National Greenhouse Gas Inventory Report of JAPAN

May, 2006

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

Center for Global Environmental Research

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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 70 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 and has been often held since then.

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 Mitsubishi UFJ Research and Consulting 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 Atsushi Sato, 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, 2006

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Preface

On the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC), 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/SBTA/2004/8).

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/SBSTA/2004/8).

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, 2006

Climate Change Policy Division
Global Environment Bureau
Ministry of the Environment

Executive Summary of
National GHGs Inventory Report of Japan 2006

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 2004[1], on the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC).

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.

For the submission of Japan's inventories, the trial use of the *UNFCCC Reporting Guidelines on Annual Inventories* (FCCC/SBSTA/2004/8) has been determined by the Conference of the Parties, and the inventory will be reported in accordance with this guideline. For the preparation of the LULUCF inventory, the *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereafter, *LULUCF-GPG*) was published in 2003, and parties are required to seek to apply the *LULUCF-GPG* to their inventory reporting from 2005 and after ward.

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

Total greenhouse gas emission in fiscal 2004 (the sum of emissions of each type of greenhouse gas multiplied by its global warming potential [GWP][2]; except for carbon dioxide removals) was 1,530 million tons (in CO_2 equivalents), an increase by 12.2% from FY1990. Removals of carbon dioxide in FY1995 were 88.0 million tons[3], an increase by 22.2% 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

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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.

8.0%.

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).

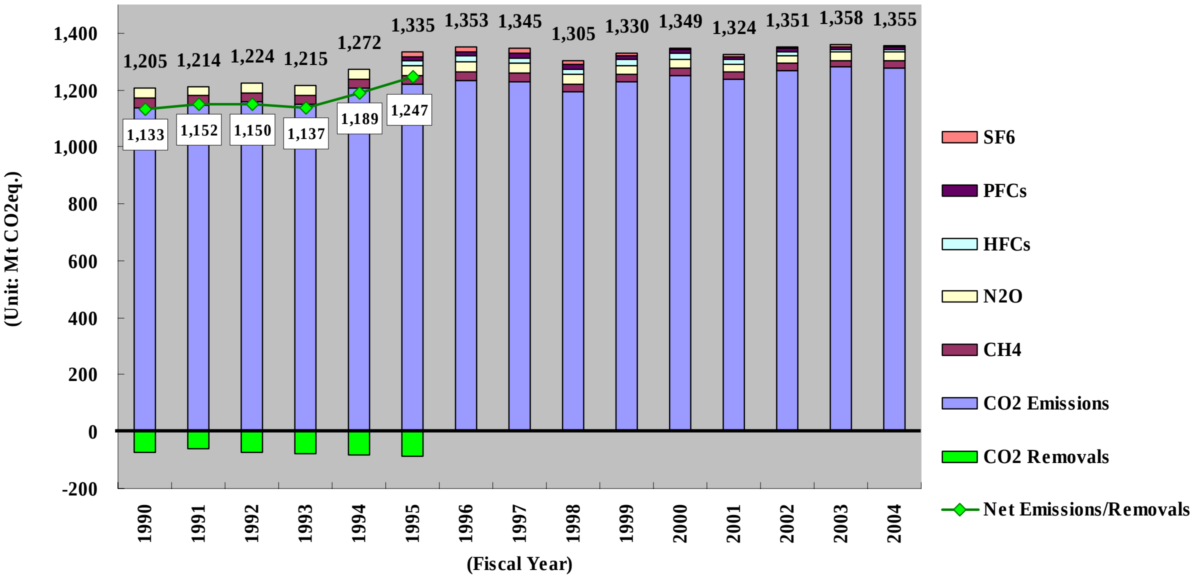

Figure 1 Trends in emission and removals of greenhouse gases in Japan

* 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	2004
CO2 Emissions	1	1,138.8	1,148.1	1,158.0	1,149.8	1,206.4	1,219.5	1,233.7	1,227.9	1,191.9	1,229.2	1,251.1	1,236.1	1,269.3	1,279.4	1,279.2
Removals	1	-72.0	-62.1	-73.2	-78.4	-83.6	-88.0	NE	NE	NE	NE	NE	NE	NE	NE	NE
CH4	21	33.2	32.9	32.6	32.5	31.9	31.3	30.7	29.6	28.7	28.0	27.3	26.4	25.4	24.8	24.4
N2O	310	33.2	32.7	33.0	32.7	33.9	34.4	35.7	36.3	34.9	28.8	31.3	28.1	28.0	28.1	28.4
HFCs	HFC-134a：1,300 etc.	0.0	0.0	0.0	0.0	0.0	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3	8.5
PFCs	PFC-14：6,500 etc.	0.0	0.0	0.0	0.0	0.0	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0	9.9
SF6	23,900	0.0	0.0	0.0	0.0	0.0	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.7	4.5
Gross Total		1,205.1	1,213.7	1,223.6	1,215.0	1,272.3	1,334.8	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9
Net Total		1,133.1	1,151.7	1,150.4	1,136.6	1,188.7	1,246.8	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9

*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 FY2004 by sector[4] shows that the Energy sector accounted for 88.9%, followed by Industrial processes at 5.5%, Solvents and other product use at 0.02%, Agriculture at 2.0% and Waste at 3.5%.

Removals by Land-use land use change and forestry in FY1995 were approximately 6.2% as a proportion of total emissions.

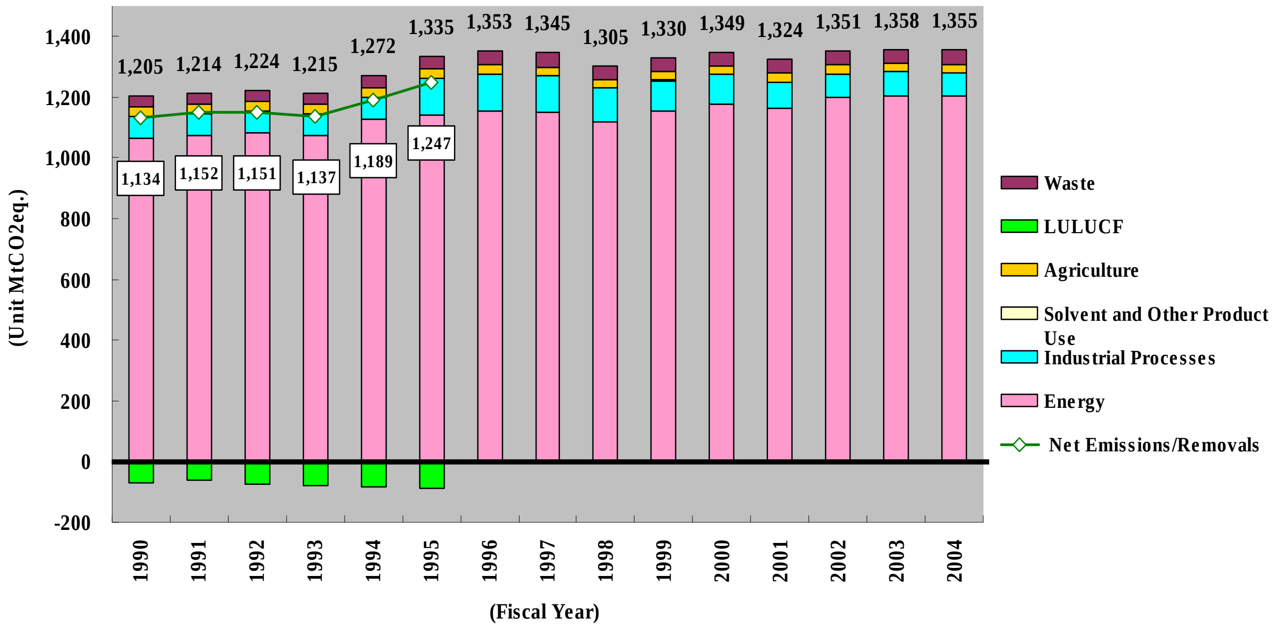

Figure 2 Trends in emissions and removals of greenhouse gases in each category

* 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	2004
Energy	1,067.0	1,074.2	1,082.5	1,075.7	1,128.0	1,140.3	1,153.8	1,148.2	1,117.6	1,155.4	1,175.2	1,162.1	1,197.3	1,205.5	1,204.4
Industrial Processes	68.4	69.3	69.5	68.3	70.4	120.1	123.7	121.5	112.5	100.0	98.7	87.6	80.0	77.3	75.0
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	0.3
Agriculture	32.4	32.4	32.3	32.1	31.6	31.0	30.4	29.7	29.3	28.8	28.5	28.2	27.9	27.7	27.6
Land Use, Land Use Change and Forestry	-71.5	-61.6	-72.8	-78.0	-83.3	-87.8	NE	NE	NE	NE	NE	NE	NE	NE	NE
Waste	37.0	37.5	38.9	38.4	41.8	43.0	44.5	45.4	45.1	45.2	46.1	45.5	45.2	47.4	47.5
Net Emissions/Removals	1,133.6	1,152.1	1,150.9	1,137.0	1,189.0	1,247.1	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9
ABS	1,276.6	1,275.4	1,296.4	1,293.0	1,355.6	1,422.6	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9
Emissions	1,205.1	1,213.7	1,223.6	1,215.0	1,272.3	1,334.8	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9

*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 FY2004 were 2,090 Gg, a decrease by 3.9% compared to FY1990, and by 3.5% compared to the previous year.

Carbon monoxide (CO) emissions inFY2004 were 2,731 Gg, a decrease by 32.1% compared to FY1990, and by 4.5% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY2004 were 1,713 Gg, a decrease by 11.5% compared to FY1990, and an decrease by 1.2% compared to the previous year.

Sulfur dioxide (SO_2) emissions inFY2004 were 831 Gg, a decrease by 20.3% compared to FY1990, and by 0.9% compared to the previous year.

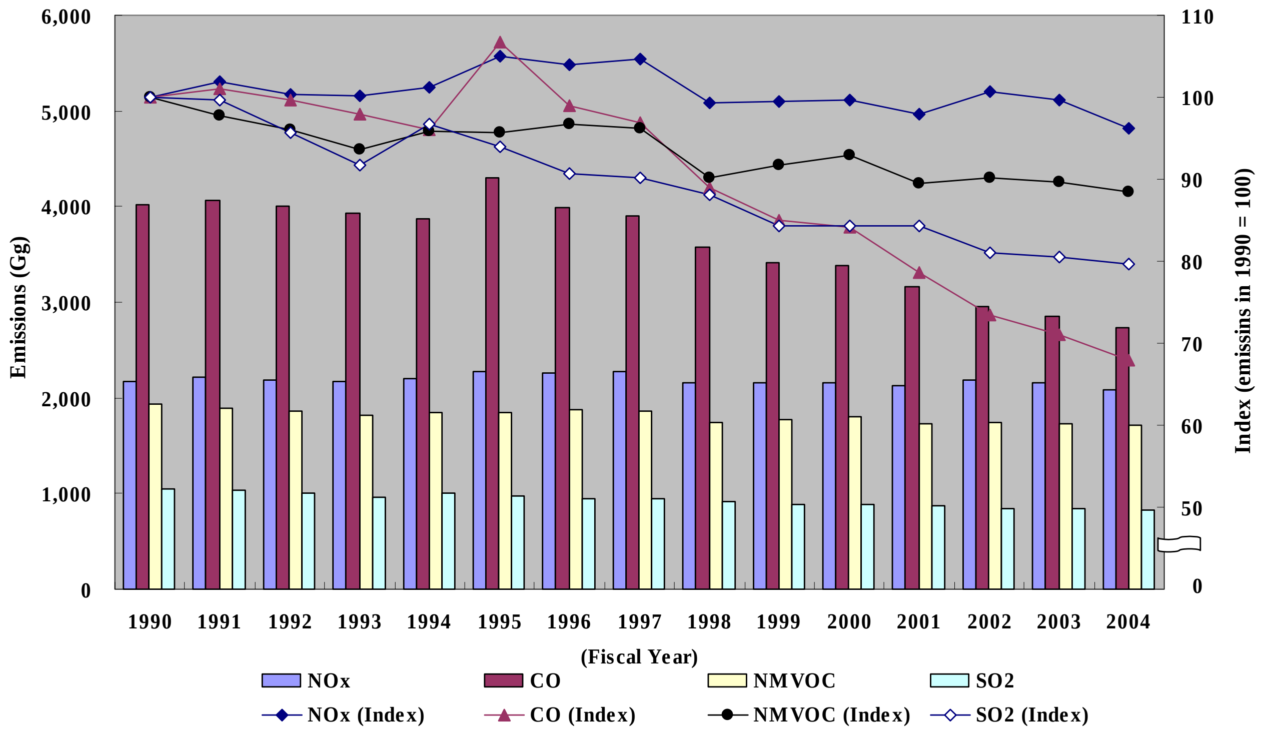

Figure 3 Trends in Emissions of Indirect Greenhouse Gases and SO_2

Chapter 1. Introduction and QA/QC plan

1.1. Background Information on Greenhouse Gas Inventories and Climate Change (1990–2004)

In accordance with Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC), this document reports Japan’s inventory of emissions and removals of greenhouse gases, their precursors, and other substances from FY 1990 through FY 2004 to the FCCC secretariat.

Methodologies for developing the inventory are described in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereafter, *Revised 1996 IPCC Guidelines*) and the *Good Practice and Uncertainty Management in National Greenhouse Gas Inventories (2000)* (hereafter, *the Good Practice Guidance (2000)*), developed by the Intergovernmental Panel on Climate Change (IPCC), and the estimation methodologies of the emissions and removals of greenhouse gas should be in line with them. In 2003, the *IPCC Good Practice Guidance for Land Use, Land-Use Change, and Forestry* (hereafter, *LULUCF-GPG*), was published. Parties are required to seek to apply the *LULUCF-GPG* to their inventory reporting from 2005 and after ward.

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[1], 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)[2], of the Center for Global Environmental Research of the National Institute for Environmental Studies.

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.

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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.

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

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.

