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NATIONAL COMMUNICATIONS

COMMUNICATIONS FROM PARTIES INCLUDED IN ANNEX I TO THE CONVENTION: GUIDELINES, SCHEDULE AND PROCESS FOR CONSIDERATION

Addendum

DETAILED INFORMATION ON ELECTRICITY TRADE AND INTERNATIONAL BUNKER FUELS

Note by the secretariat

CONTENTS

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I. INTRODUCTION

A. Mandate

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its first session, considered the allocation and control of emissions from international bunker fuels, and requested the secretariat to provide it with an options paper on the allocation and control of international bunker fuels for consideration at a future session (FCCC/SBSTA/1995/3). At its second session, with a view to overcoming inconsistencies in the presentation of data on inventories, the SBSTA further requested the secretariat to address issues such as temperature adjustments, electricity trade, bunker fuels, use of global warming potentials, land-use change, and forestry in the documentation to be prepared for consideration by the SBSTA at its third session (FCCC/SBSTA/1996/8).

B. Scope of the note

2. This note is an addendum to the secretariat's proposal for revised guidelines for the preparation of national communications by Annex I Parties (FCCC/SBSTA/1996/9). It should be read in conjunction with document FCCC/SBSTA/1996/9/Add.1 which describes methodological issues and identifies possible action the SBSTA may wish to consider. It provides detailed information on electricity trading and international bunkers to supplement document FCCC/SBSTA/1996/9/Add.1.

3. In preparing this document, the secretariat reviewed data gathered by international organizations such as the United Nations, the Statistical Office of the European Communities (EUROSTAT), the International Energy Agency (IEA), the International Civil Aviation Organization (ICAO), and the International Maritime Organization (IMO). The aviation and marine sector data, in particular, differ among sources, over time, in the number of countries covered, and in methodologies. In this regard, the secretariat has chosen to use data which demonstrate issues associated with particular options, rather than attempt to find data that are completely consistent. Data for non-Annex I countries are presented in some cases for comparative purposes. Also, the secretariat did not undertake a comprehensive analysis of all data. The SBSTA is invited to consider the data needed for the allocation options identified in this note and to provide guidance on this issue.

4. Section III of this document, on emissions from international bunkers, is divided between aviation and marine bunkers, since the structure of the industries is different and hence also the possible allocation and control options that may be selected.

II. ACCOUNTING FOR THE EMISSIONS ASSOCIATED WITH ELECTRICITY TRADE

A. Introduction

5. The primary purpose of this section is to provide detailed information on the extent of trading, together with the implications of and possible options to account for emissions associated with electricity trade. The general background, possible action by the SBSTA and a preliminary discussion of options may be found in document FCCC/SBSTA/1996/9/Add.1.

B. Background information on electricity trade

6. Electricity is currently exported and imported by many countries. In the context of the United Nations Framework Convention on Climate Change (UNFCCC), these electricity trades could be viewed as an activity that may be addressed jointly by the Parties involved. Recent efforts in many countries to liberalize their electricity markets and to remove physical barriers to electricity trade could increase the amount of such trade in the future. The extent of existing electricity trade as well as future trends in electricity trade are described below for the Nordic region of Europe, Western Europe, Eastern and Central Europe, and North America as these regions are currently undergoing the significant change.[1, 2]

Nordic region

7. In 1993, 18 terawatt hours (TWh) of electricity were exchanged between Denmark, Finland, Norway, and Sweden, representing 5 per cent of total generation in these countries. Electricity exchange in the Nordic countries began on a bilateral basis as early as 1915 when the first connection between Denmark and Sweden was established. Denmark, Norway, Sweden, and Finland now trade through Nordel, an association of the major generators responsible for operating the grids, the exchanges being the result of substantial differences in the structure of

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[1] In the context of this note, the Nordic region refers to Denmark, Finland, Norway, and Sweden. Western Europe refers to Austria, Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Portugal, Spain, Switzerland, and the United Kingdom of Great Britain and Northern Ireland. Eastern and Central Europe consists of Belarus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Russian Federation, Slovakia, and Ukraine. North America refers to Canada, Mexico, and the United States of America.

[2] Other regions in the world, for example Latin America, also trade electricity. The secretariat is attempting to obtain data on this region and others.

their capacity and in the variable costs of their electricity.[3] More than 99 per cent of Norway's electricity comes from hydropower; Denmark's system is approximately 97 per cent thermal with a heavy dependence on coal; Sweden depends on a mix of hydropower and nuclear power; and Finland depends on a mix of hydropower, nuclear power, and thermal power.[4] The historical pattern has been for Norway and Sweden to export excess power during wet seasons and years, through the utilization of bilateral agreements on the basis of short-run marginal costs,[5] and to import in dry and cold seasons and years. Short-term exports of hydro-based power in peak periods and imports of thermal in off-peak periods are also possible during a 24-hour period. Data on the exports and imports of electricity in the Nordic countries in 1993 are presented in table 1.

Table 1. Bilateral electricity trade flows among the Nordic countries, 1993[a]
(Terawatt hours)

	Exports to					
Exports from	Denmark	Finland	Norway	Sweden	Other[b]	Total
Denmark	..	..	0.19	1.31	3.60	5.10
Finland	..	..	0.01	0.42	..	0.43
Norway	2.14	0.06	..	6.18	..	8.38
Sweden	3.98	3.14	0.51	..	0.51	8.57
Other[b]	0.13	4.77	..	..	..	4.90
Total	6.25	7.97	0.71	7.91	4.11	27.38

Source: International Energy Agency, *Electricity Information 1994*, Paris, 1995.

Notes: The following symbols have been used in some tables:

Two dots (..) indicate that data are not available.
A hyphen (-) indicates that the item is not applicable.
A minus sign (-) before a figure indicates an amount subtracted. Note that the minus sign comes

[3] Tomas Larsson, "Benefits from electricity trade in northern Europe under CO_2 constraints," forthcoming in *Systems Modelling for Energy Policy*, Bunn and Larsen (eds.), John Wiley & Sons.

[4] International Energy Agency, *Energy Statistics of OECD Countries*, Paris, 1995.

[5] Larsson, Grohnheit and Unander, *Common Action and Electricity Trade in Northern Europe*, to be presented at the International Federation of Operational Research Societies 14th Triennial Conference, Vancouver, Canada, 8-12 July 1996.

immediately before the number.
A point (.) is used in English to indicate decimals.

[a] Values identify point of entry or exit, but do not necessarily identify point of consumption.
[b] Other refers to Germany and the Russian Federation.

