in the NERI model for 1998. Since in general no city-pair data with information about destination airport is available from CAA-DK, the method explained in chapter 2 cannot be used to make a special estimation of the fuel used by flights heading for Greenland and the Faroe Islands (North-Atlantic flights). Instead city-pair data for North-Atlantic flights must be provided by the airports in question and used as input to special simulations within the NERI model.

From Copenhagen Airport (2001), city-pair data was provided from 1991 onwards for flights leaving Copenhagen Airport bound for Greenland and the Faroe Islands. Before 1991 the flying activity remained constant at the same level as in 1991 (CAA-DK, 2001b). Since 1995 a small number of flights to the Faroe Islands are also made from the airports of Billund and Århus. Exact information from Århus Airport was only provided for 1999 and 2000 and from Billund Airport for 1998 to 2000 (Billund Airport, 2001a). For Århus Airport data from 1999 are likely to represent the years 1995-1998 (Århus Airport, 2001). In the case of Billund Airport, the flying activities in 1996 and 1997 equal the 1998 reported figures, while the flight numbers before 1996 are very small and thus not taken into account in this study (Billund Airport, 2001b). All flights are shown in appendix 4 by year, origin and destination airports and representative aircraft type.

For LTO the total fuel use is calculated by using equation (2). For each representative aircraft type the LTO fuel use factors originate from CORINAIR - modified for local airport taxi times in the NERI model, see Winther (2001). The LTO factors are also shown in appendix 4. As an example 183 flights were made with the representative aircraft B767 from Copenhagen Airport to Kangerlussuaq (Søndre Strømfjord) in Greenland in 2000. For this specific aircraft type equation (2) gives the LTO fuel use:

$$FC(B767) = N_{LTO}^{B767} \cdot FC_{LTO}^{B767} = 183 \cdot 1{,}271 kgJP1 = 233 tJP1 \quad (18)$$

All LTO fuel use results for the North-Atlantic flights are given in appendix 5 per representative aircraft for the year 1991 and onwards.

To estimate the cruise fuel use for each flight the two equations (19) and (20) are used. In these equations x_i and x_{max} denominate the separate distances and the maximum distance respectively for which the fuel use is known. These background data originate from CORINAIR (see Winther, 2001) and are given in appendix 6. The parameter y denominates the great circle distance for the individual flight in nautical miles (1 NM = 1.852 km), and are given as a part of the North-Atlantic flight data in appendix 4. The cruise fuel use $FC_{CR}(y)$ becomes:

$$FC_{CR}(y) = FC_{x_i} + \frac{(y - x_i)}{x_{i+1} - x_i} \cdot (FC_{x_{i+1}} - FC_{x_i}) \qquad x_i<y<x_{i+1},\ i = 0,1,2\ldots\max \quad (19)$$

If the flight distance y exceeds x_{max} the equation for calculating the cruise fuel use is:

$$FC_{CR}(y) = FC_{x_{\max}} + \frac{(y - x_{\max})}{x_{\max} - x_{\max-1}} \cdot (FC_{x_{\max}} - FC_{x_{\max-1}}) \qquad y>x_{max} \quad (20)$$

The flight distance between Copenhagen Airport and Kangerlussuaq (Søndre Strømfjord) is 1849 Nm. The exact cruise fuel use per aircraft type for this distance is not listed in appendix 6. However, an approximation can be made for the B767 aircraft type by using equation 19 with cruise fuel use figures for 1500 and 2000 Nm:

$$FC(1849Nm) = FC_{1500} + \frac{(1849-1500)}{2000-1500} \cdot (FC_{2000} - FC_{1500}) = 13{,}791 + \frac{(1849-1500)}{2000-1500} \cdot (18{,}469 - 13{,}791)kg = 17{,}056kg \quad (21)$$

The cruise fuel use for all 183 flights are found as 183 times 17,056 kg = 3,121 tonnes JP1. The total fuel use for all 183 flights is the sum of LTO and cruise: 233 tonnes + 3,121 tonnes = 3,354 tonnes JP1. This total equals 146 TJ using a calorific value of 43.5 GJ per tonne of JP1. All cruise fuel use results for the North-Atlantic flights and the years 1991-2000 are shown in appendix 5.

Each year's fuel use totals are computed by adding the fuel use estimated for LTO and cruise per representative aircraft type for all flights. These totals can be seen in table 6.

Table 6. Fuel use for flights between Denmark, Greenland and the Faroe Islands[2]

Origin	Destination	1985 [TJ]	1986 [TJ]	1987 [TJ]	1988 [TJ]	1989 [TJ]	1990 [TJ]	1991 [TJ]	1992 [TJ]	1993 [TJ]	1994 [TJ]	1995 [TJ]	1996 [TJ]	1997 [TJ]	1998 [TJ]	1999 [TJ]	2000 [TJ]
Denmark	Faroe Islands	140	140	140	140	140	140	140	131	122	129	130	139	138	164	181	184
Faroe Isl.	Denmark	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(131)	(122)	(129)	(130)	(139)	(138)	(164)	(181)	(184)
Denmark	Greenland	160	160	160	160	160	160	160	189	186	171	171	182	207	230	270	284
Greenland	Denmark	(160)	(160)	(160)	(160)	(160)	(160)	(160)	(189)	(186)	(171)	(171)	(182)	(207)	(230)	(270)	(284)

Source: NERI model simulations based on flight data from Copenhagen Airport.

No air traffic takes place between the Faroe Islands and Greenland. If no other information is available, the fuel used by flights between

[2] Numbers in parentheses are estimates based on the assumption that alle flights are return flights.

Denmark-Greenland and Denmark-the Faroe Islands respectively can be assumed to represent the fuel use for the return flights from Greenland and the Faroe Islands going to Denmark. In terms of flight data this is a precise assumption. Almost all the North Atlantic flights are return flights and the total fuel use estimate (per round trip) is fairly precise. However precautions must be taken in terms of fuel allocation: Due to fuel price differences more fuel is being lifted up in Copenhagen Airport compared with the fuel uplift in Greenland and the Faroe Islands (Greenlandair, 2001a and Atlantic Airways, 2001).

3.2 Fuel use for international flights from the Faroe Islands

To get more knowledge about the flying activities at the Faroe Islands city-pair flight information has been obtained from Vagar Airport for the years 1999 and 2000 (CAA-DK, 2001c). Flight data are listed in appendix 4 and since all flights to and from the Faroe Islands pass through Vagar Airport, data encompass all international aviation. The fuel use is calculated with the NERI model as explained in the previous paragraph using equation (19) and (20) together with input data from appendix 4. All results for the years 1991-2000 are shown in appendix 5 per representative aircraft.

The total results for 1999 and 2000 show that around 90% of all international jet fuel are used by flights bound for Denmark (table 7). Flight data from Copenhagen Airport and CAA-DK in Vagar are almost identical as regards number of flights and thus give almost the same amount of fuel computed. Due to this equality for the years 1999 and 2000 and due to the lack of data from CAA-DK in Vagar for the years before 1999 the city-pair information from Danish airports can be used to represent the flights from Vagar to Denmark for the years 1985-1998. Precautions must be taken as mentioned previously in relation to fuel allocation. Because of fuel price differences most of the fuel used by return flights between Denmark and the Faroe Islands is being lifted up in Denmark.

Table 7. Fuel use simulated for international flights from the Faroe Islands

Origin country	Destination country	Fuel [TJ]	
		1999	2000
Faroe Islands	Denmark	176	181
Faroe Islands	Iceland	10	14
Faroe Islands	Norway	1	3
Faroe Islands	Scotland	6	7

Source: NERI model simulations based on flight data from Vagar Airport.

An overview has shown that the number of flights bound for Iceland has been constant for many years, with an increase of about 10% starting in 1998. Flights for Norway was first opened in 1999. Until 1998 the number of flights for Scotland were only one fifth of today's numbers (CAA-DK, 2001c). For flights going to Denmark the fuel use numbers in table 7 should be used for 1999 and 2000, while for 1985-

1998 the fuel use numbers in table 6 are used. The fuel use per destination country for flights leaving the Faroe Islands is summarised in table 8.

Table 8. Summary of simulated fuel use by international flights from the Faroe Islands

	1985 [TJ]	1986 [TJ]	1987 [TJ]	1988 [TJ]	1989 [TJ]	1990 [TJ]	1991 [TJ]	1992 [TJ]	1993 [TJ]	1994 [TJ]	1995 [TJ]	1996 [TJ]	1997 [TJ]	1998 [TJ]	1999 [TJ]	2000 [TJ]
Faroe Isl. - DK	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(131)	(122)	(129)	(130)	(139)	(138)	(164)	176	181
Iceland	9	9	9	9	9	9	9	9	9	9	9	9	9	10	10	14
Norway															1	3
Scotland	1	1	1	1	1	1	1	1	1	1	1	1	1	6	6	7
Total	150	150	150	150	150	150	150	141	132	139	140	149	148	180	193	205

Source: NERI model simulations based on flight data from Vagar Airport.

3.3 Fuel use by domestic flights in the Faroe Islands

Domestic flying in the Faroe Islands is solely done by the use of a Bell 212 helicopter. Average fuel use in kg/hour and the number of flying hours were combined in order to calculate the fuel use (Atlantic Airways, 2001). Domestic flying in the Faroe Islands has been at approximately the same level in the period 1988-1999, and it is therefore recommended to use the fuel use figure for 1999 as for earlier years.

Table 9. Fuel use for Faroe internal flights

Year	Origin country	Fuel flow [kg/time]	Flying hours [timer]	Total Fuel use [tonnes]	[TJ]
1999	Faroe Islands	300	683	205	10
2000	Faroe Islands	300	781	234	11

Source: Atlantic Airways.

3.4 Fuel sales in the Faroe Islands

Information from Statistics Faroe Islands based on reported figures from Statoil, the only oil company supplying fuel in Vagar Airport, gives a total of 86 TJ jet fuel sold in 2000 (Statistics Faroe Islands, 2001).

Table 10. Aviation fuel sale figures in the Faroe Islands

		1995	1996	1997	1998	1999	2000
Jet fuel	m^3	1,928	2,109	2,209	2,402	2,801	2,474
Aviation gasoline	m^3	60	60	60	60	60	60
Total	m^3	1,988	2,169	2,269	2,462	2,861	2,534
Jet fuel	TJ	67	73	77	84	97	86
Aviation gasoline	TJ	2	2	2	2	2	2
Total	TJ	69	75	79	85	99	88

Source: Statistics Faroe Islands.

Based on the statistical fuel sale figures and the simulated fuel use for domestic and international flights a time series of fuel sales can be made for the Faroe Islands also divided into flight categories. To make these time series the fuel sale statistics are assumed to be precisely enough along with the simulated fuel use for domestic flying. The example given in table 11 for the year 2000 demonstrates the overall approach.

There is a big gap between the total fuel sale of 86 TJ and the simulated figures from the present study; 181 TJ (Denmark) + 24 TJ (Other international) + 11 TJ (domestic) = 216 TJ. It is likely that a major part of the fuel used by flights for Denmark, Iceland and Norway is actually being lifted up in these countries, due to fuel price differences (Atlantic Airways, 2001). This is reflected by the figures in table 11. The flights for Denmark and Iceland/Norway respectively, take their relative share (from simulations) of the fuel left from the total when the fuel used by domestic and Scottish flights have been subtracted.

Table 11 Fuel sale total and per flight category in 2000 for the Faroe Islands

Fuel sale in Vagar Airport	TJ
Total	86
Domestic flying (estimated)	11
International flying (estimated)	86-11 = 75
Flights for Scotland (estimated)	7
Flights for Denmark (estimated)	181/(181+14+3)*(75-7) = 62
Flights for Iceland and Norway (estimated)	(14+3)/(181+14+3)*(75-7) = 6
Other international (estimated)	7+6 = 13

The procedure explained above leads to the final time series of fuel sales in table 12 for the Faroe Islands also divided into flight categories.

Table 12 Fuel sale totals for the years 1985-2000 and per flight category for the Faroe Islands

	1985 [TJ]	1986 [TJ]	1987 [TJ]	1988 [TJ]	1989 [TJ]	1990 [TJ]	1991 [TJ]	1992 [TJ]	1993 [TJ]	1994 [TJ]	1995 [TJ]	1996 [TJ]	1997 [TJ]	1998 [TJ]	1999 [TJ]	2000 [TJ]
Total sale	67	67	67	67	67	67	67	67	67	67	67	73	77	84	97	86
Faroe-DK	53	53	53	53	53	53	53	52	52	52	52	58	62	64	76	62
Other int.	4	4	4	4	4	4	4	5	5	5	5	5	5	10	11	13
Domestic	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11

Source: Total sale, Statistics Faroe Islands; Faroe Islands-DK and Other international, adjusted NERI-model results; Domestic, NERI-model.

3.5 Fuel use for flights from Greenland

No official flight statistics for Greenland could be made available for this study. Instead, fuel use information in total numbers is gathered by Statistics Greenland as a part of their national fuel sale inventory for 2000 (Statistics Greenland, 2001). This inventory also contains fuel sale figures back to 1982. No distinction is made between domestic and international aviation fuel use, but in practice all fuel is used for civil aviation.

Most of the domestic flights in Greenland are carried out by Greenlandair (2001a, b), First Air (2001) and Alpha Air (2000) and information on fuel use has been obtained from these airline companies. A few international trips are bound for Canada (First Air and Greenlandair) and Iceland (Greenlandair and Icelandair), although international flying is dominated by flights headed for Copenhagen Airport as the only Danish destination.

The majority of domestic fuel is used by Greenlandair. An overview of the flying activity for the other airline companies in historical years show that First Air had approximately the same domestic fuel use in 1997 and 1998 as given for 1999 and no domestic flying before 1997. Their international fuel uplift in Greenland in 1995-1998 was marginal (similar size as for the year 2000) and even lower from 1981-1994 (First Air, 2001). Air Alpha began flying in Greenland in 1994 and the activity and hence fuel use has increased year by year up to today's figures (Air Alpha, 2000). No information has been obtained from Icelandair.

Table 13. Jet fuel use information for Greenland obtained by airline companies

Year	Company	Domestic	International		
		[TJ]	Denmark	Other countries	Total
		[TJ]	[TJ]	[TJ]	[TJ]
1999	Air Alpha	10	-	-	
	Greenlandair	340	219[3]	13[3]	232[3]
	First Air	17	-	10	10
	Total	367	219	23	242
2000	Air Alpha	10	-	-	
	Greenlandair	353		2[3]	101[4]
	First Air	-	-	3	3
	Total	363	-	5	104

Source: Airline companies.

The majority of international fuel is used by flights bound for Copenhagen, although in table 13 only fuel figures from Greenlandair are listed for this route (also for reverse flying). Since in practise all flights between Greenland and Denmark are round trips, a comparison with fuel figures from Statistics Greenland could be made in the following way:

1. For domestic and "other international countries" use figures from table 11. Take only half of the other international fuel figures by Greenlandair since they report fuel also for the return flights. For 1999 this yields: 10 TJ+340 TJ+17 TJ+6,5 TJ+10 TJ= 384 TJ. For 2000 the fuel amount is: 10 TJ + 353 TJ + 1 TJ + 3 TJ = 367 TJ.