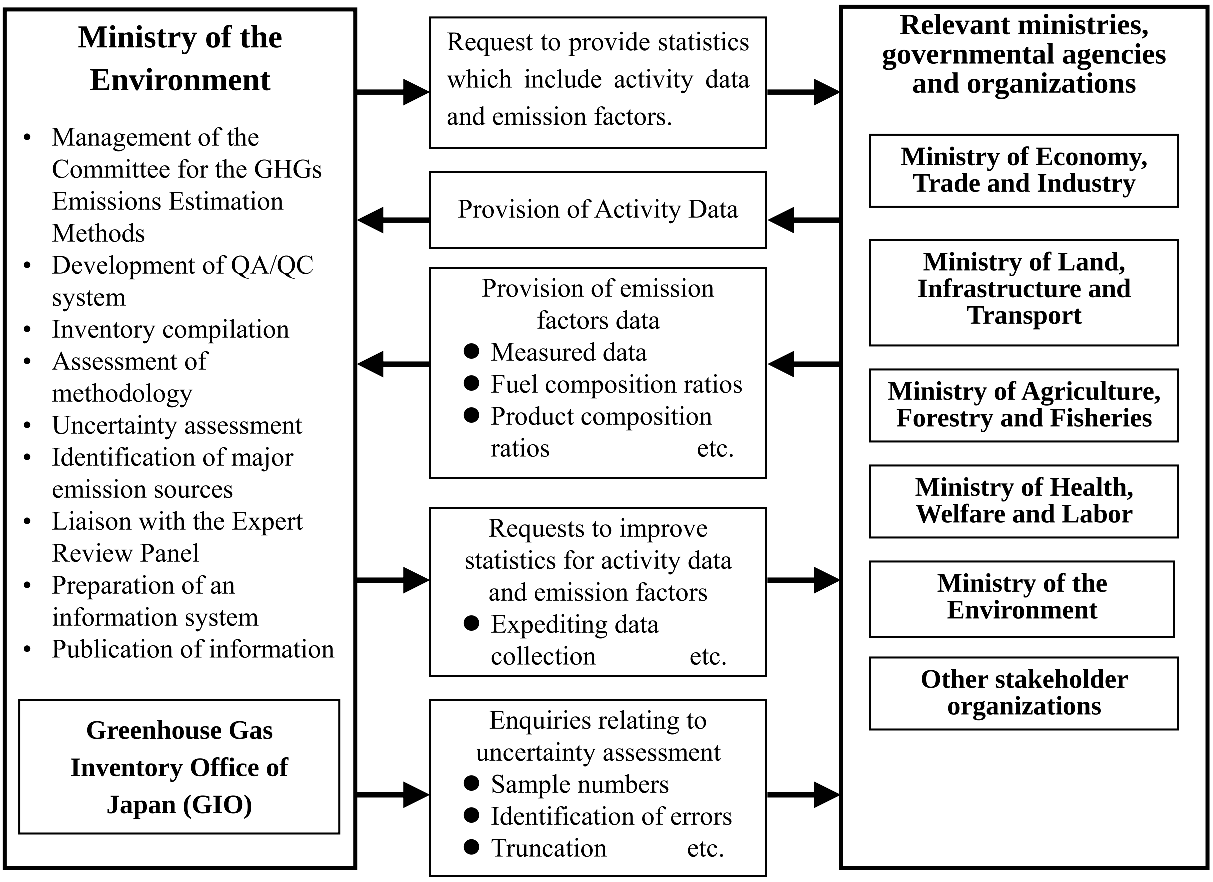

Figure 1-1 Institutional arrangement for the inventory preparation in Japan

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 / number of people per *johkasou* facility / 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 / General outlook on electric power supply and demand
	Ministry of Land, Infrastructure and Transport	Annual of Land Transport Statistics / Survey on Transport Energy / Statistical Yearbook of Motor Vehicle Transport / Survey on Current State of Land Use、Survey on Current State of Urban Park Development / Sewage Statistics
	Ministry of Agriculture, Forestry and Fisheries	Crop Statistics / Livestock Statistics / Vegetable Production and Shipment Statistics / World Census of Agriculture and Forestry / Statistics of Arable and Planted Land Area / Handbook of Forest and Forestry Statistics / Table of Food Supply and Demand
	Ministry of Health, Welfare and Labor	Statistics of Production by Pharmaceutical Industry / Water Works Statistics
Relevant Organizations	Federation of Electric Power Companies	Amount of Fuel Used by Pressurized Fluidized Bed Boilers
	Japan Coal Energy Center	Coal Production
	Japan Cement Association	Amount of clinker production / Amount of waste input to in raw material processing / Amount of RPF incineration
	Japan Iron and Steel Federation	Emissions from Coke Oven Covers, Desulfurization Towers, and Desulfurization Recycling Towers
	Japan Paper Association	Amount of final disposal of industrial waste / Amount of RPF incineration
	local public entity	Carbon Content of Waste by Composition

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.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”).

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.[3] 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. In Japan, the inventory preparation procedures conducted by the MOE (including the GIO and private-sector companies commissioned for the job), which is the agency involved in inventory preparation, as well as by other related agencies and organizations, are considered to be QC procedures.

The process of evaluating and verifying assessment methods by Japanese experts conducted within the Committee for the Greenhouse Gases Emissions Estimation Methods (Step 2: Expert review of previous inventories [Committee for the Greenhouse Gases Emissions Estimation Methods]) is considered to be a quality assurance (QA) activity in which outside experts not involved in inventory preparation conduct external reviews, thereby evaluating and verifying data quality in view of scientific findings and data availability.

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[3] 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.

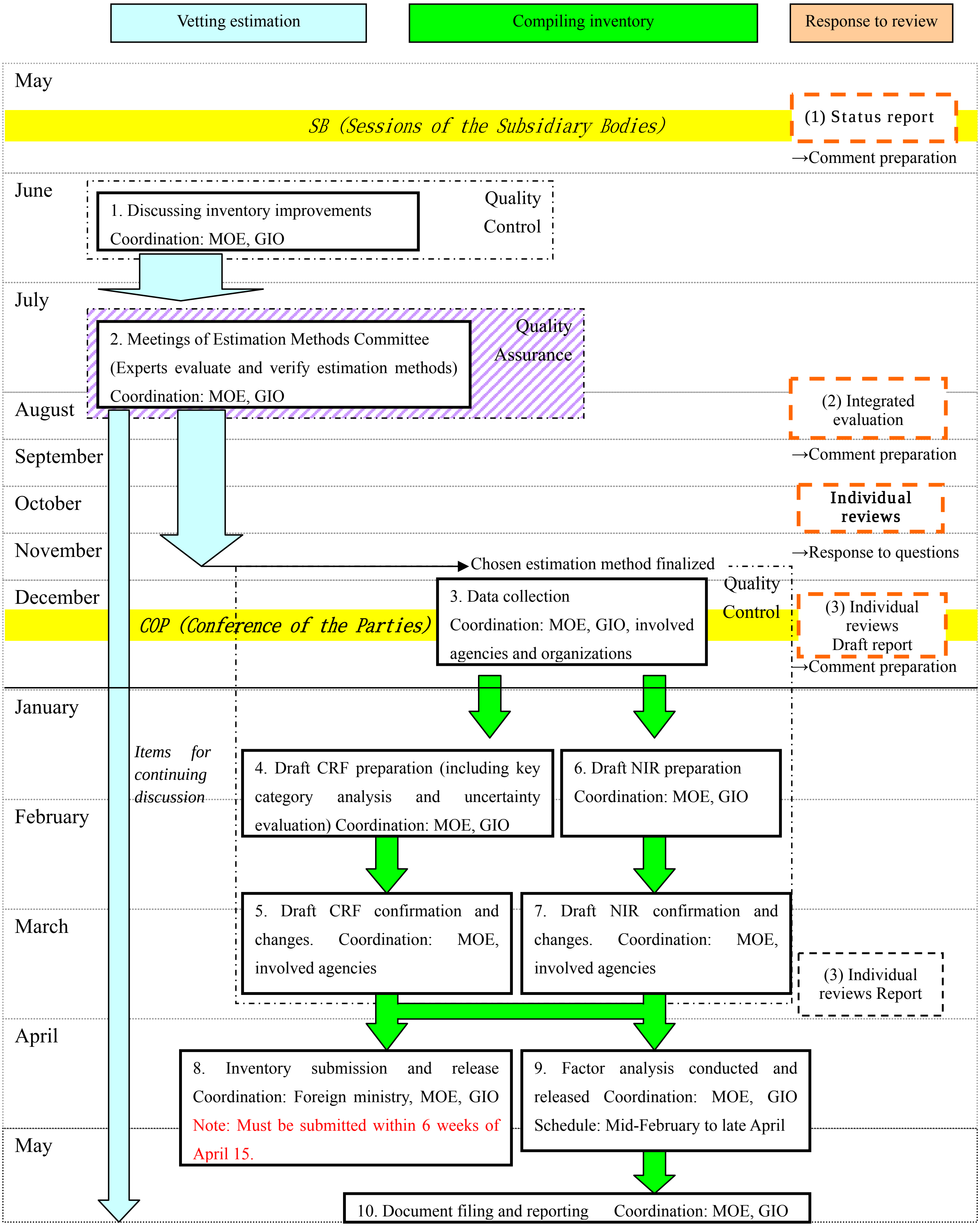

Figure 1-2 Process of the inventory compilation

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, Tier2 Level Assessment and Tier2 Trend Assessment) resulted in the following table 1-2 of 34 sources, which were determined as Japan's key categories in fiscal 2004. Refer to Annex 1 for more detailed results.

Table 1-2 Japan's key source categories in FY2004

	A **IPCC Source Category**		**B** **Direct GHGs**	**D** **Current Year Estimate (Gg CO$_2$eq.)**	**Level Tier.1**	**Trend Teir.1**	**Level Tier.2**	**Trend Teir.2**
#1	1A Stationary Combustion	Solid Fuels	CO2	427,547.48	#1	#2	#1	#2
#2	1A Stationary Combustion	Liquid Fuels	CO2	343,946.42	#2	#1	#5	#7
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	230,273.39	#3	#4	#6	#16
#4	1A Stationary Combustion	Gaseous Fuels	CO2	166,893.26	#4	#3	#3	#6
#5	6C Waste Incineration		CO2	35,394.80	#5	#6	#2	#5
#6	2A Mineral Product	1. Cement Production	CO2	31,415.59	#6	#8	#8	#14
#7	1A3 Mobile Combustion	d. Navigation	CO2	12,893.54	#7	#16		
#8	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,879.82	#8		#14	
#9	1A3 Mobile Combustion	a. Civil Aviation	CO2	10,663.39	#9	#14	#23	
#10	4A Enteric Fermentation		CH4	7,141.03	#10		#26	
#11	6A Solid Waste Disposal on		CH4	5,832.26	#11	#12	#18	#15
#12	4C Rice Cultivation		CH4	5,807.29	#12		#19	#23
#13	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	1,017.90		#5	#22	#1
#14	2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF6	958.39		#7		#3
#15	2B Chemical Industry	3. Adipic Acid	N2O	838.90		#9		#12
#16	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	5,101.00		#10	#12	#11
#17	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	764.80		#11	#27	#4
#18	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	4,016.28		#13	#13	#13
#19	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	57.18		#15		#8
#20	1A Stationary Combustion		N2O	4,199.57		#17	#15	#17
#21	1A3 Mobile Combustion	a. Civil Aviation	N2O	106.49			#4	#9
#22	4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,251.62			#7	#10
#23	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	3,917.21			#9	#21
#24	1A3 Mobile Combustion	b. Road Transportation	N2O	5,710.93			#10	#22
#25	4B Manure Management		N2O	4,732.22			#11	#18
#26	4B Manure Management		CH4	2,549.06			#16	#20
#27	4D Agricultural Soils	3. Indirect Emissions	N2O	2,948.83			#17	#19
#28	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF6	1,784.38			#20	#24
#29	6B Wastewater Handling		N2O	1,302.98			#21	
#30	1A Stationary Combustion		CH4	517.03			#24	
#31	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	882.00			#25	
#32	2F(a) Consumption of Halocarbons	4. Aerosols/Metered Dose Inhalers	HFCs	2,190.01			#28	
#33	1A3 Mobile Combustion	d. Navigation	N2O	106.55			#29	
#34	6B Wastewater Handling		CH4	1,499.75				#25

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 the problems enumerated below are proposed as those to be solved by the Committee for the Greenhouse Gas Emissions Estimation Methods. Our approach for dealing with these problems is to examine them, in accordance with Japan's QA/QC plan, by giving priority to important ones such as those involving key categories and those flagged in reviews.

1.3.1. Crosscutting Issues

- For the not-estimated (NE) categories it is necessary to take into account the possibility of emissions and to further investigate the state of emissions (see 1.5 Completeness and Annex 5 regarding not-estimated source categories).

- 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[4].

1.3.2. Energy (Category1)

1.3.2.1. Fuel Combustion (CO_2)

- Estimation methods for NMVOC emissions from sources including products other than organic solvents and for emissions from byproduct fuel use have not been subjected to long-term consideration, raising the possibility of insufficient estimation accuracy. As work has begun in Japan on producing a VOC inventory, this matter will be addressed while verifying the accuracy of current estimation methods.

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

- As activity data in this sector, we use the value obtained through proportionally distributing the energy consumption given in General Energy Statistics, and the energy consumption proportions according to industry type, fuel type, and furnace type, as estimated from MAP

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[4] FCCC/WEB/IRI(2)/2003/JPN para.14

Surveys. However, comparison of statistical data for industry type and furnace type reveals a contradiction in which data not counted for one are counted for the other. Although activity data are determined while taking this problem into account, further consideration shall be accorded to the soundness of our method. Additionally, it is likely we will no longer be able to use fuel consumption data from MAP Surveys from the FY2002 survey onward, and discussions are needed now how to deal with this.

- Emissions recovered from electric arc furnaces must be deduced to obtain the electric arc furnace emission factor, but this will be a long-term effort due to the difficulty of determining recoveries.

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.

- Discussions will be conducted on methods of estimating and otherwise assessing GHG (CH_4, N_2O) emissions from new products (such as fuel cell vehicles and low-emission vehicles) resulting from technological innovation.

1.3.3. Industrial Processes (Category2)

1.3.3.1. CO_2, CH_4 and N_2O

- Some data are no longer available due to reasons including the elimination of statistical items, and discussions will be needed on how to address this.

1.3.3.2. F-gas

- 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. Use of Solvents and Other Products (Category 3)

- Estimation methods for NMVOC emissions from sources including products other than organic solvents and for emissions from byproduct fuel use have not been subjected to long-term consideration, raising the possibility of insufficient estimation accuracy. As work has begun in Japan on producing a VOC inventory, this matter will be addressed while verifying the accuracy of current estimation methods (same as above).

1.3.5. 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.

- Although the inventory does not reflect the effects of remedial measures against CH_4 emissions from enteric fermentation, we currently lack research data needed to set emission factors that take natural conditions and livestock management conditions into account.

- In the livestock waste management sector, cattle and swine wastes are mixed and cannot be strictly separated. The present emission factor categories of “feces,” “urine,” and “mixed feces and urine” cannot fully describe the actual situation, but as data for setting new emission factors are currently insufficient, the problem will be addressed as data become available.

- Estimation of emissions in livestock waste management does not reflect disposal by piling it up outside or digging holes for disposal, or composting in a composting facility. While getting ideas from new findings and other countries' inventories, we will conduct long-term discussions on dividing “deposition and other management” of feces and “deposition” disposal of mixed urine and feces into the two categories of “deposition” and “outdoor disposal,” and set an emission factor for each.

- There is not enough knowledge on histosols to know what land was originally histosol, or how much land which could be called histosol remained in the past. Discussions are underway to provide for conformity with the land use, land use change, and forestry sectors.

1.3.6. Land Use, Land-Use Change and Forestry (Category5)

- As it has been in the process of verifying the latest land area statistics and developing various parameters necessary for the estimation in the Forest land sector, emissions and removals have been decided to be reported as "NE" (Not Estimated) from 1996 onwards. It will be considered to incorporate the results of the data developed to the inventories as appropriate in the future. In addition, it is also under verification of the land area statistics and has been developing various parameters, which will be lead to be considered to reflect the developed data as appropriate in the Settlements sector.

- Key category analysis, uncertainty assessment and preparation of QA/QC plan have not been conducted under the inventory of the LULUCF sector in this submission. However, it is necessary to develop the national system as soon as possible since the implementation of these analyses and assessments have been laid down in the UNFCCC reporting guidelines, and they are also stipulated as the essential factors under the Kyoto Protocol.

- As the Ministry of the Environment has been preparing the inventory with cooperation from relevant ministries and agencies after establishing national system in the source category, there also is a necessity to develop national system for the preparation of the inventory in the LULUCF sector.

1.3.7. Waste (Category6)

- At present there is no information available on the recovery of CH_4 emissions from landfill disposal sites, CH_4 emissions arising from industrial wastewater treatment, and CH_4 emissions arising from the treatment of domestic and commercial wastewater. Long-term discussions will be held on findings pertaining to CH_4 recovery amount.