8. Electricity imports and exports between Nordic countries could increase in the near future. Finland, Norway, and Sweden have recently liberalized their electricity markets and Denmark plans to do so. Moreover, several new transmission lines between Nordic countries and other countries are currently planned or under construction: these include grid connections between Germany and Denmark, two cables between Germany and Norway, a cable between the Netherlands and Norway, two cables between Finland and the Baltic States, and a grid connection between Norway and Sweden. [6]

Western Europe

9. In 1993, 136.9 TWh of electricity were exchanged between countries of Western Europe representing 7 per cent of total generation in these countries.[7] Because of the physical and economic structure of the utility systems in Western Europe, as well as the surplus generating capacity in some countries, there are substantial incentives for electricity trade in this region. Currently, France and Switzerland are net exporters to the rest of Western Europe, with Italy and the Netherlands being the largest net importers. Exports from France mostly consist of long-term contracts for excess nuclear capacity, while exports from Switzerland result from excess hydroelectric and nuclear capacity with low variable costs. There are, however, flows in both directions between most neighbouring countries in Western Europe. Data on the exports and imports of electricity in West European countries in 1993 are reported in table 2.

10. The amount of electricity trade in Europe could increase as the European Union moves forward

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[6] International Energy Agency, Standing Group on Long-Term Co-operation, "Inter-system competition and trade in electricity -- Implications for the environment and environmental policy," IEA/SLT (95)25, draft paper dated 20 November 1995.

[7] International Energy Agency, *Electricity Information 1994*, Paris, 1995.

with its plans to liberalize the electricity market although the pace of this process may differ among countries. Energy ministers are discussing a proposal to open up to competition 25 per cent of Europe's electricity market. Competition would begin two years after the passage of legislation by the European Union Council of Energy Ministers and the European Parliament. [8]

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[8] *International Herald Tribune*, 7 May 1996.

Table 2. Bilateral electricity trade flows among countries of Western Europe, 1993[a)]
(Terawatt hours)

	Exports to												
Exports from	Austria	Belgium	France	Germany	Italy	Luxembourg	Netherlands	Portugal	Spain	Switzerland	UK	Other	Total
Austria	..	..	..	3.2	1.7	..	..	..	..	1.3	..	2.5	8.8
Belgium	..	..	1.5	..	..	0.7	3.2	..	..	..	..	..	5.4
France	..	4.4	..	13.7	17.5	0.1	..	..	2.7	9.7	17.0	0.1	65.1
Germany	4.9	..	0.5	..	..	3.7	10.8	..	..	7.9	..	5.1	32.8
Italy	..	..	0.2	..	..	..	..	..	..	0.1	..	0.4	0.7
Luxembourg	..	..	..	0.4	..	..	..	..	..	..	..	..	0.4
Netherlands	..	0.1	..	0.2	..	..	..	..	..	..	..	..	0.3
Portugal	..	..	..	..	..	..	..	..	1.9	..	..	..	1.9
Spain	..	..	1.1	..	..	..	..	2.1	..	..	..	..	3.2
Switzerland	0.6	..	0.7	5.7	19.5	..	..	..	..	..	..	0.2	26.7
UK	..	..	..	..	..	..	..	..	..	..	..	..	0.0
Other	3.3	..	..	8.6	1.4	..	..	..	..	..	..	..	13.2
Total	8.8	4.5	4.0	31.9	40.1	4.4	14.0	2.1	4.6	19.0	17.0	8.3	158.4

Source: International Energy Agency, *Electricity Information 1994*, Paris 1995.

a) Values identify point of entry or exit, but do not necessarily identify point of consumption.
b) Others include the Czech Republic, Denmark, Hungary, Poland and the former Yugoslavia.

Central and Eastern Europe

11. The electricity systems of Central and Eastern Europe are strongly interdependent. Those of Belarus, Estonia, Latvia, Lithuania, and the Ukraine were established as part of the unified power system of the former Soviet Union. Power plants were located in this system without consideration of boundaries. Thus, although there has been a substantial reduction in energy demand in this region recently, some Central and Eastern European countries still import electricity, as they rely on capacity located outside their borders.[9]

12. The change in the structure of institutions in Central and Eastern Europe makes it difficult to utilize historical patterns of electricity trade to predict future trends. Some countries are trying to reduce their dependence on traditional sources of electricity. For instance, the Czech Republic, Hungary and Poland, which are currently integrated and synchronized with the Eastern European electricity system, have recently formed an organization, CENTREL, to prepare the way for adapting their electricity systems to the requirements of the Western European system. Data on the net imports of electricity in Central and Eastern European countries from 1990 to 1993 are presented in table 3.

Table 3. Net imports and exports of electricity in Central and Eastern Europe[a], 1990-1993
(Terawatt hours)

	Year			
Party	**1990**	**1991**	**1992**	**1993**
Belarus	9.4	10.4	6.5	-24.4
Czech Republic	-0.7	-2.5	-3.0	-2.1
Estonia	-7.0	-4.8	-3.2	-1.6
Hungary	11.1	7.4	3.5	2.5
Latvia	3.6	4.2	4.1	2.5
Lithuania	-12.0	-12.8	-5.3	-2.7
Poland	-1.0	-2.6	-4.0	-2.4
Russian Federation	-4.5	-12.1	-16.2	6.0
Slovakia	5.2	4.3	3.7	2.0
Ukraine[b]	-28.3	-14.8	-5.1	-1.5

Source: International Energy Agency, *Energy Statistics for non-OECD countries*,

[9] International Energy Agency, *Electricity in European Economies in Transition*, Paris, 1994.

Paris, 1995.

[a] Net imports are positive. Net exports are negative.
[b] Not a Party.

North America

13. Canada, Mexico and the United States trade electricity on a small scale with the United States being a net importer from both countries. In 1993, the United States imported approximately 1 per cent of its power from Canada and less than 0.1 per cent from Mexico.[10] Data on the export and import of electricity in North America in 1993 are presented in table 4.

Table 4. Bilateral electricity trade flows in North America, 1993[a]
(Terawatt hours)

	Exports to			
Exports from	Canada	Mexico	United States of America	Total
Canada	-	..	37.09	37.09
Mexico	..	-	1.99	1.99
United States of America	9.81	0.85	-	10.66
Total	9.81	0.85	39.08	49.74

Source: Energy Information Administration, United States Department of Energy, *Electric Power Annual 1994*, Volume II (Operational and Financial Data), tables 41 and 42 (November 1995).

[a] Values identify point of entry or exit, but do not necessarily identify point of consumption.

14. The United States electricity market is undergoing significant changes. The Federal Energy Regulatory Commission, which regulates power sales across State boundaries, has published a final rule which aims at rapidly introducing competition to the wholesale power market of the United States, but it is difficult to predict the impact that these changes will have on exports and imports.

2. The implications of electricity trading

[10] Energy Information Administration, United States Department of Energy, *Electric Power Annual 1994*, Volume II (Operational and Financial Data), tables 41 and 42 (November 1995).

