National Greenhouse Gas Inventory Report of JAPAN

May, 2005

Ministry of the Environment, Japan
Greenhouse Gas Inventory Office of Japan (GIO), CGER, NIES

Center for Global Environmental Research

National Institute for Environmental Studies, Japan

Table of Contents

Annex 1.	Key Categories
Annex 2.	Detailed Discussion of Methodology and Data for estimating CO_2 Emissions from Fossil Fuel Combustion
Annex 3.	Other Detailed Methodological Descriptions for Individual Source or Sink Categories
Annex 4.	CO_2 Reference Approach and Comparison with Sectoral Approach, and Relevant Information on the National Energy Balance
Annex 5.	Assessment of Completeness and (Potential) Sources and Sinks of Greenhouse Gas Emissions and Removals Excluded
Annex 6.	Additional Information to be considered as part of the NIR Submission or Other Useful Reference Information
Annex 7.	Methodology and Results of Uncertainty Assessment
Annex 8.	National Greenhouse Gas Emissions in Fiscal Year 2003 (for Domestic Publication)
Annex 9.	Hierarchical Structure of Japan’s National GHG Inventory File System
Annex 10.	Summary of Common Reporting Format

Acknowledgement

The Kyoto Protocol accepted by Japan in June 2002 targets the reduction of six greenhouse gases (GHGs): carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF_6). Quantified targets for reductions in emissions of greenhouse gases have been set for each of the developed nations. The target given to Japan for the first commitment period (five years from 2008 to 2012), is to reduce average emissions of greenhouse gases by six percent from the base year (1990 for carbon dioxide, methane and nitrous oxide, and 1995 for HFCs, PFCs, and sulfur hexafluoride). At the same time, the developed countries are required to improve the accuracy of their emission estimates, and by one year before the beginning of the commitment period (2007), a national system for the estimation of anthropogenic emissions by sources and removals by sinks of the aforementioned greenhouse gases must have in place. The GHGs inventories are therefore important data for Japan in reporting its achievement of the Kyoto Protocol’s commitment.

Estimation of GHGs emissions has started in Japan since the latter half of the 1980s. Since 1992, with the cooperation of ministries, the Environment Agency has estimated carbon dioxide emissions and has submitted annual reports to the Council of Ministers for Global Environmental Conservation every year. The Government also publicizes total emissions of greenhouse gases in Japan.

The GHGs inventory including this report represents the combined knowledge of over 60 experts in a range of fields from universities, industrial bodies, regional governments, relevant government departments and agencies, and relevant research institutes, who are members of the Committee for the Greenhouse Gas Emissions Estimation Methods established in November 1999.

In compiling GHGs inventories, the Greenhouse Gas Inventory Office of Japan (GIO) would like to acknowledge not just the work of the Committee members in seeking to develop the methodology, but those experts who made available the latest scientific knowledge, the industrial bodies and government departments and agencies that made available the data necessary to compile the inventories, and the UFJ Institute and the Suuri Keikaku Co. Ltd. who provided immeasurable assistance in compiling the inventories. We would like to express our gratitude to the Climate Change Policy Division of the Global Environment Bureau of the Ministry of the Environment for their efforts and support to the establishment of the GIO in July 2002.

Tomoyuki Aizawa, a GIO researcher, and Masato Yano, a GIO collaborating researcher, were responsible for writing this report and compiling the inventory files. Chisa Umemiya, a GIO assistant fellow, did proofreading. Finally, our Secretary, Masako White conducted relevant administrative duties including the liaison with the Convention Secretariat.

May, 2005

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Preface

On the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and Article 7 of the Kyoto Protocol, all Parties to the Convention are required to submit national inventories of greenhouse gas emissions and removals to the Secretariat of the Convention. Therefore, the inventories on emissions and removals of greenhouse gases and precursors are reported in the Common Reporting Format (CRF) and in this National Inventory Report, in accordance with UNFCCC Inventory Reporting Guidelines (FCCC/CP/2002/8).

This Report presents Japan's institutional arrangement for the inventory preparation, the estimation methods of greenhouse gas emissions and removals from sources and sinks, the trends in emissions and removals for greenhouse gases (carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF_6)) and precursors (nitrogen oxides (NO_X), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), and sulfur dioxide (SO_2)).

The structure of this report is fully in line with the recommended structure indicated in the Annex I of UNFCCC Inventory Reporting Guidelines (FCCC/CP/2002/8).

The Executive Summary focuses on the latest trends in emissions and removals of greenhouse gases in Japan. Chapter 1 deals with the institutional arrangement for the inventory preparation, summary of the estimation methodology, key source category analysis, and results of uncertainty assessment. Chapter 2 describes the latest information on trends in emissions and removals of greenhouse gases in Japan. Chapters 3 to 8 provide the detailed estimation methods for emissions and removals respectively, described in the *Revised 1996 IPCC Guidelines*. Chapter 9 comprises current status of reporting of the emissions from sources not covered by IPCC guidelines. Chapter 10 provides the explanations on improvement and recalculation (data revision, addition of new source, etc.) from since the previous submission.

Annex offers additional information to assist further understanding of Japan's inventory. The background data submitted to the secretariat provides the complete process of estimating Japan's inventory.

For the latest updates or changes in data, refer to the web-site (URL: www-gio.nies.go.jp) of the Greenhouse Gas Inventory Office of Japan (GIO).

May, 2005

Climate Change Policy Division
Global Environment Bureau
Ministry of the Environment

Executive Summary of National GHGs Inventory Report of Japan 2005

E.S. 1. Background Information on Greenhouse Gas Inventories and Climate Change

This National Inventory Report comprises the inventory of the emissions and removals of greenhouse gases, indirect greenhouse gases and SO_2 in Japan for fiscal 1990 through to 2003[1], on the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and Article 7 of the Kyoto Protocol. The submission of Japan's inventories is based on the *UNFCCC Reporting Guidelines on Annual Inventories* (FCCC/CP/2002/8) adopted by the Conference of the Parties.

Estimation methodologies of greenhouse gas inventories should be in line with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereafter, *Revised 1996 IPCC Guidelines*) which was developed by the Intergovernmental Panel on Climate Change (IPCC). In 2000, the *Good Practice and Uncertainty Management in National Greenhouse Gas Inventories (2000)* (hereafter, *the Good Practice Guidance (2000)*) was published. The Guidance presents the methods for choosing methodologies appropriate to the circumstances of each country and quantitative methods for evaluating uncertainty. Parties are required to seek to apply the *Good Practice Guidance (2000)* to their inventory reporting from 2001 and after ward.

E.S. 2. Summary of National Emission and Removal Related Trends

Total greenhouse gas emission in fiscal 2003 (the sum of emissions of CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 converted to CO_2 equivalents by multiplying its global warming potential [GWP][2] respectively; excluding carbon dioxide removals) was 1,339 million tons (in CO_2 equivalents), an increase by 12.8% compared to emissions (CO_2, CH_4, N_2O, excluding carbon dioxide removals) in FY1990 (Removals of carbon dioxide in FY1995 were 96.7 million tons[3], an increase by 15.3% from FY1990). Compared to emissions in the base year under the Kyoto Protocol (FY1990 for emissions of CO_2, CH_4, N_2O; FY1995 for emissions of HFCs, PFCs, and SF_6), it increased by 8.3%.

It should be noted that emissions of HFCs, PFCs and SF_6 in the period from 1990 to 1994 and emissions and removals by Land-use change and forestry sector after 1995 have not been estimated (NE).

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[1] " Fiscal" is used because CO_2 is the primary GHGs emissions and estimated on the fiscal year basis; from April of the year to March of the next year.

[2] Global Warming Potential (GWP): It is the coefficients that indicate degrees of greenhouse gas effects caused by greenhouse gases converted into the proportion of equivalent degrees of CO_2. The coefficients are subjected to the *Second National Assessment Report* (1995) issued by the Intergovernmental Panel on Climate Change (IPCC).

[3] In the inventory submitted under the FCCC, removals by forest planted before 1990 are contained. Therefore, this value do not correspond to 13 Mt indicated in the annex of "Draft decision -/CMP.1 (Land use, land-use change and forestry) (FCCC/CP/2001/13/Add.1 p54) adopted in the decision 11/COP7.

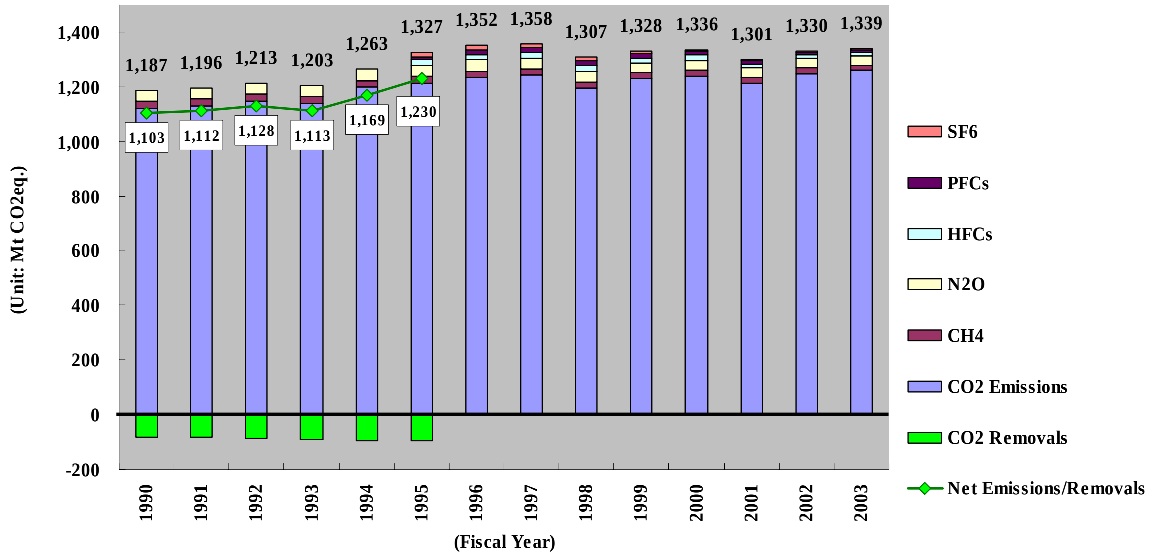

Figure 1 Trends in emission and removals of greenhouse gases in Japan

* Values in boxes represent net emissions or removals. No values appear after 1995, however, as carbon dioxide removals have not been estimated.

Table 1 Trends in emission and removals of greenhouse gases in Japan

[Mt CO2 eq.]	GWP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO2 Emissions	1	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8	1,259.4
Removals	1	-83.9	-83.9	-85.6	-90.1	-93.5	-96.7	NE	NE	NE	NE	NE	NE	NE	NE
CH4	21	24.8	24.7	24.6	24.5	24.1	23.5	22.9	22.1	21.5	21.1	20.7	20.2	19.5	19.3
N2O	310	40.2	39.7	39.9	39.6	40.5	40.6	41.5	41.9	40.6	35.1	37.5	34.6	34.7	34.6
HFCs	HFC-134a：1,300 etc.	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3
PFCs	PFC-14：6,500 etc.	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0
SF6	23,900	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.5
Gross Total		1,187.3	1,195.8	1,213.4	1,202.9	1,262.8	1,326.9	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1
Net Total		1,103.4	1,111.9	1,127.8	1,112.8	1,169.3	1,230.2	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

* NE: Not Estimated

* CH_4 and N_2O emissions in Table 1 include emissions from Land-Use Change and Forestry based on the estimation method decided by the UNFCCC. On the contrary, since emissions from Land-Use Change and Forestry are regarded as RMU (removal unit) according to Article 3.3 of the Kyoto Protocol, they are not included in GHG emissions based on Kyoto Protocol (refer annex 8 table 1).

E.S. 3. Overview of Source and Sink Category Emission Estimates and Trends

The breakdown of emissions and removals of greenhouse gases in FY2003 by sector[4] shows that the Energy sector accounted for 89.5%, followed by Industrial processes at 5.6%, Solvents and other product use at 0.02%, Agriculture at 2.5% and Waste at 2.4%.

Removals by Land-use change and forestry in FY1995 were approximately 7.3% as a proportion of total emissions.

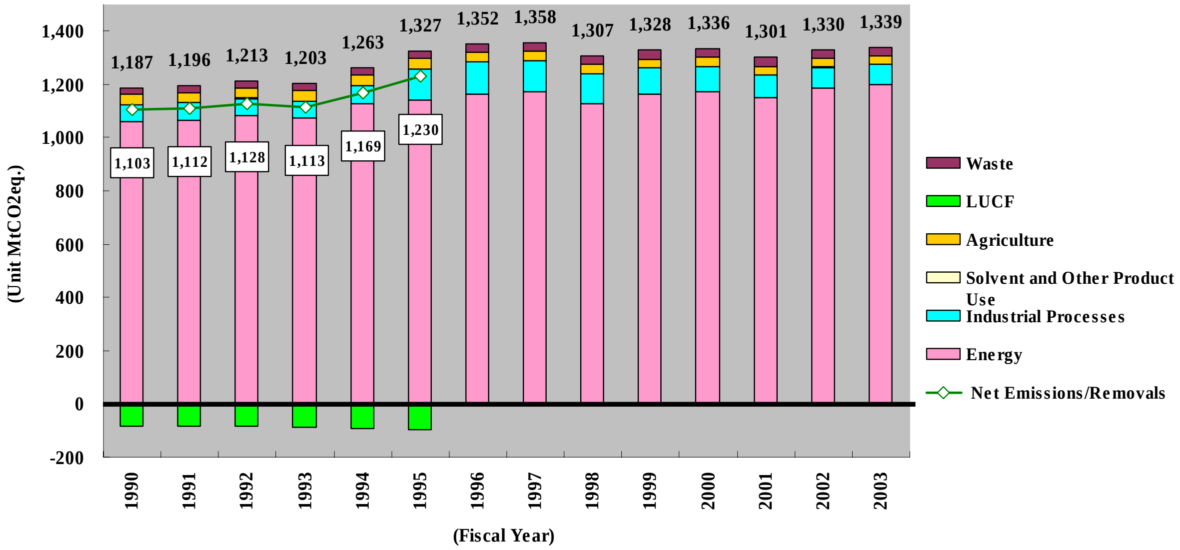

Figure 2 Trends in emissions and removals of greenhouse gases in each category

* Values in boxes represent net emissions or removals. No values appear after 1995, however, as carbon dioxide removals have not been estimated.

Table 2 Trends in emissions and removals of greenhouse gases in each category

[Mt CO_2 eq.]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy	1,058.3	1,065.4	1,081.4	1,072.2	1,128.0	1,142.4	1,163.8	1,171.4	1,129.1	1,163.2	1,172.1	1,149.9	1,186.2	1,198.9
Industrial Processes	64.8	65.7	66.1	65.0	66.9	116.6	120.2	118.1	109.5	97.8	96.3	84.9	78.1	75.1
Solvent and Other Product Use	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
Agriculture	39.0	38.8	38.7	38.6	38.0	37.1	36.2	35.4	34.9	34.4	34.1	33.7	33.4	33.2
Land Use Change and Forestry	-83.8	-83.8	-85.5	-90.0	-93.5	-96.6	NE	NE	NE	NE	NE	NE	NE	NE
Waste	24.9	25.5	26.6	26.6	29.3	30.3	31.2	32.3	32.8	32.7	33.4	32.5	31.9	31.6
Net Emissions/Removals	1,103.4	1,111.9	1,127.8	1,112.8	1,169.3	1,230.2	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

*NE: Not Estimated

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[4] It implies “Category” indicated in the *Revised 1996 IPCC Guidelines* and *CRF*.

E.S. 4. Other Information (Indirect Greenhouse Gases)

Under UNFCCC, it is required to report emissions of indirect greenhouse gases (NO_X, CO, NMVOC and SO_2), other than 6 types of greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) which are not controlled by the Kyoto Protocol. Emission trends of these gases are indicated below.

Nitrogen oxide (NO_X) emissions in FY2003 were 201.5Gg, a decrease by 1.8% compared to FY1990, and by 0.6% compared to the previous year.

Carbon monoxide (CO) emissions in FY2003 were 344.4Gg, a decrease by 15.7% compared to FY1990, and by 0.2% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY2003 were 172.7Gg, a decrease by 10.4% compared to FY1990, and an increase by 0.1% compared to the previous year.

Sulfur dioxide (SO_2) emissions in FY2003 were 84.9Gg, a decrease by 15.1% compared to FY1990, and by 0.6% compared to the previous year.

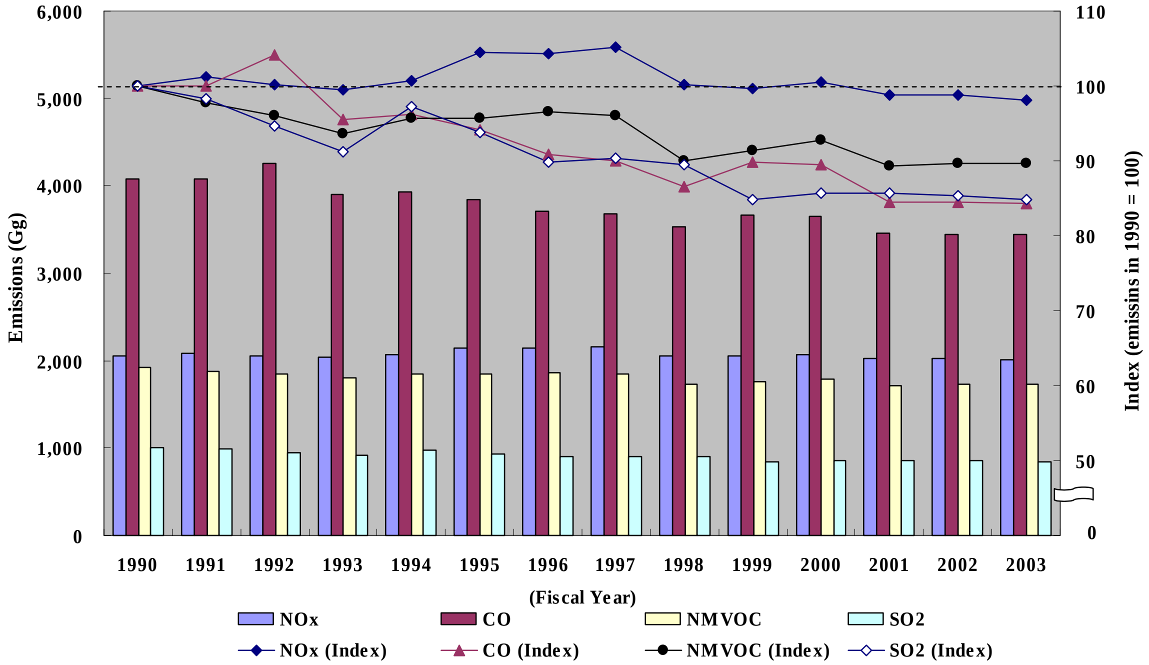

Figure 3 Trends in Emissions of Indirect Greenhouse Gases and SO_2

Chapter 1. Introduction and QA/QC plan

1.1. Background Information on Greenhouse Gas Inventories and Climate Change

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1.2. QA/QC plan

1.2.1. Inventory compilation system

In Japan, the Ministry of the Environment (MOE) has annually compiled and submitted the national greenhouse gas inventory to UNFCCC secretariat under the UNFCCC in cooperation with relevant ministries, governmental agencies and organizations (see Figure 1-1).

The MOE has overall responsibility for the national inventory. In order to response to the international requirements and to reflect the latest scientific knowledge in the inventory, the MOE has convened and managed the Committee for the Greenhouse Gas Emissions Estimation Methods. On the basis of the results of the Committee's deliberations, the MOE compiles inventories including the estimation of GHGs emissions and removals, identification of key categories[2], and uncertainty assessment. The actual task of inventory compilation, including data input, calculation of emissions and removals and preparation of Common Reporting Format (CRF) and National Inventory Report (NIR), is achieved by Greenhouse Gas Inventory Office of Japan (GIO)[3], of the Center for Global Environmental Research of the National Institute for Environmental Studies.

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[1] " Fiscal" is used because CO_2, the primary GHG emission in Japan, is estimated on the fiscal year basis; from April of the year to March of the next year.

[2] The *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (2003), which was welcomed in COP9, extends the key source analysis to LULUCF categories. In the latest UNFCCC reporting guidelines (FCCC/SBSTA/2004/8), the term "key source category" was revised to "key category". Japan adopts the term "key category" according to these guidelines, although it has not conducted key category analysis covering the LULUCF categories.

[3] GIO has consigned a part of task to private consultants.

The relevant ministries, governmental agencies and organizations concerned provide data for emission factors, activity data, etc., through the ways such as the publication of relevant statistics. They also offer assistance for the preparation of inventory, for example, by providing information necessary for the assessment of uncertainty. List of the relevant ministries, governmental agencies and organizations is presented below.

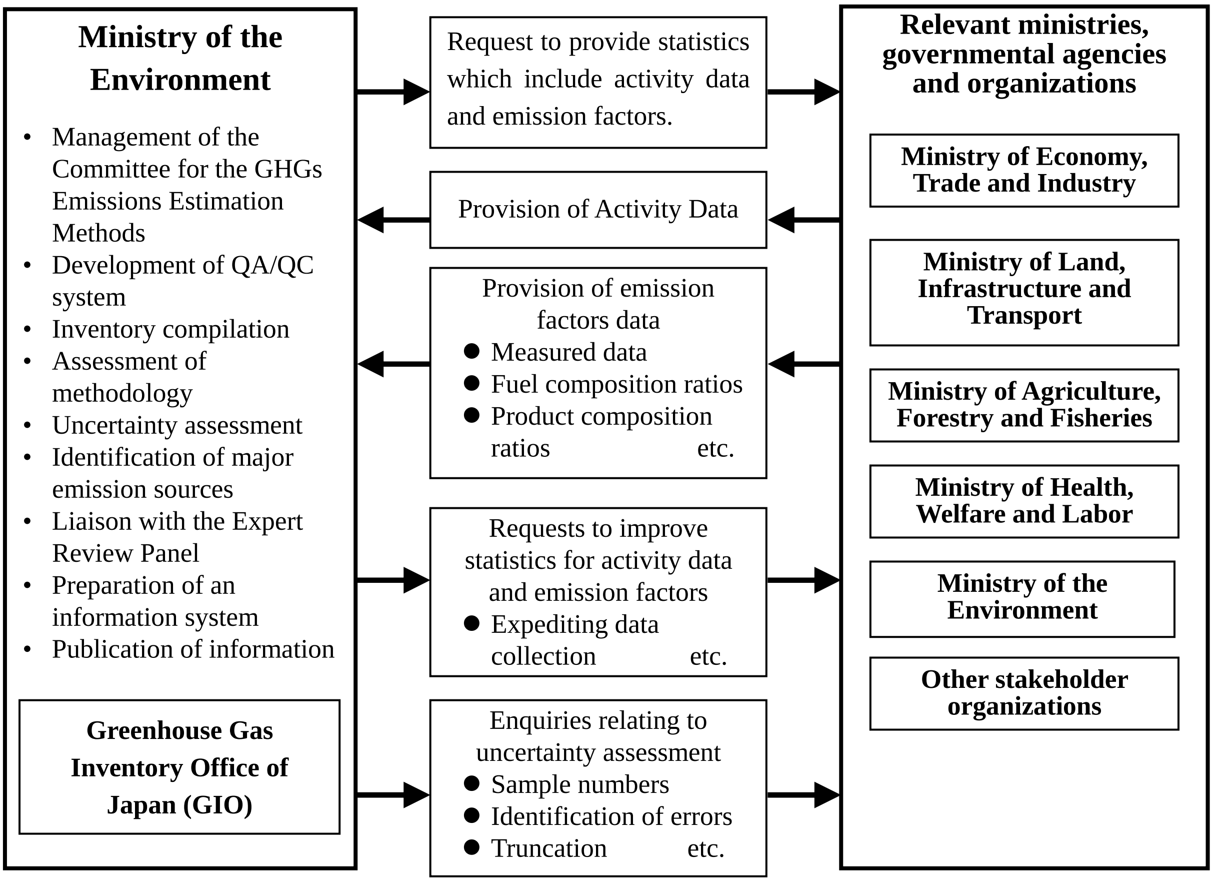

Figure 1-1 Institutional arrangement for the inventory preparation in Japan

Table 1-1 List of the relevant ministries

		Major data or statistics
Relevant ministries	Ministry of the Environment	Research of Air Pollutant Emissions from Stationary Sources / volume of waste in landfill / volume of incinerated waste / population using johkasou[4] / volume of human waste treated at human waste treatment facilities
	Ministry of Economy, Trade and Industry	General Energy Statistics / Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke / Yearbook of Iron and Steel, Non-ferrous Metals, and Fabricated Metals Statistics / Yearbook of Chemical Industry Statistics / Yearbook of Ceramics and Building Materials Statistics / Census of Manufactures
	Ministry of Land, Infrastructure and Transport	Survey on Transport Energy / Statistical Yearbook of Motor Vehicle Transport / Statistical Yearbook of Air Transport
	Ministry of Agriculture, Forestry and Fisheries	Crop Statistics / Livestock Statistics / Vegetable Production and Shipment Statistics / Statistics of Arable and Planted Land Area
	Ministry of Health, Welfare and Labor	Statistics of Production by Pharmaceutical Industry

Table 1-2 List of the governmental agencies and organizations

		Major data or statistics
Relevant Organizations	Federation of Electric Power Companies	Volume of fuel consumption at pressurized fluidized-bed combustion
	Japan Coal Energy Center	Production volume of coal
	Japan Cement Association	Moisture content, purity and MgO content of limestone
	Japan Iron and Steel Federation	Emissions from coke furnace cover, desulfurization tower and regeneration desulfurization tower
	local public entity	Carbon content in each type of waste

1.2.2. Brief General Description of Methodologies and Data Sources Used

The methodology used in estimation of GHG emissions or removals is basically in accordance with the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)*. However, Japan's country-specific methodologies were used for "2.A.1. carbon dioxide emissions from cement production", "2.A.2. carbon dioxide emissions from lime production", "4.C. methane emissions from rice cultivation" and "6.A. methane emissions from solid waste disposal on land" etc., in order to reflect the actual situations of emissions in Japan.

Basically, actual measurements or estimates based on researches conducted in Japan were used for the emissions factors. However, the default values given in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)* were used for categories from which emissions were thought to be quite low (such as "1.B.2.a.ii fugitive emissions from fuel (oil and natural gas")), and emission sources for which the reality of emissions is unsure (such as " 4.D.3. indirect emissions from soil in agricultural land").

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[4] "Johkasou" is a system developed in Japan for on-site treatment of wastewater from households.

1.2.3. Brief Description of the Process of Inventory Preparation and Implementation of QA/QC

Japan has compiled an inventory by following the steps shown in Figure 1-2, in order to ensure and maintain the quality control for such as the completeness, accuracy and consistency of data. Submission of inventory to the UNFCCC secretariat is due on April 15th every year.[5] Dates overlapping between different steps are due to the fact that Japan implements more than one step contemporaneously to enhance working efficiency.

As shown in Figure 1-2, Japan has implemented QC activities, such as checking estimation accuracy and archiving documents, in each step of the inventory compilation process in accordance with *Good Practice Guidance (2000)* to manage the quality of inventories. Japan has implemented Step 2 [Expert review of previous inventories (Committee for the Greenhouse Gases Emissions Estimation Methods)] as QA activities, and in that step, it reviews data quality taking into account scientific knowledge and data availability.

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[5] Annex I Parties have to submit their inventories within 6 weeks from the submission date, which is April 15th, to be eligible to participate in the Kyoto mechanism.

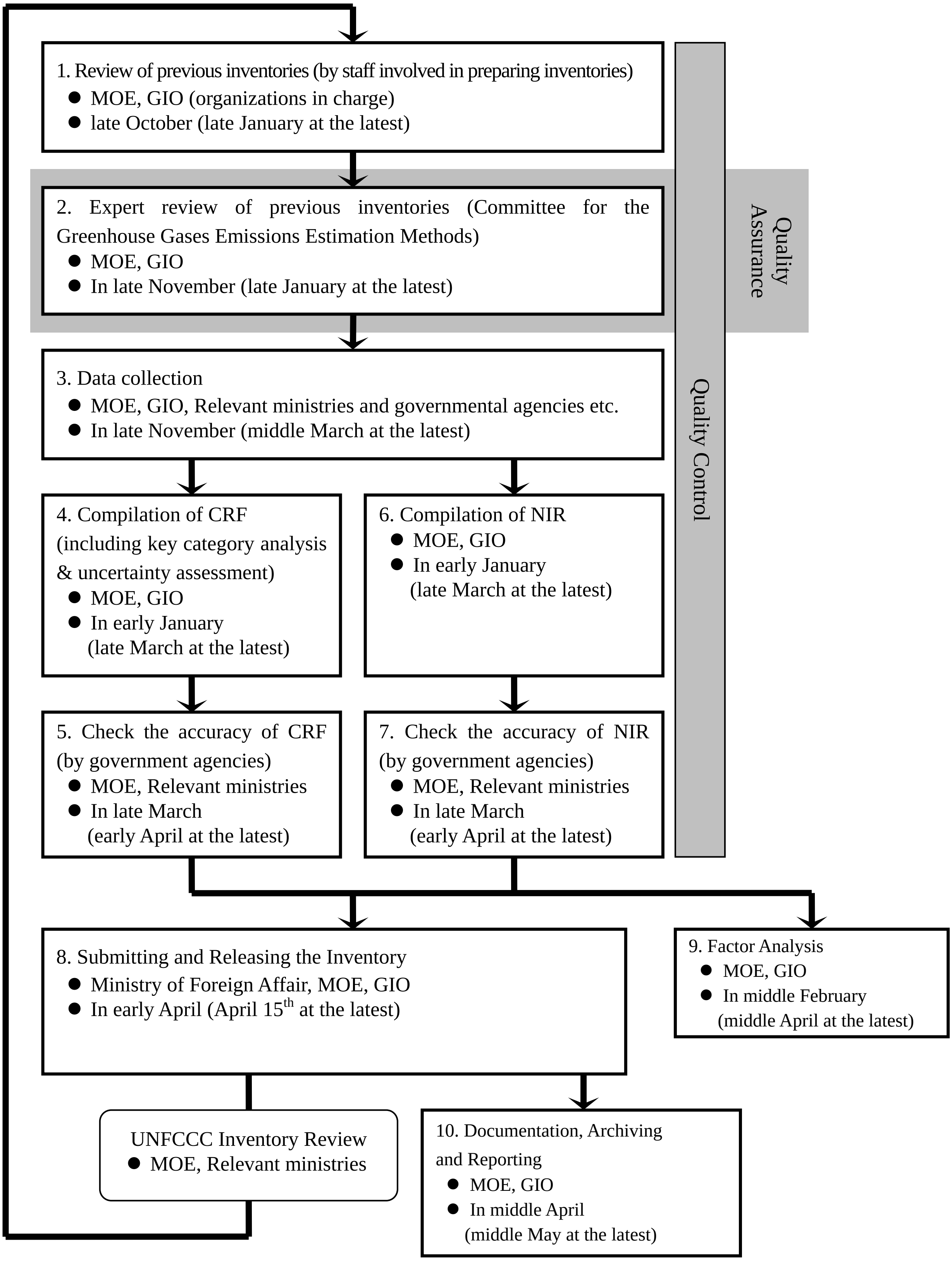

Figure 1-2 Process of the inventory compilation

1.2.4. Brief Description of Key Categories

Key categories were assessed in accordance with the *Good Practice Guidance (2000)* (Tier 1 level assessment or trend assessment and qualitative analysis).

The assessment using these methods (Tier1 Level Assessment, Tier1 Trend Assessment and Qualitative Analysis) resulted in the following table of 25 sources, which were determined as Japan's key categories in fiscal 2003. Refer to Annex 1 for more detailed results.

Table 1-3 Japan's key source categories in FY2003

	A **IPCC Source Category**		**B** **Direct GHGs**	**Level**	**Trend**	**Qualitative Analysis**
#1	1A Stationary Combustion	Solid Fuels	CO2	#1	#2	
#2	1A Stationary Combustion	Liquid Fuels	CO2	#2	#1	
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	#3	#4	
#4	1A Stationary Combustion	Gaseous Fuels	CO2	#4	#3	
#5	2A Mineral Product	1. Cement Production	CO2	#5	#7	
#6	6C Waste Incineration		CO2	#6	#10	
#7	1A Stationary Combustion	Other Fuels	CO2	#7		
#8	1A3 Mobile Combustion	d. Navigation	CO2	#8		
#9	4B Manure Management		N2O	#9	#14	●
#10	1A3 Mobile Combustion	a. Civil Aviation	CO2	#10	#12	
#11	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#11	#16	
#12	4A Enteric Fermentation		CH4	#12		
#13	1A3 Mobile Combustion	b. Road Transportation	N2O	#13		
#14	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs		#5	
#15	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6		#6	
#16	2B Chemical Industry	3. Adipic Acid Production	N2O		#8	●
#17	2F(a) Consumption of Halocarbons	5. Solvents	PFCs		#9	
#18	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#11	
#19	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#13	
#20	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs		#15	
#21	4C Rice Cultivation		CH4		#17	
#22	1A3 Mobile Combustion	a. Civil Aviation	CH4			●
#23	1A3 Mobile Combustion	a. Civil Aviation	N2O			●
#24	6B Wastewater Handling		N2O			●
#25	6C Waste Incineration		N2O			●

N.B. Figures recorded in the Level and Trend columns indicate the ranking of individual level and trend assessments.

1.3. Further Inventory Development

For further development of inventory, following issues need to be addressed. All issues indicated below are suggested in the Committee for the Greenhouse Gas Emissions Estimation Methods. Hence, some of them may not be required in the inventories submission under the UNFCCC. Therefore, it is important to tackle them with consideration of the priority.

1.3.1. Crosscutting Issues

- With regard to the sources reported as “NE”, its emission status needs to be considered for the theoretical possibility for emissions.

- Sources estimated with default values of the *Revised 1996 IPCC Guidelines* or *Good Practice Guidance (2000)* could be overestimated because the default values may not reflect the circumstances of Japan correctly. Therefore, the estimation methods need to be improved in accordance with expansion of the scientific country-specific information if it’s available.

- Japan has reported its emissions of greenhouse gases in fiscal year basis (April to March). However, the *Revised 1996 IPCC Guidelines* requires to report in calendar year basis in the course of calculation of greenhouse gas emissions and removals. During the in-country visit review in 2003 under UNFCCC, difficulties in converting the data to calendar year basis and possibility of counting on calendar year basis after 2004 were discussed. Expert Review Team (ERT) concluded that it would be preferable for Japan to continue to report to the UNFCCC on a fiscal year basis, but encourages Japan to continue its work on the possibilities for conversion[6].

1.3.2. Energy (Category1)

1.3.2.1. Fuel Combustion (CO_2)

- In the current inventories, emission factors of liquid fuels such as crude oil, oil products, refinery gas, etc., are fixed from 1990 to following years. Detailed analysis of the oil refinery sector of the inventories revealed that carbon content in crude oil input to refinery is not balanced with that in each oil product and refinery gas. Essentially, in the oil refinery sector, carbon input and output should be balanced. Hence, the current method has issues to be addressed. Fluctuations of emissions relating to this issue would amount to be a few percent of national emission, therefore, immediate actions need to be taken to address these issues.

- Carbon included in solvents emitted to atmosphere as NMVOC is converted to CO_2 by atmospheric oxidation in short time. Reporting these CO_2 emissions in the inventory is indicated in the new *UNFCCC Reporting Guidelines on Annual Inventories*[7] adopted in

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[6] FCCC/WEB/IRI(2)/2003/JPN para.14
[7] FCCC/CP/2002/8

COP8. From 2004, inclusion of these emissions as part of inventory should be conducted, and the framework of CO_2 emission estimation including the emissions such as NMVOC emission from product use except for solvent, and cascade usage of by-product fuel should be reviewed.

- Discharged synthetic detergent and interfacial active agent within a watershed are decomposed in sewage works and generate greenhouse gases. In the current inventory, these emissions are not estimated. The estimation method of these emissions will be considered. One possible option may be the method to adjust the deduction ratio of fuel (naphtha and LPG) used as feedstock in chemical industry.

- In the current inventory, waste used as fuel in sectors other than the waste treatment may not be counted, including the usage of wasted plastic in blast furnaces. The *Revised 1996 IPCC Guidelines* mentions "Incineration of waste for waste-to-energy facilities should be reported here (category 1 energy sector) and not under Section 6.C."[8] However, these emissions are reported under Section 6.C. in Japan.

1.3.2.2. Fuel Combustion (Stationary Sources: CH_4, N_2O)

- In the estimation methods of activity data used for normal pressure fluidized bed boiler, adequacy of assumptions (boiler efficiency: 85%, annual utilization: 8,000 hours) needs to be reviewed.

1.3.2.3. Fuel Combustion (Mobile Sources: CH_4, N_2O)

- There are few measured data on N_2O emission factors of road transportation. These data are affected by the type of equipped catalyst, temperature of catalyst, and aged deterioration of catalyst. Therefore, development of the driving cycle (such as 10-15 mode) applied for measuring GHGs from automobile is needed, as well as the accumulation of measured data are needed.

- CH_4 and N_2O emissions from natural gas vehicles and motorcycles are not estimated. Methods of estimation for these emissions are needed as well as the establishing of these emission factors.

- Taking account of development and dissemination of advanced products derived from technical innovation (such as fuel-cell vehicles, natural gas vehicles, and low emission vehicles), estimation method for GHGs (CH_4 and N_2O) emissions from these vehicles needs to be developed. Furthermore, collection of activity data of natural gas vehicle, which is rising to the dissemination level, should be developed.

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[8] The *Revised 1996 IPCC Guidelines* vol.1, p1.3, N.B. Remarks in parentheses are not cited.

1.3.3. Industrial Processes (Category2)

1.3.3.1. CO_2, CH_4 and N_2O

- *Good Practice Guidance (2000)* may need to be applied to the estimation of emissions from sources listed below. Adequacy of application of the *Good Practice Guidance (2000)* to these sources needs to be reviewed.
  - CO_2 emissions from lime production (category 2.A.2.)
  - CO_2 emissions from iron and steel production (category 2.C.1.)

- Carbon contained in the fuel for non-energy use as reduction agent in metal production may be failed to be counted. Therefore, estimation method needs to be reviewed.

1.3.3.2. F-gas

- There are few types of PFCs used in Japan for which 100-year GWP values are not yet approved by the COP. Information on current status of consumption of these gases is should be grasped and reported separately along with the knowledge of these PFCs' GWP.

- Reporting of F-gas is based on the documentation from the Chemical and Bio Sub-Group, Industrial Structure Council, the Ministry of Economy, Trade and Industry. The Chemical and Bio Sub-Group has estimated the emission of F-gas in accordance with the *Good Practice Guidance (2000)*.

- Some substances of F-gas are emitted from only few companies, and their aggregated data is reported without its details such as emissions by gases because of the confidentiality. However, some sources mentioned above have large amount of emissions. Since the code of practice for the handling of confidential information was adopted in COP, handling of these data along the code of practice would be needed.

- Credibility of estimation should be developed by evaluating mass-balance between actual emissions and potential emissions (including amount of production, export, import, shipment, consumption, stock, disposal, recovery, destruction, recycling, reclamation and emissions).

1.3.4. Agriculture (Category4)

- Since there is no single statistics for all crops in Japan, various statistics are used in compiling Japan's inventories. Definition of each crop in these statistics may be different. Hence, in calculating the total amount of farm products, it is important to take care of double counting and left out of data. The estimation for total growing area of farmland has same issues.

1.3.5. Land-Use Change and Forestry (Category5)

- Emissions and removals after 1995 should be reported after the application of estimation methods according to *LULUCF-GPG*, published in the end of 2003, is thoroughly examined.

1.3.6. Waste (Category6)

- Discharged synthetic detergent and interfacial active agent within a watershed are decomposed in sewage works and generate greenhouse gases. In the current inventory, these emissions are not estimated. The review of these emission estimates will be conducted. One possible option may be the method to adjust the deduction ratio of fuel used as feedstock in chemical industry may be one option. (*Previously mentioned in 1.6.2.2.a. Fuel Combustion* (CO_2))

- In the current inventory, waste used as fuel in sectors other than the waste treatment may not be counted, including the usage of wasted plastic in ballast furnaces. The *Revised 1996 IPCC Guidelines* mentions “Incineration of waste for waste-to-energy facilities should be reported here (category1 energy sector) and not under Section 6.C.” However, these emissions are reported under Section 6.C. in Japan. (*Previously mentioned in 1.6.2.2.a. Fuel Combustion* (CO_2))

- Generally, usage of recyclable resources encourages establishing a sound material-cycle society and is expected to decrease GHGs national total emissions. However, the method provided by the *Revised 1996 IPCC Guidelines*, in which emissions from waste-to-energy facilities should be reported under the energy sector, aims to estimate the emissions by sectors. If these emissions from recycling which were included in the waste sector are counted in the energy sector according to the *IPCC Guidelines*, it might discourage the incentive for promoting thermal recovery or chemical recycle. Therefore, the assessment which does not discourage the promotion of recycling should be considered separately from methods to estimation methods of inventories.

- In category 6.C.: “municipal solid waste incineration”, CO_2 emissions are estimated only from wasted plastics derived from fossil fuels, and incinerated synthetic fibers which should be estimated are not included in the activity data. Therefore, collection of the activity data should be improved.

1.4. General Uncertainty Evaluation, Including Data on the Overall Uncertainty for the Inventory Totals

1.4.1. Uncertainty of Japan's Total Emissions

Total emissions in Japan for fiscal 2003 were approximately 1.34 billion tons (carbon dioxide equivalents). Uncertainty of total emissions has been assessed at 2% and uncertainty introduced into the trend in total national emissions has been assessed at 3%. Refer Annex 7 for details of assessment method and precise results.

Table 1-4 Uncertainty of Japan's Total Emissions

IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	[%]	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national C	rank
1A. Fuel Combustion (CO2)	CO2	1,188,099.7	88.7%	2%	9	1.94%	1
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	3,206.4	0.2%	46%	2	0.11%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	6,954.9	0.5%	166%	1	0.86%	2
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	589.8	0.0%	14%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	49,310.9	3.7%	4%	8	0.13%	6
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	25,801.6	1.9%	25%	4	0.47%	4
3. Solvent & other Product Use	N2O	320.8	0.0%	5%	7	0.00%	9
4. Agriculture	CH4、N2O	33,230.3	2.5%	18%	5	0.46%	5
6. Waste	CO2、CH4、N2O	31,615.4	2.4%	31%	3	0.73%	3
Total Emissions	(D)	1,339,129.9	100.0%	(E) **2%**			

1) C = A × B / D

2) $E = \sqrt{C_1^2 + C_2^2 + \cdots\cdots}$

Hereafter, the same method for calculating uncertainty assessment has been used in each sector appearing in Tables 3 and follows.

1.4.2. Sources which have highly-contribute to the uncertainty of total emissions

"The proportion of the uncertainty of each emissions source to total emissions" (hereafter, "degree of contribution") is useful in examining the contributions to the uncertainties of total emissions from individual sources. Table 1-5 shows the top 20 ranks in sources with a high degree of contribution to uncertainty of total emissions.

Table 1-5 Sources with a high degree of contribution to uncertainty of total emissions

#	IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
#3	1A. Fuel Combustion - Solid Fuels - Steam Coal (imported)	CO2	234,862.3	0.5%	6.8%	7%	146	1.19%	1
#12	1A. Fuel Combustion - Liquid Fuels - Gasoline	CO2	140,571.0	0.6%	8.5%	9%	140	0.90%	2
#31	1A. Fuel Combustion (Transport) - a. Civil Aviation	N2O	110.3	10000.0%	5.0%	10000%	1	0.82%	3
#25	1A. Fuel Combustion - Gaseous Fuels - LNG	CO2	108,835.3	2.3%	9.3%	10%	136	0.78%	4
#161	6. Waste - C. Waste Incineration - Industrial Solid Waste	CO2	10,155.4	—	—	71%	57	0.54%	5
#5	1A. Fuel Combustion - Solid Fuels - Coke	CO2	65,894.5	5.0%	8.2%	10%	135	0.47%	6
#158	6. Waste - C. Waste Incineration - Municipal Solid Waste	CO2	13,183.8	11.2%	44.8%	46%	95	0.45%	7
#16	1A. Fuel Combustion - Liquid Fuels - Diesel Oil or Gas Oil	CO2	100,178.7	0.4%	5.8%	6%	148	0.44%	8
#70	2. Industrial Processes - E. Production of F-gas - 1. By-product Emissions (HCFC-22)	HFCs	5,022.8	100.0%	5.0%	100%	40	0.38%	9
#19	1A. Fuel Combustion - Liquid Fuels - Heating Oil C	CO2	98,132.3	0.5%	4.3%	4%	160	0.32%	10
#27	1A. Fuel Combustion - Gaseous Fuels - Town Gas*	CO2	59,204.4	5.0%	3.9%	6%	147	0.28%	11
#15	1A. Fuel Combustion - Liquid Fuels - Kerosene	CO2	70,079.6	0.2%	5.2%	5%	154	0.27%	12
#33	1A. Fuel Combustion (Transport) - b. Road Transportation	N2O	6,429.7	50.0%	5.0%	50%	83	0.24%	13
#17	1A. Fuel Combustion - Liquid Fuels - Heating Oil A	CO2	81,690.6	0.6%	3.8%	4%	162	0.23%	14
#129	4. Agriculture - D. Agricultural Soils - 3. Indirect Emissions - N Leaching & Run-off	N2O	3,663.2	—	—	84%	50	0.23%	15
#8	1A. Fuel Combustion - Solid Fuels - Blast Furnace Gas	CO2	40,821.7	5.0%	5.0%	7%	143	0.22%	16
#124	4. Agriculture - D. Agricultural Soils - 1. Direct Soil Emissions - Synthetic Fertilizers	N2O	2,062.5	—	—	130%	24	0.20%	17
#107	4. Agriculture - B. Manure Management - Non-Dairy Cattle	N2O	3,641.1	—	—	72%	56	0.20%	18
#23	1A. Fuel Combustion - Liquid Fuels - Refinery Gas	CO2	32,940.4	1.0%	7.6%	8%	142	0.19%	19
#1	1A. Fuel Combustion - Solid Fuels - Coking Coal	CO2	26,049.3	0.9%	9.3%	9%	138	0.18%	20

1.5. General Assessment of the Completeness

In this inventory, emissions from some categories are not estimated and reported as “NE”. It should be noted that emissions from many of these categories are expected to be very small or the status of the emissions is not clearly defined. Major categories which should be studied in the future are listed below.

It should be noted that emissions of HFCs, PFCs and SF_6 in the period from 1990 to 1994 and emissions and removals by Land-use change and forestry sector after 1995 have not been estimated (NE).

➢ Energy
- CH_4 emissions from Low-Emission Vehicle (Natural Gas Vehicle)
- CH_4 and N_2O emissions from Railways (Solid Fuels, Other Fuels such as gasoline and heating oil)
- N_2O emissions from Coal Mining
- N_2O emissions from Solid Fuel Transformation
- Fugitive emissions of CO_2, CH_4 and N_2O from Venting and Flaring
    - ✧ Fugitive emissions of CO_2 and CH_4 from Venting at Gas Wells
    - ✧ Fugitive emissions of CO_2, CH_4 and N_2O from Flaring at Oil Wells and Gas Wells

➢ Industrial Processes
- CO_2 emissions from Soda Ash Product and Use (including Desulfurizing Facilities)
- CO_2 emissions from Carbide Production
    - ✧ CO_2 emissions from Silicon Carbide Production
    - ✧ CO_2 emissions from Calcium Carbide Production
- N_2O emissions from Ethylene Production
- N_2O emissions from Coke Production

➢ Agriculture
- CH_4 emissions from Enteric Fermentation for Buffalo, Camels and Llamas, and Mules and Asses
- CH_4 emissions from Manure Management for Buffalo, Camels and Llamas, and Mules and Asses
- N_2O emissions from Crop Residue and Cultivation of Histosols on Agricultural Soils
- CH_4 and N_2O emissions from Field Burning of Other Agricultural Residues

➢ Waste
- CO_2 emissions from Managed Waste Disposal on Land
- CO_2 emissions from Unmanaged Waste Disposal Sites

Chapter 2. Trends in GHGs Emissions and Removals

2.1. Description and Interpretation of Emission and Removal Trends for Aggregate Greenhouse Gases

2.1.1. Greenhouse Gas Emissions and Removals

Total greenhouse gas emission in fiscal 2003[1] (the sum of emissions of CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 converted to CO_2 equivalents by multiplying its global warming potential [GWP][2] respectively; excluding for carbon dioxide removals) was 1,339 million tons (in CO_2 equivalents), an increase by 12.8% compared to emissions (CO_2, CH_4, N_2O, excluding carbon dioxide removals) in FY1990 (Removals of carbon dioxide in FY1995 were 96.7 million tons[3], an increase by 15.3% from FY1990). Compared to emissions in the base year under the Kyoto Protocol (FY1990 for emissions of CO_2, CH_4, N_2O; FY1995 for emissions of HFCs, PFCs, and SF_6), it increased by 8.3%.

It should be noted that emissions of HFCs, PFCs, and SF_6 in the period from 1990 to 1994, and emissions and removals by Land-use change and forestry sector after 1995 have not been estimated (NE).

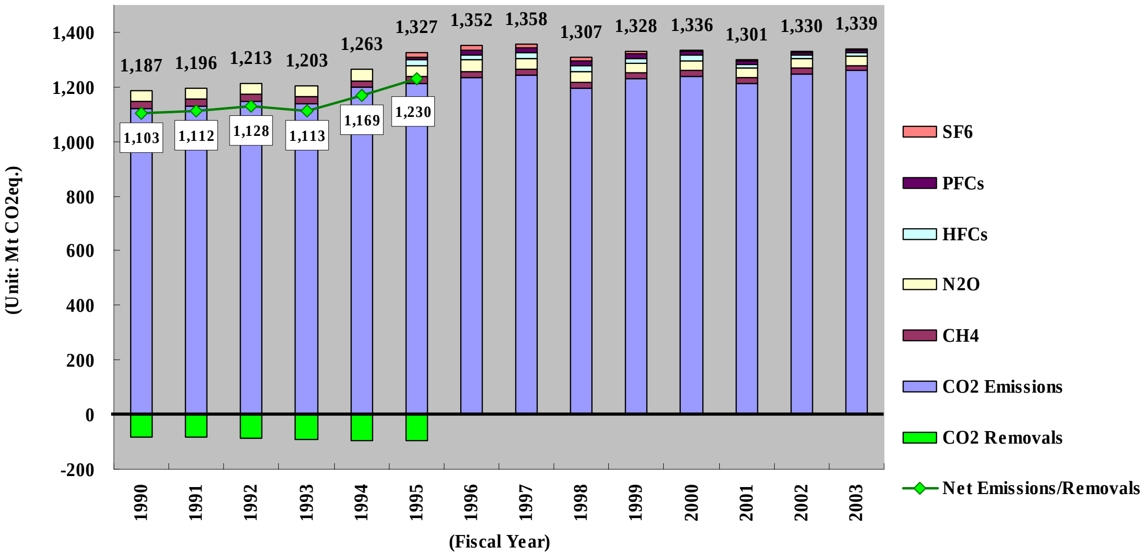

Figure 2-1 Trends in emission and removals of greenhouse gases in Japan

* Values in boxes represent net emissions or removals. No values appear after 1995, however, as carbon dioxide removals have not been estimated.

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[1] "Fiscal" is used because CO_2 is the primary GHGs emissions and estimated on the fiscal year basis; from April of the year to March of the next year.

[2] Global Warming Potential (GWP): It is the coefficients that indicate degrees of greenhouse gas effects caused by greenhouse gases converted into the proportion of equivalent degrees of CO_2. The coefficients are subjected to the *Second National Assessment Report* (1995) issued by the Intergovernmental Panel on Climate Change (IPCC).

[3] In the inventory submitted under the FCCC, removals by forest planted before 1990 are contained. Therefore, this value do not correspond to 13 Mt indicated in the annex of "Draft decision -/CMP.1 (Land use, land-use change and forestry) (FCCC/CP/2001/13/Add.1 p54) adopted in the decision 11/COP7.

2.1.2. CO_2 Emissions Per Capita

Total carbon dioxide emissions in fiscal 2003 were 1,259 million tons, giving an emission of 9.87 tons per capita. Compared to fiscal 1990, it represents an increase of 12.2% in total carbon dioxide emissions, and an increase of 8.7% in carbon dioxide emissions per capita. Carbon dioxide emissions compared to the previous year increased by 0.9% in total emissions and increased by 0.8% per capita.

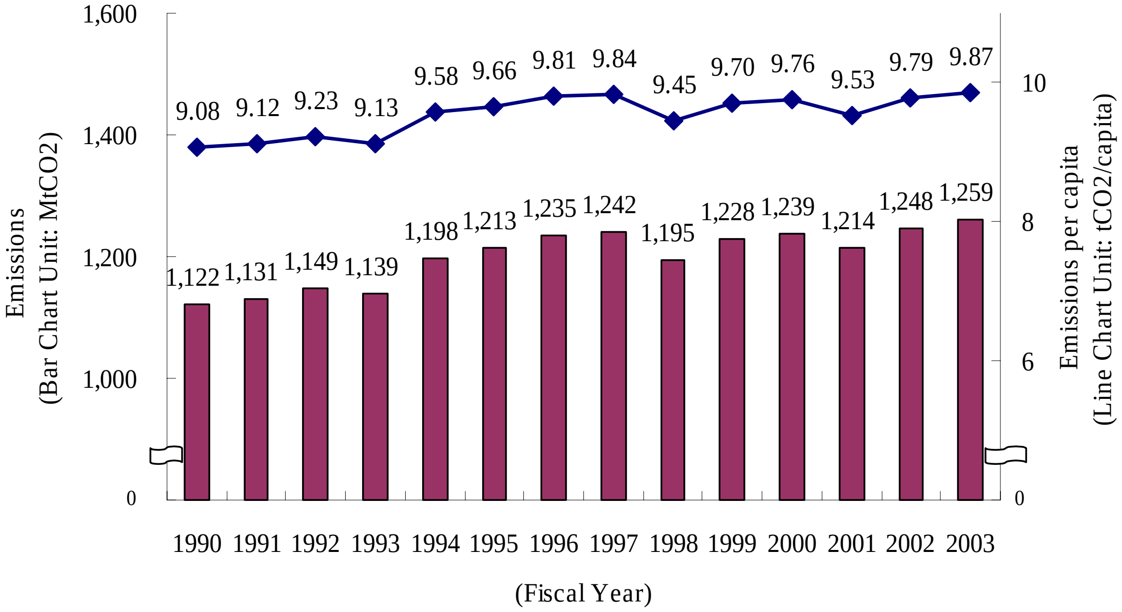

Figure 2-2 Trends in total CO_2 emissions and CO_2 emissions per capita

Source of population: Ministry of Public Management, Home Affairs, Posts and Telecommunications Japan, *Population Census*

MPMHAPTJ, *Annual Report on Current Population Estimates*

2.1.3. CO_2 Emissions per unit of GDP

Carbon dioxide emissions per unit of GDP in fiscal 2003 were 2,270 tons/billion yen, resulting in a decrease by 5.2% since fiscal 1990, and a decrease by 2.3% from the previous year.

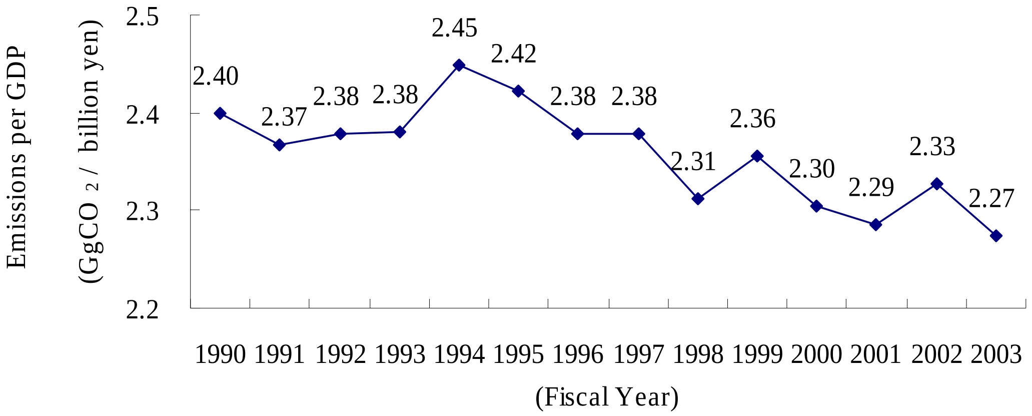

Figure 2-3 Trends in CO_2 emissions per unit of GDP

Source of GDP: website of Economic and Social Research Institute (Preliminary Estimates of National Expenditure Oct-Dec.2004, Fixed-based)

2.2. Description and Interpretation of Emission and Removal Trends by Gas

Emissions of carbon dioxide in FY2003 were 1,259 million tons, comprising 94.0% of the total. It represents an increase by 12.2% from fiscal 1990, and an increase by 0.9% in comparison with the previous year. Removals of CO_2 in FY1995[4] were 96.7 million tons, equivalent to 7.3% of total annual greenhouse gas emissions. It represents an increase by 15.3% from FY1990, and an increase by 3.4% in comparison with the previous year.

Emissions in FY2003 of CH_4 were 19.3 million tons (in CO_2 eq.), comprising 1.4% of total emissions. The value represents a reduction by 22.3% from FY1990 and 1.2% in comparison with the previous year.

Emissions in FY2003 of N_2O were 34.6 million tons (in CO_2 eq.), comprising 2.6% of total emissions. The value represents a reduction by 13.9% from FY1990, and 0.2% in comparison with the previous year.

Emissions in CY2003 of HFCs were 12.3 million tons (in CO_2 eq.), comprising 0.9% of total emissions. The value represents a reduction by 39.2% on CY1995, and 4.7% in comparison with the previous year.

Emissions in CY2003 of PFCs were 9.0 million tons (in CO_2 eq.), comprising 0.7% of total emissions. The value represents a reduction by 28.2% from CY1995, and 8.3% in comparison with the previous year.

Emissions in CY2003 of SF_6 were 4.5 million tons (in CO_2 eq.), comprising 0.3% of total emissions. The value represents a reduction by 73.6% on CY1995, and 15.3% in comparison with the previous year.

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[4] Statistics on removals of CO_2 have not been updated. The most recently available data is therefore for FY1995.

Table 2-1 Trends in emissions and removals of greenhouse gas in Japan

[Mt CO2 eq.]	GWP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO2 Emissions	1	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8	1,259.4
Removals	1	-83.9	-83.9	-85.6	-90.1	-93.5	-96.7	NE	NE	NE	NE	NE	NE	NE	NE
CH4	21	24.8	24.7	24.6	24.5	24.1	23.5	22.9	22.1	21.5	21.1	20.7	20.2	19.5	19.3
N2O	310	40.2	39.7	39.9	39.6	40.5	40.6	41.5	41.9	40.6	35.1	37.5	34.6	34.7	34.6
HFCs	HFC-134a：1,300 etc.	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3
PFCs	PFC-14：6,500 etc.	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0
SF6	23,900	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.5
Gross Total		1,187.3	1,195.8	1,213.4	1,202.9	1,262.8	1,326.9	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1
Net Total		1,103.4	1,111.9	1,127.8	1,112.8	1,169.3	1,230.2	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

* NE: Not Estimated

* CH_4 and N_2O emissions in Table 2-1 include emissions from Land-Use Change and Forestry based on the estimation method decided by the UNFCCC. On the contrary, since emissions from Land-Use Change and Forestry are regarded as RMU (removal unit) according to Article 3.3 of the Kyoto Protocol, they are not included in GHG emissions based on Kyoto Protocol (refer annex 8 table 1).

2.2.1. CO_2[5]

CO_2 emissions in FY2003 were 1,259 million tons, an increase by 12.2% from FY1990, and an increase by 0.9% in comparison with the previous year.

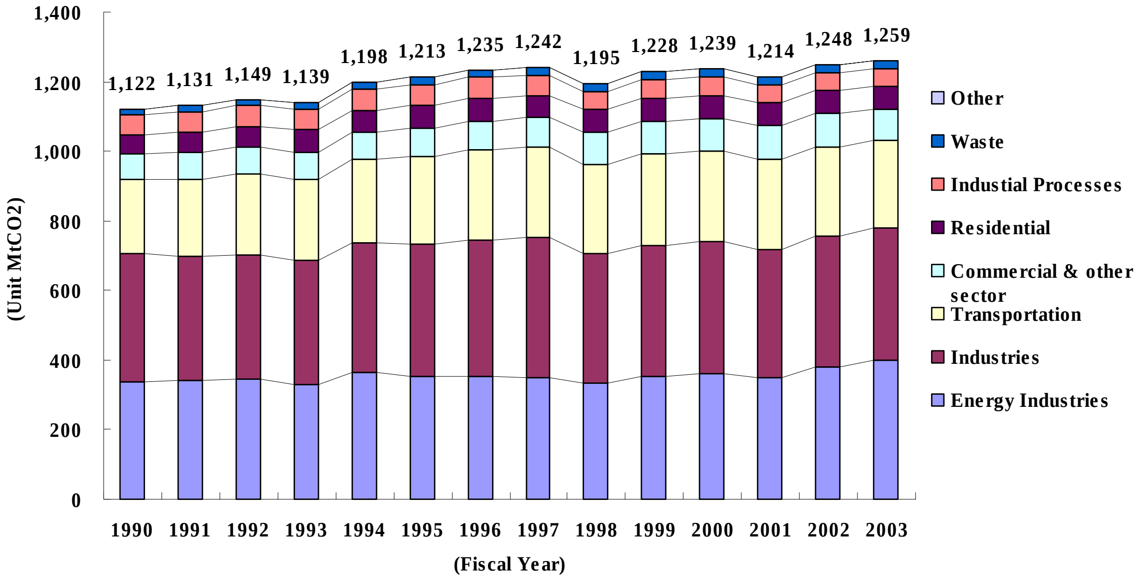

Figure 2-4 Trends in CO_2 emissions

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[5] CO_2 associated with LUCF sector has been excluded.

The breakdown of CO_2 emissions in FY2003 shows that carbon dioxide emitted in association with the Fuel combustion accounted for 94% of the total, carbon dioxide from the Industrial processes accounted for 3.8%, and carbon dioxide from the Waste sector accounted for 1.9%.

The Energy industries sector accounts for 31.7% of emissions of CO_2 from the Fuel combustion, making it the single largest source of emissions followed by the Industries at 30.2% and the Transport sector at 20.1%.

Fluctuations in emissions by sector show that CO_2 emissions from the Fuel combustion in the Energy industries sector, which accounts for about 30% of CO_2 emissions, increased by 17.8% compared to FY1990, and increased by 5.0% compared to the previous year.

CO_2 emissions from the Fuel combustion in the industries increased by 3.3% compared to FY1990, and increased by 1.3% compared to the previous year.

CO_2 emissions from the Fuel combustion in the transportation increased by 20.1% compared to FY1990, and decreased by 0.9% compared to the previous year.

CO_2 emissions from the Fuel combustion in the commercial and other sector increased by 22.6% compared to FY1990, and decreased by 7.1% compared to the previous year.

CO_2 emissions from the Fuel combustion in the residential sector increased by 15.1% compared to FY1990, and decreased by 3.2% compared to the previous year.

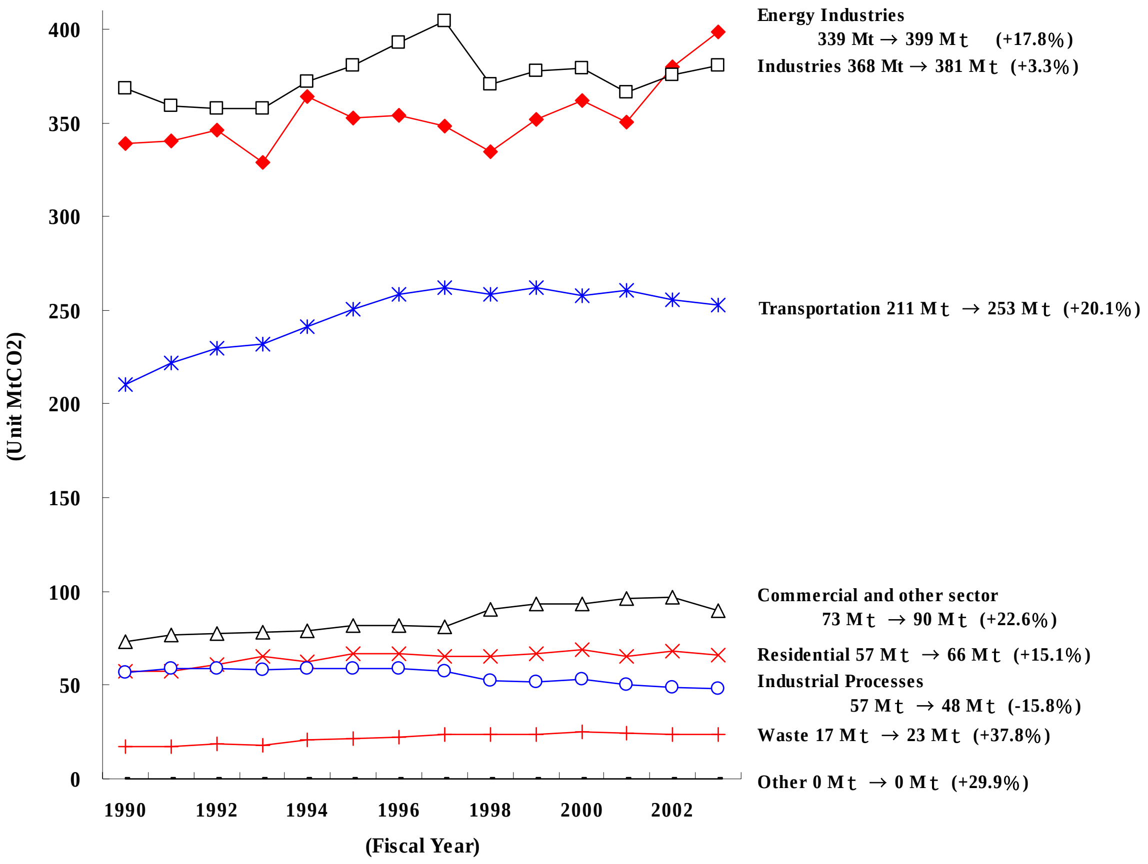

Figure 2-5 Trends in CO_2 emissions in each sector

Table 2-2 Trends in CO_2 emissions in each sector

[Gg CO2]

Category	1990	1995	2000	2002	2003
1A. Fuel Combustion	1,048,332.15	1,132,241.07	1,161,365.77	1,175,509.80	1,188,099.74
Energy Industry	338,571.89	352,633.52	362,159.09	379,656.59	398,776.60
Public Electricity & Heat Production	296,840.62	311,936.88	324,818.69	345,068.47	363,939.61
Petroleum Refining	14,321.90	16,479.79	16,322.87	16,361.12	16,481.43
Manufacture of Solid Fuel and Other Energy Industry	27,409.37	24,216.85	21,017.53	18,226.99	18,355.56
Industries	368,498.95	380,363.21	378,850.21	375,610.06	380,558.86
Manufacturing Industries &	335,046.99	346,464.86	349,059.49	345,819.34	350,768.14
Agriculture, Forestry and Fisheries	33,451.96	33,898.35	29,790.72	29,790.72	29,790.72
Transport	210,663.43	250,654.62	258,059.82	255,290.53	252,930.31
Civil Aviation	7,162.95	10,278.98	10,677.61	10,934.33	11,063.68
Road Transportation	189,204.04	225,179.46	231,897.37	229,236.27	227,177.66
Railways	941.98	828.30	707.44	668.81	628.69
Navigation	13,354.45	14,367.88	14,777.39	14,451.11	14,060.27
Commercial and Residential	130,597.88	148,589.72	162,296.66	164,952.63	155,833.98
Commercial & other sector	73,321.97	81,743.10	93,226.72	96,828.96	89,905.85
Residential	57,275.91	66,846.62	69,069.94	68,123.67	65,928.13
Other	0.00	0.00	0.00	0.00	0.00
1B. Fugitive Emissions from Fuel	0.51	0.60	0.61	0.64	0.67
2. Industrial Processes	57,008.97	59,213.29	52,797.32	48,716.11	47,986.38
Mineral Products	53,465.31	55,588.39	49,403.45	45,791.24	45,368.17
Chemical	3,543.66	3,624.90	3,393.87	2,924.87	2,618.21
6. Waste	16,935.48	21,627.24	24,794.08	23,536.68	23,339.20
Total	1,122,277.11	1,213,082.21	1,238,957.79	1,247,763.22	1,259,425.99

2.2.2. CH_4

Methane emissions in FY2003 were 19.3 million tons (in CO_2 equivalents), a decrease by 22.3% compared to FY1990, and by 1.2% in comparison with the previous year.

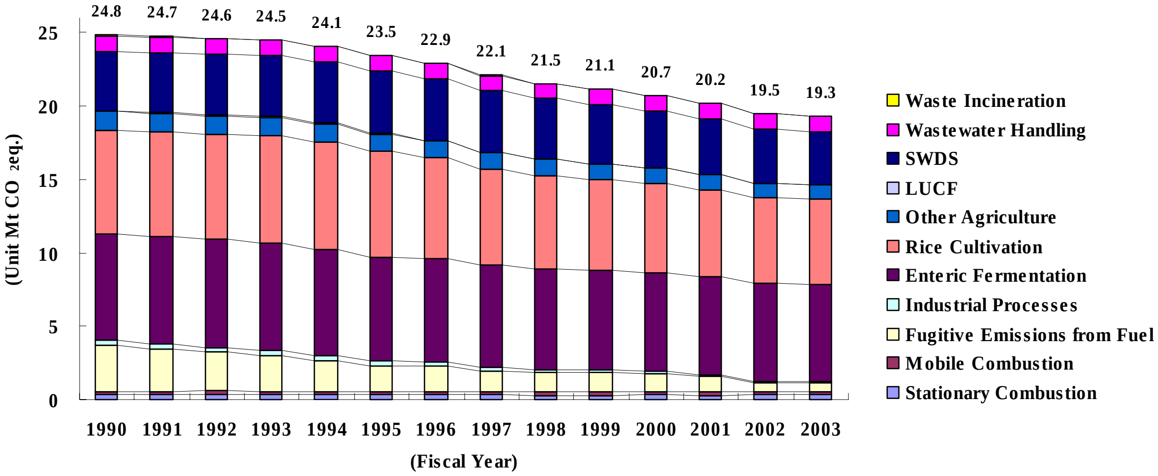

Figure 2-6 Trends in CH_4 emissions

The breakdown of methane emissions in FY2003 shows that methane emitted from enteric fermentation in livestock accounted for 34% of the total, making it the single largest source of emissions. It is followed by methane emissions from rice cultivation at 30%, and methane emissions from SWDS (Solid Waste Disposal Site) at 19%.

Table 2-3 Trends in CH_4 emissions

[Gg CO2eq.]

Category	1990	1995	2000	2002	2003
1A. Fuel Combustion	531.75	547.72	537.25	529.37	526.53
1A1. Energy Industries	-32.67	-35.60	-41.89	-41.89	-41.89
1A2. Industries	227.51	213.96	204.45	204.03	203.84
1A3. Transport	195.19	208.28	220.46	215.22	217.45
1A4. Residential / Institutional	141.72	161.09	154.22	152.01	147.14
1B. Fugitive Emissions from Fuels	3,176.12	1,761.47	1,220.46	603.74	589.17
1B1. Solid Fuels	2,806.43	1,344.68	769.13	118.34	93.86
1B2. Oil & Natural Gas	369.69	416.78	451.33	485.40	495.30
2. Industrial Processes	337.80	303.30	163.74	124.34	116.72
4. Agriculture	15,568.88	15,478.64	13,829.68	13,484.13	13,417.47
4A. Enteric Fermentation	7,249.10	7,118.91	6,759.12	6,672.13	6,615.72
4B. Manure Management	1,072.55	991.38	927.81	914.99	911.74
4C. Rice Cultivation	7,075.73	7,200.86	6,018.51	5,788.92	5,785.48
4D. Agricultural Soils	3.06	2.72	2.30	2.28	2.29
4F. Field Burning of Agricultural Residue	168.45	164.77	121.94	105.80	102.23
5. LUCF	53.07	86.37	NE	NE	NE
6. Waste	5,154.16	5,280.43	4,969.15	4,769.76	4,635.28
6A. SWDS	4,044.84	4,238.80	3,927.55	3,720.76	3,594.25
6B. Wastewater Handling	1,095.78	1,029.04	1,028.96	1,038.23	1,029.80
6C. Waste Incineration	13.54	12.59	12.63	10.77	11.23
Total	24,821.79	23,457.93	20,720.27	19,511.34	19,285.17

2.2.3. N_2O

N_2O emissions in FY2003 were 34.6 million tons (in CO_2 equivalents), a decrease by 13.9% compared to FY1990, and by 0.2% in comparison with the previous year. In March 1999, N_2O abatement equipment came on stream in the adipic acid production plant, causing a sharp decline in emissions from the Industrial processes during the period from FY1998 to FY1999. In FY2000, N_2O emissions increased because of a decrease in operational rate of the abatement equipment. In 2001, N_2O emissions decreased with resuming the normal operation of the equipment.

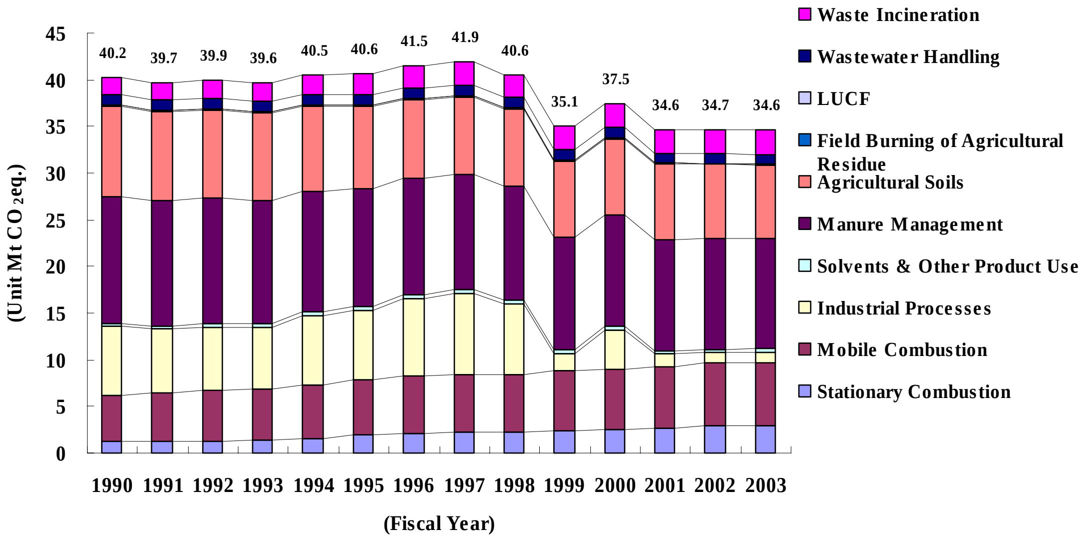

Figure 2-7 Trends in N_2O emissions

The breakdown of nitrous oxide emissions in FY2003 shows that emissions from manure management accounted for 34% of the total, making it the single largest source of emissions. It is followed by emissions from agricultural soils at 23%, and emissions from fuel combustion of motor vehicles and other mobile sources of 19%.

Table 2-4 Trends in N_2O emissions

[Gg CO2eq.]

Category	1990	1995	2000	2002	2003
1A. Fuel Combustion	6,218.89	7,866.27	8,971.81	9,603.57	9,634.81
1A1. Energy Industries	299.44	720.19	836.94	855.76	847.64
1A2. Industries	845.25	1,214.59	1,562.07	1,987.22	1,986.55
1A3. Transport	5,022.73	5,863.37	6,503.45	6,694.19	6,737.47
1A4. Residential / Institutional	51.46	68.11	69.35	66.40	63.16
1B. Fugitive Emissions from Fuel	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	7,415.74	7,367.31	4,248.29	1,183.59	1,207.81
3. Solvent & Other Product Use	287.07	437.58	340.99	334.05	320.83
4. Agriculture	23,426.62	21,588.45	20,259.42	19,923.78	19,812.88
4B. Manure Management	13,550.26	12,650.39	12,004.47	11,859.43	11,826.36
4D. Agricultural Soils	9,746.46	8,797.87	8,144.17	7,978.29	7,903.83
4F. Field Burning of Agricultural Residue	129.90	140.19	110.78	86.07	82.68
5. LUCF	5.39	8.77	NE	NE	NE
6. Waste	2,854.11	3,363.21	3,643.72	3,639.64	3,640.90
6B. Wastewater Handling	1,097.88	1,093.37	1,051.81	1,006.93	996.88
6C. Waste Incineration	1,756.22	2,269.84	2,591.91	2,632.71	2,644.03
Total	40,207.81	40,631.58	37,464.23	34,684.64	34,617.24

2.2.4. HFCs

Emissions of HFCs in 2003[6] were 12.3 million tons (in CO_2 equivalents), a decrease by 39.2% compared to 1995, and by 4.7% in comparison with the previous year.

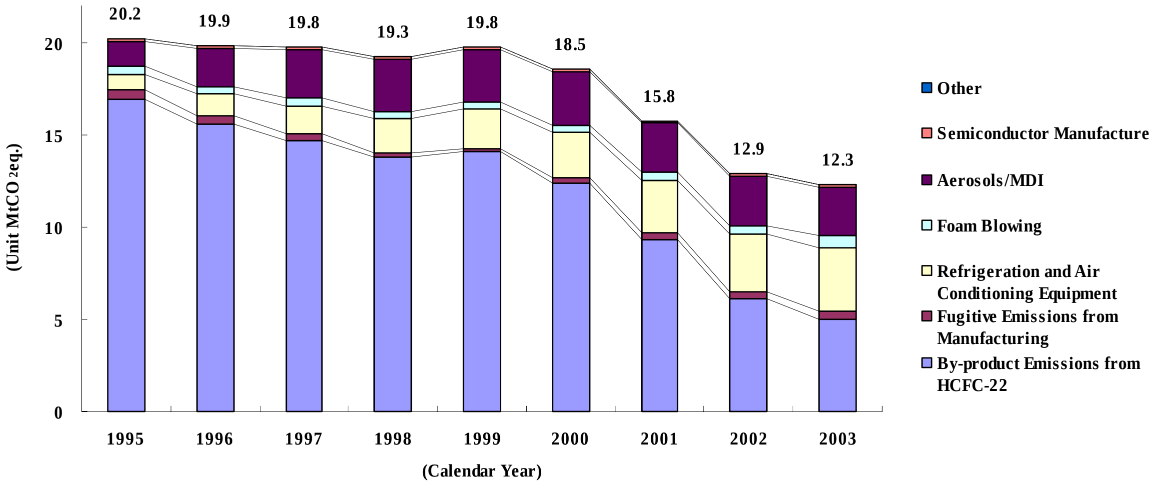

Figure 2-8 Trends in HFCs emissions

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[6] Emissions of calendar year basis are adopted for HFCs, PFCs and SF_6.

The breakdown of HFCs emissions in 2003 shows that by-product HFC-23 emission during production of HCFC-22 accounted for 41% of the total, followed by emissions from refrigerants of refrigeration and air conditioning equipment at 28%, and emissions from aerosols / MDI at 21%.

Table 2-5 Trends in HFCs emissions

[Gg CO2eq.]

Category	1995	2000	2001	2002	2003
2E. Productions of F-gas	17,456.50	12,654.54	9,709.42	6,484.42	5,462.21
2E1. By-product Emissions from Production of HCFC-22	16,965.00	12,402.00	9,336.60	6,095.70	5,022.81
2E2. Fugitive Emissions	491.50	252.54	372.82	388.72	439.40
2F. Consumption of F-gas	2,776.17	5,894.43	6,056.54	6,418.73	6,838.62
2F1. Refrigeration and Air Conditioning Equipment	809.13	2,449.23	2,817.91	3,161.55	3,447.96
2F2. Foam Blowing	456.96	437.71	413.01	446.68	653.12
2F4. Aerosols/MDI	1,365.00	2,849.54	2,702.77	2,692.33	2,624.06
2F6. Semiconductor Manufacture	145.08	157.95	122.85	118.17	113.49
2F8. Other	0.00	0.00	0.00	0.00	0.00
Total	20,232.67	18,548.97	15,765.96	12,903.15	12,300.83

2.2.5. PFCs

PFCs emissions in 2003 were 9.0 million tons (in CO_2 equivalents), a decrease by 28.2% compared to 1995, and by 8.3% in comparison with the previous year.

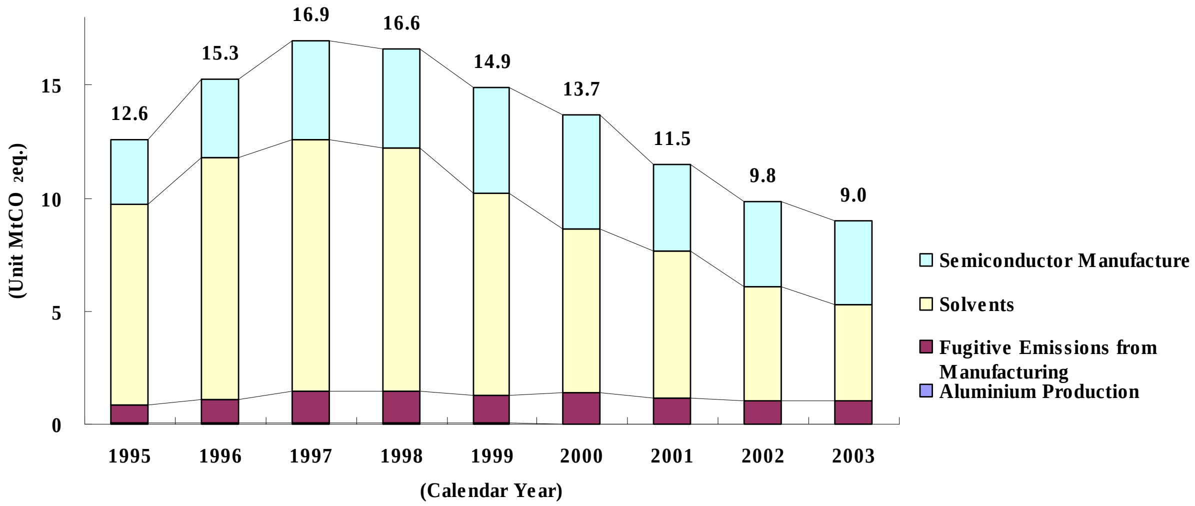

Figure 2-9 Trends in PFCs emissions

The breakdown of PFCs emissions in 2003 shows that emission from solvents in washing metals etc. accounted for 48% of the total, followed by emissions from semiconductor manufacture at 41%, and fugitive emissions from manufacturing at 11%.

Table 2-6 Trends in PFCs emissions

[Gg CO2eq.]

Category	1995	2000	2001	2002	2003
2C3. Aluminium Production	72.46	18.29	16.26	15.10	15.10
2E2. Fugitive Emissions	762.90	1,382.60	1,123.70	1,043.60	1,016.40
2F. Consumption of F-gas	11,737.70	12,284.90	10,360.00	8,786.50	7,995.40
2F5. Solvents	8,880.00	7,211.30	6,497.20	5,002.00	4,288.00
2F6. Semiconductor Manufacture	2,857.70	5,073.60	3,862.80	3,784.50	3,707.40
Total	12,573.06	13,685.79	11,499.96	9,845.20	9,026.90

2.2.6. SF_6

Emissions of SF_6 in 2003 were 4.5 million tons (in CO_2 equivalents), a decrease by 73.6% compared to 1995, and by 15.3% in comparison with the previous year.

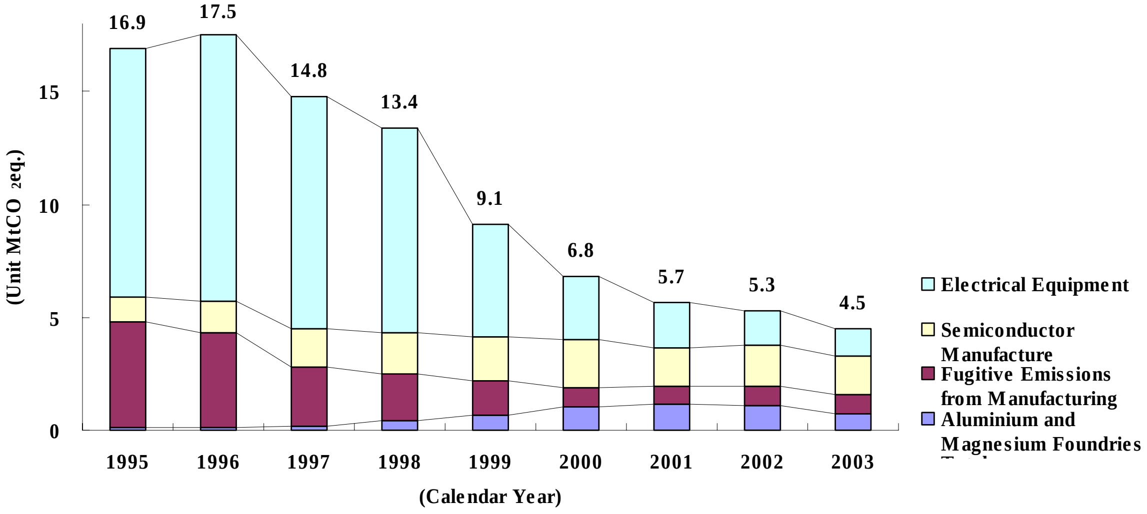

Figure 2-10 Trends in SF_6 emissions

The breakdown of SF_6 emissions in 2003 shows that emissions from semiconductor manufacture accounted for 38%, followed by emissions from the electrical equipment at approximately 27%, and fugitive emissions from manufacturing at 18%.

Table 2-7 Trends in SF_6 emissions

[Gg CO2eq.]