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 2004 were approximately 1.35 billion tons (carbon dioxide equivalents). Uncertainty of total emissions has been assessed at 3% and uncertainty introduced into the trend in total national emissions has been assessed at 4%. Refer Annex 7 for details of assessment method and precise results.

Table 1-3 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	1,192,865.5	88.0%	3%	9	2.60%	1
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	4,716.4	0.3%	43%	2	0.15%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	6,237.6	0.5%	146%	1	0.67%	3
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	584.2	0.0%	14%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	52,147.9	3.8%	7%	7	0.28%	6
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	22,879.1	1.7%	19%	5	0.32%	5
3. Solvent & other Product Use	N2O	297.5	0.0%	5%	8	0.00%	9
4. Agriculture	CH4、N2O	27,605.5	2.0%	26%	3	0.53%	4
6. Waste	CO2、CH4、N2O	47,535.3	3.5%	23%	4	0.82%	2
Total Emissions	(D)	1,354,868.9	100.0%	(E) 3%			

1) $C = A \times B / D$

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.

1.5. General Assessment of the Completeness

In this inventory, emissions from some categories are not estimated and reported as “NE”. The FY2005 report dealt with categories reported as not estimated (NE) by examining the possibilities of GHG emissions and newly estimating the emissions in many of the categories which were thought to be highly in need of estimation improvement, such as categories whose emissions were expected to be large.

Source categories reported as NE in this year’s report include those whose emissions are thought to be very small, those whose emissions are unknown, and those for which emission estimation methods have not been developed. In accordance with Japan’s QA/QC plan, discussions will be held on emission possibilities, emission estimation, and other matters pertaining to these categories. See Annex 5 for a list of not-estimated emission source categories.

Due to the many categories in which it is difficult to obtain past activity data for 1990–1994 emissions of HFCs, PFCs, and SF_6, such sources are reported as NE.

It should be noted that emissions and removals by Land use, Land-use change and forestry sector after 1995 have not been estimated (NE).

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 2004[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 1,355 million tons (in CO_2 equivalents), an increase by 12.4% compared to emissions (CO_2, CH_4, N_2O, excluding carbon dioxide removals) in FY1990 (Removals of carbon dioxide in FY1995 were 88.0 million tons[3], an increase by 22.2% 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 8.0%.

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, Land Use change and forestry sector after 1995 have not been estimated (NE).

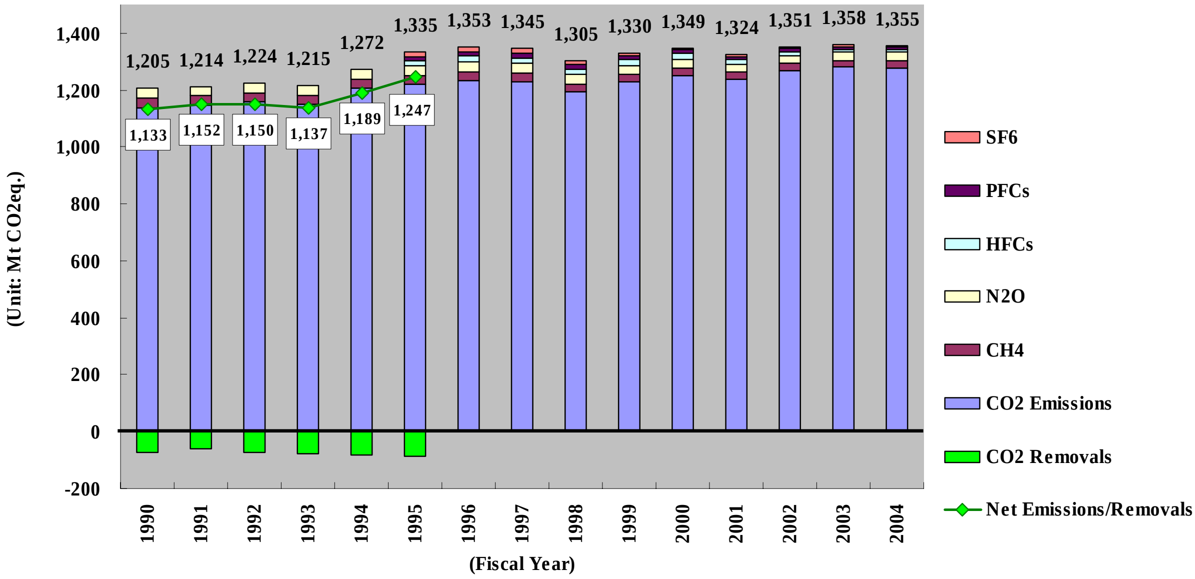

Figure 2-1 Trends in emission and removals of greenhouse gases in Japan

* 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 2004 were 1,279 million tons, giving an emission of 10.02 tons per capita. Compared to fiscal 1990, it represents an increase of 12.3% 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 decreased by 0.0% in total emissions and decreased by 0.1% per capita.

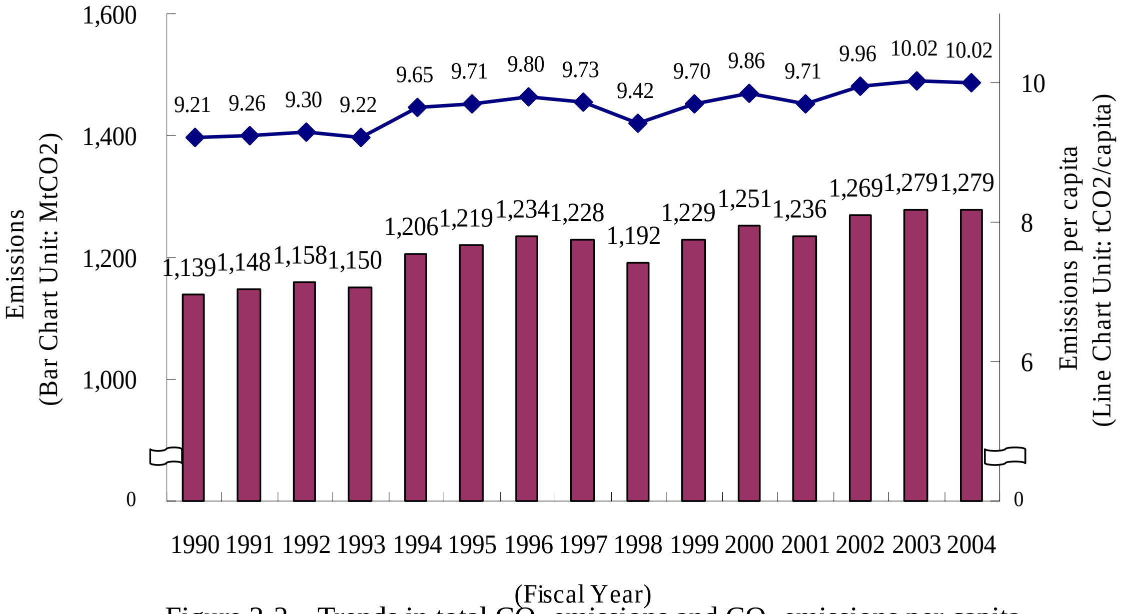

Figure 2-2 Trends in total CO_2 emissions and CO_2 emissions per capita

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 2004 were 2,410 tons/billion yen, resulting in a decrease by 1.0% since fiscal 1990, and a decrease by 2.1% from the previous year.

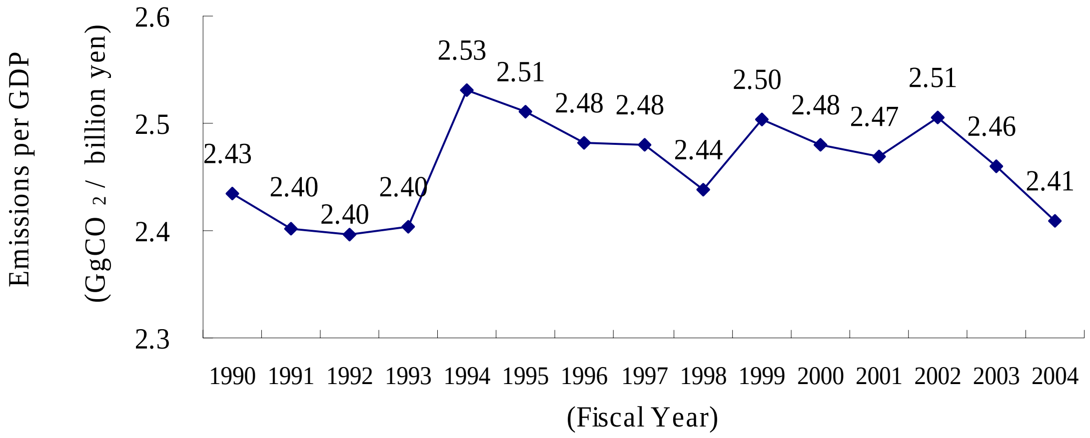

Figure 2-3 Trends in CO_2 emissions per unit of GDP

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 FY2004 were 1,279 million tons, comprising 94.4% of the total. It represents an increase by 12.3% from fiscal 1990, and a decrease by 0.0% in comparison with the previous year. Removals of CO_2 in FY1995[4] were 88.0 million tons, equivalent to 6.6% of total annual greenhouse gas emissions. It represents an increase by 22.2% from FY1990, and an increase by 5.3% in comparison with the previous year.

Emissions in FY2004 of CH_4 were 24.4 million tons (in CO_2 eq.), comprising 1.8% of total emissions. The value represents a reduction by 26.4% from FY1990 and 1.5% in comparison with the previous year.

Emissions in FY2004 of N_2O were 28.4 million tons (in CO_2 eq.), comprising 2.1% of total emissions. The value represents a reduction by 14.4% from FY1990, and an increase by 1.2% in comparison with the previous year.

Emissions in CY2004 of HFCs were 8.5 million tons (in CO_2 eq.), comprising 0.6% of total emissions. The value represents a reduction by 58.0% on CY1995, and 30.8% in comparison with the previous year.

Emissions in CY2004 of PFCs were 9.9 million tons (in CO_2 eq.), comprising 0.7% of total emissions. The value represents a reduction by 21.1% from CY1995, and an increase by 10.5% in comparison with the previous year.

Emissions in CY2004 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 5.7% in comparison with the previous year.

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	2004
CO2 Emissions	1	1,138.8	1,148.1	1,158.0	1,149.8	1,206.4	1,219.5	1,233.7	1,227.9	1,191.9	1,229.2	1,251.1	1,236.1	1,269.3	1,279.4	1,279.2
Removals	1	-72.0	-62.1	-73.2	-78.4	-83.6	-88.0	NE	NE	NE	NE	NE	NE	NE	NE	NE
CH4	21	33.2	32.9	32.6	32.5	31.9	31.3	30.7	29.6	28.7	28.0	27.3	26.4	25.4	24.8	24.4
N2O	310	33.2	32.7	33.0	32.7	33.9	34.4	35.7	36.3	34.9	28.8	31.3	28.1	28.0	28.1	28.4
HFCs	HFC-134a：1,300 etc.	0.0	0.0	0.0	0.0	0.0	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3	8.5
PFCs	PFC-14：6,500 etc.	0.0	0.0	0.0	0.0	0.0	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0	9.9
SF6	23,900	0.0	0.0	0.0	0.0	0.0	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.7	4.5
Gross Total		1,205.1	1,213.7	1,223.6	1,215.0	1,272.3	1,334.8	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9
Net Total		1,133.1	1,151.7	1,150.4	1,136.6	1,188.7	1,246.8	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9

* NE: Not Estimated

* CH_4 and N_2O emissions in Table 2-1 include emissions from Land Use, Land Use Change and Forestry based on the estimation method decided by the UNFCCC. On the contrary, since emissions from Land Use, 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).

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

2.2.1. CO_2[5]

CO_2 emissions in FY2004 were 1,279 million tons, comprising 94.4% of the total. It represents an increase by 12.3% from fiscal 1990, and a decrease by 0.0% in comparison with the previous year.

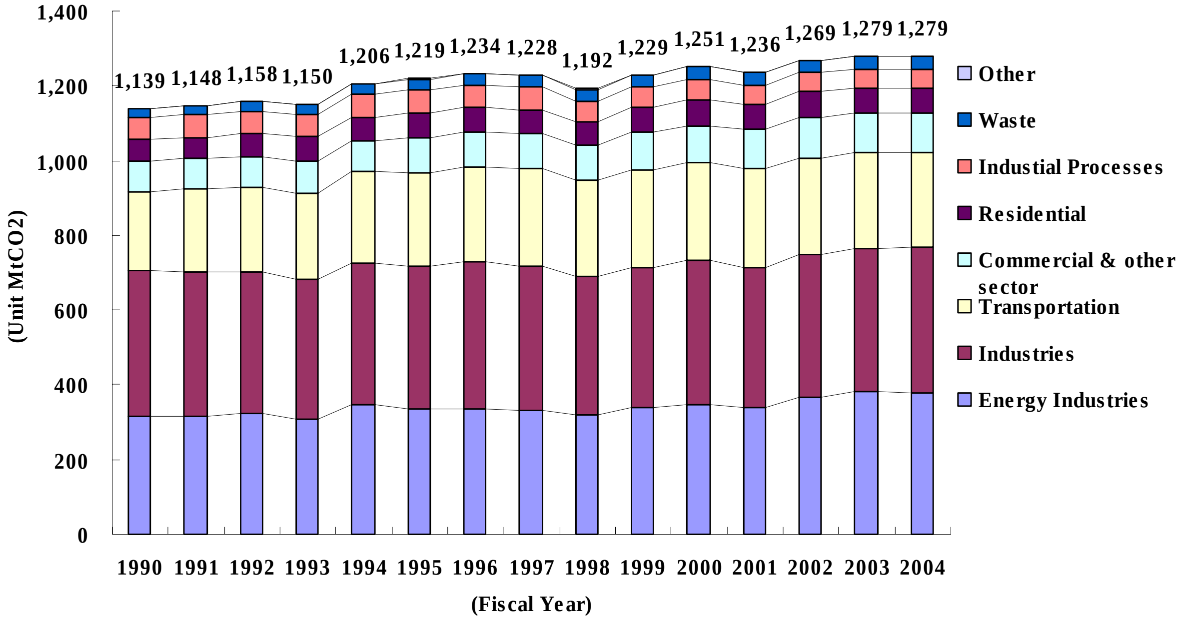

Figure 2-4 Trends in CO_2 emissions

The breakdown of CO_2 emissions in FY2004 shows that carbon dioxide emitted in association with the Fuel combustion accounted for 93.2% of the total, carbon dioxide from the Industrial processes accounted for 3.6%, and carbon dioxide from the Waste sector accounted for 2.8%.

The Industries accounts for 30.4% of emissions of CO_2 from the Fuel combustion, making it the single largest source of emissions followed by the Energy industries sector at 29.6% and the Transport sector at 19.9%.

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 20.0% compared to FY1990, and decreased by 1.1% compared to the previous year.

CO_2 emissions from the Fuel combustion in the industries decreased by 0.1% compared to FY1990, and increased by 1.4% compared to the previous year.

CO_2 emissions from the Fuel combustion in the transportation increased by 20.6% compared to FY1990, and decreased by 0.1% compared to the previous year.

CO_2 emissions from the Fuel combustion in the commercial and other sector increased by 26.9% compared to FY1990, and decreased by 1.4% compared to the previous year.

CO_2 emissions from the Fuel combustion in the residential sector increased by 13.9% compared to FY1990, and decreased by 0.8% compared to the previous year.