15. The current trend to deregulate and liberalize the electricity industry in many countries and the possible increase in the extent of international electricity trading will have implications that are difficult to predict for greenhouse gas emissions, precursors of ozone such as nitrogen oxides (NO_x) and other air pollutants, such as particulates and sulphur dioxide (SO_2).[11] The impacts will vary between regions and over time. One study of the United States market concludes that carbon dioxide (CO_2), NO_x, and SO_2 emissions will increase in the near term (two to twelve years) in part from a decrease in demand-side management [12] and investment in renewables, but mostly from the increased use of older, low variable cost, fossil fuel power plants and/or the premature closure of existing, expensive nuclear facilities.[13] Another study reaches similar conclusions, namely, that electricity restructuring in the United States is likely to have negative impacts on the environment, including increases in CO_2 emissions, because older, fossil fuel plants are likely to operate more often and longer than they would without restructuring.[14] These results may change for longer time periods and may not typify all regions, but many of the factors which will influence air pollution in the deregulated United States market will also affect deregulated markets in other regions, i.e. factors such as plant retirement age, plant utilization rate, the efficiency with which electricity is generated, fuel choice, and the rate of growth in the demand for electricity as prices change owing to competition.

16. Deregulation and any associated increase in electricity trading may, on the other hand, also create opportunities to reduce greenhouse gases in a more cost-effective manner than is currently possible. A study of Denmark, Norway and Sweden evaluated the effects of allowing countries to jointly accept one common emission reduction goal and to work together using electricity trading to reach that goal. The cost of reaching different goals was determined for scenarios which differ in the extent of electricity trade (no trade, trade limited to current transmission capacity, and unlimited trade) and in the extent of countries' ability to jointly implement emission reduction goals. The results indicate that jointly accepting one

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[11] Richard Rosen and others, *Promoting Environmental Quality in a Restructured Electric Industry*, prepared for the National Association of Regulatory Utility Commissioners (15 December 1995).

[12] Demand -side management refers to efforts to influence customers' demand for (purchase of) electricity. It usually consists of efforts to reduce this demand in order to decrease the need for new generation capacity.

[13] Henry Lee and Negeen Darani, *Electricity Trading and the Environment*, Environment and Natural Resources Program, Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University (22 November 1995).

[14] Richard Rosen and others, *loc. cit.*

common emission reduction goal and trading in electricity could both significantly lower the cost of reducing emissions to Denmark, Norway and Sweden, compared to the costs if each country acted alone.[15]

C. Options to account for the greenhouse gas emissions associated with electricity trade

17. The two basic ways to account for the emissions associated with the export or import of electricity are for either the exporting Party or the importing Party to do the accounting. However, an accurate estimate of the emissions associated with electricity imports only appears feasible on the basis of information obtained from the exporting Party regarding, for example, the actual sources or average sources of electricity. There does not appear to be an obvious basis for an option whereby the importing country can make a determination of the emissions by itself. Therefore, further consideration is given to just two options for the treatment of emissions associated with the import and export of electricity. They are:

(a) To require Parties that generate electricity to account for all emissions, even if the electricity is exported (referred to below as the generator option); and

(b) To require Parties that consume electricity to account for the emissions on the basis of information provided by, and in coordination with, the exporting Party (referred to below as the bilateral agreement option).

The generator option

18. Under this option Parties would include all emissions associated with electricity generation in their inventories, even if the electricity is exported.[16]

19. There are several advantages to the use of this option. First, the methodologies and data needed to calculate emissions associated with domestic electricity generation are currently available. Data on fuel consumption, the basis for this calculation, are collected in all Annex I countries, and the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories provide a method for estimating emissions. Secondly, this option does not require bilateral discussion of the quantity and nature of exports and imports.

20. The disadvantage of this option is that the consuming country does not have to account for the

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[15] Tomas Larsson, "Benefits from electricity trade in northern Europe under CO_2 constraints," forthcoming in *Systems Modelling for Energy Policy*, Bunn and Larsen (eds.), John Wiley & Sons.

[16] They would continue, however, to account for imports and exports of primary energy as discussed in the IPCC Guidelines for National Greenhouse Gas Inventories.

emissions associated with the electricity it utilizes. At the same time, a net exporting Party will have an increases in its national greenhouse gas emissions, if the electricity it exports is generated from fossil fuel. This would also need to be taken into account in its projections and has implications for the policies and measures for both Parties. For example, it may be more difficult for the net exporting Party to meet its emission limitation or reduction goal.

The bilateral agreement option

21. Under this option, a Party would increase its national emission inventory if it imports electricity produced by fossil fuel combustion, and decrease its national inventory if it exports electricity produced from fossil fuels. The quantity of emissions would be determined on the basis of information shared by the Parties, either informally or through formal agreements between them. Both Parties would need to alter their emission forecasts, if long-term contracts are negotiated.

22. There are several advantages to this option. The first is that the consuming country has the primary responsibility to account for the emissions associated with the electricity it imports. A second advantage is that it provides a mechanism for Parties which decide to jointly implement common emission reduction goals, using electricity trade, to do so in a transparent manner.

23. There are also several disadvantages to the bilateral agreement option. First, to apply this option, Parties would need to exchange the necessary data, compare calculations, and ensure that they are in agreement on adjustments to their national inventories. Secondly, there is no methodology currently available for use by Parties exporting or importing electricity to estimate the emissions in another country. With regard to this issue two approaches are possible. Countries could choose to use any mutually acceptable approach, providing they identify the procedure in their respective national inventories. Alternatively, a general methodology could be developed to be agreed by the Conference of the Parties. Regardless of what approach is taken, Parties will need to address the following types of questions:

(a) How should the emissions associated with electricity trade be calculated?

(b) What data are necessary to make this calculation?

(c) Are such data already available? If not, how should they be collected?

(d) Should calculations be completed for every trade, monthly for all trades, annually for all trades, or otherwise?

(e) How should the emissions associated with electricity lost during transmission be calculated and allocated between trading Parties?

(f) How should emissions based on electricity trades between more than two Parties be estimated?

(g) Should projections include estimates of future electricity trades?

24. The question of how the emissions associated with electricity trade should be calculated may not be easy to answer. In some cases, Parties may wish to base the calculation on the actual source. In other cases, they may prefer average sources. [17] The use of emissions associated with the average of sources, however, may lead to a situation where the emissions associated with traded electricity are under- or over-counted. For example, in a situation where the average sources are used to calculate the emissions, but where the baseload is nuclear and the marginal source uses fossil fuel, the emissions associated with the exported electricity would be underestimated. However, provided both countries agreed on the quantity, the total emissions reported by both countries should not be affected.

III. EMISSIONS FROM INTERNATIONAL BUNKER FUELS

A. Introduction

25. The primary purpose of this section is to provide detailed information on the scope and possible options for allocating and controlling emissions associated with international aviation and marine bunkers. [18] The general background, possible action by the SBSTA and a preliminary discussion of options may be found in document FCCC/SBSTA/1996/9/Add.1.