2. For international flights to DK let the fuel amount from table 7 (1999: 270 TJ and 2000: 284 TJ) represent the fuel use for these flights. The total fuel use based on information from airline companies and NERI model results gets: 384 TJ+270 TJ= 654 TJ (1999); and 367 TJ + 284 TJ = 651 TJ.

[3] Also for return flights
[4] Fuel uplift in Greenland

Table 14. Fuel use from Statistics Greenland, airline companies and NERI estimates

Year	Statistics Greenland	Airline companies		NERI simulations	Airline companies/ NERI simulations
	Total	Domestic	International	DK-Greenland	Total calculated
	TJ	TJ	TJ	TJ	TJ
1999	721	367	17	270	654
2000	830	363	4	284	651

The fuel use data behind this study has been validated by SAS in Copenhagen (2001a) per flight for the aircraft type B767 and by flight numbers by SAS in Copenhagen and in Søndre Strømfjord (SAS, 2001a and 2001b). As regards the aircraft type B757, Greenlandair reports a fuel use around 20% higher for a Søndre Strømfjord-Copenhagen-Søndre Strømfjord return flight compared with the fuel use behind the NERI model (Greenlandair, 2001b). In spite of this difference the total NERI results are close to the fuel use in actual flights, since the total B757 fuel use comprises less than half of the grand fuel use total for the flying between Greenland and Denmark. The discrepancy between Statistics Greenland and airline companies/NERI simulation figures is moderate in 1999 (around 9%), however increasing to 22% in 2000. The missing fuel amount from Icelandair international flights plays no role in the total budget.

If extra fuel was added to the NERI B757 simulated numbers, as indicated by Greenlandair figures for everyday fuel consumption, the fuel sale/simulated fuel use discrepancies would be somewhat smaller. However, one important issue would tend to once again widen the gap between simulated fuel use and fuel sale figures: Under actual flying conditions the experience is that 2/3 of all fuel is being lifted up in Copenhagen Airport while only 1/3 is lifted up in Greenland (Greenlandair, 2001a).

For the years 1985-2000, a time series of fuel use can be established from the fuel sale figures reported by Statistics Greenland (2001). The JP1 sales are reported directly in the statistics for 1993 to 2000. Due to lack of data for previous years the 1993 JP1 sales figure is used to represent the 1985-1992 time series totals. For all years the next step is to subtract the fuel used by flights from Greenland to Denmark and other international flights, and in this way obtain figures for domestic fuel use. Even though big uncertainties exist as regards fuel sold versus fuel used by flights other than domestic ones, the procedure for making a split in fuel use as outlined above is the only feasible way forward with the present data available.

Table 15. Time series of total fuel sales and per flight category in Greenland

	1985 [TJ]	1986 [TJ]	1987 [TJ]	1988 [TJ]	1989 [TJ]	1990 [TJ]	1991 [TJ]	1992 [TJ]	1993 [TJ]	1994 [TJ]	1995 [TJ]	1996 [TJ]	1997 [TJ]	1998 [TJ]	1999 [TJ]	2000 [TJ]
Total sale	309	309	309	309	309	309	309	309	309	265	291	345	375	905	721	830
Greenland-DK	160	160	160	160	160	160	160	189	186	171	171	182	207	230	270	284
Other int.													3	3	17	4
Domestic.	149	149	149	149	149	149	149	120	123	93	120	163	165	672	434	542

Source: Total sale, Statistics Greenland; Greenland-DK, NERI-model; Other international, Airline companies (1999/2000 table 12).

The large fluctuations in fuel sales suggest that the fuel sale statistics are still imprecise. Some indications are given that the 1993-1997 figures tend to be to low whereas the figures for 1998-2000 might be higher than accurate numbers. Two arguments motivate this. The air traffic has increased in Greenland during the time period; however, not at a level more than doubling the JP1 fuel sales from 1997 to 1998 as can be seen in table 15. Also the differences in 1999 and 2000 between fuel sold and fuel simulations (table 14) raise concern - given the fact that the differences would become real if the effect of fuel price differences on fuel used by international flights could be accounted for in the simulations (as mentioned previously in this paragraph).

3.6 Conclusion

In order to estimate the fuel used in future years by flights from Denmark to Greenland and the Faroe Islands, respectively, city-pair flight data must be obtained directly from the airports of Copenhagen, Billund and Århus. In this study this has been done for historical years: With some modifications a consistent time series of fuel use by North-Atlantic flights has been produced for the years 1985 to 2000. In situations where no other information is available these results can also represent the flights from Greenland and the Faroe Islands arriving in Denmark. The reverse sum gives a fairly accurate estimate. However, it must be stated that airline companies tend to take up more fuel in Denmark. Fuel price differences have a big influence on the precise fuel allocation.

For Greenland and the Faroe Islands domestic and international fuel use estimates have been made for 1985-2000. Internal flying in the Faroe Islands is solely helicopter flying. To make future estimates Atlantic Airways must be asked each year for data on flying hours and specific fuel use (as given in table 8). For international flights city-pair flight data must be provided by CAA-DK in Vagar Airport and used as input in the NERI model for fuel use simulations. On the same time fuel sale statistics must be provided by Statistics Faroe Islands. A big gap exists between these figures and the NERI model results. Therefore the latter figures must be adjusted in order to achieve a full consistency between model and statistical numbers.

For Greenland an effort still needs to be made in order to establish consistent aviation fuel use statistics. Considering the data available a time series of fuel use in Greenland should be made in three steps. Firstly, the total fuel sale figures must be obtained from Statistics Greenland. Secondly, the fuel used by flights for Denmark should be simulated with the NERI model, and fuel use information for other international flights should be obtained from airline companies. The final step is to let the difference between fuel sold and simulated/airline figures represent the fuel use for domestic flying. Still big uncertainties prevail for international aviation in terms of actual fuel uplift/actual fuel use stemming from fuel price differences.

In table 16 a summary is given of the fuel use for flights between Denmark, Greenland and the Faroe Islands. It must be noted that the fuel use shown in the table for flights between Denmark and the Faroe Islands and reverse do not reflect the actual fuel uplift in Denmark and the Faroe Islands stemming from fuel price differences. However, the sum is considered to be fairly precise.

Table 16. Fuel use for flights between Denmark, Greenland and the Faroe Islands

Flights	1985 [TJ]	1986 [TJ]	1987 [TJ]	1988 [TJ]	1989 [TJ]	1990 [TJ]	1991 [TJ]	1992 [TJ]	1993 [TJ]	1994 [TJ]	1995 [TJ]	1996 [TJ]	1997 [TJ]	1998 [TJ]	1999 [TJ]	2000 [TJ]
Domestic Faroe Islands	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11
Domestic Greenland	149	149	149	149	149	149	149	120	123	93	120	163	165	672	434	542
Denmark – Faroe Islands	140	140	140	140	140	140	140	131	122	129	130	139	138	164	181	184
Denmark - Greenland	160	160	160	160	160	160	160	189	186	171	171	182	207	230	270	284
Faroe Islands - Denmark	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(131)	(122)	(129)	(130)	(139)	(138)	(164)	176	181
Greenland – Denmark	(160)	(160)	(160)	(160)	(160)	(160)	(160)	(189)	(186)	(171)	(171)	(182)	(207)	(230)	(270)	(284)
International Faroe Islands	10	10	10	10	10	10	10	10	10	10	10	10	10	16	17	24
International Greenland													3	3	17	4

4 Aviation fuel use data for the Kingdom of Denmark in convention formats

Denmark is a party to two conventions established to mitigate the harmful effects of global warming and acidification/eutrophication caused by man made air pollution. The UNFCCC (United Nations Framework Convention on Climate Change) convention addresses the greenhouse effect. In a protocol to the convention, the Kyoto protocol, it was agreed to reduce the emissions of the most important climate gases in the target years 2008-2012 related to the baseline year 1990. The UNECE CLRTAP (United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution) convention contains several protocols; each of them have specific baseline and target years for emission components contributing to the overall acidification and eutrophication.

Every year Denmark is obliged to submit their national fuel use and emission estimates for air traffic as well as other sectors. The greenhouse gas emission reports are submitted to the climate convention secretariat in Bonn and the UNECE emission reports are submitted to the UNECE secretariat in Geneva. In general fuel estimates for Greenland and the Faroe Islands are not reported independently. Fuel figures for these two areas will always be a part of the total for the Kingdom of Denmark in situations where they are included as geographical areas. Within the frames of the UNFCCC convention, the Danish fuel estimates also contain figures for Greenland and the Faroe Islands. In opposition to this in the UNECE convention Greenland and the Faroe Islands are outside the Danish physical boundaries and are not parties to this convention as individual countries.

Due to lack of data it has not been possible until now to bend aviation fuel totals according to the specific UNFCCC and UNECE formats. Instead fuel use data has been used in a format as described in chapter 2. All jet fuel sold for civil purposes in Danish airports is accounted for and the flights for Greenland and the Faroe Islands are regarded as international flights. However, with the knowledge gathered in the present study a precise grouping of fuel totals can now be made to serve the specific convention needs.

According to the UNFCCC convention flights between airports in the Kingdom of Denmark are regarded as domestic flights. In this way fuel used by internal flights in 1) Denmark, Greenland and the Faroe Islands, respectively; and 2) flights between Denmark, Greenland and the Faroe Islands irrespective of origin and destination airports (North Atlantic Flights) is included under the national fuel use total (NT: National Total). This fuel use figure is the responsibility of the Kingdom of Denmark and is reported as such. International flights are defined as all flights leaving airports in the Kingdom of Denmark for other countries. The international fuel use is not a part of the national responsibility; instead this fuel use is reported as a memo item.

The new format for the UNECE convention uses two definitions regarding national fuel figures; one for the national fuel total (NT) and one for the national protocol total (NPT). The first total equals the UNFCCC definition while the latter definition excludes fuel used by flights going to Denmark from Greenland and the Faroe Islands respectively, and domestic fuel use in Greenland and the Faroe Islands. The NPT fuel use is the responsibility of Denmark and is reported as such. The international fuel use, and the part of NT exceeding the NPT, is not a part of the national total; instead this fuel use is reported as a memo item for consistency reasons with the UNFCCC convention.

In the existing UNECE format, the national fuel use total is defined as fuel used by Danish domestic flights. The international fuel part is used by flights going to other countries including Greenland and the Faroe Islands. However, the UNECE convention addresses acidification as an environmental theme and therefore components other than greenhouse gases emitted during LTO are counted as national emission totals irrespective of the destinations of the flights. Table 17 explains how to group the fuel quantities according to the UNFCCC and UNECE conventions and to exemplify this the fuel use figures for 2000 are filled in.

Table 17. Fuel use definitions according to UNFCCC and UNECE for the Kingdom of Denmark

Flights	Source Table	Fuel use [TJ]	UNFCCC	UNECE	UNECE – new format
Domestic Denmark	5	1,831	NT	NT	NPT (and NT)
Domestic Greenland	15	542	NT		(NT)
Domestic Faroe Islands	12	11	NT		(NT)
Denmark – Greenland	6	284	NT	International	NPT (and NT)
Denmark – Faroe Islands	6/12	184+(181-62) = 303	NT	International	NPT (and NT)
Greenland – Denmark	15	284	NT		(NT)
Faroe Islands – Denmark	12	62	NT		(NT)
International Denmark	5/6/12	(32,832-284-303) = 32,245	International	International	International
International Greenland	15	4	International		International
International Faroe Islands	12	13	International		International
National Total (NT)			3,317	1,831	(3,317)
National Protocol Total (NPT)					2,418
International			32,262	32,832	32,262
Grand Total		35,579	35,579	34,663	35,579

In the Faroe Islands the difference between total simulated figures (181 TJ) and estimated fuel sale (62 TJ) equals 119 TJ for Danish flights. Assumably the reason is over-fuelling in Danish airports and the difference must therefore be added to the Danish fuel use for flights to the Faroe Islands.

Following the same principle a 1985-2000 time series of fuel use is produced for the UNFCCC and UNECE conventions. On the same time the data in table 18 serve as input data for emission estimates as required by the two conventions.

Table 18. Time series of fuel use according to UNFCCC and UNECE convention format

Convention	Category	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
		[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]	[TJ]
UNFCCC	NT	2,888	3,070	3,241	3,392	3,536	3,322	3,114	3,131	2,970	2,991	3,165	3,323	3,391	3,695	3,403	3,317
	Int.	20,203	21,365	23,116	24,541	25,443	24,385	22,555	23,309	22,951	25,178	25,736	27,184	27,800	29,856	31,526	32,262
UNECE	NT	2,129	2,311	2,482	2,633	2,777	2,563	2,355	2,361	2,221	2,287	2,433	2,508	2,526	2,225	2,062	1,831
	Int.	20,586	21,748	23,499	24,924	25,826	24,768	22,938	23,703	23,324	25,550	26,110	27,581	28,213	30,337	32,049	32,832
UNECE New	NPT	2,517	2,699	2,869	3,020	3,165	2,950	2,743	2,760	2,599	2,663	2,811	2,910	2,947	2,719	2,613	2,418
	NT	2,888	3,070	3,241	3,392	3,536	3,322	3,114	3,131	2,970	2,991	3,165	3,323	3,391	3,695	3,403	3,317
	Int.	20,203	21,365	23,116	24,541	25,443	24,385	22,555	23,309	22,951	25,178	25,736	27,184	27,800	29,856	31,526	32,262

5 Dividing fuel use by passenger and freight

Flights in general are classified as regular (scheduled) or non-regular (charter/taxi) flights. In everyday aviation, regular flights also carry a certain amount of cargo. Being either regular or non-regular, cargo flights are generally classified as cargo flights. Depending on the flight data available, fuel use inventories for airfreight transportation can be made with an increased level of detail. In Denmark a fuel use inventory for sole domestic cargo flights has been made as a part of the DEA model. The results are shown in paragraph 5.1. Ideally the results from this exercise could also be used to estimate the fuel use allocated to cargo transport on passenger flights. This is explained in paragraph 5.2.

Several obstacles render a fuel use inventory in which the fuel use allocated to cargo is estimated on every flight. Flight data can be made available on a city-pair level, but at present the number of passengers and gross cargo weight cannot be provided to support a total fuel use inventory for cargo transportation. For instance, no information is given on the cabin factor and specification of cargo, instead this information is recorded internally at the airline companies in question. It is not possible to assume these parameters precisely enough as input to a meaningful calculation procedure. This is due to the large differences in total aircraft take off weight and the weight of passengers and cargo for each flight. Specifically, for the estimation of fuel use referred to passengers the cabin factor varies a lot from one flight to another. Also the number of seats available can be very different for the same aircraft type.