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

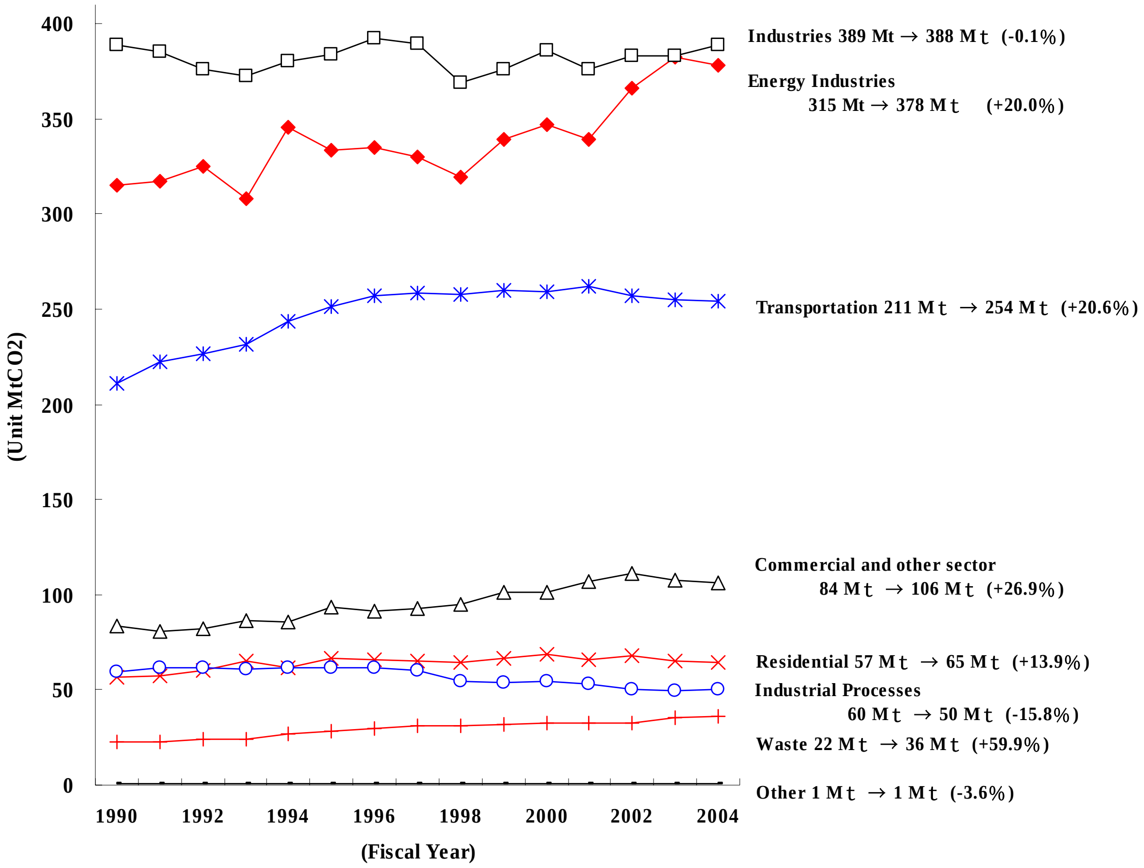

Figure 2-5 Trends in CO_2 emissions in each sector

Table 2-2 Trends in CO_2 emissions in each sector

[Gg CO2]

Category	1990	1995	2000	2003	2004
1A. Fuel Combustion	1,056,448.04	1,129,195.98	1,163,403.65	1,193,920.25	1,192,865.53
Energy Industry	315,132.65	333,459.37	347,086.10	382,645.00	378,310.97
Public Electricity & Heat Production	290,580.91	308,318.77	321,787.98	358,711.11	354,469.56
Petroleum Refining	15,893.24	16,956.42	17,284.55	15,997.47	15,813.05
Manufacture of Solid Fuel and Other Energy Industry	8,658.50	8,184.18	8,013.57	7,936.42	8,028.36
Industries	388,981.27	384,062.52	386,218.94	383,038.83	388,475.81
Manufacturing Industries &	367,576.51	364,516.67	369,907.25	367,366.25	372,595.10
Agriculture, Forestry and Fisheries	21,404.76	19,545.85	16,311.69	15,672.58	15,880.72
Transport	211,053.69	251,175.26	259,230.32	254,621.01	254,478.37
Civil Aviation	7,162.41	10,278.29	10,677.13	11,063.18	10,663.39
Road Transportation	189,227.88	225,390.19	232,981.28	228,795.91	230,273.39
Railways	932.45	819.36	707.28	628.53	648.04
Navigation	13,730.95	14,687.42	14,864.63	14,133.40	12,893.54
Commercial and Residential	140,270.72	159,629.92	170,000.35	172,679.75	170,626.30
Commercial & other sector	83,602.43	93,309.56	101,042.07	107,596.33	106,068.56
Residential	56,668.29	66,320.36	68,958.28	65,083.41	64,557.75
Other	1,009.70	868.90	867.93	935.67	974.08
1B. Fugitive Emissions from Fuel	36.67	50.98	36.08	34.52	35.04
2. Industrial Processes	59,814.95	61,846.66	54,796.77	49,904.82	50,374.33
Mineral Products	55,124.30	57,157.86	50,466.05	46,382.43	46,917.11
Chemical Industry	4,513.97	4,525.47	4,177.99	3,377.39	3,308.42
Metal Production	176.68	163.32	152.73	145.01	148.81
6. Waste	22,456.85	28,386.89	32,913.01	35,502.59	35,903.07
Total	1,138,756.51	1,219,480.50	1,251,149.51	1,279,362.19	1,279,177.97

2.2.2. CH_4

Methane emissions in FY2004 were 24.4 million tons (in CO_2 eq.), comprising 1.8% of total emissions. The value represents a reduction by 26.6% from FY1990 and 1.5% in comparison with the previous year.

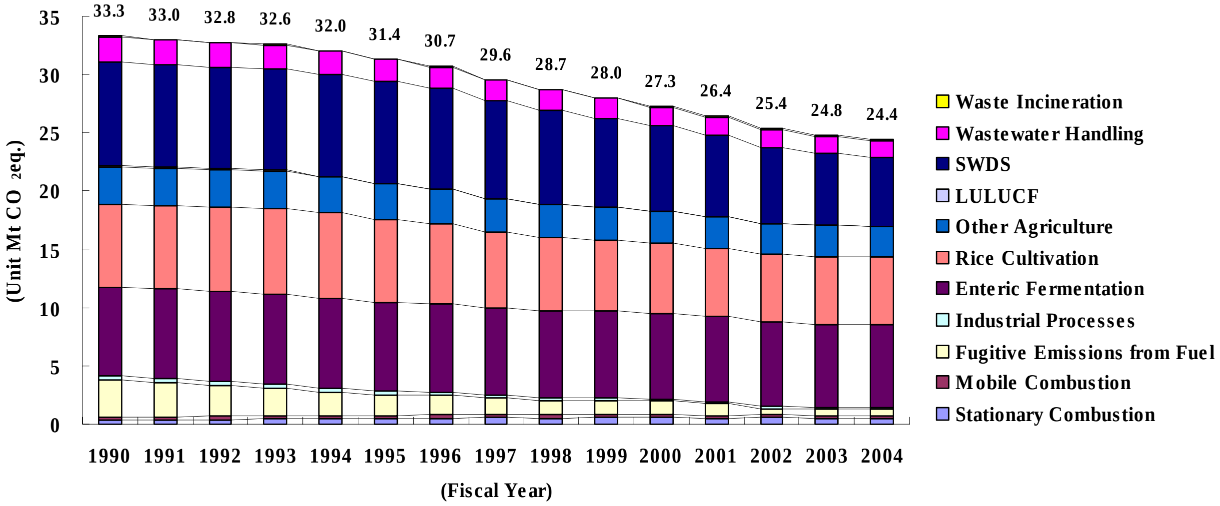

Figure 2-6 Trends in CH_4 emissions

The breakdown of methane emissions in FY2004 shows that methane emitted from enteric fermentation in livestock accounted for 29% of the total, making it the single largest source of emissions. It is followed by methane emissions from SWDS (Solid Waste Disposal Site) at 24%, and ethane emissions from rice cultivation at 24%.

Table 2-3 Trends in CH_4 emissions

[Gg CO2eq.]

Category	1990	1995	2000	2003	2004
1A. Fuel Combustion	619.62	756.64	786.91	743.84	746.19
1A1. Energy Industries	17.65	23.07	31.44	33.42	32.51
1A2. Industries	152.56	240.31	248.37	241.63	245.00
1A3. Transport	249.85	251.56	248.39	234.30	229.16
1A4. Residential / Institutional	199.57	241.71	258.71	234.49	239.52
1B. Fugitive Emissions from Fuels	3,163.74	1,749.70	1,201.02	564.03	549.05
1B1. Solid Fuels	2,806.43	1,344.68	769.13	93.86	66.51
1B2. Oil & Natural Gas	357.31	405.01	431.89	470.17	482.54
2. Industrial Processes	337.80	303.30	163.74	116.72	115.92
4. Agriculture	17,967.80	17,792.62	16,115.86	15,640.24	15,598.86
4A. Enteric Fermentation	7,641.73	7,575.17	7,344.65	7,176.15	7,141.03
4B. Manure Management	3,120.57	2,895.37	2,644.16	2,576.76	2,549.06
4C. Rice Cultivation	7,075.73	7,200.86	6,018.51	5,785.48	5,807.29
4F. Field Burning of Agricultural Residue	129.77	121.22	108.54	101.85	101.48
5. LULUCF	120.08	85.28	NE	NE	NE
6. Waste	11,077.79	10,664.61	9,025.27	7,726.88	7,413.01
6A. SWDS	8,881.48	8,729.71	7,308.40	6,153.58	5,832.26
6B. Wastewater Handling	2,133.41	1,869.46	1,640.77	1,492.39	1,499.75
6C. Waste Incineration	62.90	65.44	76.10	80.91	80.99
Total	33,286.84	31,352.15	27,292.79	24,791.72	24,423.04

2.2.3. N_2O

N_2O emissions in FY2004 were 28.4 million tons (in CO_2 eq.), comprising 2.1% of total emissions. The value represents a reduction by 15.4% from FY1990, and an increase by 1.2% 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.

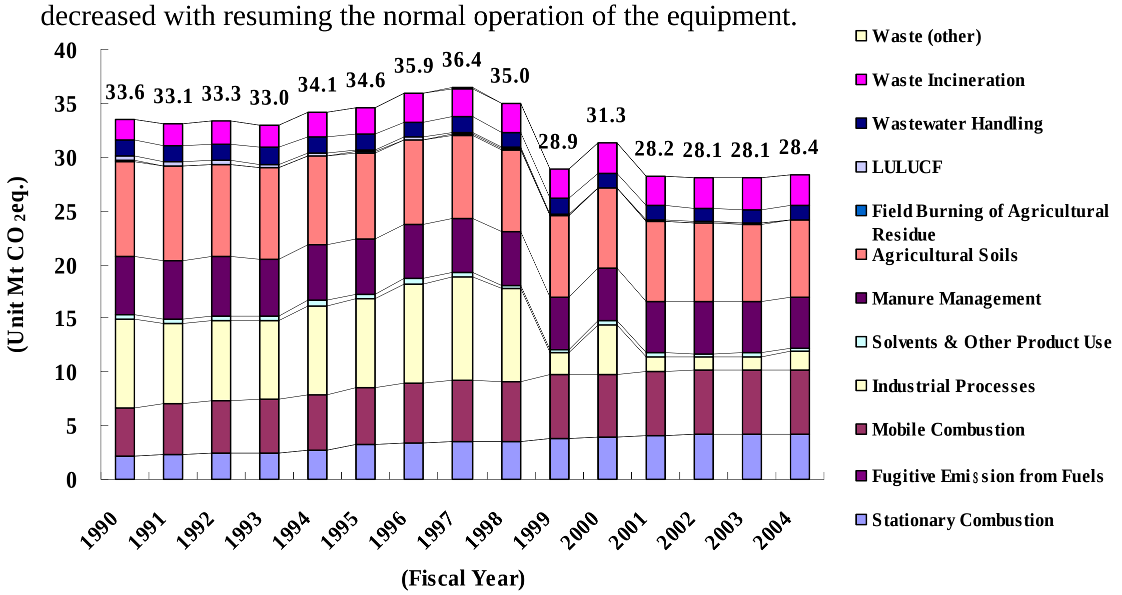

Figure 2-7 Trends in N_2O emissions

The breakdown of nitrous oxide emissions in FY2004 shows that emissions from emissions from agricultural soils for 25% of the total, making it the single largest source of emissions. It is followed by emissions from fuel combustion of motor vehicles and other mobile sources at 21%, and manure management accounted of 17%.

Table 2-4 Trends in N_2O emissions

[Gg CO2eq.]

Category	1990	1995	2000	2003	2004
1A. Fuel Combustion	6,710.23	8,547.30	9,741.51	10,194.96	10,207.78
1A1. Energy Industries	643.86	1,140.94	1,373.38	1,494.27	1,506.28
1A2. Industries	1,232.14	1,684.83	2,168.97	2,319.06	2,341.13
1A3. Transport	4,557.57	5,344.88	5,842.58	6,030.44	6,008.45
1A4. Residential / Institutional	276.65	376.65	356.59	351.20	351.91
1B. Fugitive Emissions from Fuels	0.11	0.16	0.11	0.11	0.11
2. Industrial Processes	8,266.95	8,212.71	4,690.09	1,259.55	1,657.60
3. Solvent & Other Product Use	287.07	437.58	340.99	320.83	297.54
4. Agriculture	14,433.41	13,247.33	12,384.23	12,068.34	12,006.61
4B. Manure Management	5,542.94	5,111.60	4,844.01	4,753.35	4,732.22
4D. Agricultural Soils	8,786.55	8,047.03	7,459.04	7,240.27	7,200.44
4F. Field Burning of Agricultural Residue	103.92	88.70	81.18	74.72	73.94
5. LUCF	370.28	185.01	NE	NE	NE
6. Waste	3,481.99	3,923.81	4,167.60	4,208.91	4,219.23
6B. Wastewater Handling	1,550.99	1,456.51	1,365.12	1,287.56	1,302.98
6C. Waste Incineration	1,910.88	2,451.07	2,783.83	2,902.04	2,896.71
6D. Waste (other)	20.12	16.24	18.66	19.31	19.54
Total	33,550.04	34,553.89	31,324.54	28,052.71	28,388.87

2.2.4. HFCs

Emissions of HFCs in 2004[6] were 8.5 million tons (in CO_2 eq.), comprising 0.6% of total emissions. The value represents a reduction by 58.0% on CY1995, and 30.8% in comparison with the previous year.