B. Background information on the aviation industry

The aviation sector

26. Air traffic is customarily divided into three categories: civil aviation, comprising aircraft used for the commercial transport of passengers and freight; military aviation, comprising aircraft under the control of national armed forces; and light aviation, comprising recreational and small corporate aircraft. As used in this paper, bunker fuel emissions are exclusively related to civil aviation, which is by far the largest of these three categories. There are some 150 to 200 airline companies that operate international flights.

27. At present, there is generally a strong connection between airlines and countries, for instance in the case of national carriers. However, given the trend towards privatization and the merging of airlines, this connection may not be maintained. With regard to aircraft, many are registered in countries for economic reasons, but may actually be leased or chartered for operation elsewhere.

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[17] It should be recognized that the production of electricity from a new power plant can affect the entire grid. Some sources may be taken off line and others added. In a few instances these secondary effects may need to be considered.

[18] For the purpose of this paper, international bunker fuels are defined as fuels sold to any air or marine vessel engaged in international transport.

28. The great majority of aircraft are subsonic, that is, they fly at less than the speed of sound, although there are 13 civilian supersonic aircraft in service. By far the most commonly used type of fuel is aviation kerosene. There are no internationally agreed specifications for this fuel, but national and industry specifications ensure its quality and uniformity worldwide. Globally, there are about 70 to 100 producers of aviation fuel.

29. The fuel intake of an aircraft does not necessarily take place in the country of departure. Since carrying excess fuel increases the weight of the aircraft and hence the amount of fuel required to reach the next airport, aircraft on long-haul flights usually only take on the amount of fuel required to reach the next airport. On shorter flights, aircraft may carry sufficient fuel for several stops, depending upon fuel prices and other considerations.

30. The amount of fuel oil uplifted by civilian air carriers registered in a country and the amount of fuel uplifted by all civilian air carriers in that country are shown in table 5.

Table 5. Estimates of fuel by uplifted by civilian air carriers, 1993
(*millions of tons*)

Country	Fuel uplifted by carriers registered in a country	Fuel uplifted by all carriers in a country
Australia	2.08	1.66
Brazil	1.14	1.10
Canada	1.51	1.72
France	3.10	3.06
Germany	4.02	3.96
Italy	1.56	1.49
Japan	4.06	5.30
Netherlands	2.40	2.07
New Zealand	1.14	0.78
Republic of Korea	1.79	1.30
Russian Federation	3.30	1.72
Singapore	2.20	1.87
Spain	1.13	1.12
Switzerland	1.29	1.20
Thailand	1.08	1.96
United Arab Emirates	0.30	1.38
United Kingdom	6.66	7.04
United States of America	14.41	14.52

Note: The data in this table were provided by ICAO on the basis of its scheduled airline production database. They do not include non-scheduled, private or military operations. Some flights may be double counted. Sector fuel quantities have been calculated by ICAO on the basis of the scheduled flight time, using data for each aircraft type supplied by the aircraft manufacturers. No use of fuel for holding or diversion is assumed.

31. The production of civilian aircraft and engines is limited to a small number of

large companies, which respond to the demand by airlines for aircraft with different attributes. In this regard, the industry is unique in so far as the number of major manufacturers is very small.

Greenhouse gases in the aviation sector

32. The greenhouse gases emitted from aircraft are carbon dioxide (CO_2) and water vapour (H_2O), and the precursors carbon monoxide (CO), nitrogen oxides (NO_x) and volatile organic compounds (VOC).

33. The combustion of one kilogram of fuel produces 3,155 grams of CO_2 and 1,237 grams of water vapour, with small variations depending on the composition of the fuel. The quantity of SO_x exhaust depends entirely on the sulphur content of the fuel. The emissions of NO_x, CO and VOCs per kilogram of combusted fuel are known within certain ranges. However, these strongly depend on the jet engine, the characteristics of the specific flight, the phase of the flight and on the type of fuel. The majority of NO_x emissions occur during cruise flight, but it is difficult to measure emissions directly under those conditions. CO and VOCs are the products of incomplete combustion, and their emissions occur mainly during landing and take-off because engines are then operating at reduced power settings.

34. CO_2 and NO_x are considered to be the main contributors to the greenhouse effect from air traffic emissions. The IPCC estimated in *Climate Change 1994* that the indirect effect of aircraft NO_x emissions is roughly the same as the direct effect of aircraft CO_2 emissions. At the cruising altitudes of subsonic aircraft the NO_x emissions contribute to the formation of ozone. At those altitudes, the greenhouse effect of ozone is at its strongest.

35. The impact of NO_x depends on the altitude of the actual emission. The cruising altitude of supersonic aircraft, near or in the ozone layer, is higher than that of subsonic aircraft. At that altitude NO_x emissions contribute to ozone depletion.

Magnitude of greenhouse gas emissions from aviation

36. The emissions from international aviation as reported by the Annex I Parties for 1990 are presented in annex I. Only seven Parties reported separate data on emissions from aviation bunkers. In addition, for comparative purposes the secretariat used IEA data, based on deliveries of aviation fuels, to estimate the CO_2 emissions for 1992 presented in annex II. The year 1992 was utilized because the data cover also countries with economies in transition and because for 1990 the IEA did not differentiate between international and other aviation bunkers. While the data for CO_2 in the two annexes are largely similar, many are different. This suggests a need for further efforts to improve the quality of data reported to different institutions.

37. In addition to IEA, other institutions such as the United Nations, EUROSTAT and ICAO collect fuel data. Each of these sources has different methodologies and categories which have changed with time. The data obtained by the United Nations and the IEA are aggregated at national level, which means that information concerning the different aviation companies and fuel suppliers is lost. On the other hand, EUROSTAT has these data available, but only for European countries. Differences in data from various sources would need to be considered by Parties in any determination of whether to allocate emissions retroactively or to establish a future date for their allocation.

38. The total amount of fuel used for international civil aviation is estimated to be about 138 Mt, representing 435 Mt CO_2.[19] The IPCC (1994) estimates that global emissions from all sources in 1990 amounted to about 26,000 Mt CO_2. This suggests that international aviation accounted for about 2 per cent of global CO_2 emissions from all sources in 1990.