The amount of cargo transported also varies from flight to flight. The total cargo weight depends on how much cargo capacity is being used on a volume or weight basis. In some cases the aircraft takes off with maximum take off weight and is loaded to a cargo maximum by weight. In other situations the aircraft are only half booked and in addition have only a small part of their maximum cargo weight on board. Situations also occurs when the aircraft is fully loaded with passengers and cargo, the take off mass nevertheless being somewhat smaller than maximum take off weight, since the gross cargo weight is only small referred to its cubic content.

Although no data is available at present for the detailed fuel use inventory, the method is nevertheless explained in paragraph 5.3. By all accounts from 2001 and onwards, the CAA-DK will be able to provide exactly the input data sought for (CAA-DK, 2001b).

5.1 Existing method

Realising the data gap in this specific working field, a sensible way is to begin a fuel use inventory for air cargo transportation by estimating the fuel use for sole cargo flights. At the same time it is clear that not all fuel allocated to air cargo transport will be accounted for in such an inventory. The total fuel figure becomes greater, if also cargo on passenger flights is considered in the calculations.

5.1.1 Domestic sole cargo flights

A fuel use inventory has already been made for domestic sole cargo flights as a part of the DEA model, DEA (2000), see section 2.2. The domestic fuel share for specific cargo flights is between 11 and 14%.

Although only minor differences were found between the DEA model and the refined method results (as explained in chapter 2), the city-pair data behind the DEA model can be updated with year 2000 data and further used as input to the NERI city-pair model. In this way a consistency is assured with the other results of this report.

Table 19. Fuel use estimates for domestic sole cargo flights (from DEA, 2000)

	1991 [TJ]	1992 [TJ]	1993 [TJ]	1994 [TJ]	1995 [TJ]	1996 [TJ]	1997 [TJ]	1998 [TJ]	1999 [TJ]
Cargo	265	268	261	282	303	304	320	326	230
Passenger	1,997	1,958	1,966	1,957	1,996	2,206	2,242	1,953	1,749
Total	2,262	2,226	2,227	2,239	2,299	2,510	2,562	2,279	1,979

5.1.2 International sole cargo flights

Also the international amount of fuel for specific cargo flights can be estimated. This exercise will only be made for Copenhagen Airport and the year 2000 when city-pair flight information is obtained. Rough estimates for previous years and for other airports can be made by using LTO/aircraft type flight statistics already available (Copenhagen Airport, 2001).

5.2 Mixed flights – simple method

Given the constraints in making a cargo fuel use inventory using load factor data for each flight, ideally it is also possible to make a lower level approximation. The basis for this inventory would be the cargo fuel use inventory based on city-pair flight data described in paragraph 5.1. If information is also given on the total amount of cargo handled in Danish airports and part of the cargo handled in relation to specific cargo flights, an approximation of the fuel use part for cargo transportation could be made for passenger flights. This fuel use would be calculated as the ratio between total cargo weight on passenger flights and the total cargo weight flown on specific cargo flights, multiplied with the total fuel use for specific cargo flights:

$$FC_{P.F.}(Cargo) = \frac{M_{T,P.F.}}{M_{T,C.F.}} \cdot FC_{C.F.} = \frac{(M_T - M_{T,C.F.})}{M_{T,C.F.}} \cdot FC_{C.F.} \quad (22)$$

Where

$FC_{P.F.}(Cargo)$ = Total fuel use associated with cargo transportation on passenger flights

$FC_{C.F.}$ = Total fuel use for specific domestic and international cargo flights

M_T = Total cargo weight transported in Danish airports

$M_{T,P.F.}$ = Total weight of cargo transported with passenger flights

$M_{T,C.F.}$ = Total weight of cargo transported with specific cargo flights in Danish airports

Equation 22 can also be expressed as:

$$FC_{P.F.}(Cargo) = \frac{M_T}{M_{T,C.F.}} \cdot FC_{C.F.} - FC_{C.F.} \quad (23)$$

Then the total fuel consumption for cargo transportation on all flights, FC (Cargo), gets:

$$FC(Cargo) = FC_{P.F.}(Cargo) + FC_{C.F.}(Cargo) = \frac{M_T}{M_{T,C.F.}} \cdot FC_{C.F.} \quad (24)$$

At present the total air cargo weight M_T is known from official CAA-DK statistics. However, if this information should be used it must only refer to the cargo weight on flights leaving Danish airports. The data for M_T should therefore be investigated further as in Statistics Denmark (2000); by this source the cargo weight is given for both domestic and international air transport from 1989 to 1999, while only total figures are given for 1987 and 1988. If information also could be provided for the total cargo weight transported on sole cargo flights, the method outlined above would be fit for making an approximation of the fuel used for air cargo transportation. At this level two factors would influence the precision of the final result. Firstly, the aircraft type distribution for cargo flights is assumed as equal to the one for passenger flights also carrying cargo weight. Secondly, the total cargo amount also comprises a part of the cargo being transported on trucks to airports in other countries from where it is flown out.

5.3 Mixed flights – specific method

The prospects of making a detailed and complete fuel use inventory for air cargo transportation is becoming increasingly better in the future. On any given time, the CAA-DK are willing to prepare their flight statistics in a way which allows for the data requested by authorities (ministries or agencies), e.g. in relation to national obligations in the field of energy or air pollution. From 2001 and onwards, the flight statistics gathered by CAA-DK will presumably become detailed to a degree so that each flight starting from a large Danish airport will be registered also in terms of number of passengers and cargo weight. For each flight the passenger and cargo part can be derived as a direct split in the specific flight fuel use by passenger cargo weight ratio:

$$FC(i) = FC_C(i) + FC_P(i) = \frac{M_C}{M_C + M_P} \cdot FC(i) + \frac{M_P}{M_C + M_P} \cdot FC(i) \quad (25)$$

Where
$FC(i)$ = Fuel use per flight, i.
$FC_C(i)$ = Fuel use associated with cargo transportation per flight, i.
$FC_P(i)$ = Fuel use associated with passenger transportation per flight, i.
M_C = Cargo weight per flight, i.
M_P = Weight of passengers per flight, i.

With the number of passengers, N_P, and the average weight per passenger, M_N, inserted (25) becomes:

$$FC(i) = \frac{M_C}{M_C + N_P \cdot M_N} \cdot FC(i) + \frac{N_P \cdot M_N}{M_C + N_P \cdot M_N} \cdot FC(i) \quad (26)$$

The cargo and passenger part of the total fuel use can be found by adding up the fuel use contributions for all flights:

$$FC_C = \sum_i \frac{M_C}{M_C + N_P \cdot M_N} \cdot FC(i) \quad (27)$$

$$FC_P = \sum_i \frac{N_P \cdot M_N}{M_C + N_P \cdot M_N} \cdot FC(i) \quad (28)$$

This is done separately for domestic and international flights. Major benefits from making a cargo/passenger fuel use inventory as explained are achieved in important areas. The real aircraft type distribution is behind the estimations and the cargo figures have been filtered for the amount of cargo transported by road, since the cargo weight is related to the specific flights.

As mentioned before the total weight of cargo (separated in domestic and international) handled in Danish airports is known for historical years (Statistics Denmark, 2000). For a given year, X, the fuel use associated with cargo transportation is found as the ratio between the total cargo weight in year X and year 2001 multiplied by the fuel used for cargo transportation in 2001 found in (27):

$$FC_C(X) = \frac{M_{T,C}(X)}{M_{T,C}(2001)} \cdot FC_C(2001) \quad (29)$$

Where
$FC_C(X)$ = Total fuel use associated with cargo transportation in year X.
$M_{T,C}(X)$ = Total cargo weight in year X.
$M_{T,C}(2001)$ = Total cargo weight in year 2001.
$FC_C(2001)$ = Total fuel use associated with cargo transportation in year 2001.
M_C = Cargo weight per flight, i.
M_P = Weight of passengers per flight, i.

The fuel use in (29) is calculated separately for domestic and international cargo transportation. The fuel used for domestic and international passenger transportation is subsequently derived as:

$$FC_P(X) = FC(X) - FC_C(X) = FC(X) - \frac{M_{T,C}(X)}{M_{T,C}(2001)} \cdot FC_C(2001) \quad (30)$$

Where
$FC_P(X)$ = Total fuel use associated with passenger transportation in year X.
$FC(X)$ = Total fuel use in year X.

Mainly two factors influence the precision of the final result. Firstly, the aircraft type distribution for cargo flights in historical years is assumed to equal the one for 2001. Secondly, the total cargo amount for historical years also comprises a part of the cargo being transported on trucks to airports in other countries from where it is flown out.

5.4 Conclusion

At present a cargo related fuel use inventory can be made solely for cargo flights, since data on cargo and passenger weight per passenger flight is not available. An inventory for cargo flights has been made with the DEA model for domestic aviation in the time period 1991-1999. This inventory can be recalculated and updated with numbers for the year 2000 using the NERI model. On the same time an international cargo fuel use can be made for the year 2000, while more rough estimates can be produced for the previous years.

Based on the fuel use inventory for sole cargo flights ideally an approximation of the fuel use allocated cargo transport by passenger flights can be obtained. Necessary for these calculations are the total domestic/international cargo weights being handled in Danish Airports and the correspondent weight of cargo transported by sole cargo flights. Total weight numbers are available from official CAA-DK statistics; however it must be examined whether the data only refers to cargo weight on flights leaving Danish airports. The cargo weight on sole cargo flights still needs to be provided from CAA-DK.

The prospects of making a detailed and complete fuel use inventory for air cargo transportation will become increasingly better in the future. From 2001 and onwards, the flight statistics gathered by CAA-DK will presumably become detailed to a degree so that each flight starting from a large Danish airport will be registered also in terms of number of passengers and cargo weight.

References

Alpha Air (2000): Unpublished data material and pers. comm. Inge Merete Friis.

Atlantic Airways (2001): Unpublished data material. E-mail from Hans Erik Jakobsen.

Billund Airport (2001a): Unpublished data material and pers. comm., Jette Giørtz.

Billund Airport (2001b): Pers. comm., Ronny Lilienvald.

BKL I/S (2000): Pers. comm. Finn Poulsen, the fuel depot at Copenhagen Airport.

CAA-DK (2000): Statistik over luftfartsaktiviteter 1999, www.slv.dk

CAA-DK (2001a): Statistik over luftfartsaktiviteter 2000, www.slv.dk

CAA-DK (2001b): Pers. comm., Henrik Gravesen.

CAA-DK (2001c): Unpublished data material and pers. comm., Torfinn Jacobsen.

Copenhagen Airport (1996): VVM Fagprojekt - Luftforurening, Copenhagen Airport, Copenhagen (in Danish).

Copenhagen Airport (1998): Traffic Statistics 1985-1990, Copenhagen Airport, Copenhagen.

Copenhagen Airport (2001): Traffic Statistics 1991-2000, Lars H. Hansen, Copenhagen Airport, Copenhagen (unpublished data material).

CORINAIR (1999): Atmospheric Emission Inventory Guidebook Vol. 3, Second Edition, EMEP Task Force on Emission Inventories, European Environmental Agency, Copenhagen.

DEA (2000): Danish Energy Agency, End-use statistics (unpublished data material).

First Air (2001): Unpublished data material and pers. comm., Gary Plexman.

Greenlandair (2001a): Unpublished data material and pers. comm., Thomas Leth Jørgensen.

Greenlandair (2001b): Unpublished data material and pers. comm., Hanne Bertels.

ICAO (1995): ICAO Engine Exhaust Emissions Data Bank, Doc 9646-AN/943, First Edition - 1995, ICAO, Montreal.

ICAO (1998): Aircraft Type Designators, Doc 8643/26, 26th Edition, ICAO, Montreal.

ICAO (1999): Location Indicators, Doc 7910/93, 93th Edition, ICAO, Montreal.

Ministry of Transport (2000a): Notat om energiforbrug til indenrigsluftfart, Copenhagen (in Danish).

Ministry of Transport (2000b): TEMA2000. Technical report, Copenhagen (in Danish).

SAS (2001a): Pers. comm. Karl-Erik Kjøller, Copenhagen.

SAS (2001b): Pers. comm. Leif Pedersen, Søndre Strømfjord.

Statistics Denmark (1986): Statistical Yearbook 1986, Statistics Denmark, Copenhagen (in Danish).

Statistics Denmark (1989-1999): Statistical Yearbook 1989-1999 editions, Statistics Denmark, Copenhagen (in Danish).

Statistics Denmark (2000): Transport 2000, ISBN 87-501-1134-5, Statistics Denmark, Copenhagen (in Danish).

Statistics Faroe Islands (2001): Pers. comm., Simona Nielsen, Argir.

Statistics Greenland (2001): Unpublished data material and pers. comm., Andreas Vedel, Nuuk.

Statoil (2001): Pers. comm., Jens Bjørnmose, Copenhagen.

Winther, M. (2000): A Model for Calculating the Fuel Use and Emissions from IFR Flights Using the New CORINAIR Guidelines. I: Joumard, R. (ed): 9th Symposium Transport and Air Pollution. Report of INRETS. Vol. 2.

Winther, M. (2001): 1998 Fuel Use and Emissions for Danish IFR Flights. Environmental Project no. 628, 2001. 112 p. Danish EPA. Prepared by the National Environmental Research Institute, Denmark. Electronic report at homepage of the Danish EPA http://www.mst.dk/udgiv/Publications/2001/87-7944-661-2/html/.

Århus Airport (2001): Unpublished data material and pers. comm., Thomas Sigvardt.