Category	1995	2000	2001	2002	2003
2C4. SF_6 Used in Aluminium and Magnesium Foun	119.50	1,027.70	1,147.20	1,123.30	740.90
2E2. Fugitive Emissions	4,708.30	860.40	788.70	836.50	812.60
2F. Consumption of F-gas	12,089.40	4,931.94	3,734.74	3,323.35	2,920.32
2F6. Semiconductor Manufacture	1,099.40	2,141.44	1,711.24	1,780.55	1,716.02
2F7. Electrical Equipment	10,990.00	2,790.50	2,023.50	1,542.80	1,204.30
Total	16,917.20	6,820.04	5,670.64	5,283.15	4,473.82

2.3. Description and Interpretation of Emission and Removal Trends by Categories

The breakdown of emissions and removals of greenhouse gases in FY2003 by sector[7] shows that the Energy sector accounted for 89.5%, followed by Industrial processes at 5.6%, Solvents and other product use at 0.02%, Agriculture at 2.5% and Waste at 2.4%.

Removals by Land-use change and forestry in FY1995 were approximately 7.3% as a proportion of total emissions.

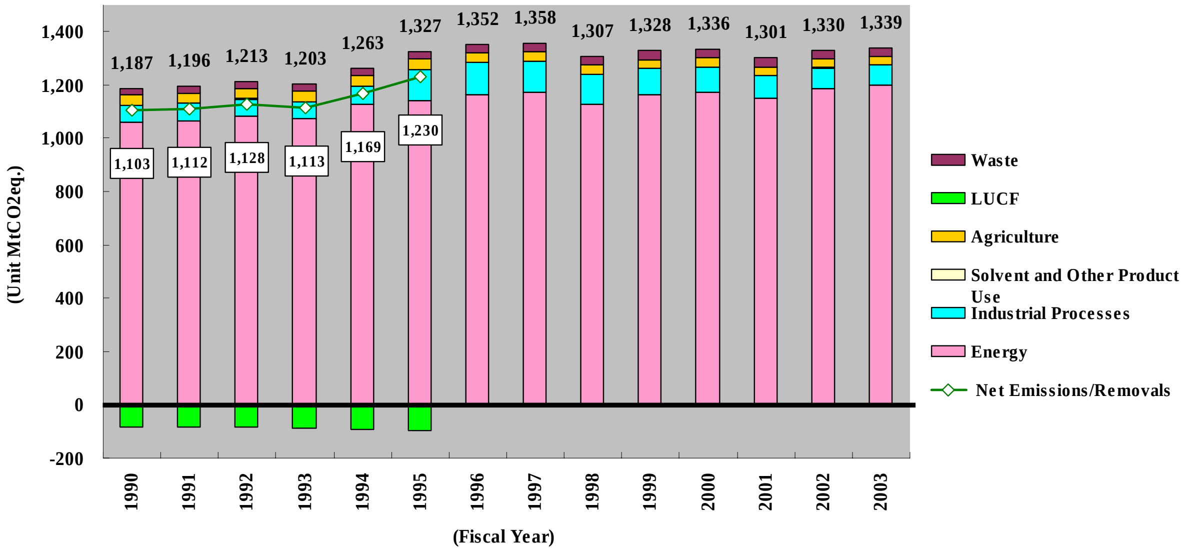

Figure 2-11 Trends in emissions and removals of greenhouse gases in each category

* Values in boxes represent net emissions or removals. No values appear after 1995, however, as carbon dioxide removals have not been estimated.

Table 2-8 Trends in emissions and removals of greenhouse gases in each category

[Mt CO_2 eq.]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy	1,058.3	1,065.4	1,081.4	1,072.2	1,128.0	1,142.4	1,163.8	1,171.4	1,129.1	1,163.2	1,172.1	1,149.9	1,186.2	1,198.9
Industrial Processes	64.8	65.7	66.1	65.0	66.9	116.6	120.2	118.1	109.5	97.8	96.3	84.9	78.1	75.1
Solvent and Other Product Use	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
Agriculture	39.0	38.8	38.7	38.6	38.0	37.1	36.2	35.4	34.9	34.4	34.1	33.7	33.4	33.2
Land Use Change and Forestry	-83.8	-83.8	-85.5	-90.0	-93.5	-96.6	NE	NE	NE	NE	NE	NE	NE	NE
Waste	24.9	25.5	26.6	26.6	29.3	30.3	31.2	32.3	32.8	32.7	33.4	32.5	31.9	31.6
Net Emissions/Removals	1,103.4	1,111.9	1,127.8	1,112.8	1,169.3	1,230.2	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

*NE: Not Estimated

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[7] It implies “Category” indicated in the *Revised 1996 IPCC Guidelines* and *CRF*.

2.3.1. Energy

Emissions from the Energy sector in FY2003 were 1,199 million tons (in CO_2 equivalents), an increase by 13.3% compared to FY1990, and an increase by 1.1% in comparison with the previous year.

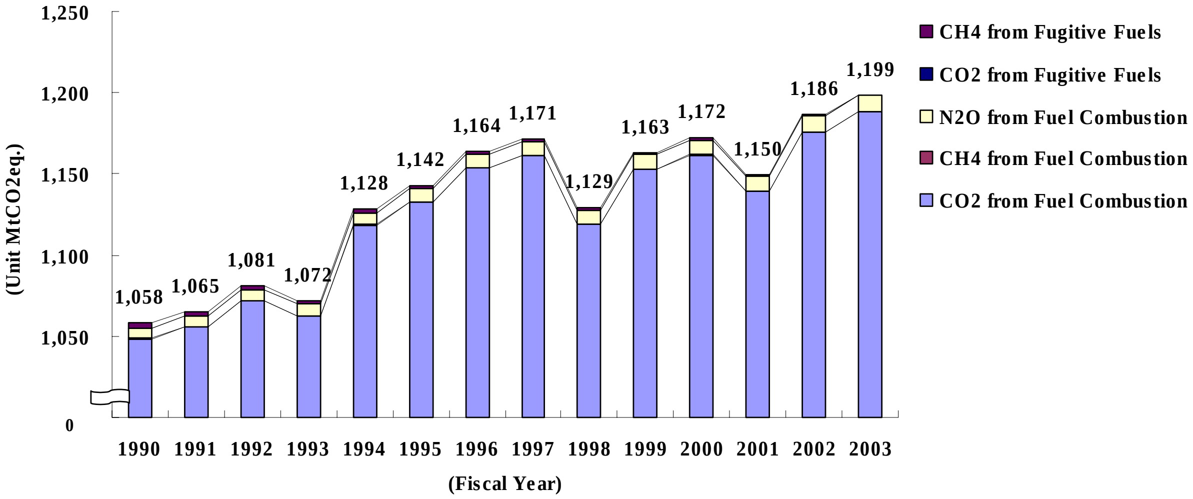

Figure 2-12 Trends in GHGs emissions from the Energy sector

The breakdown of emissions of greenhouse gases from the Energy sector in FY2003 shows that emission of CO_2 accounted for 99%, making it the single largest source of emissions.

Table 2-9 Trends in GHGs emissions from the Energy sector

[Gg CO_2eq.]

Source Category	1990	1995	2000	2002	2003
1A. Fuel Combustion	1,055,082.79	1,140,655.07	1,170,874.83	1,185,642.74	1,198,261.09
CO_2	1,048,332.15	1,132,241.07	1,161,365.77	1,175,509.80	1,188,099.74
CH_4	531.75	547.72	537.25	529.37	526.53
N_2O	6,218.89	7,866.27	8,971.81	9,603.57	9,634.81
1B. Fugitive Emissions from Fuel	3,176.63	1,762.07	1,221.07	604.38	589.83
CO_2	0.51	0.60	0.61	0.64	0.67
CH_4	3,176.12	1,761.47	1,220.46	603.74	589.17
Total	1,058,259.43	1,142,417.14	1,172,095.89	1,186,247.11	1,198,850.92

2.3.2. Industrial Processes

Emissions from the Industrial processes sector in FY2003 were 75.1 million tons (in CO_2 equivalents), an increase by 16.0% compared to FY1990, and a decrease by 3.8% in comparison with the previous year.

It should be noted that emissions of HFCs, PFCs, and sulfur hexafluoride have not been estimated (NE) through 1990 to 1994.

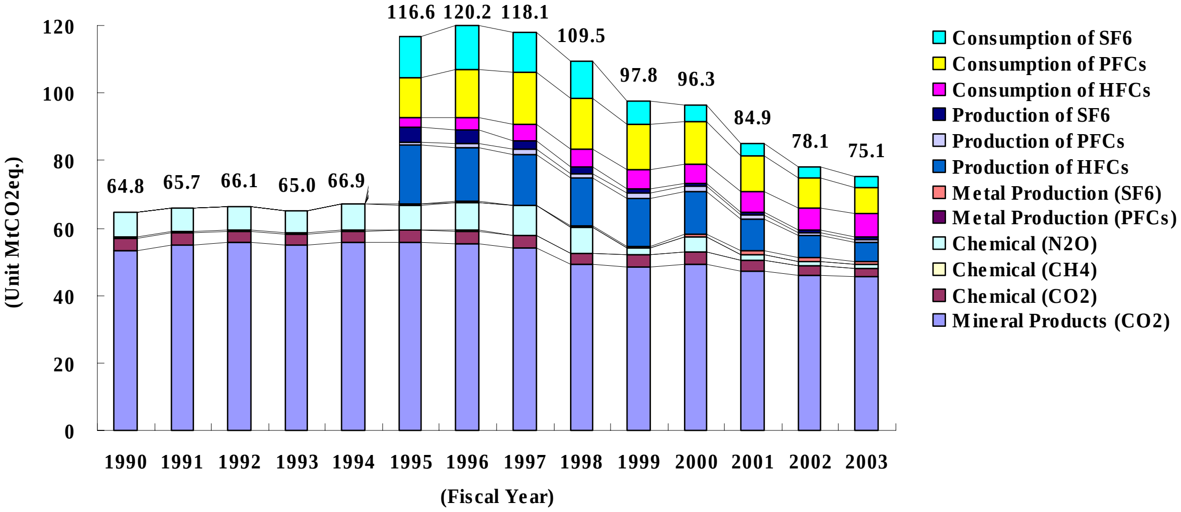

Figure 2-13 Trends in GHGs emissions from the Industrial processes sector

The breakdown of emissions of greenhouse gases from the Industrial processes sector in FY2003 shows that emissions from mineral products, such as CO_2 emissions from the limestone in cement production account for 60%, making it the single largest source of emissions followed by the emissions from the consumption of PFCs such as semiconductor manufacture at 11% and the consumption of HFCs at 9%.

Table 2-10 Trends in GHGs emissions in the Industrial processes sector

[Gg CO_2eq.]

Category	1990	1995	2000	2002	2003
2A. Mineral Products (CO2)	53,465.31	55,588.39	49,403.45	45,791.24	45,368.17
2B. Chemical Industry	11,297.21	11,295.50	7,805.90	4,232.80	3,942.74
CO_2	3,543.66	3,624.90	3,393.87	2,924.87	2,618.21
CH_4	337.80	303.30	163.74	124.34	116.72
N_2O	7,415.74	7,367.31	4,248.29	1,183.59	1,207.81
2C. Metal Production	0.00	191.96	1,045.99	1,138.40	756.00
PFCs	NE	72.46	18.29	15.10	15.10
SF_6	NE	119.50	1,027.70	1,123.30	740.90
2E. Production of F-gas	0.00	22,927.70	14,897.54	8,364.52	7,291.21
HFCs	NE	17,456.50	12,654.54	6,484.42	5,462.21
PFCs	NE	762.90	1,382.60	1,043.60	1,016.40
SF_6	NE	4,708.30	860.40	836.50	812.60
2F. Consumption of F-gas	0.00	26,603.27	23,111.27	18,528.58	17,754.34
HFCs	NE	2,776.17	5,894.43	6,418.73	6,838.62
PFCs	NE	11,737.70	12,284.90	8,786.50	7,995.40
SF_6	NE	12,089.40	4,931.94	3,323.35	2,920.32
Total	64,762.51	116,606.83	96,264.15	78,055.54	75,112.46

2.3.3. Solvent and Other Product Use

Emissions from the Solvents and other product use in FY2003 were 321 thousand tons (of CO_2 equivalents), an increase by 11.8% on FY1990, and a decrease by 4.0% in comparison with the previous year. The only substance included in calculations in this sector is laughing gas (nitrous oxide) used as a general anesthetic in hospitals.

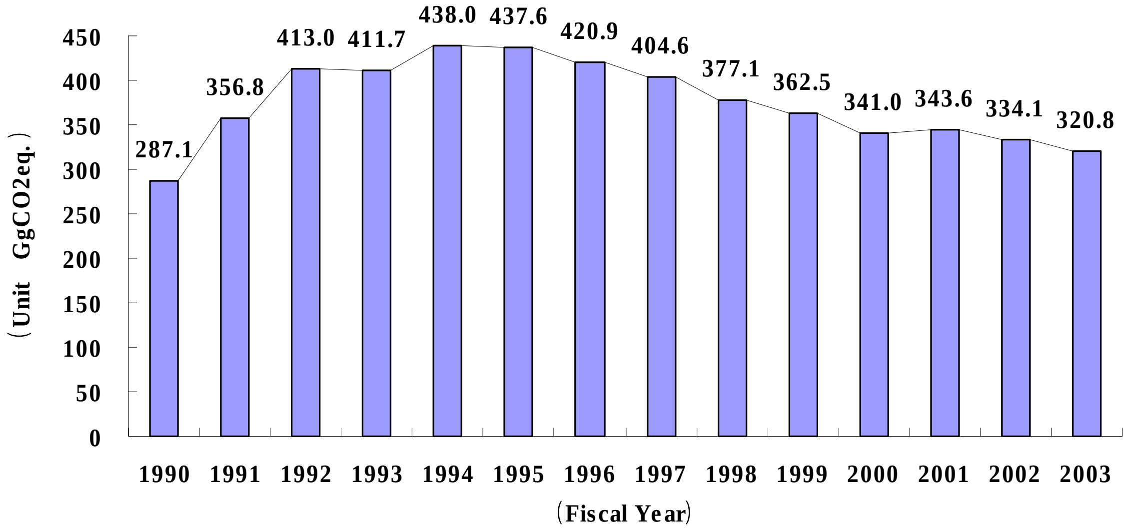

Figure 2-14　　Trends in GHGs emissions from the Solvent and other product use sector

2.3.4. Agriculture

Emissions from the Agriculture in FY2003 were 33.2 million tons (in CO_2 equivalents), a decrease by 14.8% compared to FY1990, and by 0.5% in comparison with the previous year.

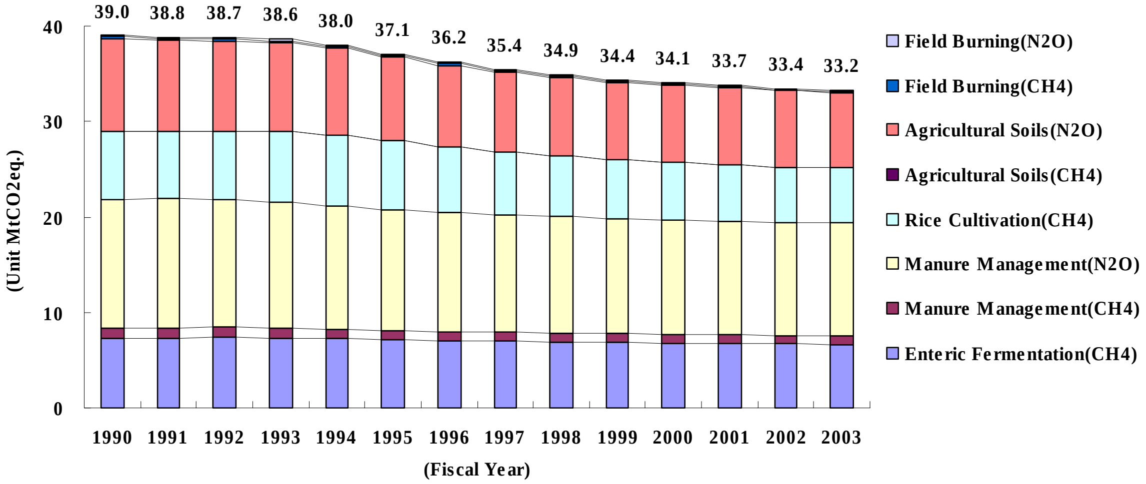

Figure 2-15　　Trends in GHGs emissions from the Agriculture sector

The breakdown of emissions of greenhouse gases from the Agriculture in FY2003 shows that N_2O emissions from manure management account for 36%, making it the single largest source followed by N_2O emissions from agricultural soils due to the nitrogen-based fertilizers at 24%, and CH_4 emissions from enteric fermentation at 20%.

Table 2-11 Trends in GHGs emissions from the Agriculture sector

[Gg CO_2eq.]

Category	1990	1995	2000	2002	2003
4A. Enteric Fermentation(CH4)	7,249.10	7,118.91	6,759.12	6,672.13	6,615.72
4B. Manure Management	14,622.80	13,641.77	12,932.28	12,774.42	12,738.10
CH_4	1,072.55	991.38	927.81	914.99	911.74
N_2O	13,550.26	12,650.39	12,004.47	11,859.43	11,826.36
4C. Rice Cultivation(CH4)	7,075.73	7,200.86	6,018.51	5,788.92	5,785.48
4D. Agricultural Soils	9,749.52	8,800.59	8,146.46	7,980.57	7,906.13
CH_4	3.06	2.72	2.30	2.28	2.29
N_2O	9,746.46	8,797.87	8,144.17	7,978.29	7,903.83
4F. Field Burning of Agricultural Residues	298.35	304.97	232.73	191.87	184.92
CH_4	168.45	164.77	121.94	105.80	102.23
N_2O	129.90	140.19	110.78	86.07	82.68
Total	38,995.50	37,067.09	34,089.10	33,407.91	33,230.35

2.3.5. Land-Use Change and Forestry

Removals of carbon dioxide in the Land-use change and forestry in fiscal 1995 was 96.6 million tons, an increase by 15.2% on FY1990, and by 3.4% in comparison with the previous year. Emissions and removals since FY1996 have not been estimated (NE) because the data was not prepared.

The single greatest sink of removals is forest. Conversely, the single greatest source of emissions of carbon dioxide is the harvested wood.

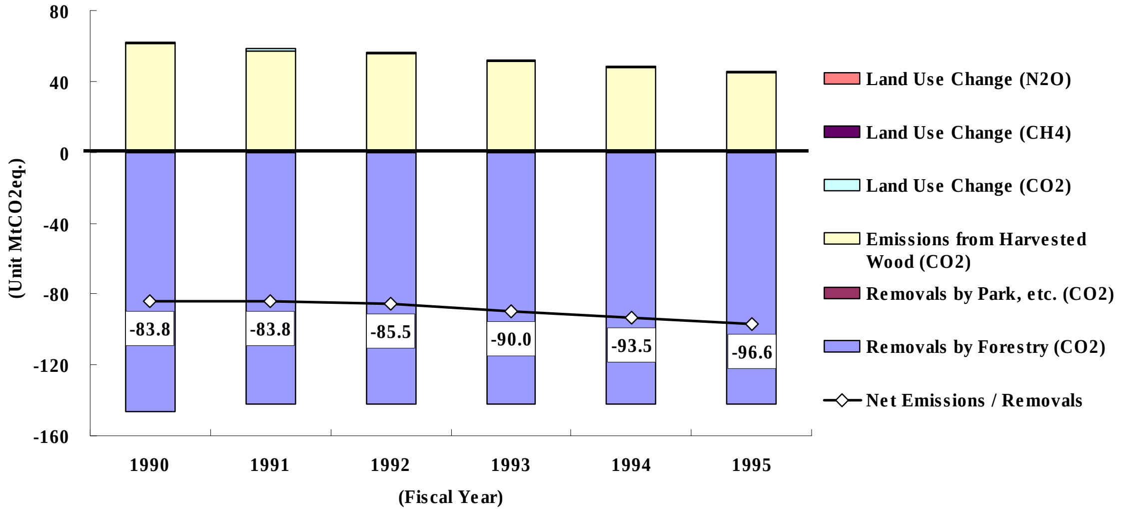

Figure 2-16 Trends in emissions and removals of GHGs from the Land-use change and forestry sector

Table 2-12 Trends in emissions and removals of GHGs from the Land-use change and forestry sector

[Gg CO_2eq.]

Category	1990	1991	1992	1993	1994	1995
5A2. Removals by Forestry	-146,056.09	-142,032.48	-142,061.31	-142,090.14	-142,118.97	-142,147.79
5A5. Removals by Park etc.	-90.65	-94.28	-103.41	-106.82	-111.55	-114.49
5A5. Emissions from Havested Wood	61,664.52	57,352.68	55,680.02	51,193.14	47,758.15	44,614.75
5B. Forestry & Grassland Conversion	637.61	999.46	1,007.09	1,014.72	1,022.35	1,037.61
CO_2	579.15	907.83	914.76	921.69	928.62	942.48
CH_4	53.07	83.19	83.83	84.46	85.10	86.37
N_2O	5.39	8.44	8.51	8.57	8.64	8.77
Total	-83,844.62	-83,774.63	-85,477.60	-89,989.10	-93,450.01	-96,609.92

2.3.6. Waste

Emissions from the Waste in FY2003 were 31.6 million tons (in CO_2 equivalents), an increase by 26.7% compared to FY1990, and a decrease by 1.0% in comparison with the previous year.

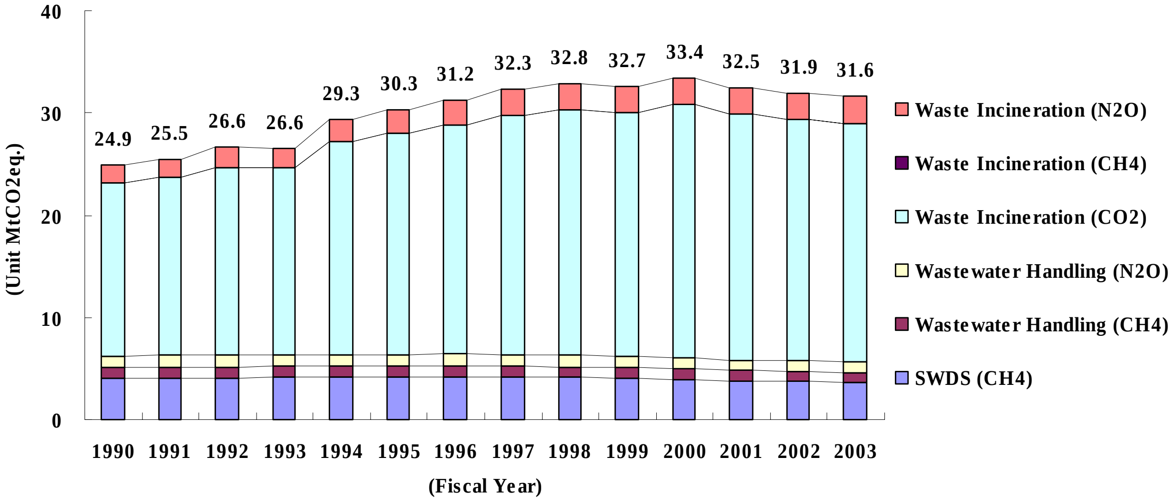

Figure 2-17 Trends in GHGs emissions from the Waste sector

The breakdown of GHGs emissions from the Waste in FY2003 shows that CO_2 emissions from waste derived from petrochemicals such as waste plastics and waste oil incineration, accounting for 74%, making it the single largest source of emissions. It is followed by CH_4 emissions from solid waste disposal sites at 11%, and N_2O emissions from combustion of waste (including waste products derived from substances other than fossil fuels) at 8%.

Table 2-13 Trends in GHGs emissions from the Waste sector

[Gg CO_2eq.]

Category	1990	1995	2000	2002	2003
6A. SWDS (CH_4)	4,044.84	4,238.80	3,927.55	3,720.76	3,594.25
6B. Wastewater Handling	2,193.66	2,122.41	2,080.77	2,045.16	2,026.68
CH_4	1,095.78	1,029.04	1,028.96	1,038.23	1,029.80
N_2O	1,097.88	1,093.37	1,051.81	1,006.93	996.88
6C. Waste Incineration	18,705.24	23,909.66	27,398.63	26,180.16	25,994.45
CO_2	16,935.48	21,627.24	24,794.08	23,536.68	23,339.20
CH_4	13.54	12.59	12.63	10.77	11.23
N_2O	1,756.22	2,269.84	2,591.91	2,632.71	2,644.03
Total	24,943.75	30,270.88	33,406.95	31,946.08	31,615.38

2.4. Description and Interpretation of Emission Trends for Indirect Greenhouse Gases and SO_2

Under UNFCCC, it is required to report emissions of indirect greenhouse gases (NO_X, CO, NMVOC and SO_2), other than 6 types of greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) which are not controlled by the Kyoto Protocol. Emission trends of these gases are indicated below.

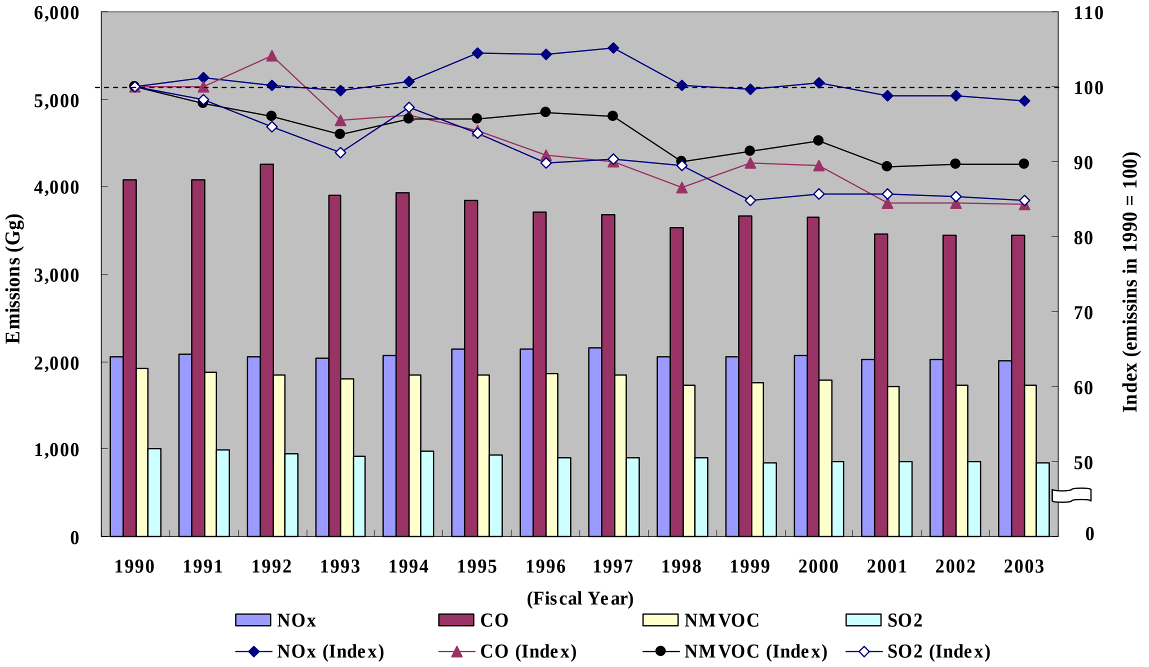

Figure 2-18 Trends in Emissions of Indirect Greenhouse Gases and SO_2

Nitrogen oxide (NO_X) emissions in FY2003 were 2,015 Gg, a decrease by 1.8% compared to FY1990, and by 0.6% compared to the previous year.

Carbon monoxide (CO) emissions inFY2003 were 3,444 Gg, a decrease by 15.7% compared to FY1990, and by 0.2% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY2003 were 1,727 Gg, a decrease by 10.4% compared to FY1990, and an increase by 0.1% compared to the previous year.

Sulfur dioxide (SO_2) emissions inFY2003 were 849 Gg, a decrease by 15.1% compared to FY1990, and by 0.6% compared to the previous year.

Table 2-14 Trends in Emissions of Indirect Greenhouse Gases and SO_2

[Gg]

	1990	1995	2000	2002	2003
NOx	2,053.29	2,144.08	2,063.94	2,027.81	2,015.42
CO	4,086.17	3,848.97	3,653.63	3,450.04	3,444.12
NMVOC	1,926.94	1,842.77	1,787.48	1,726.07	1,727.19
SO_2	1,000.72	938.19	857.09	854.16	849.21

1990年：100

	1990	1995	2000	2002	2003
NOx	100.0	104.4	100.5	98.8	98.2
CO	100.0	94.2	89.4	84.4	84.3
NMVOC	100.0	95.6	92.8	89.6	89.6
SO_2	100.0	93.8	85.6	85.4	84.9

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Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 2*, August 2002

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Chapter 3. Energy (CRF sector 1)

3.1. Fuel Combustion (1.A.)

3.1.1. Fuel Combustion (CO_2)

• *Methodology for Estimating Emissions of GHGs*

The Tier 1 Sectoral Approach has been used in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.10, Fig. 2.1) to calculate emissions. The country-specific emission factors are used for all types of fuel. Activity data is taken from the Energy Balance Table (Agency for Natural Resource and Energy "*General Energy Statistics*"[1]) (Gross Calorific Value). (Refer to *1A-CO2-****-2005.xls¥SA(CRF)* for results of calculations. Refer to *1A-CO2-****-2005.xls* for calculation process.)

• *Emission Factors*

The country-specific values represented as carbon content per unit of calorific value (Gross Calorific Value) have been used for all emission factors. These values were developed based on an assumption that all carbon in fuel becomes carbon dioxide. Emission factors for 1990 and latest year are shown in the following table.

In the sectoral approach, the emission factors for coke, coke oven gases, blast furnace gas, converter furnace gases, and coal briquettes were taken to be the average values calculated by dividing the estimated amount of combusted carbon in coke production (e.g. coaking coal, imported coal, oil coak) by the total consumed calorific value of coke, coak oven gases, blast furnace gas and converter furnace gases. The emission factor for town gas has been calculated by summing the total carbon content in fossil fuels injected as raw material, and dividing it by the total calorific value of the town gas manufactured. For more details, refer to Annex 2 of this report.

In the reference approach based on the domestic primary energy supply, the adopted emission factors of coke and coke oven gas are based on the actual measurement.

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[1] *General Energy Statistics* is produced by the Agency for Natural Resources and Energy using data provided by the Ministry of Internal Affairs and Communications, Ministry of Land Infrastructure and Transport (MLIT), and Ministry of Agriculture Forestry and Fisheries of Japan (MAFF). In this process, the Agency for Natural Resources and Energy receives assistance from MLIT and MAFF.

Table 3-1 Emission factors for fuel combustion (Sectoral Approach)

tC/TJ(Gross)

	1990	1995	2000	2002	2003
Solid Fuels					
Coal					
Imported Steel Making Coal	**23.65**	**23.65**	**23.65**	**23.65**	**23.65**
Coaking Coal	**23.65**	**23.65**	**23.65**	**23.65**	**23.65**
PCI Coal	**23.65**	**23.65**	**23.65**	**23.65**	**23.65**
Imported Coal	**24.71**	**24.71**	**24.71**	**24.71**	**24.71**
Indigenous Coal	**24.90**	**24.90**	**24.90**	**24.90**	**24.90**
Hard Coal or Anthracite & Lignite	**24.71**	**24.71**	**24.71**	**24.71**	**24.71**
Coal Products					
Coke	**28.52**	**28.55**	**25.91**	**24.72**	**24.83**
Coke Oven Gas	**28.52**	**28.55**	**25.91**	**24.72**	**24.83**
Blast Furnace Gas	**28.52**	**28.55**	**25.91**	**24.72**	**24.83**
Converter Furnace Gas	**28.52**	**28.55**	**25.91**	**24.72**	**24.83**
Liquid Fuels					
Oil					
Crude Oil	**18.66**	**18.66**	**18.66**	**18.66**	**18.66**
Natural Gas Liquid & Condensate	**18.66**	**18.66**	**18.66**	**18.66**	**18.66**
Oil Products					
Liquified Petroleum Gas	**16.32**	**16.32**	**16.32**	**16.32**	**16.32**
Naphtha	**18.17**	**18.17**	**18.17**	**18.17**	**18.17**
Gasoline	**18.29**	**18.29**	**18.29**	**18.29**	**18.29**
Jet Fuel	**18.31**	**18.31**	**18.31**	**18.31**	**18.31**
Kerosene	**18.51**	**18.51**	**18.51**	**18.51**	**18.51**
Diesel Oil or Gas Oil	**18.73**	**18.73**	**18.73**	**18.73**	**18.73**
Heating Oil A	**18.90**	**18.90**	**18.90**	**18.90**	**18.90**
Heating Oil C	**19.54**	**19.54**	**19.54**	**19.54**	**19.54**
Lublicating Oil	**19.22**	**19.22**	**19.22**	**19.22**	**19.22**
Other Heavy Oil Products	**20.77**	**20.77**	**20.77**	**20.77**	**20.77**
Oil Coke	**25.35**	**25.35**	**25.35**	**25.35**	**25.35**
Refinary Gas	**14.15**	**14.15**	**14.15**	**14.15**	**14.15**
Gaseous Fuels					
Natural Gas					
Liquefied Natural Gas	**13.47**	**13.47**	**13.47**	**13.47**	**13.47**
Indigenous Natural Gas	**13.47**	**13.47**	**13.47**	**13.47**	**13.47**
Town Gas					
Town Gas	**14.53**	**14.21**	**13.91**	**13.79**	**13.34**

N.B.: based on Gross Calorific Value

Source: Environmental Agency "*The Estimation of CO_2 in Japan*" (1992). Emission factors for Coke, Coke Oven Gas, Blast Furnace Gas, Converter Furnace Gas and Town Gas were calculated separately.

Table 3-2 Emission factors for fuel combustion (Sectoral Approach) (Table for Referential EF)

tC/TJ(Gross)

			1990	1995	2000	2002	2003
Solid Fuels							
	Indigenous Coal		**24.90**	**24.90**	**24.90**	**24.90**	**24.90**
		Underground	**24.90**	**24.90**	**24.90**	**24.90**	**24.90**
		Open Pit	**24.90**	**24.90**	**24.90**	**24.90**	**24.90**
	Lignite		**24.71**	**24.71**	**24.71**	**24.71**	**24.71**
	Coal Briquette		**28.52**	**28.55**	**25.91**	**24.72**	**24.83**
	COM						
	CWM		**24.71**	**24.71**	**24.71**	**24.71**	**24.71**
	Coal Tar		**28.52**	**28.55**	**25.91**	**24.72**	**24.83**
Liquid Fuels							
	Crude Oil						
		Crude Oil for Power Generation	**18.66**	**18.66**	**18.66**	**18.66**	**18.66**
		Vitumous Mixture Fuel	**18.66**	**18.66**	**18.66**	**18.66**	**18.66**
	Liquified Petroleum Gas						
		Propane Gas	**16.32**	**16.32**	**16.32**	**16.32**	**16.32**
	Gasoline						
		Regular	**18.29**	**18.29**	**18.29**	**18.29**	**18.29**
		Premium	**18.29**	**18.29**	**18.29**	**18.29**	**18.29**
	Heating Oil B		**19.22**	**19.22**	**19.22**	**19.22**	**19.22**
	Heating Oil C						
		Heating Oil C for Power Generation	**19.54**	**19.54**	**19.54**	**19.54**	**19.54**
	Asphalt		**20.77**	**20.77**	**20.77**	**20.77**	**20.77**
Gaseous Fuels							
	Coal Mining Gas		**13.47**	**13.47**	**13.47**	**13.47**	**13.47**
	Town Gas						
		4A～7C	**13.94**	**13.94**	**13.94**	**13.94**	**13.94**
		12A･13A	**13.94**	**13.94**	**13.94**	**13.94**	**13.94**
		LPG	**13.94**	**13.94**	**13.94**	**13.94**	**13.94**

N.B.: based on Gross Calorific Value

Source: Environmental Agency "*The Estimation of CO_2 in Japan*" (1992). Emission factors for Coal Briquette, Coal Tar and Town Gas were calculated separately.

Table 3-3 Emission factors for fuel combustion (Reference Approachs)

tC/TJ(Gross)

		1990	1995	2000	2002	2003
for RA	Coke Oven Gas	**10.99**	**10.99**	**10.99**	**10.99**	**10.99**
for RA	Coke etc	**29.38**	**29.38**	**29.38**	**29.38**	**29.38**

N.B.: based on Gross Calorific Value

Source: Environmental Agency "*The Estimation of CO_2 in Japan*" (1992).

• *Activity Data*

Final energy consumption data for energy conversion, industry, residential and commercial, and transport as depicted in Japan’s Energy Balance Table (*General Energy Statistics*) were used for activity data (Refer to *1A-CO2-****-2005.xls¥****FY(EU)* for details).

For some fuels, a portion of final energy consumption was used to purposes other than combustion. Therefore, energy consumption indicated in “Non-Energy” of Energy Balance Table is deducted.

• *Assumptions Relating to Allocation of Carbon Dioxide from Auto Power Generation and Industrial Steam Generation*

The *Revised 1996 IPCC Guidelines* require the carbon dioxide emitted from auto power generation, etc., to be counted in the corresponding sector in principle. In Japan’s Energy Balance Table[2] (hereafter; “New EB”), the fuel consumed as an input to auto power generation and industrial steam generation are presented under “Auto Power Generation” and “Industrial Steam Generation” in the Energy Conversion Sector. Hence, carbon dioxide emissions from “Auto Power Generation” and “Industrial Steam Generation” are allocated to each of the final consumption sector.

• *Issues to be addressed*

In the current inventories, emission factors of liquid fuels such as crude oil, oil products, refinery gas, etc. are fixed from 1990 to following years. Analysis of the oil refinery sector of the inventories in detail revealed that carbon content in crude oil input to refinery is not balanced with those in each oil product and refinery gas.

Essentially, in the oil refinery sector, carbon input and output should be balanced. The current method has issues to be addressed and, in order to find a solution to this issues, discussion is currently under way to solve the difference in carbon content from the perspective of energy and carbon balance in the petroleum refinery.

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[2] Agency of Natural Resources and Energy organizes the New EB by integrating the energy statistics using the data from the Ministry of Public Management, Home Affairs, Posts and Telecommunications, the Ministry of Land, Infrastructure and Transport, the Ministry of Agriculture, Forestry and Fisheries, etc. Agency of Natural Resources and Energy is asking the Ministry of Land, Infrastructure and Transport and the Ministry of Agriculture, Forestry and Fisheries for cooperation when making it.

3.1.2. Stationary Combustion (1.A.1., 1.A.2., 1.A.4.: CH_4 and N_2O)

• *Methodology for Estimating Emissions of GHGs*

In accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p.2.38 Fig.2.3), estimation has been based on the *Research of Air Pollutant Emissions from Stationary Sources* (Ministry of the Environment), hereafter, "*MAP Survey*"..

Complete enumeration surveys, in the form of the *MAP Survey*, were carried out in fiscal 1992, 1995, 1996, and 1999, in relation to all facilities emitting soot and smoke. Also, in fiscal 1990, 1991, 1993, and 1994, sampling surveys were conducted in relation approximate half of all facilities and operating sites.

• *Emission Factors*

-Facilities emitting soot and smokes

The emission factors have been used for the value estimated from data organized in Japan Sociality Atmospheric Environment "*Reports on Greenhouse gas emissions estimation methodology*" (1996). (Refer to *1A-eftable-2005.xls* for details. Available only in Japanese.) Emissions of nitrous oxide from fluidized bed boilers have been estimated separately. (Refer to *1A-N2Ofb-2005.xls* for details. Available only in Japanese.)

-Small facilities (commercial and other sector, manufacturing sector)

The emission factor for heating boilers (Furnace code in *MAP Survey*: 0102) has been used for the emission factor.

-Residential sector

The default Values from the *Revised 1996 IPCC Guidelines,* which were expressed in Net Calorific basis, were converted into Gross Calorific basis and used as the emission factors for methane and nitrous oxide.

Table 3-4 References for measurement data used in establishment of emission factors

	References
1	Hokkaido Prefecture, *Report of GHG Emissions Intensity from Stationary Combustion*, 1991
2	Hyogo Prefecture, *Report of GHG Emissions Intensity from Stationary Combustion*, 1991
3	Osaka Prefecture, *Study of GHG Emissions Intensity from Stationary Combustion*, 1991
4	Hokkaido Prefecture, *Report of GHG Emissions Intensity from Stationary Combustion*, 1992
5	Hyogo Prefecture, *Report of GHG Emissions Intensity from Stationary Combustion*, 1992
6	City of Kitakyusyu, *Report of GHG Emissions Intensity from Stationary Combustion*, 1992
7	Hyogo Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1993
8	Hyogo Prefecture, *Report of GHG Emissions Intensity from Stationary Combustion*, 1994
9	Kanagawa Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1995
10	Niigata Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1995
11	Osaka Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1995
12	Hiroshima Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1995
13	Fukuoka Prefecture, *Report of GHG Emission Factors from Stationary Combustion*, 1995
14	City of Osaka, *Study of GHG Emission Factors from Stationary Combustion*, 1995
15	City of Kobe, *Study of GHG Emission Factors from Stationary Combustion*, 1995
16	Hokkaido Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1996
17	Ishikawa Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1996
18	Kyoto Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1996
19	Osaka Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1996
20	Hyogo Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1996
21	Hiroshima Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1996
22	Fukuoka Prefecture, *Report of GHG Emission Factors from Stationary Combustion*, 1996
23	Kyoto Prefecture, *Report of GHG Emission Factors from Stationary Combustion*, 1997
24	Hyogo Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1997
25	Fukuoka Prefecture, *Report of GHG Emission Factors from Stationary Combustion*, 1997
26	Japan Sociality Atmospheric Environment, *Reports on Greenhouse gas emissions estimation methodology*, 1996
27	Osaka Prefecture, *Study of GHG Emission Factors from Stationary Combustion*, 1999
28	Hyogo Prefecture, *Report of GHG Emission Factors from Stationary Combustion*, 2000
29	The Institute of Applied Energy, *Report for Trend of Fuel Quality in Lowering Environmental Atmospheric Quality*, 2000
30	Measurement Data prepared by Committee for the Greenhouse Gases Emissions Estimation Methods in FY1999
31	Data prepared by the Federation of Electric Power Companies of Japan
32	IPCC, *Revised 1996 IPCC Guidelines (Reference Manual)*, 1997

Table 3-5 Furnace and fuel types applied in establishment of emission factors for CH_4

Code	Furnace types	Fuel types
CH_4-1	Boiler, Gas Generator	Heating Oil C, Heating oil B, CrudeOil
CH_4-2	Boiler, Gas Generator	Heating Oil A, Diesel Oil or Gas Oil, Kerosene, Naphtha, Other Liquid Fuels
CH_4-3	Boiler, Gas Generator	Gaseous Fuels
CH_4-4	Boiler	Harvested Wood, Charcoal
CH_4-5	Boiler	Pulping Waste Liquor
CH_4-6	Boiler, Gas Generator	Fuel Coal, Cokes, Other Solid Fuels
CH_4-7	Sintering Furnace	Solid Fuels, Liquid Fuels, Gaseous Fuels
CH_4-8	Pelletizing Furnace (Steel and Non-Ferrous Metal)	Solid Fuels, Liquid Fuels, Gaseous Fuels
CH_4-9	Metal Rolling Furnace, Metal Treating Furnace, Metal Forging Furnace	Liquid Fuels, Gaseous Fuels
CH_4-10	Petroleum Furnace	Liquid Fuels, Gaseous Fuels
CH_4-11	Catalytic Regenerator	Cokes, Other Solid Fuels (Carbon)
CH_4-12	Brick Furnace, Ceramic Furnace, Other Furnace	Solid Fuels, Liquid Fuels, Gaseous Fuels
CH_4-13	Aggregate Drying Furnace, Cement Raw Material Drying Furnace, Brick Raw Material Drying Furnace	Solid Fuels, Liquid Fuels, Gaseous Fuels
CH_4-14	Other Drying Furnace	Solid Fuels, Liquid Fuels, Gaseous Fuels
CH_4-15	Electric Arc Furnace	Electricity
CH_4-16	Gas Turbine	Liquid Fuels, Gaseous Fuels
CH_4-17	Diesel Engine	Liquid Fuels, Gaseous Fuels
CH_4-18	Gas Engine, Petrol Engine	Liquid Fuels, Gaseous Fuels
CH_4-19	Other Furnace	Liquid Fuels
CH_4-20	Other Furnace	Solid Fuels
CH_4-21	Other Furnace	Gaseous Fuels
CH_4-22	Household Equipment	Liquid Fuels
CH_4-23	Household Equipment	Solid Fuels
CH_4-24	Household Equipment	Gaseous Fuels

Table 3-6 Furnace and fuel types applied in establishment of emission factors for CH_4

Code	Furnace types	Fuel types
N_2O-1	Boiler	Heating Oil C, Heating Oil B, Crude Oil
N_2O-2	Boiler	Heating Oil A, Diesel Iil or Gas Oil, Kerosene, Naphtha, Other Liquified Fuels
N_2O-3	Boiler	Gaseous Fuels
N_2O-4	Gas Generator	Liquid Fuels, Gaseous Fuels
N_2O-5	Boiler	Pulping Waste Liquor
N_2O-6	Boiler (Non fluidized bed boiler）	Solid Fuels
N_2O-7	Blast Furnace	Coke Oven Gas, Blast Furnace Gas, Other Gaseous Fuels
N_2O-8	Petroleum Furnace	Liquid Fuels, Gaseous Fuels
N_2O-9	Catalytic Regenerator	Coke, Other Solid Fuels (Carbon)
N_2O-10	Electric Arc Furnace	Electricity
N_2O-11	Coke Oven	Town Gas, Coke Oven Gas, Blast FurnaceGas, Converter Furnace Gas, Offgas, Other Gaseous Fuels
N_2O-12	Gas Turbine	Liquid Fuels, Gaseous Fuels
N_2O-13	Diesel Engine	Liquid Fuels, Gaseous Fuels
N_2O-14	Gas Engine, Petrol Engine	Liquid Fuels, Gaseous Fuels
N_2O-15	Other Furnace	Liquid Fuels
N_2O-16	Other Furnace	Solid Fuels
N_2O-17	Other Furnace	Gaseous Fuels
N_2O-18	Pressure-Fluidized Bed Boiler	Solid Fuels
N_2O-19	Pressurised-Fluidised Bed Boiler	Fuel Coal
N_2O-20	Household Equipment	Liquid Fuels
N_2O-21	Household Equipment	Solid Fuels
N_2O-22	Household Equipment	Gaseous Fuels

• *Activity Data*

-Facilities emitting soot and smokes

The results from the MAP Survey conducted in complete enumeration survey years were used.

As for the MAP Survey conducted in sampling survey years, the results were divided into the following three categories to estimate activity data:

(a) Sampled factories in common with the most recent complete enumeration survey

(b) Sampled factories not in common with the most recent complete enumeration survey (i.e., new factories)

(c) Factories not sampled, to which growth rates in activity data by industry type were applied

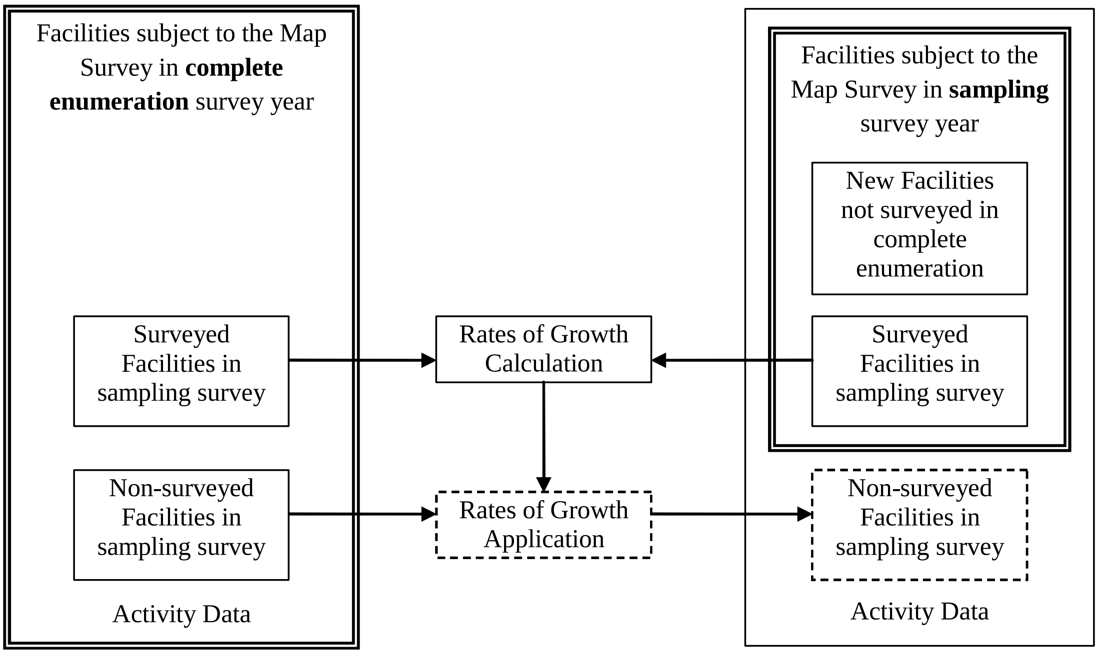

Figure 3-1 Relationship

Activity data from the sampling survey was used for category (a) and (b). Activity level was estimated for the factories not subject to sampling (c) in the sampling year; for factories in category (c) that are in common with the most recent complete enumeration survey, the rates of growth in calorific value, SO_X emissions, and NO_X emissions were estimated by industry types, and the activity level was estimated by multiplying the number of non-common factories from the most recent complete enumeration survey by the growth rates.

In estimating growth rates, however, factories in common with both the most recent complete enumeration survey and sampling survey for which the growth rate per factory fell outside the range 0.5 to 2, were excluded when the growth rates were formulated.

For FY1990 and FY1991, activity data was estimated using the FY1989 complete enumeration survey as a benchmark. For FY1993 and FY1994, activity data was estimated using the FY1992 complete enumeration survey as a benchmark.

Regarding years in which the *Map Survey* was not carried out, activity level was estimated by applying the growth rate from the most recent complete enumeration survey. Growth rates were established for each type of industry by identifying the energy consumption for the relevant year from documents such as the Ministry of the Economy, Trade and Industry's the *Structural Survey of Energy Consumption in Commerce and Manufacturing*.

-Small facilities (commercial and other sector, manufacturing sector)

By subtracting the consumption volumes of fuel for each industry derived from the *MAP Survey* from the consumption volumes of fuel for each industry given in the Agency for Natural Resources and Energy's *General Energy Statistics*, consumption of fuel by industry type at small facilities was estimated. Those estimates were deemed to be the activity data for small facilities. Where the activity data identified in the *MAP Survey* was higher than the data level identified in the *General Energy Statistics*, the relevant level was deemed to be 0 (zero). The subject fuels were town gas, LPG, kerosene, and heating oil A.

-Residential sector

Consumption by type of fuel for residential use in *General Energy Statistics* has been taken for the activity data. Subject fuels were town gas, LPG, kerosene, steaming coal, and coal briquettes

• *Outline of the MAP Survey*

-Objective

The objective is to promote reasonable and effective atmospheric environmental policy, with to obtain the information on current activities according to the Air Pollutant Control Law (e.g. (i) current status on registration of stationary sources which are soot and smokes emitting facilities registered to a local government and facilities emitting ordinary soot or particular soot, (ii) current status of air pollutant control), to develop the submitted data on facilities emitting soot and smokes, and to estimate amount of air pollutant emissions from facilities emitting soot and smokes.

-Target

(a) "Facilities emitting soot and smokes" defined in the article 2, paragraph 2 of the Air Pollutant Control Law (including "Facilities emitting soot and smokes" defined in the Electric Utility Law and the Town Gas Utility Law)
(b) "Facilities emitting mine smoke" or "Facilities emitting soot and smoke" defined in the article 2 of the "Ministerial Ordinance for standard of regulation to avoid mine pollution" according to the Security of Mine Law
(c) Facilities regulated by municipal bylaw of local governments
(d) Other

-Method

This survey is conducted with survey questionnaires. The response sheets and this survey's explanations are distributed to target facilities mentioned above.

Complete enumeration surveys, in the form of the *MAP Survey*, were carried out in fiscal 1992, 1995, 1996, and 1999, in relation to all facilities emitting soot and smoke. Also, in fiscal 1990, 1991, 1993, and 1994, sampling surveys were conducted in relation approximate half of all facilities and operating sites.

• *Point to Note*

The emission values from a number of sources of emissions have been given as negative values. The reason is that the concentrations of methane and nitrous oxide in exhaust gases become lower than their concentrations in intake gases due to combustion. However, during the in-country review in October 2003, the Expert Review Team (ERT) noted that negative emission factors are not consistent with the current IPCC Guidelines, which count the positive emissions in the flue gases rather than the difference between flue gas and ambient concentrations. In order to meet the requirement by the ERT, calculation of emission factors is currently under way in accordance with the emissions in flue gas.

3.1.3. Mobile Combustion (1.A.3.: CH_4 and N_2O)

3.1.3.1. Road Transportation (1.A.3.b.)

- ***Methodology for Estimating Emissions of GHGs***

Emissions have been calculated using the Tier 3 method, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.45, Fig. 2.5). The country-specific emission factors were used for each category of vehicle. The activity data was estimated by using running mileage and fuel efficiency which were provided from the Ministry of Land, Infrastructure and Transport's *Statistical Yearbook of Motor Vehicle Transport*. (Refer to *1A3-car-2005.xls* for details on the calculation process).

- ***Emission Factors***

Emission factors for methane and nitrous oxide have been established for each type of fuel in each category of vehicle, using actual Japanese data. The method used to establish emission factors was to take a weighted average of the emission factors estimated for each class of running speed, using the proportion of mileage by each class of running speed given in the Ministry of Land, Infrastructure and Transport's *Road Transport Census*. The emission factors reflect the actual motor vehicle operation in Japan because the proportion of mileage by each class of running speed during congestion was applied. Details on the method for establishing emission factors is described in the Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 3*, (September 2000) and Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 3*, (August 2002).

The emissions factors for methane and nitrous oxide is listed below. In addition, the values in FY[3]2001 were adopted for the value after FY2002 because the latest data was not available at this time.

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[3] FY (Fiscal Year): Starting from April of the year to March of the next year

Table 3-7 Methane emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	2000	2002	2003
Gasoline	Light Vehicle	gCH4/km	0.011	0.011	0.011	0.010	0.010
	Passenger Vehicle (including LPG)	gCH4/km	0.011	0.011	0.011	0.010	0.010
	Light Cargo Truck	gCH4/km	0.011	0.011	0.011	0.011	0.011
	Small Cargo Truck	gCH4/km	0.035	0.035	0.035	0.035	0.035
	Regular Cargo Truck	gCH4/km	0.035	0.035	0.035	0.035	0.035
	Bus	gCH4/km	0.035	0.035	0.035	0.035	0.035
	Special Vehicle	gCH4/km	0.035	0.035	0.035	0.035	0.035
Diesel	Passenger Vehicle	gCH4/km	0.002	0.002	0.002	0.002	0.002
	Small Cargo Truck	gCH4/km	0.009	0.009	0.008	0.008	0.008
	Regular Cargo Truck	gCH4/km	0.017	0.016	0.015	0.015	0.015
	Bus	gCH4/km	0.019	0.018	0.017	0.017	0.017
	Special Vehicle	gCH4/km	0.017	0.015	0.013	0.013	0.013

Table 3-8 Nitrous oxide emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	2000	2002	2003
Gasoline	Light Vehicle	gN2O/km	0.019	0.021	0.022	0.023	0.023
	Passenger Vehicle (including LPG)	gN2O/km	0.027	0.029	0.030	0.030	0.030
	Light Cargo Truck	gN2O/km	0.021	0.022	0.023	0.023	0.023
	Small Cargo Truck	gN2O/km	0.027	0.029	0.027	0.027	0.027
	Regular Cargo Truck	gN2O/km	0.039	0.041	0.039	0.039	0.039
	Bus	gN2O/km	0.045	0.046	0.044	0.044	0.044
	Special Vehicle	gN2O/km	0.039	0.042	0.038	0.038	0.038
Diesel	Passenger Vehicle	gN2O/km	0.007	0.007	0.007	0.007	0.007
	Small Cargo Truck	gN2O/km	0.025	0.025	0.025	0.025	0.025
	Regular Cargo Truck	gN2O/km	0.025	0.025	0.025	0.025	0.025
	Bus	gN2O/km	0.025	0.025	0.025	0.025	0.025
	Special Vehicle	gN2O/km	0.025	0.025	0.025	0.025	0.025

• *Activity Data*

Estimates of annual running mileage by each category of vehicle and by each type of fuel have been used as activity data. The method of estimating activity data was to multiply the proportion of running mileage for each fuel, which was calculated from fuel consumption and fuel efficiency, by the running distance for each category of vehicle given in the Ministry of Land, Infrastructure and Transport's *Statistical Yearbook of Motor Vehicle Transport*. (Refer to *1-AD-2005.xls¥car(****)* for the process of estimating activity data).

• *Completeness*

-Natural gas

Currently, the majority of natural gas vehicles in use around the world, including Japan, are driven by compressed natural gas (CNG). Researches on development of a practical liquid natural gas (LNG) vehicle have been active since fiscal 1996 in Japan.

At the end of March 2004, the number of natural gas vehicles (CNG vehicles and others) owned was approximately 20,638[4] (only 0.03% of total motor vehicles owned, which was 77.4 million[5] at the end of March 2004). On the assumption that emissions are almost negligible, and that an emission factor has not been established, it has been reported as "NE" ("not estimated").

-Biomass fuels

Currently, ethanol vehicles driven by biomass fuels are not running in Japan. For that reason, the emissions of methane and nitrous oxide associated with the use of vehicles using biomass as fuel has been reported as "NO".

-Other (Methanol)

The number of methanol vehicles owned in Japan was only 62 at the end of February 2004 (data obtained from the Organization for the Promotion of Low Emission Vehicles). Therefore activity data is negligible, and has not been reported, as it is assumed that the emissions are also negligible.

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[4] From the website of the Japan Gas Association (http://www.gas.or.jp/default.html)

[5] From the website of the Automobile Inspection and Registration Association (http://www.aira.or.jp/data/data.html)

3.1.3.2. Civil Aviation (1.A.3.a.)

- ***Methodology for Estimating Emissions of GHGs***

Emissions have been calculated using the Tier 2a method for jet fuel and the Tier 1 for aviation gasoline, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.58, Fig. 2.7). (Refer to *1A3-2005.xls¥ Airplane Emissions* for detail on the calculation process.)

- ***Emission Factors***

-Jet fuel

The default values given in the *Revised 1996 IPCC Guidelines* are used for emission factors for methane and nitrous oxide for LTO. The values used for emission factors for methane and nitrous oxide for cruising were calculated by converting the default values given in the *Revised 1996 IPCC Guidelines* into kg-CH_4/l using the specific gravity of jet fuel (0.78 t/kl). The following table provides the emission factors for methane and nitrous oxide at LTO and cruising.

-Aviation gasoline

The default values given in the *Revised 1996 IPCC Guidelines* are used for emission factors for methane and nitrous oxide.

Table 3-9 Methane and nitrous oxide emission factors for aircraft

		CH_4	N_2O
jet aircraft (Jet fuel)	During takeoff and landing*	0.3 [kg-CH_4/LTO]	0.1 [kg-N_2O/LTO]
	During flight	0 [kg-CH_4/kl]	0.078 [kg-N_2O/kl]
Other than jet aircraft (Aviation gasoline)	-	0.06 [g-CH_4/MJ]	0.0009 [g-N_2O/MJ]

* LTO=Landing/takeoff cycle

Source: Ministry of the Environment, *Results of Review of Greenhouse Gases Emissions Estimations Part 3* (August 2002)
Revised 1996 IPCC Guidelines, Volume 3, Table I-47

(Refer to *1-EF-2005.xls¥airplane* for detail on the calculation process.)

- ***Activity Data***

-Jet fuel

The number of takeoffs and landings given in the *Statistical Yearbook of Air Transport* of the Ministry of Land, Infrastructure and Transport is used as activity data at takeoff and landing. Fuel Consumption for takeoff and landing was calculated by multiplying fuel consumption for one takeoff or landing given in the IPCC/OECD guidelines, by the number of takeoffs and landings given above.

Fuel consumption for cruising was estimated by subtracting the amount of jet fuel consumed at takeoff and landing, from total jet fuel consumption calculated from the *Statistical Yearbook of Air Transport* of Ministry of Land, Infrastructure and Transport.

-Aviation gasoline

Consumption (converted into net calorific value) of gasoline in airplane sector taken from the *General Energy Statistics* of the Agency for Natural Resources and Energy was used for activity data.

3.1.3.3. Navigation (1.A.3.d.)

• *Methodology for Estimating Emissions of GHGs*

Emissions were calculated using the default values for methane and nitrous oxide given in the *Revised 1996 IPCC Guidelines*, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.52, Fig. 2.6).

(Refer to *1A3-2005.xls¥ShipEmissions* for details of the calculation process.)

• *Emission Factors*

The default values for Ocean-Going Ships (diesel engines) given in the *Revised 1996 IPCC Guidelines* were converted to emission factor per liter using the calorific value for each type of fuel (gas oil, heating oils A, B and C). The following gives the default values from the *Revised 1996 IPCC Guidelines*.

Table 3-10 Default emission factors for navigation

	Value
Methane Emission Factor	0.007 [g-CH_4/MJ]
Nitrous Oxide Emission Factor	0.002 [g-N_2O/MJ]

Source: *Revised 1996 IPCC Guidelines* Vol. 3, page 1.90, Table 1-48

• *Activity Data*

Consumption of each fuel type in internal navigation sector taken from the *General Energy Statistics* of the Agency for Natural Resources and Energy was used for activity data.

• *Point to Note*

The default emission factor given in the *Revised 1996 IPCC Guidelines*, etc., is expressed in net calorific value. Therefore, in order to apply this emission factor, gross calorific value, which is generally adopted in Japan’s energy statistics, is first converted into net calorific value, and then it is used for the conversion to the liter-based emissions factor.

• *Completeness*

The Common Reporting Format (CRF) provides a “Residual Oil” category, which is believed to correspond to ‘Heating Oil’ in Japan. Emissions of methane and nitrous oxide from heating oil A, B, and C have been calculated for each type of fuel. The resulting emissions have been reported under Other Fuels in the CRF, and, therefore, the Residual Oil column has been reported as “IE”.

3.1.3.4. Railways (1.A.3.c.)

- ***Methodology for Estimating Emissions of GHGs***

This source of emissions is not a key source category, and emissions were calculated by multiplying the default emission factor given in the *Revised 1996 IPCC Guidelines* by fuel consumption on a calorific basis. (Refer to *1A3-2005.xls¥Train Emissions* for details of the calculation process).

The *Good Practice Guidance (2000)* does not provide a decision tree for a calculation method for this source.

- ***Emission Factors***

A default value for “Diesel Engines - Railways”, given in the *Revised 1996 IPCC Guidelines*, was converted to emission factor per liter using the calorific value of gas oil.

The following table gives the default values from the *Revised 1996 IPCC Guidelines*.

Table 3-11 Default emission factors of railways

	Value
Methane Emission Factor	0.004 [g-CH_4/MJ]
Nitrous Oxide Emission Factor	0.03 [g-N_2O/MJ]

Source: *Revised 1996 IPCC Guidelines* Vol. 3, p.1.91, Table 1-49

- ***Activity Data***

Consumption of gas oil in railways sector taken from the *General Energy Statistics* of the Agency for Natural Resources and Energy was used for activity data.

- ***Point to Note***

The default emission factor given in the *Revised 1996 IPCC Guidelines*, etc., is expressed in net calorific value. Therefore, in order to apply this emission factor, the calorific value, which is generally expressed as gross calorific value in Japan’s energy statistics, is converted into the net calorific value.

- ***Completeness***

The emission factors for greenhouse gases associated with the use of coal in steam engines are given in the *Revised 1996 IPCC Guidelines*. As a result of calculating emissions of methane and nitrous oxide arising from the use of coal in steam engines using this emission factor, activity data has been found to be quite small (steam engines (locomotives) are almost seen for tourism purposes in Japan only), and emissions are negligible (less than 1 Gg of carbon dioxide on a carbon dioxide equivalent basis for the number of significant decimal places given in the CRF). The value has therefore been reported as “NE”.

3.2. Fugitive Emissions from Fuels (1.B.)

3.2.1. Solid Fuels (1.B.1.)

3.2.1.1. Coal Mining (1.B.1.a.)

3.2.1.1.a. Underground Mines (1.B.1.a.i.)

• *Methodology for Estimating Emissions of GHGs*

-Mining Activities

Emissions from mining activities were drawn from actual measurements obtained from individual coal mines, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.72, Fig. 2.10). (Refer to *1B1-2005.xls* for the calculation process.)

-Post-Mining Activities

Emissions from post-mining activities were calculated using the Tier 1 method, which uses default emission factors in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.73, Fig. 2.11). (Refer to *1B1-2005.xls* for the calculation process.)

• *Emission Factors*

-Mining Activities

The emission factor for mining activities was established by dividing the emissions of methane gas identified in a survey by Japan Coal Energy Center (J-COAL), by the production volume of coal from underground mining given in the Ministry of Economy, Trade and Industry *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke*.

Table 3-12 Emission factors for mining activities – Underground mines

Item	Unit	1990	1995	2000	2002	2003	Reference
Coal Production of Underground Mines	kt	6,775	5,622	2,364	734	738	Surveyed by J-COAL
CH_4 Total Emissions	$1000m^3$	181,358	80,928	48,110	5,924	4,092	Surveyed by J-COAL
CH_4 Total Emissions	Gg-CH_4	121.5	54.2	32.2	4.0	2.7	=CH_4 [$1000m^3$] / 1000 × 0.67 [Gg/10^6m^3]
Emission Factor	kgCH_4/t	17.9	9.6	13.6	5.4	3.7	CH_4 Total Emissions / Coal Production of Underground Mines

-Post-Mining Activities

A value (1.6 [kg-CH_4/t-coal]) was used as the emission factor for post-mining activities. It was derived by converting the median (2.45 [m^3/t]) of the default values given in the *Revised 1996 IPCC Guidelines* (0.9–4.0 [m^3/t]), using the concentration of methane at atmospheric pressure and 20ºC (0.67 [Gg/10^6m^3]).

Calculation of Emission Factor

2.45 [m^3/t] × 0.67 [Gg/10^6m^3] = 1.6 [kg-CH_4/t-coal]

- ***Activity Data***

The value used for activity data for underground mining and post-mining activities was derived by subtracting the open-cut mining production from the total coal production as given in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and *Yearbook of Mineral Resources and Petroleum Products Statistics* prepared by the Ministry of Economy, Trade and Industry and the data provided by Japan Coal Energy Center.

3.2.1.1.b. Surface Mines (1.B.1.a.ii.)

- ***Methodology for Estimating Emissions of GHGs***

-Mining Activities

Emissions were calculated using the Tier 1 method and the default emission factor in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.71, Fig. 2.9). (Refer to *1B1-2005.xls* for the calculation process.)

-Post-Mining Activities

Emissions were calculated using the Tier 1 method and the default emission factor in accordance with Decision Tree or the *Good Practice Guidance (2000)* (Page 2.73, Fig. 2.11). (Refer to *1B1-2005.xls* for the calculation process.)

- ***Emission Factors***

-Mining Activities

A value (0.77 [kg-CH_4/t-coal]) was used as the emission factor for mining activities. It was derived by converting the median (1.15 [m^3/t]) of the default values given in the *Revised 1996 IPCC Guidelines* (0.3–2.0 [m^3/t]), using the concentration of methane at one atmospheric pressure and 20°C (0.67 [Gg/10^6m^3]).

Calculation of Emission Factor

1.15 [m^3/t] × 0.67 [Gg/10^6m^3] = 0.77 [kg-CH_4/t-coal]

-Post-Mining Activities

A value (0.07 [kg-CH4/t-coal]) was used as emission factor for post-mining activities. It was derived by converting the median (0.1 [m^3/t]) of the default values given in the Revised 1996 IPCC Guidelines (0–0.2 [m^3/t]), using the concentration of methane at one atmospheric pressure and 20°C (0.67 [Gg/10^6m^3]).

Calculation of Emission Factor

$0.1\ [m^3/t] \times 0.67\ [Gg/10^6 m^3] = 0.07\ [kg\text{-}CH_4/t\text{-coal}]$

- ***Activity Data***

The figure for the open-cut production given in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* prepared by the Ministry of Economy, Trade and Industry and the data provided by the Japan Coal Energy Center were used as the activity data for mining and post-mining activities

- ***Completeness***

Along with the methane emission during coal mining, carbon dioxide may be released to the atmosphere as emissions from mining, depending on its concentration in coal being mined. Japanese coal strata are not thought to contain build-ups of carbon dioxide in higher concentrations than in the atmosphere, but no actual data is available, making it impossible to calculate emissions at this point in time.

The Common Reporting Format provides a column for reporting carbon dioxide emissions associated with coal mining, but provides no default emission factor. As it is also not possible to estimate an upper limit for an emission factor, the figure has been reported as “NE”.

3.2.1.2. Solid Fuel Transformation (1.B.1.b.)

The activities that belong under this category have been considered as the production of coking coal and coal briquettes.

Methane emissions from the production of coking coal have been reported in Category 2 Industrial Processes (see Chapter 4).

The process of coal briquette production includes introducing water to coal, and squeeze-drying it. Therefore, the process is not thought to involve any chemical reactions, but the emission of carbon dioxide, methane or nitrous oxide cannot be denied. However, as no actual measurements have been taken, however, it is not presently possible to calculate emissions. There is no default value for the emission of carbon dioxide or methane associated with solid fuel transformation, either, and since it is also not possible to estimate an upper limit for an emission factor, the demission has been reported as “NE”.

3.2.2. Oil and Natural Gas (1.B.2.)

3.2.2.1. Oil (1.B.2.a.)

3.2.2.1.a. Exploration (1.B.2.a.i.)

- ***Methodology for Estimating Emissions of GHGs***

This source is not a key source category, and for that reason, the emissions were calculated by multiplying the default emission factor for exploration given in the *Good Practice Guidance (2000)* by the number of wells drilled, and by multiplying the number of the wells tested for oil and gas by the default emission factor for testing.
(Refer to *1B2-2005.xls¥1B2a i Exploration* for detail on the calculation process.)

The *Good Practice Guidance (2000)* does not provide a decision tree for a calculation method for this source.

- ***Emission Factors***

The emission factors from the *Good Practice Guidance (2000)* for drilling and testing wells were used.

Table 3-13 Emission factors for exploratory and testing wells [Gg/number of wells]

	CH_4	CO_2	N_2O
Drilling	4.3×10^{-7}	2.8×10^{-8}	0
Testing	2.7×10^{-4}	5.7×10^{-3}	6.8×10^{-8}

Source: *GPG (2000)* Table 2.16

- ***Activity Data***

-Drilling

The data given in the *Natural Gas Annual Report* compiled by the Natural Gas Mining Association were used for exploratory wells.

-Testing

It was not possible to readily ascertain statistically the number of wells in which oil and gas testing had been carried out, and even where such tests are conducted, not all wells are successful. For these reasons, the median of exploratory wells and successful wells was used as the number of the wells tested for oil and gas.

3.2.2.1.b. Production (1.B.2.a.ii.)

• *Methodology for Estimating Emissions of GHGs*

Emissions relating to fugitive emissions from petroleum production and servicing of oilfield production wells were calculated using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.81, Fig. 2.13). (Refer to *1B2-2005.xls¥1B2a ii Production* for details of the calculation process.)

• *Emission Factors*

-Production

The default value for conventional crude oil given in the *Good Practice Guidance (2000)* was used for the emission factor of fugitive emissions from petroleum production. (The median of the default values was used for methane).

Table 3-14 EF for fugitive emissions from petroleum production [Gg/1000 m^3 1)]

		CH_4 2)	CO_2	N_2O 3)
Conventional Oil	Fugitive emissions	1.45×10^{-3}	2.7×10^{-4}	0

Source: *GPG (2000)* Table 2.16
1) 1 m^3 = 1 kilo liter
2) The default value is 1.4×10^{-3} – 1.5×10^{-3}
3) Excluded from calculations, as the default value is 0 (zero)

-Servicing

The default value given in the *Good Practice Guidance (2000)* was used as the emission factor for fugitive emissions from servicing of petroleum production wells.

Table 3-15 EF for fugitive emissions from servicing of petroleum production wells [Gg/number of wells]

	CH_4	CO_2	N_2O 1)
Production Well (Servicing)	6.4×10^{-5}	4.8×10^{-7}	0

Source: *GPG (2000)* Table 2.16
1) Excluded from calculations, as the default value is 0 (zero)

• *Activity Data*

-Production

The values for production of crude oil in Japan given in the METI's *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* were used as the activity data for fugitive emissions from production.

-Servicing

The number of wells at the end of May in each year given in the METI's *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* was used as the activity data of fugitive emissions from servicing of production wells. Production wells are typically shut down or re-tapped for oil in accordance with demand, and the number of wells fluctuates in a whole year, and it is not consistent throughout any year. As the winter demand season from October to May seems to be a typical average, the number of wells at the end of May was used as the value representative of the relevant year.

Activity data after FY2002 were excluded from the statistical survey. Therefore, the data for FY2001 was used as provisional data after FY2002.

3.2.2.1.c. Transport (1.B.2.a.iii.)

- ***Methodology for Estimating Emissions of GHGs***

Emissions relating to fugitive emissions associated with transport were calculated using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.81, Fig. 2.13). (Refer to *1B2-2005.xls¥1B2a iii Transport* for details of the calculation process.)

- ***Emission Factors***

The default values given in the *Good Practice Guidance (2000)* were used as the emission factors.

Table 3-16 Emission factors during transport of crude oil [Gg/1000 m^3]

		CH_4	CO_2	N_2O 1)
Oil Transport	Tanker Trucks and Rail Cars	2.5×10^{-5}	2.3×10^{-6}	0

Source: *GPG (2000)* Table 2.16

1) Excluded from calculations, as the default value is 0 (zero)

- ***Activity Data***

The values for production of oil in Japan given in the METI’s *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* were used as the activity data for fugitive emissions from transport.

- ***Assumptions Relating to Estimation of Emissions***

In this category, fugitive emissions during transport of crude oil produced from offshore fields in Japan to land, and fugitive emissions from overland transport are calculated.

Crude oil for sea transport is carried out entirely by pipeline, and is not expected to generate any fugitive emissions. Land transport includes a number of methods, including pipeline, trucks, and tanker rail cars, but it is difficult to differentiate them statistically. For that reason, it has been assumed that all of the produced oil is transported by tanker trucks or rail cars in calculations.

3.2.2.1.d. Refining / Storage (1.B.2.a.iv.)

• *Methodology for Estimating Emissions of GHGs*

-Refining

Emissions relating to fugitive emissions from refining were calculated using the Tier 1 method in accordance with Decision Tree the *Good Practice Guidance (2000)* (Page 2.82, Fig. 2.14).

-Storage

Emissions relating to fugitive emissions from storage should be calculated using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.82, Fig.2.14), but as the country-specific emission factor is available for this emissions source, it was applied to the inventories instead. (Refer to *1B2-2005.xls¥1B2a iii Refining_Storage* for details of the calculation process.)

• *Emission Factors*

-Refining

The emission factor for fugitive emissions during refining is affected by the fact that, because it is not possible for fugitive methane emissions to occur during normal oil refining operations in Japan, such emissions are considered to be very small. For that reason, the lower limit of the default value given in the *Revised 1996 IPCC Guidelines* was used.

Table 3-17 Emission factor during refining of crude oil

Emission Factor [kg-CH_4/PJ]	
Oil Refining	90$^{1)}$

Source: *GPG (2000)* Table 2.16
1) The default value is 90–1,400

-Storage

Oil is stored in either corn-roof tanks or floating-roof tanks. All oil storage in Japan adopts floating-roof tanks, which means that fugitive methane emissions are considered to be very small. If fugitive methane emissions were to occur, they could only occur by vaporization of oil left on the exposed wall wet with oil when the floating roof descends as the stored oil is removed; thus, the amount of fugitive methane emissions would be small.

The Petroleum Association of Japan has conducted experiments relating to the evaporation of methane from tank walls by modeling the floating-roof tank to calculate estimates of methane emissions.

The emission factor associated with storage of crude oil is a value derived by converting the estimates of the Petroleum Association (0.007 Gg/year as at 1998) to a net calorific value and dividing it by the relevant activity data.

Table 3-18 Assumptions for calculation of emission factor during oil storage

Methane Emissions	Input of Crude Oil to Oil Refining Industry		Emission Factor
[kg-CH_4/year]	[PJ: Gross Calorific Value] 1)	[PJ: Net Calorific Value]2)	[kg-CH_4/PJ]
7,000	9,921	9,424.95	0.7427

1) Agency for Natural Resources and Energy, *General Energy Statistics*

2) Net Calorific Value = Gross Calorific Value ×0.95

- ***Activity Data***

The value used for activity data during refining and storing was the converted net calorific values of NGL and refined crude oil in petroleum refining industry taken from the *General Energy Statistics* compiled by the Agency for Natural Resources and Energy.

- ***Point to Note***

The default emission factors given in the *Revised 1996 IPCC Guidelines* and elsewhere are expressed in net calorific values. Therefore, in order to use the IPCC default emission factor per unit of calorific value, the activity data were converted to net calorific values.

- ***Completeness***

Oil and NGL are refined and stored in Japan, and where carbon dioxide is dissolved in crude oil, it is conceivable that it will be emitted as a result of the relevant activity. The level of carbon dioxide emitted by the activity is probably negligible, but because there are no examples of measurement of the carbon dioxide content in crude oil, it is not currently possible to calculate emissions.

The Common Reporting Format (CRF) offers a column in which emissions of carbon dioxide associated with petroleum refining and storage should be reported, but there is no default emission factor, and since it is also not possible to estimate an upper limit to the emission factor, the figure has been reported as “NE”.

3.2.2.1.e. Distribution of Oil Products (1.B.2.a.v.)

Petroleum products are distributed in Japan, and where methane and carbon dioxide are dissolved, it is conceivable that either or both will be emitted as a result of the relevant activity. The levels of methane or carbon dioxide emitted by the activity is probably negligible, in light of the composition of the petroleum products, but because there are no examples of measurement of the methane or carbon dioxide content of petroleum products, it is not currently possible to calculate emissions.

The Common Reporting Format (CRF) offers a column in which methane and carbon dioxide emissions associated with petroleum supply should be reported, but there is no default emission factor, and since it is also not possible to estimate an upper limit to the emission factor, the figure has been reported as “NE”.

3.2.2.2. Natural Gas (1.B.2.b.)

3.2.2.2.a. Exploration (1.B.2.b.-)

There is test drillings of oil and gas fields in Japan, and it is conceivable that the activity could give rise to emissions of carbon dioxide, methane, or nitrous oxide. It is difficult, however, to distinguish between oilfields and gas fields prior to test drilling, and for that reason the figures are calculated in conjunction with the aforementioned section 3.2.2.1.a) Exploration, and reported as "IE".

3.2.2.2.b. Production / Processing (1.B.2.b.i.)

- ***Methodology for Estimating Emissions of GHGs***

Fugitive emissions of the production of natural gas and processing of natural gas, such as adjusting its constituent elements, and servicing natural gas production wells was calculated using the Tier 1 method, and in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.80, Fig. 2.12) (Refer to *1B2-2005.xls¥1B2b i Production_Processing* for detail on the calculation process.).

- ***Emission Factors***

-Production

The default values given in the *Good Practice Guidance (2000)* were used for the emission factors of fugitive emissions during the production of natural gas. (The median of the default values was used for methane).

Table 3-19 Emission factors of fugitive emissions during production of natural gas [$Gg/10^6\ m^3$]

		CH_4 1)	CO_2	N_2O 2)
Natural Gas Production	Fugitive Emissions	2.75×10^{-3}	9.5×10^{-5}	0

Source: *GPG (2000)* Table 2.16

1) The default values are $2.6\times10^{-3} – 2.9\times10^{-3}$

2) Excluded from calculations, as the default value is 0 (zero)

-Processing

The default values given in the *Good Practice Guidance (2000)* for the emission factors of fugitive emissions during processing of natural gas were used. (The median of the default values was used for methane).

Table 3-20 Emission factors during processing of natural gas [Gg/10^6 m^3]

		CH_4 1)	CO_2	N_2O 2)
Processing of Natural Gas	Processing in general (General treatment plant, Sweet Gas Plants)	8.8×10^{-4}	2.7×10^{-5}	0

Source: *GPG (2000)* Table 2.16

1) The default values are $6.9 \times 10^{-4} - 10.7 \times 10^{-4}$

2) Excluded from calculations, as the default value is 0 (zero)

-Servicing

The default values for fugitive emissions during servicing of natural gas production wells given in the *Good Practice Guidance (2000)* were used.

Table 3-21 Emission factors during servicing of natural gas production wells [Gg/number of wells]

	CH_4	CO_2	N_2O 1)
Production Well (Servicing)	6.4×10^{-5}	4.8×10^{-7}	0

Source: *GPG (2000)* Table 2.16

1) Excluded from calculations, as the default value is 0 (zero)

• *Activity Data*

-Production and Processing

The production volume of natural gas in Japan given by the Ministry of Economy, Trade and Industry in its *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* was used as the activity data during its production and processing.

-Servicing

The number of wells at the end of May, given by the Ministry of Economy, Trade and Industry in its *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke*, was used for the activity data for fugitive emissions during servicing of production wells. There are gas fields in which production wells are typically shut down or re-tapped in accordance with demand, and in a whole year the number of wells fluctuates, and is not consistent throughout any year. As the winter demand season from October to May seems to be a typical average, the number of wells at the end of May was used for the value representative of the relevant year.

Activity data after FY2002 was excluded from the statistical survey. Therefore, the data for FY2001 was used as provisional data after FY2002.

3.2.2.2.c. Transmission (1.B.2.b.ii.)

• *Methodology for Estimating Emissions of GHGs*

Fugitive emissions from the transmission of natural gas were calculated using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance* (2000) (Page 2.80, Fig.2.12) (Refer to *1B2-2005.xls¥1B2b ii Transmission* for details on the calculation process.)

• *Emission Factors*

The default values given in the *Good Practice Guidance (2000)* were used for the emission factors of fugitive emissions from transmission. (The median of the default values was used for methane).

Table 3-22 EF for fugitive emissions from transmission of natural gas

[Gg-gas/km-pipeline]

		CH_4	CO_2	N_2O 3)
Fugitive emissions during transmission of natural gas	Fugitive emissions	2.5×10^{-3} 1)	1.6×10^{-5}	0
	Venting	1.0×10^{-3} 2)	8.5×10^{-6}	0
	Total	3.5×10^{-3}	2.45×10^{-5}	0

Source: *GPG (2000)* Table 2.16

1) The default values are 2.1×10^{-3} – 2.9×10^{-3}

2) The default values are 0.8×10^{-3} – 1.2×10^{-3}

3) Excluded from calculations, as the default value is 0 (zero)

• *Activity Data*

The production volume per kilometer of pipeline for natural gas in Japan given in the *Natural Gas Annual Report* compiled by the Natural Gas Mining Association was used for the activity data for fugitive emissions from the transmission of natural gas.

3.2.2.2.d. Distribution (1.B.2.b.ii.-)

• *Methodology for Estimating Emissions of GHGs*

Emissions relating to fugitive emissions from distribution should be calculated using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.82, Fig. 2.14), but because the country-specific emission factor is available for this emission source, it was applied to the inventories instead.

The object of the calculations is the methane emitted during the normal operation of LNG receiving terminals, town gas production facilities, and satellite terminals in Japan, as well as the methane emitted during a regular maintenance or construction. The primary sources of emissions are the gases sampled during an analysis and residual gases emitted during a regular maintenance of manufacturing facilities. (Refer to *1B2-2005.xls¥1B2b ii Distribution* for details of the calculation process.)

• *Emission Factor*

The emission factor was calculated by dividing emission of methane during the normal operation of LNG receiving terminals, town gas production facilities, and satellite terminals in Japan, as well as during regular maintenance or construction, by the calorific value (905 [kg-CH_4/PJ]) of the raw material input (LNG, natural gas).

• *Activity Data*

The volume of LNG and natural gas used as raw material for town gas given in the Energy Balance Table was used as the activity data in this category.

• *Point to Note*

As the country-specific emission factor is being used, the gross calorific value given in the Energy Balance Table was used as is for activity data.

• *Completeness*

Town gas is produced in Japan, and approximate 90% of town gas are based on LNG and free of carbon dioxide. Domestic natural gas, however, contains minute amounts of carbon dioxide. Therefore when town gas is produced from domestic natural gas, a negligible quantity of fugitive carbon dioxide emissions is probably released.

The ratio of carbon dioxide to methane in domestic natural gas in general, is only 7.5% at a maximum. If it is assumed that fugitive carbon dioxide emissions from this source escape in association with methane and in proportion to their constituent ratios, then the annual estimate is approximately 11 [t-CO_2]. Therefore, the emissions from this source category was reported as “NE”.

3.2.2.2.e. At industrial plants and power station / in residential and commercial sectors (1.B.2.b. -)

Activity that may be assumed to come under this category in Japan is the use of town gas and other gaseous fuels, and it is conceivable that carbon dioxide or methane could escape to the atmosphere in association with the use of such fuels. The amount would be very small, but since there is no actual measurements have ever been taken, it is not currently possible to calculate emissions.

The Common Reporting Format provides a column for reporting methane and carbon dioxide emissions associated with 5) Fugitive emissions from Industrial Plants, Power Stations, and the Consumer Goods Sector (Residential and Commercial), but provides no default emission factor for the activity, and since it is also not possible to estimate an upper limit for an emission factor, the data has been reported as “NE”.

3.2.2.3. Venting and Flaring (1.B.2.c.)

3.2.2.3.a. Venting (Oil) (1.B.2.c.-venting i)

- ***Methodology for Estimating Emissions of GHGs***

Emission from oilfield venting was calculated using the Tier 1 method, and in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.81, Fig. 2.13)

- ***Emission Factors***

The default values for conventional oil given in the *Good Practice Guidance (2000)* were used for the emission factors of oilfield venting. (The median of the default values was used for methane).

Table 3-23 Emission factors of oilfield venting

		CH_4 1)	CO_2	N_2O 2)
Conventional Oil	Venting valves [Gg/1000 m^3]	1.38×10^{-3}	1.2×10^{-5}	0

Source: *GPG (2000)* Table 2.16

1) The default values are 6.2×10^{-5} — 270×10^{-5}

2) Excluded from calculations, as the default value is 0 (zero)

- ***Activity Data***

The production volume of oil in Japan given by the Ministry of Economy, Trade and Industry in its *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* was used as the activity data of fugitive emissions from oilfield venting.