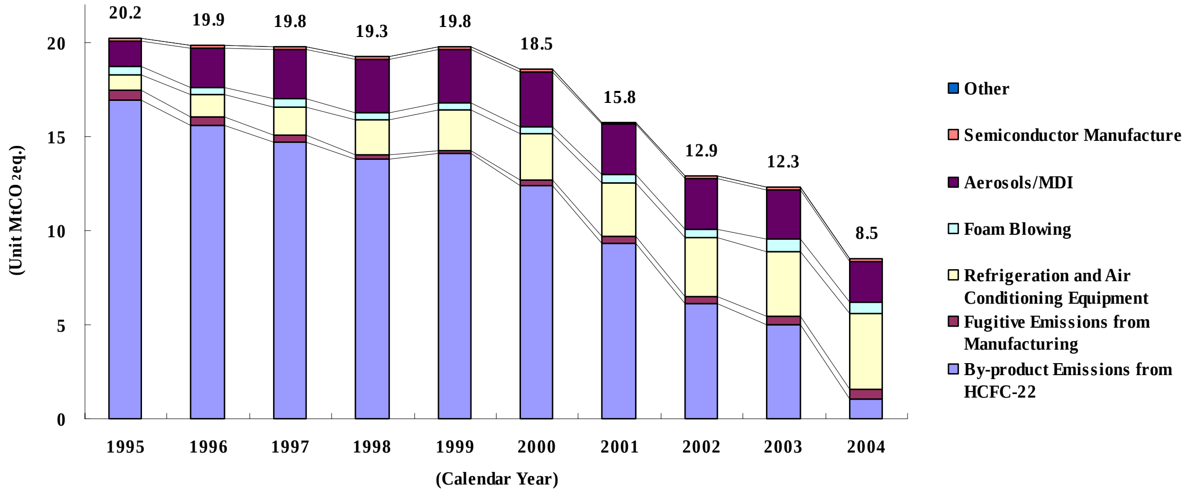

Figure 2-8 Trends in HFCs emissions

The breakdown of HFCs emissions in 2004 shows that emissions from refrigerants of refrigeration and air conditioning equipment accounted for 47% of the total, followed by emissions from aerosols / MDI at 26%, and by-product HFC-23 emission during production of HCFC-22 at 12%.

Table 2-5 Trends in HFCs emissions

[Gg CO2eq.]

Category	1995	2000	2002	2003	2004
2E. Productions of F-gas	17,456.50	12,654.54	6,484.42	5,462.21	1,573.80
2E1. By-product Emissions from Production of HCFC-22	16,965.00	12,402.00	6,095.70	5,022.81	1,017.90
2E2. Fugitive Emissions	491.50	252.54	388.72	439.40	555.90
2F. Consumption of F-gas	2,776.49	5,891.76	6,411.89	6,813.37	6,926.71
2F1. Refrigeration and Air Conditioning Equipment	809.13	2,449.23	3,160.71	3,434.03	4,016.28
2F2. Foam Blowing	456.96	437.71	446.65	653.19	590.64
2F4. Aerosols/MDI	1,365.00	2,847.38	2,686.01	2,613.35	2,190.01
2F7. Semiconductor Manufacture	145.40	157.44	118.52	112.80	129.78
2F9. Other	0.00	0.00	0.00	0.00	0.00
Total	20,232.99	18,546.30	12,896.31	12,275.58	8,500.51

2.2.5. PFCs

PFCs emissions in 2004 were 9.9 million tons (in CO_2 eq.), comprising 0.7% of total emissions. The value represents a reduction by 21.1% from CY1995, and an increase by 10.5% in comparison with the previous year.

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

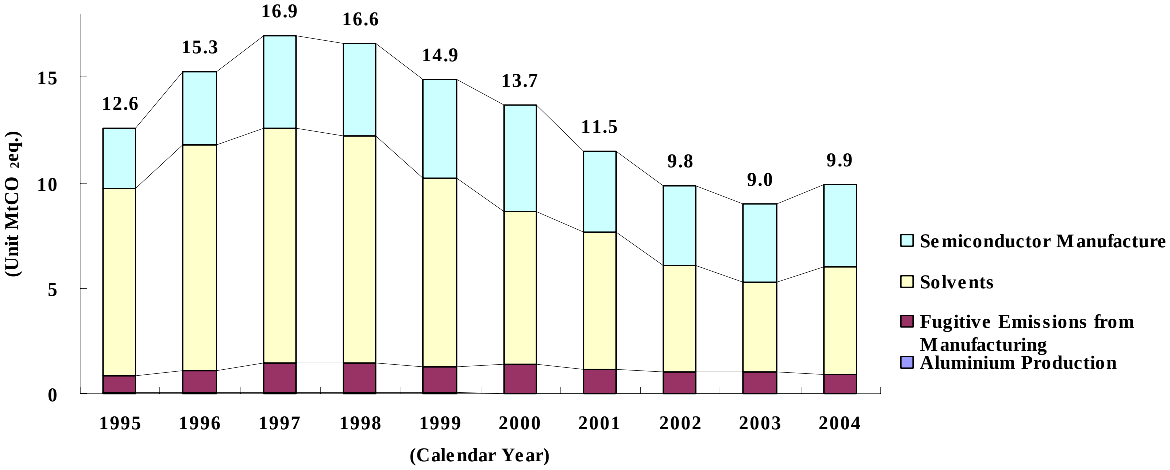

Figure 2-9 Trends in PFCs emissions

The breakdown of PFCs emissions in 2004 shows that emission from solvents in washing metals etc. accounted for 51% of the total, followed by emissions from semiconductor manufacture at 40%, and fugitive emissions from manufacturing at 9%.

Table 2-6 Trends in PFCs emissions

[Gg CO2eq.]

Category	1995	2000	2002	2003	2004
2C3. Aluminium Production	72.46	18.29	15.10	15.10	14.78
2E2. Fugitive Emissions	762.90	1,382.60	1,043.60	1,016.40	882.00
2F. Consumption of F-gas	11,737.80	12,283.63	8,785.49	7,944.85	9,018.21
2F5. Solvents	8,880.00	7,211.30	5,002.00	4,236.00	5,101.00
2F7. Semiconductor Manufacture	2,857.80	5,072.33	3,783.49	3,708.85	3,917.21
Total	12,573.16	13,684.52	9,844.19	8,976.35	9,914.98

2.2.6. SF_6

Emissions of SF_6 in 2004 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 5.7% in comparison with the previous year.

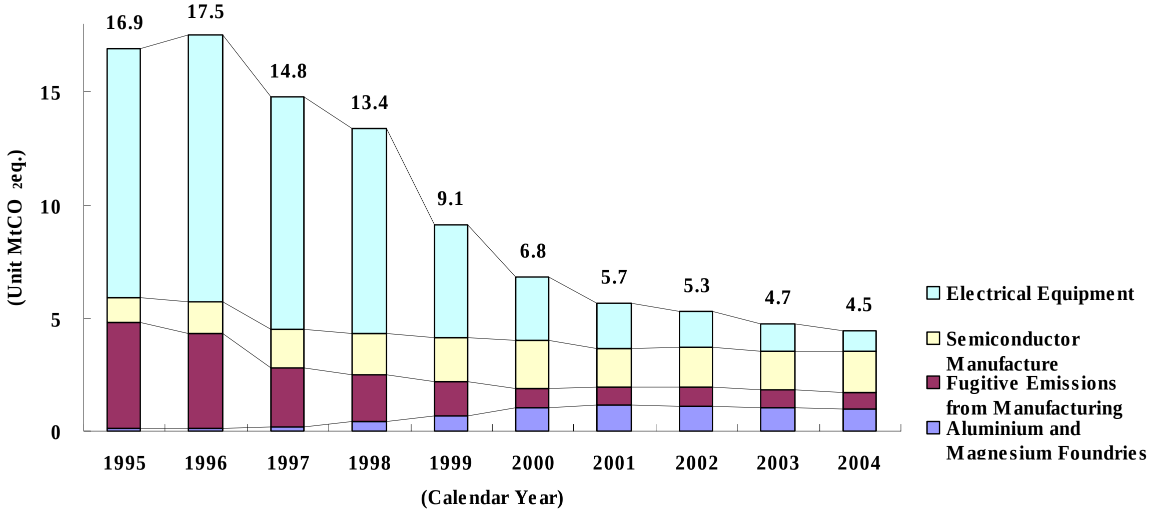

Figure 2-10 Trends in SF_6 emissions

The breakdown of SF_6 emissions in 2004 shows that emissions from semiconductor manufacture accounted for 40%, followed by emissions from Magnesium Foundries at 21%, and emissions from the electrical equipment at 21%.

Table 2-7 Trends in SF_6 emissions

[Gg CO2eq.]

Category	1995	2000	2002	2003	2004
2C4. SF_6 Used in Aluminium and Magnesium Foun	119.50	1,027.70	1,123.30	1,003.80	956.00
2E2. Fugitive Emissions	4,708.30	860.40	836.50	812.60	764.80
2F. Consumption of F-gas	12,093.82	4,930.39	3,323.18	2,917.91	2,742.77
2F7. Semiconductor Manufacture	1,099.82	2,141.26	1,779.24	1,715.74	1,784.38
2F8. Electrical Equipment	10,994.00	2,789.13	1,543.94	1,202.17	958.39
Total	16,921.62	6,818.49	5,282.98	4,734.31	4,463.57

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

The breakdown of emissions and removals of greenhouse gases in FY2004 by sector[7] shows that the Energy sector accounted for 88.9%, followed by Industrial processes at 5.5%, Solvents and other product use at 0.02%, Agriculture at 2.0% and Waste at 3.5%.

Removals by Land Use, Land Use change and forestry in FY1995 were approximately 6.2% as a proportion of absolute value of total emissions/removals.

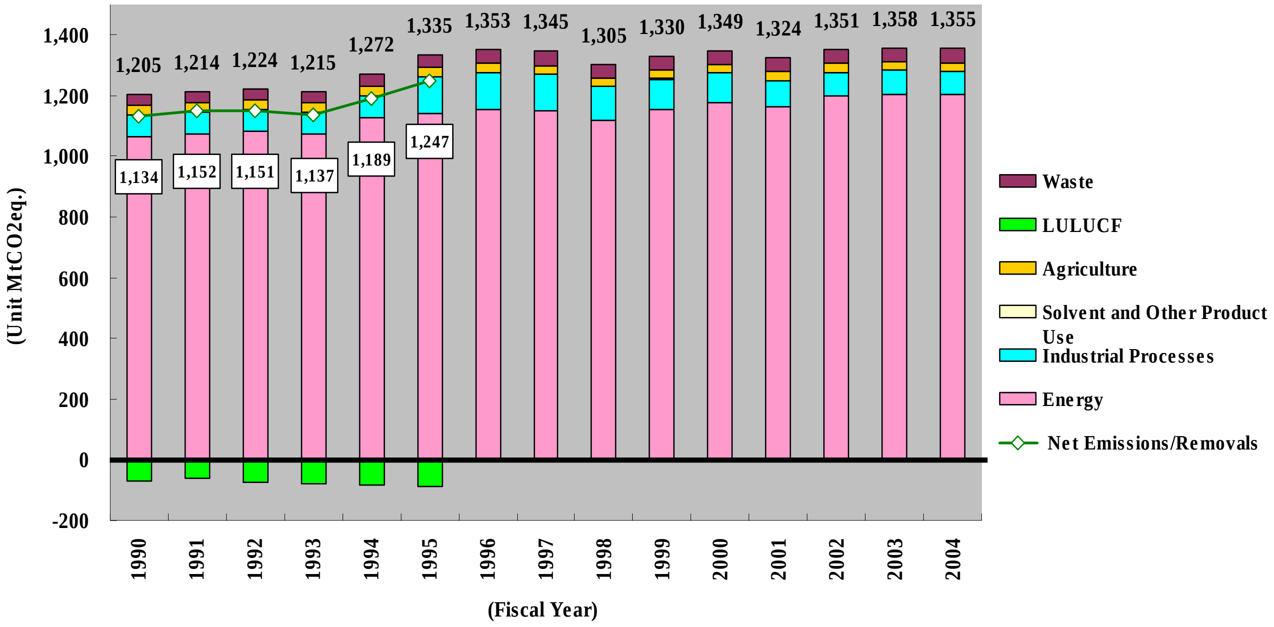

Figure 2-11 Trends in emissions and removals of greenhouse gases in each category

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

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

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	2004
Energy	1,067.0	1,074.2	1,082.5	1,075.7	1,128.0	1,140.3	1,153.8	1,148.2	1,117.6	1,155.4	1,175.2	1,162.1	1,197.3	1,205.5	1,204.4
Industrial Processes	68.4	69.3	69.5	68.3	70.4	120.1	123.7	121.5	112.5	100.0	98.7	87.6	80.0	77.3	75.0
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	0.3
Agriculture	32.4	32.4	32.3	32.1	31.6	31.0	30.4	29.7	29.3	28.8	28.5	28.2	27.9	27.7	27.6
Land Use, Land Use Change and Forestry	-71.5	-61.6	-72.8	-78.0	-83.3	-87.8	NE	NE	NE	NE	NE	NE	NE	NE	NE
Waste	37.0	37.5	38.9	38.4	41.8	43.0	44.5	45.4	45.1	45.2	46.1	45.5	45.2	47.4	47.5
Net Emissions/Removals	1,133.6	1,152.1	1,150.9	1,137.0	1,189.0	1,247.1	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9
ABS	1,276.6	1,275.4	1,296.4	1,293.0	1,355.6	1,422.6	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9
Emissions	1,205.1	1,213.7	1,223.6	1,215.0	1,272.3	1,334.8	1,352.7	1,345.3	1,304.8	1,329.8	1,348.8	1,323.6	1,350.7	1,358.2	1,354.9

*NE: Not Estimated

2.3.1. Energy

Emissions from the Energy sector in FY2004 were 1,204 million tons (in CO_2 equivalents), an increase by 12.9% compared to FY1990, and an decrease by 0.1% in comparison with the previous year.

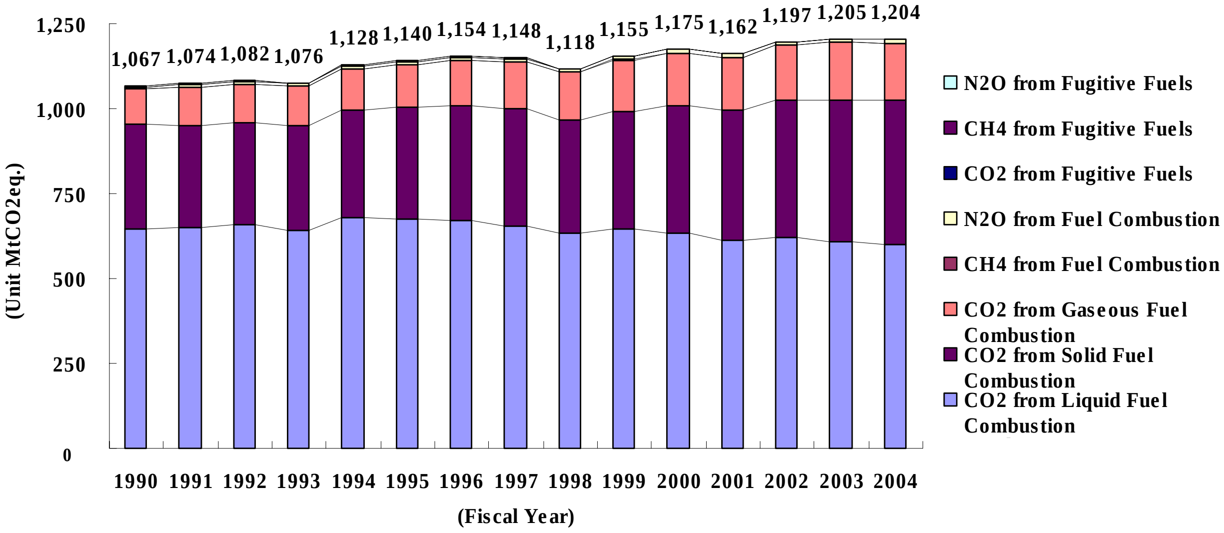

Figure 2-12 Trends in GHGs emissions from the Energy sector

The breakdown of emissions of greenhouse gases from the Energy sector in FY2004 shows that CO_2 emissions from liquid fuel account for 50%, making it the single largest source of emissions followed by the CO_2 emissions from solid fuel at 35% and the CO_2 emissions from Gaseous fuel at 14%.