Appendix 1

Fuel use factors 1985-2000 per aircraft type for Copenhagen Airport and other airports and aggregated for domestic flights (other airports)

LTO	Airport	Destination	Aircraft type	Fuel [tonnes per LTO]				
				Approach/Landing	Taxi	Take off	Climb out	[Total/LTO]
	Copenhagen		MD81	0.175	0.168	0.198	0.073	0.614
			MD87	0.187	0.177	0.219	0.080	0.663
			DC9	0.159	0.191	0.215	0.104	0.669
			F50	0.070	0.126	0.000	0.101	0.297
			B737	0.145	0.154	0.125	0.058	0.481
			B767	0.316	0.287	0.344	0.202	1.148
			F100	0.116	0.142	0.102	0.047	0.407
			EA310	0.145	0.147	0.136	0.030	0.457
			B757	0.267	0.306	0.197	0.116	0.886
			EA320	0.132	0.146	0.169	0.074	0.522
			B747	0.533	0.622	1.089	0.375	2.619
			MD11	0.418	0.448	0.678	0.243	1.787
			B727	0.165	0.198	0.261	0.071	0.695
			L188	0.426	0.537	0.615	0.306	1.884
			DC10	0.433	0.491	0.681	0.249	1.855
			EA300	0.310	0.308	0.558	0.101	1.276
			BA11	0.140	0.154	0.149	0.053	0.496
			BA46	0.111	0.112	0.175	0.048	0.445
			S365	0.004	0.016	0.009	0.001	0.031
			SF34	0.026	0.020	0.010	0.008	0.064
	Other airports	Domestic	MD81	0.175	0.078	0.198	0.073	0.524
			MD87	0.187	0.082	0.219	0.080	0.568
			DC9	0.159	0.089	0.215	0.104	0.566
			F50	0.070	0.057	0.000	0.101	0.228
			B737	0.145	0.071	0.125	0.058	0.399
			B767	0.316	0.113	0.344	0.202	0.974
			F100	0.116	0.066	0.102	0.047	0.330
			EA310	0.145	0.063	0.136	0.030	0.373
			B757	0.267	0.120	0.197	0.116	0.700
			EA320	0.132	0.061	0.169	0.074	0.436
			B747	0.533	0.239	1.089	0.375	2.236
			MD11	0.418	0.176	0.678	0.243	1.515
			B727	0.165	0.082	0.261	0.071	0.579
			L188	0.426	0.249	0.615	0.306	1.597
			DC10	0.433	0.194	0.681	0.249	1.557
			EA300	0.310	0.121	0.558	0.101	1.090
			BA11	0.140	0.071	0.149	0.053	0.413
			BA46	0.111	0.052	0.175	0.048	0.385
			S365	0.004	0.007	0.009	0.001	0.022
			SF34	0.026	0.009	0.010	0.008	0.053
	Other airports	Domestic agg.	1985	0.110	0.063	0.099	0.082	0.354
			1986	0.109	0.064	0.093	0.084	0.350
			1987	0.107	0.063	0.091	0.083	0.344
			1988	0.106	0.062	0.089	0.082	0.339
			1989	0.106	0.062	0.089	0.081	0.338
			1990	0.110	0.064	0.095	0.083	0.352
			1991	0.107	0.060	0.096	0.075	0.338
			1992	0.105	0.059	0.086	0.077	0.327
			1993	0.107	0.058	0.085	0.073	0.323
			1994	0.107	0.058	0.086	0.073	0.324
			1995	0.108	0.059	0.088	0.075	0.330
			1996	0.096	0.054	0.069	0.072	0.291
			1997	0.100	0.057	0.074	0.074	0.305
			1998	0.101	0.057	0.076	0.073	0.307
			1999	0.100	0.058	0.070	0.080	0.308
			2000	0.097	0.058	0.064	0.079	0.299
		International	Large aircraft	0.100	0.052	0.136	0.049	0.337

Source: Copenhagen Airport (1996) combined with engine specific fuel flows (ICAO, 1995).

Airport	Destination	Aircraft type	Fuel [GJ]				
			Approach/Landing	Taxi	Take off	Climb out	[Total/LTO]
Copenhagen		MD81	7.6	7.3	8.6	3.2	26.7
		MD87	8.1	7.7	9.5	3.5	28.9
		DC9	6.9	8.3	9.3	4.5	29.1
		F50	3.0	5.5	0.0	4.4	12.9
		B737	6.3	6.7	5.4	2.5	20.9
		B767	13.7	12.5	15.0	8.8	49.9
		F100	5.0	6.2	4.4	2.0	17.7
		EA310	6.3	6.4	5.9	1.3	19.9
		B757	11.6	13.3	8.6	5.0	38.5
		EA320	5.8	6.4	7.4	3.2	22.7
		B747	23.2	27.0	47.4	16.3	113.9
		MD11	18.2	19.5	29.5	10.6	77.7
		B727	7.2	8.6	11.3	3.1	30.2
		L188	18.5	23.4	26.8	13.3	82.0
		DC10	18.8	21.4	29.6	10.8	80.7
		EA300	13.5	13.4	24.3	4.4	55.5
		BA11	6.1	6.7	6.5	2.3	21.6
		BA46	4.8	4.9	7.6	2.1	19.4
		S365	0.2	0.7	0.4	0.1	1.3
		SF34	1.1	0.9	0.5	0.3	2.8
Other airports	Domestic	MD81	7.6	3.4	8.6	3.2	22.8
		MD87	8.1	3.6	9.5	3.5	24.7
		DC9	6.9	3.9	9.3	4.5	24.6
		F50	3.0	2.5	0.0	4.4	9.9
		B737	6.3	3.1	5.4	2.5	17.4
		B767	13.7	4.9	15.0	8.8	42.4
		F100	5.0	2.9	4.4	2.0	14.4
		EA310	6.3	2.7	5.9	1.3	16.2
		B757	11.6	5.2	8.6	5.0	30.5
		EA320	5.8	2.6	7.4	3.2	19.0
		B747	23.2	10.4	47.4	16.3	97.3
		MD11	18.2	7.7	29.5	10.6	65.9
		B727	7.2	3.6	11.3	3.1	25.2
		L188	18.5	10.8	26.8	13.3	69.5
		DC10	18.8	8.4	29.6	10.8	67.7
		EA300	13.5	5.3	24.3	4.4	47.4
		BA11	6.1	3.1	6.5	2.3	18.0
		BA46	4.8	2.3	7.6	2.1	16.8
		S365	0.2	0.3	0.4	0.1	1.0
		SF34	1.1	0.4	0.5	0.3	2.3
Other airports	Domestic agg.	1985	4.8	2.8	4.3	3.6	15.4
		1986	4.7	2.8	4.1	3.7	15.2
		1987	4.7	2.7	3.9	3.6	15.0
		1988	4.6	2.7	3.9	3.6	14.7
		1989	4.6	2.7	3.9	3.5	14.7
		1990	4.8	2.8	4.1	3.6	15.3
		1991	4.6	2.6	4.2	3.3	14.7
		1992	4.6	2.6	3.7	3.3	14.2
		1993	4.6	2.5	3.7	3.2	14.1
		1994	4.7	2.5	3.7	3.2	14.1
		1995	4.7	2.6	3.8	3.3	14.4
		1996	4.2	2.4	3.0	3.1	12.7
		1997	4.4	2.5	3.2	3.2	13.3
		1998	4.4	2.5	3.3	3.2	13.4
		1999	4.3	2.5	3.1	3.5	13.4
		2000	4.2	2.5	2.8	3.4	13.0
	International	Large aircraft	4.3	2.2	5.9	2.1	14.7

Source: Copenhagen Airport (1996) combined with engine specific fuel flows (ICAO, 1995).

Appendix 2

Number of LTO's per aircraft type

Airport	Traffic	Destination	Aircraft type	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Copenhagen	Sch./Charter	International	MD81	7,530	7,750	7,979	8,484	9,143	9,201	9,054	12,069	13,122	13,128	14,980	15,452	15,607	16,695	16,951	17,438
Copenhagen	Sch./Charter	International	MD87	7,530	7,750	7,979	8,484	9,143	9,201	9,054	12,069	13,122	13,128	14,980	15,452	15,607	16,695	16,951	17,438
Copenhagen	Sch./Charter	International	DC9	13,940	14,346	14,771	15,705	16,926	17,034	16,760	13,116	10,668	12,217	9,061	10,254	11,354	10,036	6,692	4,800
Copenhagen	Sch./Charter	International	F50	7,094	11,119	12,719	11,316	10,971	13,000	9,650	10,385	13,124	13,725	14,236	16,306	19,108	22,029	24,635	22,031
Copenhagen	Sch./Charter	International	B737	4,585	4,463	5,151	5,974	6,942	7,652	6,726	8,178	9,885	12,418	13,175	11,899	13,042	14,274	22,610	27,100
Copenhagen	Sch./Charter	International	B767	2,141	1,494	1,016	744	606	1,785	2,588	2,806	3,427	2,944	3,826	3,487	4,509	3,817	3,565	3,376
Copenhagen	Sch./Charter	International	F100	1,072	1,142	1,242	1,310	1,448	1,511	1,731	1,784	2,364	2,844	3,642	3,970	4,262	3,001	2,402	3,701
Copenhagen	Sch./Charter	International	EA310	0	0	0	406	476	416	470	843	851	914	377	191	205	268	263	451
Copenhagen	Sch./Charter	International	B757	1,081	1,287	1,354	1,814	1,417	1,694	1,683	1,590	1,515	1,357	1,355	1,530	1,545	1,451	2,034	2,169
Copenhagen	Sch./Charter	International	EA320	0	0	0	69	339	616	1,598	2,340	2,593	1,326	1,589	2,464	2,801	4,002	3,884	3,470
Copenhagen	Sch./Charter	International	B747	1,864	1,736	1,253	1,233	1,304	1,164	1,238	1,100	731	567	553	441	395	479	689	908
Copenhagen	Sch./Charter	International	MD11	0	1	2	3	4	5	0	4	105	356	263	154	159	269	173	166
Copenhagen	Sch./Charter	International	B727	2,889	3,495	3,940	3,308	2,722	1,926	1,748	2,079	1,476	1,507	1,988	3,186	2,951	2,422	2,010	2,203
Copenhagen	Sch./Charter	International	L188	519	48	349	98	80	24	229	767	969	590	396	202	15	67	21	13
Copenhagen	Sch./Charter	International	DC10	1,427	1,787	2,329	2,697	2,788	1,692	624	345	102	438	402	673	877	784	648	498
Copenhagen	Sch./Charter	International	EA300	331	406	974	1,228	1,090	989	499	276	59	169	210	342	656	1,434	1,314	551
Copenhagen	Sch./Charter	International	BA11	672	670	632	680	940	1,031	926	935	632	613	1,210	676	279	166	44	22
Copenhagen	Sch./Charter	International	BA46	0	0	1	313	737	866	483	538	564	527	761	3,784	4,538	3,569	5,299	5,264
Copenhagen	Sch./Charter	International	S365	0	0	0	1,612	2,508	2,879	2,679	2,832	3,598	4,962	5,454	6,409	7,345	8,141	9,264	9,344
Copenhagen	Sch./Charter	International	SF34	3,067	2,802	3,156	3,919	4,367	3,109	5,578	5,440	5,327	4,237	4,366	5,426	3,848	2,965	4,547	7,334
Copenhagen	Sch./Charter	International	Total	57,452	59,967	63,525	70,073	75,672	74,685	75,754	80,944	85,606	89,172	94,189	103,645	110,343	113,556	124,945	129,592

Source: Copenhagen Airport (1998, 2001).

Airport	Traffic	Destination	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Copenhagen	Scheduled	International	50,983	55,390	59,797	64,204	68,611	70,610	68,192	73,203	78,467	81,619	86,155	94,550	101,342	104,450	116,437	122,932
Aalborg	Scheduled	International																
Århus	Scheduled	International																
Billund	Scheduled	International						2,121	2,480	2,924	4,476	5,198	5,903	7,325	8,394	8,145	7,807	8,357
Esbjerg	Scheduled	International																
Karup	Scheduled	International																
Odense	Scheduled	International																
Roskilde	Scheduled	International																
Rønne	Scheduled	International																
Sønderborg	Scheduled	International																
Other airports	Scheduled	International	1,650	1,793	1,936	2,078	2,221	2,286	2,015	2,740	2,746	2,692	3,075	6,179	5,310	5,165	3,724	3,920
Copenhagen	Charter	International	4,762	4,906	5,051	5,196	5,341	5,185	5,125	6,294	5,767	6,349	6,669	7,747	7,761	8,114	7,559	5,345
Aalborg	Charter	International																
Århus	Charter	International																
Billund	Charter	International						1,499	1,413	1,620	1,606	1,994	2,432	2,827	3,007	3,152	3,428	3,264
Esbjerg	Charter	International																
Karup	Charter	International																
Odense	Charter	International																
Roskilde	Charter	International																
Rønne	Charter	International																
Sønderborg	Charter	International																
Other airports	Charter	International	3,442	3,687	3,931	4,176	4,420	3,485	3,506	2,878	2,656	2,031	2,376	3,251	3,508	3,708	3,847	3,634
Copenhagen	Other traffic	International	7,206	6,149	5,093	4,036	2,980	2,477	2,032	1,165	1,036	1,001	1,139	1,200	1,104	1,083	1,089	1,178
Aalborg	Other traffic	International																
Århus	Other traffic	International																
Billund	Other traffic	International						2,148	2,053	1,806	1,533	1,641	1,841	1,600	1,302	1,650	1,637	1,224
Esbjerg	Other traffic	International																
Karup	Other traffic	International																
Odense	Other traffic	International																
Roskilde	Other traffic	International																
Rønne	Other traffic	International																
Sønderborg	Other traffic	International																
Vojens	Other traffic	International																
Other airports	Other traffic	International	10,517	12,055	13,593	15,131	16,669	11,381	11,936	11,832	13,684	11,243	11,608	8,493	10,784	10,619	9,235	6,284

Source: Statistics Denmark (1986, 1989-1999) and CAA-DK (2000, 2001a).

Airport	Traffic	Destination	Aircraft type	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Copenhagen	Sch./Charter	Domestic	MD81	1,625	1,672	1,722	1,831	1,973	1,985	1,954	3,064	3,995	3,951	3,879	3,705	3,680	3,336	2,513	1,936
Copenhagen	Sch./Charter	Domestic	MD87	1,625	1,672	1,722	1,831	1,973	1,985	1,954	3,064	3,995	3,951	3,879	3,705	3,680	3,336	2,513	1,936
Copenhagen	Sch./Charter	Domestic	DC9	3,785	3,896	4,011	4,265	4,596	4,625	4,551	2,247	139	97	124	127	183	309	1,061	639
Copenhagen	Sch./Charter	Domestic	F50	7,393	9,000	9,868	10,247	10,684	10,135	7,572	10,223	9,825	9,764	10,618	13,682	13,890	11,150	11,954	11,112
Copenhagen	Sch./Charter	Domestic	B737	1,350	1,314	1,516	1,759	2,044	2,252	1,980	1,615	1,591	1,766	1,890	1,924	2,914	2,266	1,629	2,018
Copenhagen	Sch./Charter	Domestic	B767	17	12	8	6	5	14	20	21	41	24	35	44	33	44	35	46
Copenhagen	Sch./Charter	Domestic	F100	0	0	0	0	0	0	0	0	1	2	19	10	5	9	1	402
Copenhagen	Sch./Charter	Domestic	EA310	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0
Copenhagen	Sch./Charter	Domestic	B757	13	15	16	22	17	20	20	17	15	6	7	14	33	3	17	42
Copenhagen	Sch./Charter	Domestic	EA320	0	0	0	1	6	11	29	85	150	100	95	131	121	116	71	76
Copenhagen	Sch./Charter	Domestic	B747	26	24	17	17	18	16	17	1	0	2	1	0	4	0	4	1
Copenhagen	Sch./Charter	Domestic	MD11	0	1	2	3	4	5	0	0	0	0	0	0	0	0	0	0
Copenhagen	Sch./Charter	Domestic	B727	428	518	584	490	403	285	259	254	245	154	247	483	459	326	110	3
Copenhagen	Sch./Charter	Domestic	L188	11	1	8	2	2	1	5	1	2	1	212	15	6	0	2	2
Copenhagen	Sch./Charter	Domestic	DC10	5	6	7	9	9	5	2	0	0	12	62	63	52	18	11	12
Copenhagen	Sch./Charter	Domestic	EA300	7	8	20	25	22	20	10	5	10	70	70	23	85	74	103	55
Copenhagen	Sch./Charter	Domestic	BA11	0	0	0	0	0	0	0	0	0	1	4	8	8	0	0	0
Copenhagen	Sch./Charter	Domestic	BA46	0	0	0	27	63	73	41	90	56	131	159	33	32	6	9	42
Copenhagen	Sch./Charter	Domestic	S365	0	0	0	5	7	9	8	10	15	15	14	12	26	27	6	1
Copenhagen	Sch./Charter	Domestic	SF34	2,446	2,234	2,516	3,125	3,481	2,479	4,447	3,931	4,154	4,120	4,528	6,662	5,342	4,733	3,262	2,767
Copenhagen	Sch./Charter	Domestic	Total	19,643	21,555	22,905	24,731	26,600	25,008	25,362	24,630	24,268	24,172	25,936	30,627	30,440	25,759	23,113	21,013

Source: Copenhagen Airport (1998, 2001).