3.2.2.3.b. Venting (Gas) (1.B.2.c.-venting ii)

In the context of venting activity in gas fields in Japan, it is possible that gas bursts could occur, but normally wells are closed, and there is small likelihood of emissions. However, since the reality in relation to emissions is unclear, they have been reported as “NE”.

3.2.2.3.c. Venting (Combined) (1.B.2.c.-venting iii)

Statistically, in Japan’s oil and gas fields are handled as two separate categories, and fugitive emissions from venting at combined fields are included in either fugitive emission from venting valves at oil or gas fields. Therefore, they have therefore been reported as “IE”.

3.2.2.3.d. Flaring (1.B.2.c.-flaring)

Production capacity at oil and gas fields in Japan is small, and there is no generation of excess associated gas. Therefore, it may be assumed that there is virtually no activity that equates to flaring. However, since the reality in relation to emissions is unclear, and it is not possible to establish an upper limit for an emission factor, they have been reported as “NE”.

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Chapter 4. Industrial Processes (CRF sector 2)

4.1. Mineral Products (2.A.)

4.1.1. Cement Production (2.A.1.)

- ***Methodology for Estimating Emissions of GHGs***

The country-specific method is used for this source of emissions. The volume of limestone used as the raw material in cement was multiplied by the emission factor to calculate the emissions. (Refer to *2-CO2-2005.xls¥2A1 Cement* for detail on the calculation process.)

- ***Emission Factors***

The emission factor in each year was calculated by multiplying the weight-to-weight ratio of limestone to carbon dioxide in the chemical reaction, by the purity of the limestone used in FY1992 and FY2000 onwards (obtained from the Japan Cement Association) by all domestic cement manufacturers (18 companies).

Calculation of Emission Factor (FY 2003 as an example)

- Molecular weight of $CaCO_3$ (primary constituent of limestone): 100.0872
- Molecular weight of CO_2 : 44.0098
- Purity of limestone: 94.3%（from the Japan Cement Association）

$$\text{Emission Factor} = (\text{Molecular weight of } CO_2 / \text{Molecular weight of } CaCO_3) \times \text{Purity} = (44.0098/100.0872) \times 0.943 = 0.4147 \ [\text{t-}CO_2/\text{t}] = 415 \ [\text{kg-}CO_2/\text{t}]$$

（Refer to *2-CO2-2005.xls¥2A1 Cement* for other years）

- ***Activity Data***

The activity data for carbon dioxide emissions from cement production was calculated by correcting the fiscal year measure of limestone consumption on wet weight basis, given in the Ministry of Economy, Trade and Industry *Yearbook of ceramics and building materials Statistics*, by using the ratio of water content (obtained from the Japan Cement Association), and then converting it to a dry weight value. Activity data in FY2003 have not been available yet. Therefore, the CY2003 value was used as provisional data.

- ***Japanese Country-Specific Method***

According to the methodology in Decision Tree of the *Good Practice Guidance (2000)* (Page 3.10, Fig. 3.1), the volume of clinker, the main intermediate product of cement manufacture, is to be multiplied by the emission factor for carbon dioxide derived from the calcium oxide content of clinker. In Japan, however, there has been no investigation on the statistical values associated with the volume of clinker produced. It is therefore very difficult to obtain historical volumes of manufactured clinker.[1]

Japanese cement manufacturing industry uses a wide variety of recycled waste products and by-products as raw material. Therefore, clinker may contain calcium oxide that does not become a source of carbon dioxide emission. For that reason, in estimating emissions of carbon dioxide, it is necessary to determine the amount of calcium oxide contained in the clinker that has been derived from limestone. The content may vary wildly, however, depending on the type of product, the factory in which it was manufactured, and the time when it was manufactured, causing to introduce significant levels of uncertainty. At the same time, Japanese cement works use limestone that is much purer than that used at cement plants in Europe. Therefore, a calculation methodology based on the consumption of limestone[2] should make it less uncertain.

For the foregoing reasons, the amount of limestone was used as a basis of the methodology in Japan instead of clinker.

4.1.2. Lime Production (2.A.2.)

• *Methodology for Estimating Emissions of GHGs*

The country-specific method is used for this emission source. The volume of limestone and dolomite used as the raw material for lime is multiplied by the emission factor to calculate emissions. (Refer to *2-CO2-2005.xls¥Limestone and 2-CO2-2005.xls¥dolomite* for details of the calculation process.)

• *Emission Factors*

-Limestone

The purity of quarried limestone from each of eight regions obtained in a survey by Japan Lime Association, and the amount of residual carbon dioxide[3], were used to establish an emission factor using a weighted average for the production volume of each region. The emission factor is 428 [kg-CO_2/t].

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[1] Portland Cement Clinker given in the *Yearbook of ceramics and building materials statistics*, is not the "clinker" recommended for use in calculations in the *GPG*.

[2] According to the Cement Sub-Group of the WBCSD (World Business Council for Sustainable Development), in its Cement CO_2 Protocol, "CO_2 Emissions Monitoring and Reporting Protocol for the Cement Industry Guide to the Protocol, Version 1.6, WBCSD Working Group Cement (October 19, 2001)", a methodology based on the total volume and constituent proportions of raw material (Japan's methodology), and a methodology based on clinker production volume allowing for CKD (Cement Kiln Dust) (the GPG methodology), are theoretically equivalent.

[3] The carbon dioxide remaining in the raw material after the manufacture of quicklime

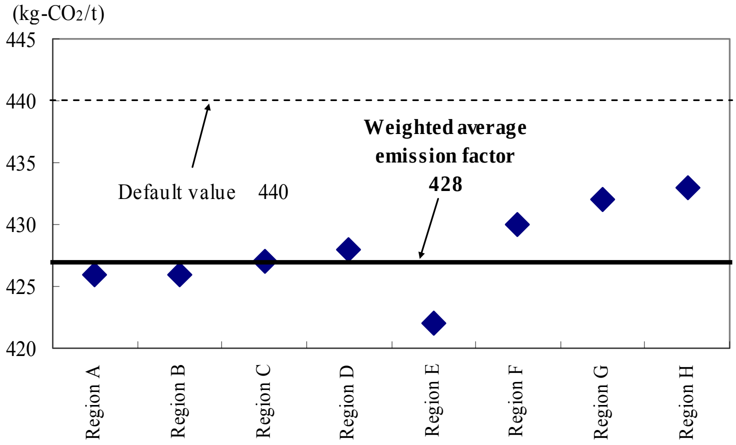

Figure 4-1 Emission factor for limestone used in lime production

N.B. Production volumes are confidential

Source: Data from the Japan Lime Association

-Dolomite

The emission factor was set by the weighted average based on the purity of quarried dolomite from each of three regions obtained in a survey by Japan Lime Association, and the amount of residual carbon dioxide (carbon dioxide remaining in the raw material after the lime production). The emission factor is 449 [kg-CO_2/t].

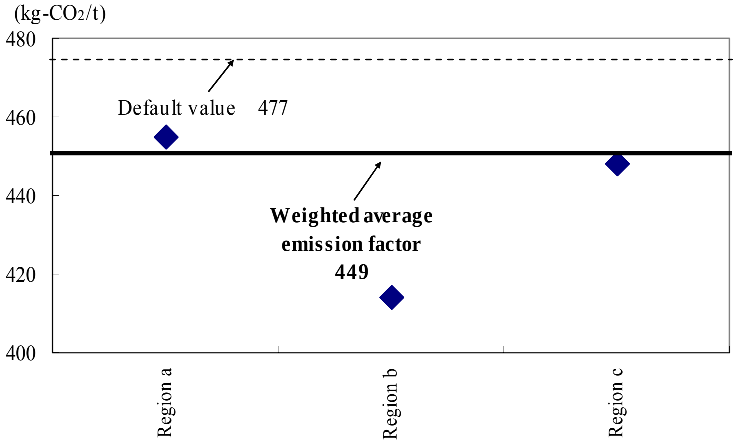

Figure 4-2 Emission factor for dolomite used in lime production

N.B. Production volumes are confidential

Source: Data from the Japan Lime Association

- ***Activity Data***

The volume of limestone and dolomite sold for lime (on calendar year basis) given in the Ministry of Economy, Trade and Industry's *Yearbook of minerals and non-ferrous metals statistics*, was used for activity data for carbon dioxide emissions associated with the manufacture of quicklime. Activity data after CY2002 were excluded from the statistical survey. Therefore, the CY2001 data was used as provisional data.

- ***Japanese Country-Specific Method***

According to the decision Tree of the *Good Practice Guidance (2000)* (page 3.20, Fig. 3.2), emission factors are to be established on the basis of the amount of quicklime manufactured by type. It is not unclear, however, whether the Japanese product categorization corresponds to the product categorization used in the methodology given in the *GPG (2000)*. Therefore, it is not possible to apply this methodology, and Japan has undertaken to calculate emissions using the methodology given above for the time being.

4.1.3. Limestone and Dolomite Use (2.A.3.)

- ***Methodology for Estimating Emissions of GHGs***

The volumes of limestone and dolomite used in iron and steel production and as raw materials in soda-lime glass are multiplied by the emission factors to calculate emissions. (Refer to *2-CO2-2005.xls¥Limestone* and *2-CO2-2005.xls¥dolomite* for details on the calculation process.)

- ***Emission Factors***

-Limestone

The emission factor for this source was calculated by multiplying the weight-to-weight ratio of limestone to carbon dioxide in the chemical reaction, by the purity of limestone. The emission factor is 435 [kg-CO_2/t].

Calculation of Emission Factor（Limestone）

$CaCO_3 \rightarrow CaO + CO_2$

- Proportion of CaO extractable from limestone: 55.4%[a]
- Molecular weight of $CaCO_3$（primary constituent of limestone）: 100.0869[b]
- Molecular weight of CaO: 56.0774 [b]

Purity = Proportion of CaO extractable from limestone
× Molecular weight of $CaCO_3$ / Molecular weight of CaO
= 55.4% × 100.0869 / 56.0774 = 98.88%

Molecular weight of CO_2: 44.0095

Emission Factor = (Molecular weight of CO_2/Molecular weight of $CaCO_3$) × Purity
= 44.0095 / 100.0869 × 0.9888 = 0.4348 [t-CO_2/t]
= **435** [kg-CO_2/t]

Source

a. Median of 54.8%～56.0%: Japan Lime Association *The Story of Lime*

b. IUPAC Atomic Weights of the Elements 1999
(http://www.chem.qmul.ac.uk/iupac/AtWt/AtWt9.html)

-Dolomite

The emission factor for this source was calculated by multiplying the proportion of calcium oxide extractable from dolomite (33.1% to 35.85%; Japan Lime Association, *The Story of Lime*), by the weight-to-weight ratio of calcium carbonate to carbon dioxide in the chemical reaction, and by multiplying the proportion of magnesium oxide extractable from dolomite (17.2% to 19.5%; Japan Lime Association, *The Story of Lime*) by the weight-to-weight ratio of magnesium carbonate to carbon dioxide, then adding the two products. The emission factor is 471 [kg-CO_2/t].

Calculation of Emission Factor (Dolomite)

$CaCO_3 \rightarrow CaO + CO_2$

$MgCO_3 \rightarrow MgO + CO_2$

Proportion of CaO extractable from dolomite: 34.5%[a]
Proportion of MgO extractable from dolomite: 18.3%[b]

Molecular weight of $CaCO_3$ (primary constituent of dolomite) : 100.0869[c]
Molecular weight of $MgCO_3$ (primary constituent of dolomite): 84.3139[c]
Molecular weight of CaO: 56.0774[c]
Molecular weight of MgO: 40.3044[c]

$CaCO_3$ content = Proportion of CaO extractable from dolomite
× Molecular weight of $CaCO_3$ / Molecular weight of CaO
= (34.5% × 100.0869) / 56.0774 × 100 = 61.53%
$MgCO_3$content = Proportion of MgO extractable from dolomite
× Molecular weight of $MgCO_3$ / Molecular weight of MgO
= 18.3% × 84.3139/40.3044 × 100 = 38.39%

Molecular weight of CO_2: 44.0095

Emission Factor = ([Molecular weight of CO_2 / Molecular weight of $CaCO_3$]
× $CaCO_3$ content)
+ ([Molecular weight of CO_2/ Molecular weight of $MgCO_3$]
× $MgCO_3$ content)
= ([44.0095/100.0869]×0.6153) + ([44.0095/84.3139]×0.3839)
= 0.2706 [t-CO_2/t] + 0.2004 [t-CO_2/t] = 0.4709 [t-CO_2/t]
= **471** [kgCO_2/t]

Source
a. Median of 33.1%～35.8%: Japan Lime Association *The Story of Lime*
b. Median of 17.2%～19.5%: Japan Lime Association *The Story of Lime*
c. IUPAC Atomic Weights of the Elements 1999
(http://www.chem.qmul.ac.uk/iupac/AtWt/AtWt9.html)

- ***Activity Data***

The volumes of limestone and dolomite sold for use in steel refining and soda glass, as given in the Ministry of Economy, Trade and Industry’s *Yearbook of minerals and non-ferrous metals statistics*[4], were used as the activity data for carbon dioxide emissions from limestone and dolomite use.

Volumes of limestone and dolomite sold for soda glass in 2000 and 2001 were excluded from the statistical survey. Therefore, the average of the latest years was used as provisional consumption data.

- ***Completeness***

Emissions of carbon dioxide from limestone and dolomite used in the sinter furnace that is part of the iron and steel production process were included in this emission source (Category 2.A.3. of the Common Reporting Format (hereafter, CRF)). (See 4.3.1.3. Sinter (2.C.1.-))

4.1.4. Soda Ash Production Use (2.A.4.)

Soda ash in Japan is produced using a parallel production method. In the parallel production method, carbon dioxide generated during the calcinations of limestone and synthesis of ammonia is uses as a raw material for production of soda ash. The carbon dioxide is almost entirely incorporated into the product, but it is likely that some carbon dioxide is released to the atmosphere in the manufacturing process. The carbon dioxide in question may already have been calculated in Limestone and Dolomite Use (2.A.3.), and Ammonia Production (2.B.1.), but as investigation to date is inadequate, it was reported as “NE”.

4.1.5. Asphalt Roofing (2.A.5.)

Asphalt roofing is manufactured in Japan, but information about the manufacturing process and activity data is inadequate, and it is not possible to definitively conclude that carbon dioxide are not emitted from the manufacture of asphalt roofing. Emissions have also never been actually measured, and as no default emission value is available, it is not currently possible to calculate emissions. Therefore, it has been reported as “NE”.

4.1.6. Road Paving with Asphalt (2.A.6.)

Roads in Japan are paved with asphalt, but almost no carbon dioxide would be emitted in the process. It is not possible, however, to be completely definitive about such emissions. Emissions have also never been actually measured, and as no default emission value is available, it is not currently possible to calculate emissions. Therefore, it has been reported as “NE”.

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[4] Due to the restructuring of statistics, data after FY2002 was obtained from *Yearbook of Mineral Resources and Petroleum Products Statistics* of METI.

4.2. Chemical Industry (2.B.)

4.2.1. Ammonia Production (2.B.1.)

1) CO_2

- ***Methodology for Estimating Emissions of GHGs***

The volumes of the different types of fuel consumed as raw materials in the production of ammonia were multiplied by the emission factor to calculate the emissions. (Refer to *2-CO2-2005.xls¥Ammonia* for detail on the calculation process).

- ***Emission Factors***

The same emission factors as used in calculating carbon dioxide from the fuel combustion sector were used. (Refer to Chapter 3.)

- ***Activity Data***

The fixed units (e.g., weight, volume) for different types of fuel given in the table below, from the Ministry of Economy, Trade and Industry's *Yearbook of the Current Survey of Energy Consumption,* were converted using the calorific values given in the Agency for Natural Resources and Energy's the *General Energy Statistics* to obtain the activity data. Data on the consumption of certain types of the fuel is confidential.

Table 4-1 Raw materials used in ammonia production, and their calorific values

Raw Material	Unit	Calorific Value [a]	
		up to FY1999	after FY2000
Coal	kg	26.0 [MJ/kg] [b]	26.6 [MJ/kg] [b]
Naphtha	L	33.5 [MJ/L]	34.1 [MJ/L]
Petroleum coke	kg	35.6 [MJ/kg]	35.6 [MJ/kg]
LPG	kg	50.2 [MJ/kg]	50.2 [MJ/kg]
LNG	kg	54.4 [MJ/kg]	54.5 [MJ/kg]
Natural gas	m^3	41.0 [MJ/Nm^3]	40.9 [MJ/Nm^3]
Coke oven gas	m^3	20.1 [MJ/Nm^3]	21.1 [MJ/Nm^3]
Petroleum-derivative hydrocarbon gases	m^3	39.3 [MJ/Nm^3] [c]	44.9 [MJ/Nm^3] [c]

a. Gross Calorific Value
b. The calorific value of imported steaming coal was used.
c. The calorific value of oil refinery gas was used.

- ***Point to Note***

Fuel consumption in this category has been deducted from activity data in the energy sector (Refer to Chapter 3).

2) CH_4

Emission of methane from the ammonia production has been confirmed by actual measurements. As there are not any sufficient examples enough to enable the establishment of an emission factor, it is not currently possible to calculate emission levels. The *Revised 1996 IPCC Guidelines* also do not give a default emission factor. Therefore, methane was reported as “NE”.

3) N_2O

Emission of nitrous oxides from the ammonia production is not theoretically conceivable, and given that even in actual measurements the emission factor for nitrous oxides is below the limits of measurement, nitrous oxides were reported as “NA”.

4.2.2. Nitric Acid Production (2.B.2.)

• *Methodology for Estimating Emissions of GHGs*

Emissions reported from factories and the emission factors[5] were used in accordance with Decision Tree of the *Good Practice Guidance (2000)* (page 3.31, Fig. 3.4) to report on emissions.

• *Emission Factors*

Aggregated emissions reported from factories to the Ministry of Economy, Trade and Industry have been reported, but emissions from the individual factory are categorized as confidential data. For convenience, therefore, actual data from ten factories located throughout Japan was shown to establishing emission factors using weighted averages of the production volumes of each factory, which were then recorded on the calculation sheet. (Refer to *2-N2O-2005.xls¥N2Oemissions* for detail.)

The emission factors for all factories fall within the range 0.8~8.6 [kg N_2O/t HNO_3 (98%)].

• *Activity Data*

Production volumes (on fiscal year basis) of nitric acid (converted at 98%) given in the Ministry of Economy, Trade and Industry’s *Yearbook of Chemical Industries Statistics* were used as the activity data for emissions of nitrous oxide during the manufacture of nitric acid. The fiscal data for the latest year was directly provided by the Ministry of Economy, Trade and Industry.

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[5] Data provided by METI

4.2.3. Adipic Acid Production (2.B.3.)

- ***Methodology for Estimating Emissions of GHGs***

Emissions reported by operating sites, emission factor and decomposition volumes were used in accordance with Decision Tree of the *Good Practice Guidance (2000)* (page 3.31, Fig. 3.4) to report on emissions.

Calculation of Emissions

Emissions = Emission Factor × Production of adipic acid
= [Rate of generation of N_2O × (1 - Rate of decomposition of N_2O
× Operating rate of decomposition unit)] × Production of adipic acid

Source: *GPG (2000)*, page 3.30, Equation 3.9

- ***Emission Factors***

Values calculated using the above equation has been used as the emission factors. Parameters were established by the following methods. Relevant data used in estimation is confidential.

-Rate of generation of nitrous oxide

The figure based on actual measurement[6] data has been used. The actual measurement data is provided from the only operating site in Japan that is producing adipic acid as an end product.

-Rate of decomposition of nitrous oxide

The figure used is the result of measurement of the rate of decomposition of nitrous oxide in the operating site.

-Operating rate of decomposition unit

A full-scale survey on the number of hours operated is conducted annually for N_2O decomposition units and adipic acid production plants. The figure adopted here is based on this survey.

Calculation of operating ratio of decomposition unit

Operating ratio of decomposition unit (%)
= Number of hours worked of decomposition unit
/ Number of hours worked of adipic acid production plants × 100 (%)

Number of hours worked of decomposition unit:
Hours starting from the beginning of feeding the entire volume of N_2O gases till the end of feeding
Number of hours worked of adipic acid production plants:
Hours starting from the beginning of feeding materials till the end of feeding

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[6] Miyazaki Prefecture, Environmental Agency, *Emission of Greenhouse Gases from Fixed Sources*, 1995

- ***Activity Data***

The data used for activity data for nitrous oxide emissions associated with the manufacture of adipic acid was the production of adipic acid submitted to the Ministry of Economy, Trade and Industry by the manufacturer. Relevant data used in estimation is confidential.

- ***Point to Note***

From 1990 to 1997, N_2O emissions from the adipic acid production increased gradually. However, given the fact that N_2O decomposition units started operating in adipic acid production plants after May 1999, the emissions after 1999 have decreased dramatically. The temporary growth of the emissions in 2000 resulted from the low operating ratio of N_2O decomposition units then due to the breakdown of the decomposition units.

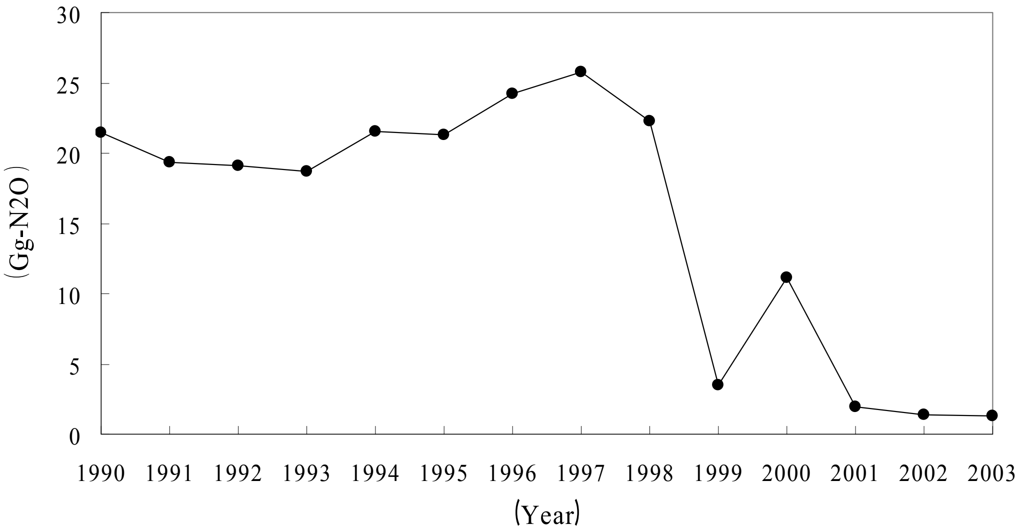

Figure 4-3　Trend of N_2O emissions from the adipic acid production

4.2.4. Carbide Production (2.B.4.)

4.2.4.1. Silicon Carbide (2.B.4.-)

1) CO_2

Only one company in Japan produces silicon carbide. Carbon dioxide is thought to be emitted in the process of silicon carbide production, but the data required for activity data for the calculation of emissions (use of coking coal) has not been published, and as it is not currently possible to calculate emission levels, the data was reported as “NE”.

2) CH_4

Silicon carbide is manufactured in Japan in electric arc furnaces, and when it is manufactured, the oxidation of coking coal used as a reducing agent is thought to give rise to methane. The electric arc furnaces used in the production of carbide correspond to Table No. 1-12 of Execution Ordinance for the Air Pollution Control Law, and emissions of methane from such furnaces have already been calculated under Emissions of Methane Associated with the Use of Electric Arc Furnaces, Combustion of Fuel (1A). Therefore, the emissions have been reported as “IE”.

4.2.4.2. Calcium Carbide (2.B.4.-)

1) CO_2

Calcium carbide is produced in Japan, and emissions for carbon dioxide from the manufacturing process have been confirmed through actual measurements. The gathered data in relation to the realities of emissions is insufficient, however, and it is still required to investigate on the appropriateness of applying the default emission factor. Therefore, at this point, emissions have not been calculated, and have been reported as “NE”.

2) CH_4

The gathered data about the realities of methane emissions in the calcium carbide manufacturing process is insufficient, and it is not currently possible to calculate emission levels. As no default emission factor has been given, too, it is not currently possible to calculate emission levels, and hence it has been reported as “NE”.

4.2.5. Other (2.B.5.)

4.2.5.1. Carbon Black (2.B.5.-)

- ***Methodology for Estimating Emissions of GHGs***

Production of carbon black was multiplied by the country-specific emission factor to report on methane emissions from carbon black production.

- ***Emission Factors***

Five major companies, providing 96% of domestic production, recover methane generated in the carbon black production processes and use it in recovery furnaces and flare stacks. Therefore, there are no emissions during normal operation. Hence, the emission factor was established by estimating emissions of methane during routine inspections and the boiler inspection carried out by the five major domestic producers, deriving from weighted averages and using production volumes of carbon black. The emission factor is 0.35 [kg-CH_4/t].

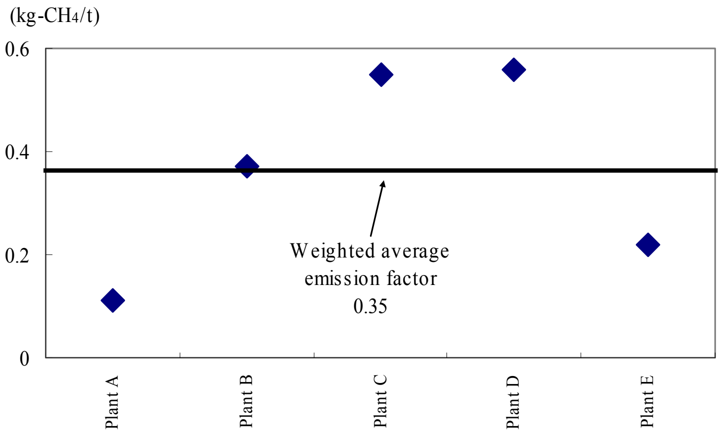

Figure 4-4 CH_4 Emission factor for carbon black production

Source: Data provided by the Carbon Black Association

Table 4-2 Methane emissions and carbon black production by five main domestic producers

	Carbon black production [t/year]	Methane emissions [kg-CH_4/year]	Emission factor [kg-CH_4/t]
Total from five main companies	701,079	246,067	0.350

Source: Data provided by the Carbon Black Association (1998 actual results)

- ***Activity Data***

Carbon black production volumes (on fiscal year basis) given in the *Yearbook of Chemical Industries Statistics* compiled by the Ministry of Economy, Trade and Industry (METI) were used for activity data for methane emissions associated with the manufacture of carbon black. The data for the latest year was directly provided by the METI since it was not indicated in the latest *Yearbook of Chemical Industries Statistics*.

4.2.5.2. Ethylene (2.B.5.-)

1) CO_2, CH_4

- ***Methodology for Estimating Emissions of GHGs***

Emissions of methane and carbon dioxide associated with the manufacture of ethylene were reported by multiplying ethylene production by country -specific emission factor.

- ***Emission Factors***

-CH_4

Estimates of volume of exhaust gas from flare stacks at operational startup and shutdown at operating sites in Japan (assuming that 98% of the volume that enters is combusted), and measured volume of exhaust gas from naphtha cracking furnace and furnaces heated by re-cycled gas, were divided by the production volume to calculate emission factors for each company. The weighted average of production from each company was then applied to establish the emission factor. The emission factor is 0.015 [kg-CH_4/t].

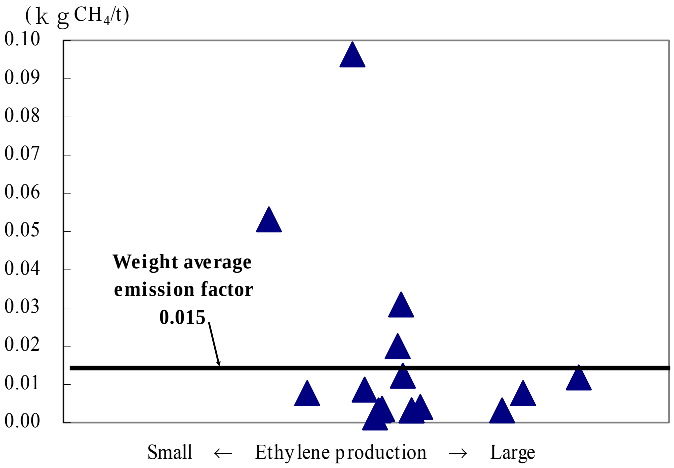

Figure 4-5 Emission factor for methane from manufacturing ethylene

Source: Data provided by the Japan Petrochemical Industry Association

-CO_2

Emission factors for a normal operation and an unsteady operation at operating sites in Japan were established using actual measurement data recorded in FY2000. The emission factor was set, assuming that all carbon dioxide refined in the naphtha-cracking sector is emitted, which was a pre-condition in establishing the emission factor. The emission factor is 0.028 [t-CO_2/t]

Table 4-3 Emission factor for CO_2 from ethylene production (FY2000)

	[t-CO_2 / t]
Ethylene production	0.028

Source: Data provided by the Japan Petrochemical Industry Association

- ***Activity Data***

Ethylene production volumes (on fiscal year basis) from the *Yearbook of Chemical Industries Statistics* compiled by the Ministry of Economy, Trade and Industry (METI) were used as activity data for emissions of methane and carbon dioxide from ethylene production. The data for the latest year was directly provided by the METI since it was not indicated in the latest *Yearbook of Chemical Industries Statistics*.

2) N_2O

There is almost no nitrogen in naphtha, the raw material in ethylene production, and the ethylene production process takes place under conditions that are almost completely devoid of oxygen. Even if there is any generation of nitrous oxide from the process, it can be considered to be negligible. However, there are no measurement results, and the *Revised 1996 IPCC Guidelines* do not provide a default value, making it impossible to calculate nitrous oxide emissions. Therefore, it has been reported as “NE”.

4.2.5.3. 1,2-Dichloroethane (2.B.5.-)

• *Methodology for Estimating Emissions of GHGs*

Methane emissions from 1,2-dichloroethane production were reported by multiplying production volumes by country-specific emission factor.

• *Emission Factors*

The concentration of methane in waste gas from three member companies of the Vinyl Environmental Council (representing approximately 70% of total 1,2-dichloroethane production in Japan) was measured, and weighted averages were calculated to establish the emission factor. The emission factor is 0.0050 [kg-CH_4/t].

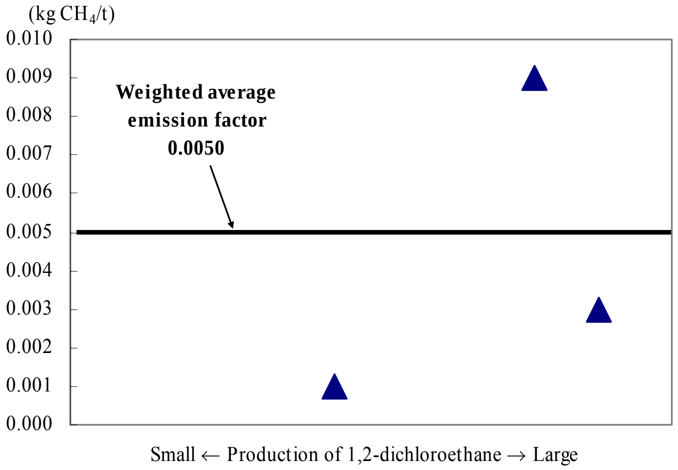

Figure 4-6 Methane emission factors for 1,2-dichloroethane production

Source: Data provided by the Vinyl Environmental Council

• *Activity Data*

Dichloroethane production volumes (on fiscal year basis) from the *Yearbook of Chemical Industries Statistics* compiled by the Ministry of Economy, Trade and Industry (METI) were used as activity data for methane emissions from 1,2-dichloroethane production. The data for the latest year was directly provided by the METI since it was not indicated in the latest *Yearbook of Chemical Industries Statistics*.

4.2.5.4. Styrene (2.B.5.-)

- ***Methodology for Estimating Emissions of GHGs***

Methane emissions from styrene production were reported by multiplying styrene production volumes by country-specific emission factor.

- ***Emission Factors***

Estimates of volume of exhaust gas from flare stacks at operational startup and shutdown at operating sites in Japan (assuming that 98% of the volume that enters is combusted), and measured volume of waste gas from heating furnaces, were divided by the production volume to calculate emission factors for each company. The weighted average of production from each company was then applied to establish the emission factor. The emission factor is 0.031 [kg-CO_2/t].

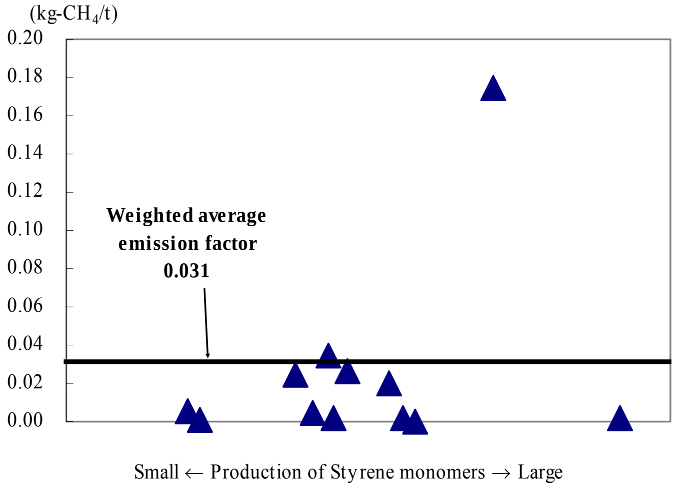

Figure 4-7 Methane emission factors for styrene production

Source: Data provided by the Japan Petrochemical Industry Association

- ***Activity Data***

Styrene monomer production volumes (on fiscal year basis) from the *Yearbook of Chemical Industries Statistics* compiled by the Ministry of Economy, Trade and Industry (METI) were used as activity data for methane emissions from styrene production. The data for the latest year was directly provided by the METI since it was not indicated in the latest *Yearbook of Chemical Industries Statistics*.

4.2.5.5. Methanol (2.B.5.-)

- ***Methodology for Estimating Emissions of GHGs***

Production volumes of methanol were multiplied by the default emission factor given in the *Revised 1996 IPCC Guidelines* to report on methane emissions from methanol production between 1990 and 1995.

- ***Emission Factors***

The default value for methanol given in the *Revised 1996 IPCC Guidelines* was used. The emission factor is 2 [kg-CH_4/t].

Table 4-4 Methane emission factor from methanol production

	[kg-CH_4 / t]
Methanol Production	2

Source: Revised 1996 IPCC Guidelines Vol. 2 p 2.22, Table 2-9

- ***Activity Data***

Production volumes of methanol (on calendar year basis) given in *Methanol Supply and Demand* published by the Methanol and Formalin Association were used as activity data for methane emissions from methanol production.

- ***Point to Note***

Methanol production (synthesis) in Japan ceased in 1995, due to a difference in domestic and international prices, and since then all methanol consumed in Japan has been imported subsequently. Around 1995, domestic plants for methanol production also ceased to exist. Since 1996, no methanol has been produced domestically and it has been reported as “NO”.

In addition, refined methanol given in the *Yearbook of Chemical Industries Statistics* is called Production of Refined Methanol, which is identified as shipment volumes. The only process in the course of refining methanol is the dehydration of synthesized methanol. In principle, therefore, methane is not generated. It is not appropriate to use the data on Production of Refined Methanol, identified as shipment volumes, as the activity data.

4.2.5.6. Coke (2.B.5.-)

1) CH_4

- ***Methodology for Estimating Emissions of GHGs***

Methane emissions from coke production were reported by multiplying the production volume of coke by the country-specific emission factor.

- ***Emission Factors***

Methane emissions from coke production come from two sources: methane in combustion exhaust gas that leaks between the carbonization chamber and the combustion chamber, and methane emitted from the coking furnace lid, the desulfurization tower, or the desulfurization recycling tower, in the carbonization process.

-Combustion exhaust gas

The production volume of coke was used in conjunction with the concentration of methane in the exhaust gas from coking furnaces operated by five companies at seven operating sites (surveyed by the Japan Iron and Steel Federation) to derive a weighted average, which was established as the emission factor. The emission factor is 0.089 [kg-CH_4/t].

It is possible that there is some overlap between the emission factor for industrial processes (fugitive from processes) and methane from fuel combustion sources, but as the majority should be fugitive emissions, it has been reported in this category.

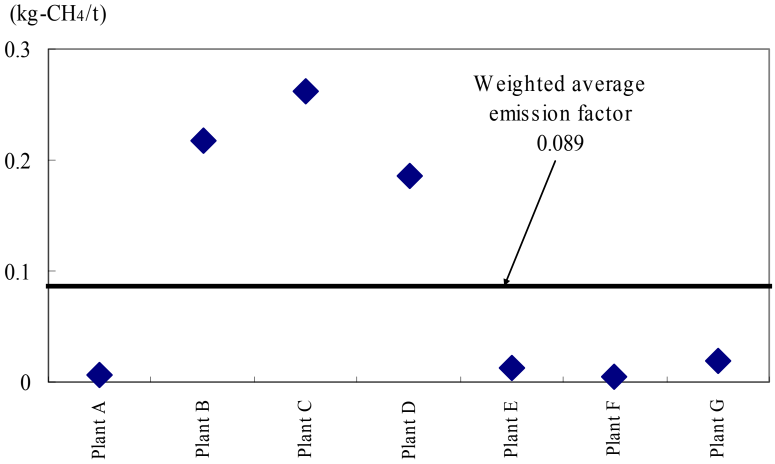

Figure 4-8 Emission factors for methane in combustion exhaust gas from coking furnaces

Source: Data provided by the Japan Iron and Steel Federation

-Coking furnace lid, desulfurization tower, and desulfurization recycling tower

The Japan Iron and Steel Federation has had a voluntary plan in place since fiscal 1997 to manage noxious atmospheric pollutants, and methane emissions have been estimated from emissions of other substances from the lid of coking furnaces. The emission factor has been established by taking a weighted average using this data and the volume of production of coke.

Table 4-5 Emission factor of methane from coking furnace lids, desulfurization towers, and desulfurization recycling towers

Fiscal year	CH_4 EF [kg-CH_4/t]	Remarks
1990～1996	0.238	It has been assumed that changes in emission factor are small, and the actual figure for 1995 has been applied to other fiscal years in which no actual results are available.
1997～1999	0.180	It has been assumed that values for fiscal 1998 and 1999 were the same as in 1997.
2000	0.101	Actual results
2001	0.062	Actual results
2002	0.052	Actual results
2003	0.042	Actual results

Source: Data provided by the Japan Iron and Steel Federation

-Methane emission factor for coke production

The aforementioned *Combustion Exhaust Gas* and *Coking Furnace Lids, Desulfurization Towers, and Desulfurization Recycling Towers* have been added, and the resulting figure has been used as the emission factor.

• *Activity Data*

Production volume (on fiscal year basis) given in the *Yearbook of production, supply and demand of petroleum, coal and coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* compiled by the Ministry of Economy, Industry and Trade has been used as the activity data for methane emitted from coke production.

• *Completeness*

The SBDT[7] (Table 2(I).A-Gs2) in the CRF requires emissions of carbon dioxide and methane from coke production to be reported as a sub-category of 2.C.1. Steel Manufacture, but coke is also manufactured in Japan in industries other than the steel industry. The emissions have therefore been counted in this category.

2) CO_2, N_2O

Coke is mainly produced in the iron and steel production in Japan, and it is conceivable that carbon dioxide and nitrous oxide will be generated during the carbonization of coal in the process of producing coke, and it may leak from the lid of the coking furnace. Currently, however, there is no actual measurement data of emissions, and it is not possible to calculate emissions. No default emission factor is given in the *Revised 1996 IPCC Guidelines*, and emissions have been reported as “NE”.

4.3. Metal Production (2.C.)

4.3.1. Iron and Steel Production (2.C.1.)

4.3.1.1. Steel (2.C.1.-)

1) CO_2

Coke oxidizes when it is used as a reduction agent in the steel production, and carbon dioxide is generated. The volume of coke used has been included under consumption of fuel in Fuel Combustion Sector (1.A.), and the carbon dioxide generated through the oxidization of coke used as a reducing agent has already been calculated under Fuel Combustion Sector (1.A.), too. Therefore, it has been reported as “IE”.

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[7] SBDT: Sectoral Background Data Table

4.3.1.2. Pig Iron (2.C.1.-)

1) CO_2

Carbon dioxide generated from pig iron production is emitted when coke is used as a reduction agent. The amount of coke used has been included under consumption of fuel in Fuel Combustion Sector (1.A.), and the carbon dioxide generated through the oxidization of coke used as a reducing agent has already been calculated under Fuel Combustion Sector (1.A.), too. Therefore, it has been reported as “IE”.

2) CH_4

It is not theoretically possible that methane will be generated in association with the pig iron production, and it has been confirmed that methane is not emitted from actual measurements. Therefore, emissions have been reported as “NA”.

4.3.1.3. Sinter (2.C.1.-)

1) CO_2

Carbon dioxide generated in the course of sinter production is all generated as a result of the combustion of coke fines, and such emissions correspond to Fuel Combustion Sector (1.A.), and have all been taken into account under Fuel Combustion Sector (1.A.). For that reason, occurrence of carbon dioxide in the industrial process area is inconceivable, and it has been reported as “NA”.

Carbon dioxide emissions from limestone and dolomite used in the sinter production have been counted under *4.1.3. Limestone and Dolomite Use (2.A.3.)*.

2) CH_4

Methane generated in the course of sinter production is all generated as a result of the combustion of coke fines, and such emissions correspond to Fuel Combustion Sector (1.A.), and have all been taken into account under Fuel Combustion Sector (1.A.). For that reason, occurrence of methane in the industrial process area is inconceivable, and it has been reported as “NA”.

4.3.1.4. Coke (2.C.1.-)

1) CO_2

Coke is mainly produced in the iron and steel production in Japan, and it is conceivable that carbon dioxide generated during the carbonization of coal in the process of producing coke may leak from the lid of the coking furnace. Currently, however, there is no actual measurement data of emissions, and it is not possible to calculate emissions. No default emission factor is given in the *Revised 1996 IPCC Guidelines*, and emissions have been reported as “NE”.

2) CH_4

Emissions of methane were calculated at *4.2.5.6. Coke (2.B.5.-)*, and have been reported as "IE".

4.3.2. Ferroalloys Production (2.C.2.)

1) CO_2

Ferroalloys are produced in Japan, and the carbon dioxide that is generated in association with the ferroalloys production is emitted as a result of the oxidization of coke used as a reducing agent. Consumption of coke is included in consumption of fuel under Fuel Combustion Sector (1.A.), and carbon dioxide generated as a consequence of the oxidization of coke used as a reduction agent has already been calculated under Fuel Combustion Sector (1.A.). Residual carbon in the ferroalloys is oxidized when the ferroalloys are used in the production of steel, and are released to the atmosphere as carbon dioxide. Therefore, it has been reported as "IE".

2) CH_4

Ferroalloys are manufactured in Japan in electric arc furnaces, small-scale blast furnaces, and Thermit furnaces. Methane generated in association with the ferroalloys production is thought to be generated when the oxidization of coke, a reduction agent, takes place. Methane emissions from the various types of furnace have already been incorporated under Fuel Combustion Sector (1.A.), and have therefore been reported as "IE".

4.3.3. Aluminium Production (2.C.3.)

1) PFCs

• *Methodology for Estimating Emissions of GHGs*

Emissions were calculated by multiplying production volumes from primary refining of aluminum by emission factors calculated at domestic facilities based on the methods specified in the *Revised 1996 IPCC Guidelines*.

• *Emission Factors*

Emission factors have been established by using the calculation method for emission factor stipulated in the Tier 1b manual method of the *Revised 1996 IPCC Guidelines*. The emission factors are given below.

Table 4-6 PFCs emission factor of aluminum production

	Unit	1995	2000	2001	2002	2003
PFC-14 (CF_4)	kg PFC-14/t	0.542	0.377	0.330	0.318	0.315
PFC-116 (C_2F_6)	kg PFC-116/t	0.054	0.038	0.033	0.031	0.031

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

- ***Activity Data***

Volume of production of aluminum given in the *Yearbook of Minerals and Non-Ferrous Metals Statistics* compiled by the Ministry of Economy, Trade and Industry was used for activity data for PFCs associated with aluminum smelting. Primary aluminum production in Japan is as small as 0.03% of the world total production.

2) CO_2

Carbon dioxide generated in association with aluminum smelting is emitted in conjunction with the oxidization of the anode paste used as a reducing agent. Consumption of coke, the main ingredient in the anode paste has been included in fuel consumption under Fuel Combustion Sector (1.A.), and the carbon dioxide that is generated by the oxidization of coke used as a reducing agent has already been calculated under Fuel Combustion Sector (1.A.). Therefore, it has been reported as “IE”.

3) CH_4

There is a small amount of hydrogen in the pitch that act as a raw material for the anode paste used in aluminum smelting. Theoretically, therefore, it is possible that methane could be generated. As there is no actual data on emissions, however, it is not possible to calculate emissions. There is also no emission factor offered in the *Revised 1996 IPCC Guidelines*, and no data on the hydrogen content of pitch. As it is not possible to estimate an emission factor, emissions have been reported as “NE”.

4.3.4. SF_6 Used in Aluminium and Magnesium Foundries (2.C.4.)

4.3.4.1. Aluminium

The Japan Aluminum Association has indicated that there is no evidence of use of SF_6 when casting aluminum in Japan, at least to the extent of the data the Association holds. Complete knowledge in relation to use of the substance by individual companies is not easily attainable. Hence, it has been reported as “NE”.

4.3.4.2. Magnesium

The data that has been reported is given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council, for emissions of SF_6 used in magnesium foundries. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2C* for detail on the calculation process and related indices.)

Table 4-7 Indices related to SF_6 used in magnesium foundries

	Unit	1995	2000	2001	2002	2003
Consumption of SF_6	t	5	43	48	47	31
Molten Magnesium	t	1,840	14,231	14,562	17,500	17,724

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

4.4. Other Production (2.D.)

4.4.1. Pulp and Paper (2.D.1.)

(According to the CRF, it is required to report on emissions of nitrogen oxides (NO_X), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), and sulfur dioxide (SO_2).)

4.4.2. Food and Drink (2.D.2.)

Foods and drinks are manufactured in Japan, and because carbon dioxide is used in the manufacturing process (frozen carbon dioxide and raw material for carbonated drinks, etc.), it is conceivable that carbon dioxide is emitted into the atmosphere in the course of manufacturing. The carbon dioxide used in the process of manufacturing foods and drinks, however, is a by-product gas of petrochemical products, and as such emissions have already been incorporated into Fuel Combustion Sector (1.A.), they have been reported as “IE”.

4.5. Production of Halocarbons and SF_6 (2.E.)

4.5.1. By-product Emissions: Production of HCFC-22 (2.E.1.-)

The figure that has been reported is that given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council, for emissions of by-product HFC-23 associated with the production of HCFC-22. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2E* for details on the calculation process and related indices.)

Table 4-8 Indices related to By-product Emissions of HFC-23: Production of HCFC-22

	Unit	1995	2000	2001	2002	2003
HCFC-22 production	t	81,000	95,271	88,157	72,787	77,310
Generation Factor	%	2.13%	1.70%	1.39%	1.54%	1.65%
Emission Factor	%	1.79%	1.11%	0.91%	0.72%	0.56%

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

4.5.2. Fugitive Emissions (2.E.2.)

The figures that have been reported are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for fugitive emissions from manufacture of HFCs, PFCs, and SF_6. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2E* for detail on the calculation process and related indices.)

Table 4-9 Indices related to fugitive emissions from HFCs, PFCs, and SF_6 production

GHGs	Item	Unit	1995	2000	2001	2002	2003
HFCs	HFCs production	t	28,280	29,505	38,361	43,816	49,257
	Emission Factor	%	1.17%	0.51%	0.60%	0.66%	0.54%
PFCs	PFCs production	t	1,207	2,337	2,141	2,278	2,602
	Emission Factor	%	8.82%	7.87%	6.91%	5.88%	4.92%
SF_6	SF_6 production	t	2,392	1,556	1,666	1,642	1,757
	Emission Factor	%	8.24%	2.31%	1.98%	2.13%	1.94%

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

4.6. Consumption of Halocarbons and SF_6 (2.F.)

4.6.1. Refrigeration and Air Conditioning Equipment (2.F.1.)

4.6.1.1. Domestic Refrigeration (2.F.1.-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for HFCs emissions from domestic refrigeration. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-10 Indices related to emissions of HFCs from domestic refrigeration

Item	Unit	1995	2000	2001	2002	2003
Total HFC Charged in the year	t	520	590	563	414	250
Fugitive Ratio from Manufacturing	%	1.0%	1.0%	0.49%	0.44%	0.21%
Device Stock	1000 devices	7,829	33,238	37,664	41,221	43,183
Refrigerant contained	g / device	150	125	128	125	125
Refrigerant filled while using	%	0.3%	0.3%	0.3%	0.3%	0.3%
Discarded Devices	1000 devices	0	160	320	573	904

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

2) PFCs

As there are no records of their usage of PFCs for domestic refrigeration in Japan, it was reported as "NO".

4.6.1.2. Commercial Refrigeration (2.F.1.-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFC emissions from commercial refrigeration. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-11 Indices related to emissions of HFCs from commercial refrigeration

Item	Unit	1995	2000	2001	2002	2003
Device contained HFC Production (Manufacturing)	1000 devices	214	1,061	973	1,518	1,706
Refrigerant contained from Manufacturing	kg / device	840	476	713	2,291	2,598
Fugitive Refrigerant Ratio from Manufacturing	%	-	(0.2%)	(0.2%)	0.2%	0.2%
Device contained HFC Production (Application)	%	10	34	67	523	659
Refrigerant contained from Installation	t	15,944	5,496	6,344	1,800	1,802
Fugitive Refrigerant Ratio from Installation	1000 devices	1.0%	1.0%	1.0%	1.0%	1.0%
Device contained HFC Stocks	%	292	3,862	4,761	6,186	8,174
Fugitive Refrigerant Ratio from Supplementation	t	1.0%	1.0%	1.0%	1.0%	1.0%
Accident Occurrence Ratio	%	0.95%	0.96%	0.88%	1.13%	1.00%
Used Devices Contained HFC Production	1000 devices	0	40	46	55	57
Collect Ratio of HFC under Regulation	%	-	-	-	50	(66)※

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

*: Calculated from current data

2) PFCs

It is thought that there is no actual case for use of PFCs for commercial refrigeration, but as it has not been confirmed, emissions have been reported as “NE”.

4.6.1.3. Automatic Vender Machine (2.F.1.-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFCs emissions from automatic vender machines. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls ¥2F1* for detail on the calculation process and related indices.)

Table 4-12 Indices related to emissions of HFCs from automatic vender machines

Item	Unit	1995	2000	2001	2002	2003
Device contained HFCs Production (Distribution)	1000 devices	0	272	344	321	344
Fugitive Ratio from Manufacturing	%	-	-	0.5%	0.3%	0.3%
Working Devices	1000 devices	0	284	628	949	1,293
Annual breakdown Ratio	%	-	-	0.35%	0.35%	0.35%
Refrigerant contained	g / device	-	300	280	240	220
Refrigerant filled while servicing	g / device	-	-	-	-	-
Fugitive Ratio form Servicing	%	-	-	0.90%	0.59%	0.54%
Discarded Devices	1000 devices	0	0	0	0	0

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

2) PFCs

It is thought that there is no actual case for use of PFCs for automatic vender machine, but as it has not been confirmed, emissions have been reported as “NE”.

4.6.1.4. Transport Refrigeration (2.F.1.-)

1) HFCs

HFCs emissions have been reported as “NE”, as it is thought that emissions have not been assessed. However, some emissions from this category may have been included in commercial refrigeration and air conditioning. It will be necessary in future to confirm the detail.

2) PFCs

It is thought that there is no actual case for use of PFCs for transport refrigeration, but as it has not been confirmed, emissions have been reported as “NE”.

4.6.1.5. Industrial Refrigeration (2.F.1.-)

1) HFCs

HFCs emissions have been reported as “IE”, as they are included in *4.6.1.2. Commercial Refrigeration (2F1-).*

2) PFCs

It is thought that there is no actual case for use of PFCs for industrial refrigeration, but as it has not been confirmed, emissions have been reported as “NE”.

4.6.1.6. Stationary Air-Conditioning (Household) (2.F.1.-)

1) HFCs

The figures that have been reported are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial

Structure Council for HFCs emissions associated with stationary air-conditioning (household). The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F1* for details on the calculation process and related indices.)

Table 4-13 Indices related to emissions of HFCs from stationary air-conditioning (household)

Item	Unit	1995	2000	2001	2002	2003
Production(distribution) of devices containing HFCs	1000 devices	0	1,053	2,610	2,940	3,846
Refrigerant contained	g / device	-	1,000	1,000	1,000	1,000
Fugitive Ratio from Manufacturing	%	-	(0.1%)	(0.1%)	0.2%	0.2%
Fugitive Ratio from Installation	%	-	3.0%	2.0%	1.0%	1.0%
Device contained HFCs Stocks	1000 devices	0	1,702	4,312	7,252	10,799
Incidence Rate of accident or breakdown	%	-	0.08%	0.08%	0.08%	0.08%
Fugitive Ratio from accident	%	-	100%	100%	100%	100%

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

2) PFCs

It is thought that there is no actual case for use of PFCs for stationary air-conditioning (household), but as it has not been confirmed, emissions have been reported as “NE”.

4.6.1.7. Mobile Air-Conditioning (Car Air Conditioners) (2.F.1.-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFC-134a emissions from car air conditioners. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-14 Indices related to emissions of HFC-134a from car air conditioners

Item	Unit	1995	2000	2001	2002	2003
Vehicle used HFCs Production	1000 vehicle	9,770	9,761	9,413	9,887	9,910
Assembly Emission Factor	g / vehicle	3.5	3.5	3.5	3.5	3.5
Vehicle Stock	1000 vehicle	15,655	42,374	46,684	50,731	54,057
Average Refrigerant Weight per Vehicle	g / vehicle	700	615	603	588	582
Annual Operation Emission Factor (Passenger Vehicle)	g / vehicle / year	15	15	15	15	15
Ratio of Repairing	%	4%	4%	4%	4%	4%
Ratio of Vehicle leaking	%	50%	50%	50%	50%	50%
Vehicle Collapsed Completely	1000 vehicle	50	136	149	162	173
Refrigerant Filled in collapsed completely	g / vehicle	681	610	591	573	558
Vehicle Disassembled	1000 vehicle	116	789	996	1,266	1,552
Refrigerant Filled in disassembled	g / vehicle	676	593	579	577	544
Refrigerant Recovered	t	-	-	8	61	(246)*

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

*: Calculated from current data

2) PFCs

It is thought that there is no actual case for use of PFCs for mobile air-conditioning (car air conditioners), but as it has not been confirmed, emissions have been reported as “NE”.

4.6.2. Foam Blowing (2.F.2.)

4.6.2.1. Hard Form (2.F.2.-)

4.6.2.1.a. **Urethane Foam (2.F.2.--)**

The figures that have been reported are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFC-134a emissions from urethane foam production. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F2* for details on the calculation process and related indices.)

Table 4-15 Indices related to emissions of HFC-134a from urethane foam

Item	Unit	1995	2000	2001	2002	2003
Total HFC used in the year	t	0	167	177	201	233
Assembly Emission Rate	%	10.0%	10.0%	10.0%	10.0%	10.0%
Operational Emission Rate	%	4.5%	4.5%	4.5%	4.5%	4.5%

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

*: Default values given in *Good Practice Guidance (2000)* were used for assembly emission rate and operational emission rate.

4.6.2.1.b. **Polyethylene Foam (2.F.2.--)**

The figures that have been reported are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial

Structure Council for HFC-134a emissions associated with polyethylene foam production. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F1* for details on the calculation process and related indices.)

Table 4-16 Indices related to emissions of HFC-134a from polyethylene foam

Item	Unit	1995	2000	2001	2002	2003
HFC-134a used in the year	t	350	320	290	299	294
HFC-152a used in the year	t	14	0	0	0	0

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

*: Default values given in *Good Practice Guidance (2000)* were used for assembly emission rate and operational emission rate.

4.6.2.1.c. **Polystyrene Foam (2.F.2.--)**

The figures that have been reported are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFC-134a emissions associated with polystyrene foam production. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F2* for details on the calculation process and related indices.)

Table 4-17 Indices related to emissions of HFC-134a from polystyrene foam

Item	Unit	1995	2000	2001	2002	2003
Total HFC used in the year	t	0	0	10	35	638
Foam Yield Rate	%	75.0%	75.0%	75.0%	75.0%	75.0%
Operational Emission Rate	%	-	-	2.5%	2.5%	2.5%

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

*: Default values given in *Good Practice Guidance (2000)* were used for assembly emission rate and operational emission rate.

4.6.2.2. Soft Form (2.F.2.-)

All foam using HFCs for forming is hard foam. Emissions have therefore been reported as “NO”.

4.6.3. Fire Extinguishers (2.F.3.)

There may be actual case of use within Japan, but as it has not been confirmed, emissions have been reported as “NE”.

4.6.4. Aerosols/Metered Dose Inhalers (2.F.4.)

4.6.4.1. Aerosols (2.F.4.-)

The figures that have been reported are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for HFC-134a and HFC-152a emissions associated with aerosols. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F4* for details on the calculation process and related indices.)

Table 4-18 Indices related to emissions of HFCs from aerosols

Item	Unit	1995	2000	2001	2002	2003
Potential Emissions of HFC-134a	t	1,300	2,044	1,827	2,003	1,598
Potential Emissions of HFC-152a	t	0	34	119	189	553
Ratio of products containing single chemical	%	70%	88%	86%	95%	95%
Mixing Rate of products containing single chemical(HFC-134a)	%	-	15%	13%	16%	16%
Assembly Fugitive Ratio	%	5%	4%	3%	3%	3%
Assembly Fugitive Ratio	%	-	8%	15%	47%	80%

N.B. Figures for "Ratio of products containing single chemical" and "Assembly Fugitive Ratio" are estimates.

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

4.6.4.2. Metered Dose Inhalers (2.F.4.-)

The figures that have been reported are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for HFC-134a and HFC-227ea emissions associated with MDI. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F4* for details on the calculation process and related indices.)

Table 4-19 Indices related to emissions of HFCs from MDI

Item	Unit	1995	2000	2001	2002	2003
Domestic consumption for MDI	t	-	1.4	1.0	0.9	0.6
Imported consumption for MDI	t	-	42.0	45.0	46.5	47.3
Amount of Disposal	t	-	0.2	0.1	0.3	0.2
Domestic consumption for MDI	t	-	0.0	5.1	7.9	25.5
Imported consumption for MDI	t	-	3.6	6.7	5.2	3.6
Amount of Disposal	t	-	0.0	0.0	0.2	0.4

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

4.6.5. Solvents (2.F.5.)

The figures that have been reported for this source are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for PFC emissions associated with the use of solvents during washing of consumer electronics parts, manufacture of semiconductors, and manufacture of liquid crystals. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F5* for details on the calculation process and related indices.)

In addition, in electronic component production process, some years' implied GWP are smaller than 6,500 because PFC which is not indicated in the CRF[8] is used.

Table 4-20 Indices related to emissions of PFCs from solvents

Item	Unit	1995	2000	2001	2002	2003
Amount of Shipping PFCs for Solvent	t	1,400	953	803	549	610

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

4.6.6. Semiconductors (2.F.6.)

The figures that have been reported for this source are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for PFCs emissions associated with the use of solvents during the manufacture of semiconductors, and the manufacture of liquid crystals. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F6* for details on the calculation process and related indices.)

Table 4-21 Indices related to emissions of F-gas from manufacturing of semiconductors

Item	Unit	1995	2000	2001	2002	2003
PFCs purchased	t	523	910	707	765	819
HFC-23 purchased	t	48	49	40	43	38
SF_6 purchased	t	91	132	94	95	95
Supply Rate for Process	%	90.0%	90.0%	90.0%	90.0%	90.0%
Chemical Reaction Consumption Rate of PFCs etc.	%	20% - 80%				
Reselection Efficiency of PFCs etc.	%	90.0%	90.0%	90.0%	90.0%	90.0%
Generation Rate of by-product	%	C_2F_6(PFC-116):10%, C_3F_8(PFC-218):20%, c-C_4F_8(PFC-c318):10%				
Desellection Efficiency of CF_4	%	90.0%	90.0%	90.0%	90.0%	90.0%

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

Table 4-22 Indices related to emissions of F-gas from manufacturing of liquid crystals

Item	Unit	1995	2000	2001	2002	2003
PFC-14 purchased	t	20.7	47.3	30.9	41.0	46.6
PFC-116 purchased	t	0.4	2.7	3.9	3.4	5.3
PFC-c318 purchased	t	0.0	0.0	0.0	0.0	0.5
HFC-23 purchased	t	0.1	0.7	1.0	1.3	1.3
SF_6 purchased	t	11.5	85.3	83.3	93.8	99.1
Supply Rate for Process	%	90.0%	90.0%	90.0%	90.0%	90.0%
Chemical Reaction Consumption Rate of PFCs etc.	%	20% - 80%				
Reselection Efficiency of PFCs etc.	%	90.0%	90.0%	90.0%	90.0%	90.0%
Generation Rate of by-product	%	C_2F_6(PFC-116):10%, c-C_4F_8(PFC-c318):10%				
Desellection Efficiency of CF_4	%	90.0%	90.0%	90.0%	90.0%	90.0%

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

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[8] CF_4, C_2F_6, C_3F_8, C_4F_{10}, c-C_4F_8, C_5F_{12} and C_6F_{14} are indicated in the CRF.

4.6.7. Electrical Equipment (2.F.7.)

The figures that have been reported for this source are given in a documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for SF_6 emissions from electrical equipment. The associated indices are given in the table below. (Refer to *2-Fgas-A-2005.xls¥2F7* for details on the calculation process and related indices.)

Table 4-23 Indices related to emissions of SF_6 from electrical equipment

	Item	Unit	1995	2000	2001	2002	2003
Electrical Equipment Assemble	SF_6 purchased	t	1,380	649	577	470	591
	SF_6 contained	t	1,464	450	425	348	459
	Stocks of SF_6	t	-	105	87	70	95
	Assembly Fugitive Rate	%	29%	15%	11%	11%	6%
Electrical Equipment Operation	Stocks of SF_6	t	6,300	8,000	8,300	8,400	8,600
	Operational Fugitive Rate	%	0.1%	0.1%	0.1%	0.1%	0.1%
	Servicing Collect Rate	%	60%	93%	96%	97%	97%
	Dismantlement Collect Rate	%	0%	94%	97%	98%	98%

Source: Chemical and Bio Sub-Group documents, Industrial Structure Council, METI

References

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Cement Sub-Group of the WBCSD (World Business Council for Sustainable Development), *Cement Protocol, "CO_2 Emissions Monitoring and Reporting Protocol for the Cement Industry Guide to the Protocol, Version 1.6, WBSCD Working Group Cement"* October 19, 2001

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(http://www.chem.qmul.ac.uk/iupac/AtWt/AtWt9.html"

Japan Lime Association, *The Story of Lime*

Methanol and Formalin Association, *Methanol Supply and Demand*

Chapter 5. Solvent and Other Product Use (CRF sector 3)

5.1. Paint Application (3.A.)

Paint solvents are used in Japan, but their application is basically restricted only to mixing and they are assumed not to take part in chemical reactions. Therefore, they do not generate carbon dioxide or nitrous oxide. They have been reported as “NO.”

5.2. Degreasing and Dry-Cleaning (3.B.)

1) CO_2

Degreasing and dry-cleaning are practiced in Japan.

Degreasing is defined as “washing processes that do not involve chemical reactions”, and it is assumed that it does not generate carbon dioxide. Although the carbon dioxide emissions may occur in association with washing methods involving dry ice or carbonic gas, such methods are not thought to be used in Japan.

There are no processes in dry-cleaning in which chemical reactions may occur, and it is basically assumed that it does not generate carbon dioxide. However washing methods using liquefied carbonic gas are being used experimentally in research facilities, and it is not possible to completely negate the possibility of carbon dioxide emissions.

As a result, these activities have been reported as “NE” due to the fact that the nature of their emissions is ill-defined, and the absence of a default emission factor prevents any calculations from being performed.

2) N_2O

Degreasing and dry-cleaning are practiced in Japan, but degreasing is defined under the heading, ‘washing processes that do not involve chemical reactions’, and there are no processes in dry-cleaning in which chemical reactions may occur. Therefore, it is assumed that nitrous oxide is not generated. In Japan, there are also no methods which have the potential to emit nitrous oxide used for degreasing or dry-cleaning, and they have therefore been reported as “NA”.

5.3. Chemical Products, Manufacture and Processing (3.C.)

(The Common Reporting Format (CRF) requires that emissions of NMVOC should be reported.)

5.4. Other (3.D.)

5.4.1. Use of Nitrous Oxide for Anesthesia (3.D.-)

1) N_2O

- ***Methodology for Estimating Emissions of GHGs***

In relation to emissions of nitrous oxide in association with the use of anesthetics (laughing gas), the actual amount of nitrous oxide used as an anesthetic has been reported.

- ***Emission Factors***

It is assumed that all of the nitrous oxide used as a medical gas escapes to the atmosphere. Therefore, no emission factor has therefore been established.

- ***Activity Data***

The number and volume of shipments of general anesthetics (nitrous oxide) (on calendar year basis) given in the Ministry of Health, Labor and Welfare's *Statistics of Production by Pharmaceutical Industry* is used.

2) CO_2

Only nitrous oxide is used as a general anesthetic in Japan, and carbon dioxide is not used. Therefore, they have been reported as “NO”.

5.4.2. Fire Extinguishers (3.D.-)

1) CO_2

Many types of fire extinguishers in Japan are filled with carbon dioxide, which is emitted into the atmosphere when a fire extinguisher is used. All of the carbon dioxide with which the fire extinguishers are filled, however, is the by-product gas generated from petrochemicals or petroleum refining. Such emissions are included in the calculation of Chapter 1, section 1.A.1.b. Petroleum Refining, and therefore, have been reported as “IE”.

2) N_2O

There are fire extinguishers used in Japan that are filled with nitrogen gas. When such fire extinguishers are used, there is a possibility that the emitted nitrogen gas may engage in a series of chemical reactions which generate nitrous oxide. There is still no sufficient data on the reality of nitrous oxide emissions associated with the use of fire extinguishers filled with nitrogen gas, and it is not currently possible to calculate emissions. There is also no default emission factor, and it is not possible to estimate an upper limit for emission factor. Hence, it is reported as “NE”.

5.4.3. Aerosol Cans (3.D.-)

1) CO_2

Aerosol products, including spray cans which are filled with carbon dioxide, are manufactured in Japan. The carbon dioxide with which the cans are filled in the manufacturing process could conceivably leak and be emitted to the atmosphere, but the carbon dioxide used in the aerosol industry is a by-product gas of petrochemical products. These emissions are counted in the Combustion of Fuel sector (1.A.), and have been reported as “IE”.

2) N_2O

Aerosol products manufactured in Japan do not use nitrous oxide. In principle, no nitrous oxide is emitted, too, and it has been reported as “NA”.

References

Ministry of Health, Labor and Welfare’s *Statistics of Production by Pharmaceutical Industry*

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *Review of Greenhouse Gases Emissions Estimation Methods Part 2*, August 2002

Chapter 6. Agriculture (CRF sector 4)

The Revised 1996 IPCC Guidelines require emissions from the agricultural sector to be reported as a three-year average. The Japanese inventory uses the year before and the year after the relevant year to report a three-year average for emissions.

6.1. Enteric Fermentation (4.A.)

6.1.1. Cattle (4.A.1.)

- ***Methodology for Estimating Emissions of GHGs***

Methane emissions associated with enteric fermentation in cattle have been calculated, using a methodology similar to the Tier 2 method, but country-specific to Japan.

To reflect the actual situation of emissions in Japan, categorization of cattle is defined as shown below, and the estimation of methane emissions is conducted by type and age. (Refer to *4A-CH4-2005.xls* for details of the calculation process.)

Table 6-1 Categorization and assumptions underlying calculation of methane emissions associated with enteric fermentation in cattle

Type of livestock		Assumptions underlying calculation of emissions
Dairy cattle	Lactating	―
	Dry	―
	Heifer (Under Two Years)	Assuming calves accounting for 25% of the herd are 6 months-old or younger, they have been exclede from estimates.
Non-Dairy cattle	Dairy breeding	Assuming calves accounting for 25% of the herd are 6 months-old or younger, they have been exclede from estimates.
	Fattening (One Year and Over)	―
	Fattening (Under One Year)	Assuming calves accounting for 50% of the herd are 6 months-old or younger, they have been exclede from estimates.
	Breeding Cows (One Year and Over)	―
	Breeding Cows (Under One Year)	Assuming calves accounting for 50% of the herd are 6 months-old or younger, they have been exclede from estimates.

• *Emission Factors*

The emission factor for methane associated with enteric fermentation in cattle has been established on the basis of breath testing of ruminant livestock in Japan; it is based on the measured data for volume of methane generated from dry matter intake.

Results of measurements have made it clear that it is possible to estimate methane from enteric fermentation in ruminant livestock using the equation given below, which uses dry matter intake as the explanatory variable.[1]

Equation for estimating methane emissions associated with enteric fermentation in ruminant livestock

$$Y = -17.766 + 42.793 X - 0.849X^2$$

Y：Volume of methane generated [l / day]
X：Dry matter intake [kg/day]

Average dry matter intake estimated from *Japan Feed Standards* compiled by the Japan Livestock Industry Association is applied to the above equation to establish the following table of emission factors.

Table 6-2 Process of calculating emission factors for methane emissions associated with enteric fermentation in cattle

Type of livestock			Dry matter intake [kg]	Volume of CH_4 generated		
				[l/day/head]	[g/day/head][a]	[kg/year/head][b]
Dairy cattle	Lactating		15.8	446.5[c]	319	116.4
	Dry		7.5	255.4	182	66.6
	Heifer (Under Two Years of Age)		7.9	267.3	191	69.7
Non-Dairy cattle	Breeding Cows		5.8	201.9	144	52.6
	Fattening	Under One Year	7.3	249.4	178	65.0
		One Year and Older	5.2	181.8	130	47.3
	Dairy breeding		9.5	312.2	223	81.4

a: Volume of methane generated (l/day/head) is divided by 22.4 [l/mol] and multiplied by the molecular weight of methane (16).
b: Volume of methane generated (g/day/head) has been multiplied either by 365 (days) or 366 (days).
c: These values may differ from calculating value because of rounding off.

• *Activity Data*

The values used for activity data for this source are the herd size for each type of livestock at 1 February in each year, recorded by the Ministry of Agriculture, Forestry and Fisheries in its *Livestock Statistics*.

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[1] Shibata, Terada, Kurihara, Nishida and Iwasaki; "Estimation of Methane Production in Ruminants": Animal Sciences and Technology, Vol.64, No.8, August 1993

- ***Japanese Country-Specific Method***

In accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.24 Fig. 4.2), calculations for dairy and non-dairy cattle should be performed using the Tier 2 method. The Tier 2 method requires the total energy intake of livestock to be multiplied by the methane conversion factor to derive the emission factor, but it has been in practice in Japan on livestock-related research to use volume of dry matter intake. It is considered that, by applying the results of previous researches, the estimation method using volume of dry matter intake provides more accurate data. Therefore, the emission factor has been established using the volume of dry matter intake.

6.1.2. Sheep, Goats, Horses & Swine (4.A.3., 4.A.4., 4.A.6., 4.A.8.)

- ***Methodology for Estimating Emissions of GHGs***

Methane emissions associated with enteric fermentation in sheep, goats, horses and swine have been calculated, using the Tier 1 method, in accordance with Decision Tree of the *Good Practice Guidance (2000)*. (Refer to *4A-CH4-2005.xls* for details of the calculation process.)

- ***Emission Factors***

The emission factor for methane associated with sheep and goats has been established in the same way as for cattle, based on the emissions of methane estimated from dry matter intake. The emission factor for swine has been established on the basis of results of research conducted in Japan. The emission factor used for horses is the default value given in the *Revised 1996 IPCC Guidelines*.

Table 6-3 Emission factors for CH_4 associated with enteric fermentation in sheep, goats, horses and swine

Type of livestock	Dry Matter Intake [kg]	Volume of CH_4 generated		
		[l/day/head]	[g/day/head][a]	[kg/year/head][b]
Sheep, Goats	0.8	15.9	11	4.1
Swine [c]	—	4.2	3	1.1
Horses [d]	—	69.0	49	18.0

a: Volume of methane generated (l/day/head) is divided by 22.4 [l/mol] and multiplied by the molecular weight of methane (16).

b: Volume of methane generated (g/day/head) has been multiplied either by 365 (days) or 366 (days).

c: Mamoru Saito, *Methane emissions from fattening swine and expectant swine*, Japan Society of Animal Science, *Animal Science Journal*, 59: pp 773–778 (1988)

d: *Revised 1996 IPCC Guidelines*（Crutzen, P.J., et al. “Methane production by domestic animals, wild ruminants, other herbivorous fauna, and humans.” Tellus, 33B: pp 271 - 284 (1986))

- ***Activity Data***

The values used for activity data for swine are the herd size at 1 February in each year, as recorded by the Ministry of Agriculture, Forestry and Fisheries in its *Livestock Statistics*.

The values used for activity data for sheep, goats and horses are the herd size for each type of livestock indicated in the “*FAOSTAT Data base*”.

6.1.3. Poultry (4.A.9.)

It is conceivable that methane is emitted from enteric fermentation in poultry, but the Japanese literature offers no data on emission factors, and neither the *Revised 1996 IPCC Guidelines* nor the *Good Practice Guidance (2000)* offer default emission factors. Therefore, this category has been reported as “NE”.

In addition, poultry other than hens and broiler are not covered by official statistics, suggesting that they may be assumed to be negligible.

6.1.4. Buffalo, Camels and Llamas, Mules and Asses (4.A.2., 4.A.5., 4.A.7.)

The animals that would come under this category in Japan are to be found in zoos or tourist farms. The herd sizes can be expected to be extremely small, and emissions have not been estimated. Therefore, this category has been reported as “NE”.

6.1.5. Other (4.A.10.)

The only livestock that are breeded in Japan are cattle, sheep, goats, horses, swine and poultry. Therefore, this category has been reported as “NO”.

6.2. Manure Management (4.B.)

6.2.1. Dairy Cattle, Non-Dairy Cattle, Swine, Hens & Broiler (CH4, N2O: 4.B.1., 4.B.8., 4.B.9.)

- ***Methodology for Estimating Emissions of GHGs***

Methane emissions associated with management of livestock excretion have been calculated by multiplying the emission factor for each treating method of livestock manure by the amount of organic matter contained in the manure for each type of livestock (dairy cattle, non-dairy cattle, swine, hens, and broilers). (Refer to *4B-CH4-2005.xls* for details of the calculation process.)

Nitrous oxide emissions associated with management of livestock excretion have been calculated by multiplying the emission factor for each treating method of livestock manure by the amount of nitrogen contained in the manure for each type of livestock (dairy cattle, non-dairy cattle, swine, hens, and broilers). (Refer to *4B-N2O-2005.xls* for details of the calculation process.)

• *Emission Factors*

Emission factors for methane and nitrous oxide associated with Animal Waste Management System (hereafter, AWMS) of dairy cattle, non-dairy cattle, swine, hens, and broilers have been established for each treating method of for each type of livestock, on the basis of the results of research carried out in Japan. Actual values are given in the following tables.

Table 6-4 Emission factors for each method of treating manure from cattle

State of Manure (Separated or Mixed)		Treating method	CH$_4$ EF [g CH$_4$/g-organic matter]	N$_2$O EF [g N$_2$O-N/g TN]
Separated	Feces	Sunlight drying	0.0125 %	0.4 %
		Thermal drying	0 %	0.4 %
		Composting	0.025 %	0.75 %
		Deposition	0.33 %	4.65 %
		Incineration	0.4 %	0.1 %
	Urine	Composting	0.025 %	11 %
		Wastewater management	0 %	12 %
		Pit storage	0.92 %	0.75 %
Mixed		Sunlight drying	0.125 %	0.4 %
		Thermal drying	0 %	0.4 %
		Composting	0.025 %	11 %
		Deposition	0.33 %	4.65 %
		Wastewater management	0 %	12 %
		Pit storage	0.92 %	0.75 %

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*, March 2002
Japan Livestock Technology Association, *GHGs emissions control in livestock Part4*, March 1999
Y. Fukumoto, *et al. Measurement of NH$_3$, N$_2$O and CH$_4$ emissions from swine manure composting using a new dynamic chamber system,* Proceedings of 1st IWA International Conference on Odor and VOCs; Measurement, Regulation and Control techniques. Australia pp 613-620. March 2001

Table 6-5 Emission factors for each method of treating manure from Swine Hen & Broiler

State of Manure (Separated or Mixed)		Treating method	CH_4 EF [g CH_4/g-organic matter]		N_2O EF [g N_2O-N/g TN]	
Separated	Feces	Sunlight drying	0.0125	%	0.4	%
		Thermal drying	0	%	0.4	%
		Composting	0.025	%	0.75	%
		Deposition	1.3 *	%	4.65	%
		Incineration	0.4	%	0.1	%
	Urine	Composting	0.025	%	6.7 *	%
		Wastewater management	0	%	12	%
		Pit storage	0.92	%	0.75	%
Mixed		Sunlight drying	0.125	%	0.4	%
		Thermal drying	0	%	0.4	%
		Composting	0.025	%	6.7 *	%
		Deposition	1.3 *	%	4.65	%
		Wastewater management	0	%	12	%
		Pit storage	2.6 *	%	0.75	%

*: Indicates values that are different from the emission factors for cattle
Source: Same as for emission factors for dairy and beef cattle.

- ***Activity Data***

The values used for the activity data for emissions of methane ane nitrous oxide associated with management of livestock excretion from dairy cattle, non-dairy cattle, swine, hens and broilers, are estimates of the volume of organic matter and the volume of nitrogen excreted annually by various types of livestock, respectively.

The method of estimating volumes of organic matter and nitrogen excreted annually by various types of livestock was to calculate by multiplying number of the head of each type of livestock by the volume of manure excreted per head, to obtain the volume of generated manure. Then the volumes of organic matter and nitrogen contained in manure were estimated, which were allocated to each method of treatment. The method for calculating activity data is given below.

Estimating activity data for CH_4 (volume of organic matter excreted by each type of livestock)

Volume of organic matter excreted [Gg] ＝ Livestock herd or flock size [1000 head]
× volume of feces or urine excreted [t/head/year]
× proportion of organic matter in feces or urine [%]
× proportions of feces and urine separated [%]
× share of each treating method [%]

Source:
Livestock herd/flock: MAFF, *Livestock Statistics*
Volume of feces or urine excreted: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*, March 2002
Proportion of organic matter in feces or urine: Same as above
Proportions of feces or urine separated: Same as above
Share of each treating method: Japan Livestock Technology Association, *GHGs emissions control in livestock Part4*, March 1999

Estimating activity data for N_2O (volume of nitrogen excreted by each type of livestock)

Volume of nitrogen excreted [Gg] ＝ Livestock herd or flock size [1000 head]
× volume of feces or urine excreted [t/head/year]
× nitrogen content in feces or urine [%]
× proportion of feces and urine separated [%]
× share of each treating method [%]

Source:
Nitrogen content in feces or urine: Japan Livestock Technology Association *GHGs emissions control in livestock* Summary
Other elements of the equation are same as for methane.

Table 6-6 Feces and urine excreted, by type of livestock

Type of livestock	Annual amount of feces excreted [t/head/year]	Annual amount of urine excreted [t/head/year]
Dairy Cattle	12.6	3.72
Non-Dairy Cattle	6.77	2.49
Swine	0.808	1.5
Hen	0.0441	—
Broiler	0.0474	—

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*, March 2002

Table 6-7 Organic matter and nitrogen content in manure, by type of livestock

Type of livestock	Organic matter content		Nitrogen content	
	Feces	Urine	Feces	Urine
Dairy Cattle	16%	0.5%	0.4%	0.8%
Non-Dairy Cattle	18%	0.5%	0.4%	0.8%
Swine	20%	0.5%	1.0%	0.5%
Hen	15%	—	2.0%	—
Broiler	15%	—	2.0%	—

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*, March 2002

Table 6-8 Proportion of separated and mixed treatment of manure, by type of livestock

Type of livestock	Separated	Mixed
Dairy Cattle	60%	40%
Non-Dairy Cattle	7%	93%
Swine	70%	30%
Hen	100%	—
Broiler	100%	—

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*, March 2002

Table 6-9 Share of each treatment method by type of livestock

State of Manure (Separated or Mixed)		Treating method	Dairy Cattle	Non-Dairy Cattle	Swine	Hen	Broiler
Separated	Feces	Sunlight drying	2.8%	1.5%	7.0%	30.0%	15.0%
		Thermal drying	0.0%	0.0%	0.7%	3.0%	0.0%
		Composting	9.0%	11.0%	62.0%	42.0%	5.1%
		Deposition	88.0%	87.0%	29.6%	23.0%	66.9%
		Incineration	0.2%	0.5%	0.7%	2.0%	13.0%
	Urine	Composting	1.5%	9.0%	10.0%	–	–
		Wastewater management	2.5%	2.0%	45.0%	–	–
		Pit storage	96.0%	89.0%	45.0%	–	–
Mixed		Sunlight drying	4.7%	3.4%	6.0%	–	–
		Thermal drying	0.0%	0.0%	0.0%	–	–
		Composting	20.0%	22.0%	29.0%	–	–
		Deposition	14.0%	74.0%	20.0%	–	–
		Wastewater management	0.3%	0.0%	22.0%	–	–
		Pit storage	61.0%	0.6%	23.0%	–	–

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Part4*, March 1999

- ***Completeness***

Poultry other than hens and broiler are not covered by official statistics, and they are assumed to be negligible. Therefore, only hens and broiler are considered as estimation target from poultry.

- ***Reporting in Common Reporting Format (CRF)***

In the CRF, with regard to CH_4 emissions from this category, it is required to report emissions by each livestock. However, for N_2O emissions from this category, it is required to report emissions by AWMS (10. Anaerobic Lagoons、11. Liquid Systems、12. Solid Storage and Dry Lot、13. Other (please specify)).

Results of estimation in this category were aggregated according to classification of AWMS in Table 6-10 and reported in the CRF.

Table 6-10 Correspondence between Japan's classification and CRF's

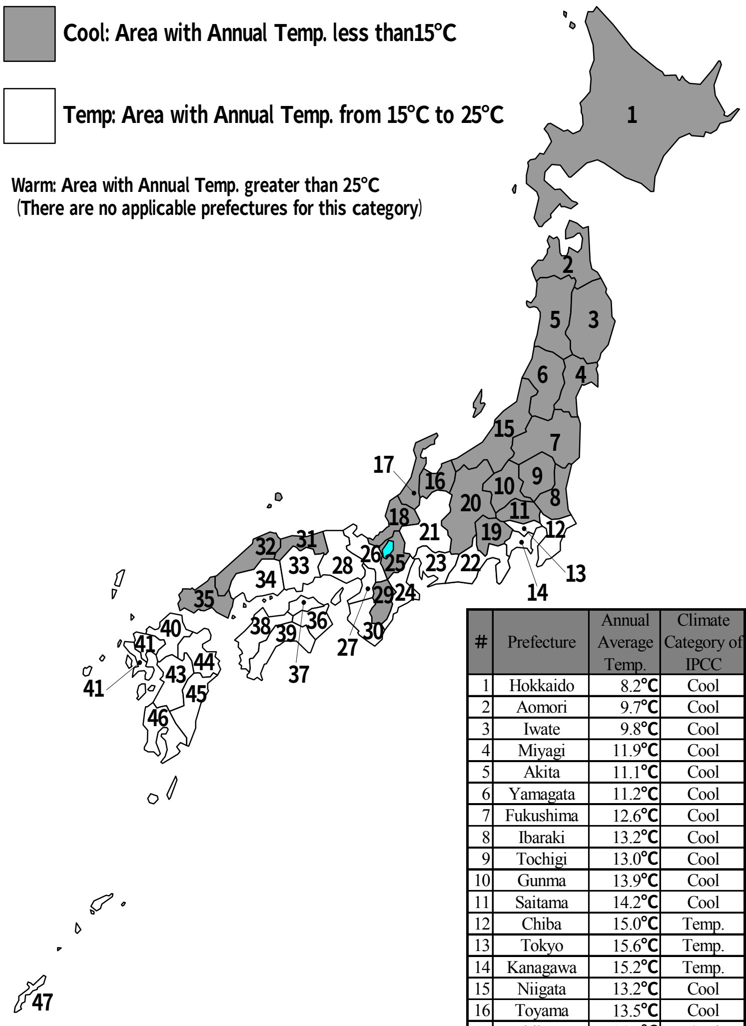
Japan's Classification			Classification in the CRF
State of Manure (Separated or Mixed)		Treating method	
Separated	Feces	Sunlight drying	12. Solid Storage and Dry Lot
		Thermal drying	13. Other (a. Thermal Drying)
		Composting	13. Other (b. Composting)
		Deposition	13. Other (c. Piling)
		Incineration	13. Other (d. Incineration)
	Urine	Composting	13. Other (e. Liquid Composting)
		Wastewater management	13. Other (f. Purification)
		Pit storage	11. Liquid Systems
Mixed		Sunlight drying	12. Solid Storage and Dry Lot
		Thermal drying	13. Other (a. Thermal Drying)
		Composting	13. Other (e. Liquid Composting)
		Deposition	13. Other (c. Piling)
		Wastewater management	13. Other (f. Purification)
		Pit storage	11. Liquid Systems

"10. Anaerobic Lagoons" have been reported as "NO". Because there are quite small number of livestock farmers who has enough area of field to spread manure, and it is assumed that there are no livestock farmers who use anaerobic lagoons. There are cases when manure is spread to fields in Japan, but even in these cases, stirring is conducted before the spreading. Therefore, there are no anaerobic manure management systems.

• *Climate Regions*

In the Tier 1 method, the *Good Practice Guidance (2000)* requires that emissions be calculated using herd size by climate regions.

In accordance with the climate categories given in the *Revised 1996 IPCC Guidelines*, Japan should be divided into temperate and cool zones. The average temperature over all prefectures in Japan is around 15 ºC. This figure is almost the same as the threshold given in the *Revised 1996 IPCC Guidelines*. Therefore, emissions have been calculated on the assumption that all of Japan falls into the temperate zone, without a need to categorize regions into temperate or cool zone.