Factors likely to affect future aviation emissions

39. The Committee on Aviation Environmental Protection of ICAO has predicted that air traffic will grow at an annual rate of 5 per cent for the foreseeable future. The growth rate of emissions may be somewhat less because of the following:

(a) Changes in aircraft engines, for example, 'propfan'[20] engines may be introduced after the year 2000 and could increase efficiency by 20 per cent. Also, improvements in the combustion process, for example through the use of staged combustion, could reduce NO_x emissions compared with present engine emission levels. New engines that utilize more advanced technology might be introduced after 2010 and this may lead to lower emissions from engines of equivalent power;

(b) Improvements to aircraft frames, for example, by reducing drag and introducing lighter materials;

(c) Increases in the size of aircraft, which may offer emission benefits because they would use less fuel per passenger-kilometre;

(d) Implementation of operational measures, for example, by:

[19] Balashov and Smith, "ICAO analyses trends in fuel consumption by world's airlines", *ICAO Journal*, August 1992.

[20] J.A. Peper and H.B.G. ten Have, *Inventory of Air Pollution from Civil Aviation in Dutch Airspace in 1992*, NLR Report CR 94413 L, 1994. National Aerospace Laboratory, Amsterdam.

(i) Lowering cruising altitudes, reducing cruising speeds or changing flight routes;

(ii) Improving the efficiency of air traffic control systems;

(iii) Modifying the distribution of airspace (especially between civil and military aircraft) and allowing the airspace to be managed in a flexible manner; and

(iv) Changing the landing and take-off cycle in and around airports.

(e) Changes in policies relating, for example, to taxes and subsidies for the airline industry and/or competing modes of transportation.

The role of international bodies

40. ICAO was established by the Convention on International Civil Aviation (1944) and became one of the specialized agencies of the United Nations. One hundred and eighty-three Parties signed the Convention, making it the fundamental treaty governing international civil aviation. Bilateral air service agreements which regulate relations between individual States are based on the Convention.

41. In 1981, ICAO established standards for the control of aircraft emissions through an engine certification scheme. These standards, which are included in annex 16 (volume II) to the Convention on International Civil Aviation, establish limits for three pollutants (NO_x, CO and HC) from new engines. ICAO keeps the standards under review. In March 1993, for example, the ICAO Council agreed to reduce the permitted amounts of NO_x by 20 per cent. A committee of experts, the Committee on Aviation Environmental Protection, is charged with making recommendations regarding environmental policy to the decision-making bodies of ICAO.

C. Allocation options and control of emissions from international aviation bunkers

42. A preliminary discussion of allocation options which takes into account the characteristics of the aviation industry and the factors mentioned in document FCCC/SBSTA/1996/9/Add.1 is given below. Considerations to be borne in mind in this connection are: the data required to implement different options; the need for methodologies; and the relationship of the options to possible policies and measures, such as taxes, standards and voluntary agreements.

Option 1 No allocation

43. This option represents the status quo, that is reporting of emissions by Parties in a separate category. In the case of no allocation, the emissions from international aviation would still need to be considered in relation to Article 4.2 of the Convention. In that case, ICAO may be able to be of assistance. However, Parties would need to consider the extent to which emissions could and should be controlled, and perhaps the approach, for example, voluntary measures, taxes, or standards. The attribution of the final responsibility for the control of international emissions would also have to be considered in lieu of ICAO because ICAO is not a Party.

Option 2 Allocation of global emissions from bunker fuels to Parties in proportion to their national emissions

44. This option would allocate emissions in proportion to the contribution of a Party to global emissions. For example, the 1990 share of global international aviation was about 2 per cent of the global CO_2 emissions from all sources. With proportional allocation, each Party would add about 2 per cent to its domestic emissions in order to cover all international emissions jointly. Other allocation methods could lead to higher allocations for some Parties, and lower allocations for others.

45. This option acknowledges the international character of international emissions, while still allocating them. It may create an incentive for international control measures and it leaves the basis for control open, since it does not relate emissions to an activity such as bunker fuel sales or aircraft or passenger movements.

Option 3 Allocation to Parties according to the country where the bunker fuel is sold

46. This option would allocate emissions to Annex I Parties on the basis of aviation fuel sales based on data similar to those contained in table 5. Eventually, it may be possible, with the cooperation of the airline industry, to break emissions down further on the basis of aircraft type. The option appears to have a precedent, namely in the allocation of emissions from fuel use in road transport, since fuel may be sold in one country and emissions may occur in another, although road transport differs with regard to the number of vehicles and decision-making processes.

47. With regard to its effect on possible controls, the option would provide little incentive to apply national standards for aircraft as these could create inequities among countries. Other measures such as taxes might apply, but since an aircraft could take on extra fuel elsewhere or change its flight routes to avoid taxes or levies, such a measure might need consideration at international level.

Option 4 Allocation to Parties according to the nationality of the transporting company, the country where the aircraft is registered, or the country of the operator

48. This set of three options has the common feature that the owner/operator relationship is a primary determinant for allocation. The first case has the advantage that national airlines typically maintain information on the amount of fuel they have uplifted that could be made available to Parties. This may be a more complex process for the case of aircraft registered in one country, but owned and operated in another country. Similar figures based on fuel uptake (instead of consumption) by any operator would require a greater breakdown of figures.

49. An advantage of this option is that the country of the owner/operator may be in a good position to require its owner/operators to reduce their world-wide fuel usage, for instance by setting standards or charging taxes and levies. However, measures linked to owner/operators may create inequities among Parties, unless there is an international agreement. In any case, identifying the link between airlines, aircraft and countries may become more complicated if airlines change the country where they are based, merge, or change leasing arrangements.

Option 5* Allocation to Parties according to the country of departure or destination of an aircraft or vessel. Alternatively the emissions related to the journey of an aircraft or vessel could be shared between the country of departure and the country of arrival

50. This option would require sharing information between Parties. It might be feasible, in particular for long flights, but it would be much more complex for short flights, in so far as it would require breaking fuel intake or consumption down by country of departure and destination. Nevertheless, if aircraft movements could be broken down by aircraft types, this allocation option could account for differences in emissions between various aircraft. It could even account for differences in emissions which are related to cruising altitudes and routes. Methodologies for calculating emissions, on this basis are not available and would need to be developed.

51. As in the case of option 3, standards for aircraft and engine design could help control emissions, but there would be few incentives for national standards as these could create inequities among countries. Also, as in the previous option, any consideration of taxes as a control may be more effective if done at international level.

* Options considered to be less practical because of data requirements or inadequate global coverage.

Option 6* Allocation to Parties according to the country of departure or destination of passenger or cargo. Alternatively, the emissions related to the journey of a passenger or cargo could be shared by the country of departure and the country of arrival

52. This option would require Parties to compile information based on the destination of the cargo and passengers. The statistics would have to be cross-referenced to fuel use. While conceptually possible, at the present time there is no system to acquire the data or methodology to calculate the emissions. Acquiring the detailed information would also involve additional administration and some extra cost.

Option 7* Allocation to Parties according to the country of origin of the passenger or owner of the cargo

53. This option requires the same statistics as option 5, but would have to be cross-referenced with data on the country of origin of the passenger and owner of the cargo. This higher level of detail would involve additional administration and could be costly. There is no methodology for calculating emissions and no precedent for this approach among existing IPCC methodologies.