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

[Gg CO_2eq.]

Source Category	1990	1995	2000	2003	2004
1A. Fuel Combustion	1,063,777.89	1,138,499.92	1,173,932.07	1,204,859.06	1,203,820
Liquid Euel CO_2	646,156.89	675,688.08	633,156.09	609,856.74	598,425
Solid Fuel CO_2	305,990.32	327,309.95	374,986.67	417,018.18	427,547
Gaseous Fuel CO_2	104,300.83	126,197.95	155,260.89	167,045.34	166,893
CH_4	619.62	756.64	786.91	743.84	746
N_2O	6,710.23	8,547.30	9,741.51	10,194.96	10,208
1B. Fugitive Emissions from Fuel	3,200.53	1,800.83	1,237.21	598.66	584
CO_2	36.67	50.98	36.08	34.52	35
CH_4	3,163.74	1,749.70	1,201.02	564.03	549
N_2O	0.11	0.16	0.11	0.11	0.11
Total	1,066,978.42	1,140,300.75	1,175,169.28	1,205,457.72	1,204,404

2.3.2. Industrial Processes

Emissions from the Industrial processes sector in FY2004 were 75.0 million tons (in CO_2 equivalents), an increase by 9.7% compared to FY1990, and a decrease by 2.9% 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.

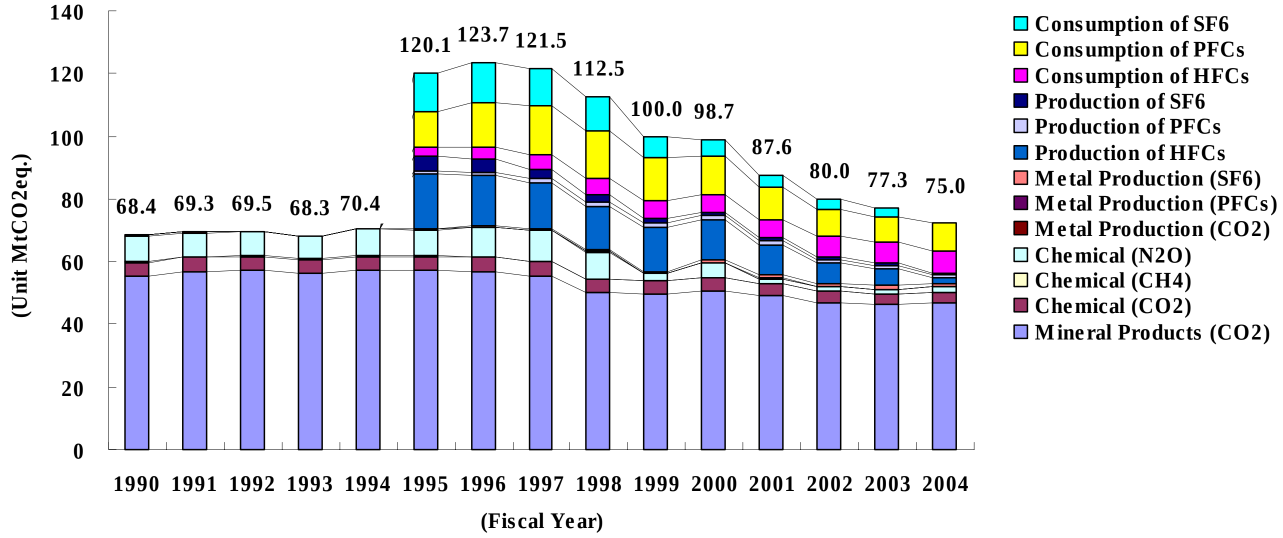

Figure 2-13 Trends in GHGs emissions from the Industrial processes sector

The breakdown of emissions of greenhouse gases from the Industrial processes sector in FY2004 shows that emissions from mineral products, such as CO_2 emissions from the limestone in cement production account for 63%, making it the single largest source of emissions followed by the emissions from the consumption of PFCs such as semiconductor manufacture at 12% 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	2003	2004
2A. Mineral Products (CO2)	55,124.30	57,157.86	50,466.05	46,382.43	46,917.11
2B. Chemical Industry	13,118.72	13,041.47	9,031.81	4,753.66	5,081.94
CO_2	4,513.97	4,525.47	4,177.99	3,377.39	3,308.42
CH_4	337.80	303.30	163.74	116.72	115.92
N_2O	8,266.95	8,212.71	4,690.09	1,259.55	1,657.60
2C. Metal Production	176.68	355.28	1,198.72	1,163.91	1,119.58
CO_2	176.68	163.32	152.73	145.01	148.81
PFCs	NE	72.46	18.29	15.10	14.78
SF_6	NE	119.50	1,027.70	1,003.80	956.00
2E. Production of F-gas	0.00	22,927.70	14,897.54	7,291.21	3,220.60
HFCs	NE	17,456.50	12,654.54	5,462.21	1,573.80
PFCs	NE	762.90	1,382.60	1,016.40	882.00
SF_6	NE	4,708.30	860.40	812.60	764.80
2F. Consumption of F-gas	0.00	26,608.11	23,105.78	17,674.30	18,687.68
HFCs	NE	2,776.49	5,891.76	6,813.37	6,926.71
PFCs	NE	11,737.80	12,283.63	7,943.02	9,018.21
SF_6	NE	12,093.82	4,930.39	2,917.91	2,742.77
Total	68,419.70	120,090.43	98,699.91	77,265.51	75,026.92

2.3.3. Solvent and Other Product Use

Emissions from the Solvents and other product use in FY2004 were 298 thousand tons (of CO_2 equivalents), an increase by 3.6% on FY1990, and a decrease by 7.3% 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.

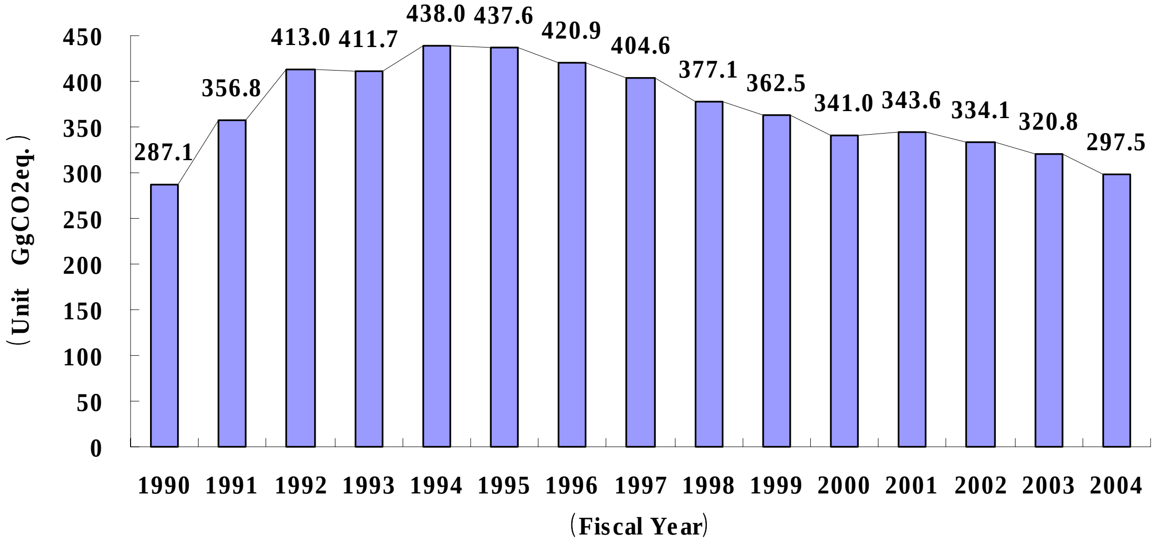

Figure 2-14 Trends in GHGs emissions from the Solvent and other product use sector

2.3.4. Agriculture

Emissions from the Agriculture in FY2004 were 27.6 million tons (in CO_2 equivalents), a decrease by 14.8% compared to FY1990, and by 0.4% in comparison with the previous year.

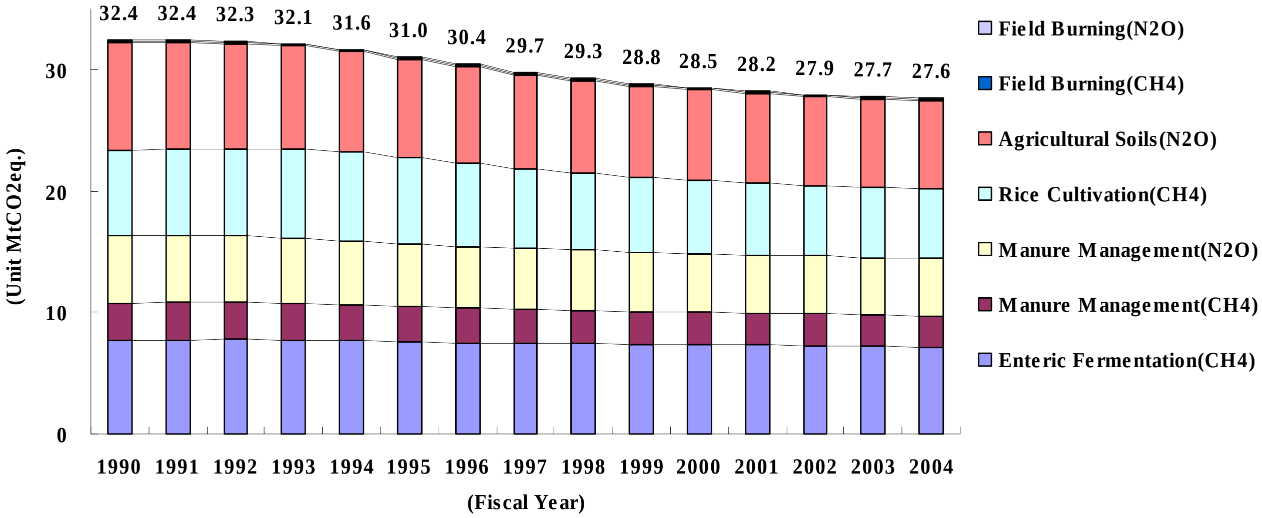

Figure 2-15 Trends in GHGs emissions from the Agriculture sector

The breakdown of emissions of greenhouse gases from the Agriculture in FY2004 shows that N_2O emissions from agricultural soils due to the nitrogen-based fertilizers for 26%, making it the single largest source followed by CH_4 emissions from enteric fermentation at 26%, and CH_4 emissions from rice cultivation at 21%.

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

[Gg CO_2eq.]

Category	1990	1995	2000	2003	2004
4A. Enteric Fermentation(CH4)	7,641.73	7,575.17	7,344.65	7,176.15	7,141.03
4B. Manure Management	8,663.51	8,006.97	7,488.17	7,330.11	7,281.28
CH_4	3,120.57	2,895.37	2,644.16	2,576.76	2,549.06
N_2O	5,542.94	5,111.60	4,844.01	4,753.35	4,732.22
4C. Rice Cultivation(CH4)	7,075.73	7,200.86	6,018.51	5,785.48	5,807.29
4D. Agricultural Soils (N2O)	8,786.55	8,047.03	7,459.04	7,240.27	7,200.44
4F. Field Burning of Agricultural Residues	233.69	209.92	189.72	176.57	175.43
CH_4	129.77	121.22	108.54	101.85	101.48
N_2O	103.92	88.70	81.18	74.72	73.94
Total	32,401.21	31,039.95	28,500.09	27,708.58	27,605.47

2.3.5. Land Use, Land Use Change and Forestry

Net Removals (including CH_4 and N_2O emissions) in the Land Use, Land Use Change and Forestry in fiscal 1995 was 87.8 million tons, an increase by 22.7% on FY1990, and by 5.4% in comparison with the previous year. Emissions and removals since FY1996 have not been estimated (NE) because the data was not prepared.

In 1995, the category "Forest land" was net removal and other land use categories were net emissions.

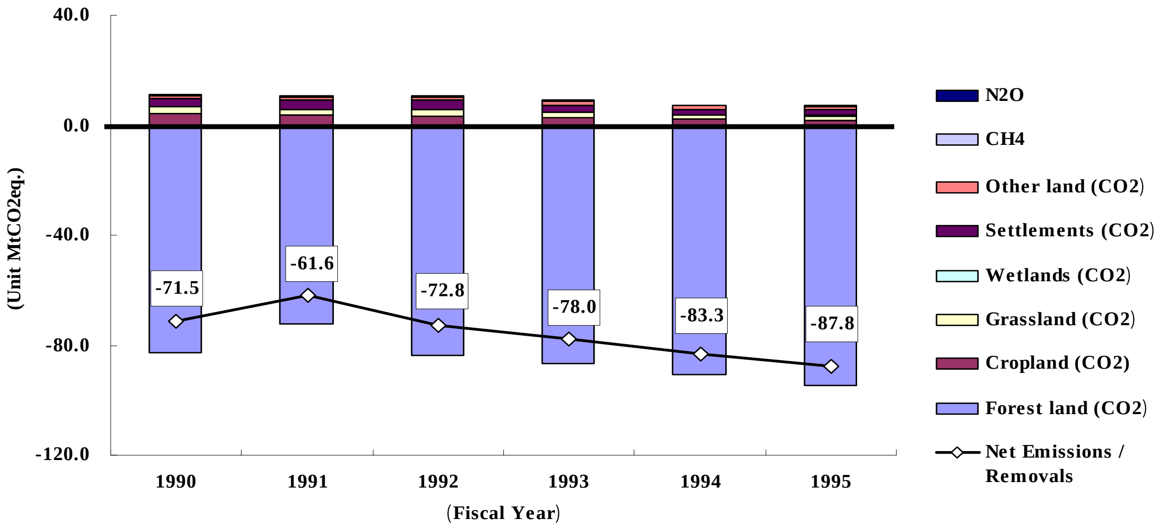

Figure 2-16 Trends in emissions and removals of GHGs from the LULUCF sector

Table 2-12 Trends in emissions and removals of GHGs from the LULUCF sector

[Gg CO_2eq.]

排出源	1990	1991	1992	1993	1994	1995
5A. Forest land	-82,722.94	-72,288.00	-83,560.22	-86,910.12	-90,709.54	-94,881.08
5B. Cropland	4,663.77	3,907.86	3,785.16	3,085.51	2,194.72	2,005.16
5C. Grassland	2,450.83	2,104.62	2,013.07	1,737.97	1,784.93	1,625.12
5D. Wetlands	69.70	66.70	199.42	87.25	95.80	227.91
5E. Settlements	2,821.02	3,340.30	3,659.19	2,727.91	2,121.48	2,067.38
5F. Other land	1,180.22	1,251.80	1,127.09	1,282.44	1,206.40	1,184.34
Total	-71,537.41	-61,616.72	-72,776.30	-77,989.03	-83,306.21	-87,771.16

2.3.6. Waste

Emissions from the Waste in FY2004 were 47.5 million tons (in CO_2 equivalents), an increase by 28.4% compared to FY1990, and an increase by 0.2% in comparison with the previous year.