#	Prefecture	Annual Average Temp.	Climate Category of IPCC
1	Hokkaido	8.2°C	Cool
2	Aomori	9.7°C	Cool
3	Iwate	9.8°C	Cool
4	Miyagi	11.9°C	Cool
5	Akita	11.1°C	Cool
6	Yamagata	11.2°C	Cool
7	Fukushima	12.6°C	Cool
8	Ibaraki	13.2°C	Cool
9	Tochigi	13.0°C	Cool
10	Gunma	13.9°C	Cool
11	Saitama	14.2°C	Cool
12	Chiba	15.0°C	Temp.
13	Tokyo	15.6°C	Temp.
14	Kanagawa	15.2°C	Temp.
15	Niigata	13.2°C	Cool
16	Toyama	13.5°C	Cool
17	Ishikawa	14.1°C	Cool
18	Fukui	14.1°C	Cool
19	Yamanashi	13.9°C	Cool
20	Nagano	11.5°C	Cool
21	Gifu	15.1°C	Temp.
22	Shizuoka	16.1°C	Temp.
23	Aichi	15.1°C	Temp.
24	Mie	15.1°C	Temp.
25	Shiga	14.1°C	Cool
26	Kyoto	15.3°C	Temp.
27	Osaka	16.3°C	Temp.
28	Hyogo	15.6°C	Temp.
29	Nara	14.4°C	Cool
30	Wakayama	16.1°C	Temp.
31	Tottori	14.5°C	Cool
32	Shimane	14.3°C	Cool
33	Okayama	15.8°C	Temp.
34	Hiroshima	15.0°C	Temp.
35	Yamaguchi	14.7°C	Cool
36	Tokushima	15.9°C	Temp.
37	Kagawa	15.3°C	Temp.
38	Ehime	15.8°C	Temp.
39	Kochi	16.4°C	Temp.
40	Fukuoka	16.2°C	Temp.
41	Saga	16.1°C	Temp.
42	Nagasaki	16.7°C	Temp.
43	Kumamoto	16.2°C	Temp.
44	Oita	15.7°C	Temp.
45	Miyazaki	17.0°C	Temp.
46	Kagoshima	17.6°C	Temp.
47	Okinawa	22.4°C	Temp.

(Source) Japan Meteorological Agencty "Climate Charts of Japan"

Figure 6-1 Categorization of climate in prefectures in Japan, as indicated in the *Revised 1996 IPCC Guidelines*

6.2.2. Sheep, Goats & Horses (4.B.3., 4.B.4., 4.B.6.)

1) CH_4

• *Methodology for Estimating Emissions of GHGs*

Methane emissions associated with a management of the manure of sheep, goats and horses have been calculated, using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.33, Fig. 4.3) (Refer to *4B-CH4-2005.xls* for details of the calculation process.)

• *Emission Factors*

The emission factors for methane associated with a management of manure from sheep, goats and horses are the default values for temperate zones in industrialized nations, given in the *Revised 1996 IPCC Guidelines*.

Table 6-11 Emission factors for sheep, goats and horses

Type of livestock	Emission Factors [kg CH_4/head/year]
Sheep	0.28
Goats	0.18
Horses	2.08

Source: *Revised 1996 IPCC Guidelines* Vol. 2 p. 4.6 Table 4-4

• *Activity Data*

The values used for activity data for sheep, goats and horses are the herd size for each type of livestock indicated in the "*FAOSTAT Data base*".

2) N_2O

• *Methodology for Estimating Emissions of GHGs*

N_2O emissions associated with a management of the manure of sheep, goats and horses have been calculated, using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.41, Fig. 4.4) (Refer to *4B-CH4-2005.xls* for details of the calculation process.)

• *Emission Factors*

The emission factors for N_2O associated with a management of manure from sheep, goats and horses are the default values for temperate zones in industrialized nations, given in the *Revised 1996 IPCC Guidelines*.

Table 6-12 Emission factors for sheep, goats and horses

Type of livestock	Emission Factors [kg N_2O/head/year]
Sheep	12
Goats*	40
Horses*	40

Source: *Revised 1996 IPCC Guidelines* Vol. 3, page 4.99, Table 4-20
* : value for "Other animals"

- ***Activity Data***

The values used for activity data for sheep, goats and horses are the herd size for each type of livestock indicated in the "*FAOSTAT Data base*".

6.3. Rice Cultivation (4.C.)

6.3.1. Intermittently Flooded (Single Aeration) (4.C.1.-)

- ***Methodology for Estimating Emissions of GHGs***

Methane emissions from intermittently flooded paddy fields (Single Aeration) have been calculated, using emission factors by types of organic matter spread and by types of soil, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.79, Fig. 4.9). (Refer to *4C-CH4-2005.xls* for details of the calculation process.)

- ***Emission Factors***

The following table summarizes the emission factors established for each category of this source.

The established emission factors are based on actual measurements of five soil types, with and without straw amendment. Actual data on soil types subject to composting is not available, but the methane emission of composted soil is 1.2 to 1.3 times more than that of un-composted soil. Therefore, the emission factor for composted soil, by soil type, was established as 1.25 times larger than the value for un-composted soil.

Table 6-13 Methane emission factor for intermittently flooded paddy fields (single aeration)

Soil Type	Straw amendment [$gCH_4/m^2/year$]	Various compost amendment [$gCH_4/m^2/year$]	No-amendment [$gCH_4/m^2/year$]
Andosol	8.50	7.59	6.07
Yellow soil	21.4	14.6	11.7
Lowland soil	19.1	15.3	12.2
Gley soil	17.8	13.8	11.0
Peat soil	26.8	20.5	16.4

Source: Haruo Tsuruta, *Emission Rates of Methane from Rice Paddy Fields and Nitrous Oxide from Fertilized Upland Fields Estimated from Intensive Field Measurement for Three Years (1992-1994) All Over Japan*

• *Activity Data*

It is assumed that intermittently flooded paddy fields (single aeration) comprise some 98% of planted paddy area and constantly flooded paddies[2] comprise the remaining 2%.

The method of establishing activity data for emissions of methane from intermittently flooded paddy fields (single aeration) was to multiply the planted paddy area given in the Ministry of Agriculture, Forestry and Fisheries in *Statistics of Cultivated and Planted area*, by the proportion of area by each soil types, and then by the proportion subject to organic mulch management.

Table 6-14 Proportion of Japan's surface area represented by specific soil types

Type of soil		Proportion of Japan's surface area
Andosol	Andosol, moist andosol, andosol gley soil	11.9%
Yellow soil	Brown forest soil, gray ground soil, gley ground soil, yellow soil, dark red soil	9.4%
Lowland soil	Brown lowland soil, grey lowland soil	41.5%
Gley soil	Gley soil, strong gley soil	30.8%
Peat soil	Black peat, peat soil	6.4%
Total		100.0%

Source: Ministry of Agriculture, Forestry and Fisheries, *Basic Survey of Ground Strength*

Table 6-15 Proportion of organic mulch management in Japan

Organic amendment	Proportion
Straw amendment	60%
Various compost amendment	20%
No-amendment	20%

Source: Survey conducted by MAFF

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[2] *Revised 1996 IPCC Guidelines,* vol.2 Workbook, p4.18, Table 4.9

• *Water management regime in Japanese paddy fields*

The general practice of intermittent flooding (single aeration) by paddy farmers in Japan is different in nature from the intermittently flooded paddy field (complex drainage of ponded water) concept in the *IPCC Guidelines*. The diagram below presents the outline.

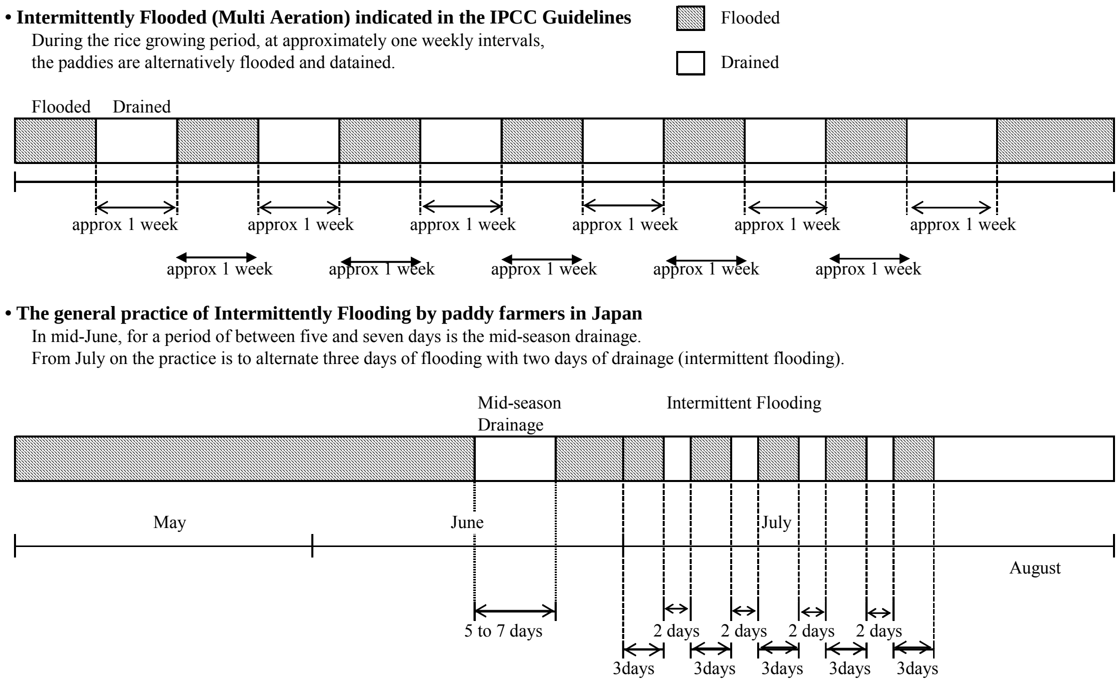

Figure 6-2 Comparison of water management regime in Japan and intermittent flooding (single aeration) indicated in the *IPCC Guidelines*

6.3.2. Continuously Flooded (4.C.1.-)

• *Methodology for Estimating Emissions of GHGs*

Methane emissions from continuously flooded paddies have been calculated by using country-specific emission factors for different soil types and for different organic amendments, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.79, Fig. 4.9). (Refer to *4C-CH4-2005.xls¥ Continuously Flooded* for details of the calculation process.)

• *Emission Factors*

Research results[3] in Japan indicate that emissions of methane from intermittently flooded paddy fields are 42% to 45% less than those from continuously flooded paddy

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[3] Kazuyuki Yagi, *Establishment of GHGs reduction model*, Incorporated foundation, Society for the Study of Agricultural Technology: “A Report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000F.Y. ” p.27

fields. This knowledge formed the basis for the establishment of an emission factor for methane from constantly flooded paddy fields: divide the nominal emission factor for intermittently flooded paddy fields by 0.435.

Table 6-16 Emission factor for methane from constantly flooded paddy fields

	Emission Factors [$gCH_4/m^2/year$]
Intermittently flooded paddy fields (mid-season drainage)	15.98*
Constantly flooded paddy fields	36.74

* : 3.4.C.1 Implied emission factor for intermittently flooded paddy fields (single aeration)

- ***Activity Data***

It is assumed that intermittently flooded paddy fields (single aeration) comprise some 98% of planted paddy area and constantly flooded paddies comprise the remaining 2%.

The method of establishing activity data for emissions of methane from constantly flooded paddy fields was to multiply the planted paddy area given in the Ministry of Agriculture, Forestry and Fisheries in *Statistics of Cultivated and Planted area*, by 2%.

6.3.3. Rainfed & Deep Water (4.C.2., 4.C.3.)

As indicated in the IRRI (International Rice Research Institute) *World Rice Statistics 1993–94*, rain-fed paddy fields and wet bed methods do not exist in Japan. Therefore, this category has been reported as “NO”.

6.3.4. Other (4.C.4.)

Just as indicated in the IRRI (International Rice Research Institute) *World Rice Statistics 1993-94*, a possible source of emissions in this category is upland crop paddies, but since upland crop paddies are not flooded, like the soil of fields, they are acidic and do not become anaerobic. The bacteria that generate methane are definitely anaerobic, and unless the soil is maintained in an anaerobic state, there will be no generation of methane. As generation of methane is not feasible, this category was reported as “NA”.

6.4. Agricultural Soils (4.D.)

6.4.1. Direct Soil Emissions (N2O) (4.D.1.)

6.4.1.1. Synthetic Fertilizers (4.D.1.-)

6.4.1.1.a. Fields (4.D.1.--)

- ***Methodology for Estimating Emissions / Removals of GHGs***

Nitrous oxide emissions associated with the application of synthetic fertilizer to farmland soil (field lands) were calculated, using country-specific emission factors, and in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page. 4.55 Fig. 4.7) (Refer to *4D-N2O-2005.xls¥S-Fertilizer(dry)* for details on the calculation process).

- ***Emission Factors***

Emission factors for nitrous oxide associated with the application of synthetic fertilizers to farmland soil (field lands) were established using the following steps (i) to (iii), based on actual data measurement conducted in Japan.

(i) Input volume of nitrogen was calculated by multiplying planted area for each type of crop by the amount of applied fertilizer
(ii) The input volume of nitrogen for each type of crop was multiplied by the emission factor based on actual measurements, respectively, to derive the amount of nitrous oxide generation
(iii) The total nitrous oxide generation from all crops was divided by the total input volume of nitrogen for each crop to derive the emission factor.

Table 6-17 The process of calculating emission factor for nitrous oxide associated with applying synthetic fertilizer to dry fields

Farm Products	Area [ha]	Application Rate [kgN/10a]	N total input [kgN]	EF [N2O-N/N]	N2O generated [kgN2O-N]
Vegetables	539,750	21.27	114,804,825	0.00773	887,441
Fruits	295,300	14.70	43,409,100	0.00690	299,523
Tea	51,200	48.50	24,832,000	0.04740	1,177,037
Potatoes	99,950	12.70	12,693,650	0.02010	255,142
Pulse	183,200	3.10	5,679,200	0.00730	41,458
Feed crops	1,038,000	10.00	103,800,000	0.00600	622,800
Sweet potatoes	45,600	6.20	2,827,200	0.00727	20,554
Wheat	275,600	10.00	27,560,000	0.00486	133,942
Buckwheat	35,500	4.12	1,462,600	0.00730	10,677
Mulberries	10,300	16.20	1,668,600	0.00730	12,181
Industrial Crops	146,000	22.90	33,434,000	0.00730	244,068
Tobacco	25,300	15.40	3,896,200	0.00730	28,442
Total	2,745,700		376,067,375		3,733,265
Emission Factor（Total Emissions [kgN2O-N]／N total input [kgN]）					**0.993%**

Source: Haruo Tsuruta, *Establishment of GHGs Reduction Model*; Society for the Study of Agricultural Technology, *A Report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000F.Y.*

• *Activity Data*

Activity data for nitrous oxide emissions associated with the application of synthetic fertilizers to dry fields was derived by subtracting the volume of nitrogen-based fertilizer applied to paddies from "demand for nitrogen-based fertilizers" given in the Ministry of Agriculture, Forestry and Fisheries *Yearbook of Fertilizer Statistics (Pocket Edition)*. The method of calculating activity data is given below. Refer 6.4.1.1.b for the calculation of the volume of nitrogen-based fertilizer applied to paddies.

Activity data for N_2O emissions from the application of synthetic fertilizers to dry fields

Volume of nitrogen-based fertilizer applied to fields [t]
= Demand for nitrogen-based fertilizers [t]
− Area of wet rice cropping [ha] × Volume of fertilizer per 10a of rice [kg/10a]

Source:
Demand for nitrogen-based fertilizers, volume of fertilizer per 10a of rice: MAFF, *Yearbook of Fertilizer Statistics (Pocket Edition)*
Area of wet rice cropping: MAFF, *Statistics of Cultivated and Planted Area*

6.4.1.1.b. Paddy Fields (4.D.1.--)

• *Methodology for Estimating Emissions of GHGs*

Emissions of nitrous oxide associated with the application of synthetic fertilizer to farmland soil (paddies) have been calculated using the country-specific emission factors, in accordance with Decision Tree of the *Good Practice Guidance (2000)*(Page 4.55, Fig. 4.7). (Refer to *4D-N2O-2005.xls¥S-Fertilizer(rice)* for detail on the calculation process.)

• *Emission Factors*

Emission factors have been established on the basis of actual measurements taken in Japan.

Table 6-18 Emission factor for N_2O from the application of synthetic fertilizer to paddies

	Emission Factors [kgN_2O-N/kgN]
N_2O emissions from applying synthetic fertilizer to paddies	0.00673

Source: Haruo Tsuruta, *Establishment of GHGs reduction model*, Incorporated foundation, Society for the Study of Agricultural Technology, *A Report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000F.Y.*

• *Activity Data*

Activity data for nitrous oxide emissions associated with the application of synthetic fertilizer to paddies was derived by multiplying "area of wet rice cropping" given in the

Ministry of Agriculture, Forestry and Fisheries *Statistics of Cultivated and Planted Area*, by “volume of fertilizer applied per 10a of rice” given in the Ministry of Agriculture, Forestry and Fisheries *Yearbook of Fertilizer Statistics (Pocket Edition)*.

6.4.1.2. Organic Fertilizer (Animal Wastes Applied to Soils) (4.D.1.-)

• *Methodology for Estimating Emissions of GHGs*

Emissions of nitrous oxide associated with the application of organic fertilizer (livestock and other compost and barnyard manure) to agricultural soils have been calculated using the country-specific emission factors, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.55, Fig. 4.7).
(Refer to *4D-N2O-2005.xls¥ AnimalWaste* for detail on the calculation process.)

Emission factors applied in this category are based on measured data by crop types in Japan. Emissions of nitrous oxide are estimated for each type of crop by multiplying the emission factor and applied volume of nitrogen for corresponding crops. The sum of emissions for each type of crop corresponds to the total emissions from this category.

Calculation of N_2O emissions from the application of organic fertilizers to agricultural soils

Volume of N_2O emissions from the application of livestock manure（$kg\text{-}N_2O\text{-}N$）

$$= \Sigma_{\text{Type of crop}} \{\text{Emission factor by type of crop}\ (kg\text{-}N_2O\text{-}N/kg\text{-}N) \times \text{Volume of nitrogen applied, by type of crop}\ (kg\ N)\}$$

Volume of nitrogen applied, by type of crop（kg-N）

$$= \text{Area of cultivated land by type of crop}\ (ha) \times \text{Volume of nitrogen applied per unit area, by type of crop}\ (kg\text{-}N/10a) \times 10$$

Source: Haruo Tsuruta, *Establishment of GHGs reduction model*, Incorporated foundation, Society for the Study of Agricultural Technology, *A Report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000F.Y.*

• *Emission Factors*

There is little actual measurement data available in Japan on emission factors for nitrous oxide from composts, barnyard manure, and organic fertilizers. Therefore, it was assumed that the nitrous oxide associated with the application of composts, and barnyard manure, and organic fertilizers is the same for synthetic fertilizers, and actual data on emission factors for nitrous oxide from the application of synthetic fertilizers measured for each type of crop have been used. The emission factors are shown below.

Table 6-19 Nitrous oxide emission factors, by type of crop

Type of crop	Emission Factors [kgN_2O-N/kgN]
Vegetables	0.00773
Rice	0.00673
Fruit	0.0069
Tea	0.0474
Potatoes	0.0201
Pulse	0.0073
Feed crops	0.006
Sweet potato	0.00727
Wheat	0.00486
Buckwheat	0.0073
Mulberries	0.0073
Industrial crops	0.0073
Tobacco	0.0073

Source: Haruo Tsuruta, *Establishment of GHGs reduction model*, Incorporated foundation, Society for the Study of Agricultural Technology, *A Report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000F.Y.*

- ***Activity Data***

Activity data for nitrous oxide emission associated with the application of organic fertilizers to agricultural soils was derived by multiplying the area of cultivation for each type of crop, by the volume of nitrogen applied per unit area for each type of crop.

The source of the data on volume of nitrogen applied per unit area for each type of crop was the same as for emission factor. The sources of the data on the area of cultivation for each type of crop were as shown below.

Table 6-20 Sources of data on area under cultivation for each type of crop

Source	Type of crop
MAFF, *Statistics of Cultivated and Planted Area*	Vegetables, Rice, Fruit, Tea, Pulse, Sweet potato, wheat, Buckwheat, Mulberries, Industrial crops
MAFF, *Vegetable Production and Shipment Statistics*	Potatoes
The data of “Japan Tobacco Inc.”	Tobaccos

6.4.1.3. N-fixing Crops (4.D.1.-)

Nitrous oxide emissions from N-fixing crops have been included in either synthetic fertilizers or organic fertilizers (it is difficult to list them separately), and, therefore, it was reported as “IE”.

6.4.1.4. Crop Residue (4.D.1.-)

The default value given in the *Good Practice Guidance (2000)* for nitrous oxide emissions associated with the application of crop residue to agricultural soil is not considered applicable to the circumstances of emissions in Japan and has been reported as “NE”.

6.4.1.5. Cultivation of Histosols (4.D.1.-)

The default value given in the *Good Practice Guidance (2000)* for nitrous oxide emissions associated with the application of cultivation of histosols, is not considered applicable to the circumstances of emissions in Japan and has been reported as “NE”.

6.4.1.6. Direct Soil Emissions（CH_4） (4.D.1.)

Methane-generating bacteria are absolutely anaerobic, and if soil is not maintained in an anaerobic state, methane generation is not possible. In other words, once the paddies are flooded, the soil becomes starved of oxygen and becomes anaerobic, resulting in the generation of methane by methane-generating bacteria. Conversely, the soil in fields is normally acidic, and does not become anaerobic. Therefore, it is not theoretically possible for methane generation to take place in field soil. For that reason, direct emission of methane from soil has been reported as “NA”.

6.4.2. Animal Production (4,D,2,)

- ***Methodology for Estimating Emissions of GHGs***

Emissions of methane and nitrous oxide associated with animal production (methane or nitrous oxide from manure directly excreted onto grazing land or into water troughs by grazing livestock) have been calculated using the country-specific emission factors, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.55, Fig. 4.7). (Refer to *4D-N2O-2005.xls¥AnimalProduction* for details on the calculation process.)

- ***Emission Factors***

Emission factors have been established on the basis of the results of calculations of methane and nitrous oxide emissions from the manure of grazing cattle in Japan.

Table 6-21 Emission factors for animal production

GHGs	Emission Factors	Unit
CH_4	3.67	[g CH_4/head/day]
N_2O	0.32	[g N_2O-N/head/day]

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Part6, March 2001*

- ***Activity Data***

Activity data for methane and nitrous oxide emissions associated with animal production was derived by multiplying grazing herd size by grazing time.

The size of herds on public farms is selected as data for grazing herd size, given in the Ministry of Agriculture, Forestry and Fisheries *Survey on Public ranches farms*. The figure used for grazing time (191 days from late April to October) is established by Shibuya et al.[4]

- ***Grazing in Japan***

In Japan, grazing of dairy or non-dairy cattle is not typically practiced, and the statistics do not identify grazing herd size, too. Therefore, the size of grazing herds on public ranches farms has been used as activity data.

6.4.3. Indirect Emissions (4.D.3.)

6.4.3.1. Atmospheric Deposition (4.D.3.-)

- ***Methodology for Estimating Emissions of GHGs***

Nitrous oxide emissions associated with atmospheric deposition have been calculated using default emission factors, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.69, Fig. 4.8).
(Refer to *4D-N2O-2005.xls¥AtmosphericDeposition* for detail on the calculation process.)

<u>Calculation of nitrous oxide emissions associated with atmospheric deposition</u>

Emissions of nitrous oxide from atmospheric deposition [kg N_2O-N]
= Default emission factor [kg N_2O-N/kg NH_3-N+NO_X-N]
× Volume of nitrogen volatilized from ammonia and nitrogen oxides from livestock manure and synthetic fertilizers [kg NH_3-N+NO_X-N]

Volume of nitrogen volatilized as ammonia or nitrogen oxides from livestock manure and synthetic fertilizers [kg NH_3-N+NO_X-N]
= {Volume of synthetic nitrogen-based fertilizers applied to soil [kg N]
× Proportion of volatilization from synthetic fertilizer as ammonia or nitrogen oxides
+ $\Sigma_{\text{Type of Livestock}}$ (Herd size by type of livestock [head]
× Volume of nitrogen emitted by type of livestock [kg/head])
× Proportion of volatilization from amount of nitrogen from livestock manure as ammonia or nitrogen oxides}

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[4] Japan Livestock Technology Association, *GHGs emissions control in livestock Part6, March 2001*

• *Emission Factors*

The default value given in the *Revised 1996 IPCC Guidelines* has been used as the emission factor for this source.

Table 6-22 Emission factor for nitrous oxide emissions associated with atmospheric deposition

	Emission Factor [kgN_2O-N/kg NH_3-N & NO_X-N deposited]
Nitrous oxide emissions associated with atmospheric deposition	0.01

Source: *Revised 1996 IPCC Guidelines* Vol.2 Table 4-18 (*Good Practice Guidance (2000)* Table4.18)

• *Activity Data*

Synthetic Fertilizers

Activity data for nitrous oxide emissions associated with atmospheric deposition in the application of synthetic fertilizers was derived by multiplying "demand for nitrogen-based fertilizers" given in the Ministry of Agriculture, Forestry and Fisheries *Yearbook of Fertilizer Statistics (Pocket Edition)* by the default value of $Frac_{GASF}$, the proportion of nitrogen volatilized as ammonia or nitrogen oxides from synthetic fertilizers, given in the *Revised 1996 IPCC Guidelines*.

Table 6-23 $Frac_{GASF}$: Proportion of nitrogen volatilized as ammonia or nitrogen oxides from synthetic fertilizers

Value	Unit
0.1	[kg NH_3-N + NO_X-N/kg of synthetic fertilizer nitrogen applied]

Source: *Revised 1996 IPCC Guidelines* Vol.2 Table 4-17

Manure

As for activity data for nitrous oxide emissions associated with atmospheric deposition relative to livestock manure, it was derived by multiplying the volume of nitrogen excreted by each type of livestock, as given in the *Revised 1996 IPCC Guidelines,* by the livestock herd size as given in *FAO statistics* and in *Livestock Statistics* prepared by the Ministry of Agriculture, Forestry and Fisheries, and then multiplying the product by the default value of $Frac_{GASM}$, the proportion of nitrogen volatilized as ammonia or nitrogen oxides from livestock manure, given in the *Revised 1996 IPCC Guidelines*.

Table 6-24 Volume of nitrogen excreted by type of livestock

Type of livestock	Annual volume of nitrogen excreted [kg N/head/year]
Non-dairy cattle	40
Dairy cattle	60
Poultry	0.6
Sheep	12
Swine	16
Other	40

Source: *Revised 1996 IPCC Guidelines* Vol.2 Table 4-6 (Asia & Far East)

Table 6-25 $Frac_{GASM}$: Proportion of nitrogen volatilized from livestock manure as ammonia or nitrogen oxides

Value	Unit
0.2	[kg NH_3-N + NO_X-N/kg of nitrogen excreted by livestock]

Source: *Revised 1996 Guidelines* Vol. 2, Table 4-17

6.4.3.2. Nitrogen Leaching and Run-off (4.D.3.-)

- ***Methodology for Estimating Emissions of GHGs***

Nitrous oxide emissions associated with nitrogen leaching and run-off have been calculated using default values, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 4.69 Fig. 4.8). (Refer to *4D-N2O-2005.xls¥ N-Leaching and Run-off* for detail on the calculation process.)

Calculation of nitrous oxide emitted in association with nitrogen leaching and run-off

Volume of nitrous oxide emitted in association with nitrogen leaching and run-off [kg N_2O-N]
= Default emission factor [kg N_2O-N/kg N]
× Volume of leached nitrogen and nitrogen run-off [kg N]

Volume of leached nitrogen and nitrogen run-off [kg N]
= {Volume of synthetic nitrogen fertilizer applied to soil [kg N]
+ $\Sigma_{\text{Type of livestock}}$ (Herd size by type of livestock [head]
× Volume of nitrogen emitted by type of livestock [kg/head])}
× Proportion of applied nitrogen subject to leaching and run-off

- ***Emission Factors***

The default value given in the *Revised 1996 IPCC Guidelines* has been used as the emission factor for this source.

Table 6-26 Emission factor for N_2O emissions associated with nitrogen leaching and run-off

	Emission Factors [kgN_2O-N/kg N]
Nitrous oxide emitted in association with nitrogen leaching and run-off	0.025

Source: *Revised 1996 Guidelines* Vol. 2, Table 4-18 (*Good Practice Guidance (2000)* Table 4.18)

- ***Activity Data***

Activity data was derived by multiplying the proportion of applied nitrogen subject to leaching and run-off, as given in the *Revised 1996 IPCC Guidelines*, by the amount of nitrogen in livestock manure and synthetic fertilizer derived from atmospheric deposition.

Table 6-27 $Frac_{LEACH}$: Proportion of nitrogen applied subject to leaching and run-off

Value	Unit
0.3	[kg N/kg nitrogen of fertilizer or manure]

Source: *Revised 1996 IPCC Guidelines* Vol. 2, Table 4-17

6.4.3.3. Indirect Emissions (CH_4) (4.D.3.)

Direct emission of methane from soil is not possible, and consequently it is not theoretically possible for methane to be emitted indirectly from field soil as well. Therefore, these sources have been reported as “NA”.

Except for atmospheric deposition or nitrogen leaching and run-off, there is no conceivable source of methane emissions from cultivated farmland soil other than direct emissions from soil, animal production, and indirect emissions. Therefore, they have therefore been reported as “NO”.

6.5. Prescribed Burning of Savannas (4.E.)

This source is given in the *IPCC Guidelines* as “being for the purpose of managing pastureland in sub-tropical zones”. There is no equivalent activity in Japan, and this source has been reported as “NO”.

6.6. Field Burning of Agricultural Residues (4.F.)

6.6.1. Rice Straw, Rice Chaff & Straw of Wheat, Barley, Oats and Rye (4.F.1.)

- ***Methodology for Estimating Emissions of GHGs***

The country specific method has been used to calculate emissions of methane and nitrous oxide in association with incineration of rice straw, rice chaff & straw of wheat, barley, oats and rye. (Refer to *4F-CH4-2005.xls¥Rice* and *¥4F-N2O-2005.xls¥Rice* for details of the calculation process.)

Calculation of CH_4 emissions from burning of rice straw, rice chaff & straw of wheat etc.

Volume of CH_4 emitted from burning of rice straw, rice chaff & straw of wheat etc. [Gg CH_4]
= Volume of straw, chaff, or barley straw incinerated [t] × Carbon content
× Proportion of carbon emitted as carbon dioxide
× Molar ratio of methane and carbon dioxide in waste gas

Calculation of N_2O emissions from burning of rice straw, rice chaff & straw of wheat etc.

Volume of N_2O emitted from burning of rice straw, rice chaff & straw of wheat etc. [Gg N_2O]
= Volume of straw, chaff, or barley straw incinerated [t] × Carbon content
× Proportion of carbon emitted as carbon dioxide
× Molar ratio of nitrous oxide and carbon dioxide in waste gas

• *Emission Factors*

Carbon content and other parameters have been established on the basis of actual measurements taken in Japan.

Table 6-28 Carbon content of rice straw, rice chaff, & straw of wheat, barley, oats and rye

	Carbon content	Note
Rice Straw	0.356	Median adopted between 0.369[a] and 0.342[b]
Rice Chaff	0.344	Actual measurements from Bando et al.[a]
Straw of wheat etc.	0.356	Same assumption as for rice straw

Source:
a: Bando, Sakamaki, Moritomi and Suzuki, *Study on methane & nitrous oxide emission from biomass burning*, National Institute for Environmental Studies "*Final Reports of The Global Environment Research Fund in 1992*"
b: Yoshinori Miura and Tadanori Kannno, *Emissions of Trace Gases (CO_2, CO, CH_4 and N_2O) Resulting from Rice Straw Burning*, Soil Sci.Plant Nutr.,43(4), 849-854,1997

Table 6-29 Carbon content of rice straw, rice chaff & straw of wheat, barley, oats and rye

	Proportion of carbon emitted as carbon dioxide	Note
Rice straw	0.684	Median adopted between 0.8[a] and 0.567[b]
Rice chaff	0.8	Actual measurements from Bando et al.[a]
Straw of wheat etc.	0.684	Same assumption as for rice straw

Source: As for carbon content

Table 6-30 Molar ratio of CH_4 and CO_2 in gas from combustion of rice straw, rice chaff & straw of wheat, barley, oats and rye

	Molar ratio of CH_4 and CO_2 in gas	Note
Rice straw	0.0134	Median adopted between 0.0159[a] and 0.109[b]
Rice chaff	0.0157	Actual measurements from Bando et al.[a]
Straw of wheat etc.	0.0134	Same assumption as for rice straw

Source: As for carbon content

Table 6-31 Molar ratio of N_2O and CO_2 in gas from combustion of rice straw, rice chaff & straw of wheat, barley, oats and rye

	Molar ratio of N_2O and CO_2 in gas	Note
Rice straw	0.00070	Median adopted between 0.00015[a] and 0.00124[b]
Rice chaff	0.000059	Actual measurements from Bando et al.[a]
Straw of wheat etc.	0.00070	Same assumption as for rice straw

Source: As for carbon content

- ***Activity Data***

-Straw of Wetland Rice & Chaff of Wetland Rice

Survey results from Ministry of Agriculture, Forestry and Fisheries have been adopted for rice straw and rice chaff incineration volumes.

-Straw of Wheat, Barley, Oats and Rye

Volume of straw of wheat, barley, oats and rye incinerated has been derived by multiplying the proportion of volume of incinerated rice straw to volume of harvested rice, by the barley harvest volumes given in the Ministry of Agriculture, Forestry and Fisheries *Crop Statistics*.

6.6.2. Maize, Peas, Soybeans, Adzuki beans, Kidney beans, Peanuts, Potatoes, Sugarbeet & Sugar cane (4.F.1., 4.F.2., 4.F.3., 4.F.4.)

- ***Methodology for Estimating Emissions of GHGs***

Emissions of methane and nitrous oxide associated with the incineration of maize, peas, soybeans, adzuki beans, kidney beans, peanuts, potatoes, sugarbeet and sugar cane have been calculated using default values, in accordance with Decision Tree or the *Good Practice Guidance (2000)* (Page 4.52 Fig. 4.6). (Refer to *4F-CH4-2005.xls* and *4F-N2O-2005.xls* for details of the calculation process.)

Calculation of methane emissions associated with combustion of maize, peas, soybeans, adzuki beans, kidney beans, peanuts, potatoes, sugarbeets and sugar canes

Volume of methane emitted in association with combustion of maize etc. [Gg CH_4]

$$= \Sigma_{\text{Type of crop}} \{\text{Total amount of carbon released, by type of crop [Gg C]} \times \text{Default value for rate of emission of methane} \times 16/12\}$$

Total amount of carbon released, by type of crop [Gg C]

$$= \Sigma_{\text{Type of crop}} \{\text{Annual crop production [Gg]} \times \text{Ratio of residue to crop production} \times \text{Average fraction of dry matter in stubble} \times \text{Proportion burnt in fields} \times \text{degree of oxidation} \times \text{percentage of Carbon content}\}$$

Calculation of nitrous oxide emissions associated with incineration of maize, peas, soybeans, adzuki beans, kidney beans, peanuts, potatoes, sugarbeets and sugar canes

Nitrous oxide emissions associated with incineration of maize etc. [Gg N_2O]

$$= \Sigma_{\text{Type of crop}} \{\text{Total volume of nitrogen released per crop [Gg N]}\} \times \text{Default nitrous oxide emission rate} \times 44/28\}$$

Total volume of nitrogen released by type of crop [Gg N]

$$= \Sigma_{\text{Type of crop}} \{\text{Annual crop production [Gg]}\} \times \text{Ratio of residue to crop production} \times \text{Average fraction of dry matter in stubble} \times \text{Proportion burnt in fields} \times \text{degree of oxidation} \times \text{Nitrogen formation rate}^{※}\}$$

※ For sugarbeet, carbon formation rate and N/C ratio have been used in place of nitrogen formation rate.

• *Emission Factors*

The default value given in the *Revised 1996 IPCC Guidelines* for this source was used as the emission factor.

Table 6-32 Emission factors for CH_4 and N_2O emissions from the incineration of maize, peas, soybeans, adzuki beans, kidney beans, peanuts, potatoes, sugarbeets and sugar canes

	Value	Unit
CH_4	0.005	[kg CH_4/kg C]
N_2O	0.007	[kg N_2O/kg N]

Source: *Revised 1996 IPCC Guidelines* Vol. 2, Table 4-16

• *Activity Data*

Activity data has been derived by multiplying the parameters given in the equation by the production volume of each type of crop given in the Ministry of Agriculture, Forestry and Fisheries *Crop Statistics*, and *Vegetable Production and Shipment Statistics*.

Table 6-33 Residue/Crop Product Ratio, Dry Matter Fraction, Carbon Fraction, and Nitrogen Fraction

Crop	Residue/Crop Product Ratio	Dry Matter Fraction	Carbon Fraction	Nitrogen Formation Rate
Corn	1.0	0.86	0.4709	0.0081
Peas	1.5	0.87	0.45[a]	0.0142
Soy	2.1	0.89	0.45[a]	0.0230 [b]
Adzuki, beans[b]	2.1	0.89	0.45[a]	0.0230
Peanuts	1.0	0.86	0.45[a]	0.0106
Potatoes	0.4	0.6[c]	0.4226	0.0110
Sugarbeets	0.2	0.2	0.4072	0.0150[d]
Sugar cane	1.62	0.83[c]	0.4235	0.0040

Source: *Good Practice Guidance (2000)* Table 4.16

a: In the absence of a default value, values for dicotyledonous and monocotyledonous plants have been used. Noboru Murayama, et al. *Alimentation of Crops and Fertilizer*, Buneido, p.26

b: The value given at ‘beans’ in Table 4.16 of GPG (2000) has been applied.

c: *Revised 1996 IPCC Guidelines* Vol. 2, Table 4-15

d: No default values are given. The median values given in the *Revised 1996 IPCC Guidelines* Vol. 2, p.4.30（0.01–0.02）have been adopted.

Table 6-34 Default values for oxidation, and proportion burnt in fields

	Value	Unit
Proportion burnt in fields	0.10	—
Rate of oxidation	0.90	—

Source: *Revised 1996 IPCC Guidelines* Vol. 3, p. 4.83

6.6.3. Dry bean (4.F.2.-)

Dry beans are a type of kidney beans, and the term refers to the mature, husked vegetable. Kidney beans in Japan are eaten before ripening, however, which means there is little of this type of product. Kidney beans are included in Beans (4.F.2.), under ‘Other crops’ and, therefore, the dry beans have been reported as “IE”.

6.6.4. Other (4.F.5.)

It is possible that agricultural waste other than cereals, pulse, root vegetables and sugar canes are burnt in the fields. However, data on actual activity is not available and it is not possible to establish the emission factor. Therefore, these sources have been reported as “NE”.

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Chapter 7. Land-Use Change and Forestry (CRF sector5)

7.1. Changes in Forest and Other Woody Biomass Stocks (5.A.)

7.1.1. Temperate Forests (5.A.2.)

- ***Methodology***

To estimate changes in carbon stock stemming from tree growth in temperate forests, carbon dioxide emissions and removals for FY1990 to FY1995 were calculated respectively for intensively managed forests (single storied forests: sugi cedar, etc.), semi-natural forests (beech, oak, etc.) and others (Cut-over forests and lesser stocked forests, bamboo, etc.) using the methodology given in the *Revised 1996 IPCC Guidelines*. (Refer to *5-2005.xls¥5A2* for details of the calculation process)

- ***Parameters***

-Average annual biomass growth rate

The average annual biomass growth rate is calculated by multiplying the wood density by the biomass expansion factor and by the annual increment in volume per unit area (hectare) for each forest type.

Table 7-1 Average annual biomass growth rate by forest type (dm = dry matter)

Item	Unit	1990	1991	1992	1993	1994	1995
Intensively Managed Forest (Single Storied Forest: Sugi Cedar etc.)	[t dm/ha]	5.03	4.96	4.96	4.96	4.96	4.96
Semi-Natural Forest (Beech, Oak etc.)	[t dm/ha]	2.05	1.94	1.94	1.94	1.94	1.94
Other	[t dm/ha]	0.00	0.00	0.00	0.00	0.00	0.00

Table 7-2 Wood density by forest type (dm = dry matter)

Forest type	Wood density [t dm/m^3]
Intensively Managed Forests (single storied forests: sugi cedar etc.)	0.4
Semi-Natural Forests (beech, oak etc.)	0.6
Others (Cut-over forests and lesser stocked forests, bamboo)	0.6
Multi Storied Forests *	0.6

Source: Forestry Agency
* Reference values

Table 7-3 Biomass expansion factors by forest type

Forest type	Biomass expansion factor
Intensively Managed Forests (single storied forests: sugi cedar etc.)	1.7
Semi-Natural Forests (beech, oak etc.)	1.9
Others (Cut-over forests and lesser stocked forests, bamboo)	1.9

Source: Forestry Agency

Table 7-4 Annual increment in volume per unit area (hectare)

Forest type	Annual increment in volume per unit area [m^3/ha]	
	1990	1991 onwards
Intensively Managed Forests (single storied forests: sugi cedar etc.)	7.4	7.3
Semi-Natural Forests (beech, oak etc.)	1.8	1.7
Others (Cut-over forests and lesser stocked forests, bamboo)	0.0	0.0

Source: Based on the Forestry Agency's *Forest Status Survey*

-Carbon fraction of dry matter

The default value given in the *Revised 1996 IPCC Guidelines* has been adopted as the carbon fraction of dry matter.

Carbon fraction of dry matter
0.5

Source: *Revised 1996 IPCC Guidelines* Vol. 2 Page 5.5

- ***Activity Data***

Values given in the Forestry Agency's *Handbook of Forestry Statistics* have been used to determine the activity data for changes in forest and other woody biomass stocks in temperate forests. Refer to the following table for details.

Table 7-5 Classifications in *Handbook of Forestry Statistics*

Forest type	*Handbook of Forestry Statistics* classifications	Notes
Intensively Managed Forests (single storied forests: sugi cedar etc.)	Forest land: Planted Forests	–
Semi-Natural Forests (beech, oak etc.)	Forest land: Semi-Natural forests	–
Others (Cut-over forests and lesser stocked forests, bamboo)	Cut-over forests and lesser stocked forests, bamboo	Add an adjustment value (54 [ha]) to the values in the left column to ensure consistency with the National Land-Use Plan

- ***Point to Note***

It should be noted that, while the natural forests assumed in EU and US is too old to expect its function as a carbon stock, and increase in old-growth stock for natural forests in Europe and the US is negligible, Japan has included post-harvest regeneration forests under Semi-Natural Forests, too.

7.1.2. Other (5.A.5.)

7.1.2.1. Harvested Wood (5.A.5.-)

- ***Methodology***

To determine carbon stock decrease by harvested wood, carbon dioxide emissions for FY1990 to FY1995 were calculated respectively for industrial round wood, bed-log for mushroom culture, and fuel wood, using the methodology given in the *Revised 1996 IPCC Guidelines* (Refer to *5-2005.xls¥5A2* for details of the calculation process).

- ***Parameters***

-Biomass conversion / Expansion ratio

Factors for conversion to biomass have been calculated by multiplying the wood density by biomass expansion factor established for each timber type. For round wood, because a weighting is applied according to production volumes of timber from coniferous and broadleaf trees, the biomass conversion factor changes according to the age of tree.

Table 7-6 Average annual biomass growth rate by forest type (dm = dry matter)

Item	Unit	1990	1991	1992	1993	1994	1995
Industrial Roundwood	[t dm/m^3]	0.83	0.81	0.81	0.79	0.77	0.77 *
Bed-log for mushroom culture	[t dm/m^3]	1.14	1.14	1.14	1.14	1.14	1.14
Fuelwood	[t dm/m^3]	1.14	1.14	1.14	1.14	1.14	1.14

* Data of *Industrial Roundwood* in 1995 is a tentative value

Table 7-7 Wood density by timber type

Timber type		Wood density [t dm/m^3]	Notes
Industrial Roundwood	Needle-leafed forests	0.4	Apply Planted Forest values
	Broad-leafed forests	0.6	Apply Semi-Natural Forest values
Bed-log for mushroom culture		0.6	Apply Multi Storied Forest values
Fuelwood		0.6	Apply Semi-Natural Forest values

Source: Forestry Agency

Table 7-8 Biomass expansion factor by timber type

Timber type		Biomass Expansion factor	Notes
Industrial Roundwood	Needle-leafed forests	1.7	Apply Planted Forest values
	Broad-leafed forests	1.9	Apply Semi-Natural Forest values
Bed-log for mushroom culture		1.9	Apply Multi Storied Forest
Fuelwood		1.9	Apply Semi-Natural Forest values

Source: Forestry Agency

Table 7-9 Trends in production volumes of Needle-leafed forests and Broad-leafed forests

Item	Unit	1990	1991	1992	1993	1994	1995
Roundwood of needle-leafed forests	[1000m^3]	19,549	19,037	18,900	18,772	19,090	18,067
Roundwood of broad-leafed forests	[1000m^3]	9,751	8,901	8,214	6,798	5,366	4,830
Total	[1000m^3]	29,300	27,938	27,114	25,570	24,456	22,897
Share of roundwood of needle-leafed forests	[%]	66.7%	68.1%	69.7%	73.4%	78.1%	78.9%
Share of roundwood of broad-leafed forests	[%]	33.3%	31.9%	30.3%	26.6%	21.9%	21.1%

Source: Forestry Agency, *Handbook of Forestry Statistics*

-Carbon fraction of dry matter

The default value given in the *Revised 1996 IPCC Guidelines* has been adopted as the carbon fraction of dry matter.

Carbon fraction of dry matter
0.5

Source: *Revised 1996 IPCC Guidelines* Vol. 2 Page 5.5

- ***Activity Data***

The activity data for a decrease in carbon stock due to timber harvesting has been calculated by dividing timber supply volumes, given in the Forestry Agency's *Handbook of Forestry Statistics*, by the yield. The yield is assumed on the basis of 79% of standing trees becoming commercial timber.

7.1.2.2. Other (Parks and Green space conservation zones) (5A5-)

- ***Methodology***

To determine changes in tree stocks in parks and green space conservation zones, carbon dioxide emissions and removals for FY1990 to FY1995 have been calculated using the methodology given in the *Revised 1996 IPCC Guidelines* (Refer to *5-2005.xls¥5A5* for details of the calculation process).

• *Parameters*

-Annual biomass increment

The default value for temperate forest deciduous trees given in the *Revised 1996 IPCC Guidelines* has been adopted as the average annual growth rate for trees in municipal parks and green conservation areas.

Table 7-10 Annual average aboveground biomass uptake by natural regeneration for trees in park and green space conservation zones

	Average annual growth rate [t dm/ha]
Temperate forests: deciduous trees	2.0

Source: *Revised 1996 IPCC Guidelines* Vol. 3, p 5.20

-Carbon fraction of dry matter

The default value given in the *Revised 1996 IPCC Guidelines* has been adopted as the carbon fraction of dry matter.

Carbon fraction of dry matter
0.5

Source: *Revised 1996 IPCC Guidelines* Vol. 2, Page 5.5

• *Activity Data*

Activity data for changes in tree stocks in parks and green space conservation zones has been calculated by multiplying the ratio of tree-covered land area, which was calculated from the number of trees and the park area, by the area of parks and green space conservation zones in Ministry of Land, Infrastructure and Transport studies. The ratio of tree coverage of green conservation areas is assumed to be 100%.

Table 7-11 Tree coverage of parks

	高木本数 (A)	既存樹林本数 (B)	既存樹林面積 (C)	樹林面積 (D)=(A)*(C)/(B)	公園面積 (E)	樹林面積率 (F)=(D)/(E)	緑化面積率 (G)	樹林面積率 (F) ※ただし、(F)が(G)よりも大きい場合は、(G)の値を採用
Square parks	2,544,874	144,358	119	2,106	11,178	0.19	0.30	0.19
Neighborhood parks	1,805,246	317,664	391	2,223	7,468	0.30	0.44	0.30
Community parks	1,464,939	375,771	523	2,040	6,178	0.33	0.46	0.33
Comprehensive parks	8,340,919	3,874,627	3,102	6,677	17,064	0.39	0.59	0.39
Sport parks	1,788,274	465,148	712	2,736	9,313	0.29	0.43	0.29
Large scaled parks	3,574,512	1,925,988	2,032	3,771	8,739	0.43	0.66	0.43
Specific parks	4,834,290	2,621,727	2,131	3,929	10,637	0.37	0.62	0.37
National government parks	775,279	161,329	132	633	1,609	0.39	0.70	0.39
Buffer greenbelts	1,069,787	362,660	157	463	1,393	0.33	0.71	0.33
Ornamental green spaces	2,409,496	1,025,383	1,100	2,585	7,831	0.33	0.64	0.33
Greenways	296,697	28,291	89	931	704	1.32	0.60	0.60
Specified community parks	215,179	61,338	79	277	855	0.32	0.49	0.32

Source: Ministry of Land, Infrastructure and Transport, *Survey for preparation of 5 years Greenery Promotion Plan* (1995)

7.2. Forest and Grassland Conversion (5.B.)

• *Methodology*

Carbon dioxide, methane and nitrous oxide emissions from forests and grasslands conversion have been calculated for FY1990 to FY1995 using the methodology given in the *Revised 1996 IPCC Guidelines* (Refer to *5-2004.xls¥5A5* for details of the calculation process).

• *Parameters*

-Amount of biomass before and after conversion

Tree stocks per hectare have been calculated by dividing stocks of the semi-natural forests and cut-over forests and lesser stocked forests given in the Forestry Agency's *Handbook of Forestry Statistics,* by the area of semi-natural forests. Amount of biomass before conversion has been estimated by multiplying tree stocks per hectare by wood density and by the biomass expansion factor. Amount of biomass after conversion is assumed to be 0.

Table 7-12 Process of estimating biomass before conversion

Item	Unit	1990	1991	1992	1993	1994	1995
Trunk volume	[1000m^3]	1,597,844	1,656,674 *	1,715,504 *	1,774,333 *	1,833,163 *	1,891,993
Area of forest	[kha]	10,327	10,341 *	10,355 *	10,370 *	10,384 *	10,398
trunk volume per unit area	[m^3/ha]	154.70	160.20 *	165.70 *	171.10 *	176.50 *	182.00
Density	[t dm / m^3]	0.4	0.4	0.4	0.4	0.4	0.4
Conversion factor	[t dm total / tdm trunk]	1.7	1.7	1.7	1.7	1.7	1.7
Biomass before conversion	[t dm/ha]	105.0	109.0	113.0	116.0	120.0	124.0

* Imputation of values from 1991-1994 are based on linear interpolation.

-Fraction of biomass burned on-site

Fraction of biomass burned on-site was determined by assuming that 30% of harvested timber is burned on-site and the remaining 70% is used for sawn timber.

Table 7-13 Fraction of biomass burned on site etc.

	Fraction
On-site burning	0.3
Off-site burning	0.0
Portion left to decay on site.	0.0

-Fraction of biomass oxidized

The default value given in the *Revised 1996 IPCC Guidelines* has been used to determine biomass oxidization.

Fraction of biomass oxidized
0.9

Source: *Revised 1996 IPCC Guidelines* Vol. 2, Page 5.15

-Carbon fraction of dry matter

The default value given in the *Revised 1996 IPCC Guidelines* has been adopted as the carbon fraction of dry matter.

Carbon fraction of dry matter
0.5

Source: *Revised 1996 IPCC Guidelines* Vol. 2, p 5.5

-Nitrogen-Carbon Ratio

The default value given in the *Revised 1996 IPCC Guidelines* has been used to determine the Nitrogen-Carbon ratio.

N-C ratio
0.01

Source: *Revised 1996 IPCC Guidelines* Vol. 2, p 5.18

-Methane and Nitrous Oxide emission ratios

The default values given in the *Revised 1996 IPCC Guidelines* have been used to determine the CH_4 and N_2O emission ratios.

Table 7-14 CH_4 and N_2O emission ratios

GHG	Emission ratio	Unit
CH_4	0.012	[CH_4-C / carbon from combustion source]
N_2O	0.007	[N_2O-N / nitrogen in fuel]

Source: *Revised 1996 IPCC Guidelines* Vol. 2, Table 5-7

• *Activity Data*

The difference between planted forest and semi-natural forest areas from the previous year and the relevant year given in the *Handbook of Forestry Statistics* has been used as the activity data for carbon dioxide, methane, and nitrous oxide emissions associated with forest and grassland conversion. Where the increase in planted forests is greater than the reduction in area of semi-natural forests, it is assumed that semi-natural forests have been converted to planted forests, and the activity data (conversion of use from forests to other applications) has been reported as ‘0’.

7.3. Abandonment of Managed Lands (5.C.)

Although it is supposed that activities corresponding to this category do exist in Japan, the lack of data for estimation has resulted in reporting of emissions as “NE”.

7.4. CO_2 Emissions and Removals from Soil (5.D.)

Although it is supposed that activities corresponding to this category do exist in Japan, the lack of data for estimation has resulted in reporting of emissions as “NE”.

References

IPCC, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, 1997

Forestry Agency, *Forest Status Survey*

Forestry Agency, *Handbook of Forestry Statistics*

Ministry of Land, Infrastructure and Transport, *Survey for preparation of 5 years Greenery Promotion Plan*, 1995

Chapter 8. Waste (CRF sector6)

8.1. Solid Waste Disposal on Land (6.A.)

• *Methodology for Estimating Emissions of GHGs*

Methane and carbon dioxide emitted from this source have been calculated using the country-specific method. Emissions have been calculated by multiplying the emission factor by the volume of carbon which was biologically decomposed in the relevant year from the carbon included in waste in landfill in the past (Refer to *6A-2005.xls* for details on the calculation process).

• *Emission Factors*

-Outline

Waste has been categorized into kitchen garbage, waste papers or waste textiles, and waste wood, and emission factors have been established for each type of waste respectively.

Emission factors by the carbon content in each type of waste were estimated by multiplying the rate of conversion to gas from waste in landfill and the proportions of methane or carbon dioxide in the generated gas.

The data used in calculating emission factors is based on the results of measurement on municipal solid waste. It has been assumed that the carbon content in industrial waste is same as municipal solid waste, and the same value has been used.

-Carbon Content

Carbon content in each type of waste has been estimated as an average for the relevant year, by using actual results from the data gathered in cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka; calculate a moving average of the carbon content in each type of waste over a five-year period, centered around the relevant year, for each municipal government; and convert it to a weighted average using the individual populations of each municipality. (For details on the assumptions underlying the calculations, refer to *6-EF-2005.xls¥6A-CH4*.)

Table 8-1 Carbon content in kitchen garbage (%)

City	1990	1995	2000	2002	2003
Tokyo	42.49	40.66	42.47	42.47 *	42.47 *
Yokohama	42.32	43.64	46.54	45.67	46.37
Kawasaki	—	42.82	41.67	45.75	41.65
Kobe	—	43.73	47.19	47.34	42.20
Fukuoka	42.69	41.51	43.14	44.55	44.22

* Using the 2000 figure because of absence.

Source: Data provided by the cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka

Table 8-2 Carbon content in waste papers or waste textiles (%)

City	1990	1995	2000	2002	2003
Tokyo	43.79	40.63	41.93	41.93 *	41.93 *
Yokohama	43.66	43.30	42.19	42.34	42.44
Kawasaki	-	35.84	38.99	42.85	40.54
Kobe	-	42.27	40.88	42.34	42.74
Fukuoka	42.23	41.66	41.83	40.59	41.15

* Using the 2000 figure because of absence.

Source: Data provided by the cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka

Table 8-3 Carbon content in waste wood (%)

City	1990	1995	2000	2002	2003
Tokyo	43.90	46.77	35.32	35.32 *	35.32 *
Yokoyama	50.03	48.66	47.94	42.67	47.47
Kawasaki	—	41.23	42.71	46.14	44.51
Kobe	—	46.65	46.33	46.57	42.98
Fukuoka	47.92	46.65	46.65	46.96	45.22

* Using the 2000 figure because of absence.

Source: Data provided by the cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka

-Rate of conversion of waste to gas

The rate of conversion to gas from carbon in kitchen garbage in landfill was set at 50%, on the basis of *Estimates of Volume of Methane Released from Sewage Treatment Plants by Matsuzawa et al.*, from a 1993 collection of research papers presented to the 4th Academic Conference on Waste.

-Proportions of methane or carbon dioxide in generated gas

The proportion of methane was set at 55% on the basis of *Primary Screening of Greenhouse Gases Generated in Association With the Biological Breakdown of Organic Wastes by Watanabe et al.*, from a 1992 collection of papers presented to the 13th Japan City Cleaning Research Conference, but carbon dioxide generated together with methane is dissolved in moisture content in landfill sites. Therefore, the proportion of methane is thought to be less than 55%. For that reason, the default value given in the *Revised 1996 IPCC Guidelines* was used and the proportion of methane was set at 50%. It was then assumed that any gas other than methane was carbon dioxide, and the proportion of carbon dioxide was also set at 50%.

• *Activity Data*

Activity data has been calculated for municipal solid waste and industrial waste, respectively. The proportion of carbon decomposed in the relevant year has been derived by multiplying the volume of biodegradable landfill (volume of landfill by type of waste [dry basis], provided by the Waste Management and Recycling Department of the Minister’s Secretariat, Ministry of the Environment) by the rate of decomposition according to the passage of time in years. The total amount of carbon decomposed in the relevant year from the buried waste has been used as activity data (Refer to *6A-AD-2005.xls* for details on the calculation process).

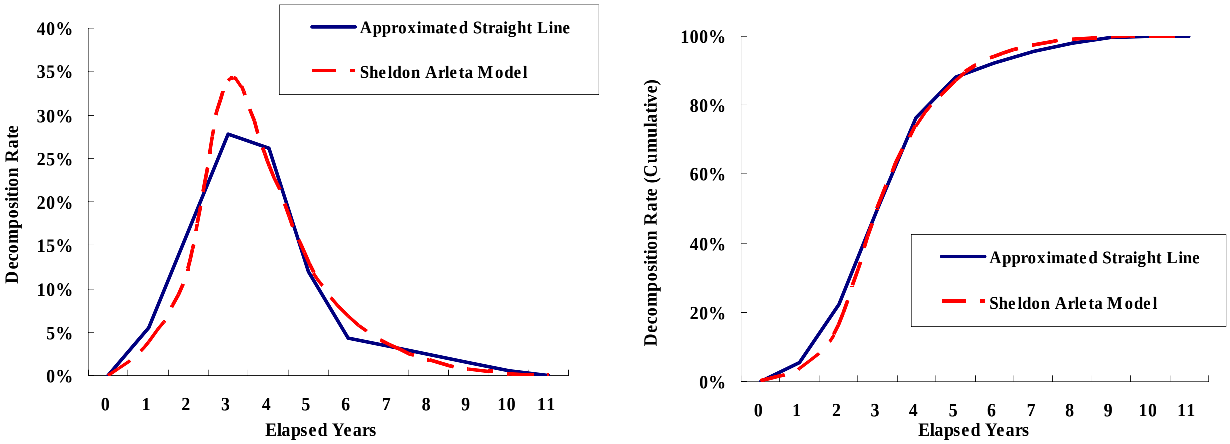

Figure 8-1 Rate of decomposition of kitchen garbage

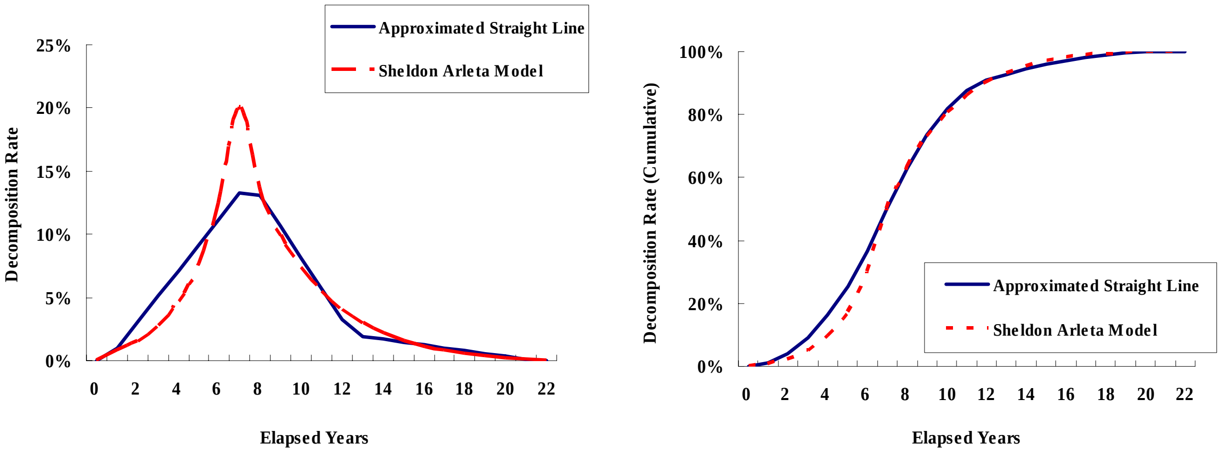

Figure 8-2 Rate of decomposition of waste papers or waste textiles

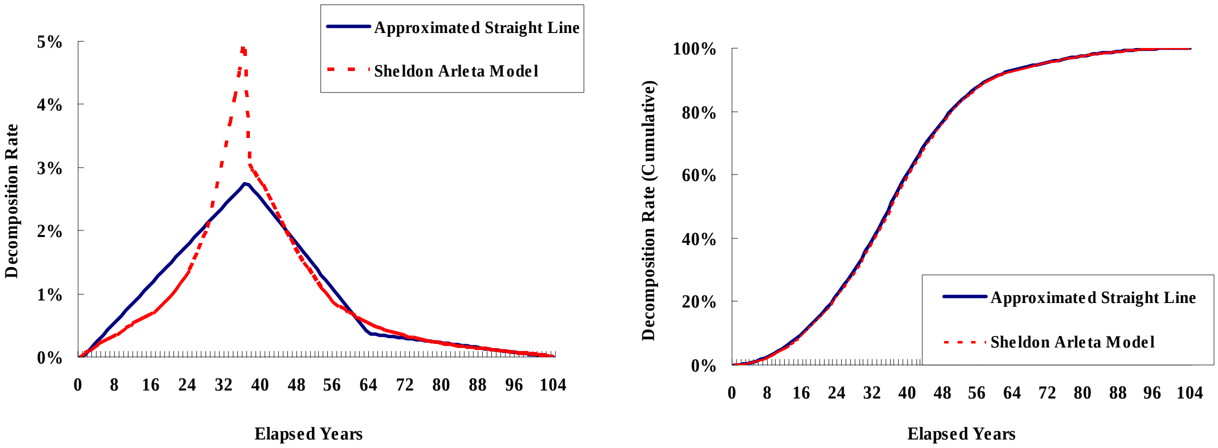

Figure 8-3 Rate of decomposition of waste papers or waste wood

Source: Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 3*, September 2000

- ***Japanese Country-Specific Method***

Decision Tree of the *Good Practice Guidance (2000)* (Page 5.6, Fig. 5.1) requires that the Tier 2 first order decay (FOD) method is used in calculation.

Researches have been conducted to understand the actual emissions of methane on waste landfill sites in Japan. The results of these researches have been used to derive emissions, using a more advanced model of a simple approximation of the Sheldon Arleta model that depicts the decomposition of waste on a landfill sites over time.

- ***Carbon Dioxide Emissions***

The carbon dioxide emitted from this source is biological in its origin. Therefore, it has not been added to Japan’s total emissions. As a reference, these carbon dioxide emissions have been provided under “Additional Information” in the Common Reporting Format.

8.2. Wastewater Handling (6.B.)

8.2.1. Industrial Wastewater (6.B.1.)

1) CH_4

- ***Methodology for Estimating Emissions of GHGs***

Emissions have been derived by multiplying the emission factor for BOD by the annual BOD burden from the industry that generates the largest BOD burden (Refer to *6B-2005.xls¥6B1-Ind* for details on the calculation process.).

- ***Emission Factors***

The Water Environment Department of the Environmental Management Bureau in the Ministry of the Environment in its Comprehensive Survey of Emissions of Water Quality Contaminants, reports that the most typical means for treating industrial wastewater is the activated sludge method, which is also applied in treating domestic wastewater. Although there are slight differences in the way this treating method is applied to industrial and domestic wastewater, when comparing based on BOD, there seems to be no great difference between their applications. Therefore, the data on methane emissions given at *8.2.2.1. Sewage Treatment Plant (6.B.2.-)* has been used to calculate the volume of methane emitted per BOD to establish the emission factor.

Calculation of emission factor

- Methane emissions per volume of treated wastewater by the activated sludge method: Methane emission factor for sewage treatment plant
- Planned run-off water quality: Planned run-off water quality of municipal solid domestic wastewater

Emission factor = Methane emissions per volume of treated wastewater by the activated sludge method / Planned run-off water quality

$= 0.00088\ [\mathrm{kg\ CH_4/m^3}] / 180\ [\mathrm{mg\ BOD/\ L}]$

$= 0.004888\ [\mathrm{kg\ CH_4/kg\ BOD}]$

$= 0.0049\ [\mathrm{kg\ CH_4/kg\ BOD}]$

Table 8-4 Number of operating sites by method of wastewater treatment (FY2000)

#	Wastewater Handling System	Total establishments	Ratio
1	Activated Sludge	15,972	45.9%
2	Other Biological Handling	6,209	17.9%
3	Coagulator, Floatation	3,877	11.2%
4	Sand Filtration	245	0.7%
5	Ozonation	68	0.2%
6	Activated Carbon	365	1.0%
7	Oily Water Separator	382	1.1%
8	Other High-Intensity Handling	633	1.8%
9	Other	2,873	8.3%
	No Answer	4,147	11.9%
	Total	34,771	100.0%

Source: Water Environment Department, Environmental Management Bureau, Ministry of the Environment *Comprehensive Survey of Emissions of Water Quality Contaminants*

• *Activity Data*

-Outline

With a reference of the industry types given in the *Revised 1996 IPCC Guidelines*, activity data was obtained by totaling up the BOD burden from each industry of which levels in methane emissions associated with wastewater handling and BOD concentrations in wastewater are high.

BOD concentration by each industrial sub-category was multiplied by the volume of wastewater, and the total of the products was taken as activity data (BOD burden). For industrial sub-categories of which BOD raw water quality by industry wastewater was not provided, activity data was derived by substituting average BOD raw water quality by industry medium category.

-BOD concentration

BOD raw water quality for industrial sub-categories given in the Japan Sewage Works Association *Guidelines and Analysis of Comprehensive Planning Surveys for the Provision of Water Mains, by Catchment Area 1999 Edition* was used for BOD concentration by industry sub-category.

-Volume of wastewater

The volume of water used for treatment of products, by industrial sub-category, and the volume of water used for washing given in the Ministry of Economy, Trade and Industry's *Table of Industrial Statistics - Land and Water* were used for the volume of wastewater.

Table 8-5 Industries of which activity data was calculated, and BOD burden [kt BOD/year (CY)]

Code	Category of Manufacturing	1990	1995	2000	2002	2003
9	Food Manufacturing	593.0	681.8	583.5	705.0	705.0 *
10	Beverage, Tobacco and Feeding Stuff Manufacturing	137.9	142.7	139.0	129.0	129.0 *
11	Textile Manufacturing (excluding: Clothing Material, Other Textile)	164.8	138.2	101.8	89.8	89.8 *
12	Clothing Material and Other Textile Manufacturing	2.2	4.0	2.5	2.1	2.1 *
15	Pulp, Paper and Other Paper Manufacturing	1,699.7	1,589.2	1,582.7	1,546.2	1,546.2 *
17	Chemical Industries	787.5	735.7	751.3	753.1	753.1 *
18	Petroleum Products and Coal Product Manufacturing	3.0	2.2	2.6	1.7	1.7 *
19	Plastic Products Manufacturing	12.3	11.7	12.4	11.6	11.6 *
20	Rubber Products Manufacturing	0.9	0.9	0.6	0.7	0.7 *
21	Chamois, Chamois Products and Fur Skin Manufacturing	5.9	5.0	3.7	2.8	2.8 *
Total		3,407.2	3,311.4	3,180.0	3,242.0	3,242.0 *

* Drainage volumes in 2002 are replaced by that in 2001.

Source: Calculated from BOD concentration (Japan Sewage Works Association （*Guidelines and Analysis of Comprehensive Planning Surveys for the Provision of Water Mains, by Catchment Area 1999 Edition*） and volume of wastewater (*Ministry of Economy, Trade and Industry Table of Industrial Statistics – Land and Water*)

8.2.2. Domestic and Commercial Wastewater (6.B.2.)

8.2.2.1. Sewage Treatment Plant (6.B.2.-)

- ***Methodology for Estimating Emissions of GHGs***

Emissions of methane and nitrous oxide from this source have been calculated using the country-specific method, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 5.14, Fig. 5.2). Emissions were derived by multiplying the volume of sewage treated at sewage treatment plants by the emission factor (Refer to *6B-2005.xls¥6B2-D&C* for details of the calculation process).

- ***Emission Factors***

Emission factors were established by adding the simple averages for each treatment process, having taken the actual volume of methane and nitrous oxide released from sludge treatment and water treatment processes measured at sewage treatment plants from research studies conducted in Japan.

Table 8-6 Actual volume of methane released from each treatment process [mg CH_4/m^3]

Water treatment process					Sludge treatment process			Source
Detritus pond	Initial settling pond	Biological reaction tank	Final settling pond	Total	Concentration tank	De-watering chamber	Total	
---	59.0	---	590.0	649.0	510.0	---	510.0	a
---	260.0			260.0	420.0	---	420.0	a
---	37.0	240.0	3.0	280.0	320.0	---	320.0	b
---	16.0	145.0	0.6	161.6	48.0	54.0	102.0	b
38.0	250.0	89.0	---	377.0	51.0	190.0	241.0	b
---	8.0	253.0	0.0	261.0	194.0	81.0	275.0	b
---	51.0	328.0	0.7	379.7	441.0	80.0	521.0	b
---	2.0	815.0	0.0	817.0	272.0	123.0	395.0	c
5.0	21.7	430.0	2.0	458.7	---	---	---	d
22.5	4.8	1,002.6	0.0	1,029.9	---	---	---	d
0.3	127.0	252.5	1.4	381.2	---	---	---	d
2.6	1.8	298.8	0.2	303.4	---	---	---	d
1.5	68.1	1,877.3	3.2	1,950.1	---	---	---	d
0.3	2.4	89.9	0.5	93.1	---	---	---	d
Simple average				**528.7**	**Simple average**		**348.0**	

N.B. --- Indicates that no measurements have been taken, or that data is not available.

a : Kyosai and Mizuochi *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1990 Global Environment Research Fund Outcome Report

b : Kyosai and Mizuochi *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1992 Global Environment Research Fund Outcome Report

c : Takeishi, Suzuki, and Matsubara *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1993 Global Environment Research Fund Outcome Report

d : Nakamura, Suzuki, Sonemura, Ochi, and Harada *B-16(8) Sewage Treatment System Technology for Limiting Greenhouse Gases* FY1997 Global Environment Research Fund Outcome Report

Calculation of methane emission factor

$$\begin{aligned}\text{Emission factor} &= \text{Simple average of emission factor for water treatment processes} \\ &\quad + \text{Simple average of emission factor for sludge treatment processes} \\ &= 528.7\ [\text{mg } CH_4/m^3] + 348.0\ [\text{mg } CH_4/m^3] \\ &= 8.764 \times 10^{-4}\ [\text{kg } CH_4/m^3] \\ &= \underline{8.8 \times 10^{-4}\ [\text{kg } CH_4/m^3]}\end{aligned}$$

Table 8-7 Measurements of N_2O released from each treatment process [mg N_2O/m^3]

Water treatment process				Sludge treatment process			Source
Initial Settling Pond	Biological reaction tank	Final settling pond	Total	Concentration tank	De-watering chamber	Total	
0.0	17.9	0.0	17.9	0.6	---	0.6	a
0.0	20.3	0.0	20.3	1.2	---	1.2	a
0.0	1.3	0.1	1.4	0.0	---	0.0	a
---	28.3	0.0	28.3	---	---	---	b
---	994.7	0.0	994.7	---	---	---	b
---	60.7	0.0	60.7	---	---	---	b
---	---	---	91.8	---	---	---	c
---	---	---	67.6	---	---	---	c
Simple average			**160.3**	**Simple average**		**0.6**	

N.B. Sources 2 and 3 are given in (mg-N/m^3) units and have been converted to (mg-N_2O/m^3)

--- Indicates that no measurements have been taken, or that data is not available.

a: Takeishi, Suzuki, and Matsubara *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1993 Global Environment Research Fund Outcome Report

b: Nakamura, Suzuki, Sonemura, Ochi, and Harada *B-16(8) Sewage Treatment System Technology for Limiting Greenhouse Gases* FY1997 Global Environment Research Fund Outcome Report

c: Inamori and Mizuochi B-16(8) On-Site Surveys of Balance of Methane and Nitrous Oxide from Sewage and Waste FY1998 Global Environment Research Fund Outcome Report

Calculation of nitrous oxide emission factor

$$\begin{aligned}\text{Emission factor} &= \text{Simple average of emission factor for water treatment processes} \\ &\quad + \text{Simple average of emission factor for sludge treatment processes} \\ &= 160.3\ [\text{mg } N_2O/m^3] + 0.6\ [\text{mg } N_2O/m^3] \\ &= 1.609 \times 10^{-4}\ [\text{kg } N_2O/m^3] \\ &= 1.6 \times 10^{-4}\ [\text{kg } N_2O/m^3]\end{aligned}$$

• *Activity Data*

Activity data for methane and nitrous oxide emissions associated with water treatment at sewage treatment plants was derived by subtracting the volumes subject to primary processing from the annual volume of water treated, as given in the Japan Sewage Works Association *Sewage Statistics (Admin. Ed.)*.

The reason for subtracting volumes subject to primary processing is as follows:

(i) Methane and nitrous oxide emitted from this source are primarily emitted from biological reaction tanks, and

(ii) The annual volume of water treated as given in the *Sewage Statistics (Admin. Ed)* includes primary treatment volumes that are only subject to settling. Therefore, if the annual volume of treated water was used as activity data, the estimates would be too large.

8.2.2.2. Domestic Sewage Treatment Plant (Private Sewerage Tank) (6.B.2.-)

- ***Methodology for Estimating Emissions of GHGs***

Methane and nitrous oxide emitted from this source were calculated using the country-specific method, in accordance with Decision Tree the *Good Practice Guidance (2000)* (Page 5.14, Fig. 5.2). Emissions were derived by multiplying the annual population of treatment for each type of domestic sewage treatment plant by the emission factor (Refer to *6B-2005.xls¥6B2-D&C* for details of the calculation process).

- ***Emission Factors***

Emission factors for methane and nitrous oxide have been established by each type of domestic sewage treatment plants, including community plants, gappei-shori johkasou, tandoku-shori johkasou, and vault toilets.

"gappei-shori johkasou" is a system developed in Japan for on-site treatment both human waste and household wastewater together.

"tandoku-shori johkasou" is a system developed in Japan for on-site treatment of human waste only.

Table 8-8 Methane emission factor for domestic sewage treatment plants

Domestic waste water treatment facilities	Methane emission factor [kg CH_4/person-year]
Community plants[a]	0.195
Gappei-shori johkasou[a]	1.106
Tandoku-shori johkasou[b]	0.196
Vault toilets[c]	0.196

a: Masaru Tanaka, *Compendium of Waste,* Maruzen 1998

b: Uses averages of actual measurements given in Takeishi, Suzuki, and Matsubara *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1993 and FY1994 Global Environment Research Fund Outcome Report

c: Assumed to be same as for isolation type tandoku-shori johkasou

Table 8-9 Nitrous oxide emission factor for domestic sewage treatment plant

Domestic waste water treatment facilities	Nitrous oxide emission factor [kg N_2O/person-year]
Community plants [a]	0.0394
Gappei-shori johkasou[a]	0.0264
Tandoku-shori johkasou[b]	0.0200
Vault toilets [c]	0.0200

a: Uses averages of actual measurements given in Tanaka, Inoue, Matsuzawa, Osako, and Watanabe *B-2(1) Research into Volumes Released from Waste Treatment Plants* 1994 Global Environment Research Fund Outcome Report1)

b: Uses averages of actual measurements given in 1) and Takeishi, Suzuki, and Matsubara, *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1993 and FY1994 Global Environment Research Fund Outcome Report

c: Assumed to be same as for isolation type tandoku-shori johkasou

• *Activity Data*

Annual treatment population by type of domestic sewage treatment plant for community plants, gappei-shori johkasou, tandoku-shori johkasou, and vault toilets given in the Ministry of the Environment’s *Waste Treatment in Japan*, was used as the activity data for methane and nitrous oxide emitted in association with domestic waste water treatment facilities.

• *Domestic Wastewater Treatment Facilities in Japan*

The approach in Japan is to provide adequate consideration to the characteristics, efficacy, and economy of each type of system for treating wastewater, in order to choose the system most suited to each region, thereby avoiding excessive investment and providing the necessary infrastructure efficiently.

At the end of March 2003, more than 77% of the country had wastewater treatment facilities in place, and the target of ongoing introduction of such infrastructure is shifting from major urban regions to small and medium-sized municipalities. Small and medium-sized municipalities are low in population density and low in proportion of flat land. The municipalities responsible for commissioning this work only have limited amount of funds, and they require more economical infrastructure solutions.

Therefore, the circumstances would suggest that gappei-shori johkasou should be suited to the domestic wastewater treatment requirements of the small and medium-sized municipalities as well as sewage infrastructures, and their installation should be pursued systematically as the focal point of domestic wastewater measures.

8.2.2.3. Human-Waste Treatment Plant (6.B.2.-)

1) CH_4

- ***Methodology for Estimating Emissions of GHGs***

Methane emitted from this source has been calculated using the country-specific methodology, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 5.14, Fig. 5.2). Emissions were calculated by multiplying the volume of domestic wastewater treated at human waste treatment plants, by the emission factor (Refer to *6B-2005.xls¥6B2-D&C* for details of the calculation process).

- ***Emission Factors***

A weighted average of emission factors for methane emissions for each treatment process, including anaerobic treatment, aerobic treatment, standard de-nitrification treatment, high load de-nitrification treatment, and membrane separation, was derived using the treatment capacity of each method of treatment (Refer to *6-EF-2005.xls¥ 6B2c* for details of the calculation process).

Table 8-10 Methane emission factors by each treatment process

Treatment method	Methane emission factor [kg CH_4/m^3]
Anaerobic treatment [a]	0.543
Aerobic treatment [b]	0.00545
Standard de-nitrification treatment [c]	0.0059
High load de-nitrification treatment [c]	0.005
Membrane separation [d]	0.00545
Other [d]	0.00545

a: Actual methane emissions given in the Japan Environmental Sanitation Center *Report of Analytical Survey of Methane Emissions FY1989 Commissioned by the Environmental Agency* multiplied by the rate of recovery of 1-methane (90%).

b: Actual data on emissions is not available. A simple average of standard- and high-load de-nitrification has been used.

c: Tanaka, Inoue, Matsuzawa, Osako, and Watanabe *B-2(1) Research into Volumes Released from Waste Treatment Plants* FY1994 Global Environment Research Fund Outcome Report

d: Actual data on emissions is not available. The emission factor for Aerobic treatment has been substituted.

Table 8-11 Trends in treatment capacity by treatment process

	Unit	1990	1995	2000	2002	2003
Anaerobic Treatment	kl/day	34,580	19,869	10,996	8,518	5,641 **
Aerobic Treatment	kl/day	26,654 *	19,716	12,166	10,411	8,339 **
Standard Denitrogen	kl/day	25,196 *	30,157	31,908	32,230	33,756 **
High-Intensity Denitrogen	kl/day	8,158 *	13,817	16,498	16,735	18,616 **
Membrane Separation	kl/day	0 *	1,616	2,375	2,759	3,138 **
Other	kl/day	13,777	20,028	25,917	27,566	27,668 **
Total	kl/day	108,365	105,203	99,860	98,219	97,157 **

* These values were estimated because statistics division was different.

** Data of 2003 are extrapolated by trend of 1992-2002. The division of the statistics is different before 1992.

<u>*Calculation of methane emission factor (FY2003)*</u>

Emission factor
= (Methane emission factor for anaerobic treatment × Treatment capacity of anaerobic treatment
+ Methane emission factor for aerobic treatment × Treatment capacity of aerobic treatment
+ Methane emission factor for standard de-nitrification
× Treatment capacity of standard de-nitrification
+ Methane emission factor for high load de-nitrification
× Treatment capacity of high load de-nitrification
+ Methane emission factor for membrane treatment × Treatment capacity of membrane treatment
+ Methane emission factor for other treatments × Treatment capacity of other treatments)
/ Total treatment capacity of all treatment formats

$$= (0.543\ [\mathrm{kg\ CH_4/m^3}] \times 5{,}641\ [\mathrm{kL/day}] + 0.00545\ [\mathrm{kg\ CH_4/m^3}] \times 8{,}339\ [\mathrm{kL/day}]$$
$$+ 0.0059\ [\mathrm{kg\ CH_4/m^3}] \times 33{,}756\ [\mathrm{kL/day}] + 0.005\ [\mathrm{kg\ CH_4/m^3}] \times 18{,}616\ [\mathrm{kL/day}]$$
$$+ 0.00545\ [\mathrm{kg\ CH_4/m^3}] \times 3{,}138\ [\mathrm{kL/day}] + 0.00545\ [\mathrm{kg\ CH_4/m^3}] \times 27{,}668\ [\mathrm{kL/day}]$$
$$/ (5{,}641 + 8{,}339 + 33{,}756 + 18{,}616 + 3{,}138 + 27{,}668)\ [\mathrm{kL/day}]$$
$$= 0.037\ [\mathrm{kg\ CH_4/m^3}]$$

• *Activity Data*

Activity data for methane emissions associated with water treatment in human waste treatment facilities was derived from the volume of human waste treated at these facilities, given in the Ministry of the Environment's *Waste Treatment in Japan*.

2) N_2O

• *Methodology for Estimating Emissions of GHGs*

Nitrous oxide emitted from this source has been calculated using the country-specific methodology, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 5.14, Fig. 5.2). Emissions were calculated by multiplying the volume of nitrogen treated at human waste treatment plants, by the emission factor (Refer to *6B-2005.xls¥6B2-D&C* for details of the calculation process).

• *Emission Factors*

A weighted average of emission factors for nitrous oxide emissions for each treatment process, including high load de-nitrification treatment and membrane separation, was derived using the treatment capacity of each method of treatment (Refer to *6-EF-2005.xls¥ 6B2c* for details of the calculation process).

Table 8-12 Nitrous oxide emission factors by each treatment process

Treatment method	Nitrous oxide emission factors[kg N_2O-N/kg-N]		
	FY1990-1994	FY1995-2002	FY2003
high load de-nitrification treatment	0.042[a]	Calculated by interpolation using the values of FY1994 and FY 2003	0.0019[b]
membrane separation	0.042[a]	Calculated by interpolation using the values of FY1994 and FY 2003	0.0016[b]
Other (including anaerobic treatment, aerobic treatment, standard de-nitrification treatment)	0.0000029[c*]		

a : Use median value of actual measurements at 13 plants given in Tanaka, Inoue, Osako, Yamada, and Watanabe *B-16(7) Research into Limiting Generation of Methane and Nitrous Oxide from the Waste Sector* FY1997 Global Environment Research Fund Outcome Report

b : Use median value of actual measurements at 13 plants given in Omura, Kawakubo, and Yamada. *Study of Emission Factors for N_2O from High-load Human Waste Management.* Journal of Waste Management, 57 (260).

c : Tanaka, Inoue, Matsuzawa, Osako, and Watanabe *B-2(1) Research into Volumes Released from Waste Treatment Plants* FY1994 Global Environment Research Fund Outcome Report

* : Calculated by dividing upper limit value for standard de-nitrification treatment (0.00001kg-N2O/m^3) by treated nitrogen concentration in FY1994 (2,211mg/L).

Calculation of nitrous oxide emission factor (FY2003)

Emission factor
= (Methane emission factor for high load de-nitrification
× Treatment capacity of high load de-nitrification
+ Methane emission factor for membrane treatment × Treatment capacity of membrane treatment
+ Methane emission factor for other treatments × Treatment capacity of other treatments)
/ Total treatment capacity of all treatment formats

$$= (0.0019\ [\text{kg } N_2O/\text{kg-N}] \times 18{,}616\ [\text{kl/day}] + 0.0016\ [\text{kg } N_2O/\text{kg-N}] \times 3{,}138\ [\text{kl/day}]$$
$$+ 0.0000029\ [\text{kg } N_2O/\text{kg-N}] \times 75{,}404\ [\text{kl/day}] / (18{,}616+3{,}138+75{,}404)\ [\text{kl/day}]$$
$$= 0.0004\ [\text{kg } N_2O/\text{kg-N}]$$

• *Activity Data*

The volume of nitrogen treated at human waste treatment plants is calculated by multiplying treated nitrogen concentration by the volume of human waste treated at these facilities (the sum of collected human waste and sewage in sewerage tank), given in the Ministry of the Environment's

Waste Treatment in Japan. The treated nitrogen concentration is based on weighted average of the volume of nitrogen contained in collected human waste and sewage in sewerage tank derived using the volume of collected human waste and sewage in sewerage tank treated at human waste treatment plants.

Table 8-13 Treated nitrogen concentration

FY	Unit	1990	1995	2000	2002	2003
Treated nitrogen concentration	mg/L	3,043	2,008	1,695	1,647	1,647

Table 8-14 Volume of nitrogen contained in collected human waste and sewage in sewerage tank

FY	Unit	1990	1995	2000	2002	2003
Volume of nitrogen contained in collected human waste	mg/L	3,940	3,100	2,700	2,700	2,700
Volume of nitrogen contained in sewage in sewerage tank	mg/L	1,060	300	580	580	580

Use analytical values for FY 1989-1991, FY1992-1994, FY1995-1997 and FY1998-2000. Data after 2001 are replaced by that in 2000.