Airport	Traffic	Destination	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Copenhagen	Scheduled	Domestic	18,213	19,745	21,278	22,811	24,344	22,920	21,678	23,993	23,511	23,145	24,568	29,427	29,227	24,642	22,392	20,305
Aalborg	Scheduled	Domestic	2,351	2,514	2,678	2,841	3,005	3,005	2,997	2,936	2,944	2,687	2,889	4,075	4,562	4,641	4,391	4,166
Århus	Scheduled	Domestic	3,089	3,257	3,426	3,594	3,763	3,241	3,595	3,602	3,626	3,674	3,985	5,668	5,590	4,460	3,993	4,123
Billund	Scheduled	Domestic	2,628	2,871	3,113	3,356	3,598	3,076	3,067	3,458	3,261	3,696	4,164	4,609	4,861	3,824	3,258	2,657
Esbjerg	Scheduled	Domestic	1,925	2,130	2,336	2,541	2,747	2,088	2,207	2,243	2,218	1,947	1,909	1,921	2,052	1,357	1,314	283
Karup	Scheduled	Domestic	1,470	1,729	1,988	2,247	2,506	2,462	2,469	2,446	2,487	2,280	2,398	3,125	3,299	3,176	3,812	4,145
Odense	Scheduled	Domestic	2,135	2,255	2,375	2,494	2,614	2,816	2,864	2,662	2,643	2,385	2,383	2,129	1,927	716	1	0
Roskilde	Scheduled	Domestic	761	575	388	202	15	15	4	4	2	1	5	0	0	0	0	0
Rønne	Scheduled	Domestic	1,682	1,829	1,977	2,124	2,271	2,242	1,971	1,960	2,029	2,037	2,084	2,323	2,217	2,250	2,333	2,107
Sønderborg	Scheduled	Domestic	1,736	1,705	1,675	1,644	1,614	1,590	1,537	1,323	1,387	1,418	1,629	1,838	1,837	1,702	1,664	1,592
Vojens	Scheduled	Domestic	749	795	841	887	934	1,287	1,352	1,586							434	0
Other airports	Scheduled	Domestic	1,839	2,094	2,350	2,605	2,861	1,441	917	1,584	2,990	2,304	2,462	3,668	2,377	1,603	460	437
Copenhagen	Charter	Domestic	516	627	739	850	962	1,003	1,190	636	723	1,022	1,276	1,214	1,327	1,116	908	784
Aalborg	Charter	Domestic	16	14	12	9	7	13	7	13	6	62	63	43	36	71	45	36
Århus	Charter	Domestic	0	31	63	94	125	191	327	257	383	475	514	535	519	838	872	349
Billund	Charter	Domestic	391	403	414	426	438	421	548	577	637	722	806	815	789	636	719	750
Esbjerg	Charter	Domestic	115	101	87	74	60	31	33	306	22	25	37	32	47	49	55	42
Karup	Charter	Domestic	2	4	7	9	12	7	15	12	23	48	49	43	296	421	340	94
Odense	Charter	Domestic	11	10	9	8	7	12	7	6	17	9	6	13	10	12	1	0
Roskilde	Charter	Domestic	0	5	9	14	18	55	100	259	13	11	6	0	0	0	0	0
Rønne	Charter	Domestic	21	19	18	17	16	26	7	10	22	39	54	82	59	41	40	30
Sønderborg	Charter	Domestic	0	1	2	3	4	4	8	3	3	5	5	55	107	153	157	153
Vojens	Charter	Domestic	0	8	17	25	34	0	2	1								1
Other airports	Charter	Domestic	0	1	2	2	3	29	13	9	3	3	5	9	5	20	3	2
Copenhagen	Other traffic	Domestic	4,725	4,493	4,262	4,030	3,799	3,814	3,454	950	804	1,235	1,243	1,115	1,051	991	883	814
Aalborg	Other traffic	Domestic	6,134	5,392	4,651	3,909	3,168	3,145	3,214	3,442	3,114	7,031	6,916	6,700	6,356	6,236	6,424	4,831
Århus	Other traffic	Domestic	4,158	4,309	4,461	4,612	4,764	4,598	4,031	3,870	3,913	7,844	11,401	12,062	10,420	9,151	6,332	5,577
Billund	Other traffic	Domestic	18,727	15,347	11,966	8,586	5,205	5,428	5,395	4,627	3,358	18,646	17,281	14,795	12,262	9,487	10,322	9,611
Esbjerg	Other traffic	Domestic	5,972	4,950	3,928	2,906	1,885	1,733	1,517	1,645	1,230	5,712	5,601	4,556	5,621	5,909	6,234	5,889
Karup	Other traffic	Domestic	183	173	162	152	141	92	104	112	140	309	1,691	1,894	638	548	699	981
Odense	Other traffic	Domestic	7,270	6,449	5,628	4,807	3,986	4,089	4,205	3,523	2,967	7,181	7,776	7,848	7,871	6,662	5,439	6,887
Roskilde	Other traffic	Domestic	33,581	27,708	21,836	15,963	10,091	10,013	9,587	9,300	8,901	41,378	41,191	46,490	48,025	46,210	45,862	46,471
Rønne	Other traffic	Domestic	2,305	2,077	1,849	1,621	1,393	1,496	1,284	1,339	8,901	3,164	2,590	2,991	2,821	2,309	2,730	2,169
Sønderborg	Other traffic	Domestic	3,225	2,822	2,420	2,018	1,616	1,405	1,174	1,241	1,134	3,763	4,133	3,788	4,427	3,614	4,119	4,734
Vojens	Other traffic	Domestic	4,677	4,315	3,954	3,592	3,231	71	82	79							18	12
Other airports	Other traffic	Domestic	1,476	4,021	6,567	9,112	11,657	14,241	14,930	15,011	12,891	52,121	49,209	44,483	42,563	38,105	44,279	13,187

Source: Statistics Denmark (1986, 1989-1999) and CAA-DK (2000, 2001a).

Appendix 3

LTO Fuel use results in GJ per aircraft type for Copenhagen Airport and other airports

Airport	Destination	Aircraft type	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CPH	Dom.	B727	12,944	15,660	17,655	14,821	12,195	8,628	7,832	7,681	7,409	4,657	7,469	14,606	13,880	9,858	3,326	91
	Dom.	B737	28,258	27,506	31,743	36,819	42,785	47,155	41,452	33,810	33,308	36,971	39,567	40,279	61,005	47,439	34,103	42,247
	Dom.	B747	2,917	2,716	1,960	1,929	2,040	1,821	1,937	114	0	228	114	0	456	0	456	114
	Dom.	B757	495	589	620	831	649	776	771	655	578	231	270	539	1,271	116	655	1,618
	Dom.	B767	826	577	392	287	234	689	999	1,048	2,047	1,198	1,747	2,197	1,648	2,197	1,747	2,297
	Dom.	BA11	0	0	0	0	0	0	0	0	0	22	86	173	173	0	0	0
	Dom.	BA46	0	0	2	515	1,212	1,423	794	1,743	1,084	2,537	3,079	639	620	116	174	813
	Dom.	DC10	369	462	602	698	721	437	161	0	0	968	5,002	5,083	4,195	1,452	887	968
	Dom.	DC9	110,097	113,308	116,666	124,045	133,682	134,537	132,374	65,358	4,043	2,821	3,607	3,694	5,323	8,988	30,861	18,586
	Dom.	EA300	369	452	1,084	1,367	1,213	1,101	555	278	555	3,886	3,886	1,277	4,719	4,108	5,718	3,053
	Dom.	EA310	0	0	0	0	0	0	0	0	0	0	20	0	0	80	0	0
	Dom.	EA320	0	0	0	28	140	254	659	1,931	3,407	2,272	2,158	2,976	2,749	2,635	1,613	1,726
	Dom.	F100	0	0	0	0	0	0	0	0	18	35	336	177	88	159	18	7,109
	Dom.	F50	95,415	116,160	127,367	132,250	137,888	130,806	97,721	131,943	126,800	126,013	137,041	176,580	179,271	143,907	154,278	143,417
	Dom.	L188	928	86	625	175	144	44	410	82	164	82	17,378	1,230	492	0	164	164
	Dom.	MD11	0	78	155	233	311	389	0	0	0	0	0	0	0	0	0	0
	Dom.	MD81	43,407	44,673	45,997	48,906	52,706	53,043	52,190	81,858	106,731	105,555	103,632	98,983	98,315	89,125	67,124	51,709
	Dom.	MD87	46,880	48,248	49,678	52,820	56,923	57,287	56,366	88,408	115,271	114,002	111,924	106,904	106,182	96,257	72,495	55,847
	Dom.	S365	0	0	0	6	10	11	11	13	20	20	19	16	35	36	8	1
	Dom.	SF34	6,790	6,202	6,985	8,675	9,665	6,882	12,346	10,914	11,533	11,438	12,571	18,496	14,831	13,140	9,056	7,682
	Dom.	Total	349,696	376,717	401,531	424,405	452,516	445,282	406,577	425,836	412,968	412,937	449,907	473,848	495,253	419,613	382,685	337,443
Other	Dom.	Large aircraft	322,268	339,856	356,260	371,658	391,848	368,491	353,685	359,552	347,255	335,822	365,248	391,955	405,705	347,046	320,073	280,888

Source: Current Danish LTO fuel use results.

Airport	Destination	Aircraft type	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CPH	Int.	B727	87,362	105,693	119,152	100,031	82,305	58,233	52,860	62,869	44,634	45,572	60,117	96,345	89,239	73,242	60,783	66,619
	Int.	B737	95,992	93,436	107,831	125,072	145,338	160,186	140,810	171,207	206,944	259,972	275,820	249,107	273,036	298,828	473,343	567,341
	Int.	B747	212,409	197,799	142,730	140,482	148,574	132,615	141,044	125,322	83,282	64,598	63,003	50,243	45,002	54,572	78,497	103,448
	Int.	B757	41,654	49,573	52,162	69,905	54,599	65,260	64,841	61,258	58,369	52,281	52,204	58,947	59,525	55,903	78,364	83,566
	Int.	B767	106,917	74,614	50,733	37,158	30,272	89,130	129,212	140,096	171,101	146,986	191,022	174,096	225,122	190,572	177,991	168,554
	Int.	BA11	14,497	14,454	13,634	14,669	20,278	22,241	19,976	20,170	13,634	13,224	26,103	14,583	6,019	3,581	949	475
	Int.	BA46	0	0	18	6,069	14,280	16,761	9,353	10,418	10,922	10,205	14,737	73,278	87,879	69,114	102,616	101,939
	Int.	DC10	115,167	144,200	187,870	217,627	224,946	136,480	50,345	27,835	8,230	35,339	32,434	54,299	70,758	63,255	52,282	40,180
	Int.	DC9	405,456	417,282	429,648	456,821	492,310	495,461	487,494	381,502	310,298	355,353	263,555	298,256	330,251	291,915	194,649	139,617
	Int.	EA300	18,396	22,532	54,099	68,195	60,521	54,915	27,702	15,322	3,275	9,382	11,658	18,986	36,418	79,610	72,948	30,589
	Int.	EA310	0	0	0	8,074	9,466	8,273	9,347	16,765	16,924	18,177	7,497	3,798	4,077	5,330	5,230	8,969
	Int.	EA320	0	0	0	1,562	7,697	13,989	36,300	53,155	58,902	30,121	36,095	55,972	63,627	90,909	88,228	78,824
	Int.	F100	18,957	20,195	21,963	23,166	25,606	26,720	30,611	31,548	41,805	50,293	64,405	70,205	75,369	53,070	42,477	65,448
	Int.	F50	91,561	143,509	164,159	146,049	141,602	167,780	124,541	134,034	169,385	177,142	183,737	210,453	246,617	284,317	317,945	284,336
	Int.	L188	42,515	3,931	28,638	8,022	6,578	2,005	18,771	62,871	79,428	48,362	32,460	16,558	1,230	5,492	1,721	1,066
	Int.	MD11	0	78	155	233	311	389	0	311	8,162	27,672	20,443	11,971	12,359	20,910	13,448	12,903
	Int.	MD81	201,170	207,038	213,173	226,656	244,264	245,827	241,875	322,437	350,556	350,729	400,194	412,804	416,959	446,026	452,865	465,876
	Int.	MD87	217,268	223,605	230,231	244,792	263,809	265,498	261,229	348,238	378,606	378,794	432,217	445,836	450,323	481,716	489,102	503,154
	Int.	S365	0	0	0	2,147	3,339	3,834	3,568	3,771	4,791	6,608	7,263	8,535	9,781	10,841	12,337	12,443
	Int.	SF34	8,516	7,779	8,762	10,881	12,123	8,632	15,486	15,103	14,789	11,763	12,121	15,064	10,683	8,232	12,624	20,361
	Int.	Total	1,677,838	1,725,718	1,824,959	1,907,613	1,988,220	1,974,230	1,865,366	2,004,234	2,034,037	2,092,574	2,187,088	2,339,336	2,514,274	2,587,433	2,728,399	2,755,708
Other	Int.	Large aircraft	74,649	80,325	86,000	91,675	97,351	137,645	137,990	148,963	168,342	174,661	202,081	287,048	296,393	295,660	275,679	281,074

Source: Current Danish LTO fuel use results.