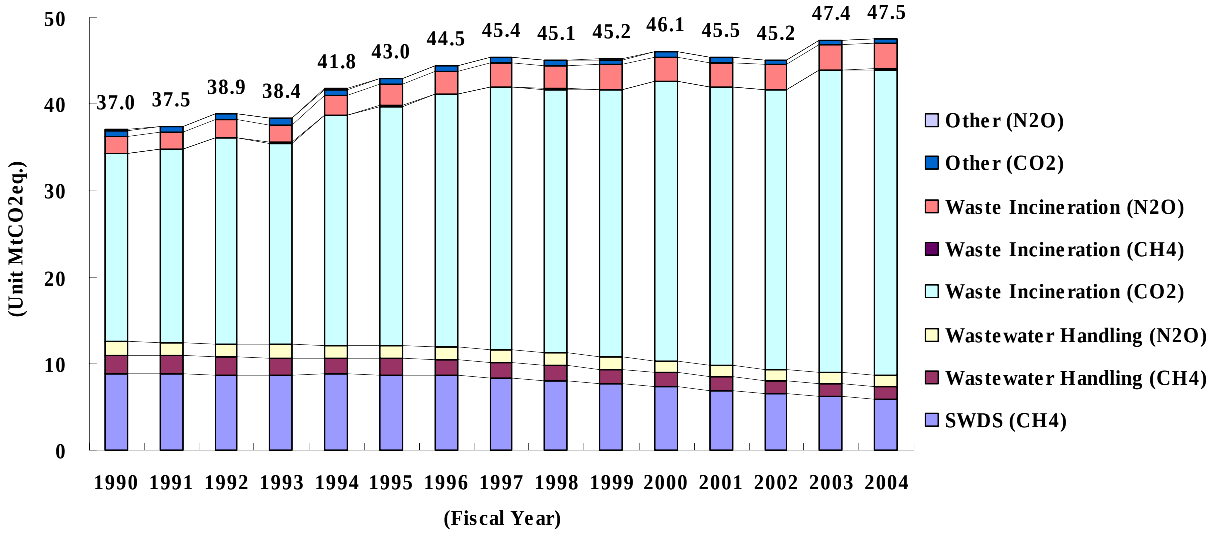

Figure 2-17 Trends in GHGs emissions from the Waste sector

The breakdown of GHGs emissions from the Waste in FY2004 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 12%, and N_2O emissions from combustion of waste (including waste products derived from substances other than fossil fuels) at 6%.

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

[Gg CO_2eq.]

Category	1990	1995	2000	2003	2004
6A. SWDS (CH_4)	8,881.48	8,729.71	7,308.40	6,153.58	5,832.26
6B. Wastewater Handling	3,684.40	3,325.97	3,005.89	2,779.95	2,802.73
CH_4	2,133.41	1,869.46	1,640.77	1,492.39	1,499.75
N_2O	1,550.99	1,456.51	1,365.12	1,287.56	1,302.98
6C. Waste Incineration	23,727.79	30,235.57	35,117.02	37,969.01	38,372.50
CO_2	21,754.02	27,719.06	32,257.09	34,986.06	35,394.80
CH_4	62.90	65.44	76.10	80.91	80.99
N_2O	1,910.88	2,451.07	2,783.83	2,902.04	2,896.71
6D. Other	722.95	684.06	674.57	535.84	527.81
CO_2	702.83	667.83	655.91	516.53	508.26
N_2O	20.12	16.24	18.66	19.31	19.54
Total	37,016.63	42,975.31	46,105.89	47,438.38	47,535.30

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.

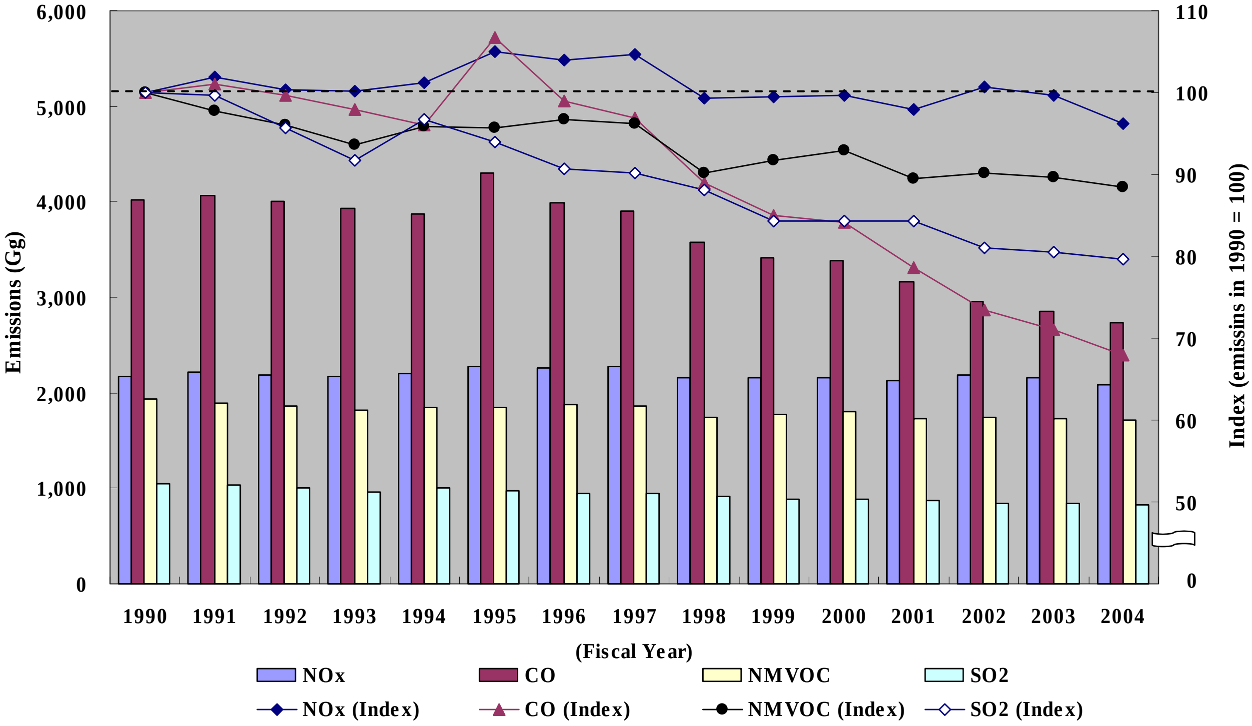

Figure 2-18 Trends in Emissions of Indirect Greenhouse Gases and SO_2

Nitrogen oxide (NO_X) emissions in FY2004 were 2,090 Gg, a decrease by 3.9% compared to FY1990, and by 3.5% compared to the previous year.

Carbon monoxide (CO) emissions inFY2004 were 2,731 Gg, a decrease by 32.1% compared to FY1990, and by 4.5% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY2004 were 1,713 Gg, a decrease by 11.5% compared to FY1990, and an decrease by 1.2% compared to the previous year.

Sulfur dioxide (SO_2) emissions inFY2004 were 831 Gg, a decrease by 20.3% compared to FY1990, and by 0.9% compared to the previous year.

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Chapter 3. Energy (CRF sector 1)

3.1. Fuel Combustion (1.A.)

3.1.1. Fuel Combustion (CO_2)

- ***Background***

When fossil fuels such as coal, oil products and natural gas are combusted, carbon contained in these types of fuels is oxidized and emitted into the atmosphere.

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

Tier 1 Sectoral Approach has been used in accordance with the decision tree of the *Good Practice Guidance (2000)* (Page 2.10, Fig. 2.1) to calculate emissions. Country-specific emission factors are used for all types of fuel.

$$E = \sum_{ij} \left[\left(A_{ij} - N_{ij} \right) * GCV_i * 10^{-3} * EF_i * OF_i \right] * 44/12$$

E	: CO_2 emissions from fossil fuel combustion [tCO_2]
A	: Energy consumption [t, kl, m^3]
N	: Non-energy product use of fossil fuels [t, kl, m^3]
GCV	: Gross calorific value [MJ/kg, MJ/l, MJ/m^3]
EF	: Carbon content of the fuel [tC/TJ]
OF	: Oxidation factor
i	: Type of energy
j	: Sector

- ***Emission Factors***

-Carbon emission factors

, The carbon content of fuels expressed as the unit of calorific value (Gross Calorific Value) was used for carbon emission factors. Most of them are country-specific values.

Emission factors were developed based on three different concepts; (a) Energy sources other than Blast Furnace Gas (BFG) and Town gas, (b) BFG, and (c) Town gas.

(a) Energy sources other than Blast Furnace Gas (BFG) and Town gas: Emission factors are based on the carbon content of each fuel type.

(b) BFG: During iron and steel production process, in the blast furnace and L.D. converter, the amount of energy and carbon contained in coke and PCI coal which are injected to the processes and these contained in BFG and LDG which are calculated should be theoretically balanced. Since the composition of BFG is unstable, emission factors for BFG was established with annually calculated value in order to keep carbon balance in blast furnace and L.D. converter during the iron and steel production process.

(c) Town gas: Town gas is produced from the mixture of raw materials and air dilution. In order to calculate town gas emission factors, total carbon contained in fossil fuel used as raw materials was divided by the total calorific value of produced town gas.

Table 3-1 provides the emission factors for CO_2 by fuel types.

Table 3-1 Emission factors for fuel combustion

Fuel		Code	Unit	1990	1995	2000	2003	2004
Coal	Steel Making Coal	$110	tC/TJ	24.51	24.51	24.51	24.51	24.51
	Coking Coal	$111	tC/TJ	24.51	24.51	24.51	24.51	24.51
	PCI Coal	$112	tC/TJ	24.51	24.51	24.51	24.51	24.51
	Imported Steam Coal	$130	tC/TJ	24.71	24.71	24.71	24.71	24.71
	Imported Coal : for general use	$131	tC/TJ	24.71	24.71	24.71	24.71	24.71
	Imported Coal : for power generation	$132	tC/TJ	24.71	24.71	24.71	24.71	24.71
	Indigenous Steam Coal	$135	tC/TJ	24.90	24.90	24.90	24.90	24.90
	Underground	$136	tC/TJ	24.90	24.90	24.90	24.90	24.90
	Open Pit	$137	tC/TJ	24.90	24.90	24.90	24.90	24.90
	Hard Coal, Anthracite & Lignite	$140	tC/TJ	25.46	25.46	25.46	25.46	25.46
Coal Products	Coke	$161	tC/TJ	29.38	29.38	29.38	29.38	29.38
	Coal Tar	$162	tC/TJ	20.90	20.90	20.90	20.90	20.90
	Coal Briquette	$163	tC/TJ	29.38	29.38	29.38	29.38	29.38
	Coke Oven Gas	$171	tC/TJ	10.99	10.99	10.99	10.99	10.99
	Blast Furnace Gas	$172	tC/TJ	27.28	26.91	26.60	26.53	26.55
	Converter Furnace Gas	$173	tC/TJ	38.44	38.44	38.44	38.44	38.44
Oil	Crude Oil for Refinery	$210	tC/TJ	18.66	18.66	18.66	18.66	18.66
	Crude Oil for Power Generation	$220	tC/TJ	18.66	18.66	18.66	18.66	18.66
	Vitumous Mixture Fuel	$221	tC/TJ	19.96	19.96	19.96	19.96	19.96
	Natural Gas Liquid & Condensate	$230	tC/TJ	18.40	18.40	18.40	18.40	18.40
Oil Products	Slack Gasoline	$271	tC/TJ	18.17	18.17	18.17	18.17	18.17
	Slack Kerosene	$272	tC/TJ	18.51	18.51	18.51	18.51	18.51
	Slack Diesel Oil or Gas Oil	$273	tC/TJ	18.73	18.73	18.73	18.73	18.73
	Slack Fuel Oil	$274	tC/TJ	19.54	19.54	19.54	19.54	19.54
	Cracked Gasoline	$275	tC/TJ	18.17	18.17	18.17	18.17	18.17
	Cracked Diesel Oil or Gas Oil	$276	tC/TJ	18.73	18.73	18.73	18.73	18.73
	Feedstock Oil for Refinery and Mixing	$277	tC/TJ	18.66	18.66	18.66	18.66	18.66
	Naphtha	$281	tC/TJ	18.17	18.17	18.17	18.17	18.17
	Reformed Material Oil	$282	tC/TJ	18.29	18.29	18.29	18.29	18.29
	Gasoline	$310	tC/TJ	18.29	18.29	18.29	18.29	18.29
	Premium Gasoline	$311	tC/TJ	18.29	18.29	18.29	18.29	18.29
	Regular Gasoline	$312	tC/TJ	18.29	18.29	18.29	18.29	18.29
	Jet Fuel	$320	tC/TJ	18.31	18.31	18.31	18.31	18.31
	Kerosene	$330	tC/TJ	18.51	18.51	18.51	18.51	18.51
	Gas Oil or Diesel Oil	$340	tC/TJ	18.73	18.73	18.73	18.73	18.73
	Fuel Oil A	$351	tC/TJ	18.90	18.90	18.90	18.90	18.90
	Fuel Oil C	$355	tC/TJ	19.54	19.54	19.54	19.54	19.54
	Heating Oil B	$356	tC/TJ	19.22	19.22	19.22	19.22	19.22
	Heating Oil C	$357	tC/TJ	19.54	19.54	19.54	19.54	19.54
	Heating Oil C for Power Generation	$358	tC/TJ	19.54	19.54	19.54	19.54	19.54
	Lublicating Oil	$365	tC/TJ	19.22	19.22	19.22	19.22	19.22
	Asphalt	$371	tC/TJ	20.77	20.77	20.77	20.77	20.77
	Non Asphalt Heavy Oil Products	$372	tC/TJ	20.77	20.77	20.77	20.77	20.77
	Oil Coke	$375	tC/TJ	25.35	25.35	25.35	25.35	25.35
	Galvanic Furnace Gas	$376	tC/TJ	38.44	38.44	38.44	38.44	38.44
	Refinary Gas	$380	tC/TJ	14.15	14.15	14.15	14.15	14.15
	Liquified Petroleum Gas	$390	tC/TJ	16.32	16.32	16.32	16.32	16.32
Natural Gas	Liquefied Natural Gas	$410	tC/TJ	13.47	13.47	13.47	13.47	13.47
	Indigenous Natural Gas	$420	tC/TJ	13.90	13.90	13.90	13.90	13.90
	Indigenous Natural Gas	$421	tC/TJ	13.90	13.90	13.90	13.90	13.90
	Coal Mining Gas	$422	tC/TJ	13.47	13.47	13.47	13.47	13.47
	Off-gas from Crude Oil	$423	tC/TJ	13.90	13.90	13.90	13.90	13.90
Town Gas	Town Gas	$450	tC/TJ	14.04	13.99	13.80	13.72	13.82
	Town Gas	$460	tC/TJ	14.04	13.99	13.80	13.72	13.82
	Small Scale Town Gas	$470	tC/TJ	16.32	16.32	16.32	16.32	16.32

(a)Energy sources other than Blast Furnace Gas (BFG) and Town gas

Adequacy assessment was conducted for emission factors which were used in the inventories submitted in 2005 based on the following 3 criteria.

- Comparison with theoretical upper and lower limit
- Comaprison with default values indicated in 1996 revised IPCC guidelines
- Carbon balance assessment for energy group with Energy Balance Table (*General Energy Statistics*).

Emissions factors assessed as adequate continue to be used in this inventory, and the ones assessed as inadequate were substituted by the values given in Ministry of the Environment, committee for the Greenhouse gases Emissions Estimation Methods, in its *GHGs Estimation Methods Committee Report Part 1*, August 2002.

(b) BEG and (c) Town gas

Values for these fuels are established with annually calculated values based on the carbon balance of their production processe. For more details, refer to Annex 2 of this report.

-Oxidation factor

For each type of energy, country-specific oxidation factors were established considering the actual conditions of fuel combustion in Japan based on survey on related industrial groups, manufacturing corporations and experts.