Source : Okazaki, Shimizu, and Morita. *Study of Operation Records Based on Precision Function Inspection of Human Waste Management Plant.* Japan Environmental Sanitation Center Report, 28.

Table 8-15 Volume of human waste treated at their treatment plants

FY	Unit	1990	1995	2000	2002	2003
Volume of collected human waste	1000kl/year	20,406	18,049	14,673	14,490	14,114
Volume of sewage in sewerage tank	1000kl/year	9,224	11,545	13,234	14,305	13,933
Total	1000kl/year	29,630	29,594	27,907	28,795	28,047

Data from the Ministry of the Environment's *Waste Treatment in Japan*

8.3. Waste Incineration (6.C.)

In Japan, waste is categorized into municipal solid waste and industrial waste. Based on the laws, municipalities and business entities are responsible for its management. As with the laws, in the waste statistics, data for municipal solid waste and industrial waste are treated separately. Given the fact that some data are counted in different categories in the waste statistics, different estimation methods were provided for municipal solid waste and industrial waste in the relevant category.

8.3.1. Municipal Solid Waste Incineration (6.C.-)

1) CO_2

- ***Methodology for Estimating Emissions of GHGs***

Emissions of carbon dioxide from this source were derived by using the volume of waste plastic incinerated and Japan’s country-specific emission factor, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 5.24, Fig 5.5) (Refer to *6C-CO2-2005.xls¥MSW* for details of the calculation process).

- ***Emission Factors***

-Outline

In accordance with the *Revised 1996 IPCC Guidelines*, the carbon content in waste plastics has been multiplied by the rate of incineration of waste plastics at incineration plants.

-Carbon content in waste plastics

The carbon content in waste plastics has been estimated for relevant year as an average using actual results from the data gathered cities of Tokyo, Yokohama, Kawasaki, Kobe and Fukuoka; calculate a moving average of the carbon content for each type of waste over a five-year period, centered around the relevant year, for each municipal government; and convert it to a weighted average using the population of each municipality.

Table 8-16 Carbon content in waste plastics (municipal solid waste) (%)

City	1990	1995	2000	2002	2003
Tokyo	71.08	67.86	68.58	68.58 *	68.58 *
Yokohama	71.81	72.60	70.15	70.05	74.23
Kawasaki	—	74.68	71.18	78.52	74.15
Kobe	—	79.86	78.39	79.17	77.47
Fukuoka	70.61	75.66	75.92	78.35	77.59

* Using the 2000 figure because of absence.

Source: Data provided by the cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka

-Incineration rate of waste plastics

Considering Japan's circumstances, the maximum default value of 99% given in the *Good Practice Guidance (2000)* has been used for incineration rate of waste plastics.

Calculation of emission factor (FY2003)

Emission Factor = 1,000 [kg] × Carbon content in waste plastics (dry basis)
× Incineration rate of waste plastics × 44 / 12
= 1,000 [kg] × 72.22% × 99% × 44 / 12
= 2,620 [kg CO_2 / t]

• *Activity Data*

Activity data for emission of carbon dioxide in association with the incineration of municipal solid waste was derived from the volume of plastics incinerated in municipal solid waste, given by the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment in the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)*.

• *Carbon Dioxide Emissions from Biomass*

Carbon dioxide emissions from non-biogenic emissions have been calculated in the calculation file for carbon dioxide emissions associated with the incineration of municipal solid waste (*6C-CO2-2005.xls¥MSW*). Emissions of carbon dioxide from biomass have been reported as a reference, and have not been included in Japan's total emissions, in accordance with the *Revised 1996 IPCC Guidelines*.

2) CH_4

• *Methodology for Estimating Emissions of GHGs*

Emissions of methane from this source were derived by multiplying the volume of municipal solid waste incinerated by type of waste incineration facility, and by the emission factors defined for individual facility. (Refer to *6C-2005.xls¥MSW* for details of the calculation process.)

• *Emission Factors*

The *Revised 1996 IPCC Guidelines* do not give a methodology for calculating emission factors. Therefore, emission factors have been derived by the following method; obtain an 'air intake adjusted emission factor', adjusted for the concentration of atmospheric methane drawn into the facility, based on the measured methane concentration in flue gas shown in existing surveys, for individual incineration facility in Japan; estimate a weighted average using the volume of incineration from each facility, to obtain emission factors by both type of furnace and by type of facility; and calculate a weighted average using the number of facilities with stoker and fluid bed furnaces, to obtain emission factors by types of incineration facility.

Table 8-17 CH_4 emission factors, by type of incineration facility, for municipal solid waste

Furnace Type	Unit	1990	1995	2000	2002	2003
Continuous Incinerator	gCH_4/t	0.094	0.094	0.073	0.073 *	0.073 *
Semi-Continuous Incinerator	gCH_4/t	55	55	61	61 *	61 *
Batch type Incinerator	gCH_4/t	60	60	63	63 *	63 *

* Data after 2001 has been substituted for 2000 data.

Source: Measurement surveys (Environmental Agency *Results of Review of Calculation of Emissions of Greenhouse Gas Part 2* (2000))

Iwasaki, Tatsuichi, Ueno *Review of Causes of Emissions of Nitrous Oxide and Methane from Waste Incinerators* (1992) Annual Report of the Tokyo Metropolitan Research Institute for Environmental Protection

Japan Society of Atmospheric Environment *Method of Estimating Greenhouse Gas Emissions – Survey Report* (1996)

Waste Management and Recycling Department of the Minister’s Secretariat, *Ministry of the Environment Japan’s Waste Disposal*（CD-ROM）

Ishikawa Prefecture, City of Osaka, Kanagawa Prefecture, City of Kyoto, City of Kobe, Niigata Prefecture, Hiroshima Prefecture, Hyogo Prefecture, Fukuoka Prefecture, Hokkaido *Survey of Compilation of Emission Units of Greenhouse Gas from Stationary Sources* (1991-1997)

• *Activity Data*

Volume of material incinerated by type of incineration facility has been used as the activity data for methane emissions associated with the incineration of municipal solid waste.

The method for calculating the relevant activity data was to multiply the volume of municipal solid waste incinerated, given in the Waste Management and Recycling Department of the Minister’s Secretariat, Ministry of the Environment *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)*, by the proportion of incineration for each type of facility for incinerating municipal solid waste, from the Waste Management and Recycling Department of the Minister’s Secretariat, Ministry of the Environment *Waste Treatment in Japan*.

3) N_2O

• *Methodology for Estimating Emissions of GHGs*

Nitrous oxide emitted from this source has been calculated using Japan’s country-specific emission factor, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 5.25, Fig. 5.6) (Refer to *6C-N2O-2005.xls¥MSW* for details of the calculation process).

• *Emission Factors*

Emission factors have been derived by the following method; obtain an ‘air intake adjusted emission factor’, adjusted for the concentration of atmospheric nitrous oxide drawn into the facility, based on the measured nitrous oxide concentration in flue gas shown in existing surveys, for individual incineration facility in Japan; estimate a weighted average using the volume of incineration from each facility, to obtain emissions factors by both types of furnace and by type of facility; and calculate a weighted average using the number of facilities with stoker and fluid bed furnaces, to obtain emission factors by type of incineration facility.

Table 8-18 N_2O emission factors by type of facility for incinerating municipal solid wastes

Furnace Type	Unit	1990	1995	2000	2002	2003
Continuous Incinerator	gN_2O/t	49.0	49.0	49.4	49.4 *	49.4 *
Semi-Continuous Incinerator	gN_2O/t	48.5	48.5	49.3	49.3 *	49.3 *
Batch type Incinerator	gN_2O/t	57.0	57.0	59.9	59.9 *	59.9 *

* Data after 2001 has been substituted for 2000 data.

Source: Measurement surveys (Environmental Agency Results of Review of Calculation of Emissions of Greenhouse Gas Part 2 (2000))

Iwasaki, Tatsuichi, Ueno *Review of Causes of Emissions of Nitrous Oxide and Methane from Waste Incinerators* (1992) Annual Report of the Tokyo Metropolitan Research Institute for Environmental Protection

Japan Society of Atmospheric Environment Method of Estimating Greenhouse Gas Emissions – Survey Report (1996)

Waste Management and Recycling Department of the Minister’s Secretariat, Ministry of the Environment *Japan’s Waste Disposal*（CD-ROM）

Ishikawa Prefecture, City of Osaka, Kanagawa Prefecture, City of Kyoto, City of Kobe, Niigata Prefecture, Hiroshima Prefecture, Hyogo Prefecture, Fukuoka Prefecture, Hokkaido *Survey of Compilation of Emission Units of Greenhouse Gas from Stationary Sources* (1991-1997)

- ***Activity Data***

The volume of material incinerated by type of incineration facility was used as the activity data for nitrous oxide emitted in association with incineration of municipal solid waste, as for methane emissions.

8.3.2. Industrial Wastes Incineration (6.C.-)

1) CO_2

- ***Methodology for Estimating Emissions of GHGs***

Emissions of carbon dioxide from this source have been calculated using the volume of waste oil and waste plastics incinerated, and Japan’s country-specific emission factor, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 5.24, Fig. 5.5)

• *Emission Factors*

-Outline

In accordance with the *Revised 1996 IPCC Guidelines*, the carbon content in waste oil and waste plastic from fossil fuel was multiplied by the rate of combustion of waste oil and waste plastic from fossil fuels.

-Carbon content in waste oil and waste plastics

The carbon content in waste oil has been deemed to be 80%, from the factor of 0.8 (t-C/t) given in the Environmental Agency's *Report on a Survey of Carbon Dioxide Emissions (1992)*.

The carbon content in waste plastic has been deemed to be 70%, from the factor of 0.7 (t-C/t) given in the Environmental Agency's *Report on a Survey of Carbon Dioxide Emissions (1992)*.

-Rate of combustion

In light of the actual situation of emissions in Japan, the rate of combustion in facilities for the incineration of waste oil and waste plastics from fossil fuels was deemed to be 99.5% on the basis of the maximum default value for dangerous wastes given in the *Good Practice Guidance*.

Calculation of emission factor for waste oil from fossil fuels (industrial waste)

Emission factor
= 1,000 [kg] × Carbon content in waste oil from fossil fuel × Rate of combustion × 44/12
= 1,000 [kg] × 80% × 99.5% × 44/12
= 2,919 [kg CO_2 / t]
= 2,900 [kg CO_2 / t]

Calculation of emission factor for waste plastic (industrial waste)

Emission factor
= 1,000 [kg] × Carbon content in waste plastics from fossil fuel × Rate of combustion× 44/12
= 1,000 [kg] × 70% × 99.5% × 44/12
= 2,554 [kg CO_2 / t]
= 2,600 [kg CO_2 / t]

• *Activity Data*

The volume of incinerated industrial waste (in the form of waste oil and waste plastics) given by the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment, in its *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)*, has been used as the activity data for carbon dioxide emitted in association with industrial waste.

• *Carbon Dioxide Emissions from Biomass*

Carbon dioxide emissions from non-biogenic emissions have been calculated in the calculation file for carbon dioxide emissions associated with the incineration of industrial waste (*6C-CO2-2005.xls¥ISW*). Emissions of carbon dioxide from biomass have been reported as a reference, without being included in Japan's total emissions, in accordance with the *Revised 1996 IPCC Guidelines*.

2) CH_4

• *Methodology for Estimating Emissions of GHGs*

Emissions of methane from this source have been calculated by multiplying the volume of industrial waste incinerated by the country-specific emission factor (Refer to *6C-2005.xls¥ISW* for details of the calculation process).

• *Emission Factors*

The method for calculating emission factors is not given in the *Revised 1996 IPCC Guidelines*, but an 'air intake adjusted emission factor', adjusted for the concentration of atmospheric methane drawn into the facility, based on the measured methane concentration in flue gas shown in existing surveys was obtained for individual incineration facility. A weighted average using the volume of incineration from incineration facilities for each type of industrial wastes was calculated for establishing the emission factor.

Table 8-19 Methane emission factors for type of industrial waste

Type of waste	Emission factor [g CH_4 / t]	Remarks
Paper or wood scraps	-0.87	Weighted average of data from 5 facilities
Waste oil	0.56	Weighted average of data from 5 facilities
Waste plastics	-8.3	Weighted average of data from 4 facilities
Sludge	9.7	Weighted average of data from 19 facilities

Sources: Measurement surveys (Environmental Agency Results of Review of Calculation of Emissions of Greenhouse Gas Part 2 (2000))

Japan Society of Atmospheric Environment Method of Estimating Greenhouse Gas Emissions – Survey Report (1996)

Ishikawa Prefecture, City of Osaka, Kanagawa Prefecture, City of Kyoto, Hiroshima Prefecture, Hyogo Prefecture, *Survey of Compilation of Emission Units of Greenhouse Gas from Stationary Sources* (1991-1999)

• *Activity Data*

The volume of material incinerated by type of waste has been used as the activity data for methane emitted in association with industrial wastes.

-Other than sludge

For waste papers and waste wood, waste oil, and waste plastics, volumes of the incinerated waste were taken from the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)*. The data of 'waste papers and waste wood' for FY 2003 was extrapolated based on a trend between FY2000 and FY 2002.

-Sludge

The value used for activity data of sludge is the sum of the volume of ‘other incinerated organic sludge’, from the Waste Management and Recycling Department of the Minister’s Secretariat, Ministry of the Environment *Waste Treatment in Japan*, and the total given in the Ministry of Land, Infrastructure and Transport’s ‘*Sewage Sludge Incineration Volumes, by Flocculant*’. The data of ‘other incinerated organic sludge’ for FY 2003 was extrapolated based on a trend between FY2000 and FY 2002.

3) N_2O

• *Methodology for Estimating Emissions of GHGs*

Nitrous oxide emitted from this source has been derived by multiplying the volume of industrial waste incinerated, by Japan’s country-specific emission factor
(Refer to *6C-2005.xls¥ISW* for details of the calculation process).

Emission factors for sewage sludge are established by each flocculant and incinerator. Emission factors for high-molecular-weight flocculant / fluidized bed incinerator are established according to combustion temperature.

• *Emission Factors*

-Other than sewage sludge

Emission factors have been derived by obtaining an ‘air intake adjusted emission factor’, adjusted for the concentration of atmospheric nitrous oxide drawn into the facility, based on the measured nitrous oxide concentration in flue gas shown in existing surveys in Japan. A weighted average using the volume of incineration from incineration facilities for each type of industrial wastes was calculated for establishing the emission factor.

Table 8-20 Emission factor for nitrous oxide, by type of industrial waste

Type of industrial waste	Emission factor（g-N_2O/t）
Waste Paper, Waste Wood	10
Waste Oil	9.8
Waste Plastics	170
Sludge	450

Source: Measurement surveys (Environment Agency Results of Review of Calculation of Emissions of Greenhouse Gas Part 2 (2000))

Japan Society of Atmospheric Environment Method of Estimating Greenhouse Gas Emissions – Survey Report (1996)

Ueno, et al. *Review of Measures to Reduce Nitrous Oxide in Sewage Treatment Plants* Tokyo Metropolitan Research Institute for Environmental Protection (1995)

Nakamura, et al. *Emission of Nitrous Oxide from Incineration of Sewage Sludge* Proceedings of the 20th Japan Urban Cleaning Research Conference pp. 391–393 (1998)

Yasuda, et al. *Behavior of Nitrous Oxide Emissions Associated With Incineration of Sewage*

Sludge Journal of Japan Society of Waste Management Experts Vol. 5, No. 4, (1994)

Matsubara and Mizuochi *Survey of Emissions of Nitrous Oxide from Sewage Treatment Plants* Environmental and Sanitary Engineering Research, 8(3) (1994)

Suzuki, Ochi, Miyata *Continuous Measurement of Nitrous Oxide Emissions from Sewage Sludge Flux Furnaces* Proceedings of the 11th Environmental Engineering Symposium 2001, pp. 387–390（2001）

Takeishi, Watanabe, Matsubara, Hirayama, Maebashi, Koma, Wakasugi, and Yoshikawa *Report on Joint Research into the Behavior and Reduction of Waste Gas Components in Flux Furnaces* Public Works Research Institute, Ministry of Construction and Nagoya City Water Authority（1996）

Takeishi, Watanabe, Matsubara, Sato, Maebashi, Tanaka, Miwa, Wakasugi, and Yamashita *Report on Joint Research into the Behavior and Reduction of Waste Gas Components in Flux Furnaces* Public Works Research Institute, Ministry of Construction and Nagoya City Water Authority （1994）

Ishikawa Prefecture, City of Osaka, Kanagawa Prefecture, City of Kyoto, Hiroshima Prefecture, Hyogo Prefecture, *Survey of Compilation of Emission Units of Greenhouse Gas from Stationary Sources* (1991-1999)

-Sewage sludge

Emission factors have been derived by obtaining an ‘air intake adjusted emission factor’, adjusted for the concentration of atmospheric methane drawn into the facility, based on the measured methane concentration in flue gas shown in existing surveys in Japan. A weighted average using the volume of incineration from incineration facilities for each type of flocculant (High-molecular-weight flocculant/Fluidized Bed Incinerator, High-molecular-weight flocculant/ Multiple Hearth, Lime Sludge and Other) was calculated for establishing the emission factor. Emission factors for high-molecular-weight flocculant / fluidized bed incinerator are established according to combustion temperature (high temperature combustion [at about 800 degree] and normal temperature combustion [at about 850 degree]).

Table 8-21 Nitrous oxide emission factor for sewage sludge incineration

Type of flocculant	Type of incinerator	Combustion Temperature	Emission Factor（$g\text{-}N_2O/t$）
High-molecular-weight flocculant	Fluidized Bed Incinerator	normal temperature combustion	1,508
High-molecular-weight flocculant	Fluidized Bed Incinerator	high temperature combustion	645
High-molecular-weight flocculant	Multiple Hearth	—	882
Other	—	—	
Lime Sludge	—	—	294

Assume that emission factors for FY1990-2002 are constant.

Matsubara and Mizuochi, *Survey of Emissions of Nitrous Oxide from Sewage Treatment*

Plants Environmental and Sanitary Engineering Research, 8(3) (1994)

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• *Activity Data*

-Other than sewage sludge

The volume of matter incinerated for each type of waste papers and waste wood, waste oil, waste plastics, and sludge (excluding sewage sludge) given in the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)* have been used. For sludge (other than sewage sludge), the value given in the same reference in 'Volume of Other Organic Sludges Incinerated', has been used.

-Sewage sludge

The amount of sewage sludge incinerated by type of flocculant (High-molecular-weight flocculant/Fluidized Bed Incinerator, High-molecular-weight flocculant/ Multiple Hearth, Lime Sludge and Other), given in the Ministry of Land, Infrastructure and Transport have been used

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Chapter 9. Other (CRF sector 7)

They have been reported as "NO." *UNFCCC Reporting Guidelines (FCCC/CP/2002/8) para.29* indicates that Annex I Parties should report and explicitly describe the details of emissions from each country-specific source of gases which are not included in the IPCC Guidelines. According to this requirement, emissions from other category (CRF sector7) are indicated below.

9.1. CO_2, CH_4, N_2O, HFCs, PFCs and SF_6

The national inventory submitted this year does not include the emissions and removals of gases targeted under the Kyoto Protocol (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) from the sources which are not included in the IPCC Guideline.

9.2. NOx, CO, NMVOC and SO_2

The inventory submitted this year includes CO emissions from smoking as the emissions of indirect greenhouse gases (NOx, CO, NMVOC) and SO_2 from the sources which are not included in the IPCC Guideline (Refer to *7-2005.xls*).

Chapter 10. Recalculation and Improvements

10.1. Explanation and Justification for Recalculations

This section explains improvements on estimation of emissions and removals in the current inventory (submitted in 2005).

In accordance with the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (*GPG (2000)*), recalculations of previously reported emissions and removals are recommended in the cases of 1) application of new estimation methods, 2) addition of new categories, and 3) data refinement. Major changes in the inventory submitted last year are indicated below. Refer to Table 8(b) (Recalculation – Explanatory Information) of the Common Reporting Format (CFR) for changes other than those referred to in the following.

10.1.1. General

In general, activity data for the latest year available at the time when the inventory is compiled are often revised in the year following the submission year because of such as the publication of data in the fiscal year basis. In the national inventory submitted this year, activity data in many sources for 2002 have been changed and as a result, the emissions from those sources for the inventory year have been recalculated.

10.1.2. Energy sector

10.1.2.1. 1.A. Fuel Combustion (Stationary Combustion): CO_2

Because the values in the energy balance table (*General Energy Statistics*) for fiscal years 1990–2002 that were used as activity data for “1.A. Fuel Combustion (Stationary Combustion): CO_2” were changed, emissions for these years were recalculated.

10.1.2.2. 1.A.3. Fuel Combustion (Mobile Combustion): CH_4 and N_2O

1) “1.A.3.a. Civil Aviation (Aviation gasoline): CH_4 and N_2O”

Previously, Japan had reported emissions for “1.A.3.a. Civil Aviation (Aviation gasoline): CH_4 and N_2O” as “NE” (Negligible) because they are small.

However, because a default values for the emission factors are indicated in the *Revised 1996 IPCC Guidelines* and it is possible to estimate emissions on the basis of activity data from *General Energy Statistics*, emissions are estimated using Tier 1 and reported for the first time.

10.1.2.3. 1.B. Fugitive emissions from fuels

1) Review of notation keys for "1.B.2.b.ii. Natural gas (Distribution): CO_2"

Japan has consumed natural gas and LNG in the production of town gas. However, the CO_2 content of natural gas is low; therefore, only small amounts of CO_2 are thought to be emitted. On this account, emissions for "1.B.2.b.ii. Natural gas (Distribution): CO_2" was reported as "NE" (Negligible).

However, emission factor for CO_2 is 0 according to a report by the Japan Gas Association; therefore, in accordance with the UNFCCC inventory reporting guidelines[1], we now report it as "NA".

10.1.3. Industrial process sector

1) Change in operating rate of N_2O decomposition unit for "2.B.3. Adipic acid production: N_2O"

An N_2O decomposition unit has been operational in Japan since March 1999 at an adipic acid production plant. Therefore, we have established an emission factor for estimating emissions for "2.B.3. Adipic acid production: N_2O" that takes into account "rate of generation of nitrous oxide", "rate of decomposition of nitrous oxide" and "operating rate of decomposition unit". Among these terms, number of hours worked of decomposition unit needs to be obtained in order to calculate "operating rate of decomposition unit". Because it was identified that N_2O decomposition unit shutdowns in 1990, 2000, and 2001 have been overlooked, data was revised for the relevant years.

2) Change in activity data used for calculation of HFCs, PFCs, and SF_6 emissions

Japan uses data provided by the Ministry of Economy, Trade & Industry to estimate emissions of HFCs, PFCs, and SF_6. In the national inventory submitted in 2005, the emission estimates were changed due to change in the activity data (for details, refer to Table 8(b) of CRF-2003-v01-JPN-2005.xls).

- ***General Remarks***

The updated data for 2001-2002 includes several corrections on the error in the data, such as the modification from provisional value to definite report value.

- ***Stationary refrigeration***

The inspection of emissions including estimated data from 1995 onwards were conducted in regard with the improvement in analytical methodologies, such as the refinement of duration periods of machineries.

- ***Solvents and semiconductor manufacturing***

The relevant data from 1995 onwards was updated.

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[1] FCCC/SBSTA/2004/8 page 9, footnote 8: Even if emissions are considered to be negligible, Parties should either report the emission estimate if calculated or use the notation key "NE".

- ***Sectors except for the above***

Errors identified during the inspection of relevant data were corrected.

10.1.4. Agricultural sector

1) Recalculation of emissions for 2001 and 2002 associated with revision of data for the latest year

Emissions from the agricultural sector are based on three-year moving averages. In the national inventory submitted in 2005, emissions for 2001 and 2002 were recalculated because of revision of 2002 activity data.

2) "4.B.3., 4.B.4., 4.B.6. Manure management (sheep, goats, horses): N_2O"

Previously, Japan had not established emission factors for "4.B.3., 4.B.4., 4.B.6. Manure management (sheep, goats, horses): N_2O" and "NE" had been reported for this category.

However, a default value for the emission factor is indicated in the *Revised 1996 IPCC Guidelines*, while activity data can be obtained from FAO statistics. Therefore, emissions were estimated using Tier 1 and reported for the first time.

10.1.5. Waste sector

1) Changes in categories of activity data and activity data for "6.B.1. Industrial Wastewater: CH_4"

Japan uses the volume of water used for treatment of products, by industrial sub-category, and the volume of water used for washing as activity data for "6.B.1. Industrial Wastewater: CH_4". Because industry classifications for industrial statistics were revised due to revision of Japanese Standard industry classifications in 2002, industry type categories of activity data and activity data by industry type were changed.

Table 10-1 Differences in industry type categories of activity data and activity data by industry type

Industry type	industry type category code	1990	1995	2000	2001	2002
Food	12	497.8	529.1	549.0	555.3	555.3
	9	593.0	681.8	583.5	588.1	705.0
Beverages, tobacco, animal feed	13	137.9	142.7	139.0	137.2	137.2
	10	137.9	142.7	139.0	137.2	129.0
Textiles (excluding Apparel, other textile products)	14	159.9	135.7	101.3	101.6	101.6
	11	164.8	138.2	101.8	102.1	89.8
Apparel, other textile products	15	2.2	4.0	2.5	2.3	2.3
	12	2.2	4.0	2.5	2.3	2.1
Pulp & paper/processed paper products	18	1,640.1	1,524.0	1,527.7	1,497.9	1,497.9
	15	1,699.7	1,589.2	1,582.7	1,556.6	1,546.2
Chemicals	20	693.6	645.0	667.2	712.7	712.7
	17	787.5	735.7	751.3	796.0	753.1
Petroleum and coal products	21	3.0	2.2	2.6	2.2	2.2
	18	3.0	2.2	2.6	2.2	1.7
Plastic products (except as noted elsewhere)	22	12.3	11.8	12.4	13.3	13.3
	19	12.3	11.7	12.4	13.3	11.6
Rubber products	23	0.9	0.9	0.6	0.7	0.7
	20	0.9	0.9	0.6	0.7	0.7
Leather tanning/leather products, fur	24	5.9	5.0	3.7	3.3	3.3
	21	5.9	5.0	3.7	3.3	2.8
Total	—	3,153.6	3,000.3	3,005.9	3,026.5	3,026.5
	—	3,407.2	3,311.4	3,180.0	3,201.8	3,242.0

Upper rows (shaded in gray): 2004 inventory values; lower rows: 2005 inventory values

2) Revision of estimation method for N_2O emissions from domestic and commercial wastewater at human-waste treatment plant

For “6.B.2”, the N_2O emissions from human waste treatment plants were calculated by multiplying a weighted average of emission factors derived using the treatment capacity of each treatment process, based on *Research on Suppression Measures for Methane and Nitrous Oxide in the Waste Sector* in 1997, by the volume of human waste treated at human waste treatment plants.

However, in recent years, it is expected that the N_2O emissions per unit volume of human waste treated have been decreased since the equipment and maintenance technologies of high-load human waste treatment plants have been improved compared to those investigated in 1997. Therefore, the emission factors for N_2O emissions from these treatment processes were updated based on the results of the latest study on N_2O emissions from high-load denitrification and membrane separation treatment.

Moreover, it is assumed that the accuracy of estimated emissions from human waste treatment plants is higher when the amount of nitrogen treated in these plants is taken into account in an estimation method. Accordingly, the estimation method for relevant categories was changed to calculate the emissions by multiplying the volume of nitrogen treated in human waste treatment plants by emission factors, which is N_2O conversion ratio.

• *Previous estimation method*

The previous estimation equation is as follows.

$$\boxed{E\ (\text{kg-}N_2O) = A\ (m^3) \times EF\ (\text{kg-}N_2O/m^3)}$$

E: emissions, A: activity data (the amount of human waste treated in these plants),

EF: emission factor (N_2O emissions per $1m^3$ of human waste treated in these plants)

For emission factor, a weighted average of emission factors for N_2O emissions for each treatment process, including high load de-nitrification treatment, membrane separation and other treatments, was derived using the treatment capacity of each treatment process.

Activity data were derived from the amount of human waste treated at these plants, given in the Ministry of the Environment's *Waste Treatment in Japan*.

• *New estimation method*

The new estimation equation is as follows.

$$\boxed{E\ (\text{kg-}N_2O) = A\ (m^3) \times C\ (mg/l) \times EF\ (\text{kg } N_2O\text{-N/kg-N}) \times 44 / 28 \times 10^{-3}}$$

E: emissions, A: activity data (the amount of human waste treated in these plants),

C: treated nitrogen concentration (the amount of nitrogen contained in 1L of human waste)

EF: emission factor (the amount of nitrogen that becomes N_2O for 1 kg of nitrogen contained in human waste)

The treated nitrogen concentration is based on the weighted average of the amount of nitrogen contained in collected human waste and sewage in sewerage tank derived using the volume of collected human waste and sewage in sewerage tank treated at human waste treatment plants.

For emission factor, a weighted average of emission factors for nitrous oxide emissions for each treatment process, including high load de-nitrification treatment and membrane separation, was derived using the treatment capacity of each treatment process.

Activity data were derived from the volume of human waste treated at these plants (the sum of collected human waste and sewage in sewerage tank), given in the Ministry of the Environment's *Waste Treatment in Japan*.

Previous and new emission factors are as follows.

Table 10-2 Previous and new N_2O emission factors

Treatment method	Previous emission factor [kg-N_2O/m^3]	New emission factor [kg-N_2O-N/kg-N]		
		FY1990–1994	FY1995–2002	FY2003
High-load denitrification	0.45 [a]	0.042 [a]	Interpolated from values for 1994 and 2003	0.0019 [c]
Membrane separation	0.45 [a]	0.042 [a]	Interpolated from values for 1994 and 2003	0.0016 [c]
Others	0.00001 [b]	0.0000029 [b]		

a : Use median value of actual measurements at 13 plants given in Tanaka, Inoue, Osako, Yamada, and Watanabe *B-16(7) Research into Limiting Generation of Methane and Nitrous Oxide from the Waste Sector* FY1997 Global Environment Research Fund Outcome Report

b : Tanaka, Inoue, Matsuzawa, Osako, and Watanabe *B-2(1) Research into Volumes Released from Waste Treatment Plants* FY1994 Global Environment Research Fund Outcome Report

c : Use median value of actual measurements at 13 plants given in Omura, Kawakubo, and Yamada. *Study of Emission Factors for N_2O from High-load Human Waste Management.* Journal of Waste Management, 57 (260).

- ***Variance in emissions due to revision of estimation method***

Variance in emissions due to revision of estimation method is shown in the following.

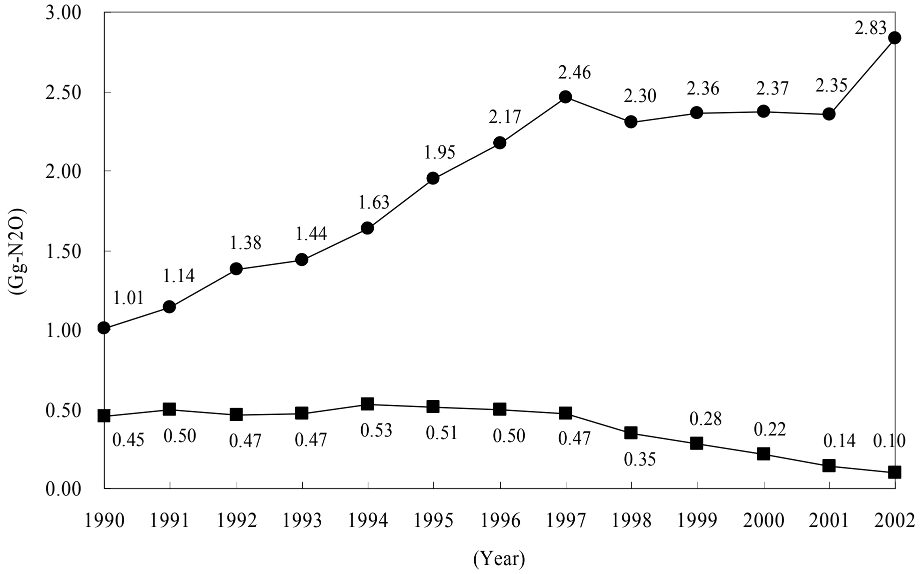

Figure 10-1 Variance in emissions for "6.B.2.- N_2O emissions from domestic and commercial wastewater (human-waste treatment plant)" using previous estimation method (circles) and new one (squares)

Note 1) Pre-revision N_2O emissions tend to be higher because high-load denitrification treatment and membrane separation treatment, which feature high emission factors, are increasingly being used in Japan. In fiscal 1990, these two methods accounted for 7.5% of overall sewage treatment, whereas by fiscal 2002, the proportion had risen to 21.9%.

Note 2) Post revision N_2O emissions tend to be lower because 1) the revision of the emission factor reflects improved technologies in high-load raw sewage treatment plants, 2) the amount of nitrogen contained in raw sewage collected by night soil carriers and in septic tank sludge is tending to decrease, and 3) the amount of septic tank sludge treated at raw sewage treatment plants is increasing compared to the amount of relatively low nitrogen concentration raw sewage.

3) Revision of estimation method for “6.C.- Industrial Waste Incineration (sewage sludge): N_2O”

In Japan, N_2O emission for “6.C. Industrial Waste Incineration (sewage sludge)” has been estimated by multiplying the amount of sewage sludge incinerated by a weighted average of emission factors derived using the amount of sewage sludge incinerated by flocculant type.

Recent research shows that the N_2O emissions can be reduced by applying a high temperature combustion (over 850 degree) in place of the normal temperature combustion (about 800 degree) to sewage sludge incineration. The Kyoto Protocol Target Attainment Plan (2004) lists the improvement of combustion process at sewage sludge incineration facilities as a means of reducing N_2O emissions, by for instance incorporating this means in a design guideline, the use of a high temperature combustion is spreading steadily. By fiscal 2002, the adoption rate had reached 33.4%. However, the effect of N_2O emission suppression using high-temperature combustion technique is not reflected in the current inventory because the N_2O emission for the relevant category was not estimated based on combustion temperature. In view of this situation, it is thought that different N_2O emission factors for sewage sludge incineration should be established for different combustion temperatures.

Therefore, emission factors for the relevant category are established on the basis of flocculant and furnace types rather than applying weighted average. Among these, different emission factors have been established for different combustion temperatures in the case of polymeric flocculant /fluidized bed furnace combination.

• *Previous estimation method*

The previous estimation equation is as follows:

$$E\ (\text{kg-}N_2O) = A\ (t) \times EF\ (\text{kg-}N_2O/t)$$

E: emissions, A: activity data (the amount of sewage sludge incinerated),

EF: emission factor (N_2O emissions per 1tonne of sewage sludge incinerated)

For emission factor, a weighted average of emission factors based on actual measurements of N_2O concentrations for each facility, was derived using the amount of sewage sludge incinerated by flocculant type (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other).

For activity data, the amount of sewage sludge incinerated by type of flocculant (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other), given in the Ministry of Land, Infrastructure and Transport have been used.

• *New estimation method*

The new estimation equation is as follows:

$$\boxed{E\ (\text{kg-}N_2O) = \Sigma Ai(t) \times EFi\ (\text{kg-}N_2O/t)}$$

E: emission mass, A: activity data (the amount of sewage sludge incinerated),

EF: emission factor (N_2O emissions per 1tonne of sewage sludge incinerated)

i: Type of treatment process and combustion temperature (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other)

For emission factor, a weighted average of emission factors based on actual measurements of N_2O concentrations for each facility, was derived using the amount of sewage sludge incinerated by flocculant type (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other). Emission factor for “high-molecular-weight flocculant / fluidized bed incinerator” is established according to combustion temperature (high temperature combustion [at about 800 degree] and normal temperature combustion [at about 850 degree]).

The activity data was the same as that used as for the previous estimation method, namely the amount of sewage sludge incinerated by type of flocculant (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other), given in the Ministry of Land, Infrastructure and Transport have been used. However, as separate emission factors were established based on flocculant types, furnace types, and combustion temperature, subdivided activity data based on flocculant type, furnace type, and combustion temperature were used.

Previous and new emission factors are as follows.

Table 10-3 Previous and new N_2O emission factors

Flocculant type	Furnace type	Combustion temperature	Previous emission factor [g-N_2O/t]	New emission factor [g-N_2O/t]
polymeric	fluidized bed	normal combustion	903	1,508
polymeric	fluidized bed	high combustion	903	645
polymeric	multi-stage	—	903	882
other	—	—	903	882
Lime-based	—	—	903	294

- ***Variance in emissions due to revision of estimation method***

Variance in emissions due to revision of estimation method is shown in the following.

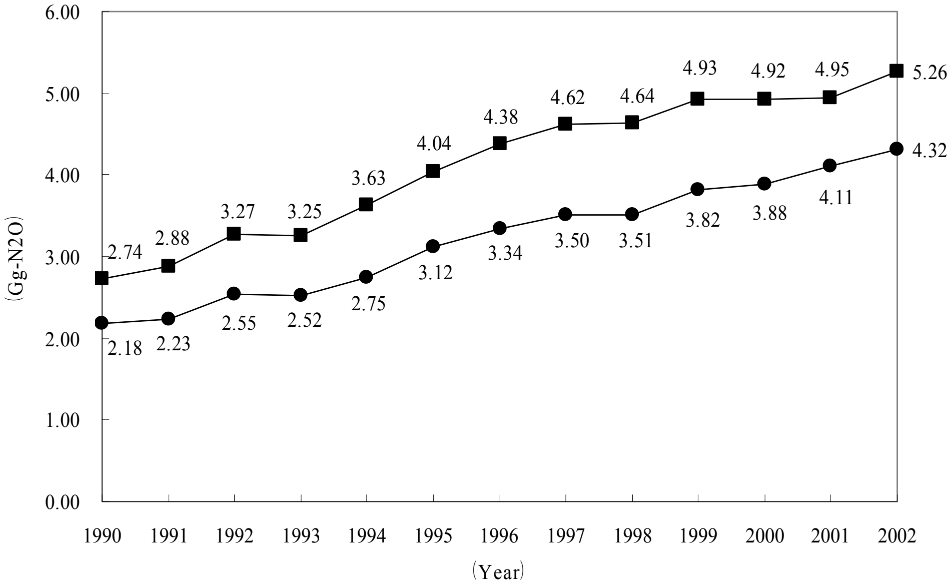

Figure 10-2 Variance in emissions for “6.C. Industrial Waste Incineration (sewage sludge)” using previous estimation method (circles) and new one (squares)

10.2. Implications for Emission Levels

Table 10-4 shows the changes made to the overall emission estimates due to the recalculations indicated in “Section 10.1. Explanation and Justification for Recalculations”.

Total emissions excluding Land-Use Change and Forestry in the base year (1990) under the UNFCCC increased slightly, and the total emissions in year 2002 decreased by 0.06% compared to the data reported in last year.

Table 10-4 Difference between the inventories submitted in 2004 and 2005 for emissions during a period from 1990 to 2002

[Mt CO_2eq.]

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2	JNGI2004[1]	1,038.4	1,047.5	1,063.3	1,048.6	1,104.6	1,116.4	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.8	1,247.6
with LUCF[3]	JNGI2005[2]	1,038.4	1,047.5	1,063.3	1,048.6	1,104.6	1,116.4	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8
	difference	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.01%*	*0.01%*
CO_2	JNGI2004	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.8	1,247.6
without LUCF	JNGI2005	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8
	difference	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.01%*	*0.01%*
CH_4	JNGI2004	24.8	24.7	24.5	24.5	24.1	23.4	22.9	22.1	21.5	21.1	20.7	20.2	19.5
	JNGI2005	24.8	24.7	24.6	24.5	24.1	23.5	22.9	22.1	21.5	21.1	20.7	20.2	19.5
	difference	*0.11%*	*0.10%*	*0.10%*	*0.10%*	*0.12%*	*0.14%*	*0.13%*	*0.15%*	*0.15%*	*0.08%*	*0.09%*	*-0.02%*	*-0.11%*
N_2O	JNGI2004	40.2	39.7	40.0	39.7	40.6	40.8	41.7	42.2	40.8	35.1	37.8	35.1	35.4
	JNGI2005	40.2	39.7	39.9	39.6	40.5	40.6	41.5	41.9	40.6	35.1	37.5	34.6	34.7
	difference	*0.03%*	*0.03%*	*-0.11%*	*-0.16%*	*-0.15%*	*-0.37%*	*-0.46%*	*-0.63%*	*-0.61%*	*0.01%*	*-0.81%*	*-1.42%*	*-1.99%*
HFCs	JNGI2004	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.6	15.9	13.3
	JNGI2005	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.02%*	*0.03%*	*0.01%*	*-0.04%*	*-0.09%*	*-0.28%*	*-0.71%*	*-3.19%*
PFCs	JNGI2004	NE	NE	NE	NE	NE	12.6	15.2	16.9	16.5	14.9	13.9	11.7	9.6
	JNGI2005	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*-0.14%*	*0.20%*	*0.01%*	*0.48%*	*0.10%*	*-1.34%*	*-1.72%*	*2.11%*
SF_6	JNGI2004	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3
	JNGI2005	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00%*	*0.00%*	*0.01%*	*-0.01%*	*0.03%*	*0.01%*	*0.00%*	*-0.12%*
Total	JNGI2004	1,103.4	1,111.9	1,127.8	1,112.8	1,169.3	1,230.3	1,352.0	1,357.8	1,306.7	1,328.4	1,336.7	1,302.3	1,330.8
with LUCF	JNGI2005	1,103.4	1,111.9	1,127.8	1,112.8	1,169.3	1,230.2	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0
	difference	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.01%*	*-0.01%*	*-0.02%*	*-0.01%*	*0.00%*	*-0.04%*	*-0.07%*	*-0.06%*
Total	JNGI2004	1,187.3	1,195.8	1,213.4	1,202.9	1,262.8	1,327.0	1,352.0	1,357.8	1,306.7	1,328.4	1,336.7	1,302.3	1,330.8
without LUCF	JNGI2005	1,187.3	1,195.8	1,213.4	1,202.9	1,262.8	1,326.9	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0
	difference	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.01%*	*-0.01%*	*-0.02%*	*-0.01%*	*0.00%*	*-0.04%*	*-0.07%*	*-0.06%*

1) JNGI2004: Japan National GHG Inventory submitted in 2004

2) JNGI2005: Japan National GHG Inventory submitted in 2005

3) LUCF: Land-Use Change and Forestry

10.3. Implication for Emission Trends, including Time Series Consistency

Table 10-5 shows the changes made to the emission trends during a period from 1990 to 2002 due to the recalculations indicated in “Section 10.1. Explanation and Justification for Recalculations”. Since the emissions of HFCs, PFCs and SF_6 prior to 1995 are not reported, a comparison of these emissions between 1995 and 2002 was performed.

Total emissions excluding Land-Use Change and Forestry decreased by approximately 0.8 million tons (in CO_2 equivalents) and by 0.1 points compared to the data reported in last year.

Table 10-5 Comparison of emissions trends between the inventories submitted in 2004 and 2005 excluding LUCF

		Trend [Mt CO_2eq.]			Trend (%)		
		JNGI2004	JNGI2005	Difference	JNGI2004	JNGI2005	Difference
CO_2	1)	125.3	125.5	0.2	11.2%	11.2%	0.0%
CH_4	1)	-5.3	-5.3	0.0	-21.2%	-21.4%	-0.2%
N_2O	1)	-4.8	-5.5	-0.7	-12.0%	-13.7%	-1.8%
HFCs	2)	-6.9	-7.3	-0.4	-34.1%	-36.2%	-2.1%
PFCs	2)	-2.9	-2.7	0.2	-23.4%	-21.7%	1.7%
SF_6	2)	-11.6	-11.6	0.0	-68.7%	-68.8%	0.0%
Total	3)	93.8	93.0	-0.8	7.6%	7.5%	-0.1%

1) Comparison of emissions between 1990 and 2002

2) Comparison of emissions between 1995 and 2002

3) Comparison of emissions between the base year of the Kyoto Protocol (CO_2, CH_4, N_2O: 1990 HFCs, PFCs, SF_6: 1995) and 2002

10.4. Recalculations, including in response to the review process, and planned improvements to the inventory

10.4.1. Improvements from inventory submitted last year

The major improvements carried out since submission of last year's inventory are listed below.

10.4.1.1. Methodology for estimating emissions of GHGs

(a) Estimation of emissions of CH_4 and N_2O from "1.A.3.a. Civil Aviation (Aviation gasoline)" was newly conducted.

(b) Notation keys used for CO_2 emissions from "1.B.2.b.ii. Natural Gas (Distribution)" were revised.

(c) For estimating N_2O emissions from "2.B.3. Adipic Acid Production", the operating rate of decomposition unit was revised.

(d) Activity data used for estimating emissions of HFCs, PFCs, SF_6 were revised.

(e) Estimation of emissions of N_2O from "4.B.3., 4.B.4., 4.B.6. Manure Management (sheep, goats and horses)" was newly conducted.

(f) For N_2O emissions from "6.B.2. Wastewater Handling (Human-waste treatment plant)", an estimation method representing the actual condition of the emissions more realistically was newly adopted.

(g) For N_2O emissions from "6.C. Industrial Waste Incineration (sewage sludge)", an estimation method representing the actual condition of the emissions more realistically was newly adopted.

* For further information, please see "10.1 Explanation and justification of recalculation".

10.4.1.2. National Inventory Report (NIR)

(a) Flow diagram of inventory compilation process is provided in “Chapter 1: Introduction”.

(b) Description of estimation method and emission trend for “2.B.3. Adipic acid production” identified as key is provided in “Chapter 4: Industrial Processes (CRF sector 2)”.

(c) For the key category analysis, in addition to Tier 1 Level Assessment and Trend Assessment, qualitative analysis was conducted and its related description is added in “Annex 1: Key Categories”.

(d) Description of methodology for estimating emissions of Precursors is added in “Annex 3: Other detailed methodological descriptions for individual source or sink categories”.

(e) List of categories not estimated is added in “Annex 5: Assessment of Completeness and (Potential) Sources and Sinks of Greenhouse Gas Emissions and Removals Excluded”

(f) Description of inventory compilation system and QA/QC plan is added in “Annex 6: Additional information to be considered as part of the NIR submission or other useful reference information”

(g) Description of methodologies and results of uncertainty assessment were integrated as Annex 7.

10.4.1.3. Common Reporting Format (CRF)

(a) Notation keys were revised as follows.

Table 10-6 Notation keys changed in 2005 inventory

Sheet name	Emission classification	Pre-change	Post-change
Table 1.A(a)s1	1.A.1.a. Public Electricity and Heat Production (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.1.b. Petroleum Refining (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries (Other Fuels): CH_4, N_2O emissions	0.00	NO
Table 1.A(a)s2	1.A.2.a. Iron and Steel (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.2.b. Non-Ferrous Metals (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.2.c. Chemicals (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.2.d. Pulp, Paper and Print (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.2.e. Food Processing, Beverages and Tobacco (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.2.f. Other (Other Fuels) : CH_4, N_2O emissions	0.00	NO
Table 1.A(a)s3	1.A.3.a. Civil Aviation (Aviation Gasoline): CH_4, N_2O emissions	NE	calculated value
	1.A.3.e. Other Transportation (Liquid Fuels): activity amount, CO_2 emissions	calculated value	NO
Table 1.A(a)s4	1.A.4.a. Commercial/Institutional (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.4.b. Residential (Other Fuels): CH_4, N_2O emissions	0.00	NO
	1.A.4.c. Agriculture/Forestry/Fisheries (Other Fuels): CH_4, N_2O emissions	0.00	NO
Table 1.B.2	1.B.2.b.ii. Natural Gas (Distribution): CO_2 emissions	0.00	NE
Table 1.C	Residual Fuel Oil: activity amount	NE	IE
Table 2(I)s2	2.F.3. Fire Extinguishers: HFC emissions (A)	IE	NE
Table 2(I).A-Gs1	2.B.3. Adipic Acid Production: activity amount	calculated value	C
Table 3	3.B. Degreasing and Dry Cleaning: CO_2 emissions	NO	NE
	3.B. Degreasing and Dry Cleaning: N_2O emissions	NO	NA
Table 3.A-D	3.B. Degreasing and Dry Cleaning: CO_2 emission factor	NO	NE
	3.B. Degreasing and Dry Cleaning: N_2O emission factor	NO	NA
Table 4s1	4.A.2. Enteric Fermentation (Buffalo): CH_4 emissions	0.00	NO
	4.A.5. Enteric Fermentation (Camels and Llamas): CH_4 emissions	0.00	NO
	4.A.7. Enteric Fermentation (Mules and Asses): CH_4 emissions	0.00	NO
	4.B.2. Manure Management (Buffalo): CH_4 emissions	0.00	NO
	4.B.5. Manure Management (Camels and Llamas): CH_4 emissions	0.00	NO
	4.B.7. Manure Management (Mules and Asses): CH_4 emissions	0.00	NO
Table 4.B(b)	4.B. Sheep: activity amount	NE	calculated value

(b) The sub-category of “4.B.13. Manure Management (Other)” was changed in Table 4s2.

(c) The sub-category of “Other” was added in Table 4.B(b).

10.4.2. Further Inventory Development

See Chapter 1 (Section 1.6.2 Further Inventory Development).

Annex 1. Key Categories

1.1. Outline of Key Category Analysis

The *UNFCCC Inventory Reporting Guidelines* require the application of the *Good Practice Guidance (2000)*, and the key category analysis[1] given in the Guidance.

The guidelines for national system under Article 5 of the Kyoto Protocol also require countries, in compiling their inventories, to follow the method given in Chapter 7 of the *Good Practice Guidance (2000)* and identify the key categories.

1.2. Results of Key Category Analysis

1.2.1. Key Categories

Key categories were assessed in accordance with the *Good Practice Guidance (2000)* assessment methods (Tier 1 level assessment or trend assessment and qualitative analysis).

The results of an analysis using methods above (Tier1 Level Assessment, Tier1 Trend Assessment and Qualitative Analysis) are summarized in the following table of 25 sources, which were Japan's key categories in fiscal 2003.

Table 1 Japan's Key Categories

	A IPCC Source Category		B Direct GHGs	Level	Trend	Qualitative Analysis
#1	1A Stationary Combustion	Solid Fuels	CO2	#1	#2	
#2	1A Stationary Combustion	Liquid Fuels	CO2	#2	#1	
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	#3	#4	
#4	1A Stationary Combustion	Gaseous Fuels	CO2	#4	#3	
#5	2A Mineral Product	1. Cement Production	CO2	#5	#7	
#6	6C Waste Incineration		CO2	#6	#10	
#7	1A Stationary Combustion	Other Fuels	CO2	#7		
#8	1A3 Mobile Combustion	d. Navigation	CO2	#8		
#9	4B Manure Management		N2O	#9	#14	●
#10	1A3 Mobile Combustion	a. Civil Aviation	CO2	#10	#12	
#11	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#11	#16	
#12	4A Enteric Fermentation		CH4	#12		
#13	1A3 Mobile Combustion	b. Road Transportation	N2O	#13		
#14	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs		#5	
#15	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6		#6	
#16	2B Chemical Industry	3. Adipic Acid Production	N2O		#8	●
#17	2F(a) Consumption of Halocarbons	5. Solvents	PFCs		#9	
#18	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#11	
#19	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#13	
#20	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs		#15	
#21	4C Rice Cultivation		CH4		#17	
#22	1A3 Mobile Combustion	a. Civil Aviation	CH4			●
#23	1A3 Mobile Combustion	a. Civil Aviation	N2O			●
#24	6B Wastewater Handling		N2O			●
#25	6C Waste Incineration		N2O			●

N.B. Figures recorded in the Level and Trend columns indicate the ranking of individual level and trend assessments.

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[1] The *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (2003), which was welcomed in COP9, extends the key source analysis to LULUCF categories. In the latest UNFCCC reporting guidelines (FCCC/SBSTA/2004/8), the term "key source category" was revised to "key category". Japan adopts the term "key category" according to these guidelines, although it has not conducted key category analysis covering the LULUCF categories.

1.2.2. Level Assessment

Level assessment involves an identification of categories as a key by calculating the proportion of emissions in each category to the total emissions. The calculated values of proportion are added from the category that accounts for the largest proportion, until the sum reaches 95%.

Tier 1 level assessment of the latest emissions (FY2003) gives the following 13 sub-categories as the key categories.

Table 2 Results of Level Assessment

	A **IPCC Source Category**		**B** **Direct GHGs**	**D** **Current Year Estimate (Gg CO_2eq.)**	**F** **% Contribution to Level**	**Cumulative**
#1	1A Stationary Combustion	Solid Fuels	CO2	409,345.00	30.6%	30.6%
#2	1A Stationary Combustion	Liquid Fuels	CO2	343,628.60	25.7%	56.2%
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	227,177.66	17.0%	73.2%
#4	1A Stationary Combustion	Gaseous Fuels	CO2	164,272.33	12.3%	85.4%
#5	2A Mineral Product	1. Cement Production	CO2	30,766.37	2.3%	87.7%
#6	6C Waste Incineration		CO2	23,339.20	1.7%	89.5%
#7	1A Stationary Combustion	Other Fuels	CO2	17,923.51	1.3%	90.8%
#8	1A3 Mobile Combustion	d. Navigation	CO2	14,060.27	1.0%	91.9%
#9	4B Manure Management		N2O	11,826.36	0.9%	92.7%
#10	1A3 Mobile Combustion	a. Civil Aviation	CO2	11,063.68	0.8%	93.6%
#11	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,363.60	0.8%	94.3%
#12	4A Enteric Fermentation		CH4	6,615.72	0.5%	94.8%
#13	1A3 Mobile Combustion	b. Road Transportation	N2O	6,429.71	0.5%	95.3%

1.2.3. Trend Assessment

The difference between the rate of change in emissions in a category and the rate of change in total emissions is calculated. The trend assessment is calculated by multiplying this value by the ratio of contribution of the relevant category to total emissions. The calculated results, regarded as trend assessment values, are added from the category of which the proportion to the total of trend assessment values is the largest, until the total reaches 95%. At this point, these categories are defined as the key categories.

Tier 1 trend assessment of the latest emissions (FY2003) gives the following 17 sub-categories as the key categories.

Table 3 Results of Trend Assessment

	A IPCC Source Category		B Direct GHGs	C Base Year Estimate (Gg CO_2eq.)	D Current Year Estimate (Gg CO_2eq.)	H % Contribution to Trend	Cumulative
#1	1A Stationary Combustion	Liquid Fuels	CO2	418,458.47	343,628.60	30.6%	30.6%
#2	1A Stationary Combustion	Solid Fuels	CO2	298,298.93	409,345.00	24.1%	54.7%
#3	1A Stationary Combustion	Gaseous Fuels	CO2	103,223.76	164,272.33	14.7%	69.3%
#4	1A3 Mobile Combustion	b. Road Transportation	CO2	189,204.04	227,177.66	6.2%	75.5%
#5	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	5,022.81	3.7%	79.3%
#6	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6	10,990.00	1,542.80	2.9%	82.2%
#7	2A Mineral Product	1. Cement Production	CO2	37,006.41	30,766.37	2.6%	84.8%
#8	2B Chemical Industry	3. Adipic Acid Production	N2O	6,650.04	404.20	1.9%	86.7%
#9	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	8,880.00	4,288.00	1.5%	88.1%
#10	6C Waste Incineration		CO2	16,935.48	23,339.20	1.4%	89.5%
#11	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4,708.30	812.60	1.2%	90.7%
#12	1A3 Mobile Combustion	a. Civil Aviation	CO2	7,162.95	11,063.68	0.9%	91.7%
#13	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2,785.23	83.03	0.8%	92.5%
#14	4B Manure Management		N2O	13,550.26	11,826.36	0.8%	93.3%
#15	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	809.13	3,447.96	0.7%	94.0%
#16	2A Mineral Product	3. Limestone and Dolomite Use	CO2	11,406.30	10,363.60	0.6%	94.5%
#17	4C Rice Cultivation		CH4	7,075.73	5,785.48	0.5%	95.1%

Table 4 Data used in the key category analysis

	A IPCC Source Category		B Direct GHGs	C Base Year Estimate (Gg CO_2eq.)	D Current Year Estimate (Gg CO_2eq.)	E Level Assessment	F % Contribution to Level	G Trend Assessment	H % Contribution to Trend
#1	1A Stationary Combustion	Liquid Fuels	CO2	418,458.47	343,628.60	0.257	25.7%	0.0755	30.6%
#2	1A Stationary Combustion	Solid Fuels	CO2	298,298.93	409,345.00	0.306	30.6%	0.0595	24.1%
#3	1A Stationary Combustion	Gaseous Fuels	CO2	103,223.76	164,272.33	0.123	12.3%	0.0362	14.7%
#4	1A Stationary Combustion	Other Fuels	CO2	17,687.56	17,923.51	0.013	1.3%	0.0008	0.3%
#5	1A Stationary Combustion		CH4	336.56	309.08	0.000	0.0%	0.0000	0.0%
#6	1A Stationary Combustion		N2O	1,196.15	2,897.34	0.002	0.2%	0.0011	0.4%
#7	1A3 Mobile Combustion	a. Civil Aviation	CO2	7,162.95	11,063.68	0.008	0.8%	0.0023	0.9%
#8	1A3 Mobile Combustion	b. Road Transportation	CO2	189,204.04	227,177.66	0.170	17.0%	0.0154	6.2%
#9	1A3 Mobile Combustion	c. Railways	CO2	941.98	628.69	0.000	0.0%	0.0003	0.1%
#10	1A3 Mobile Combustion	d. Navigation	CO2	13,354.45	14,060.27	0.010	1.0%	0.0003	0.1%
#11	1A3 Mobile Combustion	a. Civil Aviation	CH4	2.94	5.11	0.000	0.0%	0.0000	0.0%
#12	1A3 Mobile Combustion	b. Road Transportation	CH4	164.80	184.28	0.000	0.0%	0.0000	0.0%
#13	1A3 Mobile Combustion	c. Railways	CH4	1.12	0.76	0.000	0.0%	0.0000	0.0%
#14	1A3 Mobile Combustion	d. Navigation	CH4	26.33	27.30	0.000	0.0%	0.0000	0.0%
#15	1A3 Mobile Combustion	a. Civil Aviation	N2O	69.75	110.31	0.000	0.0%	0.0000	0.0%
#16	1A3 Mobile Combustion	b. Road Transportation	N2O	4,720.20	6,429.71	0.005	0.5%	0.0009	0.4%
#17	1A3 Mobile Combustion	c. Railways	N2O	121.47	81.73	0.000	0.0%	0.0000	0.0%
#18	1A3 Mobile Combustion	d. Navigation	N2O	111.31	115.71	0.000	0.0%	0.0000	0.0%
#19	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2,785.23	83.03	0.000	0.0%	0.0020	0.8%
#20	1B Fugitive Emission	1a ii. Coal Mining and Handling (surface)	CH4	21.20	10.84	0.000	0.0%	0.0000	0.0%
#21	1B Fugitive Emission	2a. Oil	CO2	0.20	0.25	0.000	0.0%	0.0000	0.0%
#22	1B Fugitive Emission	2a. Oil	CH4	36.26	42.45	0.000	0.0%	0.0000	0.0%
#23	1B Fugitive Emission	2a. Oil	N2O	0.00	0.00	0.000	0.0%	0.0000	0.0%
#24	1B Fugitive Emission	2b. Natural Gas	CO2	0.30	0.41	0.000	0.0%	0.0000	0.0%
#25	1B Fugitive Emission	2b. Natural Gas	CH4	314.44	428.78	0.000	0.0%	0.0001	0.0%
#26	1B Fugitive Emission	2c. Venting & Flaring	CO2	0.01	0.01	0.000	0.0%	0.0000	0.0%
#27	1B Fugitive Emission	2c. Venting & Flaring	CH4	18.98	24.07	0.000	0.0%	0.0000	0.0%
#28	2A Mineral Product	1. Cement Production	CO2	37,006.41	30,766.37	0.023	2.3%	0.0064	2.6%
#29	2A Mineral Product	2. Lime Production	CO2	5,052.59	4,238.20	0.003	0.3%	0.0009	0.3%
#30	2A Mineral Product	3. Limestone and Dolomite Use	CO2	11,406.30	10,363.60	0.008	0.8%	0.0014	0.6%
#31	2B Chemical Industry	1. Ammonia Production	CO2	3,376.61	2,410.48	0.002	0.2%	0.0009	0.3%
#32	2B Chemical Industry	2. Nitric Acid Production	N2O	765.70	803.61	0.001	0.1%	0.0000	0.0%
#33	2B Chemical Industry	3. Adipic Acid Production	N2O	6,650.04	404.20	0.000	0.0%	0.0047	1.9%
#34	2B Chemical Industry	5. Ethylene	CO2	167.05	207.72	0.000	0.0%	0.0000	0.0%
#35	2B Chemical Industry	5. Carbon Black, Ethylene, Ethylene Dichloride, Styrene, Methanol, Coke	CH4	337.80	116.72	0.000	0.0%	0.0002	0.1%

Table 5 Data used in the key category analysis (continued.)

	A IPCC Source Category		B Direct GHGs	C Base Year Estimate (Gg CO_2eq.)	D Current Year Estimate (Gg CO_2eq.)	E Level Assessment	F % Contribution to Level	G Trend Assessment	H % Contribution to Trend
#36	2C Metal Production	3. Aluminium Production	PFCs	72.46	15.10	0.000	0.0%	0.0000	0.0%
#37	2C Metal Production	4. SF6 Used in Aluminium and Magnesium Foundries	SF6	119.50	740.90	0.001	0.1%	0.0004	0.2%
#38	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	5,022.81	0.004	0.4%	0.0092	3.7%
#39	2E Production of Halocarbons and SF6	2. Fugitive Emissions	HFCs	491.50	439.40	0.000	0.0%	0.0001	0.0%
#40	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	809.13	3,447.96	0.003	0.3%	0.0018	0.7%
#41	2F(a) Consumption of Halocarbons	2. Foam Blowing	HFCs	456.96	653.12	0.000	0.0%	0.0001	0.0%
#42	2F(a) Consumption of Halocarbons	4. Aerosols/ Metered Dose Inhalers	HFCs	1,365.00	2,624.06	0.002	0.2%	0.0008	0.3%
#43	2F(a) Consumption of Halocarbons	6. Semiconductor Manufacture	HFCs	145.08	113.49	0.000	0.0%	0.0000	0.0%
#44	2F(a) Consumption of Halocarbons	7. Other (for studies, medical use, etc.)	HFCs	0.00	0.00	0.000	0.0%	0.0000	0.0%
#45	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	762.90	1,016.40	0.001	0.1%	0.0001	0.1%
#46	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	8,880.00	4,288.00	0.003	0.3%	0.0037	1.5%
#47	2F(a) Consumption of Halocarbons	6. Semiconductor Manufacture	PFCs	2,857.70	3,707.40	0.003	0.3%	0.0004	0.2%
#48	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4,708.30	812.60	0.001	0.1%	0.0030	1.2%
#49	2F(a) Consumption of Halocarbons	6. Semiconductor Manufacture	SF6	1,099.40	1,780.55	0.001	0.1%	0.0004	0.2%
#50	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6	10,990.00	1,542.80	0.001	0.1%	0.0071	2.9%
#51	3 Solvent & Other Product Use	Using Laughing Gas in Hospital	N2O	287.07	320.83	0.000	0.0%	0.0000	0.0%
#52	4A Enteric Fermentation		CH4	7,249.10	6,615.72	0.005	0.5%	0.0009	0.3%
#53	4B Manure Management		CH4	1,072.55	911.74	0.001	0.1%	0.0002	0.1%
#54	4B Manure Management		N2O	13,550.26	11,826.36	0.009	0.9%	0.0020	0.8%
#55	4C Rice Cultivation		CH4	7,075.73	5,785.48	0.004	0.4%	0.0013	0.5%
#56	4D Agricultural Soils	2. Animal Production	CH4	3.06	2.29	0.000	0.0%	0.0000	0.0%
#57	4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,340.62	3,484.75	0.003	0.3%	0.0008	0.3%
#58	4D Agricultural Soils	2. Animal Production	N2O	6.18	4.64	0.000	0.0%	0.0000	0.0%
#59	4D Agricultural Soils	3. Indirect Emissions	N2O	5,399.66	4,414.44	0.003	0.3%	0.0010	0.4%
#60	4F Field Burning of Agricultural Residues		CH4	168.45	102.23	0.000	0.0%	0.0001	0.0%
#61	4F Field Burning of Agricultural Residues		N2O	129.90	82.68	0.000	0.0%	0.0000	0.0%
#62	6A Solid Waste Disposal on Land		CH4	4,044.84	3,594.25	0.003	0.3%	0.0005	0.2%
#63	6B Wastewater Handling		CH4	1,095.78	1,029.80	0.001	0.1%	0.0001	0.0%
#64	6B Wastewater Handling		N2O	1,097.88	996.88	0.001	0.1%	0.0001	0.1%
#65	6C Waste Incineration		CO2	16,935.48	23,339.20	0.017	1.7%	0.0034	1.4%
#66	6C Waste Incineration		CH4	13.54	11.23	0.000	0.0%	0.0000	0.0%
#67	6C Waste Incineration		N2O	1,756.22	2,644.03	0.002	0.2%	0.0005	0.2%

1.2.4. Qualitative Analysis

Key categories identified in the qualitative analysis include the categories in which: mitigation techniques have been employed, significant variance of emissions and removals has been confirmed, a high uncertainty exists due to the solo implementation of the Tier 1 analysis of key categories, and unexpectedly high or low estimates are identified.

In Japan, the categories in which mitigation techniques have been employed, emissions and removals have been newly estimated, and estimation methods have been changed, are identified as key in terms of the quantitative analysis.

- ➢ category in which: mitigation techniques have been employed
  - 2.B.3. N_2O emission from adipic acid production
- ➢ categories in which emissions and removals have been newly estimated
  - 1.A.3.a. CH_4 and N_2O emissions from Civil Aviation (Aviation Gasoline)
  - 4.B.3., 4.B.4., 4.B.6. N_2O emissions from Manure Management (Sheep, Goats and Horses)
- ➢ categories in which estimation methods have been changed
  - 6.B. N_2O emissions from Wastewater Handling
  - 6.C. N_2O emissions from Waste Incineration

Annex 2. Detailed Discussion of Methodology and Data for estimating CO_2 Emissions from Fossil Fuel Combustion

2.1. Emission Factors of Coke, Coke Oven Gas and Blast Furnace Gas, etc.

The sectoral approach is used to calculate CO_2 emissions from fuel combustion in accordance with the *Good Practice Guidance (2000)*. Verification of the results of calculations, including the calculation results obtained by the reference approach, is required to report in the common reporting format (CRF).

In calculating Japan's inventory, the sectoral and reference approach applies different values as the emission factors for the fuels produced from coking coal (coke, coal tar, briquettes, coke oven gas, blast furnace gas, and converter gas). The reasons are explained as follows.

2.1.1. Sectoral Approach

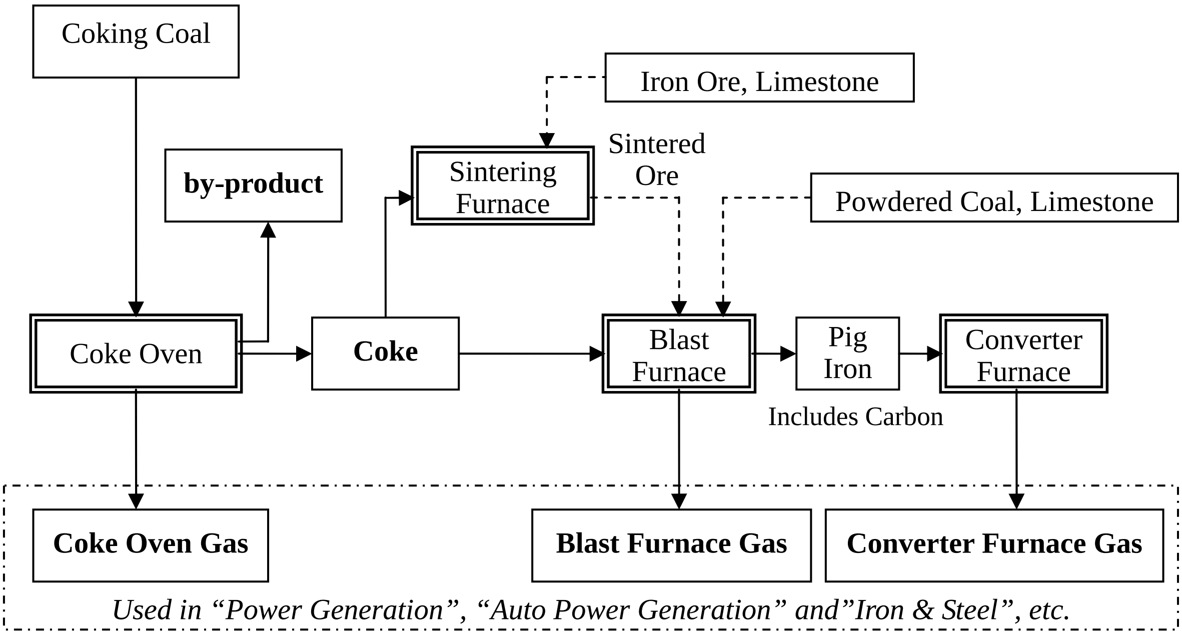
2.1.1.1. Assumption of Emission Factors

Carbon in coking coal is transferred to coke to coke oven gas, and other by-products during the production of coke.

The generally reported CO_2 emission factor for coke is the actual emissions of CO_2 in complete coke combustion. But combustion in iron blast furnaces, which is the main application of coke, produces blast furnace gas as a by-product of incomplete combustion, which is then consumed as a fuel in other sectors (this is called the cascading use of fuel). Hence, determination of the point of time for the actual CO_2 emissions during the whole process remains to be a question. Furthermore, as blast furnace gas also contains CO_2 from limestone, applying the CO_2 emission factor determined by an analysis of constituents in blast furnace gas directly to the estimation is inappropriate in order to avoid double counting.

For these reason, the integration of all coke-related fuels (coke, coal tar, briquettes, coke oven gas, blast furnace gas, and converter gas) was conducted in calculation in the sectoral approach; calculating the combusted amount of carbon in coke (the primary product made from coking coal), coke oven gas, and other by-products, and dividing it by the generic calorific values of all coke-related fuels for determining the average emission factor. Hence, a determination of the point of time for the actual CO_2 emissions is not a factor; instead, the CO_2 emission was determined according to the proportion of heat used by a sector to total consumed calorific values generated through the oxidation process from carbon to CO to CO_2.

Products from coking coal other than coke and coke oven gas are tar, hydrocarbon oil, and BTX (benzene, toluene, and xylene).



Note) "by-products" such as "Coal Tar", "Hydrocarbon Oil", "BTX", etc. are used as raw material of chemical products.

Figure 1 Manufacturing Flow for Coke, Coke Oven Gas, Blast Furnace Gas, and Other Products

It is estimated that about 6% of carbon in coking coal is transferred to tar, hydrocarbon oil, and BTX, which is mostly used as raw materials and ingredients, while a very small portion is used as fuel in blast furnaces and cement kilns. However, in the reference approach, which uses emission factors based on actual measurements, shows that only about 85% of the carbon in coking coal is used to make coke and coke oven gas. This value is smaller than the data found in the literature, and it might underestimate the CO_2 emissions from coking coal. Hence, the yield used in determining the carbon portion transferred to coke and coke oven gas was set from the literature at 94%. The for-combustion application of the remaining 6% by-products was added to bring the percentage of coking coal carbon burned as 95%. It is assumed that the remaining 5% carbon is not burned.

There are still additional emissions to be added to CO_2 emissions from by-products, such as the CO_2 generated through chemical reactions occurring in the electrolysis of metals when using carbon electrodes made from tar. These emissions must be determined in the future.

2.1.1.2. Estimation Process of Emission Factors

Emission factors used in the sectoral approach were calculated in accordance with the reasons described above.

Table 1 lists the raw material inputs for manufacturing coke and other products in terms of their calorific values (gross calorific value: TJ). Table 2 shows the production of coke and by-product gases (gross calorific value: TJ).

Table 3 presents the calculated emission factors for coke and other fuels. Table 1 results were multiplied by the emission factor for each fuel type to calculate the carbon input, which was then divided by the results in Table 2 to calculate average emission factors with regard to the percentage of carbon combusted (95%).

Table 1 Raw Material Inputs for Coke Production

[TJ]

	1990	1995	2000	2002	2003
Total Input of Raw Material for Cokes	2,367,737	2,180,028	1,878,142	1,866,009	1,919,553
Coking Coal	2,121,327	1,986,921	1,698,080	1,697,424	1,754,643
Imported Coal	213,005	167,911	147,076	147,522	151,481
Indigenous Coal	0	0	0	0	0
Hard Coal or Anthracite & Lignite	0	0	0	0	0
Oil Coke	33,405	25,196	32,986	21,064	13,430

Table 2 Production of Coke and By-product Gases

[TJ]

	1990	1995	2000	2002	2003
Total Coal Product Converted (A)	1,874,900	1,723,045	1,636,551	1,703,648	1,744,006
Coke & Related Products	1,031,750	921,853	778,105	822,326	855,776
Coke Oven Gas	362,589	334,896	336,600	357,296	365,828
Blast Furnace Gas	414,450	404,922	450,921	449,504	448,396
Converter Furnace Gas	66,111	61,374	70,925	74,522	74,006

Table 3 Calculation of Emission Factors for Coke and Other Products

[Gg-C]

	EF [tC/TJ] (Gross)	1990	1995	2000	2002	2003
Total Input of Raw Material for Cokes		56,280	51,779	44,630	44,323	45,581
Coking Coal	23.65	50,169	46,991	40,160	40,144	41,497
Imported Coal	24.71	5,263	4,149	3,634	3,645	3,743
Indigenous Coal	24.90	0	0	0	0	0
Hard Coal or Anthracite & Lignite	24.71	0	0	0	0	0
Oil Coke	25.35	847	639	836	534	340

Total Input of Raw Material for Cokes*0.95 (B)	53,466	49,190	42,399	42,107	43,302

Average EF (B)/(A)	[tC/TJ] (Gross)	**28.52**	**28.55**	**25.91**	**24.72**	**24.83**

2.1.2. Reference Approach

For coke, coke oven gas, blast furnace gas and other products, only exported coke appears in the "primary energy" section of the energy balance tables. For that reason, actually measured emission factors for coke were used.

2.2. Emission Factor of Town Gas

To calculate town gas emission factors, the total carbon in fossil fuel inputs used as raw materials was divided by the total calorific value of the town gas produced.

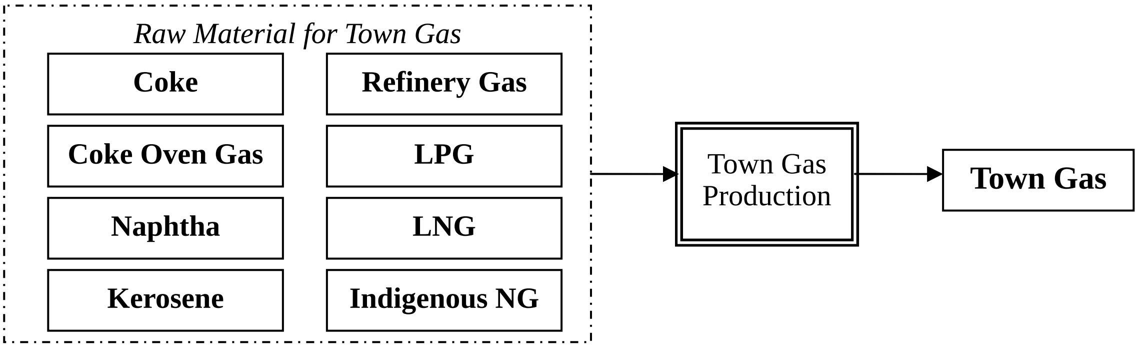


Figure 2 Manufacturing Flow for Town Gas

Table 4 presents the calorific value (gross calorific value: TJ) of the raw material inputs for manufacturing town gas.

Table 5 shows the calculated emission factors for town gas. Carbon inputs were calculated by multiplying the results in Table 4 by the emission factor of each fuel type. These results were then divided by the town gas yield ((A) in Table 4) to calculate the average emission factors.

Table 4 Raw Material Inputs for Manufacturing Town Gas

[TJ]

	1990	1995	2000	2002	2003
Total Input of Raw Material for Town Gas	665,681	894,139	1,061,463	1,167,233	1,176,329
Coke	0	0	0	0	0
Coke Oven Gas	19,178	12,205	9,573	7,876	5,704
Naphtha	0	0	0	0	0
Kerosene	10,936	15,038	3,728	2,462	1,635
Refinary Gas	13,114	14,061	13,112	13,711	14,141
Liquified Petroleum Gas	118,299	128,909	109,735	93,227	76,347
Liquefied Natural Gas	464,233	676,078	864,278	982,182	1,005,597
Indigenous Natural Gas	39,920	47,849	61,036	67,775	72,905
Town Gas Converted (A)	664,661	892,307	1,061,122	1,167,464	1,209,968

Table 5 Calculation of Town Gas Emission Factors

[Gg-C]

	EF [tC/TJ]	1990	1995	2000	2002	2003
Total Input of Raw Material for Town Gas (B)		9,657	12,682	14,759	16,100	16,147
Coke	Flactuated in every year	0	0	0	0	0
Coke Oven Gas	Flactuated in every year	547	348	248	195	142
Naphtha	18.17	0	0	0	0	0
Kerosene	18.51	202	278	69	46	30
Refinary Gas	14.15	186	199	186	194	200
Liquified Petroleum Gas	16.32	1,931	2,104	1,791	1,522	1,246
Liquefied Natural Gas	13.47	6,254	9,107	11,643	13,231	13,546
Indigenous Natural Gas	13.47	538	645	822	913	982
Average EF (B)/(A)	[tC/TJ] (Gross)	**14.53**	**14.21**	**13.91**	**13.79**	**13.34**

References

IPCC, *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, 2000

Environmental Agency, *The Estimation of* CO_2 *Emissions in Japan*, 1992

Annex 3. Other detailed methodological descriptions for individual source or sink categories

3.1. Methodology for Estimating Emissions from International Bunkers

- ***Methodology for Estimating Emissions of GHGs***

Emissions of carbon dioxide, methane and nitrous oxide from this source are derived by multiplying the consumption of each type of fuel handled by bonds by the emission factor. (Refer to *bunker-2005.xls* for details of the calculation process.)

- ***Emission Factors***

CO_2

The emission factors used for carbon dioxide are the same as those for the energy sectors, fuel combustion (CO_2) in energy sectors (Refer to Chapter 3).

CH_4, N_2O

Default values given in the *Revised 1996 IPCC Guidelines* are used for methane and nitrous oxide emission factors.

Table 1 Emission factors for methane and nitrous oxide from international bunkers

Transport mode	Type of fuel	CH_4 emission factor	N_2O emission factor
Aircraft	Jet fuel	0.002 [g CH_4/MJ] [a]	0.1 [kg N_2O/t] [b]
Shipping	Heating oil A	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]
	Heating oil B	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]
	Heating oil C	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]

a. Revised 1996 IPCC Guidelines Vol. 3, Table 1-47

b. 〃 Table 1-52

c. 〃 Table 1-48

- ***Activity Data***

Totals for bonded imports and bonded exports given in the Ministry of Economy, Trade and Industry’s *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* are used for emissions of carbon dioxide, methane, and nitrous oxide from the relevant source.

It is assumed that jet fuel is used by aircraft, while heating oil A, B and C are used by vessels.

CO_2

The kiloliter-based consumption data given in the Ministry of Economy, Trade and Industry’s *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* is converted to a Joule-based data using the standard calorific values given in the Agency for Natural Resources and Energy’s *General Energy Statistics*.

CH_4, N_2O

The *Revised 1996 IPCC Guidelines* provide a default emission factor that is based on net calorific values. Therefore, activity data in gross calorific values are converted to net calorific values by multiplying them by 0.95.

In addition, regarding activity data of N_2O from an international aviation, the *Revised 1996 IPCC Guidelines* provide a default emission factor in weight units. In order to adapt the activity data to this unit, the kiloliter-based consumption data is multiplied by the density identified by the Petroleum Association of Japan for nitrous oxide from aircraft (0.78 [g/cm^3]).

• *Categorization of Activity Data*

A and B in the diagram below correspond to the items under bonded exports and bonded imports, respectively, in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke*. C equals to the sum of A and B and it is used as the activity data for this source of emissions. This is considered to be approximately equivalent to the amount of the fuels sold in Japan for the international aviation and the marine transport.

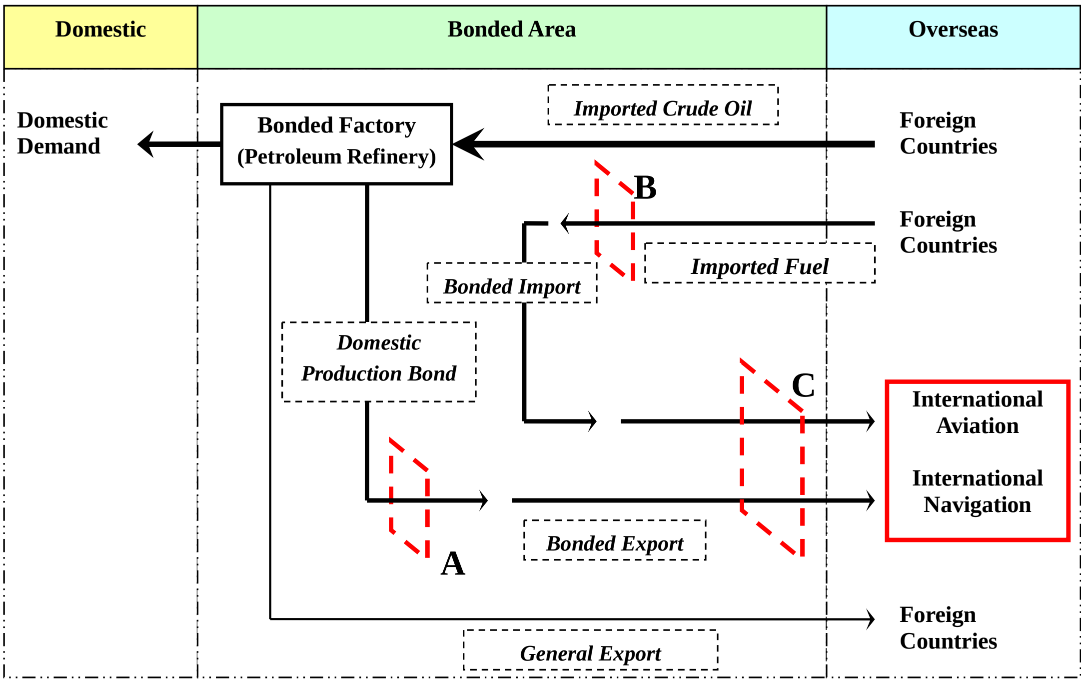


Figure 1 Activity data for international bunkers

Glossary

Bonded Jet Fuel

Under the Tariff Law, aircrafts (Japanese and non-Japanese) flying international routes are deemed to be "overseas return aircraft", and the fuel they consume is tariff-free, subject to the completion of the required procedures. The application of this legislation means that if fuel is refined from crude oil imported to Japanese refinery, both the crude oil import tariff and the petroleum tax are waived. Similarly, if fuel has been imported as a product, the product import tariff is waived. The foregoing is termed as "bonded jet fuel".

Bonded Fuel Oil

Vessels that ply voyages between Japan and other countries are deemed to be "foreign trade vessels", under the Tariff Law. The majority of their fuel is consumed outside Japanese territorial waters, and, therefore both tariffs and the petroleum tax are waived. The foregoing is termed as "bonded fuel oil".

Bonded Export

The demand for fuel supplied to aircrafts (Japanese and non-Japanese) flying international routes and ships (Japanese and non-Japanese) that ply foreign ocean routes is termed as "bonded demand". Jet fuel is supplied to aircrafts while fuel oil is supplied to ships. Of these bonded demand, the fuel supplied from products that was produced from crude oil is counted as bonded exports by the Ministry of Economy, Trade and Industry.

Bonded imports (Bond to Bond)

Fuel products that are imported from foreign countries, landed in a bonded area and supplied from the bonded area to bonded demand without going through domestic customs, is counted as bonded imports by the Ministry of Economy, Trade and Industry.

References

IPCC, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, 1997

Agency for Natural Resources and Energy, *General Energy Statistics*

Ministry Land, Infrastructure and Transport, *A new method of calculating emissions of greenhouse gas from bunkers*, 2002

Ministry of Economy, Trade and Industry, *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke*

Petroleum Association of Japan（http://www.paj.gr.jp/html/statis/kansan.html）

3.2. Methodology for Estimating Emissions of Precursors

In addition to the greenhouse gases (e.g., CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) reported under the Kyoto Protocol, Japan reports on the emissions of precursors (NOx, CO, NMVOC, SO_2) calculated by established methods. This section explains the source categories for which methodologies for estimating emissions have been provided.

Emissions from the source categories for which estimation methods have not been established are considered to be minimal, and accordingly reported as either “NO” or “NE” (or as “IE” as the case may be) based on the results of historical investigations.

3.2.1. Energy Sector

3.2.1.1. Stationary Combustion (1.A.1., 1.A.2., 1.A.4.: NO_x, CO, NMVOC, SO_2)

a) Facilities emitting soot and smokes

1) NO_x and SO_2

- ***Methodology for Estimating Emissions***

Research of Air Pollutant Emissions from Stationary Sources (“*MAP Survey*”) by the Ministry of the Environment (MoE) was used as the basis for estimation of NO_x and SO_2 emitted from fixed sources (see Page 3.12 for details of the survey). So as to ensure consistency with the *Revised 1996 IPCC Guidelines* and the *IPCC Good Practice Guidance (2000)*, the following operation isolated the emissions from the energy sector from the emissions listed in the *MAP Survey*:

1. All emissions from the following facilities and operations are reported under Energy:

   Facility: [0101–0103: Boilers]; [0601–0618: Metal rolling furnaces, metal furnaces, and metal forge furnaces]; [1101–1106: Drying ovens]; [2901–3202: Gas turbines, diesel engines, gas engines, and gasoline engines]

   Operation: [A–D: Accommodation/eating establishments, health care/educational and academic institutions, pubic bathhouses, laundry services]; [F–L: Agriculture/fisheries, mining, construction, electricity, gas, heat distribution, building heating/other operations]

2. Emissions from the facilities and operations other than the above and [1301–1304: Waste incinerators], are reported under the Industrial Processes sector. Accordingly, the emissions from the specified sources, calculated by the following methods, are subtracted from the emissions listed in the *MAP Survey* to determine the emissions from the Energy sector.