Appendix 4

Flight data, LTO and cruise fuel use for North-Atlantic flights 1991-2000

Year	Origin Airport	Destination Airport	Rep. Aircraft	Distance [NM]	Distance [km]	No. of flights	LTO Fuel [Tonnes/flight]	Cruise Fuel [Tonnes/flight]	Fuel Total [Tonnes/flight]	LTO Fuel [GJ/flight]	Cruise Fuel [GJ/flight]	Fuel Total [GJ/flight]
1991	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	354	0.614	4.000	4.614	26.692	174.008	200.701
1991	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	387	0.422	3.680	4.102	18.362	160.081	178.444
1991	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	4	0.170	1.725	1.895	7.411	75.042	82.453
1991	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	176	1.271	17.057	18.328	55.284	741.968	797.251
1991	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	DC10-30	1849	3425	1	1.836	28.499	30.335	79.870	1239.716	1319.586
1991	Copenhagen	Narssarssuaq	B737 400	1794	3322	12	0.614	10.114	10.728	26.692	439.981	466.673
1991	Copenhagen	Narssarssuaq	RJ 100	1794	3322	1	0.170	4.110	4.281	7.411	178.794	186.205
1991	Copenhagen	Thule	B767 300 ER	2080	3853	12	1.271	19.224	20.495	55.284	836.258	891.542
1991	Copenhagen	Thule	DC10-30	2080	3853	1	1.836	32.161	33.997	79.870	1399.012	1478.883
1992	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	340	0.614	4.000	4.614	26.692	174.008	200.701
1992	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	348	0.422	3.680	4.102	18.362	160.081	178.444
1992	Copenhagen	Faroe Islands Vagar	F50	725	1342	8	0.129	1.490	1.619	5.622	64.815	70.437
1992	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	175	1.271	17.057	18.328	55.284	741.968	797.251
1992	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1849	3425	1	0.170	4.233	4.403	7.411	184.134	191.545
1992	Copenhagen	Narssarssuaq	B737 400	1794	3322	80	0.614	10.114	10.728	26.692	439.981	466.673
1992	Copenhagen	Thule	B767 300 ER	2080	3853	13	1.271	19.224	20.495	55.284	836.258	891.542
1993	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	318	0.614	4.000	4.614	26.692	174.008	200.701
1993	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	323	0.422	3.680	4.102	18.362	160.081	178.444
1993	Copenhagen	Faroe Islands Vagar	F50	725	1342	5	0.129	1.490	1.619	5.622	64.815	70.437
1993	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	2	0.170	1.725	1.895	7.411	75.042	82.453
1993	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	176	1.271	17.057	18.328	55.284	741.968	797.251
1993	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	MD 82	1849	3425	1	0.759	11.765	12.523	32.998	511.760	544.758
1993	Copenhagen	Narssarssuaq	B737 400	1794	3322	82	0.614	10.114	10.728	26.692	439.981	466.673
1993	Copenhagen	Thule	B767 300 ER	2080	3853	8	1.271	19.224	20.495	55.284	836.258	891.542
1994	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	310	0.614	4.000	4.614	26.692	174.008	200.701
1994	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	375	0.422	3.680	4.102	18.362	160.081	178.444
1994	Copenhagen	Faroe Islands Vagar	F50	725	1342	2	0.129	1.490	1.619	5.622	64.815	70.437
1994	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	1	0.170	1.725	1.895	7.411	75.042	82.453
1994	Copenhagen	Faroe Islands Vagar	Shorts 360 300	725	1342	1	0.085	1.438	1.523	3.698	62.570	66.269
1994	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	173	1.271	17.057	18.328	55.284	741.968	797.251
1994	Copenhagen	Narssarssuaq	B737 400	1794	3322	70	0.614	10.114	10.728	26.692	439.981	466.673
1994	Copenhagen	Narssarssuaq	MD 82	1794	3322	1	0.759	11.411	12.169	32.998	496.374	529.372
1995	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	323	0.614	4.000	4.614	26.692	174.008	200.701
1995	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	363	0.422	3.680	4.102	18.362	160.081	178.444
1995	Copenhagen	Faroe Islands Vagar	F50	725	1342	1	0.129	1.490	1.619	5.622	64.815	70.437
1995	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	1	0.170	1.725	1.895	7.411	75.042	82.453
1995	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1849	3425	1	0.614	10.442	11.056	26.692	454.240	480.932
1995	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	200	1.271	17.057	18.328	55.284	741.968	797.251
1995	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1849	3425	3	0.170	4.233	4.403	7.411	184.134	191.545
1995	Copenhagen	Narssarssuaq	B737 400	1794	3322	1	0.614	10.114	10.728	26.692	439.981	466.673
1995	Copenhagen	Narssarssuaq	MD 82	1794	3322	18	0.759	11.411	12.169	32.998	496.374	529.372

Source: Copenhagen Airport (2001) and simulations with the NERI model (Winther, 2001).

Year	Origin Airport	Destination Airport	Rep. Aircraft	Distance [NM]	Distance [km]	No. of flights	LTO Fuel [Tonnes/flight]	Cruise Fuel [Tonnes/flight]	Fuel Total [Tonnes/flight]	LTO Fuel [GJ/flight]	Cruise Fuel [GJ/flight]	Fuel Total [GJ/flight]
1996	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	341	0.614	4.000	4.614	26.692	174.008	200.701
1996	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	392	0.422	3.680	4.102	18.362	160.081	178.444
1996	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	1	0.170	1.725	1.895	7.411	75.042	82.453
1996	Copenhagen	Faroe Islands Vagar	Shorts 360 300	725	1342	1	0.085	1.438	1.523	3.698	62.570	66.269
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	A310	1849	3425	1	1.201	16.097	17.298	52.242	700.240	752.483
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1849	3425	2	0.614	10.442	11.056	26.692	454.240	480.932
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	206	1.271	17.057	18.328	55.284	741.968	797.251
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1849	3425	2	0.170	4.233	4.403	7.411	184.134	191.545
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	Shorts 360 300	1849	3425	1	0.085	3.668	3.753	3.698	159.576	163.275
1996	Copenhagen	Narssarssuaq	B737 400	1794	3322	2	0.614	10.114	10.728	26.692	439.981	466.673
1996	Copenhagen	Narssarssuaq	MD 82	1794	3322	24	0.759	11.411	12.169	32.998	496.374	529.372
1996	Copenhagen	Thule	B767 300 ER	2080	3853	2	1.271	19.224	20.495	55.284	836.258	891.542
1997	Copenhagen	Faroe Islands Vagar	A320	725	1342	1	0.609	3.798	4.408	26.505	165.223	191.728
1997	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	334	0.614	4.000	4.614	26.692	174.008	200.701
1997	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	397	0.422	3.680	4.102	18.362	160.081	178.444
1997	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	1	0.170	1.725	1.895	7.411	75.042	82.453
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	A310	1849	3425	1	1.201	16.097	17.298	52.242	700.240	752.483
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1849	3425	3	0.614	10.442	11.056	26.692	454.240	480.932
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	216	1.271	17.057	18.328	55.284	741.968	797.251
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	MD 82	1849	3425	1	0.759	11.765	12.523	32.998	511.760	544.758
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1849	3425	4	0.170	4.233	4.403	7.411	184.134	191.545
1997	Copenhagen	Narssarssuaq	A320	1794	3322	1	0.609	9.020	9.629	26.505	392.353	418.857
1997	Copenhagen	Narssarssuaq	B727	1794	3322	1	1.029	14.676	15.705	44.760	638.418	683.179
1997	Copenhagen	Narssarssuaq	B737 400	1794	3322	6	0.614	10.114	10.728	26.692	439.981	466.673
1997	Copenhagen	Narssarssuaq	MD 82	1794	3322	29	0.759	11.411	12.169	32.998	496.374	529.372
1997	Copenhagen	Thule	B767 300 ER	2080	3853	13	1.271	19.224	20.495	55.284	836.258	891.542
1998	Billund	Faroe Islands Vagar	B737 400	632	1170	113	0.529	3.499	4.028	23.008	152.203	175.211
1998	Billund	Faroe Islands Vagar	BAe146	632	1170	20	0.363	3.215	3.578	15.798	139.854	155.652
1998	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	316	0.614	4.000	4.614	26.692	174.008	200.701
1998	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	435	0.422	3.680	4.102	18.362	160.081	178.444
1998	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	1	0.170	1.725	1.895	7.411	75.042	82.453
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1849	3425	2	0.614	10.442	11.056	26.692	454.240	480.932
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B757	1849	3425	55	0.958	13.079	14.036	41.666	568.915	610.582
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	192	1.271	17.057	18.328	55.284	741.968	797.251
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	MD 82	1849	3425	1	0.759	11.765	12.523	32.998	511.760	544.758
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1849	3425	3	0.170	4.233	4.403	7.411	184.134	191.545
1998	Copenhagen	Narssarssuaq	B727	1794	3322	2	1.029	14.676	15.705	44.760	638.418	683.179
1998	Copenhagen	Narssarssuaq	B737 400	1794	3322	9	0.614	10.114	10.728	26.692	439.981	466.673
1998	Copenhagen	Narssarssuaq	B757	1794	3322	42	0.958	12.687	13.645	41.666	551.875	593.541
1998	Copenhagen	Thule	B767 300 ER	2080	3853	12	1.271	19.224	20.495	55.284	836.258	891.542

Source: Copenhagen Airport (2001), Billund Airport (2001a) and simulations with the NERI model (Winther, 2001).

Year	Origin Airport	Destination Airport	Rep. Aircraft	Distance [NM]	Distance [km]	No. of flights	LTO Fuel [Tonnes/flight]	Cruise Fuel [Tonnes/flight]	Fuel Total [Tonnes/flight]	LTO Fuel [GJ/flight]	Cruise Fuel [GJ/flight]	Fuel Total [GJ/flight]
1999	Billund	Faroe Islands Vagar	B737 400	632	1170	131	0.529	3.499	4.028	23.008	152.203	175.211
1999	Billund	Faroe Islands Vagar	BAe146	632	1170	18	0.363	3.215	3.578	15.798	139.854	155.652
1999	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	342	0.614	4.000	4.614	26.692	174.008	200.701
1999	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	476	0.422	3.680	4.102	18.362	160.081	178.444
1999	Copenhagen	Faroe Islands Vagar	F50	725	1342	1	0.129	1.490	1.619	5.622	64.815	70.437
1999	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	1	0.170	1.725	1.895	7.411	75.042	82.453
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1849	3425	6	0.614	10.442	11.056	26.692	454.240	480.932
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B757	1849	3425	80	0.958	13.079	14.036	41.666	568.915	610.582
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	197	1.271	17.057	18.328	55.284	741.968	797.251
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	F50	1849	3425	2	0.129	3.733	3.862	5.622	162.368	167.991
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1849	3425	3	0.170	4.233	4.403	7.411	184.134	191.545
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	Shorts 360 300	1849	3425	1	0.085	3.668	3.753	3.698	159.576	163.275
1999	Copenhagen	Narssarssuaq	B737 400	1794	3322	6	0.614	10.114	10.728	26.692	439.981	466.673
1999	Copenhagen	Narssarssuaq	B757	1794	3322	75	0.958	12.687	13.645	41.666	551.875	593.541
1999	Copenhagen	Narssarssuaq	RJ 100	1794	3322	1	0.170	4.110	4.281	7.411	178.794	186.205
1999	Copenhagen	Thule	B767 300 ER	2080	3853	14	1.271	19.224	20.495	55.284	836.258	891.542
1999	Faroe Islands Vagar	Aberdeen	BAe146	329	610	44	0.363	1.690	2.054	15.798	73.535	89.332
1999	Faroe Islands Vagar	Billund	B737 400	632	1170	131	0.529	3.499	4.028	23.008	152.203	175.211
1999	Faroe Islands Vagar	Billund	BAe146	632	1170	18	0.363	3.215	3.578	15.798	139.854	155.652
1999	Faroe Islands Vagar	Copenhagen	B737 400	725	1342	340	0.529	4.000	4.529	23.008	174.008	197.016
1999	Faroe Islands Vagar	Copenhagen	BAe146	725	1342	460	0.363	3.680	4.043	15.798	160.081	175.879
1999	Faroe Islands Vagar	Glasgow	BAe146	382	707	20	0.363	1.958	2.322	15.798	85.191	100.989
1999	Faroe Islands Vagar	Reykjavik	BAe146	415	769	67	0.363	2.125	2.488	15.798	92.449	108.247
1999	Faroe Islands Vagar	Reykjavik	F50	415	769	76	0.095	0.884	0.979	4.122	38.444	42.565
1999	Faroe Islands Vagar	Stavanger	BAe146	425	788	9	0.363	2.176	2.539	15.798	94.649	110.446
1999	Faroe Islands Vagar	Ålborg	B737 400	597	1105	5	0.529	3.310	3.839	23.008	143.997	167.004
1999	Faroe Islands Vagar	Århus	BAe146	646	1196	12	0.363	3.285	3.648	15.798	142.899	158.697
1999	Århus	Faroe Islands Vagar	BAe146	646	1196	12	0.363	3.285	3.648	15.798	142.899	158.697

Source: Copenhagen Airport (2001), Vagar Airport (2001c), Billund Airport (2001a) and Århus Airport (2001) and simulations with the NERI model (Winther, 2001).

Year	Origin Airport	Destination Airport	Rep. Aircraft	Distance [NM]	Distance [km]	No. of flights	LTO Fuel [Tonnes/flight]	Cruise Fuel [Tonnes/flight]	Fuel Total [Tonnes/flight]	LTO Fuel [GJ/flight]	Cruise Fuel [GJ/flight]	Fuel Total [GJ/flight]
2000	Billund	Faroe Islands Vagar	B737 400	632	1170	132	0.529	3.499	4.028	23.008	152.203	175.211
2000	Billund	Faroe Islands Vagar	BAe146	632	1170	24	0.363	3.215	3.578	15.798	139.854	155.652
2000	Copenhagen	Faroe Islands Vagar	B737 400	725	1342	363	0.614	4.000	4.614	26.692	174.008	200.701
2000	Copenhagen	Faroe Islands Vagar	BAe146	725	1342	466	0.422	3.680	4.102	18.362	160.081	178.444
2000	Copenhagen	Faroe Islands Vagar	RJ 100	725	1342	1	0.170	1.725	1.895	7.411	75.042	82.453
2000	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	A330	1849	3425	1	1.728	21.638	23.365	75.147	941.248	1016.395
2000	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B757	1849	3425	125	0.958	13.079	14.036	41.666	568.915	610.582
2000	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1849	3425	183	1.271	17.057	18.328	55.284	741.968	797.251
2000	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1849	3425	2	0.170	4.233	4.403	7.411	184.134	191.545
2000	Copenhagen	Narssarssuaq	B737 400	1794	3322	1	0.614	10.114	10.728	26.692	439.981	466.673
2000	Copenhagen	Narssarssuaq	B757	1794	3322	81	0.958	12.687	13.645	41.666	551.875	593.541
2000	Copenhagen	Thule	B757	2080	3853	1	0.958	14.733	15.691	41.666	640.887	682.553
2000	Copenhagen	Thule	B767 300 ER	2080	3853	12	1.271	19.224	20.495	55.284	836.258	891.542
2000	Faroe Islands Vagar	Aberdeen	BAe146	329	610	70	0.363	1.690	2.054	15.798	73.535	89.332
2000	Faroe Islands Vagar	Billund	B737 400	632	1170	129	0.529	3.499	4.028	23.008	152.203	175.211
2000	Faroe Islands Vagar	Billund	BAe146	632	1170	24	0.363	3.215	3.578	15.798	139.854	155.652
2000	Faroe Islands Vagar	Copenhagen	B737 400	725	1342	362	0.529	4.000	4.529	23.008	174.008	197.016
2000	Faroe Islands Vagar	Copenhagen	BAe146	725	1342	467	0.363	3.680	4.043	15.798	160.081	175.879
2000	Faroe Islands Vagar	Glasgow	BAe146	382	707	12	0.363	1.958	2.322	15.798	85.191	100.989
2000	Faroe Islands Vagar	Reykjavik	BAe146	415	769	101	0.363	2.125	2.488	15.798	92.449	108.247
2000	Faroe Islands Vagar	Reykjavik	F50	415	769	66	0.095	0.884	0.979	4.122	38.444	42.565
2000	Faroe Islands Vagar	Stavanger	BAe146	425	788	24	0.363	2.176	2.539	15.798	94.649	110.446
2000	Faroe Islands Vagar	Århus	BAe146	646	1196	9	0.363	3.285	3.648	15.798	142.899	158.697
2000	Århus	Faroe Islands Vagar	BAe146	646	1196	9	0.363	3.285	3.648	15.798	142.899	158.697

Source: Copenhagen Airport (2001), Vagar Airport (2001c), Billund Airport (2001a) and Århus Airport (2001) and simulations with the NERI model (Winther, 2001).