Option 8* Allocation to the Party of emissions generated its national space

54. This option has a precedent in other sectors, where emissions are allocated to the Party where the emissions occur in accordance with the IPCC Guidelines. In the case of aviation, it would require cross-referencing between fuel consumption and flight route. A correlation with aircraft type would lead to more accuracy.

55. However, this option would not lead to full coverage of emissions from international aviation, many of which occur above international waters. It is therefore not seen as a feasible option.

D. Background information on the marine industry

The marine transport sector

56. The marine shipping industry is currently composed of approximately 82,000 vessels with a gross tonnage of 491 million tons, excluding vessels under 100 gross tons. It is characterized by complex relationships. A ship can be owned by a company in one country, which itself is owned by other companies in other countries, registered in another, operated by a ship-management company in a third country and crewed from a manning agency in a

* Options considered to be less practical because of data requirements or inadequate global coverage.

fourth country with nationals from yet other countries. Furthermore, carriage can be paid for by charterers, and in some cases a number of sub-charterers, based in other countries. Table 6 provides data on the major countries of registration and table 7 on the major countries of ownership of the world is cargo fleet.

Table 6. World cargo fleet by country of registration, 1995[21]
(Percentage)

Country/territory of registration	Share of vessels	Share of deadweight tonnage
Panama	10.3	15.0
Liberia*	3.6	13.5
Greece	3.6	7.2
Cyprus*	3.6	5.6
Bahamas	2.4	5.0
Norway	1.5	4.2
Malta	2.5	4.1
Japan	12.6	3.9
China	4.8	3.4
Singapore*	1.9	2.9
United States of America	1.1	2.3
Hong Kong*	0.8	2.1
Philippines	2.4	1.9
Russian Federation	4.5	1.8
India	1.0	1.6
Turkey*	2.2	1.4
Republic of Korea	1.8	1.4

[21] Lloyd's Register of Shipping, *Lloyd's Fleet Statistics, December 1992*, London, 1993, as updated by Lloyd's Register of Shipping.

Country/territory of registration	Share of vessels	Share of deadweight tonnage
St. Vincent and the Grenadines*	1.8	1.3
Italy	1.8	1.2

* Not a Party.

Table 7. World cargo fleet by country of ownership, 1992[22]
(Percentage)

Country/territory of ownership	Share of vessels	Share of deadweight tonnage
Greece	8.0	14.8
Japan	18.0	13.3
United States	2.9	8.7
Norway	4.8	7.9
Hong Kong*	2.1	4.6
China	4.5	4.0
United Kingdom of Great Britain and Northern Ireland	2.4	3.5
Russian Federation	4.8	2.8
Republic of Korea	2.3	2.7
Germany	4.0	2.5
Denmark	2.0	1.9
Sweden	1.4	1.8
Italy	2.4	1.7
India	1.1	1.6
Brazil	0.8	1.5
Singapore*	1.7	1.3
Iran*	0.5	1.2
Turkey*	2.0	1.1
France	0.8	1.0

* Not a Party.

57. Two types of marine fuel, gas oil and fuel oil, are used almost exclusively for propulsion, because of their relatively low cost and ease of handling. It is estimated that in 1990, 40 million tons of gas oil and 100 million tons of fuel oil were consumed for this purpose. [23] Marine fuels are not necessarily loaded at the outset of a voyage but rather they may be loaded at any convenient time in the ship's operating schedule.

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[22] Lloyd's Register of Shipping, *Lloyd's Fleet Statistics, December 1992*, London, 1993, as updated based on present communication.

[23] Liddy, J.P., *Bunker Fuels - A Global View towards Year 2000*, Norwegian Shipping Academy, Oslo, 1992.

Fuel costs can represent a substantial part of a ship's operating costs, in excess of 50 per cent in some cases, so the market is particularly price-sensitive. Oil prices vary considerably from port to port, and even within a port, and with time. The quantity of fuel loaded depends among other aspects, on the size of the ship and the trade in which it is involved. Oil fuels are rarely purchased direct from the manufacturer (the refinery). Instead, a range of oil traders, brokers and suppliers act as intermediaries. Table 8 provides a list of the principal countries and territories supplying international marine fuels. Collectively, these account for nearly 91 per cent of the fuel oil and 84 per cent of the gas oil supplied as international marine bunkers by countries reporting data to the United Nations.

Table 8. Principal countries/territories supplying international marine bunker fuels: shares of total world supplies, 1993
(Percentage)

Country/territory	Fuel oil	Country/territory	Gas oil
United States	21.0	Saudi Arabia	20.3
Netherlands	12.3	Netherlands	9.8
Singapore*	10.4	United States	9.4
Japan	7.9	United Kingdom	6.0
Saudi Arabia	6.4	Singapore*	4.4
Belgium	4.5	Spain	3.9
South Korea	4.2	Greece	3.7
Spain	3.4	Belgium	3.4
Greece	2.9	Italy	2.9
France	2.7	Germany	2.6
Italy	2.3	Republic of Korea	2.3
Germany	2.1	Hong Kong*	2.3
Hong Kong*	1.6	Japan	2.0
United Kingdom	1.6	Egypt	1.8
Egypt	1.5	France	1.5
Denmark	1.1	Argentina	1.3
Brazil	1.0	Angola*	1.3
Gibraltar*	1.0	Norway	1.2
Sweden	1.0	Denmark	2.3

Source: United Nations, *Energy Statistics Yearbook 1993*, United Nations, New York, 1995.

* Not a Party.

58. The diesel engine is the predominant form of power unit used in the marine industry because of its relatively high fuel efficiency, which is typically around 45 per

cent. Power requirements are dictated by various ship characteristics and circumstances. Speed, for example, is very significant due to the cube law relationship between oil fuel consumption and speed; an increase in speed of 25 per cent can result in a doubling of oil fuel consumption. However, the shipping industry's energy consumption, in terms of deadweight ton-kilometres per unit of energy, is relatively low compared to other modes of transport.

59. In terms of function, the principal division of the marine industry is between cargo-carrying vessels and ships engaged in miscellaneous activity. Cargo-carrying ships comprise bulk liquid, bulk dry cargo, passenger and other dry cargo vessels. The heading 'miscellaneous' covers fishing, offshore and harbour support services. Nearly 59 per cent of the cargo vessels are of less than 5,000 deadweight tons (dwt). They account for just over 5 per cent of total tonnage, while 1,339 vessels (3 per cent by number) are of greater than 100,000 dwt, representing 36 per cent of deadweight tonnage.