○ NO_X

If raw material falls under either [44: Metallurgical coal] or [45: Metallurgical coke], the following equation is used:

Calculation of NO_x emissions from metallurgical coal or coke (to be included in the Industrial Processes sector)

NO_x emissions from metallurgical coal or coke [t-NO_x]

= NO_x emission factor per material [t-NO_x/kcal] × energy consumed per material [kcal]

× (1 – denitrification rate [%])

If raw material falls under either [41: Iron/ironstone] or [46: Other], the following equation is used:

Calculation of NO_x emissions from iron/ironstone or other material (to be included in the Industrial Processes sector)

NO_x emissions from iron/ironstone or other material [t-NO_x]

= Nitrogen content per material [t-NO_x] × (1 – denitrification rate [%])

If, however, the emissions from the Industrial Processes sector calculated by the above equations exceed the emission volume listed in the *MAP Survey*, the total emissions listed in the Survey are considered to be the emissions from the Industrial Processes sector. Materials listed in the categories [42: Sulfide minerals] and [43: Non-ferrous metal ores] are excluded from the calculation due to the lack of data.

○ SO_2

Emissions from the Industrial Processes sector is calculated from the consumption and sulfur contents of the materials in categories from [41: Iron/ironstone] to [46: Other materials], and subtracted from the emissions listed in the *MAP Survey* to determine SO_2 emissions in the energy sector.

Calculation of SO_x emissions (in the Industrial Processes sector)

SO_x emissions [t-SO_x] = Sulfur content per material [t-SO_x] × (1 – desulphurization rate [%])

- ***Emission factors***

○ NO_x emission factors for metallurgical coal and coke

NO_x emission factors for the materials used in the calculation of NO_x emissions from metallurgical coal and coke (in the Industrial Processes sector) were established for each facility and material type based on the *MAP Survey*.

○ Denitrification rate

The denitrification rate was calculated by the following equation:

Calculation of denitrification rate

Denitrification rate [%]

= Denitrification efficiency [%] × (Hours of operation of denitrification unit [h/yr] / Hours of operation of furnace [h/yr]) × (Processing capacity of denitrification unit [m^3/yr] / max exhaust gas emission [m^3/yr])

The *MAP Survey* data were used for all items.

Denitrification efficiency: (NO_x volume before treatment – NO_x volume after treatment) / volume of smoke and soot

○ Desulphurization rate

Desulphurization rate was calculated by the following equation:

Calculation of desulphurization rate

Desulphurization rate [%]

= Desulphurization efficiency [%] × (Hours operation of desulphurization unit [h/yr] / Hours operation of furnace [h/yr]) × (Processing capacity of desulphurization unit [m^3/yr] / max exhaust gas emission [m^3/yr])

The *MAP Survey* data were used for all items.

Desulphurization efficiency: (SO_2 volume before treatment – SO_2 volume after treatment) / volume of smoke and soot

- ***Activity data***

○ Energy consumption of metallurgical coal or coke

The activity data was calculated by multiplying the consumption of materials (under [44: Metallurgical coal] and [45: Metallurgical coke]) provided in the *MAP Survey* by gross calorific value.

○ Nitrogen content of iron/ironstone and other materials

The activity data was calculated by multiplying the weighted average of nitrogen content, calculated from the nitrogen content and consumption of the materials (under [41: Iron/ironstone] and [46: Other materials]) provided in the *MAP Survey*, by the consumption volume of the material.

○ Sulfur content of various materials

The activity data was calculated by multiplying the weighted average of sulfur content, calculated on the basis of sulfur content and consumption of the material (under [44: Metallurgical coal] through [46:Other materials]) provided in the *MAP Survey*, by the consumption volume of the material.

2) CO

- ***Methodology for Estimating Emissions***

Emissions of CO from the specified sources were calculated by multiplying the energy consumption per facility type by Japan’s own emission factor.

- ***Emission factors***

CO emission factors were established based on the summary data in the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996).

- ***Activity data***

The energy consumption per facility type provided in the *MAP Survey* was used for the calculation of activity data.

3) NMVOC

- ***Methodology for Estimating Emissions***

Emissions of NMVOC from the specified sources were calculated by multiplying the energy consumption per facility type by Japan’s own emission factor.

- ***Emission factors***

NMVOC emission factors were established by multiplying the CH_4 emission factor for each facility per fuel type by the ratio of NMVOC emission to CH_4 emission factor per fuel type. The CH_4 emission factors were established from the summary data provided in the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996), while the NMVOC/CH_4 emission factor ratios were determined from the reports by Japan Environmental Sanitation Center and Institute of Behavioral Science.

- ***Activity data***

The energy consumption per facility type provided in the *MAP Survey* was used for the calculation of activity data.

b) Small facilities (commercial and other sector, manufacturing sector)

- ***Methodology for Estimating Emissions***

NO_x, CO, NMVOC, and SO_2 emitted by the specified sources were calculated by multiplying energy consumption per facility type by Japan’s own emission factor.

- ***Emission factors***

○ NO_x and SO_x

Emission factors for NO_x and SO_x were established for each fuel type for [0102: Heating system boilers] for facilities listed in [L: Heating systems for buildings/other places of business] in the *MAP Survey* by aggregating emission and energy consumption per fuel type.

○ CO

The emission factors established for [0102: Heating system boilers] based on the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996) were adopted as the CO emission factors.

○ NMVOC

NMVOC emission factors were established by multiplying the CH_4 emission factors for [0102: Heating system boilers] by the ratio of NMVOC emission to CH_4 emission factor per fuel type. The CH_4 emission factors were established from the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996), while the NMVOC/CH_4 emission factor ratios were determined from the reports by Japan Environmental Sanitation Center and Institute of Behavioral Science.

- ***Activity data***

Energy consumption by small facilities per fuel type was calculated by subtracting energy consumption per fuel type, identified by the *MAP Survey*, from energy consumption per fuel type provided in the *General Energy Statistics* (Agency for Natural Resources and Energy). If the activity data shown in the *MAP Survey* exceeded the activity data provided in the *General Energy Statistics*, the activity data for the specified sources was deemed to be zero. The fuels covered were town gas, LPG, kerosene, and heating oil A.

c) Residential sector

- ***Methodology for Estimating Emissions***

NO_x, CO, NMVOC, and SO_2 emissions from the target source were calculated by multiplying energy consumed per facility type by Japan’s own emission factor or the IPCC default emission factor.

- ***Emission factors***

○ NO_X

For solid fuels (steaming coal and coal briquettes), emission factors were established by converting the default values provided in the *Revised 1996 IPCC Guidelines* to gross calorific values.

For liquid (kerosene) and gaseous (LPG, town gas) fuels, the emission factors per usage per fuel type provided in the reports by Air Quality Management Bureau, Ministry of the

Environment were used. This report calculated the emission factors by weighting the average concentration of NO_x emissions per source unit, obtained through questionnaires and interviews in the household gas appliances industry.

○ CO

For solid fuels (steaming coal and coal briquettes), emission factors were established by converting the default values provided in the *Revised 1996 IPCC Guidelines* to gross calorific values.

For liquid (kerosene) and gaseous (LPG, town gas) fuels, the emission factors per usage per fuel type provided in the reports by Institute of Behavioral Science were used. This report tabulated the emission factors by usage and fuel using the actual values measured in Tokyo, Yokohama city and Chiba Prefecture.

○ NMVOC

For all of the solid (steaming coal and coal briquettes), liquid (kerosene), and gaseous (LPG and town gas) fuels, emission factors were established by converting the default values provided in the *Revised 1996 IPCC Guidelines* to gross calorific values.

○ SO_2

For solid fuels (steaming coal and coal briquettes), emission factors were established by converting the default values provided in the *Revised 1996 IPCC Guidelines* to gross calorific values.

For liquid fuel (kerosene), emission factors were calculated from energy consumption, specific gravity and sulfur content based on the fuel characteristics of kerosene described in information material compiled by the Petroleum Association of Japan.

- ***Activity data***

Consumption by type of fuel for residential use in *General Energy Statistics* has been taken for the activity data. The fuels covered were steaming coal, coal briquettes, kerosene, LPG, and town gas.

3.2.1.2. Mobile Combustion (1.A.3: NO_x, CO, NMVOC, and SO_2)

3.2.1.2.a. Road Transportation (1.A.3.b.)

1) NO_x, CO, and NMVOC

- ***Methodology for Estimating Emissions***

NO_x, CO, and NMVOC emissions from the specified mobile sources were calculated by multiplying the distance traveled per year for each vehicle type per fuel by Japan’s own emission factor.

- ***Emission factors***

Emission factors were established from the measured values for each vehicle class per fuel type (Environmental Management Bureau, Ministry of the Environment). The NMVOC emission factors, however, were calculated by multiplying the emission factor of THC (per Environmental Management Bureau, Ministry of the Environment) by the percentage of NMVOC in the THC emission (per Ministry of the Environment). As the 2003 data were yet to be summarized, the emission factors for 2003 used the 2002 values.

Table 2 NO_x emission factors for automobiles

Fuel type	Vehicle type	Unit	1990	1995	2000	2002	2003
Gasoline	Light Vehicle	g-NO_x/km	0.230	0.159	0.157	0.133	0.133
	Passenger Vehicle (Inc. LPG)	g-NO_x/km	0.237	0.203	0.199	0.174	0.174
	Light Cargo Truck	g-NO_x/km	0.873	0.658	0.375	0.300	0.300
	Small Cargo Truck	g-NO_x/km	1.115	0.897	0.478	0.424	0.424
	Regular Cargo Truck	g-NO_x/km	1.833	1.093	0.560	0.489	0.489
	Bus	g-NO_x/km	4.449	3.652	2.438	1.901	1.901
	Special Vehicle	g-NO_x/km	1.471	0.873	0.429	0.389	0.389
Diesel	Passenger Vehicle	g-NO_x/km	0.636	0.526	0.437	0.423	0.423
	Small Cargo Truck	g-NO_x/km	1.326	1.104	1.005	0.996	0.996
	Regular Cargo Truck	g-NO_x/km	5.352	4.586	4.334	4.334	4.334
	Bus	g-NO_x/km	4.226	3.830	3.597	3.547	3.547
	Special Vehicle	g-NO_x/km	3.377	2.761	2.152	2.061	2.061

* 2002 data were used for 2003.

Source: Environment Management Bureau, Ministry of the Environment

Table 3 CO emission factors for automobiles

Fuel type	Vehicle type	Unit	1990	1995	2000	2002	2003
Gasoline	Light Vehicle	g-CO/km	1.749	1.549	1.543	1.292	1.292
	Passenger Vehicle (Inc. LPG)	g-CO/km	2.325	2.062	2.034	1.791	1.791
	Light Cargo Truck	g-CO/km	10.420	8.540	5.508	4.620	4.620
	Small Cargo Truck	g-CO/km	9.656	10.079	8.309	7.585	7.585
	Regular Cargo Truck	g-CO/km	12.624	10.601	8.950	8.192	8.192
	Bus	g-CO/km	26.209	25.079	21.938	20.540	20.540
	Special Vehicle	g-CO/km	12.466	10.666	8.924	8.406	8.406
Diesel	Passenger Vehicle	g-CO/km	0.480	0.432	0.429	0.428	0.428
	Small Cargo Truck	g-CO/km	0.975	0.896	0.808	0.795	0.795
	Regular Cargo Truck	g-CO/km	3.221	2.988	2.440	2.370	2.370
	Bus	g-CO/km	2.579	2.534	2.200	2.100	2.100
	Special Vehicle	g-CO/km	2.109	1.893	1.297	1.217	1.217

* 2002 data were used for 2003.

Source: Environment Management Bureau, Ministry of the Environment

Table 4 NMVOC emission factors for automobiles

Fuel type	Vehicle type	Unit	1990	1995	2000	2002	2003
Gasoline	Light Vehicle	g-HC/km	0.128	0.050	0.048	0.042	0.042
		%	60%	60%	60%	60%	60%
		g-NMVOC/km	0.077	0.030	0.029	0.025	0.025
	Passenger Vehicle (Inc. LPG)	g-HC/km	0.189	0.112	0.104	0.093	0.093
		%	60%	60%	60%	60%	60%
		g-NMVOC/km	0.113	0.067	0.062	0.056	0.056
	Light Cargo Truck	g-HC/km	1.058	0.610	0.274	0.235	0.235
		%	60%	60%	60%	60%	60%
		g-NMVOC/km	0.635	0.366	0.165	0.141	0.141
	Small Cargo Truck	g-HC/km	1.188	0.882	0.346	0.290	0.290
		%	60%	60%	60%	60%	60%
		g-NMVOC/km	0.713	0.529	0.208	0.174	0.174
	Regular Cargo Truck	g-HC/km	1.658	0.959	0.471	0.397	0.397
		%	60%	60%	60%	60%	60%
		g-NMVOC/km	0.995	0.575	0.283	0.238	0.238
	Bus	g-HC/km	3.604	3.164	2.193	1.936	1.936
		%	60%	60%	60%	60%	60%
		g-NMVOC/km	2.162	1.899	1.316	1.162	1.162
	Special Vehicle	g-HC/km	1.619	0.786	0.317	0.272	0.272
		%	60%	60%	60%	60%	60%
		g-NMVOC/km	0.972	0.472	0.190	0.163	0.163
Diesel	Passenger Vehicle	g-HC/km	0.109	0.098	0.097	0.097	0.097
		%	99%	99%	99%	99%	99%
		g-NMVOC/km	0.108	0.097	0.096	0.096	0.096
	Small Cargo Truck	g-HC/km	0.389	0.343	0.258	0.247	0.247
		%	99%	99%	99%	99%	99%
		g-NMVOC/km	0.385	0.340	0.255	0.245	0.245
	Regular Cargo Truck	g-HC/km	1.634	1.488	1.040	0.978	0.978
		%	99%	99%	99%	99%	99%
		g-NMVOC/km	1.617	1.473	1.029	0.968	0.968
	Bus	g-HC/km	1.273	1.255	0.995	0.916	0.916
		%	99%	99%	99%	99%	99%
		g-NMVOC/km	1.261	1.242	0.985	0.906	0.906
	Special Vehicle	g-HC/km	1.101	0.965	0.526	0.469	0.469
		%	99%	99%	99%	99%	99%
		g-NMVOC/km	1.090	0.956	0.521	0.464	0.464

Top row: THC emission factors;

Middle row: Percentage of NMVOC in the THC emission;

* 2002 data were used for 2003.

Source: Environment Management Bureau, Ministry of the Environment

- ***Activity data***

The activity data used the travel distance per year for each vehicle class per fuel type, which were calculated by multiplying distances traveled in a year for each vehicle class per fuel type, provided in the *Statistical Yearbook of Motor Vehicle Transport* (Ministry of Land, Infrastructure and Transport), by the percentage of the distances per fuel types calculated from fuel consumption and cost data.

2) SO_2

- ***Methodology for Estimating Emissions***

The emissions of SO_2 from these sources were calculated by multiplying fuel consumption by vehicle class and fuel types by Japan's own emission factor.

- ***Emission factor***

Sulfur content (by weight) of each fuel type was used to establish emission factors.

Table 5 Sulfur content (by weight) by fuel type

	Unit	1990	1995	2000	2002	2003
Gasoline	%	0.008%	0.008%	0.008%	0.008%	0.008%
Diesel	%	0.350%	0.136%	0.136%	0.136%	0.136%
LPG	%	0.002%	0.002%	0.002%	0.002%	0.002%

Source: Gasoline/LPG – The Institute of Behavioral Science
Diesel oil – Petroleum Association of Japan

- ***Activity data***

Activity data was calculated by multiplying fuel consumption for each vehicle class per fuel type by specific gravity of each fuel type, and converting the resultant values to weight. The fuel consumption data was reported in the *Statistical Yearbook of Motor Vehicle Transport* (Ministry of Land, Infrastructure and Transport).

3.2.1.2.b. Civil Aviation (1.A.3.a: NO_x, CO, NMVOC)

- ***Methodology for Estimating Emissions***

NO_x, CO, and NMVOC emissions from the specified sources were calculated by multiplying the fuel consumption converted to net calorific value by the default emission factors provides in the *Revised 1996 IPCC Guidelines*.

- ***Emission factors***

The default emission factors provided for the "Jet and Turboprop Aircraft" category in the *Revised 1996 IPCC Guidelines* were used.

Table 6 IPCC default emission factors for aircraft

Gas	Emission factor (g/MJ)
NO_x	0.29
CO	0.12
NMVOC	0.018

Source: Revised 1996 IPCC guidelines, Vol. 3; Page 1.89, Table 1-47

- ***Activity data***

Figures for jet fuel consumption (for domestic scheduled flights and others [commuter, sightseeing and charter flights]) in the *Statistical Yearbook of Air Transport* (Ministry of Land, Infrastructure and Transport) were converted to net calorific value for the calculation of activity data.

3.2.1.2.c. Navigation (1.A.3.d.: NO_x, CO, NMVOC)

- ***Methodology for Estimating Emissions***

NO_x, CO, and NMVOC emissions from the specified sources were calculated by multiplying the fuel consumption converted to net calorific value by the default emission factors provided in the *Revised 1996 IPCC Guidelines*.

- ***Emission factors***

The default emission factors provided for the “Ocean-Going Ships” category in the *Revised 1996 IPCC Guidelines* were used.

Table 7 IPCC default emission factors for ocean-going ships

Gas	Emission factor［g/MJ］
NO_x	1.8
CO	0.18
NMVOC	0.052

Source: Revised 1996 IPCC Guidelines, Vol. 3; Page 1.90, Table 1-48

- ***Activity data***

The marine fuel consumption data per fuel type (diesel, heating oil A, heating oil B, and heating oil C) provided in the *General Energy Statistics* (Agency for Natural Resources and Energy) were converted to net calorific value for the calculation of activity data. The consumption data were based on the statistical data on marine transport (coastal services [passenger and freight]) in the *The Survey on Transport Energy* (Ministry of Land and Transport).

3.2.1.2.d. Railways (1.A.3.c.: NO_x, CO, and NMVOC)

- ***Methodology for Estimating Emissions***

NO_x, CO, and NMVOC emissions from the specified sources were calculated by multiplying fuel consumption converted to net calorific value by the default emission factors provided in the *Revised 1996 IPCC Guidelines*.

- ***Emission factors***

The default emission factors provided for the "Locomotives" category in the *Revised 1996 IPCC Guidelines* were used.

Table 8 IPCC default emission factors for locomotives

Gas	Emission factor [g/MJ]
NO_x	1.8
CO	0.61
NMVOC	0.13

Source: Revised 1996 IPCC Guidelines, Vol. 3; Page 1.89, Table 1-47

- ***Activity data***

The diesel oil consumption by railways in the *General Energy Statistics* (Agency for Natural Resources and Energy) was used for the calculation of activity data.

3.2.1.3. Fugitive emissions from fuels (1.B.: NMVOC)

3.2.1.3.a. NMVOCs fugitive emissions at oil refinery

- ***Methodology for Estimating Emissions***

NMVOC emissions from the specified sources were calculated by multiplying the capacity of oil refineries (BPSD: Barrels Per Served Day) by Japan's own emission factors and annual days of operation.

- ***Emission factor***

Based on the *Study on the total system for prevention of HC-Vapor in petroleum industries* (Agency of Natural Resources and Energy, 1975), the emission factor was established as 0.05767 (g-NMVOC/BPSD). The number of days of operation for atmospheric distillation was established as 350 days.

- ***Activity data***

Figures for the BPSD based on the results of surveys conducted by the Ministry of Economy, Trade and Industry, were used for the calculation of activity data.

3.2.1.3.b. NMVOCs emissions from lubricant oil production

- ***Methodology for Estimating Emissions***

NMVOC emissions from the specified sources were calculated by multiplying gross sales amount to consumers by Japan’s own emission factors for toluene and methyl ethyl ketone.

- ***Emission factors***

Based on internal documents of Yokohama city, emission factors were established for toluene and methyl ethyl ketone.

Table 9 Toluene and methyl ethyl ketone emission factors in lubricant oil production

Gas	Emission factor (g/kL)
Toluene	333.2
Methyl ethyl ketone	415.5

Source: Yokohama city

- ***Activity data***

Figures for gross sales amount to consumers, provided in the *Yearbook of Mineral Resources and Petroleum Production Statistics* (Ministry of Economy, Trade and Industry), were used for the calculation of activity data.

3.2.1.3.c. NMVOCs fugitive emissions at storage facilities

- ***Methodology for Estimating Emissions***

NMVOC emissions from the specified sources were calculated on the assumption that yearly emissions were the same as the 1983 volume of losses from breathing and acceptance for cone-roof type storage tanks and shipping losses from floating-roof type storage tanks at refineries and storage tanks (Petroleum Association of Japan).

- ***Emission factor***

No emission factors were established.

- ***Activity data***

No activity data were calculated.

3.2.1.3.d. NMVOCs fugitive emissions at shipping facilities

- ***Methodology for Estimating Emissions***

NMVOC emissions from specified sources were calculated by multiplying the 1983 figures for NMVOC emissions from ships and tank lorries/freight cars by the 1983 ratio of amount of shipment or that of sales to consumers.

- ***Emission factor***

No emission factors were established.

- ***Activity data***

Figures for shipment of crude oil not to be refined, gross sales amount of gasoline to consumers, export of gasoline, gross sales amount of naphtha to consumers, export of naphtha, gross sales amount of jet fuel to consumers and export of jet fuel provided in the *Yearbook of Mineral Resources and Petroleum Products Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data. Table 9 shows the relationship between the NMVOC emission sources and activity data.

Table 10 Relationship between the NMVOC emission sources and activity data

NMVOC emission source		Activity data used in calculation
Ships	Crude oil	shipment of crude oil not to be refined
	Gasoline	gross sales amount of gasoline to consumers
		export of gasoline
	Naphtha	gross sales amount of naphtha to consumers
		export of naphtha
	Jet fuel	gross sales amount of jet fuel to consumers
		export of jet fuel
Tank lorries /Freight cars	Gasoline	gross sales amount of gasoline to consumers
	Naphtha	gross sales amount of naphtha to consumers
	Jet fuel	gross sales amount of jet fuel to consumers

3.2.1.3.e. NMVOCs fugitive emissions from gas stations

- ***Methodology for Estimating Emissions***

NMVOC emissions from specified sources were calculated by multiplying amount of sales to consumers by Japan’s own emission factors for oil accepting and providing, and subtracting the portion of fuels prevented from fugitive emissions by a vapor return facility.

- ***Emission factor***

Emission factors were established for oil accepting and for oil providing, based on the *Study on the total system for prevention of HC-Vapor in petroleum industries* (Agency of Natural Resources and Energy, 1975).

Table 11 Emission factors at gas stations during oil accepting and providing

	Emission factor (kg/kL)
Oil accepting	1.08
Oil providing	1.44

Source:Study on the total system for prevention of HC-Vapor in petroleum industries (Agency of Natural Resources and Energy, 1975)

- ***Activity data***

Figures for sales amount of gasoline (for automobiles) in the *Yearbook of Mineral Resources and Petroleum Products Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data.

Fugitive emissions prevented by a vapor return facility during oil accepting at gas stations were calculated by the following equation:

Calculation of fugitive emissions prevented by vapor return facility during oil accepting

Fugitive emissions prevented by vapor return facility during fuel delivery [t]

= $\Sigma_{\text{Prefecture}}$ {(gasoline sales per prefecture [ML] × emission factor for fuel delivery [kg/kL])

× (No. of service stations with vapor return facility per prefecture

/ No. of service stations per prefecture)}

* *Based* on the data provided in the *Yearbook of Mineral Resources and Petroleum Products Statistics* (Ministry of Economy, Trade and Industry). For the number of service stations after FY 2001, the number of service stations registered under law was used.

3.2.2. Industrial Processes

3.2.2.1. Mineral Products, Chemical Industry, Metal Production, and Other Production (2.A., 2.B., 2.C., 2.D.,: NO_x, SO_2)

- ***Methodology for Estimating Emissions***

NO_x and SO_2 emissions from the specified sources were calculated for sources not included in the following facilities or operations by isolating the emissions from the Industrial Processes sector.

Facility:	[0101– 0103: Boilers]; [0601– 0618: Metal rolling furnaces, metal furnaces, and metal forge furnaces]; [1101–1106: Drying ovens]; [1301–1304: Waste incinerators]; [2901–3202: Gas turbines, diesel engines, gas engines, and gasoline engines]
Operation:	[A–D: Accommodation/eating establishments, health care/educational and academic institutions, pubic bathhouses, laundry services]; [F–L: Agriculture/fisheries, mining, construction, electricity, gas, heat distribution, building heating/other operations]

○ NO_X

If raw material falls under either [44: Metallurgical coal] or [45: Metallurgical coke], the following equation is used:

Calculation of NO_x emissions from metallurgical coal or coke (for Industrial Processes sector)

NO_x emissions from metallurgical coal or coke [t-NO_x]

= NO_x emission factor per origin [t-NO_x/kcal] × energy consumed per material [kcal]

× (1 – denitrification rate [%])

If raw material falls under either [41: Iron/ironstone] or [46: Other], the following equation is used:

Calculation of NO_x emissions from iron/ironstone or other material (for Industrial Processes sector)

NO_x emissions from iron/iron ore or other material [t-NO_x]

= Nitrogen content per material [t-NO_x] × (1 – denitrification rate [%])

If, however, the emissions from the Industrial Processes sector calculated by the above equations exceed the emission volume listed in the *MAP Survey*, the total emissions listed in the Survey are considered to be the emissions from the Industrial Processes sector. Materials listed in the categories [42: Sulfide minerals] and [43: Non-ferrous metal ores] are excluded from the calculation due to the lack of data.

○ SO_2

Based on the consumption and sulfur contents of the materials in the categories from [41: Iron/ironstone] to [46: Other materials], SO_2 emissions from the Industrial Processes sector are calculated as follows:

Calculation of SO_x emissions (in the Industrial Processes sector)

SO_x emissions [t-SO_x]

= Sulfur content per material [t-SO_x] × (1 – desulphurization rate [%])

- ***Emission factor***

○ NO_x emission factors for metallurgical coal and coke

NO_x emission factors for the materials used in calculation of NO_x emissions from metallurgical coal and coke (in the Industrial Processes sector) were established for each facility and material type based on the *MAP Survey*.

○ Denitrification rate

The denitrification rate was calculated by the following equation:

Calculation of denitrification rate

Denitrification rate [%]

= Denitrification efficiency [%] × (Hours of operation of denitrification unit [h/yr] / Hours of operation of furnace [h/yr]) × (Processing capacity of denitrification unit [m^3/yr] / max. exhaust gas emission [m^3/yr])

The *MAP Survey* data were used for all items.

Denitrification efficiency: (NO_x volume before treatment – NO_x volume after treatment) / volume of smoke and soot

○ Desulphurization rate

The desulphurization rate was calculated by the following equation:

Calculation of desulphurization rate

Desulphurization rate [%]

= Desulphurization efficiency [%] × (Hours operation of desulphurization unit [h/yr]

/ Hours operation of furnace [h/yr]) × (Processing capacity of desulphurization unit [m^3/yr]

/ max. exhaust gas emission [m^3/yr])

The *MAP Survey* data were used for all items.

Desulphurization efficiency: (SO_2 volume before treatment – SO_2 volume after treatment) / volume of smoke and soot

- ***Activity data***

○ Energy consumption of metallurgical coal or coke

The activity data was calculated by multiplying the consumption of materials (under [44: Metallurgical coal] and [45: Metallurgical coke]) provided in the *MAP Survey* by gross calorific value.

○ Nitrogen content of iron/ironstone and other materials

The activity data was calculated by multiplying the weighted average of nitrogen content, calculated from the nitrogen content and consumption of the materials (under [41: Iron/ironstone] and [46:Other raw materials]) provided in the *MAP Survey*, by the consumption volume of the material.

○ Sulfur content of various materials

The activity data was calculated by multiplying the weighted average of sulfur content, calculated on the basis of sulfur content and consumption of the material (under [41: Iron/ironstone] through [46: Other materials]) provided in the *MAP Survey*, by the consumption volume of the material.

3.2.2.2. Other (2.G.: NMVOC)

3.2.2.2.a. NMVOCs emissions from petrochemical manufacturing

- ***Methodology for Estimating Emissions***

NMVOCs emissions from petrochemical manufacturing were calculated by multiplying the production volume per type of petrochemical product by Japan's own emission factors.

- ***Emission factors***

Emission factors were established based on the *Basic Study on HC Sources* (Institute of Behavioral Science, 1987).

Table 12 NMVOC emission factors by petrochemical product

Petrochemical product	Emission factor (kg/t)
Propylene oxide	0.828
Vinyl chloride monomer	3.288
Styrene monomer	0.529
Vinyl acetate	1.299
B.T.X.	0.080
Ethylene oxide	0.421
Acrylonitrile	1.035
Butadiene	0.210
Polyethylene (produced under middle-low pressure)	1.851
Polyethylene (produced under high pressure)	1.088
ABS, AS resins	1.472
Synthetic rubber	0.248
Acetaldehyde	0.016
Terephthalic acid	0.534
Polypropylene	2.423
Ethylene and Propylene	0.016

Source:Basic Study on HC Sources (Institute of Behavioral Science, 1987).

- ***Activity data***

Figures in the petrochemical production volume by type in the *Yearbook of Mineral Resources and Petroleum Products Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data.

3.2.2.2.b. NMVOCs emissions from storage facilities for chemical products

- ***Methodology for Estimating Emissions***

NMVOCs emissions from storage facilities for chemical products were calculated on the assumption that the emission volumes were same as the 1983 combined yearly emissions of “Petrochemicals” and “Others”, given in the *Basic Study on HC Sources* (Institute of Behavioral Science, 1987). “Petrochemicals” covered base chemicals (for the chemical industry); “Other” covered solvents (shipped primarily for non-feedstock use).

- ***Emission factors***

No emission factors were established.

- ***Activity data***

No activity data were calculated.

3.2.2.2.c. NMVOCs emissions from shipping facilities for chemical products

- ***Methodology for Estimating Emissions***

NMVOCs emissions from shipping facilities for chemical products were calculated on the assumption that the emission volumes were same as the 1983 combined yearly emissions of "Petrochemicals" and "Others", shown in the *Basic Study on HC Sources* (Institute of Behavioral Science, 1987). "Petrochemicals" covered base chemicals (for the chemical industry); "Other" covered solvents (shipped primarily for non-feedstock use).

- ***Emission factors***

No emission factor has been established.

- ***Activity data***

No activity data has been established.

3.2.3. Sectors that use solvents and other products

3.2.3.1. NMVOCs emissions from paint solvent use (3.A.: NMVOC)

- ***Methodology for Estimating Emissions***

Emissions of NMVOC were calculated by multiplying the consumption of solvent by the NMVOC emission rate (the percentage of NMVOC not removed but released into atmosphere).

- ***Emission factors***

The NMOVC emission rate (92.54[%] = 100[%] – 7.46[%]) calculated from the NMVOC removal rate (7.46[%]) estimated by the Ministry of the Environment (1983) was used as the emission factor.

- ***Activity data***

Consumption of solvent was calculated by multiplying the 1990 data for solvent consumption per solvent type by the 1990 ratio of solvent consumption in paint production. The consumption data were extracted from the *Present condition and prospect about VOCs in Paint Industry* (Japan Paint Manufacturers Association). The solvent consumption ratio was provided in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry). As the statistical records on solvent consumption in paint production were discontinued, the data for 2001 were substituted for values for years 2002 and beyond.

Calculation of annual consumption of paint solvent A in Year X

Annual consumption of paint solvent A in Year X ［t］

＝Annual consumption of paint solvent A in 1990 ［t］

×(Annual consumption of paint production solvent B in Year X ［t］

/Annual consumption of paint production solvent B in 1990 ［t］)

Table 13 Relationship of types of paint solvents and solvents for paint production used in calculation

Types of Paint Solvent (A)	Types of Paint Production Solvents Used in Calculation (B)
Aliphatic compound hydrocarbon	Mineral spirit
Alicyclic compound hydrocarbon	Toluene, xylene, and other aromatic hydrocarbon
Aromatic compound hydrocarbon	Toluene, xylene, and other aromatic hydrocarbon
Petroleum mixed solvent	Mineral spirit
Alcohol solvent	Alcohol solvent
Ether, Ether Alcohol solvent	Alcohol solvent
Ester solvent	Ester solvent
Ketone solvent	Ketone solvent
Chloric solvent	Solvent with a high boiling point
Other non-chloric solvent	Solvent with a high boiling point

3.2.3.2. Degreasing, dry cleaning (3.B.: NMVOC)

3.2.3.2.a. NMVOCs emissions from metal cleansing

- ***Methodology for Estimating Emissions***

NMVOCs emissions from metal cleansing were calculated by multiplying the shipping amount of solvents (trichloro ethylene and tetrachloro ethylene) in degreasing by Japan’s own emission factor.

- ***Emission factors***

Emission factors were established as the ratio of emission to shipment (0.66 [Mg/t] = 88,014 / 133,000), based on data for 1983 in the *Report on the Survey of Measures for Stationary Sources of Hydrocarbons* (Institute of Behavioral Science, 1991).

- ***Activity data***

Shipping amount of solvents was calculated by multiplying the sales volume of trichloro ethylene and tetrachloro ethylene, provided in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry), by the ratio of consumption for metal cleansing use to total consumption of organic chloric solvent (3 type) (0.2 = 11,266 / 56,350), shown in documents from the Perchlo Association.

3.2.3.2.b. NMVOCs emissions from dry cleaning

- ***Methodology for Estimating Emissions***

NMVOCs emissions from dry cleaning were calculated on the assumption that the volume of NMOVC emissions was the same as the volume of solvents used in dry cleaning (petroleum solvents and tetrachloro ethylene).

- ***Emission factors***

No emission factors were established, as all the solvents used in dry cleaning were assumed to be discharged into the atmosphere.

- ***Activity data***

Estimates by the Institute of Cleaning Research were used for the calculation of the annual consumption of petroleum solvents and tetrachloro ethylene in 1990 and 1991.

Annual consumption in 1992 and in subsequent years was calculated by the following equation on the assumption that solvent consumption was proportional to the number of machines in operation:

Calculation of annual consumption of solvents in Year X

Annual consumption of solvents in Year X [t]

= $\Sigma_{\text{petroleum-based solvent/tetrachloroethylene}}$ {annual consumption of petroleum solvents or tetrachloroethylene in 1991 [t] × (the number of machines in operation in Year X / the number of machines in operation in 1991)}

3.2.3.3. Chemical products, manufacture and processing (3.C.: NMVOC)

3.2.3.3.a. NMVOCs emissions from paint production

- ***Methodology for Estimating Emissions***

NMVOCs emissions from paint production were calculated by multiplying the amount of solvent treated in paint production by Japan’s own emission factors.

- ***Emission factors***

Emission factors were established based on the *Manual to control HC emissions* (Air Quality Management Bureau, Ministry of the Environment, 1982).

Table 14 Emission factors for solvents used as raw material for paints

Solvent	Emission factor (%)
Toluene	0.3
Xylene	0.2
Other aromatic hydrocarbon	0.2
Mineral spirit	0.2
Alcohol solvent	0.3
Ester solvent	0.3
Methyl isobutyl ketone	0.3
Other ketones	0.2
Solvent with a high boiling point	0.1

Source:Manual to control HC emissions (Air Quality Management Bureau, Ministry of the Environment, 1982)

- ***Activity data***

Amount of solvent treated in paint production in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry) was used for the calculation of activity data. The usage of ketone solvents was allocated to “Methyl isobutyl ketone” and “Other ketones” (with approx. 63% allocated to methyl isobutyl ketones), based on the interview survey results included in *Manual to control HC emissions* (Air Quality Management Bureau, Ministry of the Environment, 1982). For 2002 and subsequent years, the 2001 values were used because the statistics were discontinued.

3.2.3.3.b. NMVOCs emissions from printing ink production

- ***Methodology for Estimating Emissions***

NMVOCs emissions from printing ink production were calculated by multiplying amount of solvent treated in paint production, by Japan’s own emission factors.

- ***Emission factors***

Emission factors were established based on the results of surveys conducted by the Ministry of the Environment, as well as *Basic study on HC sources* (Institute of Behavioral Science, 1987).

Table 15 Emission factors for solvents used as materials in printing ink

Solvent	Emission factor
Petroleum solvent	0.00033
Aromatics hydrocarbon	0.00108
Alcohol solvent	0.00105
Ester, ether solvent	0.00117

Source: *a:* *Surveys by the Ministry of the Environment*

b: *Basic Study on HC sources (Institute of Behavioral Science, 1987)*

- ***Activity data***

Amount of solvent treated in paint production in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data. For 2002 and subsequent years, the 2001 values were used because the statistics were discontinued.

3.2.3.3.c. NMVOCs emissions from printing ink solvent use

- ***Methodology for Estimating Emissions***

NMVOCs emissions from printing ink solvent use were calculated by multiplying the 1983 figures for NMVOC emissions from printing ink solvent use by the 1983 ratio of shipment amount of solvent.

- ***Emission factor***

Emission factors were established as “0.3”.

- ***Activity data***

Shipment amount of solvent in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data.

3.2.3.3.d. NMVOCs emissions from polyethylene laminate

- ***Methodology for Estimating Emissions***

NMVOCs emissions from polyethylene laminate were calculated on the assumption that the yearly emissions equaled the 1983 emissions data provided in the *Basic study on HC sources* (Institute of Behavioral Science, 1987)

- ***Emission factor***

No emission factors were established.

- ***Activity data***

No activity data were calculated.

3.2.3.3.e. NMVOCs emissions from solvent-type adhesive use

- ***Methodology for Estimating Emissions***

NMVOCs emissions from solvent-type adhesive use were assumed to equal the amount of solvents (xylene, toluene) used in adhesives.

- ***Emission factors***

No emission factors were established as all the solvents used in adhesives were assumed to be discharged into the atmosphere.

- ***Activity data***

Shipment amount of adhesive were calculated by multiplying amount of adhesives shipment by type (on calendar year basis), shown in the *Current survey report on adhesive* (Japan Adhesive Industry Association), by solvent content rate for each type shown in the *Current survey report on adhesive* (Japan Adhesive Industry Association).

Table 16 Solvent content in adhesives by type

Adhesive	Solvent content (%)
Vinyl acetate resin solvent type	65
Other resin solvent type	50
CR solvent type	71
Other synthetic rubber solvent type	76
Natural rubber solvent type	67

Source: Current survey report on adhesive (Japan Adhesive Industry Association)

3.2.3.3.f. NMVOCs emissions from gum solvent use

- ***Methodology for Estimating Emissions***

NMVOCs emissions from gum solvent use were calculated by multiplying the consumption of solvents in rubber by NMVOC emission rate (the percentage of NMVOC not removed but released into atmosphere).

- ***Emission factors***

The NMVOC emission rate (92.7[%] = 100[%] – 7.3[%]) was used. This was calculated from the 1983 estimate of the NMVOC removal rate (7.3%), provided in the *Basic study on HC sources* (Institute of Behavioral Science, 1987).

- ***Activity data***

The annual consumption of solvents in rubber was calculated by multiplying the consumption of petrol for solvent use by the ratio of the amount of rubber petrol use to total amount of gum solvent use (0.42 = 21,139 / 50,641). The consumption data were obtained either from the *Statistics of rubber products* (Ministry of Economy, Trade and Industry) or the results of surveys by the Japan Rubber Manufacturers Association; the usage rate was provided by the *Basic study on HC sources* (Institute of Behavioral Science, 1987).

3.2.3.4. Other (3.D.: NMVOC)

3.2.3.4.a. NMVOCs emissions from other solvent use for production

- ***Methodology for Estimating Emissions***

NMVOCs emissions from other solvent use for production were calculated on the assumption that the yearly emissions equaled the 1983 emissions shown in the *Basic study on HC sources* (Institute of Behavioral Science, 1987).

- ***Emission factor***

No emission factors were established.

- ***Activity data***

No activity data were calculated.

3.2.4. Agriculture

3.2.4.1. Field burning of agricultural residues (4.F.)

3.2.4.1.a. Rice Straw, Rice Chaff & Straw of Wheat, Barley, Oats and Rye (4.F.1.: CO)

- ***Methodology for Estimating Emissions***

CO emissions from the specified sources were calculated by using Japan's own Methodology for Estimating Emissions shown below:

Calculation of CO emission from burning of rice straw, chaff, and wheat straw

CO emission from burning of rice and wheat straw and chaff ［t-CO］

$=\Sigma_{\text{rice straw, wheat straw, chaff}}$ (amount of rice or wheat straw or chaff burnt ［t］

× carbon content (dry weight) × percentage of carbon released as CO

× mol ratio of CO and CO_2 in emitted gases)

- ***Emission factors***

Emission factors were established for each parameter based on the measured data available in Japan.

Table 17 Carbon content of rice/wheat straw and chaff

	Carbon content	Note
Rice straw	0.356	Adopted the median value between 0.369[a] and 0.342[b].
Chaff	0.344	Value measured by Bando et al.[a]
Wheat straw	0.356	Assumed to be the same as for rice straw

Source *a: Bando, Sakamaki, Moritomi, and Suzuki, "Study of analysis of emissions from biomass burning" (from the 1991 Report on Studies on Comprehensive Promotion Cost of Environmental Studies (National Institute of Environmental Studies, 1992))*

b: Yoshinori Miura and Tadanori Kanno, "Emissions of trace gases (CO_2, CO, CH_4, and N_2O) resulting from rice straw burning", Soil Sci. Plant Nutr., 43(4),849–854, 1997

Table 18 Percentage of carbon emitted as CO from rice and wheat straw and chaff

	Percentage of carbon emitted as CO	Note
Rice straw	0.684	Adopted the median value between 0.8[a] and 0.567[b].
Chaff	0.8	Value measured by Bando et al.[a]
Wheat straw	0.684	Assumed to be the same as for rice straw

Source *a: Bando, Sakamaki, Moritomi, and Suzuki, "Study of analysis of emissions from biomass burning" (from the 1991 Report on Studies on Comprehensive Promotion Cost of Environmental Studies (National Institute of Environmental Studies, 1992))*

b: Yoshinori Miura and Tadanori Kanno, "Emissions of trace gases (CO_2, CO, CH_4, and N_2O) resulting from rice straw burning", Soil Sci. Plant Nutr., 43(4),849–854, 1997

Table 19 Mol ratio of CO and CO2 in gases emitted from burning rice and wheat straw and chaff

	Mol ratio of CO and CO_2 in emitted gas	Note
Rice straw	0.219	Adopted the median value between values by a and b.
Chaff	0.255	Value measured by Bando et al.[a]
Wheat straw	0.219	Assumed to be the same as for rice straw

Source *a: Bando, Sakamaki, Moritomi, and Suzuki, "Study of analysis of emissions from biomass burning" (from the 1991 Report on Studies on Comprehensive Promotion Cost of Environmental Studies (National Institute of Environmental Studies, 1992))*

b: Yoshinori Miura and Tadanori Kanno, "Emissions of trace gases (CO_2, CO, CH_4, and N_2O) resulting from rice straw burning", Soil Sci. Plant Nutr., 43(4),849–854, 1997

• *Activity data*

○ Rice straw and chaff

Data from surveys by the Ministry of Agriculture, Forestry and Fisheries ("MAFF") were used for the amount of the rice straw and chaff burnt.

○ Wheat straw

The amount of wheat straw burnt was calculated by multiplying the wheat yield shown in the *Crop Statistics* (MAFF) by the percentage of rice straw burnt in proportion to the rice yield (*Crop Statistics*, MAFF).

3.2.5. Wastes

3.2.5.1. Waste incineration (6.C.)

3.2.5.1.a. Municipal Solid Waste Incineration (6.C.–)

- ***Methodology for Estimating Emissions***

The NO_x, CO, NMVOC, and SO_2 emissions from the specified sources were calculated by multiplying the incineration amount of MSW in each incinerator type by Japan’s own emission factors.

- ***Emission factors***

○ NO_X, SO_2

Emission factors were established for each incinerator type by using the emission volume and volume of treated waste identified in the *MAP Survey*. (The categories of incinerator types included: [1301: Waste incinerator (municipal waste; continuous system)] and [1302: Waste incinerator (municipal waste; batch system)]). The incineration material was [53: Municipal waste].) It should be noted that while the *MAP Survey* classified the incinerators into two classes (Continuous and Batch), this report classifies incinerators into three classes (“Continuous”, “Semi-continuous”, and “Batch”) by dividing the Continuous system and assigning those which operated for less than 3,000 hours to the “Semi-continuous” class, so as to harmonize with the statistical data by the Ministry of Heath, Labor and Welfare.

Table 20 NO_x and SO_2 emission factors for municipal waste incineration by facility type

Gas	Furnace Type	Unit	1990	1995	2000	2002	2003
Nox	Continuous Incinerator	gNOx/t	1,238	1,213	1,127	1,127	1,127
	Semi-Continuous Incinerator	gNOx/t	1,055	1,226	1,226	1,226	1,226
	Batch type Incinerator	gNOx/t	1,137	1,918	1,850	1,850	1,850
SO2	Continuous Incinerator	gSO2/t	555	539	361	361	361
	Semi-Continuous Incinerator	gSO2/t	627	1,141	712	712	712
	Batch type Incinerator	gSO2/t	1,073	1,625	1,714	1,714	1,714

* The data for 2000 were used for 2001 and subsequent years.

Source: Research of Air Pollutant Emissions from Stationary Sources (Ministry of the Environment)

○ CO

Based on the emission factors for individual facilities summarized in the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996) as well as other reports, the emission factors were established for each incinerator class. It should be noted that while the Atmospheric Environment Society report subdivided the facilities by furnace type (e.g., stoker, fluidized bed, etc.), this report determined the emission factors for three classes of “Continuous”, “Semi-continuous” and “Batch” by weighting the average of incinerated volume for each furnace so as to harmonize with the statistical data by the Ministry of Heath, Labor and Welfare.

Table 21 CO emission factors for municipal waste incineration by facility type

Gas	Furnace Type	Unit	1990	1995	2000	2002	2003
CO	Continuous Incinerator	gCO/t	561	561	566	566	566
	Semi-Continuous Incinerator	gCO/t	895	895	945	945	945
	Batch type Incinerator	gCO/t	7,182	7,182	7,264	7,264	7,264

* The data for 2000 were used for 2001 and subsequent years.

Source: Reports on Greenhouse gas emissions estimation methodology (Japan Sociality Atmospheric Environment, 1996), and others.

○ NMVOC

NMVOC emission factors were established by multiplying the CH_4 emission factors for each furnace type per fuel type by “NMVOC/CH_4”, the emission ratio for fuel type. The ratio was determined by using the reference material by Japan Environmental Sanitation Center and Institute of Behavioral Science, which estimated CH_4 and NMVOC emissions per unit calorific value.

Table 22 NMVOC emission factors for municipal waste incineration by facility type

Gas	Furnace Type	Unit	1990	1995	2000	2002	2003
NMVOC	Continuous Incinerator	gNMVOC/t	0.011	0.011	0.008	0.008	0.008
	Semi-Continuous Incinerator	gNMVOC/t	6.2	6.2	6.9	6.9	6.9
	Batch type Incinerator	gNMVOC/t	6.8	6.8	7.1	7.1	7.1

* The data for 2000 were used for 2001 and subsequent years.

Source: Report on Screening Survey Regarding Measures to Counter Global Warming (Japan Environmental Sanitation Center, 1989)

Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions (Institute of Behavioral Science, 1984)

- ***Activity data***

The activity data used was the incineration volume for each facility type as calculated by multiplying the incineration volume of municipal waste by the incineration rate for each facility type. The incineration volume data were extracted from the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)* by the Waste Management and Recycling Department of the Minister’s Secretariat, the Ministry of the Environment. The incineration rate was calculated in the *Waste Treatment in Japan* published by the Waste Management and Recycling Department of the Minister’s Secretariat, the Ministry of the Environment.

3.2.5.1.b. Industrial Wastes Incineration (6.C.–)

- ***Methodology for Estimating Emissions***

NO_x, CO, NMVOC, and SO_2 emissions from the specified sources were calculated by multiplying the incineration amount of industrial waste for each waste type by Japan’s own emission factors.

- ***Emission factors***

○ NO_X, SO_2

An emission factor was established for each type of industrial waste using the emission volume and volume of treated industrial waste identified by the *MAP Survey*. The categories of incinerator types included: [1303: Waste incinerator (industrial waste; continuous system)] and [1304: Waste incinerator (industrial waste; batch system)]. The incinerator fuel covered the categories [23: Fuel Wood] and [54: Industrial waste]). Five types of industrial waste were covered: [Waste paper], [Waste Wood], [Sludge], [Waste Oil], and [Waste Plastics]. The category [23: Fuel Wood] was applied to the Waste Paper and Waste Wood, and [54: Industrial waste] was applied to the Sludge, Waste Oil and Waste Plastics. The mixed burning of multiple wastes was excluded from the assignment of emission factors.

Table 23 NO_x and SO_2 emission factors for industrial waste by facility type

Gas	Type of waste	Unit	1990	1995	2000	2002	2003
Nox	Waste Paper, Waste Wood	gNOx/t	1,545	1,312	5,828	5,828	5,828
	Sludge	gNOx/t	999	1,158	1,415	1,415	1,415
	Waste Oil	gNOx/t	999	1,158	1,415	1,415	1,415
	Waste Plastics	gNOx/t	999	1,158	1,415	1,415	1,415
SO2	Waste Paper, Waste Wood	gSO2/t	1,528	1,274	2,118	2,118	2,118
	Sludge	gSO2/t	1,179	1,882	1,352	1,352	1,352
	Waste Oil	gSO2/t	1,179	1,882	1,352	1,352	1,352
	Waste Plastics	gSO2/t	1,179	1,882	1,352	1,352	1,352

* The data for 2000 were used for 2001 and subsequent years.

Source: Research of Air Pollutant Emissions from Stationary Sources (Ministry of the Environment)

○ CO

Based on the emission factors for individual facilities summarized in the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996) as well as other reports, an emission factor was established for each type of industrial waste. Five types of industrial waste were covered: [Waste paper], [Waste Wood], [Sludge], [Waste Oil], and [Waste plastics]. Because there is no example of a survey for Waste Paper, the emission factor for Waste Wood was used for Waste Paper. The mixed burning of multiple wastes was excluded from the emission factor.

Table 24 CO emission factors for industrial waste incinerators by operation type

Gas	Type of waste	Unit	1990	1995	2000	2002	2003
CO	Waste Paper, Waste Wood	gCO/t	1,227	1,227	1,227	1,227	1,227
	Waste Oil	gCO/t	652	652	652	652	652
	Waste Plastics	gCO/t	1,344	1,344	1,344	1,344	1,344
	Sludge	gCO/t	3,798	3,798	3,798	3,798	3,798

* The data for 2000 were used for 2001 and subsequent years.

Source: Reports on Greenhouse gas emissions estimation methodology (Japan Sociality Atmospheric Environment, 1996) and others

○ NMVOC

NMVOC emission factors were established by multiplying the CH_4 emission factors for each furnace type per fuel type by “NMVOC/CH_4”, the emission ratio for fuel type. The ratio was determined by using the reference materials by Japan Environmental Sanitation Center and Institute of Behavioral Science, which estimated CH_4 and NMVOC emissions per unit calorific value.

Table 25 NMVOC emission factors for industrial waste incineration by facility type

Gas	Type of waste	Unit	1990	1995	2000	2002	2003
NMVOC	Waste Paper, Waste Wood	gNMVOC/t	0.00	0.00	0.00	0.00	0.00
	Waste Oil	gNMVOC/t	0.06	0.06	0.06	0.06	0.06
	Waste Plastics	gNMVOC/t	0.0	0.0	0.0	0.0	0.0
	Sludge	gNMVOC/t	1.1	1.1	1.1	1.1	1.1

* 2001 values were used for 2002 and subsequent years, as the statistics were discontinued.

Source*: Report on Screening Survey Regarding Measures to Counter Global Warming (Japan Environmental Sanitation Center, 1989)*

Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions (Institute of Behavioral Science, 1984)

- ***Activity data***

The activity data used the incineration volume data for each type of waste extracted from the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)* and the *Waste Treatment in Japan* published by the Waste Management and Recycling Department of the Minister’s Secretariat, the Ministry of the Environment.

3.2.6. Other sectors

3.2.6.1. Smoking (7.–: CO)

- ***Methodology for Estimating Emissions***

CO emissions were calculated by multiplying the volume of cigarette sales by Japan’s own emission factor. (See “7-2005.xls” for details.)

- ***Emission factor***

The emission factor (0.055 [g-CO/cigarette]) was provided by Japan Tobacco Inc.

- ***Activity data***

The volume of cigarette sales published on Tobacco Institute of Japan website (http://www.tioj.or.jp/) was used for activity data.

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Annex 4. CO_2 Reference Approach and Comparison with Sectoral Approach, and Relevant Information on the National Energy Balance

This chapter explains a comparison between reference approach and sectoral approach in accordance with the UNFCCC Reporting Guidelines on Annual Inventories (FCCC/CP/2002/8, paragraph 31).

4.1. Difference in Energy Consumption

As shown in Table 1, fluctuations of difference of energy consumption between the reference approach and the sectoral approach during 1990-2003 ranges between -1.17% and 2.46%. It is relatively low compared to the inventories from other countries.

The difference can be explained by " Statistical Discrepancy", which describes the difference between input and output of fuel in the Energy Balance Table (*General Energy Statistics*) used for the preparation of inventories.

The average ratio of difference in the gaseous fuel consumption during 1990-2003 is 5.33%. It is the highest ratio among all fuel types, and it is mainly attributed to the fact that gaseous fuels include town gas produced from liquid fuels (kerosene, refinery gas, etc.), solid fuels (blast furnace gas etc.), and gaseous fuels (LNG etc.).

Table 1 Comparison of Energy Consumption

[TJ]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Reference Approach														
Liquid fuels	9.87	9.57	9.95	9.79	10.34	10.26	10.12	9.84	9.41	9.43	9.45	8.94	9.01	9.03
Solid fuels	3.31	3.37	3.30	3.33	3.55	3.66	3.71	3.85	3.65	3.92	4.11	4.14	4.39	4.54
Gaseous fuels	2.05	2.17	2.21	2.26	2.40	2.46	2.62	2.70	2.80	2.91	3.07	3.06	3.11	3.30
Total RA	**15.23**	**15.12**	**15.46**	**15.38**	**16.29**	**16.37**	**16.44**	**16.39**	**15.87**	**16.26**	**16.63**	**16.14**	**16.51**	**16.87**
Sectoral Approach														
Liquid fuels	9.48	9.59	9.79	9.53	10.04	10.04	10.02	9.74	9.45	9.57	9.37	9.06	9.20	9.05
Solid fuels	3.41	3.33	3.34	3.42	3.58	3.71	3.90	4.13	3.84	4.01	4.17	4.17	4.41	4.60
Gaseous fuels	2.17	2.32	2.34	2.39	2.53	2.61	2.73	2.85	2.91	3.08	3.20	3.19	3.30	3.43
Total	**15.06**	**15.24**	**15.48**	**15.34**	**16.14**	**16.36**	**16.65**	**16.72**	**16.20**	**16.66**	**16.75**	**16.42**	**16.91**	**17.08**
Difference (%)														
Liquid fuels	-3.96%	0.22%	-1.66%	-2.69%	-2.91%	-2.10%	-1.02%	-1.04%	0.36%	1.52%	-0.78%	1.30%	2.13%	0.19%
Solid fuels	2.97%	-1.22%	1.35%	2.74%	0.67%	1.37%	5.13%	7.21%	5.21%	2.21%	1.54%	0.77%	0.27%	1.39%
Gaseous fuels	5.56%	6.89%	6.10%	6.09%	5.33%	6.11%	4.52%	5.41%	4.08%	5.84%	4.25%	4.30%	6.25%	3.93%
Total	**-1.17%**	**0.85%**	**0.09%**	**-0.23%**	**-0.92%**	**-0.09%**	**1.25%**	**1.96%**	**2.13%**	**2.46%**	**0.72%**	**1.73%**	**2.41%**	**1.25%**

4.2. Difference in CO_2 Emissions

As shown in Table 2, fluctuations of a difference of CO_2 emissions between the reference approach and the sectoral approach during 1990-2003 ranges between -1.44% and 1.80%. It is relatively low compared to the inventories from other countries.

This difference can be explained by " Statistical Discrepancy" in the Energy Balance Table (*General Energy Statistics*) as for the difference in energy consumption.

The average ratio of the difference in the gaseous fuel consumption during 1990-2003 is

5.92%. It is the highest ratio among all fuel types, and it is mainly attributed to the fact that gaseous fuels include town gas produced from liquid fuels (kerosene, refinery gas, etc.), solid fuels (blast furnace gas etc.) and gaseous fuels (LNG etc.).

Table 2 Comparison of CO_2 Emissions

[Tg CO_2]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Reference Approach														
Liquid fuels	671.4	650.6	677.1	663.3	700.8	697.1	688.1	669.2	640.5	642.1	643.6	609.1	613.6	615.5
Solid fuels	290.9	295.6	289.7	292.2	312.5	321.5	326.6	339.6	322.3	346.2	363.8	366.6	389.2	402.1
Gaseous fuels	101.4	107.3	109.1	111.5	118.5	121.5	129.2	133.4	138.2	143.9	151.5	151.2	153.5	163.0
Total RA	**1,064**	**1,053**	**1,076**	**1,067**	**1,132**	**1,140**	**1,144**	**1,142**	**1,101**	**1,132**	**1,159**	**1,127**	**1,156**	**1,181**
Sectoral Approach														
Liquid fuels	642.1	649.0	662.3	644.0	679.0	677.6	675.1	656.1	636.4	644.9	632.0	609.7	619.9	610.1
Solid fuels	298.3	290.9	292.5	299.1	313.6	324.8	342.3	363.5	337.8	354.5	370.6	370.8	391.8	409.3
Gaseous fuels	107.9	115.5	116.6	119.2	125.6	129.8	135.9	141.4	144.7	153.2	158.7	158.5	163.9	168.6
Total	**1,048**	**1,055**	**1,071**	**1,062**	**1,118**	**1,132**	**1,153**	**1,161**	**1,119**	**1,153**	**1,161**	**1,139**	**1,176**	**1,188**
Difference (%)														
Liquid fuels	-4.35%	-0.26%	-2.19%	-2.90%	-3.11%	-2.79%	-1.88%	-1.97%	-0.64%	0.43%	-1.80%	0.11%	1.03%	-0.86%
Solid fuels	2.55%	-1.59%	0.96%	2.36%	0.34%	1.03%	4.82%	7.05%	4.82%	2.41%	1.87%	1.14%	0.65%	1.79%
Gaseous fuels	6.40%	7.71%	6.90%	6.88%	6.05%	6.85%	5.21%	6.05%	4.67%	6.42%	4.77%	4.82%	6.75%	3.46%
Total	**-1.44%**	**0.18%**	**-0.42%**	**-0.44%**	**-1.20%**	**-0.68%**	**0.83%**	**1.65%**	**1.62%**	**1.80%**	**0.21%**	**1.08%**	**1.66%**	**0.64%**

4.3. Comparison between Differences in Energy Consumption and that of CO_2 Emissions

The difference in energy consumption and the difference in CO_2 emissions generally show a similar tendency for their trends.

In the all year except 1992, balance (plus or minus) of differences of energy consumption and CO_2 emissions is the same. Only in 1992, these balances are not consistent, and the cause of this inconsistency needs to be identified.

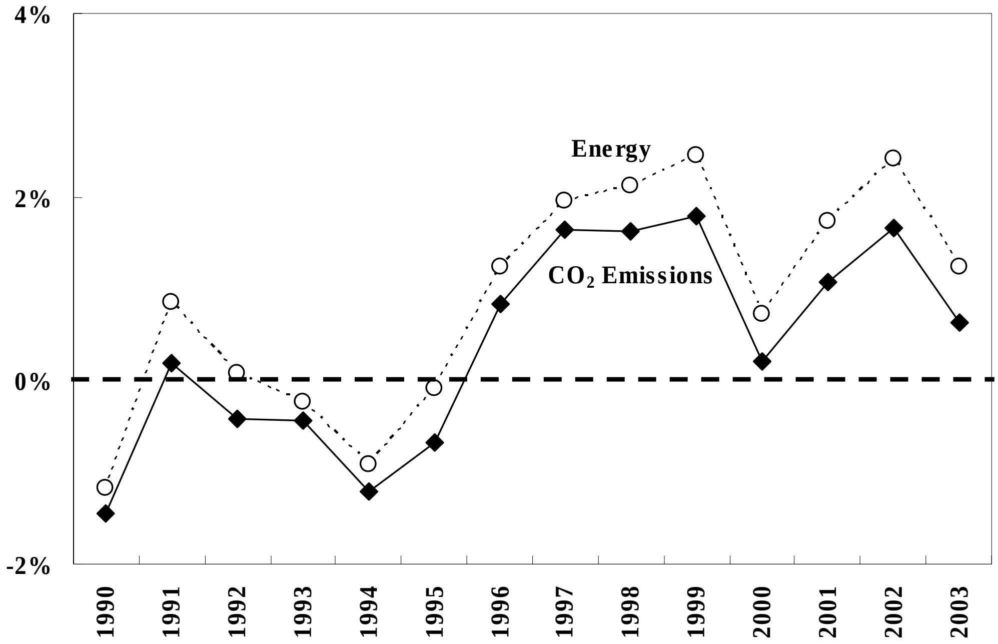

Figure 1 Trends in Difference of Energy Consumption and CO_2 Emissions

Annex 5. Assessment of Completeness and (Potential) Sources and Sinks of Greenhouse Gas Emissions and Removals Excluded

5.1. Assessment of Completeness

Current inventory is submitted in accordance with the common reporting format (CRF), which requires entering emission data or a notation key[1] such as “NO”, “NE”, or “NA” for all sources. This chapter presents the definition of notation keys and decision trees for the application of them, both of which are based on the UNFCCC reporting Guidelines (FCCC/CP/1999/7 or FCCC/CP/2002/8) and the results of Committee for Greenhouse Gases Emissions Estimation Methods in 2002.

This chapter also reports source categories which have not been estimated because i) applicability of IPCC default values is not assured, ii) default methodologies and default values are not provided, iii) activity data is not available, iv) actual condition of GHG emissions or removals is not understood clearly.

5.2. Definition of Notation Keys

When reviewing the appropriateness of applying notation keys shown in the UNFCCC reporting guideline, it is necessary to establish a common concept for an application of these keys for each sector, but unclear points described in Table 1 are found as below regarding the use of the notation keys.

- The explanation of “NO” in the UNFCCC reporting guidelines can be taken that “NO” may be applied to both situations when there are no emissions or removals because the activities do not exist in Japan, and when emissions or removals do not occur in principle although the activities do exist.

- The first sentence of the “NA” explanation in the UNFCCC reporting guidelines seems to imply that “NA” may be applied to both situations as for “NO”. However, because the second sentence states that “If categories... are shaded, they do not need to be filled in”, it also seems to mean that “NA” is applied only when the activities exist but there are no emissions or removals in principle.

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[1] These were called "standard indicators" in FCCC/CP/1999/7, but were changed to "notation keys" in FCCC/CP/2002/8.

Table 1 Notation keys indicated in UNFCCC reporting guidelines

Notation Key	Explanation
NO (Not Occurring)	"NO" (not occurring) for emissions by sources and removals by sinks of greenhouse gases that do not occur for a particular gas or source/sink category within a country;
NE (Not Estimated)	"NE" (not estimated) for existing emissions by sources and removals by sinks of greenhouse gases which have not been estimated. Where "NE" is used in an inventory for emissions or removals of CO_2, CH_4, N_2O, HFCs, PFCs or SF_6, the Party should indicate why emissions could not be estimated, using the completeness table of the common reporting format;
NA (Not Applicable)	"NA" (not applicable) for activities in a given source/sink category that do not result in emissions or removals of a specific gas. If categories in the common reporting format for which "NA" is applicable are shaded, they do not need to be filled in;
IE (Included Elsewhere)	"IE" (included elsewhere) for emissions by sources and removals by sinks of greenhouse gases estimated but included elsewhere in the inventory instead of the expected source/sink category. Where "IE" is used in an inventory, the Party should indicate, using the completeness table of the common reporting format, where in the inventory the emissions or removals from the displaced source/sink category have been included and the Party should give the reasons for this inclusion deviating from the expected category;
C (Confidential)	"C" (confidential) for emissions by sources and removals by sinks of greenhouse gases which could lead to the disclosure of confidential information, given the provisions of paragraph 19 above; (para 19: Emissions and removals should be reported on the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information.

Source : UNFCCC reporting guidelines on annual inventories (FCCC/CP/1999/7)

* The notation key "0" was deleted at COP8 from the revised UNFCCC reporting guidelines (FCCC/CP/2002/8).

In the Committee for Greenhouse Gases Emissions Estimation Methods in 2002, the meanings of the notation keys are defined based on the following policy (as shown in Table 2).

- It was decided that "NA" is applied when the activity does exist in Japan, but in principle there are no GHG emissions or removals, while "NO" will apply when the activity itself does not exist and there are no emissions or removals.

If the UNFCCC reporting guidelines are revised in future, the review of the definitions of notation keys and the way to fill them in CRF will be conducted.

Table 2 Definition of Notation Keys

Notation Key	Definition
NO (Not Occurring)	Used when there are no activities that are linked to emissions or removals for a certain source.
NE (Not Estimated)	Used when the emissions or removals of a certain source cannot be estimated.
NA (Not Applicable)	Used when an activity associated with a certain source does exist, but in principle it accompanies no occurrence of specific GHG emissions or removals. “NA” is not applied when there are no GHG emissions or removals because the GHGs in raw materials have been removed.
IE (Included Elsewhere)	IE is used when an emissions or removals are already included in other sources. For assuring the completeness of CRF, the sources in which the emissions or removals are included and the reasons for including it elsewhere are to be recorded in the table.
C (Confidential)	Used for confidential information relating to business or the military. However, in consideration of transparency in calculation of emissions or removals, information will be reported to the extent that it does not hinder business or other operations (for example, reporting the aggregated total of several substances).

5.3. Decision Tree for Application of Notation Keys

Decision tree for the application of notation keys, based on UNFCCC reporting Guidelines (FCCC/CP/1999/7 or FCCC/CP/2002/8) and the results of Committee for Greenhouse Gases Emissions Estimation Methods in 2002, is shown in Figure 1.

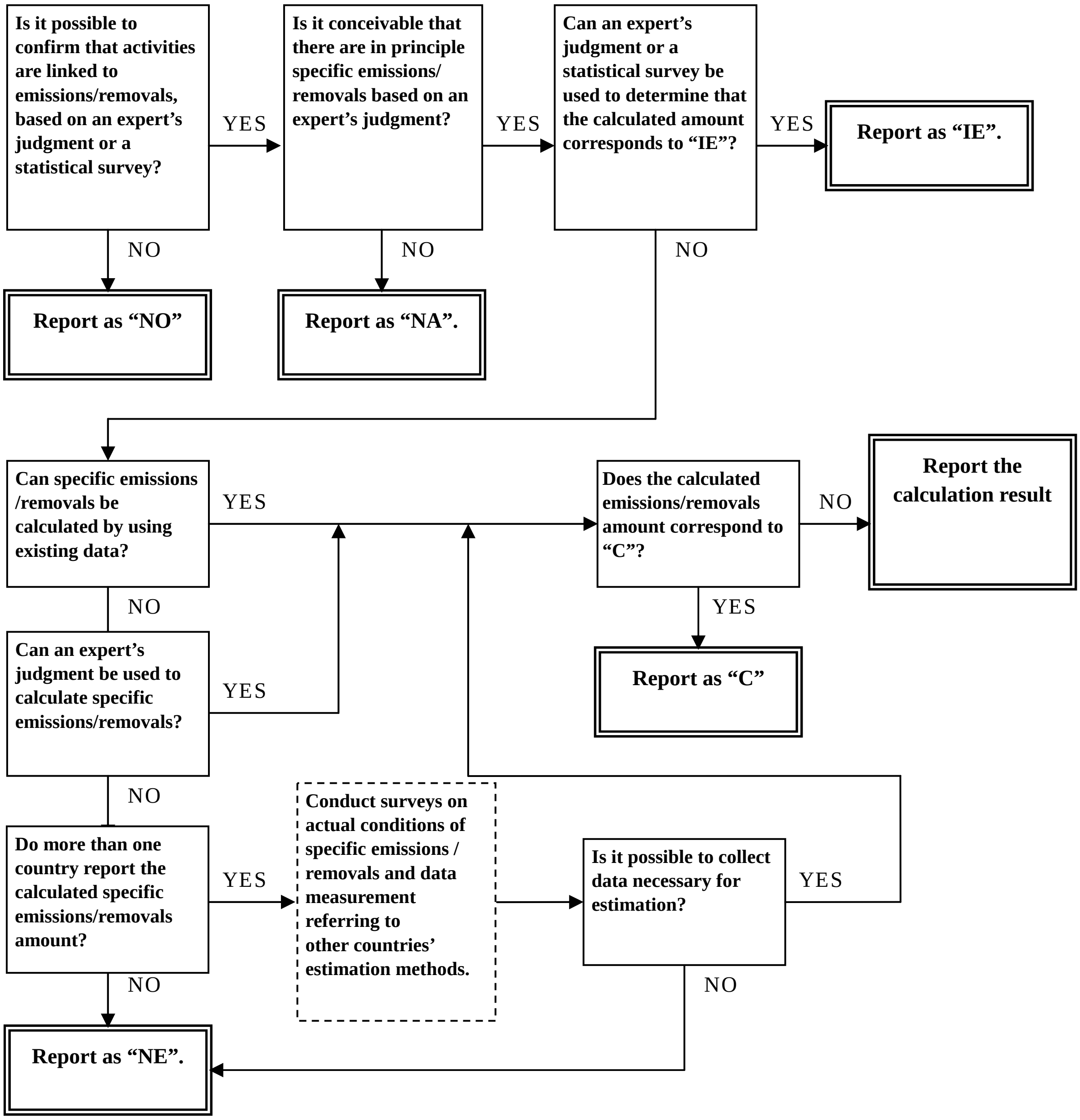

Figure 1 Decision tree for application of notation keys

5.4. Source categories not estimated in Japan’s inventory

Source categories not estimated in Japan’s inventory are listed below. It should be noted that emissions of HFCs, PFCs and SF_6 in the period from 1990 to 1994 and emissions and removals by Land-use change and forestry sector after 1995 have not been estimated (NE).

Code	Sector	Source category				Gas
1	Energy	Fuel Combustion	Mobile Combustion	Civil Aviation	Aviation Gasoline	CH_4
2	Energy	Fuel Combustion	Mobile Combustion	Civil Aviation	Aviation Gasoline	N_2O
3	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Natural Gas	CH_4
4	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Natural Gas	N_2O
5	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Other Fuels (Methanol)	CH_4
6	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Other Fuels (Methanol)	N_2O
7	Energy	Fuel Combustion	Mobile Combustion	Railways	Solid Fuels	CH_4
8	Energy	Fuel Combustion	Mobile Combustion	Railways	Solid Fuels	N_2O
9	Energy	Fuel Combustion	Mobile Combustion	Railways	Other Fuels	CH_4
10	Energy	Fuel Combustion	Mobile Combustion	Railways	Other Fuels	N_2O
11	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	CO_2
12	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	CH_4
13	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	N_2O
14	Energy	Fugitive Emissions from Fuels	Solid Fuels	Coal Mining		CO_2
15	Energy	Fugitive Emissions from Fuels	Solid Fuels	Coal Mining		N_2O
16	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		CO_2
17	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		CH_4
18	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		N_2O
19	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Refining/Storage	CO_2
20	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Distribution of Oil Products	CO_2
21	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Distribution of Oil Products	CH_4
22	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(at industrial plants and power station)	CO_2
23	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(at industrial plants and power station)	CH_4
24	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(in residential and commercial sectors)	CO_2
25	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(in residential and commercial sectors)	CH_4
26	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Venting	Gas	CO_2
27	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Venting	Gas	CH_4
28	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	CO_2
29	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	CH_4
30	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	N_2O
31	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	CO_2
32	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	CH_4
33	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	N_2O
34	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	CO_2
35	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	CH_4
36	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	N_2O
37	Energy	International Bunkers	Marine・Diesel Oil			CO_2
38	Energy	International Bunkers	Marine・Diesel Oil			CH_4
39	Energy	International Bunkers	Marine・Diesel Oil			N_2O
40	Energy	International Bunkers	Marine・Heavy Oil			CO_2
41	Energy	International Bunkers	Marine・Heavy Oil			CH_4
42	Energy	International Bunkers	Marine・Heavy Oil			N_2O
43	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Production		CO_2
44	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Use（Including desulfurization equipment）		CO_2
45	Industrial Processes	Mineral Products	Asphalt roofing			CO_2
46	Industrial Processes	Mineral Products	Road Paving with Asphalt			CO_2
47	Industrial Processes	Chemical Industry	Ammonia Production			CH_4
48	Industrial Processes	Chemical Industry	Carbide Production	Silicon Carbide		CO_2
49	Industrial Processes	Chemical Industry	Carbide Production	Calcium Carbide		CO_2
50	Industrial Processes	Chemical Industry	Carbide Production	Calcium Carbide		CH_4

Code	Sector	Source category				Gas
51	Industrial Processes	Chemical Industry	Other	Ethylene		N_2O
52	Industrial Processes	Chemical Industry	Other	Coke		CO_2
53	Industrial Processes	Chemical Industry	Other	Coke		N_2O
54	Industrial Processes	Metal Production	Iron and Steel Production	Coke		CO_2
55	Industrial Processes	Metal Production	Aluminium Production			CH_4
56	Industrial Processes	Metal Production	Aluminium Production			PFCs
57	Industrial Processes	Metal Production	SF_6 Used in Aluminium and Magnesium Foundries	Aluminium Foundries		SF_6
58	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Commercial Refrigeration	Manufacturing/Stocks/Disposal	PFCs
59	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Automatic Vender Machine	Manufacturing/Stocks/Disposal	PFCs
60	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing/Stocks/Disposal	HFCs
61	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing/Stocks/Disposal	PFCs
62	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Industrial Refrigeration	Manufacturing/Stocks/Disposal	PFCs
63	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Stationary Air-Conditioning	Manufacturing/Stocks/Disposal	PFCs
64	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Mobile Air-Conditioning	Manufacturing/Stocks/Disposal	PFCs
65	Industrial Processes	Consumption of Halocarbons and SF_6	Foam Blowing	Hard Form	Stocks and Disposal of Urethane Foam	HFCs
66	Industrial Processes	Consumption of Halocarbons and SF_6	Foam Blowing	Hard Form	Stocks and Disposal of Polystyrene Foam	HFCs
67	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	HFCs
68	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	PFCs
69	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	SF_6
70	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Aerosols	Manufacturing/Disposal	HFCs
71	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Metered Dose Inhalers	Manufacturing/Stocks/Disposal	HFCs
72	Industrial Processes	Consumption of Halocarbons and SF_6	Solvents		Manufacturing/Stocks/Disposal	HFCs
73	Industrial Processes	Consumption of Halocarbons and SF_6	Solvents		Manufacturing/Disposal	PFCs
74	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	HFCs
75	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	PFCs
76	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	SF_6
77	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Disposal	HFCs
78	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	PFCs
79	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	SF_6
80	Solvent and Other Product Use	Degreasing and Dry-Cleaning				CO_2
81	Solvent and Other Product Use	Other	Fire Extinguishers			N_2O
82	Solvent and Other Product Use	Other	Other Use of N_2O			CO_2
83	Solvent and Other Product Use	Other	Other Use of N_2O			N_2O
84	Agriculture	Enteric Fermentation	Buffalo			CH_4
85	Agriculture	Enteric Fermentation	Camels and Llamas			CH_4
86	Agriculture	Enteric Fermentation	Mules and Asses			CH_4
87	Agriculture	Enteric Fermentation	Poultry			CH_4
88	Agriculture	Manure Management	Buffalo			CH_4
89	Agriculture	Manure Management	Camels and Llamas			CH_4
90	Agriculture	Manure Management	Mules and Asses			CH_4
91	Agriculture	Manure Management	Sheep, Goats & Horses			N_2O
92	Agriculture	Agricultural Soils	Direct Soil Emissions	Crop Residue		N_2O
93	Agriculture	Agricultural Soils	Direct Soil Emissions	Cultivation of Histosols		N_2O
94	Agriculture	Field Burning of Agricultural Residues	Other			CH_4
95	Agriculture	Field Burning of Agricultural Residues	Other			N_2O
96	Waste	Solid Waste Disposal on Land	Managed Waste Disposal on Land			CO_2
97	Waste	Solid Waste Disposal on Land	Unmanaged Waste Disposal Sites			CO_2
98	Waste	Solid Waste Disposal on Land	Unmanaged Waste Disposal Sites			CH_4
99	Waste	Wastewater Handling	Industrial Wastewater			N_2O

Annex 6. Additional information to be considered as part of the NIR submission or other useful reference information

6.1. Details on Inventory Compilation System and QA/QC plan

(Step numbers given below correspond to Figure 1-2.)

6.1.1. Review of previous inventories (Step 1)

Japan bases its considerations on further improvement areas identified during inventory reviews under the UNFCCC, on results of deliberations by the Committee for the Greenhouse Gases Emissions Estimation Methods, and on other needed corrections[1] discovered in the inventory compilation process, and incorporates these into its inventory. When this results in changes to the inventory, those changes are shown in the NIR to assure transparency ("Chapter 10 : Recalculations and Improvements").

QC activities in Step 1

Prepare a list of inventory corrections.

6.1.2. Expert review of previous inventories (Committee for the Greenhouse Gases Emissions Estimation Methods) (Step 2)

The Ministry of the Environment holds meetings of the Committee for the Greenhouse Gases Emissions Estimation Methods (below, "Committee") to deliberate on inventory estimation methods for each year and on issues requiring specialized assessment and deliberation. Japanese experts in a broad range of fields conduct the discussions (Table 1).

In addition to the incorporation of discussion results into the inventory, the documents used by the Committee for especially noteworthy matters are released as Annex of NIR which helps improve inventory completeness and transparency. Committee meetings have been held every year since 1999 in conjunction with advances in international negotiations and enhancement of the domestic regime through legislation.

The activities of the Committee are considered to be Tier 2 QA activities as stipulated in GPG2000 because (1) it has the participation of experts not directly involved in preparing the inventory, and (2) it conducts detailed, objective examinations of problems in all fields by establishing working groups and breakout groups.

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[1] GIO keeps a corrections list and records the information to address needed corrections discovered when working on the inventory.

Table 1 Overview of Committee for the Greenhouse Gases Emissions Estimation Methods

Implementing body	Ministry of the Environment
Meetings started	1999
Main purposes	・ Assessing and deliberating on methods to estimate the greenhouse gases emissions and removals from all emission sources ・ Assessing uncertainties of emission estimates ・ Examining QA/QC plans ・ Preparation of the inventory (common reporting format (CRF), national inventory report (NIR))
Regime	Created working groups that have crossover discussions of problems, and breakout groups that discuss field-specific issues, under the Committee for the Greenhouse Gases Emissions Estimation Methods (Figure 3).
Members	Experts from various fields (about 60 experts participated in the Committee meetings held between December 2001 and July 2002)

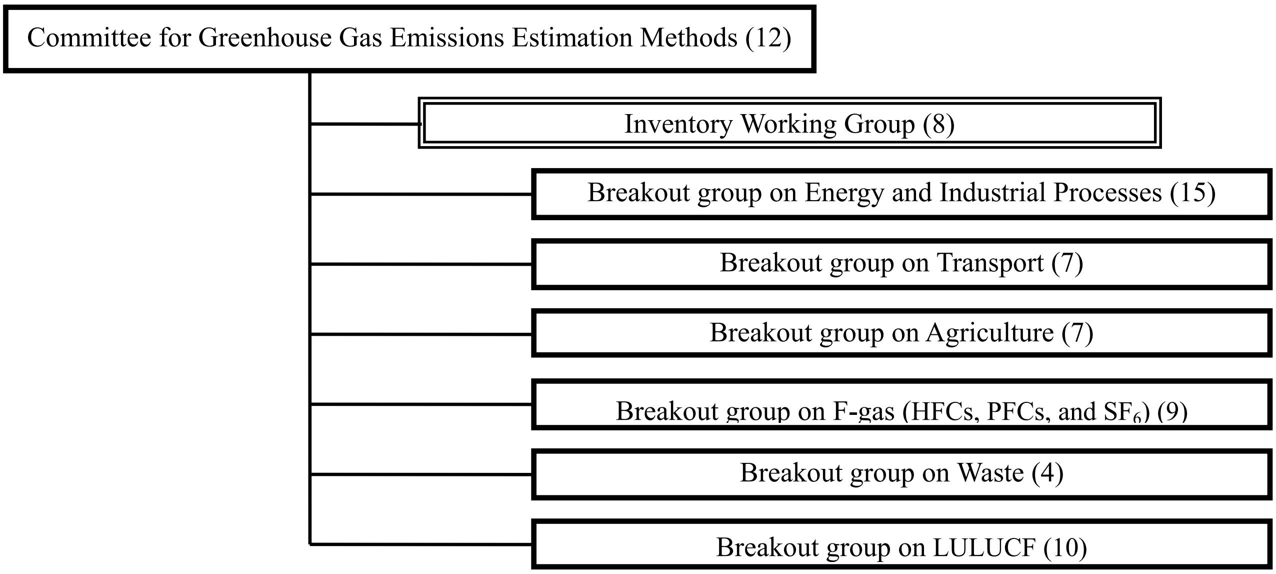


Figure 1 Organization of Committee for the Greenhouse Gases Emissions Estimation Methods (Numbers in parentheses indicate numbers of experts between December 2001 and July 2002)

QA activities

Discuss inventory quality to identify areas which can be improved, and how to improve them.

QC Activities in Step 2

Retain Committee documents and minutes.

6.1.3. Data Collection (Step 3)

Most statistics for preparing Japan's inventory are gathered from government sources available commercially. Data not found in these sources are obtained from government agencies and relevant organizations. Japan's data gathering process is described below.

6.1.3.1. Gathering Data from Government Statistics

1. GIO (Greenhouse Gas Inventory Office): Obtain government statistics needed to prepare inventory.
2. GIO: Make hard copies of pages containing data used, bind into prescribed files, and preserve. When making hard copies, marking pens or other implements are used to indicate the data used.

6.1.3.2. Gathering Data from Government Agencies and Relevant Organizations

1. GIO: Letters requesting data and files for entering them are prepared.
2. Ministry of the Environment, GIO: Data request letters and data input files are sent to government agencies and relevant organizations.
3. Government agencies and relevant organizations: The requested data are entered in the files and returned to the Ministry of the Environment or GIO.

QC Activities in Step 3

Government data obtained commercially and their hard copies are preserved.
Computer files into which data have been entered are preserved.

6.1.4. Compilation of Draft CRF (Including Key Category Analysis and Uncertainty Assessment) (Step 4)

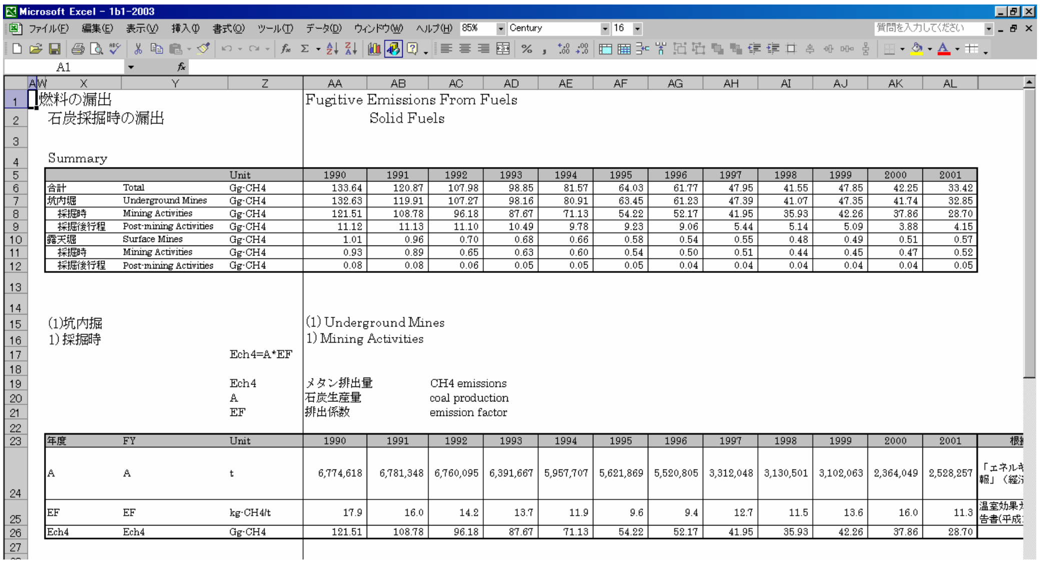
Based on the estimation equations for emission and removals, Japan carries out data entry and the estimation of emission and removals together by using estimation files having a linked structure. Key category analysis and uncertainty assessment are linked to emissions and removals estimation, and therefore are carried out nearly simultaneously with those estimation. Accordingly, data entry and estimation of emissions and removals are made into step 4 with key category analysis and uncertainty assessment, and explanations on all activities are provided.

6.1.4.1. Data Entry and Calculation of Emission and Removals

Japan makes estimation files consisting of activity data input files, emission factor input files, and background data files (files for estimating emissions and removals, including emission/removal estimation sheets and CRF link sheets; see Figures 2 and 3)[2]. Activity data input files and emission factor input files are linked to background data files, which are linked to CRF link files, which are linked to the CRF. The arrangement is structured so that when values are entered into the activity data input files and emission factor input files, the estimation of emissions and removals and updating of the CRF occur automatically (see Figure 4, and "Annex 9 : Hierarchical Structure of Japan's National GHG Inventory File System").

Because the estimation file structure is basically the same every year, the estimation files of any one year are based on copies of the previous year's files. But when estimation methods or other changes are made, other actions might be necessitated such as scrapping or merging files, or changing link structure.

In addition to estimation files, CRF link files and the CRF, Japan creates files that make reference to the emission/removal estimation sheets of background data files (verification files), and estimates the emissions and removals. Verification files are used to compute total emissions with a system and estimation method different from those of CRF link files or the CRF. For that reason, if the total emissions of the CRF and the verification files match, it is determined that there were no errors such as in data entry, inter-file links, or double counting of emission and removals.