Appendix 5

LTO and cruise fuel use results per representative aircraft type for North-Atlantic flights 1991-2000

Year	Origin Airport	Destination Airport	Rep. Aircraft	Distance [NM]	Distance [km]	No. of flights	LTO Fuel [Tonnes]	Cruise Fuel [Tonnes]	Fuel Total [Tonnes]	LTO Fuel [GJ]	Cruise Fuel [GJ]	Fuel Total [GJ]
1991	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	354	217.221	1,416.066	1,633	9,449	61,599	71,048
1991	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	387	163.359	1,424.173	1,588	7,106	61,952	69,058
1991	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	4	0.681	6.900	8	30	300	330
1991	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	176	223.676	3,001.984	3,226	9,730	130,586	140,316
1991	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	DC10-30	1,849	3,425	1	1.836	28.499	30	80	1,240	1,320
1991	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	12	7.363	121.374	129	320	5,280	5,600
1991	Copenhagen	Narssarssuaq	RJ 100	1,794	3,322	1	0.170	4.110	4	7	179	186
1991	Copenhagen	Thule	B767 300 ER	2,080	3,853	12	15.251	230.692	246	663	10,035	10,699
1991	Copenhagen	Thule	DC10-30	2,080	3,853	1	1.836	32.161	34	80	1,399	1,479
1992	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	340	208.630	1,360.064	1,569	9,075	59,163	68,238
1992	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	348	146.897	1,280.652	1,428	6,390	55,708	62,098
1992	Copenhagen	Faroe Islands Vagar	F50	725	1,342	8	1.034	11.920	13	45	519	563
1992	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	175	222.405	2,984.927	3,207	9,675	129,844	139,519
1992	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1,849	3,425	1	0.170	4.233	4	7	184	192
1992	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	80	49.089	809.160	858	2,135	35,198	37,334
1992	Copenhagen	Thule	B767 300 ER	2,080	3,853	13	16.522	249.916	266	719	10,871	11,590
1993	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	318	195.131	1,272.060	1,467	8,488	55,335	63,823
1993	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	323	136.344	1,188.651	1,325	5,931	51,706	57,637
1993	Copenhagen	Faroe Islands Vagar	F50	725	1,342	5	0.646	7.450	8	28	324	352
1993	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	2	0.341	3.450	4	15	150	165
1993	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	176	223.676	3,001.984	3,226	9,730	130,586	140,316
1993	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	MD 82	1,849	3,425	1	0.759	11.765	13	33	512	545
1993	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	82	50.317	829.389	880	2,189	36,078	38,267
1993	Copenhagen	Thule	B767 300 ER	2,080	3,853	8	10.167	153.795	164	442	6,690	7,132
1994	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	310	190.222	1,240.058	1,430	8,275	53,943	62,217
1994	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	375	158.294	1,380.012	1,538	6,886	60,031	66,916
1994	Copenhagen	Faroe Islands Vagar	F50	725	1,342	2	0.258	2.980	3	11	130	141
1994	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	1	0.170	1.725	2	7	75	82
1994	Copenhagen	Faroe Islands Vagar	Shorts 360 300	725	1,342	1	0.085	1.438	2	4	63	66
1994	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	173	219.864	2,950.814	3,171	9,564	128,360	137,924
1994	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	70	42.953	708.015	751	1,868	30,799	32,667
1994	Copenhagen	Narssarssuaq	MD 82	1,794	3,322	1	0.759	11.411	12	33	496	529
1995	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	323	198.199	1,292.060	1,490	8,622	56,205	64,826
1995	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	363	153.229	1,335.852	1,489	6,665	58,110	64,775
1995	Copenhagen	Faroe Islands Vagar	F50	725	1,342	1	0.129	1.490	2	6	65	70
1995	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	1	0.170	1.725	2	7	75	82
1995	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1,849	3,425	1	0.614	10.442	11	27	454	481
1995	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	200	254.177	3,411.345	3,666	11,057	148,394	159,450
1995	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1,849	3,425	3	0.511	12.699	13	22	552	575
1995	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	1	0.614	10.114	11	27	440	467
1995	Copenhagen	Narssarssuaq	MD 82	1,794	3,322	18	13.654	205.396	219	594	8,935	9,529

Source: Copenhagen Airport (2001) and simulations with the NERI model (Winther, 2001).

Year	Origin Airport	Destination Airport	Rep. Aircraft	Distance [NM]	Distance [km]	No. of flights	LTO Fuel [Tonnes]	Cruise Fuel [Tonnes]	Fuel Total [Tonnes]	LTO Fuel [GJ]	Cruise Fuel [GJ]	Fuel Total [GJ]
1996	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	341	209.244	1,364.064	1,573	9,102	59,337	68,439
1996	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	392	165.470	1,442.573	1,608	7,198	62,752	69,950
1996	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	1	0.170	1.725	2	7	75	82
1996	Copenhagen	Faroe Islands Vagar	Shorts 360 300	725	1,342	1	0.085	1.438	2	4	63	66
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	A310	1,849	3,425	1	1.201	16.097	17	52	700	752
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1,849	3,425	2	1.227	20.885	22	53	908	962
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	206	261.803	3,513.686	3,775	11,388	152,845	164,234
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1,849	3,425	2	0.341	8.466	9	15	368	383
1996	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	Shorts 360 300	1,849	3,425	1	0.085	3.668	4	4	160	163
1996	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	2	1.227	20.229	21	53	880	933
1996	Copenhagen	Narssarssuaq	MD 82	1,794	3,322	24	18.206	273.862	292	792	11,913	12,705
1996	Copenhagen	Thule	B767 300 ER	2,080	3,853	2	2.542	38.449	41	111	1,673	1,783
1997	Copenhagen	Faroe Islands Vagar	A320	725	1,342	1	0.609	3.798	4	27	165	192
1997	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	334	204.949	1,336.063	1,541	8,915	58,119	67,034
1997	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	397	167.581	1,460.973	1,629	7,290	63,552	70,842
1997	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	1	0.170	1.725	2	7	75	82
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	A310	1,849	3,425	1	1.201	16.097	17	52	700	752
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1,849	3,425	3	1.841	31.327	33	80	1,363	1,443
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	216	274.512	3,684.253	3,959	11,941	160,265	172,206
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	MD 82	1,849	3,425	1	0.759	11.765	13	33	512	545
1997	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1,849	3,425	4	0.681	16.932	18	30	737	766
1997	Copenhagen	Narssarssuaq	A320	1,794	3,322	1	0.609	9.020	10	27	392	419
1997	Copenhagen	Narssarssuaq	B727	1,794	3,322	1	1.029	14.676	16	45	638	683
1997	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	6	3.682	60.687	64	160	2,640	2,800
1997	Copenhagen	Narssarssuaq	MD 82	1,794	3,322	29	21.999	330.916	353	957	14,395	15,352
1997	Copenhagen	Thule	B767 300 ER	2,080	3,853	13	16.522	249.916	266	719	10,871	11,590
1998	Billund	Faroe Islands Vagar	B737 400	632	1,170	113	59.767	395.378	455	2,600	17,199	19,799
1998	Billund	Faroe Islands Vagar	BAe146	632	1,170	20	7.263	64.301	72	316	2,797	3,113
1998	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	316	193.903	1,264.059	1,458	8,435	54,987	63,421
1998	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	435	183.621	1,600.814	1,784	7,988	69,635	77,623
1998	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	1	0.170	1.725	2	7	75	82
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1,849	3,425	2	1.227	20.885	22	53	908	962
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B757	1,849	3,425	55	52.681	719.318	772	2,292	31,290	33,582
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	192	244.010	3,274.892	3,519	10,614	142,458	153,072
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	MD 82	1,849	3,425	1	0.759	11.765	13	33	512	545
1998	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1,849	3,425	3	0.511	12.699	13	22	552	575
1998	Copenhagen	Narssarssuaq	B727	1,794	3,322	2	2.058	29.353	31	90	1,277	1,366
1998	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	9	5.523	91.030	97	240	3,960	4,200
1998	Copenhagen	Narssarssuaq	B757	1,794	3,322	42	40.229	532.845	573	1,750	23,179	24,929
1998	Copenhagen	Thule	B767 300 ER	2,080	3,853	12	15.251	230.692	246	663	10,035	10,699

Source: Copenhagen Airport (2001), Billund Airport (2001a) and simulations with the NERI model (Winther, 2001).

Year	Origin Airport	Destination Airport	Rep. Aircraft	Distance [NM]	Distance [km]	No. of flights	LTO Fuel [Tonnes]	Cruise Fuel [Tonnes]	Fuel Total [Tonnes]	LTO Fuel [GJ]	Cruise Fuel [GJ]	Fuel Total [GJ]
1999	Billund	Faroe Islands Vagar	B737 400	632	1,170	131	69.287	458.358	528	3,014	19,939	22,953
1999	Billund	Faroe Islands Vagar	BAe146	632	1,170	18	6.537	57.871	64	284	2,517	2,802
1999	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	342	209.858	1,368.064	1,578	9,129	59,511	68,640
1999	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	476	200.928	1,751.696	1,953	8,740	76,199	84,939
1999	Copenhagen	Faroe Islands Vagar	F50	725	1,342	1	0.129	1.490	2	6	65	70
1999	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	1	0.170	1.725	2	7	75	82
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B737 400	1,849	3,425	6	3.682	62.654	66	160	2,725	2,886
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B757	1,849	3,425	80	76.628	1,046.281	1,123	3,333	45,513	48,847
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	197	250.365	3,360.175	3,611	10,891	146,168	157,058
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	F50	1,849	3,425	2	0.258	7.465	8	11	325	336
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1,849	3,425	3	0.511	12.699	13	22	552	575
1999	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	Shorts 360 300	1,849	3,425	1	0.085	3.668	4	4	160	163
1999	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	6	3.682	60.687	64	160	2,640	2,800
1999	Copenhagen	Narssarssuaq	B757	1,794	3,322	75	71.838	951.508	1,023	3,125	41,391	44,516
1999	Copenhagen	Narssarssuaq	RJ 100	1,794	3,322	1	0.170	4.110	4	7	179	186
1999	Copenhagen	Thule	B767 300 ER	2,080	3,853	14	17.792	269.141	287	774	11,708	12,482
1999	Faroe Islands Vagar	Aberdeen	BAe146	329	610	44	15.979	74.380	90	695	3,236	3,931
1999	Faroe Islands Vagar	Billund	B737 400	632	1,170	131	69.287	458.358	528	3,014	19,939	22,953
1999	Faroe Islands Vagar	Billund	BAe146	632	1,170	18	6.537	57.871	64	284	2,517	2,802
1999	Faroe Islands Vagar	Copenhagen	B737 400	725	1,342	340	179.830	1,360.064	1,540	7,823	59,163	66,985
1999	Faroe Islands Vagar	Copenhagen	BAe146	725	1,342	460	167.054	1,692.815	1,860	7,267	73,637	80,904
1999	Faroe Islands Vagar	Glasgow	BAe146	382	707	20	7.263	39.168	46	316	1,704	2,020
1999	Faroe Islands Vagar	Reykjavik	BAe146	415	769	67	24.332	142.393	167	1,058	6,194	7,253
1999	Faroe Islands Vagar	Reykjavik	F50	415	769	76	7.201	67.166	74	313	2,922	3,235
1999	Faroe Islands Vagar	Stavanger	BAe146	425	788	9	3.268	19.583	23	142	852	994
1999	Faroe Islands Vagar	Ålborg	B737 400	597	1,105	5	2.645	16.551	19	115	720	835
1999	Faroe Islands Vagar	Århus	BAe146	646	1,196	12	4.358	39.420	44	190	1,715	1,904
1999	Århus	Faroe Islands Vagar	BAe146	646	1,196	12	4.358	39.420	44	190	1,715	1,904

Source: Copenhagen Airport (2001), Vagar Airport (2001c), Billund Airport (2001a) and Århus Airport (2001) and simulations with the NERI model (Winther, 2001).

Year	Origin Airport	Destination Airport	Rep. Aircraft	Distance [NM]	Distance [km]	No. of flights	LTO Fuel [Tonnes]	Cruise Fuel [Tonnes]	Fuel Total [Tonnes]	LTO Fuel [GJ]	Cruise Fuel [GJ]	Fuel Total [GJ]
2000	Billund	Faroe Islands Vagar	B737 400	632	1,170	132	69.816	461.857	532	3,037	20,091	23,128
2000	Billund	Faroe Islands Vagar	BAe146	632	1,170	24	8.716	77.161	86	379	3,356	3,736
2000	Copenhagen	Faroe Islands Vagar	B737 400	725	1,342	363	222.744	1,452.068	1,675	9,689	63,165	72,854
2000	Copenhagen	Faroe Islands Vagar	BAe146	725	1,342	466	196.707	1,714.895	1,912	8,557	74,598	83,155
2000	Copenhagen	Faroe Islands Vagar	RJ 100	725	1,342	1	0.170	1.725	2	7	75	82
2000	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	A330	1,849	3,425	1	1.728	21.638	23	75	941	1,016
2000	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B757	1,849	3,425	125	119.731	1,634.815	1,755	5,208	71,114	76,323
2000	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	B767 300 ER	1,849	3,425	183	232.572	3,121.381	3,354	10,117	135,780	145,897
2000	Copenhagen	Kangerlussuaq (Sdr. Strmfj)	RJ 100	1,849	3,425	2	0.341	8.466	9	15	368	383
2000	Copenhagen	Narssarssuaq	B737 400	1,794	3,322	1	0.614	10.114	11	27	440	467
2000	Copenhagen	Narssarssuaq	B757	1,794	3,322	81	77.585	1,027.629	1,105	3,375	44,702	48,077
2000	Copenhagen	Thule	B757	2,080	3,853	1	0.958	14.733	16	42	641	683
2000	Copenhagen	Thule	B767 300 ER	2,080	3,853	12	15.251	230.692	246	663	10,035	10,699
2000	Faroe Islands Vagar	Aberdeen	BAe146	329	610	70	25.421	118.332	144	1,106	5,147	6,253
2000	Faroe Islands Vagar	Billund	B737 400	632	1,170	129	68.230	451.360	520	2,968	19,634	22,602
2000	Faroe Islands Vagar	Billund	BAe146	632	1,170	24	8.716	77.161	86	379	3,356	3,736
2000	Faroe Islands Vagar	Copenhagen	B737 400	725	1,342	362	191.466	1,448.068	1,640	8,329	62,991	71,320
2000	Faroe Islands Vagar	Copenhagen	BAe146	725	1,342	467	169.596	1,718.575	1,888	7,377	74,758	82,135
2000	Faroe Islands Vagar	Glasgow	BAe146	382	707	12	4.358	23.501	28	190	1,022	1,212
2000	Faroe Islands Vagar	Reykjavik	BAe146	415	769	101	36.679	214.653	251	1,596	9,337	10,933
2000	Faroe Islands Vagar	Reykjavik	F50	415	769	66	6.253	58.328	65	272	2,537	2,809
2000	Faroe Islands Vagar	Stavanger	BAe146	425	788	24	8.716	52.220	61	379	2,272	2,651
2000	Faroe Islands Vagar	Århus	BAe146	646	1,196	9	3.268	29.565	33	142	1,286	1,428
2000	Århus	Faroe Islands Vagar	BAe146	646	1,196	9	3.268	29.565	33	142	1,286	1,428

Source: Copenhagen Airport (2001), Vagar Airport (2001c), Billund Airport (2001a) and Århus Airport (2001) and simulations with the NERI model (Winther, 2001).