Greenhouse gases in the marine sector

60. The greenhouse gases emitted from the marine sector are carbon dioxide (CO_2) and water vapour (H_2O), and the precursors carbon monoxide (CO), nitrogen oxides (NO_x) and volatile organic compounds (VOC). The marine sector is also a source of SO_2 emissions.

61. The combustion of one kilogram of marine bunker fuel produces about 3,150 grams of CO_2 and 1,000 grams of water vapour, with small variations. The amount of SO_x exhaust depends on the fuel's sulphur content. NO_x formation is primarily dependent on extreme temperatures and consequently a feature of highly charged, and hence, highly fuel-efficient, diesel engines. CO and VOC emissions are the result of incomplete combustion, and their levels are minor in comparison to CO_2 emissions.

62. CO_2 is the main greenhouse gas resulting from marine shipping. In comparison to aviation, the global warming impact of NO_x emissions from shipping is relatively small since the emissions are at ground level. However, there is interest in reducing NO_x emissions because they contribute to acidification and ground level ozone.

Magnitude of greenhouse gas marine emissions from shipping

63. The emissions from the marine shipping industry as reported by Parties in their national communications are presented in annex I. Seven Parties reported emissions for the marine bunkers. In addition, as in the case of aviation bunkers, for comparative purposes the secretariat used IEA data, based on deliveries of marine fuels, for 1992 to estimate CO_2 emissions as presented in annex II.

64. Data on international marine bunkering are also gathered by organizations other than the IEA, such as the United Nations and Lloyd's Register of Shipping. According to United Nations statistics [24], aggregate fuel sales worldwide amounted to nearly 100 Mt in 1990 although data for some countries, for example, China and the Russian Federation, are omitted. Other sources [25] which include all countries, suggest a higher figure of 150 Mt, representing about 2 per cent of global emissions from all sources.

The role of international bodies

65. Most international marine regulations are drawn up by IMO, which is a technical organization of the United Nations. IMO develops international codes, recommendations and conventions, one of which is the International Convention for the Prevention of Pollution from Ships (MARPOL). The IMO conventions do not have the force of law, since this remains the prerogative of the member States. However, the most important IMO conventions are widely accepted by member States, which account for around 98 per cent of the world tonnage. An annex to MARPOL on air pollution is currently being considered, to phase out the use of ozone-depleting refrigerants, control the use of incinerators, and limit emissions of SO_x and NO_x. The annex will be discussed at the IMO Assembly to be held in March 1997.

E. Allocation options and control of emissions from international marine bunkers

66. A preliminary discussion of allocation options which takes into account the characteristics of the shipping industry and the factors mentioned in document FCCC/SBSTA/1996/9/Add.1 is given below. Considerations to be borne in mind in this connection are: the data required to implement different options; the need for methodologies; and the relationship of the options to possible policies and measures, such as taxes, standards and voluntary agreements.

Option 1 No allocation

67. As in the case of aviation bunkers, this option represents the status quo, that is reporting of emissions by Parties in a separate category. In the case of no allocation, the emissions from international marine bunkers would still need to be considered in relation to Article 4.2 of the Convention. In that case, IMO may be able to be of assistance. However, Parties would need to consider the extent to which emissions

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[24] United Nations, *Energy Statistics Yearbook 1993*, United Nations, New York, 1995.

[25] Oil Companies European Organization for Environmental and Health Protection (CONCAWE), *European Environmental and Refining Implications of Reducing the Sulphur Content of Marine Bunker Fuels*, CONCAWE, The Hague, 1993.

could and should be controlled,

and perhaps the approach, for example, voluntary measures, taxes, or standards. The attribution of the final responsibility for the control of international emissions would also have to be considered in lieu of IMO, because IMO is not a Party.

Option 2 Allocation to Parties in proportion to their national emissions

68. This option would allocate emissions in proportion to the contribution of a Party to global emissions. For example, international marine bunkers contributed about 2 per cent of the global emissions from all sources in 1990. With proportional allocation, each Party would add about 2 per cent to its domestic emissions inventory, in order to cover all international emissions jointly. This option may, however, distort the emissions inventories of some countries for example, land-locked countries or small countries with sizeable sea ports. Other allocation methods could lead to higher allocations for some Parties and lower allocations for others.

69. This option acknowledges the international character of marine bunker emissions, while still allocating them. It may create an incentive for international control measures, and leaves the basis for control open, since it does not relate emissions to an activity such as bunker fuel sales or ship movements.

Option 3 Allocation to Parties according to the country where the bunker fuel is sold.

70. This option would allocate emissions to Parties on the basis of marine fuel sales for which data are generally available. The option appears to have a precedent, namely in the allocation of emissions from fuel use in road transport, since fuel may be sold in one country and the emissions may occur in another, although the number of vehicles and decision-making processes are different.

71. With regard to its effect on possible controls, the option would provide little room for affecting emissions through national policies and measures. For example, a Party could not significantly influence vessel emissions through national standards. Other measures such as taxes might not be effective, since a ship could take on extra fuel elsewhere to avoid taxes or levies. Such a measure might need consideration at international level.

Option 4 Allocation to Parties according to the nationality of the transporting company, or to the country where the vessel is registered, or to the country of the operator

72. This set of three cases has the common feature that the owner/operator relationship is a primary determinant for allocation. In the first case, it would be necessary for each Party in which ship-owning companies are based, to collect annual data on oil consumption. Also, some countries such as Japan, the United States of

America and the United Kingdom of Great Britain and Northern Ireland export and import large quantities of materials by sea in ships registered, owned and / or operated by other countries. Others such as Greece and Norway, are rarely visited by ships of the country of registration or ownership, since these are engaged in cross trading. Consequently, the allocation of emissions to these countries may not accurately reflect the economic benefits derived from the vessel. Data collection systems would have to be improved or developed by some Parties.

73. In the second case, allocation by country of registration, the basis for estimating oil fuel consumption could be a ship's oil record book which is a logbook required under the provisions of MARPOL Annex I. Under this regulation, it is necessary for all fuel deliveries to be logged and reported to the country of registration. This option is attractive because the country of registration already collects a certain amount of data on each of the ships under its jurisdiction, if only for the purposes of assessing fees. However, while many of the countries listed in table 6 derive some benefits from the ships under their registration, they often have little direct responsibility for their operations. Information collection systems may also vary among countries and would need to be improved.

74. In the third case, allocation by country of the operator, a mechanism for data collection is much removed, as is the principal responsibility for maintenance and financial operations. This appears to be an important limitation.

75. With regard to the relationship to control options, only the first case appears to offer the possibility of providing incentives and mechanisms for national policies to affect emissions. As in other cases, the effectiveness of national action would appear to be limited.