燃料の漏出　Fugitive Emissions From Fuels

石炭採掘時の漏出　Solid Fuels

Summary

		Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
合計	Total	Gg-CH4	133.64	120.87	107.98	98.85	81.57	64.03	61.77	47.95	41.55	47.85	42.25	33.42
坑内堀	Underground Mines	Gg-CH4	132.63	119.91	107.27	98.16	80.91	63.45	61.23	47.39	41.07	47.35	41.74	32.85
採掘時	Mining Activities	Gg-CH4	121.51	108.78	96.18	87.67	71.13	54.22	52.17	41.95	35.93	42.26	37.86	28.70
採掘後行程	Post-mining Activities	Gg-CH4	11.12	11.13	11.10	10.49	9.78	9.23	9.06	5.44	5.14	5.09	3.88	4.15
露天堀	Surface Mines	Gg-CH4	1.01	0.96	0.70	0.68	0.66	0.58	0.54	0.55	0.48	0.49	0.51	0.57
採掘時	Mining Activities	Gg-CH4	0.93	0.89	0.65	0.63	0.60	0.54	0.50	0.51	0.44	0.45	0.47	0.52
採掘後行程	Post-mining Activities	Gg-CH4	0.08	0.08	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.05

(1)坑内掘　(1) Underground Mines

1) 採掘時　1) Mining Activities

Ech4=A*EF

Ech4　メタン排出量　CH4 emissions
A　石炭生産量　coal production
EF　排出係数　emission factor

年度	FY	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	根
A	A	t	6,774,618	6,781,348	6,760,095	6,391,667	5,957,707	5,621,869	5,520,805	3,312,048	3,130,501	3,102,063	2,364,049	2,528,257	「エネル 報」（経
EF	EF	kg-CH4/t	17.9	16.0	14.2	13.7	11.9	9.6	9.4	12.7	11.5	13.6	16.0	11.3	温室効果 告書(平成
Ech4	Ech4	Gg-CH4	121.51	108.78	96.18	87.67	71.13	54.22	52.17	41.95	35.93	42.26	37.86	28.70	

Figure 2 Example of a background data file (emission/removal estimation sheet) ("coal" in 1B1-2003.xls)

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[2] No emission coefficient input files are created for the agriculture sector due to the difficulty of separating the emission factor and activity amount.

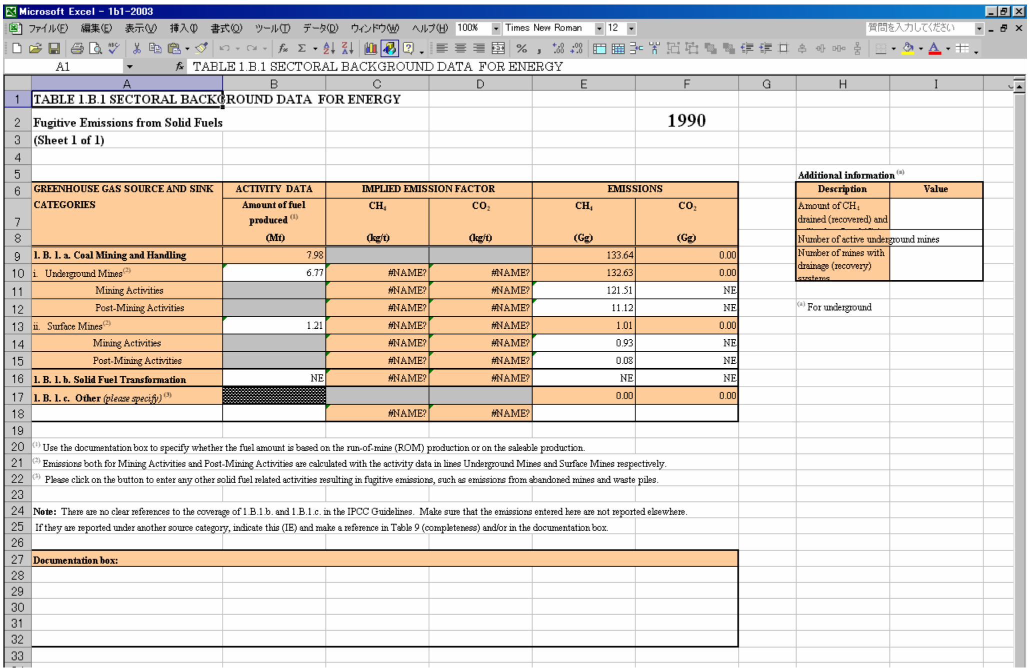


TABLE 1.B.1 SECTORAL BACKGROUND DATA FOR ENERGY

Fugitive Emissions from Solid Fuels **1990**

(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**ACTIVITY DATA**	**IMPLIED EMISSION FACTOR**		**EMISSIONS**	
	Amount of fuel produced [(1)]	**CH_4**	**CO_2**	**CH_4**	**CO_2**
	(Mt)	**(kg/t)**	**(kg/t)**	**(Gg)**	**(Gg)**
1. B. 1. a. Coal Mining and Handling	7.98			133.64	0.00
i. Underground Mines[(2)]	6.77	#NAME?	#NAME?	132.63	0.00
Mining Activities		#NAME?	#NAME?	121.51	NE
Post-Mining Activities		#NAME?	#NAME?	11.12	NE
ii. Surface Mines[(2)]	1.21	#NAME?	#NAME?	1.01	0.00
Mining Activities		#NAME?	#NAME?	0.93	NE
Post-Mining Activities		#NAME?	#NAME?	0.08	NE
1. B. 1. b. Solid Fuel Transformation	NE	#NAME?	#NAME?	NE	NE
1. B. 1. c. Other *(please specify)* [(3)]	▨			0.00	0.00
		#NAME?	#NAME?		

[(1)] Use the documentation box to specify whether the fuel amount is based on the run-of-mine (ROM) production or on the saleable production.

[(2)] Emissions both for Mining Activities and Post-Mining Activities are calculated with the activity data in lines Underground Mines and Surface Mines respectively.

[(3)] Please click on the button to enter any other solid fuel related activities resulting in fugitive emissions, such as emissions from abandoned mines and waste piles.

Note: There are no clear references to the coverage of 1.B.1.b. and 1.B.1.c. in the IPCC Guidelines. Make sure that the emissions entered here are not reported elsewhere.
If they are reported under another source category, indicate this (IE) and make a reference in Table 9 (completeness) and/or in the documentation box.

Documentation box:

Additional information [(a)]

Description	**Value**
Amount of CH_4 drained (recovered) and	
Number of active underground mines	
Number of mines with drainage (recovery) systems	

[(a)] For underground

Figure 3 Example of a background data file (CRF Link Sheet) ("CRF1990" in 1B1-2003.xls)

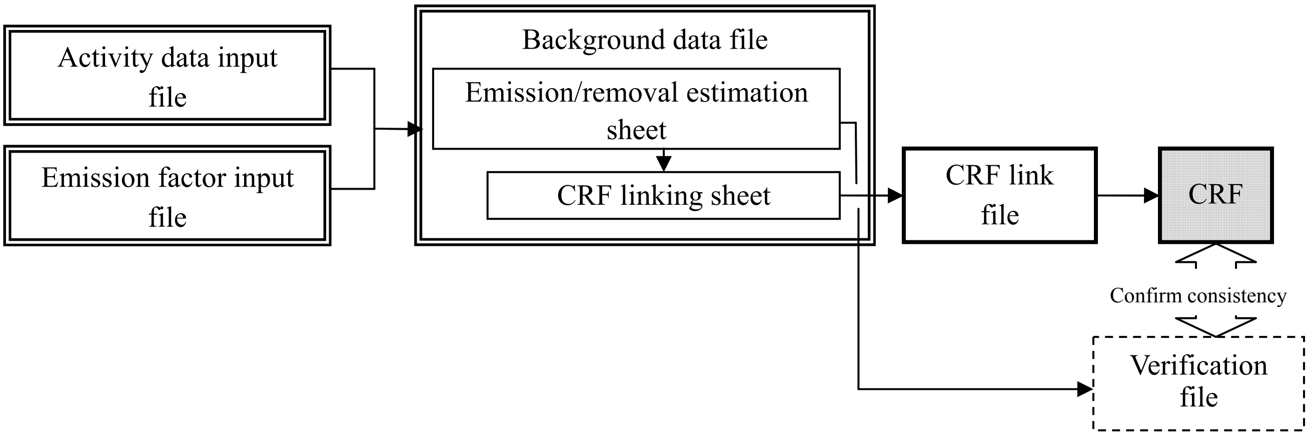


Figure 4 Structure of links among estimation File, CRF link file,

the CRF, and the verification File

QC Activities in Step 4 (Data entry and calculation of emission and removals)
Verification checks the accuracy of data entry, inter-file links,
and emission/removal calculations.

6.1.4.2. Key Category Analysis

In Japan, GIO performs key category analyses every year, and results are shown in NIR submitted every year to the UNFCCC secretariat (the results are found in "1.5 Brief Description of Key Categories" and "Annex 1 : Key categories").

Because the finalization of analysis results comes after that of emissions and removals, note that in actuality, key category analysis is also conducted after Step 5. If emission sources for which the Tier 1 calculation method is used are put among the key categories as a result of key category analysis performed after Step 5, the procedure calls for examining the estimation method for those emission sources when coming around to Step 1 again.

6.1.4.3. Uncertainty Assessment

In Japan, GIO performs an uncertainty assessment every year using the method shown in *GPG (2000)* (Tier 1). The assessment method and results are shown in the NIR submitted to the UNFCCC secretariat every year (the assessment method is in "Annex 7 Uncertainty Assessment Method" and the results are in "1.7 : General Uncertainty Evaluation, including Data on the Overall Uncertainty for the Inventory Totals" and "Annex 7 Uncertainty Assessment Method").

Because finalization of assessment results comes after that of emission and removals, note that in actuality, uncertainty assessment also occurs after Step 5.

6.1.5. Check the accuracy of Draft CRF (Step 5)

As a QC activity, after completion of Step 4, CRF electronic files (estimation files, CRF link files, CRF files) and the in-country documents that give calculated values for CRF emissions/removals are sent to the relevant government agencies to have them check the content. When data are secret, they are sent for checking only to the government agencies which submitted them.

QC Activities in Step 5

Checking the correctness of data entry
--What is checked
  Calculation files
--How check is performed
  Each government agency verifies that the statistics and data it has provided are properly entered into the calculation files.

Checking the correctness of calculated values for emission and removals
--What is checked
  Calculation files
--How check is performed
  Determine if emissions and absorption are correctly calculated in the CRF.

6.1.6. Compilation of Draft NIR (Step 6)

Japan has prepared an NIR every year since 2003. Since 2004, the structure set forth in Annex I of the UNFCCC reporting guidelines on the annual inventories (FCCC/SBSTA/2004/8) has been followed.

There are two stages of NIR preparation: (1) deciding the preparation policy and (2) writing the NIR. Specifically, in (1), the Ministry of the Environment and GIO decide on corrections to the text and additional documents after performing Step 1. In (2), because the report structure is the same every year, GIO starts with the previous year's NIR and prepares the new report by updating it with the latest data and making textual changes and additions.

QC Activities in Step 6

Prepare a list of inventory corrections. (Same as Step 1)

6.1.7. Check the accuracy of Draft NIR (Step 7)

As a QC activity, after completion of Step 6 the computer NIR files are sent to the relevant government agencies to have them confirm and correct the text.

QC Activities in Step 7

Confirm the correctness of the NIR text.

6.1.8. Submitting and Releasing the Inventory (Step 8)

Upon completion of the CRF and NIR, the inventory is submitted to the UNFCCC secretariat, and the electronic files (CRF files, estimation files, and NIR files, excluding secret data) are posted on the GIO website (http://www-gio.nies.go.jp/index-j.html).

6.1.9. Factor Analysis (Step 9)

GIO analyzes the factor of greenhouse gas emission changes for each sector (factor analysis), and prepares documents (factor analysis documents) on the results. These documents are posted on the Ministry of the Environment's website along with information on emission and removals.

Table 2 Factors used in Factor Analysis

Sector	Cause	Explanation
Industry	CO_2 emission intensity	Expressed as CO_2 emissions per unit energy consumed. An indicator energy conservation measures in the energy conversion sector, such power production, emission factor improvement in fuel conversion,
	Energy consumption intensity	Expressed as energy consumed per production index. An indicator of the extent to which energy-saving equipment has been installed in factories.
	Industrial structure	Expressed as production mix of manufacturing industries. It indicates changes in the industrial structure.
	Production index	Indicates changes in activity amount of industrial sector.
	Other	Includes correction for overlap between manufacturing and non-manufacturing industries.
Transport (passengers, freight)	CO_2 emission intensity	Expressed as CO_2 emissions per unit energy consumed. An indicator of energy conservation measures in the energy conversion sector, such as power production, etc.
	Energy consumption intensity	Expressed as energy consumed per amount of transport. Indicates improvements in fuel economy, transport efficiency, etc.
	Modal share	Expressed as the proportions of transport means in the passenger and freight sectors. Indicates changes in energy consumption structure such as modal shifts.
	Total passenger and freight transport amount	Indicates changes in activity amount of the transport sector.
Service, etc.	CO_2 emission intensity	Expressed as CO_2 emissions per unit energy consumed. An indicator of energy conservation measures in the energy conversion sector, such as power production, emission factor improvement in fuel conversion, etc.
	Energy consumption intensity	Expressed as energy consumption per unit commercial floor space. Indicates efficiency improvements in energy-consuming equipment, energy-saving activities by business, etc.
	Commercial floor space	Indicates changes in activity amount of services, etc.
Residential	CO_2 emission intensity	Expressed as CO_2 emissions per unit energy consumed. An indicator of energy conservation measures in the energy conversion sector, such as power production, etc.
	Energy consumption intensity	Expressed as energy consumption per number of households. Indicates efficiency improvements in energy-consuming appliances, energy-saving activities by citizens, etc.
	Number of households	Indicates changes in activity amount of residential sector.
	Winter climate	Indicates changes in kerosene consumption due to winter climate change.

6.1.10. Documentation, Archiving and Reporting

Japan documents the information needed to prepare its inventory, and as a rule keeps the documents in the GIO. Information considered especially important is released by appending it to the NIR. The following documents are archived.

○ Inventory correction lists (electronic files)

○ Committee documents and minutes (electronic files and hard copies)

○ Commercially available government statistics (hard copies)

○ Data input files used when collecting data (electronic files)

○ Verification files (electronic files)

○ Requested corrections to CRT and NIR drafts (electronic files, emails, etc.)

Annex 7. Methodology and Results of Uncertainty Assessment

7.1. Methodology of Uncertainty Assessment

7.1.1. Background and Purpose

Under the United Nations Framework Convention on Climate Change (UNFCCC), Annex I Parties are required to submit their inventories on greenhouse gases emissions and removals (hereafter, 'inventory') to the UNFCCC secretariat. *Good Practice Guidance (2000),* adopted in May 2000, further requires parties to quantitatively assess and report the uncertainty of their inventories. It should be noted that uncertainty assessment is intended to contribute to continuous improvement in the accuracy of inventories and that a high or low uncertainty assessed will not affect the justice of an inventory nor result in the comparison of accuracy among parties' inventories.

Japan considered uncertainty of its inventory in the Committee for the Greenhouse Gases Emissions Estimation Methods in FY2001. Japan has annually conducted uncertainty assessment based on the Committee's results since then.

This document will be used as a guideline for conducting the uncertainty assessment of Japan's inventories. It may be subjected to be adjusted as appropriate.

7.1.2. Overview of Uncertainty Assessment Indicated in the Good Practice Guidance

7.1.2.1. About Uncertainty Assessment

7.1.2.1.a. What is uncertainty?

- The term "uncertainty" refers to the degree of discrepancy in various data in comparison with a true value, stemming from number of characteristics with lack of sureness including representational reliability of measurements, and it is a concept that is much broader than that of accuracy.
- The uncertainty of emissions from a particular source is obtained by calculating and applying the uncertainty associated with the source's emission factor, and the uncertainty of activity data.
- The *Good Practice Guidance (2000)* requires uncertainty of emissions from a source to be calculated using the method given below.

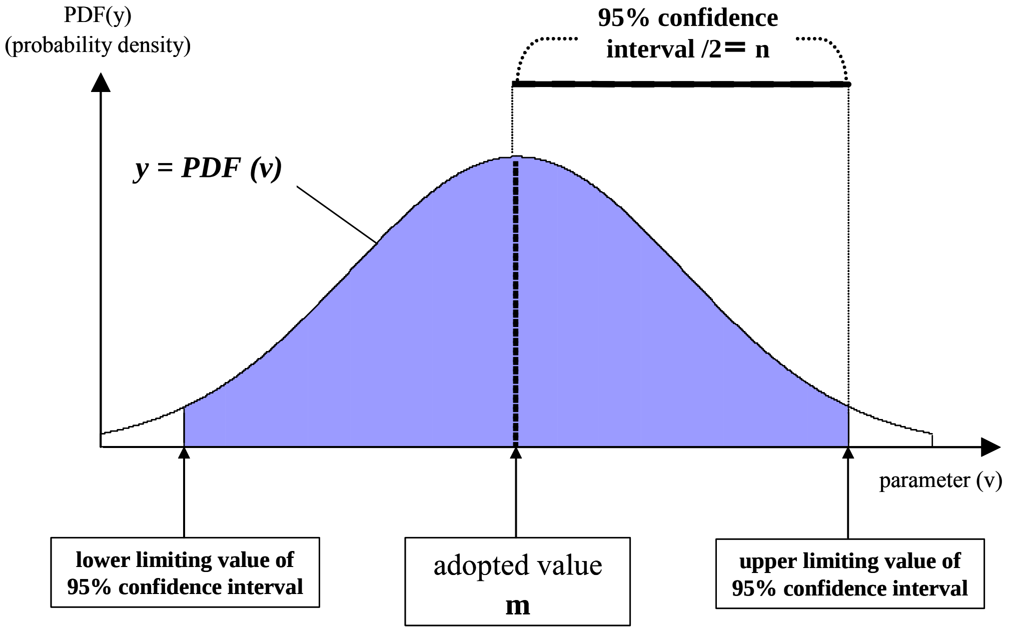
$$U = \sqrt{U_{EF}^2 + U_A^2}$$

U : Uncertainty of the emissions of the source (%)
U_{EF} : Uncertainty of the emission factor (%)
U_A : Uncertainty of the activity data (%)

7.1.2.1.b. Methodology of identifying the uncertainties of emission factors and activity data of each source

- The standard deviations of the observed values of an emission factor are used to set the probability density function, and uncertainty is assessed by seeking a 95 percent confidence interval.

$$\text{Uncertainty of EF or A} = \frac{\text{95\% confidential interval } / \ 2\ (n)}{\left|\ \text{Adaoped Value of EF or A } (m)\ \right|}$$



7.1.2.1.c. Method of determining the uncertainty of total national emissions

- By combining the uncertainties of emissions from all sources, it is possible to assess the uncertainty of Japan's total inventory.
- When there is no correlation between multiple uncertainties, and they are normally distributed, the *Good Practice Guidance (2000)* suggests two rules of expedience that relate to combining method (addition and multiplication) of uncertainties. This report adopts Rule A, given in Table 6.1 of the *Good Practice Guidance (2000)*, for the calculations.

$$U_{Total} = \frac{\sqrt{(U_1 \times E_1)^2 + (U_2 \times E_2)^2 + \cdots + (U_n \times E_n)^2}}{E_1 + E_2 + \cdots + E_n}$$

U_{Total} : Uncertainties of National Total Emissions (%)
U_i : Uncertainties of the Emissions from Source " i " (%)
E_i : the Emissions from Source " i " (%)

7.1.2.2. Targets of the Uncertainty Assessment

The *Good Practice Guidance (2000)* suggests that all uncertainties be taken into account when estimating emissions. It indicates that the following may be the reasons of uncertainty in emission factors or activity data.

Examples of common reasons of uncertainty in emission factors

- Uncertainties associated with a continuous monitoring of emissions
  - Refers to uncertainties arising from differences in conditions at the time of measurement, such as measurements that are taken annually.
- Uncertainties associated with an establishment of emission factors
  - Startup and shutdown in operation of machinery, etc., can give different emission rates relative to activity data. In these cases, the data should be partitioned, with separate emission factors and probability density functions derived for steady-state, startup and shutdown conditions.
  - Emission factors may depend on load of operation. In these cases, the estimation of total emissions and the uncertainty analysis may need to be stratified to take account of load, which is expressed, for example, as a percentage of full capacity. This could be done by the regression analysis and scatter plots of the emission rate against seemingly influential variables (e.g., emissions versus load) with load becoming a part of the required activity data.
  - Adoption of results from measurements taken for other purposes may not be representative. For example, methane measurements made for safety reasons at coalmines and landfills may not reflect total emissions. In such cases, the ratio between the measured data and total emissions should be estimated for the uncertainty analysis.
- Uncertainties associated with an estimation of emission factors from limited measured data
  - The distribution of emission factors may often differ from the normal distribution. When the distribution is already known, it is appropriate to estimate according to expert judgment, by appending a document that provides the theoretical background.

Examples of common reasons of uncertainty in activity data

- Interpretation of statistical differences: Statistical differences in energy balances usually represent a difference between amounts of primary fuels and amounts of fuels identified in the categories under ‘final consumption’ and ‘in transformation’. They can give an indication of sizes of the uncertainties of the data, especially where long time series are considered.
- Interpretation of energy balances: Production, use, and import/export data should be consistent. If not, this may give an indication of the uncertainties.
- Crosschecks: It may be possible to compare two types of activity data that apply to the same source to provide an indication of uncertainty ranges. For example, the sum of vehicle fuel consumption should be commensurate with the total of fuel consumption calculated by multiplying vehicle-km by fuel consumption efficiency for all types of vehicles.
- Vehicle numbers and types: Some countries maintain detailed vehicle registration databases with data on vehicles by type, age, fuel type, and emission control technology, all of which can be important for a detailed bottom-up inventory of methane (CH4) and nitrous oxide (N2O) emissions from such vehicles. Others do not have such detailed information and this will tend to increase the uncertainty.

Examples of common sources of uncertainty in activity data (*Continued*)
➢ Smuggling of fuel across borders: Imported fuel and the sum of sectoral fuel consumption may be compared as a crosscheck. ➢ Biomass fuels: Where formal markets for these fuels do not exist, consumption estimates may be much less accurate than for fuels in general. ➢ Livestock population data: Accuracy will depend on the extent and reliability of national census and survey methods, and there may be different accounting conventions for animals that do not live for a whole year.

7.1.2.3. Methodology of Uncertainty Assessment

The *Good Practice Guidance (2000)* suggests that uncertainty is assessed through expert judgment and actual data with consideration to the sources of uncertainty indicated in section above.

7.1.3. Methodology of Uncertainty Assessment in Japan's Inventories

7.1.3.1. Principle of Uncertainty Assessment

The following method of uncertainty assessment is used, with regard for both convenience of the compilation and suggestions made in the *Good Practice Guidance (2000)*, in a manner that as far as possible ensures there is no deviation from assessment standards among categories.

7.1.3.2. Separation between Emission Factors and Activity Data

The equation for estimating emissions from individual sources is generally represented as follows.

$$E\ (Emissions) = EF\ (Emission\ Factor) \times A\ (Activity\ Data)$$

There are sources of emissions, however, where emissions are derived from stochastic equations comprising three or more parameters, and it becomes unclear which combination of parameters should be deemed as the emission factor and the activity data.

In such cases, emission factor and activity data are basically defined in accordance with the concept of emission factor described in the *Enforcement Ordinance for the Law Concerning the Promotion of Measures to Cope with Global Warming* (March 1999).

Example: A stochastic equation comprising three or more parameters

- Emission source: Methane emissions from a waste burial site (food scraps)
- Stochastic equation :

Volume of emissions from the source
= Carbon content in food scraps × Gas conversion rate of food scraps
× Proportion of methane in generated gas × 16/12
× Food scraps broken down during the basic period of calculation, expressed in tons

= (*Emission Factor*: Carbon content of food scraps
× Gas conversion rate of food scraps
× Proportion of methane in gas generated × 16/12)
× (*Activity Data*: Food scraps broken down during the basic period of calculation, expressed in tons)

7.1.3.3. Uncertainty Assessment of Emission Factors

The uncertainty of emission factors (parameters) is assessed using the following decision tree.

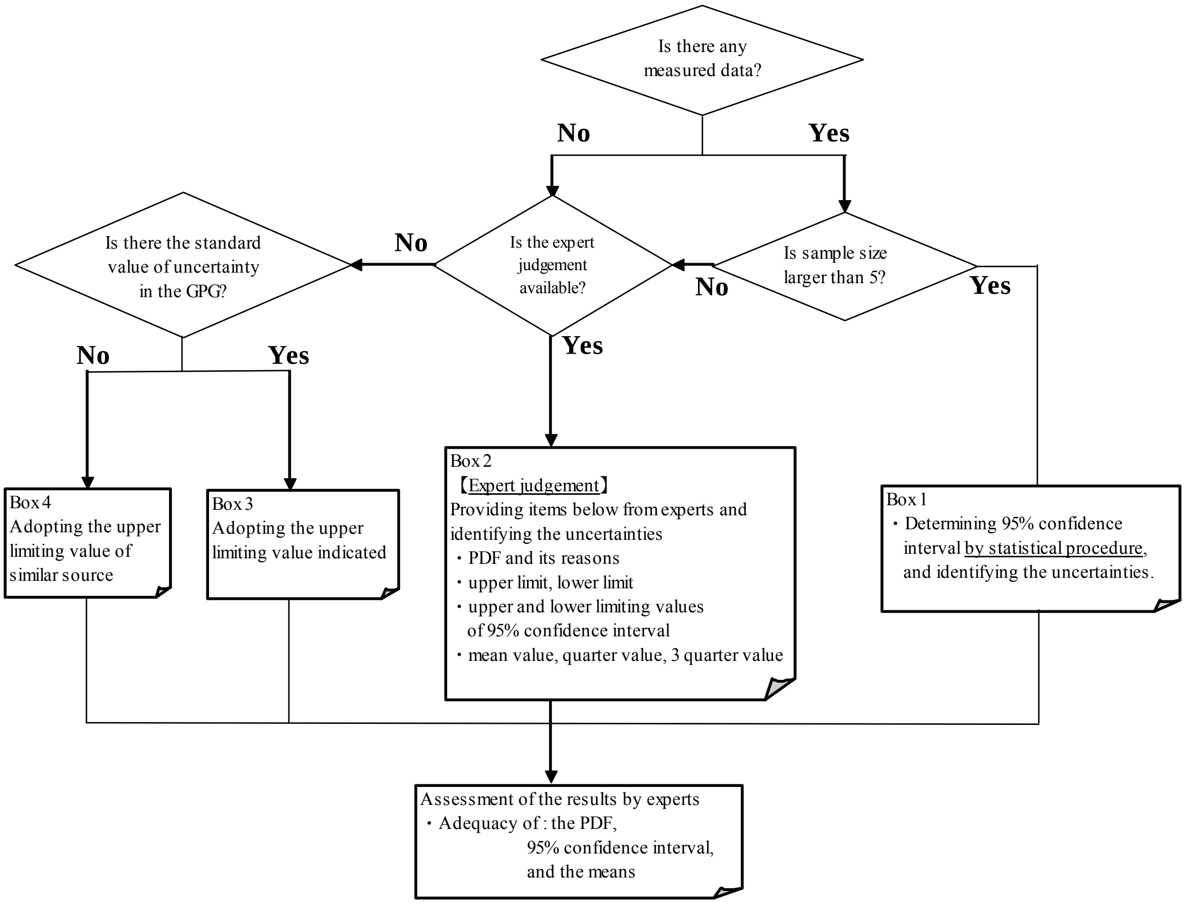


Figure 1 Decision tree for assessing uncertainty associated with emission factors established by the *Committee for the GHGs Emissions Estimation Methods*

- If an appropriate assessment cannot be made using the decision tree above, it may be done using a method that has been considered and deemed as appropriate. In such cases, the reason why an appropriate assessment could not be achieved using the decision tree, and the method applied, will both need to be clearly explained.

7.1.3.3.a. Case where there is measurement data with five or more samples (Box 1)

Where data from actual measurements is available and there are five or more[1] samples, uncertainty is assessed quantitatively in accordance with the guidelines below.

Guidelines for assessment of uncertainty associated with emission factors

Guideline 1

Where data from actual measurements is available and there are five or more samples, the central limit theorem says that the distribution of averages will follow a normal distribution curve. Assuming that all averages $\bar{x}$ and standard deviations $\sigma / \sqrt{n}$ follow a normal distribution curve, uncertainty need to be assessed on the basis of the data used to establish the emission factor only.

Guideline 2

In assessing uncertainty, it is assumed that systematic error inherent to individual items of data is already a factor in the distribution. Therefore, systematic error inherent to individual items of data need not be investigated.

Guideline 3

Items that may contribute to uncertainty, but which may not be readily quantitatively assessable, should be recorded for the future investigation. If, through expert judgment, it is possible to estimate their uncertainty, the uncertainty shall be estimated in accordance with expert judgment.

a) When it is not possible to use statistical methods to derive the distribution of data used in calculating emission factors

1) Emission factor has been established by calculating a simple average of the sample data

Where the emission factor has been calculated using a simple average, it is assumed that the data used in calculating the emission factor follows a normal distribution curve. Therefore, the standard deviation of the sample is divided by the square root of the number of samples to estimate the standard deviation of the emission factor σ_{EF}, and uncertainty is calculated by finding the 95 percent confidence interval in accordance with Equation 1.1.

---

[1] The *Good Practice Guidance* cites "adequate samples", but for convenience, the Secretariat of *Committee for the GHGs Estimation Methods* suggests the use of five or more.

$$Uncertainty\ of\ Emission\ Factor\ (\%) = \frac{1.96 \times \sigma_{EF}}{|\ EF\ |} \qquad \ldots \text{ Equation 1.1.}$$

σ_{EF} : Standard Deviation of Average
EF : Emission Factor

2) Emission factor has been calculated using a weighted average of the sample data

Where the emission factor has been derived using a weighted average of the sample data, it is assumed that the data used in calculating the emission factor follows a normal distribution. Therefore, the standard deviation σ_{EF} of the sample is derived using the equation below. Uncertainty is calculated by finding the 95 percent confidence interval of the averages in accordance with Equation 1.1. Note that the equation does not account for the uncertainty of weights wi.

The weight applied in the weighted average, wi ($\sum wi = 1$)
Sample averages : $EF = \sum (wi \times EFi)$
Unbiased variance of sample averages :

$$\sigma_{EF}^2 = \sum \left\{ w_i \times \left(EF_i - \overline{EF} \right)^2 \right\} / \left(1 - \sum w_i^2 \right) \times \sum w_i^2$$

b) When the distribution of data used in calculating emission factor is derived using statistical methods

When it is possible to derive the distribution of data used in calculating the emission factor by using statistical methods, it is assumed that the data follows a normal distribution, and the uncertainty of each piece of data is estimated on the basis of section "*a) When it is not possible to use statistical methods to derive the distribution of data used in calculating emission factors*". The uncertainty of each piece of data is then determined using Equation 1.2, and the standard deviation of the emission factor σ_{EF} is calculated, to obtain the uncertainty.

If experts at *Working Group on Inventory of Committee for the GHGs Emissions Estimation Methods* indicate that statistical analysis is inappropriate, even using five or more samples, then uncertainty should be assessed by expert judgment. Conversely, if an expert determines that it is possible to carry out statistical analysis, even with less than five samples, uncertainty shall be assessed statistically.

When weight averaging is done to obtain at emission factors, the emission factor *EF* is expressed as follows, where the emission factor of each sub-category is EF_i, the weight variable is A_i, and the total of weight variables is *A*.

$$EF = \frac{\sum_i EF_i \times A_i}{\sum_i A_i} = \frac{\sum_i EF_i \times A_i}{\mathrm{A}}$$

Substituting the distribution of the emission factor *EF*, σ_{EF}^2, and the distributions of the individual emission factors EF_i and individual weight variables A_i, σ_{EFi}^2 and σ_{Ai}^2, then σ_{EF}^2 is calculated as follows, using an equation known as the Error Propagation Equation.

$$\sigma_{EF}^2 = \sum_i \left\{ \left(\frac{\partial EF}{\partial EF_i} \right)^2 \sigma_{EFi}^2 + \left(\frac{\partial EF}{\partial A_i} \right)^2 \sigma_{Ai}^2 \right\} = \sum_i \left\{ \frac{A_i^2}{A^2} \sigma_{EFi}^2 + \frac{(EF_i - EF)^2}{A^2} \sigma_{Ai}^2 \right\} \quad \ldots \text{ Equation 1.2}$$

Thus, the uncertainty of the emission factor U is obtained using the following equation.

$$U = \frac{1.96 \times \sigma_{EF}}{|\, EF \,|}$$

7.1.3.3.b. Case where there is no actual measurement data, or there are less than five samples

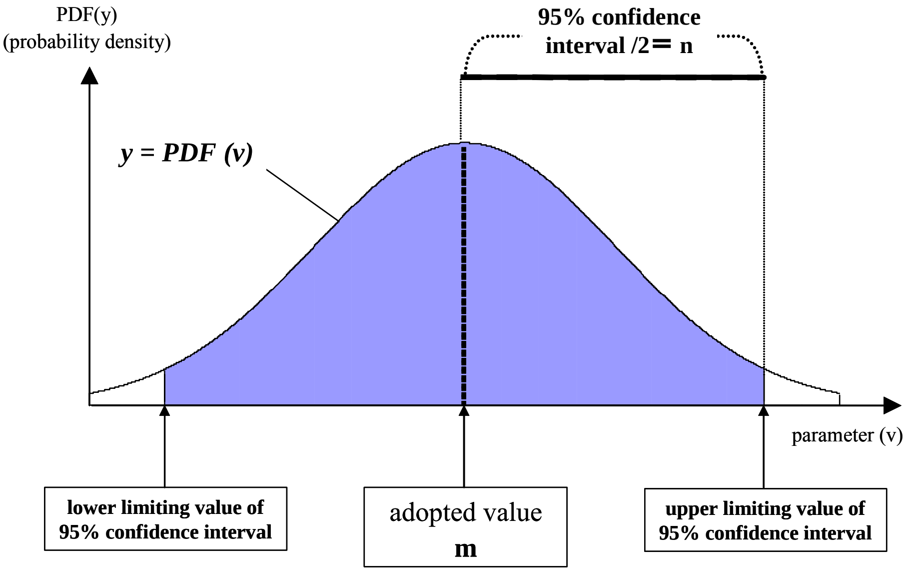
When there is no actual measurement data, or there are less than five samples, uncertainty shall be assessed by expert judgment.

a) When expert judgment is feasible (Box 2)

1) When the distribution of the probability density function of emission factors can be obtained using expert judgment

In this case, uncertainty should be assessed in accordance with expert judgment for the following. The expert providing the expert judgment, the basis for their decision, and factors contributing to uncertainty that are excluded from consideration, should be documented, and the document should be retained.

- Distribution and evidence
- Upper and lower limiting values
- Upper and lower limiting values of the 95% confidence interval
- Mean, first, and third quartile values



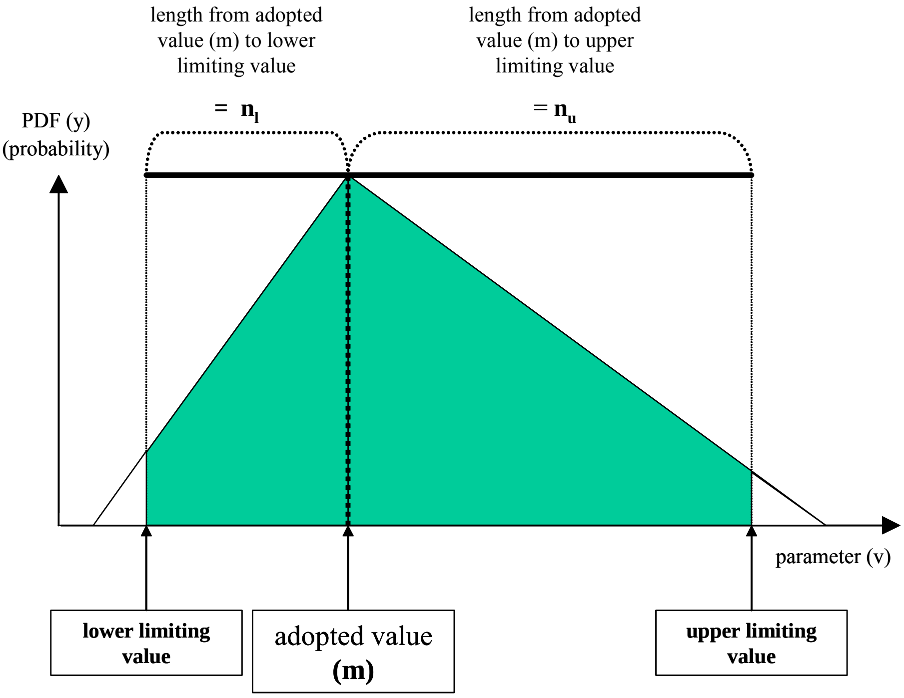
$$\mathit{Uncertainty\ of}\ \mathrm{EF}\ \mathit{or}\ \mathrm{A} = \frac{95\%\ \mathit{confidential\ interval}\ /\ 2\ (n)}{\left|\ \mathit{Adaoped\ Value\ of}\ \mathrm{EF}\ \mathit{or}\ \mathrm{A}\ (m)\ \right|}$$

2) When the distribution of the probability density function of emission factors cannot be obtained using expert judgment

Ask an expert for the upper and lower limiting values appropriate to emission factors in Japan (parameters), and draw a triangular distribution for the emission factors (parameters) with the Japanese emission factor as the vertex, and such that the upper and lower limiting values of a 95 percent confidence interval correspond to the upper and lower limiting values appropriate to the Japanese emission factor (see diagram below).

If the emission factor (parameter) used is larger than the upper limiting value, the emission factor should be used as the upper limiting value. If the emission factor (parameter) used is smaller than the lower limiting value, the emission factor (parameter) should be used as the lower limiting value.

The expert providing the expert judgment, the basis for their decision, and factors contributing to uncertainty that are excluded from consideration, should be documented, and the document should be retained.



Uncertainty in this context is calculated using the following equation.

Uncertainty to the lower limiting value Ul (%)
= – {distance to lower limiting value (nl)/mode (m)}

Uncertainty to the upper limiting value Uu (%)
= + {distance to upper limiting value (n u)/mode (m)}

Uncertainty is expressed in the form, –○% to +●%, but in assessing overall uncertainty for Japan, the largest absolute value should be used.

b) When expert judgment is not possible

1) A standard value for uncertainty is provided in the *Good Practice Guidance (2000)* (Box 3)

When the *Good Practice Guidance (2000)* provides a standard value for uncertainty for a particular emission source, an estimate of uncertainty should err on the safe side, and the upper limiting value of the standard uncertainty value given in the *Good Practice Guidance (2000)* should be used.

2) No standard value for uncertainty is provided in the *Good Practice Guidance (2000)* (Box 4)

When the *Good Practice Guidance (2000)* does not provide a standard uncertainty for a particular emission source, the standard uncertainty given in the *Good Practice Guidance (2000)* for a similar emission source should be used for the upper limiting value.

Category	Uncertainty of EF
1. Energy	
1.A. CO_2	5%
1.A. CH_4, N_2O	3%～10%
1.A.3. Transport(CH_4, N_2O)	5%
2. Industrial Processes	
Excluding HFCs, PFCs, SF_6	1%～100%
HFCs, PFCs, SF_6	5%～50%
3. Solvent and Other Product Use	-*
4. Agriculture	2%～60%
5. Land Use Change and Forestry	-**
6. Waste	5%～100%

* Category 3: The use of organic solvents and other such products are not dealt within the GPG (2000).

** Category 5: Changes in land use and forestry are not dealt with in the GPG (2000).

7.1.3.3.c. Methods for Combining Uncertainties of Emission Factors

The basic method for combining uncertainties is Tier 1 in the *Good Practice Guidance (2000)*. When a correlation between elements is strong, uncertainties may be combined using the Monte Carlo method (Tier 2 in the *Good Practice Guidance (2000)*).

a) Uncertainty of emission factor derived from a combination of multiple parameters

The uncertainty of an emission factor may be obtained at from the uncertainty of multiple parameters using the equation given below, in situations of the type described in the example on page Annex 7.5.

$$U_{EF} = \sqrt{U_1^2 + U_2^2 + \cdots + U_n^2}$$

U_{EF} : Uncertainties of Emission Factors (%)

U_i : Uncertainties of Parameter “i” (%)

7.1.3.4. Uncertainty Assessment of Activity Data

The uncertainty of activity data is assessed in accordance with the decision tree depicted below.

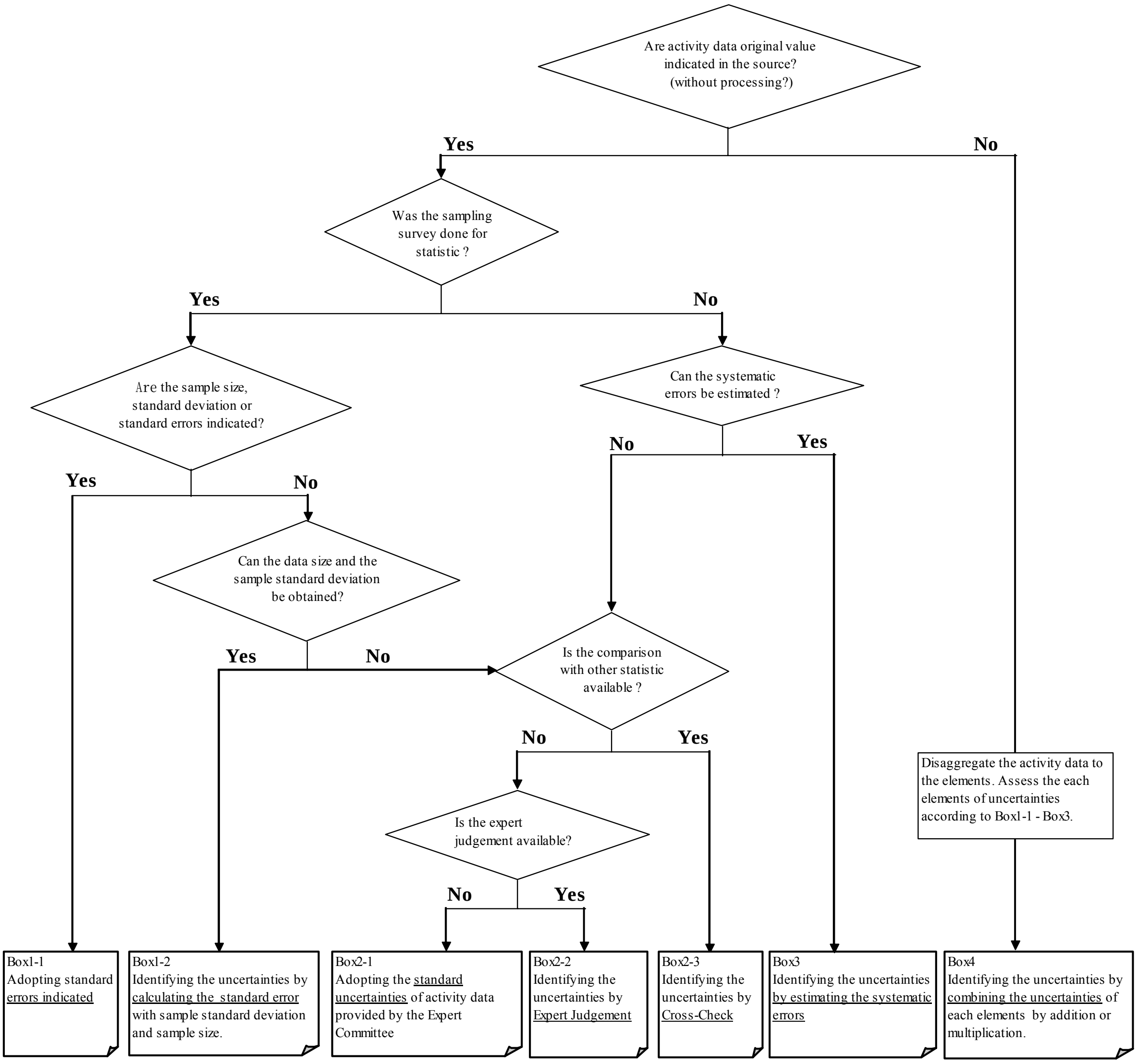


Figure 2 Decision tree for assessing uncertainty associated with activity data established by the *Committee for the GHGs Emissions Estimation Methods*

- If an appropriate assessment cannot be made using the decision tree above, it may be done using a method that has been considered and deemed as appropriate. The reason why an appropriate assessment could not be achieved using the decision tree, and the method applied, will both need to be clearly explained.

7.1.3.4.a. Using statistical values for activity data

When using statistical values for activity data, uncertainty should be quantitatively assessed in accordance with the following guidelines.

Guidelines for assessment of uncertainty associated with emission factors

Guideline 1

Only the sample error needs to be considered as part of uncertainty assessment in sample surveys.

Guideline 2

In situations other than sample surveys, if it is possible to estimate a systemic error, it should be considered as part of an uncertainty assessment.

Guideline 3

In situations other than sample surveys, if it is not possible to estimate a systemic error, uncertainty should be assessed through crosschecks, or by expert judgment.

Guideline 4

Where quantitative assessment is difficult, factors that would contribute to uncertainty should be recorded for a future investigation.

a) Statistical values based on a sample survey

1) The publisher has made errors public (Box 1-1)

When the publisher of a statistical document has made the sampling errors public in the sample survey, it should be used as the uncertainty of the activity data.

2) The publisher has not made errors public (Box 1-2)

Enquire the publisher of the statistical document for the size of the sample, the sample average, and the standard deviation of the sample. Under the assumption that the distribution of the sample reproduces the distribution of the population, assessment of uncertainty from the statistical values should be done.

$$U\ (Uncertainty) = \left(1.96 \times s / \sqrt{n}\right) / X_{ad}$$

X_{ad} : Sample average
S : Standard deviation of sample
n : Number of items of data

If, however, distribution is asymmetrical, the uncertainty U is calculated by dividing the difference between the value of the 95 percent confidence limit furthest from X_{ad} and the average value, by X_{ad}.

Confirmation of the estimation method for Japan from values drawn from the sample survey and, as far as possible, estimation of the uncertainty associated with the estimation method should be done also (e.g., multiply the sample average of the number of head of livestock raised per farm by the number of farms).

3) Amount of data and sample standard deviation are not available, and crosschecking is possible (Box 2-3)

In the case of statistics drawn from a sample survey, where the amount of data and the sample standard deviation are not available, but it is possible to compare the relevant statistical value with multiple other statistical values, uncertainty should be assessed using the same means as in the second case described at section A1.2.3 in the page A1.7 of the *Good Practice Guidance (2000)*.

$$U\ (Uncertainty) = \left(1.96 \times s\right) / X_{ap}$$

X_{ap} : Value used for activity data
s : Standard deviation (data to be cross-checked)

However, if a distribution is asymmetrical, the uncertainty U may be calculated by dividing the difference between the value of the 95 percent confidence limit furthest from X_{ad} and the average value, by X_{ad}.

Also, when there is a single other statistical value only, the assessment should be done using the same method described at 2) "When the distribution of the probability density function of emission factors cannot be obtained using expert judgment" in *Section 7.1.3.3.b.*.

4) Amount of data and sample standard deviation are not available, and expert judgment is available (Box 2-2)

In the case of statistics drawn from a sample survey where the amount of data and sample standard deviation are not available, ask an expert for the upper and lower limiting values appropriate to activity data in Japan, and draw a triangular distribution for activity data (see diagram at page *Annex 7.9*) with the Japanese activity data as the vertex, and such that the upper and lower limiting values of a 95 percent confidence interval correspond to the upper and lower limiting values appropriate to the Japanese activity data.

If the activity data used is larger than the upper limiting value, that activity data should be used as the upper limiting value. If the activity data used is smaller than the lower limiting value, that emission factor (parameter) should be taken as the lower limiting value.

The experts providing the expert judgment, the basis for their decision, and factors contributing to uncertainty that are excluded from consideration, should be documented, and the document should be retained.

5) Amount of data and sample standard deviation are not available, and expert judgment is unavailable (Box 2-3)

The following standard values established by the *Committee for the GHGs Emissions Estimations Methods* will be used.

Table 1 Uncertainty of sample statistics established by the Committee for the GHGs Emissions Estimation Methods

	Designated statistics	Other statistics
Sample survey	50 [%]	100 [%]

The values for designated statistics, approved statistics, and reported statistics have been established by the Committee for the GHGs Emissions Estimation Methods, with reference to the *Good Practice Guidance (2000)* and other material. Statistics other than designated statistics have been deemed to be twice the designated statistics.

b) Statistical values not based on a sample survey

1) Systemic error can be estimated (Box 3)

Where a systemic error can be estimated, it should be estimated and used. The method by which the systemic error is calculated should be documented, and the document should be retained.

2) Systemic error cannot be estimated, and crosschecking is possible (Box 2-3)

Where systemic error cannot be estimated, but it is possible to compare the relevant statistical value with other statistical values, uncertainty should be assessed using the same means as in Case 2 described at A1.2.3 of Section A1.7 of the *Good Practice Guidance (2000)*.

3) Systemic error cannot be estimated, crosschecking is not possible, and expert judgment is available (Box 2-2)

Same as for "*4) Amount of data and sample standard deviation are not available, and expert judgment is available (Box 2-2)*" on the previous page.

4) Systemic error cannot be estimated, crosschecking is not possible, and expert judgment is unavailable (Box 2-1)

The following standard values established by the Committee for the GHGs Emissions Estimation Methods should be used.

Table 2 Uncertainty of sample statistics established by the Committee for the GHGs Emissions Estimation Methods

	Designated statistics	Other statistics
Survey of total population (no rounding)	5 [%]	10 [%]
Survey of total population (rounding)	20 [%]	40 [%]

The values for designated statistics, approved statistics, and reported statistics have been established by the Committee for the GHGs Emissions Estimation Methods with reference to the *Good Practice Guidance* and other material. Statistics other than designated statistics have been deemed to be twice the designated statistics.

7.1.3.4.b. Using statistical values processesd as activity data (Box 3)

a) Breakdown of each element of activity data and assessment

Activity data should be broken down as shown in the following example.

- Emission source : Carbon dioxide emission from incineration of naphtha in the chemical industry
- Stochastic equation :

Activity data for relevant emission source
= Naphtha consumption × 20% (remaining 80% is fixed in the product) [2]
- ammonia raw material

After being broken down, each element of the statistical values should be assessed for uncertainty using the method shown at section "*7.1.3.4.a. Using statistical values for activity data*".

In the example above, for elements based on survey research, such as the figure of 20%, uncertainty should be assessed on the basis of the method shown at section "*7.1.3.3. Uncertainty Assessment of Emission Factors*".

b) Combining elements

Combine each element using the sum and product methods of combination, and assess the uncertainty.

- Sum method (Rule A): Where uncertainty quantities are to be combined by addition.

Activity data is expressed as $A_1 + A_2$

$$U_{A\text{-}total} = \frac{\sqrt{(U_{A1} \times A_1)^2 + (U_{A2} \times A_2)^2}}{A_1 + A_2}$$

U_{An} : Uncertainty of element An (%)

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[2] Environmental Agency, *The Estimation of CO2 Emission in Japan*, 1992

- Product method (Rule B): Where uncertainty quantities are to be combined by multiplication.

Activity data is expressed as $A_1 \times A_2$

$$U_A = \sqrt{U_{A1}{}^2 \times U_{A2}{}^2}$$

U_{An} : Uncertainty of element An (%)

7.1.3.5. Uncertainty Assessment of Emissions

7.1.3.5.a. Uncertainty assessment of emissions from individual emission sources

1) Emissions estimated from emission factor and activity data

Use the product combination equation given at Tier 1 of the *Good Practice Guidance(2000)* on the results of emission factor assessment from the previous section and the activity data, and assess the uncertainty of emissions from each emission source.

$$U_{Ei} = \sqrt{U_{EFi}{}^2 + U_{Ai}{}^2}$$

U_{Ei} : Uncertainty of emissions from emission source *i* (%)
U_{EFi} : Uncertainty of element An (%)
U_{Ai} : Uncertainty of element An (%)

2) Actual measurements taken of emissions

When emissions are derived from actual measurement, uncertainty of emissions should be assessed directly, in accordance with "*7.1.3.3. Uncertainty Assessment of Emission Factors*".

7.1.3.5.b. Calculating uncertainty of total emissions

Combine the results of assessments of emission uncertainty for multiple emission sources to assess the uncertainty of total Japanese emissions of greenhouse gases. The uncertainty of emissions from multiple sources should be combined using the product combination equation given at Tier 1 in the *Good Practice Guidance(2000)*.

$$U_{Total} = \frac{\sqrt{(U_1 \times E_1)^2 + (U_2 \times E_2)^2 + \cdots + (U_n \times E_n)^2}}{E_1 + E_2 + \cdots + E_n}$$

U_{Total} : Uncertainty of total Japanese emissions (%)
U_i : Uncertainty of emission source i (%)
E_i : Emissions from emission source i (Gg)

When the uncertainties of emissions from multiple sources are combined, only the uncertainty of emissions should be indicated. Combination of the uncertainties for both emission factor and activity data should not be done.

7.2. Results of Uncertainty Assessment

7.2.1. Assumption of Uncertainty Assessment

Uncertainty Assessment is conducted with the assumption that uncertainties of each source's emissions in FY2003 are equal to the results of uncertainty assessment in Committee for the Greenhouse Gases Emissions Estimation Methods in FY2002. For newly-established emission sources, it is assumed that the uncertainty is same as for the similar emission sources.

7.2.2. Uncertainty of Japan's Total Emissions

Fiscal 2003 total emissions in Japan were approximately 1.34 billion tons (carbon dioxide equivalents). Uncertainty of total emissions has been assessed at 2% and uncertainty introduced into the trend in total national emissions has been assessed at 3%.

Table 3 Uncertainty of Japan's Total Emissions

IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	[%]	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (CO2)	CO2	1,188,099.7	88.7%	2%	9	1.94%	1
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	3,206.4	0.2%	46%	2	0.11%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	6,954.9	0.5%	166%	1	0.86%	2
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	589.8	0.0%	14%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	49,310.9	3.7%	4%	8	0.13%	6
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	25,801.6	1.9%	25%	4	0.47%	4
3. Solvent & other Product Use	N2O	320.8	0.0%	5%	7	0.00%	9
4. Agriculture	CH4、N2O	33,230.3	2.5%	18%	5	0.46%	5
6. Waste	CO2、CH4、N2O	31,615.4	2.4%	31%	3	0.73%	3
Total Emissions	(D)	1,339,129.9	100.0%	(E) **2%**			

1) $C = A \times B / D$

2) $E = \sqrt{C_1^2 + C_2^2 + \cdots\cdots\cdots}$

Hereafter, the same method for calculating uncertainty assessment has been used in each sector appearing in Tables 2 and the following tables.

7.2.3. Sources highly-contributing to uncertainty of total emissions

"The proportion of the uncertainty of each emission source to total emissions" (hereafter, "degree of contribution") is useful in examining the contributions to the uncertainties of total emissions from individual sources. Table 2 shows the top 20 in sources with a high degree of contribution to uncertainty of total emissions.

Table 4 Sources with a high degree of contribution to uncertainty of total emissions (top 20)

#	IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
#3	1A. Fuel Combustion - Solid Fuels - Steam Coal (imported)	CO2	234,862.3	0.5%	6.8%	7%	146	1.19%	1
#12	1A. Fuel Combustion - Liquid Fuels - Gasoline	CO2	140,571.0	0.6%	8.5%	9%	140	0.90%	2
#31	1A. Fuel Combustion (Transport) - a. Civil Aviation	N2O	110.3	10000.0%	5.0%	10000%	1	0.82%	3
#25	1A. Fuel Combustion - Gaseous Fuels - LNG	CO2	108,835.3	2.3%	9.3%	10%	136	0.78%	4
#161	6. Waste - C. Waste Incineration - Industrial Solid Waste	CO2	10,155.4	—	—	71%	57	0.54%	5
#5	1A. Fuel Combustion - Solid Fuels - Coke	CO2	65,894.5	5.0%	8.2%	10%	135	0.47%	6
#158	6. Waste - C. Waste Incineration - Municipal Solid Waste	CO2	13,183.8	11.2%	44.8%	46%	95	0.45%	7
#16	1A. Fuel Combustion - Liquid Fuels - Diesel Oil or Gas Oil	CO2	100,178.7	0.4%	5.8%	6%	148	0.44%	8
#70	2. Industrial Processes - E. Production of F-gas - 1. By-product Emissions (HCFC-22)	HFCs	5,022.8	100.0%	5.0%	100%	40	0.38%	9
#19	1A. Fuel Combustion - Liquid Fuels - Heating Oil C	CO2	98,132.3	0.5%	4.3%	4%	160	0.32%	10
#27	1A. Fuel Combustion - Gaseous Fuels - Town Gas*	CO2	59,204.4	5.0%	3.9%	6%	147	0.28%	11
#15	1A. Fuel Combustion - Liquid Fuels - Kerosene	CO2	70,079.6	0.2%	5.2%	5%	154	0.27%	12
#33	1A. Fuel Combustion (Transport) - b. Road Transportation	N2O	6,429.7	50.0%	5.0%	50%	83	0.24%	13
#17	1A. Fuel Combustion - Liquid Fuels - Heating Oil A	CO2	81,690.6	0.6%	3.8%	4%	162	0.23%	14
#129	4. Agriculture - D. Agricultural Soils - 3. Indirect Emissions - N Leaching & Run-off	N2O	3,663.2	—	—	84%	50	0.23%	15
#8	1A. Fuel Combustion - Solid Fuels - Blast Furnace Gas	CO2	40,821.7	5.0%	5.0%	7%	143	0.22%	16
#124	4. Agriculture - D. Agricultural Soils - 1. Direct Soil Emissions - Synthetic Fertilizers	N2O	2,062.5	—	—	130%	24	0.20%	17
#107	4. Agriculture - B. Manure Management - Non-Dairy Cattle	N2O	3,641.1	—	—	72%	56	0.20%	18
#23	1A. Fuel Combustion - Liquid Fuels - Refinery Gas	CO2	32,940.4	1.0%	7.6%	8%	142	0.19%	19
#1	1A. Fuel Combustion - Solid Fuels - Coking Coal	CO2	26,049.3	0.9%	9.3%	9%	138	0.18%	20

7.2.4. Energy Sector

7.2.4.1. Fuel Combustion (CO_2)

In assessing uncertainty in the fuel sector, it was used to be difficult with using statistical methods (summing of systemic error) to calculate the uncertainty of energy consumption given in the *General Energy Statistics* used as activity data. Therefore, the uncertainty for consumption of each type of energy has been established by adjusting the overall uncertainty of energy consumption used in calculating activity data (energy consumption before deducting naphtha, LNG, and other non-fuel components), to make it equal to the proportion of statistical error given in the *General Energy Statistics*.

Hence, it should be noted that the values that are the results of uncertainty assessment are predicated on the foregoing.

Table 5 Results of uncertainty assessment of fuel combustion (CO_2)

IPCC Source Category			GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion	Solid Fuels	Coking Coal	CO2	26,049.3	0.9%	9.3%	9%	9	0.18%	12
		Steam Coal (imported)	CO2	0.0	1.3%	6.8%	7%	16	0.00%	26
		Steam Coal (indigenous)	CO2	234,862.3	0.5%	6.8%	7%	17	1.19%	**1**
		Hard Coal	CO2	0.0	5.0%	7.9%	9%	10	0.00%	26
		Coke	CO2	65,894.5	5.0%	8.2%	10%	6	0.47%	**4**
		Coal Tar and Coal Briquette	CO2	2,875.4	5.0%	50.9%	51%	**1**	0.11%	17
		Coke Oven Gas	CO2	32,764.3	2.2%	5.2%	6%	20	0.14%	15
		Blast Furnace Gas	CO2	40,821.7	5.0%	5.0%	7%	14	0.22%	10
		Converter Furnace Gas	CO2	6,737.4	5.0%	5.0%	7%	14	0.04%	20
	Liquid Fuels	Crude Oil	CO2	15,876.9	0.9%	9.3%	9%	8	0.11%	16
		NGL	CO2	126.1	1.7%	26.7%	27%	**2**	0.00%	23
		Gasoline	CO2	140,571.0	0.6%	8.5%	9%	11	0.90%	**2**
		Naphtha & Material Oil	CO2	138.8	0.5%	21.1%	21%	**4**	0.00%	24
		Jet Fuel	CO2	11,092.6	0.6%	8.1%	8%	12	0.07%	18
		Kerosene	CO2	70,079.6	0.2%	5.2%	5%	23	0.27%	8
		Diesel Oil or Gas Oil	CO2	100,178.7	0.4%	5.8%	6%	19	0.44%	**5**
		Heating Oil A	CO2	81,690.6	0.6%	3.8%	4%	27	0.23%	9
		Heating Oil B	CO2	230.8	5.0%	0.0%	5%	24	0.00%	25
		Heating Oil C	CO2	98,132.3	0.5%	4.3%	4%	25	0.32%	6
		Lubricating Oil	CO2	207.2	5.0%	24.2%	25%	**3**	0.00%	22
		Oil Coke & Galvanic Furnace Gas	CO2	12,514.1	0.3%	4.1%	4%	26	0.04%	19
		LPG	CO2	34,746.8	3.7%	4.1%	6%	21	0.14%	13
		Refinery Gas	CO2	32,940.4	1.0%	7.6%	8%	13	0.19%	11
		Other Oil Products	CO2	9,363.1	5.0%	19.5%	20%	**5**	0.14%	14
	Gaseous Fuels	LNG	CO2	108,835.3	2.3%	9.3%	10%	7	0.78%	**3**
		NG	CO2	2,166.2	0.7%	5.4%	5%	22	0.01%	21
		Town Gas*	CO2	59,204.4	5.0%	3.9%	6%	18	0.28%	7
	Sub Total			1,188,099.7			2%		1.94%	
Total Emissions			(D)	1,339,129.9			2%			

* Reported in Gaseous Fuels according to the main material; LNG

7.2.4.2. Stationary Combustion (CH_4 and N_2O)

Table 6 Results of uncertainty assessment of fuel combustion (CO_2)

IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (Stationary)	CH4	309.1	—	—	21%	2	0.00%	2
	N2O	2,897.3	—	—	51%	1	0.11%	1
Sub Total		3,206.4			46%		0.11%	
Total Emissions	(D)	1,339,129.9			2%			

7.2.4.3. Mobile Combustion (CH_4 and N_2O)

Table 7 Results of uncertainty assessment of mobile combustion (CH_4 and N_2O)

IPCC Source Category		GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A.Fuel Combustion (Transport)	a. Civil Aviation	CH4	5.1	200.0%	5.0%	200%	**4**	0.00%	6
		N2O	110.3	10000.0%	5.0%	10000%	**1**	0.82%	**1**
	b. Road Transportation	CH4	184.3	40.0%	5.0%	40%	6	0.01%	**4**
		N2O	6,429.7	50.0%	5.0%	50%	**5**	0.24%	**2**
	c. Railways	CH4	0.8	5.0%	10.0%	11%	7	0.00%	8
		N2O	81.7	5.0%	10.0%	11%	7	0.00%	7
	d. Navigation	CH4	27.3	200.0%	16.1%	201%	**3**	0.00%	**5**
		N2O	115.7	1000.0%	16.1%	1000%	**2**	0.09%	**3**
	Sub Total		6,954.9			166%		0.86%	
Total Emissions		(D)	1,339,129.9			2%			

7.2.4.4. Fugitive Emissions from Fuel

The uncertainty calculated for the fuel sector has been used as the uncertainty of activity data for refining and storage of crude oil and natural gas liquids (NGL), and supply of natural gas (town gas production). This uncertainty has been calculated on the basis of the results of allocating equally the overall uncertainty in the Energy Balance Table to each fuel type.

Table 8 Results of uncertainty assessment of fugitive emissions from fuel

IPCC Source Category					GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1B. Fugitive Emissions from Fuels	1. Solid Fuels	a. Coal Mining	i. Underground Mines	Mining Activities	CH4	57.6	–	–	5%	19	0.00%	9
				Post-Mining Activities	CH4	25.5	200.0%	5.0%	200%	1	0.00%	1
			ii. Surface Mines	Mining Activities	CH4	10.0	200.0%	5.0%	200%	1	0.00%	4
				Post-Mining Activities	CH4	0.9	200.0%	5.0%	200%	1	0.00%	10
	2. Oil and Natural Gas	a. Oil		i. Exploration	CO2	0.0	–	–	27%	6	0.00%	16
					CH4	0.0	–	–	27%	5	0.00%	15
					N2O	0.0	–	–	27%	4	0.00%	19
				ii. Production	CO2	0.2	–	–	25%	13	0.00%	13
					CH4	25.6	–	–	25%	14	0.00%	5
				iii. Transport	CO2	0.0	25.0%	5.0%	25%	9	0.00%	18
					CH4	0.4	25.0%	5.0%	25%	9	0.00%	11
				iv. Refining / Storage	CH4	16.4	–	–	26%	8	0.00%	8
		b. Natural Gas		i. Production / Processing	CO2	0.3	–	–	21%	15	0.00%	12
					CH4	215.9	–	–	20%	16	0.00%	2
				ii. Transmission	CO2	0.1	–	–	19%	18	0.00%	14
					CH4	192.4	–	–	20%	17	0.00%	3
				Distribution	CH4	20.5	25.0%	8.7%	26%	7	0.00%	7
		c. Venting and Flaring		Venting i. oil	CO2	0.0	25.0%	5.0%	25%	9	0.00%	17
					CH4	24.1	25.0%	5.0%	25%	9	0.00%	6
	Sub Total					589.8			14%		0.01%	
Total Emissions					(D)	1,339,129.9			2%			

7.2.5. Industrial Processes

7.2.5.1. CO_2, CH_4 and N_2O

For emissions sources with actual data available for emission factors, the emission factor dataset is deemed to be a sample of the total dataset, and the uncertainty assessment is achieved statistically. It is not a synthesis of the uncertainties of measured error of emissions from each operating site.

Table 9 Results of uncertainty assessment of industrial processes (CO_2, CH_4 and N_2O)

IPCC Source Category				GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
2. Industrial Processes	A. Mineral Products	1. Cement Production		CO2	30,766.4	1.6%	5.2%	5%	8	0.12%	1
		2. Lime Production		CO2	4,238.2	—	—	5%	9	0.02%	4
		3. Limestone & Dolomite Use		CO2	10,363.6	—	—	5%	11	0.04%	2
	B. Chemical Industries	1. Ammonia Production		CO2	2,410.5	—	—	4%	12	0.01%	6
		2. Nitric Acid Production		N2O	803.6	46.0%	5.0%	46%	7	0.03%	3
		3. Adipic Acid Production		N2O	404.2	—	—	5%	10	0.00%	8
		5. Other	Carbon Black	CH4	5.8	54.8%	5.0%	55%	6	0.00%	9
			Ethylene	CH4	2.3	77.2%	5.0%	77%	3	0.00%	11
				CO2	207.7	77.2%	5.0%	77%	3	0.01%	5
			Dichloroethylene	CH4	0.4	100.7%	5.0%	101%	2	0.00%	12
			Styrene	CH4	2.1	113.2%	5.0%	113%	1	0.00%	10
			Coke	CH4	106.1	—	—	57%	5	0.00%	7
	Sub Total				49,310.9			4%		0.13%	
Total Emissions				(D)	1,339,129.9			2%			

7.2.5.2. F-gas

Table 10 Results of uncertainty assessment of industrial processes (F-gas)

IPCC Source Category					GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
2. Industrial Processes (F-gas)	C. Metal	3. Aluminium			PFCs	15.1	33.0%	5.0%	33%	27	0.00%	21
		4. SF6 Used in Aluminium and Magnesium Foundries			SF6	740.9	33.0%	5.0%	33%	27	0.02%	13
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	5,022.8	100.0%	5.0%	100%	**4**	0.38%	**1**
		2. Fugitive Emissions			HFCs	439.4	100.0%	10.0%	100%	**1**	0.03%	11
					PFCs	1,016.4	100.0%	10.0%	100%	**1**	0.08%	7
					SF6	812.6	100.0%	10.0%	100%	**1**	0.06%	8
	F. Consumption of F-gas	1. Refrigeration and Air Conditioning Equipment	Domestic Refrigerator	manufacturing	HFCs	152.1	50.0%	40.0%	64%	6	0.01%	16
				stock	HFCs	IE	50.0%	40.0%	64%	6	0.00%	22
				disposal	HFCs	IE	–	40.0%	40%	20	0.00%	22
			Commercial Refrigerator	manufacturing	HFCs	385.1	50.0%	40.0%	64%	6	0.02%	14
				stock	HFCs	IE	50.0%	40.0%	64%	6	0.00%	22
				disposal	HFCs	0.0	–	40.0%	40%	20	0.00%	22
			Stationary Air-Conditioning	manufacturing	HFCs	75.1	50.0%	40.0%	64%	6	0.00%	18
				stock	HFCs	14.9	50.0%	40.0%	64%	6	0.00%	20
			Mobile Air-Conditioning	manufacturing	HFCs	66.7	50.0%	40.0%	64%	6	0.00%	19
				stock	HFCs	1,851.0	50.0%	40.0%	64%	6	0.09%	**4**
				disposal	HFCs	903.0	–	40.0%	40%	20	0.03%	12
		2. Foam Blowing		manufacturing	HFCs	653.1	50.0%	50.0%	71%	**5**	0.03%	9
		4. Aerosols / MDI		stock/disposal	HFCs	2,624.1	–	40.0%	40%	20	0.08%	6
		5. Solvents			PFCs	4,288.0	–	40.0%	40%	20	0.13%	**3**
		6. Semiconductor Manufacture			HFCs	113.5	50.0%	40.0%	64%	6	0.01%	17
					PFCs	3,707.4	50.0%	40.0%	64%	6	0.18%	**2**
					SF6	1,716.0	50.0%	40.0%	64%	6	0.08%	**5**
		7. Electrical Equipment		manufacturing	SF6	884.3	30.0%	40.0%	50%	19	0.03%	10
				stock	SF6	320.0	50.0%	40.0%	64%	6	0.02%	15
				Maintenance	SF6	IE	–	40.0%	40%	20	0.00%	22
				disposal	SF6	IE	–	40.0%	40%	20	0.00%	22
		8. Other (for Studies etc.)			HFCs	0.0	50.0%	40.0%	64%	6	0.00%	22
	Sub Total					25,801.6			25%		0.47%	
Total Emissions					(D)	1,339,129.9			2%			

*: Uncertainty assessment of F-gas is currently being discussed.

7.2.6. Solvents and Other Product Use

Table 11 Results of uncertainty assessment of solvent and other product use

IPCC Source Category			GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
3. Solvent and Other Product Use	D. Other	Anaesthesia	N2O	320.8	–	5.0%	5%	1	0.00%	1
	Sub Total			320.8			5%		0.00%	
Total Emissions			(D)	1,339,129.9			2%			

7.2.7. Agriculture

Table 12 Results of uncertainty assessment of Agriculture

IPCC Source Category				GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
4. Agriculture	A. Enteric Fermentation	Dairy Cattle		CH4	3,215.5	—	—	19%	50	0.05%	11
		Non-Dairy Cattle		CH4	3,163.0	—	—	22%	49	0.05%	10
		Sheep		CH4	1.0	50.0%	4.9%	50%	39	0.00%	45
		Goat		CH4	3.0	50.0%	4.9%	50%	39	0.00%	40
		Swine		CH4	223.8	50.0%	4.9%	50%	39	0.01%	22
		Horse		CH4	9.5	50.0%	4.9%	50%	39	0.00%	32
	B. Manure Management	Dairy Cattle		CH4	310.2	—	—	164%	13	0.04%	12
				N2O	2,114.2	—	—	60%	36	0.09%	6
		Non-Dairy Cattle		CH4	189.4	—	—	215%	**3**	0.03%	14
				N2O	3,641.1	—	—	72%	32	0.20%	**3**
		Swine		CH4	188.2	—	—	147%	14	0.02%	18
				N2O	3,356.8	—	—	65%	34	0.16%	**4**
		Hen		CH4	78.1	—	—	230%	**2**	0.01%	20
				N2O	1,142.2	—	—	80%	31	0.07%	8
		Broiler		CH4	144.5	—	—	233%	**1**	0.03%	16
				N2O	1,557.1	—	—	101%	20	0.12%	**5**
		Sheep		CH4	0.1	100.0%	4.9%	100%	21	0.00%	50
				N2O	0.7	50.0%	4.9%	50%	39	0.00%	46
		Goat		CH4	0.1	100.0%	4.9%	100%	21	0.00%	49
				N2O	8.2	50.0%	4.9%	50%	39	0.00%	33
		Horse		CH4	1.1	100.0%	4.9%	100%	21	0.00%	41
				N2O	6.0	50.0%	4.9%	50%	39	0.00%	36
	C. Rice Cultivation	Continuously Flooded		CH4	259.3	115.3%	7.6%	116%	17	0.02%	17
		Intermittently Flooded	Straw amendment	CH4	3,764.6	—	—	32%	48	0.09%	7
			Various compost amendment	CH4	978.7	—	—	46%	46	0.03%	13
			No-amendment	CH4	783.0	—	—	32%	47	0.02%	19
	D. Agricultural Soils	1. Direct Soil Emissions	Synthetic Fertilizers	N2O	2,062.5	—	—	130%	15	0.20%	**2**
			Animal Waste Applied to Soils	N2O	1,422.3	—	—	55%	37	0.06%	9
		2. Animal Production		CH4	2.3	114.4%	10.0%	115%	18	0.00%	37
				N2O	4.6	116.0%	10.0%	116%	16	0.00%	29
		3. Indirect Emissions	Atmospheric Deposition	N2O	751.3	—	—	52%	38	0.03%	15
			N Leaching & Run-off	N2O	3,663.2	—	—	84%	28	0.23%	**1**
	F. Field Burning of Agricultural Residue	1. Cereals	Rice	CH4	56.8	—	—	62%	35	0.00%	23
				N2O	56.4	—	—	202%	11	0.01%	21
			Wheat etc.	CH4	3.1	100.9%	50.0%	113%	19	0.00%	34
				N2O	6.4	198.7%	50.0%	205%	10	0.00%	26
			Maize	CH4	24.0	78.0%	50.0%	93%	24	0.00%	24
				N2O	10.0	204.7%	50.0%	211%	**4**	0.00%	25
		2. Pulse	Peas	CH4	0.2	78.0%	20.0%	81%	29	0.00%	48
				N2O	0.2	204.7%	20.0%	206%	8	0.00%	47
			Soybeans	CH4	2.6	78.0%	50.0%	93%	24	0.00%	38
				N2O	3.2	204.7%	50.0%	211%	**4**	0.00%	28
			Other	CH4	1.2	—	—	70%	33	0.00%	42
				N2O	1.4	—	—	168%	12	0.00%	39
		3. Tuber & Roots	Potatoes	CH4	3.8	78.0%	20.0%	81%	29	0.00%	35
				N2O	2.4	204.7%	20.0%	206%	8	0.00%	30
			Other: Sugarbeet	CH4	0.8	78.0%	50.0%	93%	24	0.00%	43
				N2O	0.3	204.7%	50.0%	211%	**4**	0.00%	44
		4. Sugar Cane		CH4	9.8	78.0%	50.0%	93%	24	0.00%	27
				N2O	2.3	204.7%	50.0%	211%	**4**	0.00%	31
	Sub Total				33,230.3			18%		0.46%	
Total Emissions				(D)	1,339,129.9			2%			

7.2.8. Waste

Table 13 Results of uncertainty assessment of Waste

IPCC Source Category				GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
6. Waste	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	Kitchen Garbage	CH4	818.5	101.3%	23.5%	104%	6	0.06%	6
			Paper & Textiles	CH4	1,607.6	102.6%	17.5%	104%	**5**	0.12%	**3**
			Waste Wood	CH4	1,168.2	104.3%	15.4%	105%	**4**	0.09%	**4**
	B. Wastewater Handling	1. Industrial Wastewater		CH4	333.6	100.0%	16.9%	101%	**7**	0.03%	8
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant	CH4	243.7	30.9%	10.0%	33%	15	0.01%	12
				N2O	654.0	145.7%	10.0%	146%	**2**	0.07%	**5**
			Private Sewerage Tank	CH4	430.7	—	—	60%	11	0.02%	9
				N2O	333.4	—	—	49%	12	0.01%	11
			Human-Waste Treatment Plant	CH4	21.8	91.6%	10.0%	92%	8	0.00%	13
				N2O	9.5	108.0%	10.0%	108%	**3**	0.00%	14
	C. Waste Incineration	Municipal Solid Waste		CO2	13,183.8	11.2%	44.8%	46%	13	0.45%	**2**
				CH4	10.3	—	—	89%	9	0.00%	15
				N2O	671.0	—	—	26%	16	0.01%	10
		Industrial Solid Waste		CO2	10,155.4	—	—	71%	10	0.54%	**1**
				CH4	1.0	—	—	264%	**1**	0.00%	16
				N2O	1,973.0	—	—	33%	14	0.05%	7
	Sub Total				31,615.4			31%		0.73%	
Total Emissions				(D)	1,339,129.9			2%			

7.2.9. Consideration of the results

The result of uncertainty assessment shows that Japan's uncertainty of national total emissions is approximately 2%. This value is relatively smaller compared to 21.3% of UK indicated in the *Good Practice Guidance (2000).* It is attributed to the fact that the ratio of Japan's N_2O emission from "4.D.1. Agricultural Soils (Direct Soil Emissions)" to the national total emissions is small compared to that of UK (the ratios of Japan and UK reported in their inventories submitted in 2003 were 0.28% and 4.1%, respectively).

Below are the results of sensitivity analysis with N_2O emissions from this source, uncertainty of emission factor and national total emissions (calculation used the reported values of inventories submitted in 2003).

Table 14 Sensitivity Analysis on N_2O emissions from "4.D. Agricultural Soils 1 Direct Emissions"

	N_2O Emissions [Gg CO_2eq.]	Uncertainty of EF	Uncertainty of Total Emissions	Note
Original	3,597.58	129.9%	2.4%	2001's Emissions contained in the GHG inventory submitted in 2003
Case 1	3,597.58	500%	2.6%	EF uncertainty was changed to UK's case
Case 2	71,951.53	129.9%	4.8%	Emissions were changed to be approximately 5% of national total emissions in 2001

7.2.10. Issues in Uncertainty Assessment

- According to the method indicated in the *Revised 1996 IPCC Guidelines*, only emission sources of which emissions had already been calculated were the subject of uncertainty assessment. No assessment has been made for emission sources not estimated (NE), or of those portions unconfirmed in emission sources for which only partial calculation has been done (PART). Therefore, it should be remembered that the uncertainty of total emissions prepared by compiling the uncertainty of emissions from each source, does not depict the uncertainty of inventory in the context of the realities of emissions.
- In the sources recalculated, consideration is needed whether to re-assess the uncertainties or not.
- Where it was not possible to carry out a statistical assessment of the uncertainty of activity data, the values were derived from those established by the Committee for the GHGs Emissions Estimations Methods, which have established the uncertainty values in relation to whether the data were derived from specified statistics, or whether they were obtained from total population surveys. But further consideration needs to be given to improve the appropriateness of this approach.
- In carrying out a statistical assessment of uncertainty, it was assumed that the averages of all samples followed a normal distribution. In some cases, however, it means that the emission factor or activity data could, in fact, be negative. Emissions can only be positive under the present IPCC guidelines, so further consideration would need to be given for the possibility to assume that the emission factor or activity data follows some other distribution.
- Where uncertainty of emissions was calculated from emission factor and activity data, in all cases the combining equation indicated by the Committee was used (the Tier 1 method given in the *Good Practice Guidance (2000)*), but when the coefficient of variation (Standard deviation/mean, and depicts sample dispersion) is 30% or greater, the *Good Practice Guidance (2000)* requires the combination to be achieved using the Monte Carlo method (*Good Practice Guidance (2000)* Tier 2 method). Further consideration needs to be given to assess feasibility to apply the Monte Carlo method to emission sources that have large coefficients of variation.
- The number of decimal places to be used when depicting uncertainty was set as follows for the uncertainty assessments conducted, but as the precision of uncertainty assessment varies between emission sources, further consideration needs to be given to the number of decimal places that are effective in uncertainty assessment.
  1) Uncertainty of emission factor is given to one decimal place.
  2) Uncertainty of activity data is also given to one decimal place.
  3) Uncertainty of emissions is given as an integer.（Proportion of total emissions attributable to the uncertainty of a particular source = two decimal places.）

7.2.11. Reference Material

Results of uncertainty assessment in this year using Table 6.1 in *GPG (2000)* are indicated below.