Appendix 6

Cruise fuel use per distance class for representative aircraft

Rep. Aircraft	Distance x [NM]	Distance x [km]	Fuel [Tonnes]	Fuel [GJ]
A310	125	232	1.270	55.246
A310	250	463	2.359	102.613
A310	500	926	4.450	193.567
A310	750	1389	6.541	284.521
A310	1000	1852	8.632	375.475
A310	1500	2778	12.992	565.153
A310	2000	3704	17.441	758.688
A310	2500	4630	22.159	963.908
A310	3000	5556	27.135	1,180.361
A310	3500	6482	32.223	1,401.712
A320	125	232	0.842	36.630
A320	250	463	1.695	73.731
A320	500	926	2.858	124.335
A320	750	1389	3.903	169.766
A320	1000	1852	5.225	227.283
A320	1500	2778	7.530	327.541
A320	2000	3704	10.064	437.765
A320	2500	4630	12.639	549.793
A330	125	232	1.862	81.003
A330	250	463	3.631	157.945
A330	500	926	6.384	277.701
A330	750	1389	9.128	397.087
A330	1000	1852	11.890	517.214
A330	1500	2778	17.559	763.813
A330	2000	3704	23.403	1,018.017
A330	2500	4630	29.483	1,282.522
A330	3000	5556	35.812	1,557.822
A330	3500	6482	42.080	1,830.498
A330	4000	7408	48.774	2,121.677
B727	125	232	1.304	56.722
B727	250	463	2.342	101.870
B727	500	926	4.247	184.759
B727	750	1389	6.080	264.497
B727	1000	1852	8.058	350.537
B727	1500	2778	12.131	527.716
B727	2000	3704	16.459	715.985
B727	2500	4630	20.825	905.897
B737 400	125	232	0.778	33.832
B737 400	250	463	1.443	62.752
B737 400	500	926	2.787	121.254
B737 400	750	1389	4.135	179.870
B737 400	1000	1852	5.477	238.257
B737 400	1500	2778	8.362	363.759
B737 400	2000	3704	11.342	493.388
B757	125	232	1.170	50.890
B757	250	463	2.157	93.837
B757	500	926	3.817	166.055
B757	750	1389	5.471	238.007
B757	1000	1852	7.138	310.490
B757	1500	2778	10.593	460.784
B757	2000	3704	14.154	615.700
B757	2500	4630	17.773	773.121
B767 300 ER	125	232	1.413	61.475
B767 300 ER	250	463	2.688	116.933
B767 300 ER	500	926	4.868	211.762
B767 300 ER	750	1389	7.048	306.590
B767 300 ER	1000	1852	9.228	401.418
B767 300 ER	1500	2778	13.791	599.930
B767 300 ER	2000	3704	18.469	803.422
B767 300 ER	2500	4630	23.187	1,008.648
B767 300 ER	3000	5556	28.292	1,230.715
B767 300 ER	3500	6482	33.622	1,462.556
B767 300 ER	4000	7408	39.014	1,697.102
B767 300 ER	4500	8334	44.697	1,944.301
B767 300 ER	5000	9260	50.591	2,200.705

Source: CORINAIR data (Winther, 2001).

Rep. Aircraft	Distance x [NM]	Distance x [km]	Fuel [Tonnes]	Fuel [GJ]
BAe146	125	232	0.676	29.388
BAe146	250	463	1.291	56.160
BAe146	500	926	2.555	111.144
BAe146	750	1389	3.805	165.519
BAe146	1000	1852	5.083	221.113
BAe146	1500	2778	7.701	334.976
DC10-30	125	232	2.346	102.072
DC10-30	250	463	4.423	192.409
DC10-30	500	926	8.106	352.623
DC10-30	750	1389	11.789	512.837
DC10-30	1000	1852	15.472	673.052
DC10-30	1500	2778	23.095	1,004.635
DC10-30	2000	3704	30.837	1,341.427
DC10-30	2500	4630	39.111	1,701.335
DC10-30	3000	5556	47.980	2,087.137
DC10-30	3500	6482	57.071	2,482.598
DC10-30	4000	7408	66.657	2,899.567
DC10-30	4500	8334	76.653	3,334.400
DC10-30	5000	9260	87.017	3,785.231
F50	125	232	0.324	14.094
F50	250	463	0.563	24.491
F50	500	926	1.049	45.632
F50	750	1389	1.539	66.947
F50	1000	1852	2.038	88.653
MD 82	125	232	1.100	47.843
MD 82	250	463	2.108	91.695
MD 82	500	926	3.561	154.897
MD 82	750	1389	4.910	213.587
MD 82	1000	1852	6.467	281.302
MD 82	1500	2778	9.520	414.131
MD 82	2000	3704	12.736	554.000
RJ 100	125	232	0.397	17.270
RJ 100	250	463	0.692	30.102
RJ 100	500	926	1.231	53.549
RJ 100	750	1389	1.780	77.430
RJ 100	1000	1852	2.338	101.703
Shorts 360 300	100	185	0.202	8.787
Shorts 360 300	125	232	0.251	10.919
Shorts 360 300	250	463	0.496	21.576
Shorts 360 300	500	926	0.992	43.152

Source: CORINAIR data (Winther, 2001).

National Environmental Research Institute

The National Environmental Research Institute, NERI, is a research institute of the Ministry of Environment. In Danish, NERI is called *Danmarks Miljøundersøgelser (DMU)*.
NERI's tasks are primarily to conduct research, collect data, and give advice on problems related to the environment and nature.

Addresses:

URL: http://www.dmu.dk

National Environmental Research Institute
Frederiksborgvej 399
PO Box 358
DK-4000 Roskilde
Denmark
Tel: +45 46 30 12 00
Fax: +45 46 30 11 14

Management
Personnel and Economy Secretariat
Research and Development Section
Department of Atmospheric Environment
Department of Environmental Chemistry
Department of Policy Analysis
Department of Marine Ecology
Department of Microbial Ecology and Biotechnology
Department of Arctic Environment

National Environmental Research Institute
Vejlsøvej 25
PO Box 314
DK-8600 Silkeborg
Denmark
Tel: +45 89 20 14 00
Fax: +45 89 20 14 14

Environmental Monitoring Co-ordination Section
Department of Lake and Estuarine Ecology
Department of Terrestrial Ecology
Department of Streams and Riparian areas

National Environmental Research Institute
Grenåvej 12-14, Kalø
DK-8410 Rønde
Denmark
Tel: +45 89 20 17 00
Fax: +45 89 20 15 15

Department of Landscape Ecology
Department of Coastal Zone Ecology

Publications:
NERI publishes professional reports, technical instructions, and the annual report. A R&D projects' catalogue is available in an electronic version on the World Wide Web.
Included in the annual report is a list of the publications from the current year.

Faglige rapporter fra DMU/NERI Technical Reports

2000

Nr. 340: Afstrømningsforhold i danske vandløb. Af Ovesen, N.B. et al. 238 s., 225,00 kr.
Nr. 341: The Background Air Quality in Denmark 1978-1997. By Heidam, N.Z. 190 pp., 190,00 DKK.
Nr. 342: Methyl t-Buthylether (MTBE) i spildevand. Metodeafprøvning. Af Nyeland, B. & Kvamm, B.L. 45 s., 75,00 kr.
Nr. 343: Vildtudbyttet i Danmark i jagtsæsonen 1999/2000. Af Asferg, T. 31 s., 40,00 kr.

2001

Nr. 344: En model for godstransportens udvikling. Af Kveiborg, O. 246 s., 130,00 kr.
Nr. 345: Important summer concentrations of seaducks in West Greenland. An input to oil spill sensitivity mapping. By Boertmann, D. & Mosbech, A. 48 pp. (elektronisk)
Nr. 346: The Greenland Ramsar sites. A status report. By Egevang, C. & Boertmann, D. 96 pp., 100,00 DKK.
Nr. 347: Nationale og internationale miljøindikatorsystemer. Metodeovervejelser. Af Christensen, N. & Møller, F. 161 s., 150,00 kr.
Nr. 348: Adfærdsmodel for persontrafik. Modelkoncept. ALTRANS. Af Rich, J.H. & Christensen, L. 153 s., 100,00 kr.
Nr. 349: Flora and fauna in Roundup tolerant fodder beet fields. By Elmegaard, N. & Bruus Pedersen, M. 37 pp., 50,00 DKK.
Nr. 350: Overvågning af fugle, sæler og planter 1999-2000 med resultater fra feltstationerne. Af Laursen, K. (red.). 103 s., 80,00 kr.
Nr. 351: PSSD – Planning System for Sustainable Development. A Methodical Report. By Hansen, H.S (ed.) 110 pp. (electronic)
Nr. 352: Naturkvalitet på stenrev. Hvilke indikatorer kan vi bruge? Af Dahl, K. et al. 128 s., 140,00 kr.
Nr. 353: Ammoniakemission fra landbruget siden midten af 80'erne. Af Andersen, J.M. et al. 45 s., 50,00 kr.
Nr. 354: Phthalates, Nonylphenols and LAS in Roskilde Wastewater Treatment Plant. Fate Modelling Based on Measured Concentrations in Wastewater and Sludge. By Fauser, P. et al. 103 pp., 75,00 DKK.
Nr. 355: Veststadil Fjord før og efter vandstandshævning. Af Søndergaard, M. et al. 54 s. (elektronisk)
Nr. 356: Landsdækkende optælling af vandfugle, vinteren 1999/2000. Af Pihl, S., Petersen, I.K., Hounisen, J.P. & Laubek, B. 46 s., 60,00 kr.
Nr. 357: The Danish Air Quality Monitoring Programme. Annual report for 1999. By Kemp, K. & Palmgren, F. 74 pp. (electronic)
Nr. 358: Partikelfiltre på tunge køretøjer i Danmark. Luftkvalitets- og sundhedsvurdering. Af Palmgren, F. et al. (Foreløbig elektronisk udgave)
Nr. 359: Forekomst af "afvigende" isbjørne i Østgrønland. En interviewundersøgelse 1999. Af Dietz, R., Sonne-Hansen, C., Born, E.W., Sandell, H.T. & Sandell, B. 50 s., 65,00 kr.
Nr. 360: Theoretical Evaluation of the Sediment/Water Exchange Description in Generic Compartment Models (Simple Box). By Sørensen, P.B., Fauser, P., Carlsen, L. & Vikelsøe, J. 58 pp., 80,00 DKK.
Nr. 361: Modelling Analysis of Sewage Sludge Amended Soil. By Sørensen, P., Carlsen, L., Vikelsøe, J. & Rasmussen, A.G. 38 pp., 75,00 DKK.
Nr. 362: Aquatic Environment 2000. Status and Trends – Technical Summary. By Svendsen, L.M. et al. 66 pp., 75,00 DDK.
Nr. 363: Regulering på jagt af vandfugle i kystzonen. Forsøg med døgnregulering i Østvendsyssel. Af Bregnballe, T. et al. 104 s., 100,00 kr.
Nr. 364: Vingeindsamling fra jagtsæsonen 2000/2001 i Danmark. Wing Survey from the 2000/2001 Hunting Season in Denmark. Af Clausager, I. 53 s., 45,00 kr.
Nr. 365: Habitat and Species Covered by the EEC Habitats Directive. A Preliminary Assessment of Distribution and Conversation Status in Denmark. By Pihl, S. et al. 121 pp. (electronic)
Nr. 366: On the Fate of Xenobiotics. The Roskilde Region as Case Story. By Carlsen, L. et al. (in press)
Nr. 367: Anskydning af vildt. Status for undersøgelser 2001. Af Noer, H. et al. 43 s., 60,00 kr.
Nr. 369: Typeinddeling og kvalitetselementer for marine områder i Danmark. Af Nielsen, K., Sømod, B. & Christiansen, T. 105 s. (elektronisk).
Nr. 370: Offshore Seabird Distributions during Summer and Autumn at West Greenland. Ship Based Surveys 1977 and 1992-2000. By Boertmann, D. & Mosbech, A. 57 pp. (electronic)
Nr. 371: Control of Pesticides 2000. Chemical Substances and Chemical Preparations. By Krongaard, T., Petersen, K.K. & Christoffersen, C. (in press)
Nr. 372: Det lysåbne landskab. Af Ellemann, L., Ejrnæs, R., Reddersen, J. & Fredshavn, J. (i trykken)
Nr. 373: Analytical Chemical Control of Phthalates in Toys. Analytical Chemical Control of Chemical Substances and Products. By Rastogi, S.C. & Worsøe, I.M. (in press)

This report contains fuel use figures for Danish civil aviation broken down into domestic and international numbers from 1985 to 2000, using a refined fuel split procedure and official fuel sale totals. The results from two different models are used. The NERI (National Environmental Research Institute) model estimates the fuel use per flight for all flights leaving Danish airports in 1998, while the annual Danish CORINAIR inventories are based on improved LTO/aircraft type statistics. A time series of fuel use from 1985 to 2000 is also shown for flights between Denmark and Greenland/the Faroe Islands, obtained with the NERI model. In addition a complete overview of the aviation fuel use from the two latter areas is given, based on fuel sale information from Statistics Greenland and Statistics Faroe Islands, and fuel use data from airline companies. The fuel use figures are presented on a level, which facilitates the further summing on fuel according to different requirements. Methods of how to allocate the fuel use for passenger and cargo transportation are also discussed.

National Environmental Research Institute
Ministry of the Environmental

ISBN 87-7772-655-3
ISSN (print) 0905-815x
ISSN (electronic) 1600-0048