Option 5* Allocation to Parties according to the country of departure or destination of a vessel. Alternatively the emissions related to the journey of a vessel could be shared between the country of departure and the country of arrival

76. This option would require sharing information between Parties. It might be feasible for long voyages, but it would be much more complex for ships making multiple short stops. It would require breaking fuel intake or consumption down by country of departure and destination. Also, it would not take into consideration the speed of a ship or other operational characteristics. Methodologies for calculating emissions, on this basis are not available and would need to be developed. As in option 3, there would appear to be little room for affecting emissions through national policies and measures.

Option 6* Allocation to Parties according to the country of departure or destination of passenger or cargo. Alternatively, the emissions related to the journey of a passenger or cargo could be shared by the country of departure and the country of arrival

77. This option would require Parties to compile information on the destination of cargo and passengers. The statistics would have to be correlated to fuel use. While conceptually possible, at the present time there is no system to acquire the data or methodology to calculate the emissions. Acquiring the detailed information would involve additional administration and some extra cost.

Option 7* Allocation to Parties according to the country of that owns the cargo or origin of the passenger

78. This option requires the same statistics as option 5, but would have to be supplemented with data on the country of origin of passengers and owner of cargoes. Moreover, the owner of a cargo may change during transport, adding further complexity. This higher level of detail would involve additional administration and could be costly. There is no methodology for calculating emissions and no precedent among existing IPCC methods for the approach.

Option 8* Allocation to the Party of emissions generated in its national space

79. As in the case of aviation, this option has a precedent in other sectors where emissions are allocated to the Party where they occur as per the IPCC Guidelines. In the case of the marine industry, it would require correlation of fuel consumption and voyage routes. A breakdown by vessel type would lead to more accuracy. However, this option would not lead to full global coverage of emissions from international marine bunkers, many of which occur in international waters. It is therefore not seen as a feasible option.

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* Options considered to be less practical because of data requirements or inadequate global coverage.

Annex I

Anthropogenic emissions of precursors from international bunkers by Annex I Parties, 1990 (*Gigagrams*)

	CO			NO_X			NMVOC			CO_2		
	Aviation	Marine	Total	Aviation	Marine	Total	Aviation	Marine	Total	Aviation	Marine	Total
Australia	3.1	3.6	6.8	16.3	54.4	70.8	0.2	2.0	2.2	4 228.0	2 053.0	6 281.0
Austria	..	..	..	..	..	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..	..	..	..	..	..
Bulgaria	..	..	..	..	..	..	..	..	..	..	..	..
Canada	12.3	25.5	37.8	4.7	13.0	17.7	1.9	8.8	10.7	3 614.0	2 066.0	5 680.0
Czech Republic	..	..	..	..	..	..	..	..	..	..	..	..
Denmark	0.7	16.6	17.3	5.1	66.1	71.1	0.2	2.5	2.7	1 915.0	3 059.0	4 975.0
Estonia	..	..	..	..	..	..	..	..	..	..	..	..
Finland	..	..	..	..	..	22.0	..	..	..	..	..	2 800.0
France	..	..	20.8	..	..	110.5	..	..	5.3	..	..	8 586.0
Germany	58.0	38.0	96.0	51.0	155.0	206.0	..	..	26.0	..	..	19 569.0
Greece	..	..	..	..	..	..	..	..	..	..	..	11 730.0
Hungary	..	..	..	..	..	..	..	..	..	..	..	..
Iceland	..	..	1.1	..	..	2.5	..	..	0.2	..	..	294.0
Ireland	..	..	2.1	..	..	5.3	..	..	0.3	..	..	1 172.0
Italy	18.0	5.1	23.2	15.5	234.4	250.0	1.2	..	1.2	3 956.0	8 494.0	12 450.0
Japan	..	..	..	..	..	..	..	..	..	..	..	31 000.0
Latvia	..	..	..	..	..	..	..	..	..	..	..	..
Liechtenstein	..	..	..	..	..	..	..	..	..	..	..	..
Luxembourg	..	..	..	..	..	..	..	..	..	..	..	..
Monaco	..	..	..	..	..	..	..	..	..	..	..	..
Netherlands	..	..	..	..	..	..	..	..	..	4 500.0	35 900.0	40 600.0
New Zealand	..	..	5.5	..	..	26.9	..	..	..	..	..	2 413.0
Norway	0.6	2.3	2.9	0.7	32.1	32.8	0.1	1.1	1.2	300.0	1 500.0	1 800.0
Poland	..	..	..	..	..	..	..	..	..	..	..	..
Portugal	..	..	2 43.2	..	..	43.0	..	..	32.2	..	..	3 938.0
Romania	..	..	..	..	..	..	..	..	..	..	..	..
Russian Federation	..	..	..	..	..	..	..	..	..	..	..	..
Slovakia	..	..	..	..	..	..	..	..	..	..	..	..
Spain	9.8	7.1	17.0	23.6	248.2	271.8	0.1	11.2	11.4	5 948.0	12 076.0	18 024.0
Sweden	..	..	44.0	..	..	60.0	..	..	15.0	..	..	4 190.0
Switzerland	..	..	..	..	..	..	..	..	..	..	..	2 160.0
United Kingdom	26.9	249.5	3.4	..	..	..	..	..	..	..	..	20 729.0
United States	..	..	..	..	..	..	..	..	..	..	..	82 942.0
Total			544.7			1 440.1			111.9			281 334

Source: Based on data submitted in national communications.

Annex II

Anthropogenic emissions of CO_2 from international bunkers by Annex I Parties, 1992
(*Gigagrams*)

	Aviation	Marine	Total*
Australia	4 721	1 653	6 374
Austria	621	..	621
Belgium	2 843	12 290	15 133
Bulgaria	879	787	1 666
Canada	3 319	1 702	5 021
Czech Republic	730	..	730
Denmark	1 847	2 687	4 534
Estonia	37	..	37
Finland	835	2 007	2 842
France	10 448	7 405	17 854
Germany	15 082	5 102	20 184
Greece	2 203	7 842	10 046
Hungary	410	..	410
Iceland	230	..	230
Ireland	930	46	976
Italy	7 284	7 093	14 378
Japan	14 231	16 607	30 838
Latvia	279	..	279
Liechtenstein	..	..	..
Luxembourg	407	..	407
Monaco	..	..	..
Netherlands	5 875	33 120	38 995
New Zealand	1 321	796	2 117
Norway	252	1 445	1 697
Poland	731	849	1 580
Portugal	1 664	1 795	3 459
Romania	557	..	557
Russian Federation	43 941	..	43 941
Slovakia	125	..	125
Spain	3 562	11 631	15 192
Sweden	1 034	2 650	3 684
Switzerland	3 190	52	3 242
United Kingdom	12 043	7 508	19 552
United States	..	90 117	90 117
Total	141 631	215 184	356 815

Source: Based on IEA Energy Statistics. Data were extracted from the EDGAR database at the RIVM in the Netherlands and processed by the secretariat.

* Does not in all cases reflect both aviation and marine data.