Table 6.1
Tier1 Uncertainty Calculation & Reporting

A			B	C	D	E	F	G	H	I	J	K	L	M
IPCC Source Category			Gas	Base year emissions	2003 emissions	Activity Data Uncertainty	Emissions Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2003	Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by Emission Factor	Uncertainty in trend in National Emissions introduced by Activity Data	Uncertainty introduced into the Trend in Total National Emissions
				Input Data	Input Data	Input Data	Input Data	(E^2+F^2)^1/2	G*D/∑D	Note B	D/∑C	I*F Note C	J*E*√2	(K^2+L^2)^1/2
				Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%	%	%	%	%	%
Total				1,236,971.2	1,339,129.9				2%					3%
1A. Fuel Combustion	Solid Fuels	Coking Coal	CO_2	19,121.2	26,049.3	9.3%	0.9%	9%	0.2%	0.4%	2.1%	0.0%	0.3%	0.3%
		Steam Coal (imported)	CO_2	22,018.0	0.0	6.8%	1.3%	7%	0.0%	-1.9%	0.0%	0.0%	0.0%	0.0%
		Steam Coal (indigenous)	CO_2	81,997.5	234,862.3	6.8%	0.5%	7%	1.2%	11.8%	19.0%	0.1%	1.8%	1.8%
		Hard Coal	CO_2	78.2	0.0	7.9%	5.0%	9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Coke	CO_2	86,359.3	65,894.5	8.2%	5.0%	10%	0.5%	-2.2%	5.3%	-0.1%	0.6%	0.6%
		Coal Tar and Coal Briquette	CO_2	3,640.7	2,875.4	50.9%	5.0%	51%	0.1%	-0.1%	0.2%	0.0%	0.2%	0.2%
		Coke Oven Gas	CO_2	35,773.5	32,764.3	5.2%	2.2%	6%	0.1%	-0.5%	2.6%	0.0%	0.2%	0.2%
		Blast Furnace Gas	CO_2	43,334.9	40,821.7	5.0%	5.0%	7%	0.2%	-0.5%	3.3%	0.0%	0.2%	0.2%
		Converter Furnace Gas	CO_2	6,902.1	6,737.4	5.0%	5.0%	7%	0.0%	-0.1%	0.5%	0.0%	0.0%	0.0%
	Liquid Fuels	Crude Oil	CO_2	58,999.3	15,876.9	9.3%	0.9%	9%	0.1%	-3.9%	1.3%	0.0%	0.2%	0.2%
		NGL	CO_2	1,328.0	126.1	26.7%	1.7%	27%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		Gasoline	CO_2	105,261.5	140,571.0	8.5%	0.6%	9%	0.9%	2.1%	11.4%	0.0%	1.4%	1.4%
		Naphtha & Material Oil	CO_2	679.4	138.8	21.1%	0.5%	21%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Jet Fuel	CO_2	9,140.6	11,092.6	8.1%	0.6%	8%	0.1%	0.1%	0.9%	0.0%	0.1%	0.1%
		Kerosene	CO_2	64,872.0	70,079.6	5.2%	0.2%	5%	0.3%	0.0%	5.7%	0.0%	0.4%	0.4%
		Diesel Oil or Gas Oil	CO_2	100,029.5	100,178.7	5.8%	0.4%	6%	0.4%	-0.7%	8.1%	0.0%	0.7%	0.7%
		Heating Oil A	CO_2	73,258.7	81,690.6	3.8%	0.6%	4%	0.2%	0.2%	6.6%	0.0%	0.4%	0.4%
		Heating Oil B	CO_2	2,090.5	230.8	0.0%	5.0%	5%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%
		Heating Oil C	CO_2	140,826.6	98,132.3	4.3%	0.5%	4%	0.3%	-4.4%	7.9%	0.0%	0.5%	0.5%
		Lubricating Oil	CO_2	67.8	207.2	24.2%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Oil Coke & Galvanic Furnace Gas	CO_2	8,138.1	12,514.1	4.1%	0.3%	4%	0.0%	0.3%	1.0%	0.0%	0.1%	0.1%
		LPG	CO_2	37,861.8	34,746.8	4.1%	3.7%	6%	0.1%	-0.5%	2.8%	0.0%	0.2%	0.2%
		Refinery Gas	CO_2	27,357.2	32,940.4	7.6%	1.0%	8%	0.2%	0.3%	2.7%	0.0%	0.3%	0.3%
		Other Oil Products	CO_2	5,464.3	9,363.1	19.5%	5.0%	20%	0.1%	0.3%	0.8%	0.0%	0.2%	0.2%
	Gaseous Fuels	LNG	CO_2	76,264.2	108,835.3	9.3%	2.3%	10%	0.8%	2.1%	8.8%	0.0%	1.2%	1.2%
		NG	CO_2	2,059.2	2,166.2	5.4%	0.7%	5%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
		Town Gas*	CO_2	35,408.3	59,204.4	3.9%	5.0%	6%	0.3%	1.7%	4.8%	0.1%	0.3%	0.3%

1A. Fuel Combustion (Stationary)					CH_4	336.6	309.1	10.0%	18.9%	21%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1,196.2	2,897.3	10.0%	49.8%	51%	0.1%	0.1%	0.2%	0.1%	0.0%	0.1%
1A.Fuel Combustion (Transport)	a. Civil Aviation				CH_4	2.9	5.1	5.0%	200%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	69.8	110.3	5.0%	10000%	10000%	0.8%	0.0%	0.0%	0.3%	0.0%	0.3%
	b. Road Transportation				CH_4	164.8	184.3	5.0%	40.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	4,720.2	6,429.7	5.0%	50.0%	50%	0.2%	0.1%	0.5%	0.1%	0.0%	0.1%
	c. Railways				CH_4	1.1	0.8	10.0%	5.0%	11%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	121.5	81.7	10.0%	5.0%	11%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	d. Navigation				CH_4	26.3	27.3	16.1%	200%	201%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	111.3	115.7	16.1%	1000%	1000%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
1B. Fugitive Emissions from Fuels	1. Solid Fuels	a. Coal Mining	i. Underground Mines	Mining Activities	CH_4	2,551.7	57.6	5.0%	2.0%	5%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%
				Post-Mining Activities	CH_4	233.5	25.5	5.0%	200%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ii. Surface Mines	Mining Activities	CH_4	19.5	10.0	5.0%	200%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				Post-Mining Activities	CH_4	1.7	0.9	5.0%	200%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2. Oil and Natural Gas	a. Oil	i. Exploration		CO_2	0.0	0.0	10.0%	24.8%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	0.0	0.0	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.0	0.0	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ii. Production		CO_2	0.2	0.2	10.0%	23.4%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	20.9	25.6	10.0%	23.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			iii. Transport		CO_2	0.0	0.0	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	0.3	0.4	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			iv. Refining / Storage		CH_4	15.0	16.4	10.0%	24.4%	26%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		b. Natural Gas	i. Production / Processing		CO_2	0.3	0.3	10.0%	18.0%	21%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	159.0	215.9	10.0%	17.4%	20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ii. Transmission		CO_2	0.0	0.1	10.0%	16.0%	19%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	145.8	192.4	10.0%	16.9%	20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Distribution		CH_4	9.6	20.5	8.7%	25.0%	26%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		c. Venting and Flaring	Venting		CO_2	0.0	0.0	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			i. oil		CH_4	19.0	24.1	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 6.1 (continued)
Tier1 Uncertainty Calculation & Reporting

A					B	C	D	E	F	G	H	I	J	K	L	M
IPCC Source Category					Gas	Base year emissions	2002 emissions	Activity Data Uncertainty	Emissions Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2001	Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by Emission Factor	Uncertainty in trend in National Emissions introduced by Activity Data	Uncertainty introduced into the Trend in Total National Emissions
						Input Data	Input Data	Input Data	Input Data	(E^2+F^2)^1/2	G*D/∑D	Note B	D/∑C	I*F Note C	J*E*√2	(K^2+L^2)^1/2
						Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%	%	%	%	%	%
2. Industrial Processes	A. Mineral Products	1. Cement Production			CO_2	37,006.4	30,766.4	5.2%	1.6%	5%	0.1%	-0.8%	2.5%	0.0%	0.2%	0.2%
		2. Lime Production			CO_2	5,052.6	4,238.2	5.0%	0.3%	5%	0.0%	-0.1%	0.3%	0.0%	0.0%	0.0%
		3. Limestone & Dolomite Use			CO_2	11,406.3	10,363.6	3.0%	3.6%	5%	0.0%	-0.2%	0.8%	0.0%	0.0%	0.0%
	B. Chemical Industries	1. Ammonia Production			CO_2	3,376.6	2,410.5	3.0%	2.0%	4%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.0%
		2. Nitric Acid Production			N_2O	765.7	803.6	5.0%	46.0%	46%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		3. Adipic Acid Production			N_2O	6,650.0	404.2	5.0%	0.0%	5%	0.0%	-0.5%	0.0%	0.0%	0.0%	0.0%
		5. Other	Carbon Black		CH_4	5.8	5.8	5.0%	54.8%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Ethylene		CH_4	1.9	2.3	5.0%	77.2%	77%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CO_2	167.1	207.7	5.0%	77.2%	77%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Dichloroethylene		CH_4	0.3	0.4	5.0%	101%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Styrene		CH_4	1.4	2.1	5.0%	113%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Mehanol		CH_4	3.5	NO	54.8%	5%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Coke		CH_4	324.8	106.1	10.0%	55.8%	57%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2. Industrial Processes (F-gas)	C. Metal Prod.	3. Aluminium			PFCs	72.5	15.1	5.0%	33.0%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. Magnesium			SF_6	119.5	740.9	5.0%	33.0%	33%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	16,965.0	5,022.8	5.0%	100.0%	100%	0.4%	-1.1%	0.4%	-1.1%	0.0%	1.1%
		2. Fugitive Emissions			HFCs	491.5	439.4	10.0%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					PFCs	762.9	1,016.4	10.0%	100.0%	100%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
					SF_6	4,708.3	812.6	10.0%	100.0%	100%	0.1%	-0.3%	0.1%	-0.3%	0.0%	0.3%
	F. Consumption of F-gas	1. Refrigeration and Air Conditioning Equipment	Domestic Refrigerator	manufacturing	HFCs	11.3	152.1	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	IE	IE	40.0%	50.0%	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	IE	IE	40.0%	—	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Commercial Refrigerator	manufacturing	HFCs	11.1	385.1	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	IE	IE	40.0%	50.0%	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.0	0.0	40.0%	—	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Stationary Air-Condition	manufacturing	HFCs	0.0	75.1	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.0	14.9	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Mobile Air-Condition	manufacturing	HFCs	56.0	66.7	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	584.1	1,851.0	40.0%	50.0%	64%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%
				disposal	HFCs	146.6	903.0	40.0%	—	40%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
		2. Foam Blowing		manufacturing	HFCs	457.0	653.1	50.0%	50.0%	71%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		4. Aerosols / MDI		stock/disposal	HFCs	1,365.0	2,624.1	40.0%	—	40%	0.1%	0.1%	0.2%	0.0%	0.1%	0.1%
		5. Solvents			PFCs	8,880.0	4,288.0	40.0%	—	40%	0.1%	-0.4%	0.3%	0.0%	0.2%	0.2%
		6. Semiconductor Manufacture			HFCs	145.1	113.5	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					PFCs	2,857.7	3,707.4	40.0%	50.0%	64%	0.2%	0.0%	0.3%	0.0%	0.2%	0.2%
					SF_6	1,099.4	1,716.0	40.0%	50.0%	64%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%
		7. Electrical Equipment		manufacturing	SF_6	9,560.0	884.3	40.0%	30.0%	50%	0.0%	-0.8%	0.1%	-0.2%	0.0%	0.2%
				stock	SF_6	1,430.0	320.0	40.0%	50.0%	64%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.1%
				Maintenance	SF_6	IE	IE	40.0%	—	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	SF_6	IE	IE	40.0%	—	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		8. Other (for Studies etc.)			HFCs	0.0	0.0	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3. Solvent	D. Other	Anaesthesia			N_2O	287.1	320.8	5.0%	—	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

4. Agriculture	A. Enteric Fermentation	Dairy Cattle		CH_4	3,831.7	3,215.5	10.0%	16.2%	19%	0.0%	-0.1%	0.3%	0.0%	0.0%	0.0%
		Non-Dairy Cattle		CH_4	3,141.1	3,163.0	10.0%	19.7%	22%	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%
		Sheep		CH_4	2.6	1.0	4.9%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Goat		CH_4	3.1	3.0	4.9%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Swine		CH_4	261.7	223.8	4.9%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Horse		CH_4	8.8	9.5	4.9%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Manure Management	Dairy Cattle		CH_4	377.6	310.2	10.0%	164%	164%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	2,573.7	2,114.2	10.0%	59.1%	60%	0.1%	-0.1%	0.2%	0.0%	0.0%	0.0%
		Non-Dairy Cattle		CH_4	189.9	189.4	10.0%	215%	215%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	3,650.7	3,641.1	10.0%	71.0%	72%	0.2%	0.0%	0.3%	0.0%	0.0%	0.0%
		Swine		CH_4	220.1	188.2	10.0%	146%	147%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	3,925.8	3,356.8	10.0%	64.7%	65%	0.2%	-0.1%	0.3%	0.0%	0.0%	0.1%
		Hen		CH_4	85.4	78.1	10.0%	230%	230%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	1,248.1	1,142.2	10.0%	79.1%	80%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
		Broiler		CH_4	198.2	144.5	10.0%	233%	233%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	2,135.9	1,557.1	10.0%	100%	101%	0.1%	-0.1%	0.1%	-0.1%	0.0%	0.1%
		Sheep		CH_4	0.2	0.1	4.9%	100%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	2.0	0.7	4.9%	50%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Goat		CH_4	0.1	0.1	4.9%	100%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	8.6	8.2	4.9%	50%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Horse		CH_4	1.0	1.1	4.9%	100%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	5.5	6.0	4.9%	50%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Rice Cultivation	Continuously Flooded		CH_4	317.1	259.3	7.6%	115%	116%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Intermittently Flooded	Straw amendment	CH_4	4,604.1	3,764.6	—	—	32%	0.1%	-0.1%	0.3%	0.0%	0.0%	0.0%
			Various compost amendment	CH_4	1,197.0	978.7	—	—	46%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			No-amendment	CH_4	957.6	783.0	—	—	32%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
	D. Agricultural Soils	1. Direct Soil Emissions	Synthetic Fertilizers	N_2O	2,638.6	2,062.5	—	—	130%	0.2%	-0.1%	0.2%	0.0%	0.0%	0.0%
			Animal Waste Applied to Soils	N_2O	1,702.0	1,422.3	—	—	55%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
		2. Animal Production		CH_4	3.1	2.3	10.0%	114%	115%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	6.2	4.6	10.0%	116%	116%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Indirect Emission	Atmospheric Deposition	N_2O	902.5	751.3	—	—	52%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			N Leaching & Run-off	N_2O	4,497.2	3,663.2	—	—	84%	0.2%	-0.1%	0.3%	0.0%	0.0%	0.0%
	F. Field Burning of Agricultural Residue	1. Cereals	Rice	CH_4	105.0	56.8	—	—	62%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	93.7	56.4	—	—	202%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Wheat etc.	CH_4	4.8	3.1	50.0%	101%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	10.2	6.4	50.0%	199%	205%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Maize	CH_4	33.0	24.0	50.0%	78.0%	93%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	13.8	10.0	50.0%	205%	211%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Pulse	Peas	CH_4	0.4	0.2	20.0%	78.0%	81%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	0.3	0.2	20.0%	205%	206%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Soybeans	CH_4	2.4	2.6	50.0%	78.0%	93%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	3.0	3.2	50.0%	205%	211%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other	CH_4	1.7	1.2	—	—	70%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	2.0	1.4	—	—	168%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Tuber & Roots	Potatoes	CH_4	4.6	3.8	20.0%	78.0%	81%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	2.9	2.4	20.0%	205%	206%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other: Sugarbeet	CH_4	0.8	0.8	50.0%	78.0%	93%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	0.3	0.3	50.0%	205%	211%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. Sugar Cane		CH_4	15.7	9.8	50.0%	78.0%	93%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	3.6	2.3	50.0%	205%	211%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 6.1 (continued)
Tier1 Uncertainty Calculation & Reporting

A				B	C	D	E	F	G	H	I	J	K	L	M
IPCC Source Category				Gas	Base year emissions	2002 emissions	Activity Data Uncertainty	Emissions Factor Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2001	Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by Emission Factor	Uncertainty in trend in National Emissions introduced by Activity Data	Uncertainty introduced into the Trend in Total National Emissions
					Input Data	Input Data	Input Data	Input Data	(E^2+F^2)^1/2	G*D/∑D	Note B	D/∑C	I*F Note C	J*E*√2	(K^2+L^2)^1/2
					Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%	%	%	%	%	%
6. Waste	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	Kitchen Garbage	CH_4	1,364.9	818.5	23.5%	101%	104%	0.1%	-0.1%	0.1%	-0.1%	0.0%	0.1%
			Paper & Textiles	CH_4	1,871.8	1,607.6	17.5%	103%	104%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
			Waste Wood	CH_4	808.2	1,168.2	15.4%	104%	105%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
	B. Wastewater Handling	1. Industrial Wastewater		CH_4	350.6	333.6	16.9%	100%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant	CH_4	182.2	243.7	10.0%	30.9%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	488.9	654.0	10.0%	146%	146%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
			Private Sewerage Tank	CH_4	451.0	430.7	10.0%	59.4%	60%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	468.4	333.4	10.0%	47.7%	49%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Human-Waste Treatment Plant	CH_4	112.0	21.8	10.0%	91.6%	92%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	140.6	9.5	10.0%	108%	108%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Waste Incineration	Municipal Solid Waste		CO_2	10,034.0	13,183.8	44.8%	11.2%	46%	0.5%	0.2%	1.1%	0.0%	0.7%	0.7%
				CH_4	12.7	10.3	10.0%	88.9%	89%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	570.2	671.0	10.0%	24.2%	26%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Industrial Solid Waste		CO_2	6,901.5	10,155.4	10.0%	70.6%	71%	0.5%	0.2%	0.8%	0.2%	0.1%	0.2%
				CH_4	0.8	1.0	10.0%	264%	264%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	1,186.0	1,973.0	10.0%	31.5%	33%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%

Annex 8. National Greenhouse Gas Emissions in Fiscal Year 2003 (for Domestic Publication)

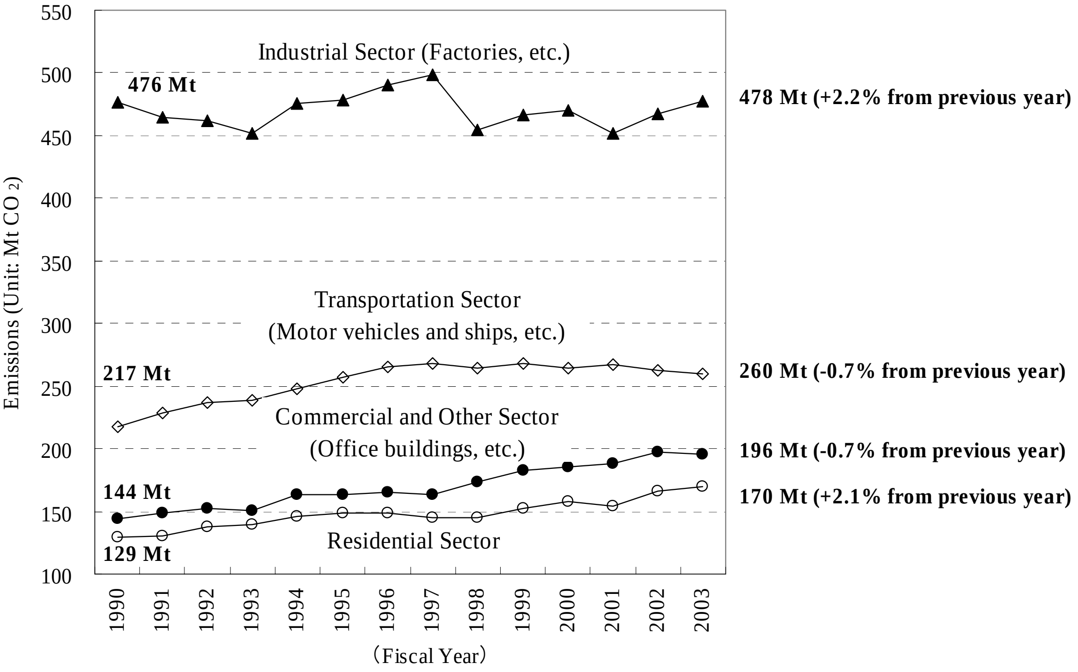
In this annex, to review the achievement of Japan's commitment of the Kyoto Protocol (6% reduction from the base year[1] [1990 for CO_2, CH_4 and N_2O, while 1995 for HFCs, PFCs and SF_6]), national total greenhouse gas emissions without LUCF sector is expressed. CO_2 emissions from power generation and heat generation (industrial steam generation and district heat supply) are allocated to the sector consuming the electricity and heat, in order to review the progress of countermeasures against global warming issues.

Summary

- Total greenhouse gas emission in fiscal 2003 was 1,339 million tons (in CO_2 equivalents)[2] .
- The figure shows an increase of 0.7% from the previous year's level.
- Compared to that in the base year under the Kyoto Protocol (in principle: 1990), it increased by 8.3%.

Sectoral breakdown of Carbon Dioxide (CO_2) emissions which accounts for more than 90% of the total greenhouse gas emissions is as follows.

< Industrial Sector (Factories, etc.) >	increase of 0.3% over fiscal 1990
< Transportation Sector (Motor vehicles and ships, etc.) >	increase of 19.8% over fiscal 1990
< Commercial and Other Sector (Office buildings, etc.) >	increase of 36.1% over fiscal 1990
< Residential Sector >	increase of 31.4% over fiscal 1990



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[1] The base year of emissions of HFCs, PFCs and SF_6 is permitted to set up the year for 1995 in accordance with Article 3, paragraph 8 of the Kyoto Protocol.

[2] This value is provisional and subject to change in accordance with the future revision of calculation methods.

8.1. National Total Greenhouse Gas Emissions

The total emissions of greenhouse gases (calculated by multiplying each greenhouse gas emissions by Global Warming Potential (GWP)[*1], and adding them up) in fiscal year 2003 is 1,339 million tons (carbon dioxide equivalents). It has increased by 8.3% compared with the total emissions (1,237million tons) of the base year under the Kyoto Protocol (1990 for CO_2, CH_4 and N_2O, while 1995 for HFCs, PFCs and SF_6)[*2] and increased by 0.7% from the previous year.

Table 1 Trend of Greenhouse Gas Emissions

[Mt CO_2 eq.]

	GWP	Base year of KP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO_2 Emissions	1	1,122.3	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8	1,259.4
CH_4	21	24.8	24.8	24.6	24.5	24.4	24.0	23.4	22.9	22.1	21.5	21.1	20.7	20.2	19.5	19.3
N_2O	310	40.2	40.2	39.7	39.9	39.6	40.5	40.6	41.5	41.9	40.6	35.1	37.5	34.6	34.7	34.6
HFCs	HFC-134a：1,300 etc.	20.2						20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3
PFCs	PFC-14：6,500 etc.	12.6						12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0
SF_6	23,900	16.9						16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.5
Gross Total		1,237.0	1,187.2	1,195.7	1,213.3	1,202.8	1,262.7	1,326.8	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

* According to Article 3.3 of the Kyoto Protocol, emissions from Land-Use Change and Forestry are regarded as RMU (removal unit). Therefore, CH_4 and N_2O emissions in Table 1 do not include emissions from Land-Use Change and Forestry. On the contrary, emissions from Land-Use Change and Forestry are included in GHG emissions based on the estimation method decided by the UNFCCC (refer chapter 2 table 2-1).

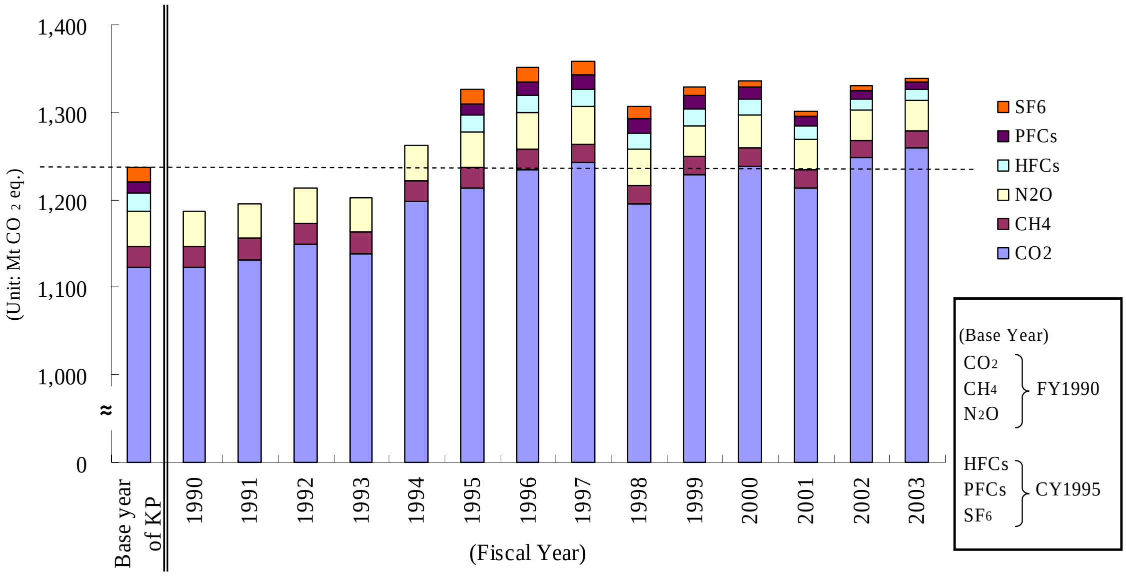


Figure 1 Trend of Total Greenhouse Gas Emissions

Since the Kyoto Protocol entered into force in February 2005, the emissions for the base year have to be fixed and reported at the latest by January 1, 2007. Emission value in this report is provisional and subject to change in accordance with the future revision of calculation methods.

*1 Global Warming Potential (GWP): It is coefficients that indicate degrees of greenhouse gas effects caused by greenhouse gases converted into the proportion of equivalent degrees of CO_2. The coefficients are subjected to the *Second National Assessment Report* (1995) issued by the Intergovernmental Panel on Climate Change (IPCC).

*2 The base year of emissions of HFCs, PFCs and SF_6 is permitted to set up the year for 1995 in accordance with Article 3, paragraph 8 of the Kyoto Protocol.

*3 The method used for the above estimations of GHGs needs a further improvement because it comprises the following subjects to be solved; it dose not fully ensure the carbon balance, etc. Government of Japan intends to continue to discuss technically on more appropriate method. Depending on the conclusion, the amount of CO_2 emission could change drastically.

*4 Emissions and removals of greenhouse gases are required to report by calendar year in accordance with the *Revised 1996 IPCC Guidelines (for National Greenhouse Gas Inventories)*. However, Japan has reported its emissions and removals of greenhouse gases in fiscal year (April to March). During the in-country visit review in 2003 under UNFCCC, difficulties on converting the data used in the past on calendar year basis and the possibility of counting the relevant data in the future on calendar year basis were discussed. Expert Review Team (ERT) concluded that estimation on fiscal year basis all through the time series would be preferable than estimation of which data for the previous years is on fiscal year basis and data for the latest year on calendar year basis, but encourages Japan to continue its work on the possibilities for conversion.

8.2. Status of Greenhouse Gas Emissions

8.2.1. Carbon Dioxide (CO_2)

Carbon dioxide emissions in fiscal year 2003 are 1,259 million tons and 9.87 ton per capita. The values increased by 12.2% and 8.7% from 1990's level and increased by 0.9% and 0.8% from the previous year, respectively.

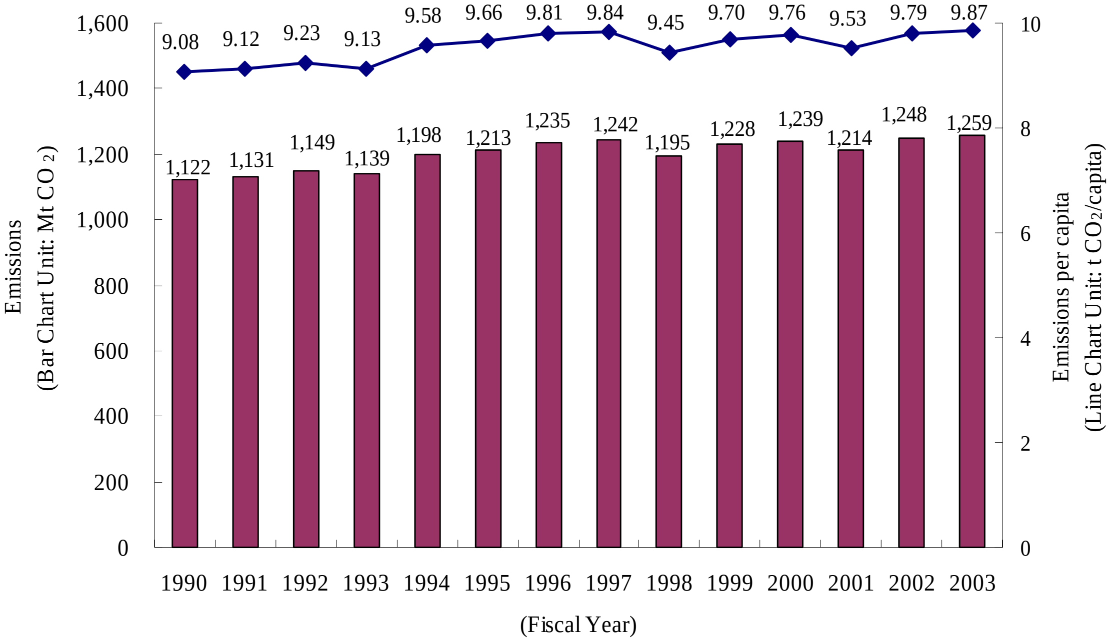


Figure 2 CO_2 Emission Trend

The emissions from the industrial sector (factories, etc. except for industrial processes) which hold 40% of the total carbon dioxide emissions increased by 0.3% in fiscal year 2003 when compared with fiscal 1990, and increased by 2.2% from the previous year. This sector includes emissions from energy consumption in manufacturing (factory), agriculture, fishery and forestry, mining and constructions. Tertiary industries are not included. Small manufacturing (factory) are reported under the commercial and other sector (office buildings, etc.) because of the limit of statistical resolution.

The emissions from the transportation sector (motor vehicles and ships, etc.) increased by 19.8% in fiscal year 2003 when compared with fiscal 1990, and decreased by 0.7% from the previous year.

The emissions from the residential sector increased by 31.4% in fiscal year 2003 when compared with fiscal 1990, and increased by 2.1% from the previous year.

The emissions from the commercial and other sector (office buildings, etc.) increased by 36.1% when compared with fiscal 1990, and decreased by 0.7% from the previous year. This sector includes emissions from offices, commercial establishments, etc. which are commonly considered as commercial sector. Some part of small manufacturing (factory) and some part of mobile sources are also included.

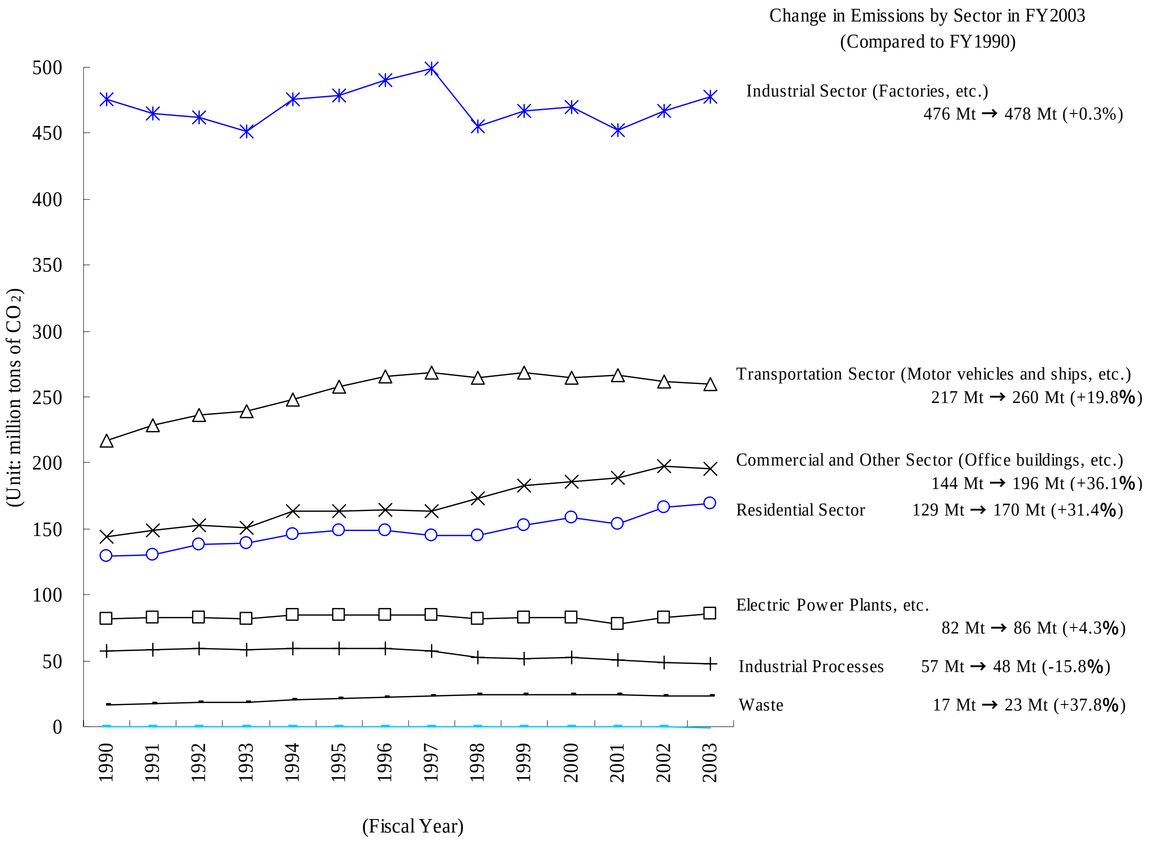


Figure 3 Changes in Carbon Dioxide Emissions

N.B. Figure 3 is created by allocating CO_2 emissions from power generation and steam generation into each of the final demand sector.

(Note) Effect of long-term shut down of nuclear power plants on CO_2 emission

For the effect of long-term shut down of nuclear power plants in FY2003, reduction in CO_2 emissions is estimated to be about 60,000 Gg-CO_2 in comparison with the assumption that these nuclear power plants had operated according to the planned operational rate before the long-term shut down (planned operational rate for FY2002: 84.1%). The reduction amounts to be about 4.9% of the total GHG emission in base year of Kyoto Protocol.

8.2.2. Methane (CH_4)

The emissions of methane in fiscal year 2003 is 19.3 million tons of carbon dioxide equivalent, decreasing by 22.1% compared to fiscal 1990, while decreasing by 1.2% compared to the previous year. The emissions from Coal Mining have remarkably decreased compared to the base year.

8.2.3. Nitrous Oxide (N_2O)

The emissions of nitrous oxide in fiscal year 2003 is 34.6 million tons of carbon dioxide equivalent, decreasing by 13.9% compared to fiscal 1990, while decreasing by 0.2% compared to the previous year. The emissions from Adipic Acid Production have remarkably decreased compared to the base year. The emissions from Agricultural Soils have remarkably decreased compared to the previous year.

8.2.4. Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride (SF_6)

The emissions of HFCs in 2003 is 12.3 million tons of carbon dioxide equivalent, decreasing by 39.2% compared to the base year (1995), while decreasing by 4.7% compared to the previous year. The emissions from By-product HFC-23 from Manufacture of HCFC-22 are continuing to decrease.

The emissions of PFCs is 9.0 million tons of carbon dioxide equivalent, decreasing by 28.2% compared to the base year (1995), while decreasing by 8.3% compared to the previous year. The emissions from Solvents and Cleaning Agent are continuing to decrease following a decrease in the previous year.

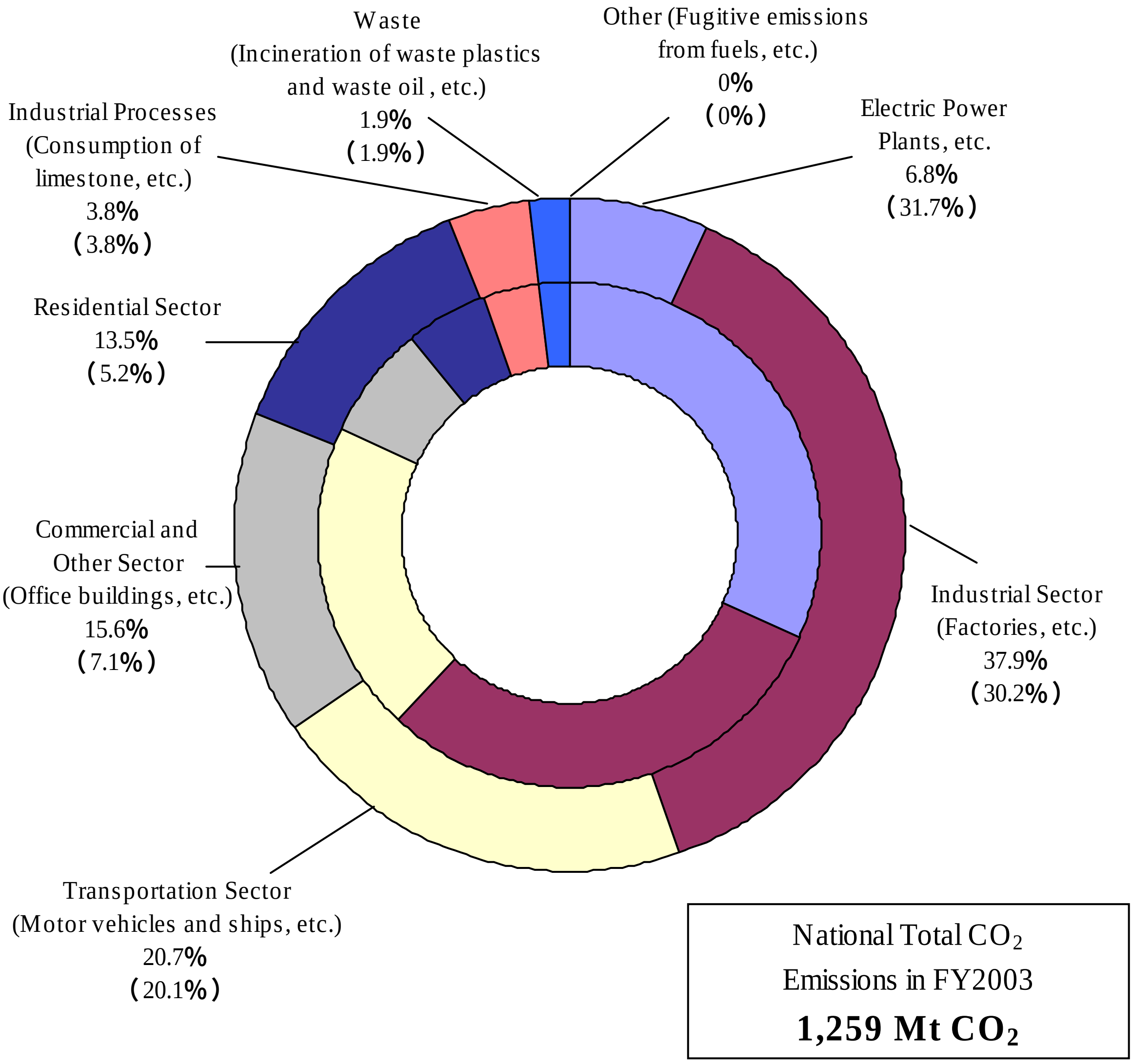
The emissions of SF_6 is 4.5 million tons of carbon dioxide equivalent, decreasing by 73.6% compared to the base year (1995), while decreasing by 15.3% compared to the previous year. The emissions from Electrical Equipment and those from Magnesium Production have decreased.

8.3. Remarks

Each greenhouse gas emission is recalculated retroactive to fiscal 1990, with the revision of calculation methods and emission factors based on the latest scientific knowledge. The calculation methods of the emissions need to be improved in accordance with the movement of the international examination or expanding of the scientific information.

Reference: Sectoral Breakdown of the emissions of Greenhouse Gases in Fiscal Year 2003

- **Carbon Dioxide (CO_2)**

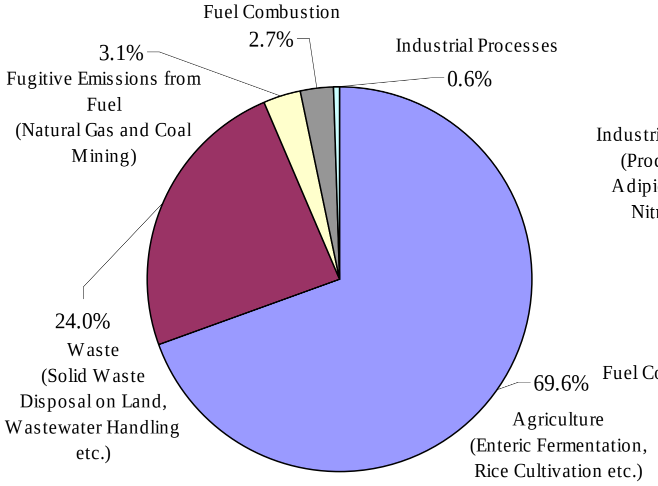


Note 1: The inner circle shows the proportion of the direct emissions by each sector (values in parentheses), and the outer circle shows the proportion of the emissions including the direct emissions and indirect emissions from power generation by electric utilities and steam generation (industrial steam generation and district heat supply) allocated to final demand sector in accordance with the electric and heat consumption (values without parenthesis).

Note 2: The added proportion among sectors is not always 100% because of the statistical error and a half adjustment.

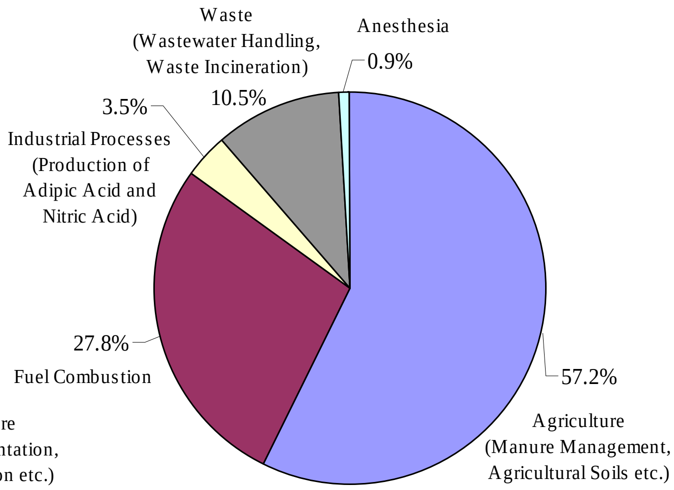
Note 3: Other includes the fugitive emissions from fuels and errors of electric power distribution, etc.

- **Methane (CH_4)**



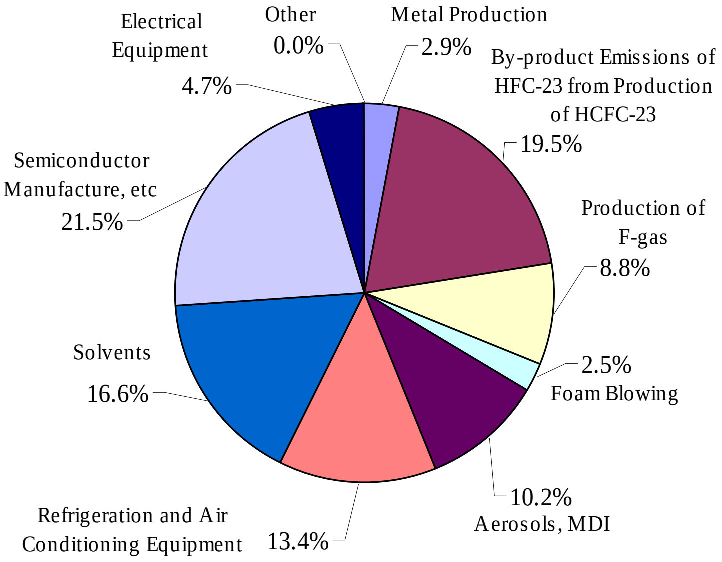
National Total CH_4 Emissions in FY2003
19.3 Mt (CO_2 eq.)

- **Nitrous Oxide (N_2O)**



National Total N_2O Emissions in FY2003
34.6 Mt (CO_2 eq.)

- **Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride (SF_6)**



National Total Emissions of F-gas in 2003
25.8 Mt (CO_2 eq.)

Annex 9. Hierarchical Structure of Japan's National GHG Inventory File System

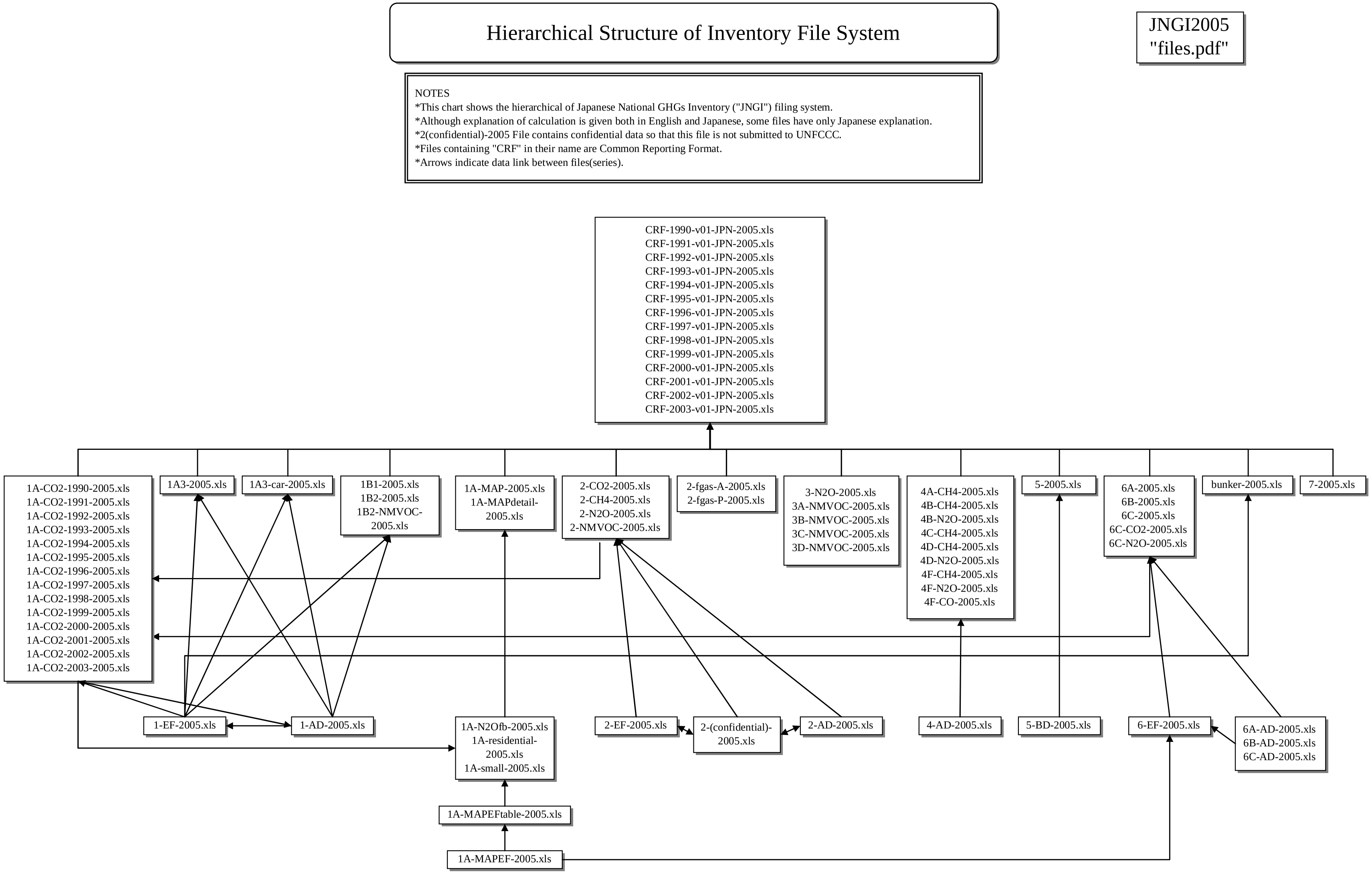
Multiple MS Excel files have been used when estimating Japanese inventory. The explanation of each MS Excel file and the hierarchical structure of Japanese National GHGs Inventory (JNGI) file system are shown below.

Table 1 Explanation of each MS Excel file

category	file name	contents
	CRF-1990-v01-JPN-2005.xls ～ CRF-2003-v01-JPN-2005.xls	Common reporting format provided by UNFCCC secretariat
1. Energy	1A3-2005.xls	GHGs emissions from transport sector (except Non-CO_2 from Car)
	1A3-car-2005.xls	Non-CO_2 emissions from car
	1A-CO2-1990-2005.xls ～ 1A-CO2-2003-2005.xls	CO_2 emissions from fuel combustions at stationary facilities
	1-AD-2005.xls	Activity Data of Caotegory1 (except Energy Balance Sheet)
	1A-MAP-2005.xls	Emissions of Non-CO_2 from stationary combustion
	1A-MAPdetail-2005.xls	Emissions of Non-CO_2 from stationary combustion fuel by fuel (for CRF reporting)
	1A-MAPEF-2005.xls	Emission Factors of Non-CO2 from stationary combustion
	1A-MAPEFtable-2005.xls	Emission Factors of Non-CO_2 from stationary combustion (original data)
	1A-N2Ofb-2005.xls	N_2O Emissions from fluidized-bed boilers
	1A-residential-2005.xls	Emissions of Non-CO_2 from Residential Sector
	1A-small-2005.xls	Emissions of Non-CO_2 from Commercial and other sector
	1B1-2005.xls	GHGs fugitive emissions from coal production
	1B2-2005.xls	GHGs fugitive emissions from oil & gas production
	1B2-NMVOC-2005.xls	NMVOC fugitive emissions from oil facilities
	1-EF-2005.xls	Emission Factors of Category1
2. Industrial Processes	2(confidential)-2005.xls	Confidential Data of Category2 (Industrial Processes)
	2-AD-2005.xls	Activity Data of Caotegory2 (except F-gas)
	2-CH4-2005.xls	CH_4 emissions from Category2 (Industrial Processes)
	2-CO2-2005.xls	CO_2 emissions from Category2 (Industrial Processes)
	2-EF-2005.xls	Emission Factors of Category2
	2-Fgas-A-2005.xls	F-gas (HFCs, PFCs, SF_6) actual emissions
	2-Fgas-P-2005.xls	F-gas (HFCs, PFCs, SF_6) potential emissions
	2-N2O-2005.xls	N_2O emissions from Category2 (Industrial Processes)
	2-NMVOC-2005.xls	NMVOC emissions from Category2 (Industrial Processes)
3. Solvent and Other Product Use	3A-NMVOC-2005.xls	NMVOC emissions from paint application use
	3B-NMVOC-2005.xls	NMVOC emissions from dry cleaning & Degreasing
	3C-NMVOC-2005.xls	NMVOC emissions from paint production, ink production & use, polyethylene laminate, solvent-type adhesive use and gum solvent use
	3D-NMVOC-2005.xls	NMVOC emissions from other solvent
	3-N2O-2005.xls	N_2O emissions from anesthesia

Explanation of each MS Excel file (continued)

category	file name	contents
4. Agriculture	4A-CH4-2005.xls	CH_4 emissions from enteric fermentation
	4-AD-2005.xls	Activity Data of Caotegory4
	4B-CH4-2005.xls	CH_4 emissions from manure management
	4B-N2O-2005.xls	N_2O emissions from manure management
	4C-CH4-2005.xls	CH_4 emissions from rice cultivation
	4D-CH4-2005.xls	CH_4 emissions from agricultural soils
	4D-N2O-2005.xls	N_2O emissions from agricultural soils
	4F-CH4-2005.xls	CH_4 emissions from field burning of agricultural residues
	4F-CO-2005.xls	CO emissions from field burning of agricultural residues
	4F-N2O-2005.xls	N_2O emissions from field burning of agricultural residues
5. LUCF	5-2005.xls	GHGs emissions/removals from/by Category5
	5-BD-2005.xls	Backdata (activity data, parameters etc.) of Category5
6. Waste	6A-2005.xls	GHGs emissions from solid waste disposal on land
	6A-AD-2005.xls	Activity data of solid waste disposal on land
	6B-2005.xls	GHGs emissions from wastewater handling
	6B-AD-2005.xls	Activity data of wastewater handling
	6C-2005.xls	GHGs emissions from waste incineration (exclude CO_2, N_2O)
	6C-AD-2005.xls	Activity data of waste incineration
	6C-CO2-2005.xls	CO_2 emissions from waste incineration
	6C-N2O-2005.xls	N_2O emissions from waste incineration
	6-EF-2005.xls	Emission Factors of Category6
7. Other	7-2005.xls	CO Emissions from tobaccos
Memo Item	bunker-2005.xls	GHGs emissions from bunker fuels



NOTES
*This chart shows the hierarchical of Japanese National GHGs Inventory ("JNGI") filing system.
*Although explanation of calculation is given both in English and Japanese, some files have only Japanese explanation.
*2(confidential)-2005 File contains confidential data so that this file is not submitted to UNFCCC.
*Files containing "CRF" in their name are Common Reporting Format.
*Arrows indicate data link between files(series).

Figure 1 Hierarchical structure of Japan's National GHG Inventory File System

Annex 10. Summary of Common Reporting Format

10.1. Emissions and Removals in 1990

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1990
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,038,374.04**	**24,821.79**	**40,207.81**	**NE**	**NE**	**NE**	**1,103,403.64**
1. Energy	**1,048,332.67**	**3,707.87**	**6,218.89**				**1,058,259.43**
A. Fuel Combustion (Sectoral Approach)	1,048,332.15	531.75	6,218.89				1,055,082.79
1. Energy Industries	338,571.89	-32.67	299.44				338,838.67
2. Manufacturing Industries and Construction	335,046.99	227.51	845.25				336,119.75
3. Transport	210,663.43	195.19	5,022.73				215,881.35
4. Other Sectors	164,049.84	141.72	51.46				164,243.03
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.51	3,176.12	0.00				3,176.63
1. Solid Fuels	NE,NO	2,806.43	NE,NO				2,806.43
2. Oil and Natural Gas	0.51	369.69	0.00				370.20
2. Industrial Processes	**57,008.97**	**337.80**	**7,415.74**	**NE**	**NE**	**NE**	**64,762.51**
A. Mineral Products	53,465.31	NO	NO				53,465.31
B. Chemical Industry	3,543.66	337.80	7,415.74	NE	NE	NE	11,297.21
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO.NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**287.07**				**287.07**
4. Agriculture	**NE**	**15,568.88**	**23,426.62**				**38,995.50**
A. Enteric Fermentation		7,249.10					7,249.10
B. Manure Management		1,072.55	13,550.26				14,622.80
C. Rice Cultivation		7,075.73					7,075.73
D. Agricultural Soils(2)	NE	3.06	9,746.46				9,749.52
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		168.45	129.90				298.35
G. Other		NO	NO				NO
5. Land-Use Change and Forestry(1)	**-83,903.07**	**53.07**	**5.39**				**-83,844.62**
6. Waste	**16,935.48**	**5,154.16**	**2,854.11**				24,943.75
A. Solid Waste Disposal on Land	NE	4,044.84					4,044.84
B. Wastewater Handling		1,095.78	1,097.88				2,193.66
C. Waste Incineration	16,935.48	13.54	1,756.22				18,705.24
D. Other	NO	NE	NE				NE.NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**30,701.13**	**42.05**	**274.75**				**31,017.93**
Aviation	13,183.16	7.83	130.44				13,321.43
Marine	17,517.97	34.22	144.31				17,696.50
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,694.38**						**18,694.38**

(1) For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	61,664.52	-146,146.74	-84,482.22			-84,482.22
B. Forest and Grassland Conversion	579.15		579.15	53.07	5.39	637.61
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE,NO
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	62,243.67	-146,146.74	-83,903.07	53.07	5.39	-83,844.62

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,187,248.26
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,103,403.64

(a) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.2. Emissions and Removals in 1991

SUMMARY 2 SUMMARY REPORT FOR CO$_2$ EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1991
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO$_2$ (1)	CH$_4$	N$_2$O	HFCs	PFCs	SF$_6$	Total
	CO$_2$ equivalent (Gg)						
Total (Net Emissions) (1)	**1,047,503.78**	**24,729.13**	**39,715.08**	**NE**	**NE**	**NE**	**1,111,947.99**
1. Energy	**1,055,413.37**	**3,467.43**	**6,503.27**				**1,065,384.06**
A. Fuel Combustion (Sectoral Approach)	1,055,412.75	532.08	6,503.27				1,062,448.10
1. Energy Industries	340,056.10	-33.08	306.93				340,329.94
2. Manufacturing Industries and Construction	325,225.33	223.86	911.68				326,360.87
3. Transport	222,082.25	200.82	5,235.56				227,518.63
4. Other Sectors	168,049.08	140.48	49.10				168,238.66
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.62	2,935.34	0.00				2,935.96
1. Solid Fuels	NE,NO	2,538.33	NE,NO				2,538.33
2. Oil and Natural Gas	0.62	397.01	0.00				397.63
2. Industrial Processes	**58,601.01**	**328.47**	**6,770.71**	**NE**	**NE**	**NE**	**65,700.18**
A. Mineral Products	55,101.92	NO	NO				55,101.92
B. Chemical Industry	3,499.09	328.47	6,770.71	NE	NE	NE	10,598.27
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO,NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF$_6$				NE	NE	NE	NE
F. Consumption of Halocarbons and SF$_6$				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**356.85**				**356.85**
4. Agriculture	**NE**	**15,670.67**	**23,132.76**				**38,803.42**
A. Enteric Fermentation		7,339.31					7,339.31
B. Manure Management		1,066.84	13,493.96				14,560.79
C. Rice Cultivation		7,094.10					7,094.10
D. Agricultural Soils (2)	NE	3.19	9,503.23				9,506.42
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		167.23	135.57				302.79
G. Other		NO	NO				NO
5. Land-Use Change and Forestry (1)	**-83,866.26**	**83.19**	**8.44**				**-83,774.63**
6. Waste	**17,355.67**	**5,179.38**	**2,943.06**				25,478.11
A. Solid Waste Disposal on Land	NE	4,100.78					4,100.78
B. Wastewater Handling		1,065.09	1,131.47				2,196.56
C. Waste Incineration	17,355.67	13.51	1,811.59				19,180.76
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**32,399.63**	**44.37**	**289.94**				**32,733.94**
Aviation	13,912.62	8.27	137.65				14,058.54
Marine	18,487.01	36.11	152.29				18,675.40
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO$_2$ Emissions from Biomass	**18,820.11**						**18,820.11**

(1) For CO$_2$ emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES Land-Use Change and Forestry	CO$_2$ emissions	CO$_2$ removals	Net CO$_2$ emissions / removals	CH$_4$	N$_2$O	Total emissions
	CO$_2$ equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	57,352.68	-142,126.77	-84,774.09			-84,774.09
B. Forest and Grassland Conversion	907.83		907.83	83.19	8.44	999.46
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO$_2$ Emissions and Removals from Soil	NE	NE	NE			NE,NO
E. Other	NO	NO	NO	NO	NO	NO
Total CO$_2$ Equivalent Emissions from Land-Use Change and Forestry	58,260.51	-142,126.77	-83,866.26	83.19	8.44	-83,774.63

Total CO$_2$ Equivalent Emissions without Land-Use Change and Forestry (a)	1,195,722.62
Total CO$_2$ Equivalent Emissions with Land-Use Change and Forestry (a)	1,111,947.99

(a) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.3. Emissions and Removals in 1992

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1992
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,063,344.69**	**24,569.91**	**39,907.36**	**NE**	**NE**	**NE**	**1,127,821.96**
1. Energy	**1,071,397.44**	**3,258.78**	**6,761.97**				**1,081,418.19**
A. Fuel Combustion (Sectoral Approach)	1,071,396.82	591.65	6,761.97				1,078,750.44
1. Energy Industries	345,832.46	-34.84	271.91				346,069.54
2. Manufacturing Industries and Construction	324,048.10	270.61	936.24				325,254.96
3. Transport	229,925.22	201.42	5,495.85				235,622.49
4. Other Sectors	171,591.03	154.45	57.97				171,803.45
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.63	2,667.12	0.00				2,667.75
1. Solid Fuels	NE,NO	2,267.52	NE,NO				2,267.52
2. Oil and Natural Gas	0.63	399.60	0.00				400.23
2. Industrial Processes	**59,127.04**	**303.51**	**6,693.99**	**NE**	**NE**	**NE**	**66,124.53**
A. Mineral Products	55,602.80	NO	NO				55,602.80
B. Chemical Industry	3,524.24	303.51	6,693.99	NE	NE	NE	10,521.73
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO,NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**413.01**				**413.01**
4. Agriculture	**NE**	**15,760.21**	**22,965.82**				**38,726.03**
A. Enteric Fermentation		7,364.53					7,364.53
B. Manure Management		1,057.01	13,403.55				14,460.57
C. Rice Cultivation		7,176.75					7,176.75
D. Agricultural Soils(2)	NE	3.17	9,426.61				9,429.78
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		158.74	135.66				294.40
G. Other		NO	NO				NO
5. Land-Use Change and Forestry(1)	**-85,569.94**	**83.83**	**8.51**				**-85,477.60**
6. Waste	**18,390.14**	**5,163.60**	**3,064.06**				26,617.80
A. Solid Waste Disposal on Land	NE	4,094.20					4,094.20
B. Wastewater Handling		1,056.12	1,114.78				2,170.89
C. Waste Incineration	18,390.14	13.28	1,949.29				20,352.70
D. Other	NO	NE	NE				NE.NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**32,852.43**	**44.86**	**294.20**				**33,191.49**
Aviation	14,210.12	8.44	140.60				14,359.16
Marine	18,642.30	36.42	153.60				18,832.33
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,370.98**						**18,370.98**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	55,680.02	-142,164.72	-86,484.70			-86,484.70
B. Forest and Grassland Conversion	914.76		914.76	83.83	8.51	1,007.09
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE.NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	56,594.78	-142,164.72	-85,569.94	83.83	8.51	-85,477.60

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,213,299.56
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,127,821.96

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.4. Emissions and Removals in 1993

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1993
2005

GREENHOUSE GAS SOURCE AND SINK	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
CATEGORIES	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,048,636.57**	**24,517.02**	**39,627.33**	**NE**	**NE**	**NE**	**1,112,780.92**
1. Energy	**1,062,292.34**	**3,029.40**	**6,851.73**				**1,072,173.46**
A. Fuel Combustion (Sectoral Approach)	1,062,291.72	547.07	6,851.73				1,069,690.52
1. Energy Industries	328,613.16	-32.79	286.89				328,867.26
2. Manufacturing Industries and Construction	324,190.80	217.71	1,022.15				325,430.67
3. Transport	232,268.93	199.93	5,477.86				237,946.72
4. Other Sectors	177,218.82	162.22	64.83				177,445.86
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.62	2,482.32	0.00				2,482.94
1. Solid Fuels	NE,NO	2,075.76	NE,NO				2,075.76
2. Oil and Natural Gas	0.62	406.56	0.00				407.18
2. Industrial Processes	**58,155.65**	**302.84**	**6,559.99**	**NE**	**NE**	**NE**	**65,018.47**
A. Mineral Products	54,812.94	NO	NO				54,812.94
B. Chemical Industry	3,342.71	302.84	6,559.99	NE	NE	NE	10,205.54
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO,NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**411.66**				**411.66**
4. Agriculture	**NE**	**15,885.14**	**22,709.03**				**38,594.17**
A. Enteric Fermentation		7,309.78					7,309.78
B. Manure Management		1,037.52	13,202.19				14,239.71
C. Rice Cultivation		7,368.45					7,368.45
D. Agricultural Soils(2)	NE	3.00	9,362.41				9,365.41
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		166.38	144.44				310.82
G. Other		NO	NO				NO
5. Land-Use Change and Forestry(1)	**-90,082.13**	**84.46**	**8.57**				**-89,989.10**
6. Waste	**18,270.72**	**5,215.19**	**3,086.35**				26,572.25
A. Solid Waste Disposal on Land	NE	4,149.71					4,149.71
B. Wastewater Handling		1,052.48	1,131.84				2,184.33
C. Waste Incineration	18,270.72	13.00	1,954.50				20,238.22
D. Other	NO	NE	NE				NE.NO
7. Other ***(please specify)***	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**34,839.77**	**49.22**	**309.90**				**35,198.88**
Aviation	13,849.72	8.23	137.03				13,994.98
Marine	20,990.06	40.99	172.86				21,203.91
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**17,522.94**						**17,522.94**

(1) For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	51,193.14	-142,196.96	-91,003.82			-91,003.82
B. Forest and Grassland Conversion	921.69		921.69	84.46	8.57	1,014.72
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	52,114.83	-142,196.96	-90,082.13	84.46	8.57	-89,989.10

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry (a)	1,202,770.02
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry (a)	1,112,780.92

(a) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.5. Emissions and Removals in 1994

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1994
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,104,620.57**	**24,090.58**	**40,546.53**	**NE**	**NE**	**NE**	**1,169,257.69**
1. Energy	**1,118,143.45**	**2,662.99**	**7,230.63**				**1,128,037.07**
A. Fuel Combustion (Sectoral Approach)	1,118,142.85	536.32	7,230.63				1,125,909.80
1. Energy Industries	363,803.68	-36.60	309.22				364,076.30
2. Manufacturing Industries and Construction	339,677.41	219.46	1,175.80				341,072.67
3. Transport	241,149.53	202.34	5,684.18				247,036.05
4. Other Sectors	173,512.23	151.13	61.44				173,724.79
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.60	2,126.67	0.00				2,127.27
1. Solid Fuels	NE,NO	1,712.96	NE,NO				1,712.96
2. Oil and Natural Gas	0.60	413.70	0.00				414.31
2. Industrial Processes	**59,170.82**	**302.31**	**7,444.42**	**NE**	**NE**	**NE**	**66,917.55**
A. Mineral Products	55,599.11	NO	NO				55,599.11
B. Chemical Industry	3,571.71	302.31	7,444.42	NE	NE	NE	11,318.44
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO,NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**438.02**				**438.02**
4. Agriculture	**NE**	**15,783.88**	**22,198.67**				**37,982.55**
A. Enteric Fermentation		7,220.20					7,220.20
B. Manure Management		1,013.06	12,916.48				13,929.54
C. Rice Cultivation		7,384.52					7,384.52
D. Agricultural Soils[(2)]	NE	2.86	9,142.04				9,144.89
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		163.24	140.15				303.39
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**-93,543.74**	**85.10**	**8.64**				**-93,450.01**
6. Waste	**20,850.05**	**5,256.30**	**3,226.17**				29,332.51
A. Solid Waste Disposal on Land	NE	4,211.56					4,211.56
B. Wastewater Handling		1,031.94	1,111.56				2,143.50
C. Waste Incineration	20,850.05	12.79	2,114.61				22,977.45
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**35,909.90**	**49.65**	**320.67**				**36,280.23**
Aviation	15,059.45	8.95	149.00				15,217.40
Marine	20,850.45	40.70	171.67				21,062.83
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**17,759.70**						**17,759.70**

(1) For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	47,758.15	-142,230.51	-94,472.36			-94,472.36
B. Forest and Grassland Conversion	928.62		928.62	85.10	8.64	1,022.35
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	48,686.77	-142,230.51	-93,543.74	85.10	8.64	-93,450.01

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,262,707.70
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,169,257.69

(a) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.6. Emissions and Removals in 1995

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1995
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,116,377.15**	**23,457.93**	**40,631.58**	**20,232.67**	**12,573.06**	**16,917.20**	**1,230,189.59**
1. Energy	**1,132,241.68**	**2,309.19**	**7,866.27**				**1,142,417.14**
A. Fuel Combustion (Sectoral Approach)	1,132,241.07	547.72	7,866.27				1,140,655.07
1. Energy Industries	352,633.52	-35.60	720.19				353,318.11
2. Manufacturing Industries and Construction	346,464.86	213.96	1,214.59				347,893.41
3. Transport	250,654.62	208.28	5,863.37				256,726.28
4. Other Sectors	182,488.07	161.09	68.11				182,717.27
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.60	1,761.47	0.00				1,762.07
1. Solid Fuels	NE,NO	1,344.68	NE,NO				1,344.68
2. Oil and Natural Gas	0.60	416.78	0.00				417.38
2. Industrial Processes	**59,213.29**	**303.30**	**7,367.31**	**20,232.67**	**12,573.06**	**16,917.20**	**116,606.83**
A. Mineral Products	55,588.39	NO	NO				55,588.39
B. Chemical Industry	3,624.90	303.30	7,367.31	NE	NE	NE	11,295.50
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		72.46	119.50	191.96
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				17,456.50	762.90	4,708.30	22,927.70
F. Consumption of Halocarbons and SF_6				2,776.17	11,737.70	12,089.40	26,603.27
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**437.58**				**437.58**
4. Agriculture	**NE**	**15,478.64**	**21,588.45**				**37,067.09**
A. Enteric Fermentation		7,118.91					7,118.91
B. Manure Management		991.38	12,650.39				13,641.77
C. Rice Cultivation		7,200.86					7,200.86
D. Agricultural Soils[2]	NE	2.72	8,797.87				8,800.59
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		164.77	140.19				304.97
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**-96,705.05**	**86.37**	**8.77**				**-96,609.92**
6. Waste	**21,627.24**	**5,280.43**	**3,363.21**				30,270.88
A. Solid Waste Disposal on Land	NE	4,238.80					4,238.80
B. Wastewater Handling		1,029.04	1,093.37				2,122.41
C. Waste Incineration	21,627.24	12.59	2,269.84				23,909.66
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**38,075.84**	**51.35**	**341.56**				**38,468.75**
Aviation	16,915.09	10.05	167.36				17,092.50
Marine	21,160.75	41.30	174.20				21,376.24
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,449.95**						**18,449.95**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES Land-Use Change and Forestry	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	44,614.75	-142,262.29	-97,647.53			-97,647.53
B. Forest and Grassland Conversion	942.48		942.48	86.37	8.77	1,037.61
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	45,557.23	-142,262.29	-96,705.05	86.37	8.77	-96,609.92

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,326,799.51
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,230,189.59

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.7. Emissions and Removals in 1996

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1996
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,234,759.40**	**22,918.12**	**41,520.33**	**19,865.63**	**15,262.78**	**17,499.66**	**1,351,825.91**
1. Energy	**1,153,372.54**	**2,258.06**	**8,218.90**				**1,163,849.50**
A. Fuel Combustion (Sectoral Approach)	1,153,371.94	542.62	8,218.90				1,162,133.47
1. Energy Industries	353,739.85	-36.99	728.98				354,431.85
2. Manufacturing Industries and Construction	359,469.37	201.54	1,305.89				360,976.81
3. Transport	258,603.30	212.86	6,117.27				264,933.43
4. Other Sectors	181,559.42	165.21	66.76				181,791.38
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.59	1,715.44	0.00				1,716.03
1. Solid Fuels	NE,NO	1,297.15	NE,NO				1,297.15
2. Oil and Natural Gas	0.59	418.29	0.00				418.88
2. Industrial Processes	**59,020.47**	**292.73**	**8,258.25**	**19,865.63**	**15,262.78**	**17,499.66**	**120,199.51**
A. Mineral Products	55,364.86	NO	NO				55,364.86
B. Chemical Industry	3,655.61	292.73	8,258.25	NE	NE	NE	12,206.58
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		65.78	143.40	209.18
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				16,070.28	1,008.00	4,182.50	21,260.78
F. Consumption of Halocarbons and SF_6				3,795.35	14,189.00	13,173.76	31,158.11
G. Other	NO	NO	NO	NE	NE	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**420.94**				**420.94**
4. Agriculture	**NE**	**15,079.07**	**21,097.90**				**36,176.97**
A. Enteric Fermentation		7,036.44					7,036.44
B. Manure Management		976.80	12,475.68				13,452.48
C. Rice Cultivation		6,906.99					6,906.99
D. Agricultural Soils(2)	NE	2.69	8,488.14				8,490.83
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		156.15	134.08				290.23
G. Other		NO	NO				NO
5. Land-Use Change and Forestry(1)	**NE**	**NE**	**NE**				**NE**
6. Waste	**22,366.39**	**5,288.27**	**3,524.34**				31,179.00
A. Solid Waste Disposal on Land	NE	4,239.29					4,239.29
B. Wastewater Handling		1,036.56	1,124.89				2,161.45
C. Waste Incineration	22,366.39	12.42	2,399.45				24,778.26
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**30,889.60**	**35.27**	**284.92**				**31,209.79**
Aviation	18,433.29	10.95	182.38				18,626.63
Marine	12,456.31	24.31	102.54				12,583.16
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,515.30**						**18,515.30**

(1) For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	0.00	0.00			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry (a)	1,351,825.91
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry (a)	1,351,825.91

(a) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.8. Emissions and Removals in 1997

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1997
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 [(1)]**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Total**
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,242,027.59**	**22,087.43**	**41,892.96**	**19,787.76**	**16,946.32**	**14,783.36**	**1,357,525.42**
1. Energy	**1,161,013.69**	**1,979.78**	**8,363.58**				**1,171,357.04**
A. Fuel Combustion (Sectoral Approach)	1,161,013.07	541.90	8,363.58				1,169,918.54
1. Energy Industries	347,965.09	-36.23	725.36				348,654.21
2. Manufacturing Industries and Construction	371,612.82	201.09	1,447.79				373,261.70
3. Transport	262,060.86	216.68	6,124.95				268,402.50
4. Other Sectors	179,374.29	160.35	65.48				179,600.13
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.62	1,437.88	0.00				1,438.50
1. Solid Fuels	NE,NO	1,006.86	NE,NO				1,006.86
2. Oil and Natural Gas	0.62	431.02	0.00				431.64
2. Industrial Processes	**57,574.40**	**241.64**	**8,718.91**	**19,787.76**	**16,946.32**	**14,783.36**	**118,052.38**
A. Mineral Products	54,003.43	NO	NO				54,003.43
B. Chemical Industry	3,570.97	241.64	8,718.91	NE	NE	NE	12,531.52
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		60.52	191.20	251.72
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				15,075.49	1,417.00	2,581.20	19,073.69
F. Consumption of Halocarbons and SF_6				4,712.27	15,468.80	12,010.96	32,192.03
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**404.60**				**404.60**
4. Agriculture	**NE**	**14,617.45**	**20,783.39**				**35,400.85**
A. Enteric Fermentation		6,957.83					6,957.83
B. Manure Management		963.29	12,343.82				13,307.11
C. Rice Cultivation		6,547.69					6,547.69
D. Agricultural Soils(2)	NE	2.58	8,310.17				8,312.75
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		146.06	129.40				275.46
G. Other		NO	NO				NO
5. Land-Use Change and Forestry(1)	**NE**	**NE**	**NE**				**NE**
6. Waste	**23,439.50**	**5,248.56**	**3,622.49**				32,310.55
A. Solid Waste Disposal on Land	NE	4,190.06					4,190.06
B. Wastewater Handling		1,046.26	1,135.29				2,181.54
C. Waste Incineration	23,439.50	12.24	2,487.20				25,938.95
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**35,478.79**	**43.27**	**323.77**				**35,845.83**
Aviation	19,125.43	11.37	189.23				19,326.02
Marine	16,353.36	31.90	134.55				16,519.81
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**19,079.62**						**19,079.62**

(1) For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 emissions**	**CO_2 removals**	**Net CO_2 emissions / removals**	**CH_4**	**N_2O**	**Total emissions**
Land-Use Change and Forestry	**CO_2 equivalent (Gg)**					
A. Changes in Forest and Other Woody Biomass Stocks	NO	0.00	0.00			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,357,525.42
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,357,525.42

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.9. Emissions and Removals in 1998

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1998
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,195,175.23**	**21,545.40**	**40,580.32**	**19,269.77**	**16,627.49**	**13,392.77**	**1,306,590.98**
1. Energy	**1,118,899.65**	**1,821.33**	**8,342.61**				**1,129,063.59**
A. Fuel Combustion (Sectoral Approach)	1,118,899.06	519.70	8,342.61				1,127,761.37
1. Energy Industries	334,364.04	-35.24	723.81				335,052.62
2. Manufacturing Industries and Construction	339,633.87	186.65	1,432.09				341,252.61
3. Transport	258,464.37	214.03	6,125.78				264,804.18
4. Other Sectors	186,436.78	154.25	60.93				186,651.97
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.58	1,301.63	0.00				1,302.22
1. Solid Fuels	NE,NO	872.46	NE,NO				872.46
2. Oil and Natural Gas	0.58	429.18	0.00				429.76
2. Industrial Processes	**52,273.28**	**226.58**	**7,694.20**	**19,269.77**	**16,627.49**	**13,392.77**	**109,484.09**
A. Mineral Products	49,082.09	NO	NO				49,082.09
B. Chemical Industry	3,191.19	226.58	7,694.20	NE	NE	NE	11,111.96
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		54.49	406.30	460.79
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				14,049.59	1,390.00	2,103.20	17,542.79
F. Consumption of Halocarbons and SF_6				5,220.18	15,183.00	10,883.27	31,286.45
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**377.05**				**377.05**
4. Agriculture	**NE**	**14,315.96**	**20,550.06**				**34,866.01**
A. Enteric Fermentation		6,891.58					6,891.58
B. Manure Management		950.81	12,232.64				13,183.45
C. Rice Cultivation		6,333.03					6,333.03
D. Agricultural Soils[2]	NE	2.47	8,191.16				8,193.64
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		138.06	126.25				264.31
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**NE**	**NE**	**NE**				**NE**
6. Waste	**24,002.30**	**5,181.54**	**3,616.40**				32,800.24
A. Solid Waste Disposal on Land	NE	4,136.21					4,136.21
B. Wastewater Handling		1,032.85	1,107.82				2,140.68
C. Waste Incineration	24,002.30	12.48	2,508.58				26,523.36
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**36,806.98**	**45.12**	**335.64**				**37,187.74**
Aviation	19,675.26	11.69	194.67				19,881.62
Marine	17,131.72	33.42	140.97				17,306.12
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**17,530.49**						**17,530.49**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	0.00	0.00			0.00
B. Forest and Grassland Conversion	NE		NE	NE	NE	0.00
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,306,590.98
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,306,590.98

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.10. Emissions and Removals in 1999

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS (Sheet 1 of 1)

Japan
1999
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,228,371.31**	**21,121.10**	**35,103.90**	**19,763.81**	**14,927.73**	**9,114.37**	**1,328,402.21**
1. Energy	**1,152,557.67**	**1,823.65**	**8,843.93**				**1,163,225.24**
A. Fuel Combustion (Sectoral Approach)	1,152,557.09	522.91	8,843.93				1,161,923.92
1. Energy Industries	351,992.33	-41.01	824.74				352,776.06
2. Manufacturing Industries and Construction	348,765.37	199.03	1,557.21				350,521.61
3. Transport	262,053.17	216.21	6,397.23				268,666.60
4. Other Sectors	189,746.23	148.69	64.74				189,959.65
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.58	1,300.74	0.00				1,301.32
1. Solid Fuels	NE,NO	865.69	NE,NO				865.69
2. Oil and Natural Gas	0.58	435.05	0.00				435.63
2. Industrial Processes	**51,885.07**	**219.48**	**1,860.70**	**19,763.81**	**14,927.73**	**9,114.37**	**97,771.16**
A. Mineral Products	48,381.05	NO	NO				48,381.05
B. Chemical Industry	3,504.02	219.48	1,860.70	NE	NE	NE	5,584.20
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		33.13	645.30	678.43
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				14,257.00	1,273.70	1,529.60	17,060.30
F. Consumption of Halocarbons and SF_6				5,506.81	13,620.90	6,939.47	26,067.18
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**362.53**				**362.53**
4. Agriculture	**NE**	**14,003.84**	**20,381.58**				**34,385.42**
A. Enteric Fermentation		6,809.34					6,809.34
B. Manure Management		937.67	12,107.64				13,045.31
C. Rice Cultivation		6,125.26					6,125.26
D. Agricultural Soils(2)	NE	2.35	8,151.74				8,154.10
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		129.21	122.19				251.41
G. Other		NO	NO				NO
5. Land-Use Change and Forestry(1)	**NE**	**NE**	**NE**				**NE**
6. Waste	**23,928.57**	**5,074.14**	**3,655.15**				32,657.86
A. Solid Waste Disposal on Land	NE	4,039.48					4,039.48
B. Wastewater Handling		1,022.36	1,066.61				2,088.97
C. Waste Incineration	23,928.57	12.30	2,588.54				26,529.42
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**35,710.44**	**43.13**	**326.47**				**36,080.04**
Aviation	19,567.32	11.63	193.60				19,772.55
Marine	16,143.12	31.50	132.87				16,307.49
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,229.90**						**18,229.90**

(1) For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	0.00	0.00			0.00
B. Forest and Grassland Conversion	NE		NE	NE	NE	0.00
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,328,402.21
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,328,402.21

(a) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.11. Emissions and Removals in 2000

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
2000
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,238,957.79**	**20,720.27**	**37,464.23**	**18,548.97**	**13,685.79**	**6,820.04**	**1,336,197.09**
1. Energy	**1,161,366.38**	**1,757.71**	**8,971.81**				**1,172,095.89**
A. Fuel Combustion (Sectoral Approach)	1,161,365.77	537.25	8,971.81				1,170,874.83
1. Energy Industries	362,159.09	-41.89	836.94				362,954.14
2. Manufacturing Industries and Construction	349,059.49	204.45	1,562.07				350,826.01
3. Transport	258,059.82	220.46	6,503.45				264,783.73
4. Other Sectors	192,087.37	154.22	69.35				192,310.95
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.61	1,220.46	0.00				1,221.07
1. Solid Fuels	NE,NO	769.13	NE,NO				769.13
2. Oil and Natural Gas	0.61	451.33	0.00				451.94
2. Industrial Processes	**52,797.32**	**163.74**	**4,248.29**	**18,548.97**	**13,685.79**	**6,820.04**	**96,264.15**
A. Mineral Products	49,403.45	NO	NO				49,403.45
B. Chemical Industry	3,393.87	163.74	4,248.29	NE	NE	NE	7,805.90
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		18.29	1,027.70	1,045.99
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				12,654.54	1,382.60	860.40	14,897.54
F. Consumption of Halocarbons and SF_6				5,894.43	12,284.90	4,931.94	23,111.27
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**340.99**				**340.99**
4. Agriculture	**NE**	**13,829.68**	**20,259.42**				**34,089.10**
A. Enteric Fermentation		6,759.12					6,759.12
B. Manure Management		927.81	12,004.47				12,932.28
C. Rice Cultivation		6,018.51					6,018.51
D. Agricultural Soils[(2)]	NE	2.30	8,144.17				8,146.46
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		121.94	110.78				232.73
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**NE**	**NE**	**NE**				**NE**
6. Waste	**24,794.08**	**4,969.15**	**3,643.72**				33,406.95
A. Solid Waste Disposal on Land	NE	3,927.55					3,927.55
B. Wastewater Handling		1,028.96	1,051.81				2,080.77
C. Waste Incineration	24,794.08	12.63	2,591.91				27,398.63
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**33,629.58**	**65.58**	**276.59**				**33,971.75**
Aviation	16,567.52	32.29	136.19				16,736.00
Marine	17,062.06	33.29	140.40				17,235.75
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,823.19**						**18,823.19**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	0.00	0.00			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,336,197.09
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,336,197.09

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.12. Emissions and Removals in 2001

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
2001
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,213,605.87**	**20,174.28**	**34,642.30**	**15,765.96**	**11,499.96**	**5,670.64**	**1,301,359.00**
1. Energy	**1,139,023.27**	**1,546.42**	**9,303.91**				**1,149,873.60**
A. Fuel Combustion (Sectoral Approach)	1,139,022.67	521.14	9,303.91				1,148,847.72
1. Energy Industries	350,601.22	-41.89	851.77				351,411.10
2. Manufacturing Industries and Construction	336,765.37	204.36	1,726.91				338,696.64
3. Transport	260,344.54	213.32	6,663.57				267,221.43
4. Other Sectors	191,311.54	145.35	61.66				191,518.55
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.60	1,025.28	0.00				1,025.88
1. Solid Fuels	NE,NO	570.30	NE,NO				570.30
2. Oil and Natural Gas	0.60	454.98	0.00				455.58
2. Industrial Processes	**50,495.16**	**130.98**	**1,337.33**	**15,765.96**	**11,499.96**	**5,670.64**	**84,900.02**
A. Mineral Products	47,333.13	NO	NO				47,333.13
B. Chemical Industry	3,162.03	130.98	1,337.33	NE	NE	NE	4,630.34
C. Metal Production	IE,NA,NO	IE,NA,NO	NO		16.26	1,147.20	1,163.46
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				9,709.42	1,123.70	788.70	11,621.82
F. Consumption of Halocarbons and SF_6				6,056.54	10,360.00	3,734.74	20,151.28
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**IE,NE,NO**		**343.60**				**343.60**
4. Agriculture	**NE**	**13,655.70**	**20,088.92**				**33,744.62**
A. Enteric Fermentation		6,712.79					6,712.79
B. Manure Management		920.28	11,920.85				12,841.12
C. Rice Cultivation		5,907.16					5,907.16
D. Agricultural Soils(2)	NE	2.26	8,070.43				8,072.69
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		113.21	97.64				210.85
G. Other		NO	NO				NO
5. Land-Use Change and Forestry(1)	**NE**	**NE**	**NE**				**NE**
6. Waste	**24,087.43**	**4,841.18**	**3,568.54**				32,497.16
A. Solid Waste Disposal on Land	NE	3,797.32					3,797.32
B. Wastewater Handling		1,031.35	1,022.04				2,053.39
C. Waste Incineration	24,087.43	12.51	2,546.50				26,646.44
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**33,421.72**	**39.79**	**304.62**				**33,766.13**
Aviation	18,722.18	11.13	183.72				18,917.03
Marine	14,699.54	28.66	120.90				14,849.10
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**17,182.64**						**17,182.64**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	0.00	0.00			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,301,359.00
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,301,359.00

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.13. Emissions and Removals in 2002

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
2002
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,247,763.22**	**19,511.34**	**34,684.64**	**12,903.15**	**9,845.20**	**5,283.15**	**1,329,990.70**
1. Energy	**1,175,510.44**	**1,133.11**	**9,603.57**				**1,186,247.11**
A. Fuel Combustion (Sectoral Approach)	1,175,509.80	529.37	9,603.57				1,185,642.74
1. Energy Industries	379,656.59	-41.89	855.76				380,470.46
2. Manufacturing Industries and Construction	345,819.34	204.03	1,987.22				348,010.59
3. Transport	255,290.53	215.22	6,694.19				262,199.94
4. Other Sectors	194,743.34	152.01	66.40				194,961.75
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.64	603.74	0.00				604.38
1. Solid Fuels	NE,NO	118.34	NE,NO				118.34
2. Oil and Natural Gas	0.64	485.40	0.00				486.04
2. Industrial Processes	**48,716.11**	**124.34**	**1,183.59**	**12,903.15**	**9,845.20**	**5,283.15**	**78,055.54**
A. Mineral Products	45,791.24	NO	NO				45,791.24
B. Chemical Industry	2,924.87	124.34	1,183.59	NE	NE	NE	4,232.80
C. Metal Production	IE,NA,NO	IE,NA,NO	NO		15.10	1,123.30	1,138.40
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				6,484.42	1,043.60	836.50	8,364.52
F. Consumption of Halocarbons and SF_6				6,418.73	8,786.50	3,323.35	18,528.58
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**IE,NE,NO**		**334.05**				**334.05**
4. Agriculture	**NE**	**13,484.13**	**19,923.78**				**33,407.91**
A. Enteric Fermentation		6,672.13					6,672.13
B. Manure Management		914.99	11,859.43				12,774.42
C. Rice Cultivation		5,788.92					5,788.92
D. Agricultural Soils[(2)]	NE	2.28	7,978.29				7,980.57
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		105.80	86.07				191.87
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**NE**	**NE**	**NE**				**NE**
6. Waste	**23,536.68**	**4,769.76**	**3,639.64**				31,946.08
A. Solid Waste Disposal on Land	NE	3,720.76					3,720.76
B. Wastewater Handling		1,038.23	1,006.93				2,045.16
C. Waste Incineration	23,536.68	10.77	2,632.71				26,180.16
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**36,700.88**	**42.90**	**335.48**				**37,079.26**
Aviation	21,150.26	12.57	207.55				21,370.38
Marine	15,550.62	30.33	127.93				15,708.88
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**17,897.98**						**17,897.98**

(1) For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

(2) See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	**CO_2 equivalent (Gg)**					
A. Changes in Forest and Other Woody Biomass Stocks	NO	0.00	0.00			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,329,990.70
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,329,990.70

(a) The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

10.14. Emissions and Removals in 2003

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
2003
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,259,425.99**	**19,285.17**	**34,617.24**	**12,300.83**	**9,026.90**	**4,473.82**	**1,339,129.95**
1. Energy	**1,188,100.41**	**1,115.70**	**9,634.81**				**1,198,850.92**
A. Fuel Combustion (Sectoral Approach)	1,188,099.74	526.53	9,634.81				1,198,261.09
1. Energy Industries	398,776.60	-41.89	847.64				399,582.35
2. Manufacturing Industries and Construction	350,768.14	203.84	1,986.55				352,958.52
3. Transport	252,930.31	217.45	6,737.47				259,885.23
4. Other Sectors	185,624.69	147.14	63.16				185,834.99
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.67	589.17	0.00				589.83
1. Solid Fuels	NE,NO	93.86	NE,NO				93.86
2. Oil and Natural Gas	0.67	495.30	0.00				495.97
2. Industrial Processes	**47,986.38**	**116.72**	**1,207.81**	**12,300.83**	**9,026.90**	**4,473.82**	**75,112.46**
A. Mineral Products	45,368.17	NO	NO				45,368.17
B. Chemical Industry	2,618.21	116.72	1,207.81	NE	NE	NE	3,942.74
C. Metal Production	IE,NA,NO	IE,NA,NO	NO		15.10	740.90	756.00
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				5,462.21	1,016.40	812.60	7,291.21
F. Consumption of Halocarbons and SF_6				6,838.62	7,995.40	2,920.32	17,754.34
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**IE,NE,NO**		**320.83**				**320.83**
4. Agriculture	**NE**	**13,417.47**	**19,812.88**				**33,230.35**
A. Enteric Fermentation		6,615.72					6,615.72
B. Manure Management		911.74	11,826.36				12,738.10
C. Rice Cultivation		5,785.48					5,785.48
D. Agricultural Soils[2]	NE	2.29	7,903.83				7,906.13
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		102.23	82.68				184.92
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**NE**	**NE**	**NE**				**NE**
6. Waste	**23,339.20**	**4,635.28**	**3,640.90**				31,615.38
A. Solid Waste Disposal on Land	NE	3,594.25					3,594.25
B. Wastewater Handling		1,029.80	996.88				2,026.68
C. Waste Incineration	23,339.20	11.23	2,644.03				25,994.45
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**37,470.22**	**45.44**	**340.62**				**37,856.28**
Aviation	20,388.55	12.12	200.08				20,600.75
Marine	17,081.67	33.32	140.54				17,255.54
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,281.46**						**18,281.46**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES Land-Use Change and Forestry	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	0.00	0.00			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,339,129.95
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,339,129.95

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.