Gaseous Fuels

Every result of measurement of soot concentration of boiler to generate powers in 2004 for gaseous fuels combustion shows that no soot was emitted; therefore, it is considered that gaseous fuels are completely combusted. The results of questionnaires also shows that gaseous fuels are completely combusted. Hence, oxidation factor for gaseous fuels combustion was se to 1.0.

Table 3-2 Data of gaseous fuel combustion

Fired condition	Provider	Survey
Complete combustion	The Federation for Electric Power Companies Japan (FEPC)	measurement of soot concentration of boiler to generate powers in 2004

Liquid Fuels (Petroleum Fuels)

Carbon contained in liquid fuel is considered to be almost completely combusted; however, unburned fuel loss, about 0.5%, may occurr depending on its fired condition. Because the data of actual measurement was not available, considering meticulous combustion management and smoke treatment in Japan, oxidation factor for liquid fuels combustion was set to 1.0.

Solid Fuels

Oxidation factor for solid fuels varies depending on fired condition, type of furnace, and coal property; therefore, it is quite difficult to obtain representational data set of actual measurement of unburned fuel loss. Meanwhile, almost all the unburned carbon generated during combustion in furnace is considered to be contained in coal ash. Coal ash is effectively utilized or landfilled. Carbon contained in coal ash which is used as raw material of cement is oxidized to carbon dioxide and emitted into the atmosphere during calcinations processes.

Average oxidation factor from 1990 to 2003 considering unburned carbon oxidized in firing process of coal ash eventually is 0.996, expressed as 3 effective digits after decimal point. 2 effective digits after the decimal point are considered to be adequate in the view of other coefficients' accuracy; therefore, oxidation factor for solid fuels is set to 1.0 rounding off to two decimal places.

• *Activity Data*

-Energy consumption and non-energy product use of fossil fuels

Values subtracting energy consumption reported under 'Non-energy' [#9500] from energy consumption reported under 'Energy Conversion & Own use' [#2000], 'Industry' [#6000], 'Residential' [#7100], 'Commercial & Others' [#7500], and 'Transportation' [#8000] in Japan's Energy Balance Table (*General Energy Statistics*) are used for activity data. Because energy consumption reported under 'Non-energy' [#9500] was used for the purposes other than combustion and was considered not emitting CO_2, these values were deducted.

In 'Energy Conversion & Own use', 'Power Generation' [#2100], 'Auto Power Generation' [#2200] , 'Industrial Steam Generation' [#2300] , 'District Heat Supply' [#2350] and 'Own Use & Loss' [#2900] are calculated, and other sectors ('Town Gas Production' [#2400] , 'Coal Products' [#2500] , 'Oil Products' [#2600] , 'Other Conversions & Blending' [#2700], 'Other Input/Output' [#3000] and 'Stock Change' [#3500]) are excluded from calculations.

Energy consumptios reported under 'Town Gas Production' [#2400] are feedstocks of town gas production, and was not used to purposes combustion. Therefore, they are excluded from calculations. Meanwhile, CO_2 emissions from carbon contained in these feedstocks are calculated with town gas consumption in final energy consumption sector (industry, residential, commercial & others and transportation).

Energy consumptions reported under 'Coal Products' [#2500] and 'Oil Products' [#2600] are feedstocks for coal products and oil products, and was not used for the purpose of combustion. Meanwhile, CO_2 emissions from carbon contained in these feedstocks are calculated with each kind of energy consumption in energy conversion sector and final energy consumption sector (industry, residential, commercial & others and transportation).

'Other Conversions & Blending' [#2700] sector means energy conversion other than power generation, steam generation, coal product and oil refinery, and product chategory change by minor operation. Energy consumption reported under this sector is not for the purpose of combusttion; therefore, this sector is excluded from calculations.

'Other Input/Output' [#3000] is sector to report the inconsistency between shipping volume and production/receiving volume. 'Stock Change' [#3500] means change in stocks in final energy consumption sector. Energy consumptions reported under both sectors are excluded from calculation because these carbons are not combusted.

-Gross calorific value

Gross calorific values used in Japan’s Energy Balance Table (*General Energy Statistics*) are adopted. エラー！参照元が見つかりません。 shows trends in gross calorific value for each fuel type. Japan’s Energy Balance Table (*General Energy Statistics*) is adopting actual calorific values based on calculation based on annual official statistics for some fuel types which can be recalculated. For other fuel types which can not be recalculated and whose composition is stable, standard calorific values based on relevant official statistics and document are adopted.

Table 3-3 Trends in gross calorific value of each fuel type

Fuel		Code	Unit	1990	1995	2000	2003	2004
Coal	Steel Making Coal	$110	MJ/kg	31.81	30.53	29.10	29.10	29.10
	Coking Coal	$111	MJ/kg	31.81	30.53	29.10	29.10	29.10
	PCI Coal	$112	MJ/kg	31.81	30.53	28.20	28.20	28.20
	Imported Steam Coal	$130	MJ/kg	25.95	25.95	26.60	26.60	26.60
	Imported Coal : for general use	$131	MJ/kg	25.95	25.95	26.60	26.60	26.60
	Imported Coal : for power generation	$132	MJ/kg	24.92	26.13	26.39	25.88	25.66
	Indigenous Steam Coal	$135	MJ/kg	24.28	24.28	22.50	22.50	22.50
	Underground	$136	MJ/kg	24.28	24.28	23.20	23.20	23.20
	Open Pit	$137	MJ/kg	18.70	18.70	18.70	18.70	18.70
	Hard Coal, Anthracite & Lignite	$140	MJ/kg	27.21	27.21	27.20	27.20	27.20
Coal Products	Coke	$161	MJ/kg	30.14	30.14	30.10	30.10	30.10
	Coal Tar	$162	MJ/kg	37.26	37.26	37.26	37.26	37.26
	Coal Briquette	$163	MJ/kg	23.90	23.90	23.90	23.90	23.90
	Coke Oven Gas	$171	MJ/m^{3}N	21.51	21.57	21.27	21.36	21.36
	Blast Furnace Gas	$172	MJ/m^{3}N	3.51	3.59	3.64	3.68	3.69
	Converter Furnace Gas	$173	MJ/m^{3}N	8.37	8.37	8.41	8.41	8.41
Oil	Crude Oil for Refinery	$210	MJ/l	38.34	38.27	38.22	38.16	38.12
	Crude Oil for Power Generation	$220	MJ/l	39.05	39.15	39.59	39.54	39.66
	Vitumous Mixture Fuel	$221	MJ/kg	30.06	30.31	29.86	29.91	29.86
	Natural Gas Liquid & Condensate	$230	MJ/l	35.74	35.51	35.41	35.34	35.50
Oil Products	Slack Gasoline	$271	MJ/l	33.63	33.63	33.57	33.55	33.55
	Slack Kerosene	$272	MJ/l	36.78	36.79	36.76	36.75	36.74
	Slack Diesel Oil or Gas Oil	$273	MJ/l	38.56	38.59	38.58	38.57	38.57
	Slack Fuel Oil	$274	MJ/l	41.82	41.77	41.79	41.78	41.76
	Cracked Gasoline	$275	MJ/l	33.63	33.63	33.57	33.55	33.55
	Cracked Diesel Oil or Gas Oil	$276	MJ/l	38.56	38.59	38.58	38.57	38.57
	Feedstock Oil for Refinery and Mixing	$277	MJ/l	38.34	38.27	38.22	38.16	38.12
	Naphtha	$281	MJ/l	33.63	33.63	33.57	33.55	33.55
	Reformed Material Oil	$282	MJ/l	35.09	35.09	35.09	35.09	35.09
	Gasoline	$310	MJ/l	34.57	34.61	34.60	34.60	34.59
	Premium Gasoline	$311	MJ/l	35.09	35.09	35.09	35.09	35.09
	Regular Gasoline	$312	MJ/l	34.48	34.48	34.48	34.48	34.48
	Jet Fuel	$320	MJ/l	36.42	36.42	36.70	36.70	36.70
	Kerosene	$330	MJ/l	36.78	36.79	36.76	36.75	36.74
	Gas Oil or Diesel Oil	$340	MJ/l	38.11	38.09	38.18	38.00	37.77
	Fuel Oil A	$351	MJ/l	39.74	39.61	39.33	39.15	39.17
	Fuel Oil C	$355	MJ/l	42.68	42.18	41.97	42.02	41.92
	Heating Oil B	$356	MJ/l	40.19	40.19	40.40	40.40	40.40
	Heating Oil C	$357	MJ/l	42.68	42.18	41.97	42.02	41.92
	Heating Oil C for Power Generation	$358	MJ/l	41.06	41.12	41.33	41.06	41.28
	Lublicating Oil	$365	MJ/l	40.19	40.19	40.20	40.20	40.20
	Asphalt	$371	MJ/kg	41.64	41.15	40.95	41.00	40.89
	Non Asphalt Heavy Oil Products	$372	MJ/kg	41.64	41.15	40.95	41.00	40.89
	Oil Coke	$375	MJ/kg	35.58	35.58	35.60	35.60	35.60
	Galvanic Furnace Gas	$376	MJ/m^{3}N	8.37	8.37	8.41	8.41	8.41
	Refinary Gas	$380	MJ/m^{3}N	39.35	39.35	44.90	44.90	44.90
	Liquified Petroleum Gas	$390	MJ/kg	50.23	50.23	50.20	50.20	50.20
Natural Gas	Liquefied Natural Gas	$410	MJ/kg	54.60	54.57	54.55	54.57	54.57
	Indigenous Natural Gas	$420	MJ/m^{3}N	42.09	42.39	42.55	42.91	42.39
	Indigenous Natura l Gas	$421	MJ/m^{3}N	42.09	42.39	42.55	42.91	42.39
	Coal Mining Gas	$422	MJ/m^{3}N	36.00	36.00	16.70	16.70	16.70
	Off-gas from Crude Oil	$423	MJ/m^{3}N	42.09	42.39	42.55	42.91	42.39
Town Gas	Town Gas	$450	MJ/m^{3}N	41.86	41.86	41.10	41.10	41.10
	Town Gas	$460	MJ/m^{3}N	41.86	41.86	41.10	41.10	41.10
	Small Scale Town Gas	$470	MJ/m^{3}N	100.50	100.50	100.50	100.50	100.50

- ***Other issues***

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

The *Revised 1996 IPCC Guidelines* requires carbon dioxide emitted from auto power generation, etc., to be counted in the corresponding sector. In Japan's Energy Balance Table (*General Energy Statistics*),, fuel consumption used for auto power generation and industrial steam generation are presented under 'Auto Power Generation' [#2200] , 'Industrial Steam Generation' [#2300] in the Energy Conversion Sector. However, auto power generation and industrial steam generation actually belong to industrial sector. Hence, carbon dioxide emissions from "Auto Power Generation" and "Industrial Steam Generation" are allocated to each section of '1A2 Manufacturing Industries and Construction'.

-Consistnecy between sectors of Japan's Energy Balance Table (*General Energy Statistics*) and of the CRF

In order to report CO_2 emissions in CRF, emissions reported under the sectors in Japan's Energy Balance Table were reported under each sector in CRF as indicated in Table 3-4.

Table 3-4 Correspondence between sectors of Japan's Energy Balance Table and of the CRF

CRF			Japan's Energy Balance Table	
1A1		Energy Industries		
	1A1a	Public Electricity and Heat Production	Power Genertion, General Electric Utilities	#2110
			Own use, General Electric Utilities	#2911
			Power Genertion, Independent Power Producing	#2150
			Own use, Independent Power Producing	#2912
			District Heat Supply	#2350
			Own use, District Heat Supply	#2913
	1A1b	Petroleum Refining	Own use, Oil Refinary	#2916
	1A1c	Manufacture of Solid Fuels and Other Energy Industries	Own use, Town Gas	#2914
			Own use, Steel Coke	#2915
			Own use, Other Conversion	#2917
1A2		Manufacturing Industries and Construction		
	1A2a	Iron and Steel	Auto: Iron & Steel	#2217
			Steam Generation: Iron & Steel	#2307
			Final Energy Consumption, Iron & Steel	#6580
			Non-Energy, Iron & Steel	#9680
	1A2b	Non-Ferrous Metals	Auto: Non-Ferrous Metal	#2218
			Steam Generation: Non-Ferrous Metal	#2308
			Final Energy Consumption, Non-Ferrous Metal	#6590
			Non-Energy, Non-Ferrous Metal	#9690
	1A2c	Chemicals	Auto: Chemical Textiles	#2212
			Steam Generation: Chemical Textiles	#2302
			Final Energy Consumption, Chemical Textiles	#6530
			Non-Energy, Chemical Textiles	#9630
			Auto: Chemical	#2214
			Steam Generation: Chemical	#2304
			Final Energy Consumption, Chemical	#6550
			Non-Energy, Chemical	#9650
	1A2d	Pulp, Paper and Print	Auto: Pulp & Paper	#2211
			Steam Generation: Pulp & Paper	#2301
			Final Energy Consumption, Pulp & Paper	#6520
			Non-Energy, Pulp & Paper	#9620
	1A2e	Food Processing, Beverages and Tobacco	Final Energy Consumption, Food	#6510
			Non-Energy, Non-Manufacturing Industry (Food)	#9610

CRF			Japan's Energy Balance Table	
	1A2f	Other		
		Construction	Final Energy Consumption, Construction	#6150
			Non-Energy, Non-Manufacturing Industry (Construction)	#9610
		Oil Products	Auto: Oil products	#2213
			Steam Generation: Oil products	#2303
			Final Energy Consumption, Oil products	#6540
			Non-Energy, Oil products	#9640
		Glass Wares	Auto: Glass Wares	#2215
			Steam Generation: Glass Wares	#2305
			Final Energy Consumption, Glass Wares	#6560
			Non-Energy, Glass Wares	#9660
		Cement&Ceramics	Auto: Cement & Ceramics	#2216
			Steam Generation: Cement & Ceramics	#2306
			Final Energy Consumption, Cement & Ceramics	#6570
			Non-Energy, Cement & Ceramics	#9670
		Machinery	Auto: Machinery & Others	#2219
			Steam Generation: Machinery & Others	#2309
			Final Energy Consumption, Machinery	#6600
			Non-Energy, Machinery	#9700
		Duplication Adjustment	Auto: Duplication Adjustment	#2220
			Steam Generation: Duplication Adjustment	#2310
			Final Energy Consumption, Duplication Adjustment	#6700
			Non-Energy, Duplication Adjustment	#9710
		Other Industries & SMEs	Auto: Others	#2250
			Final Energy Consumption, Other Industries & SMEs	#6900
			Non-Energy, Other Industries & SMEs	#9720
1A3		Transport		
	1A3a	Civil Aviation	Final Energy Consumption, Passenger Air	#8140
			Final Energy Consumption, Freight Air	#8540
			Non-Energy, Transportation (Air)	#9850
	1A3b	Road Transportation	Final Energy Consumption, Passenger Car	#8110
			Final Energy Consumption, Freight Freight, Truck & Lorry	#8510
			Final Energy Consumption, Passenger Bus	#8115
			Final Energy Consumption, Passenger, Transportation fraction estimation error	#8190
			Final Energy Consumption, Freight, Transportation fraction estimation error.	#8590
			Non-Energy, Transportation (Car, Truck & Lorry, Bus)	#9850
	1A3c	Railways	Final Energy Consumption, Passenger Rail	#8120
			Final Energy Consumption, Freight Rail	#8520
			Non-Energy, Transportation (Rail)	#9850
	1A3d	Navigation	Final Energy Consumption, Passenger Ship	#8130
			Final Energy Consumption, Freight Ship	#8530
			Non-Energy, Transportation	#9850
	1A3e	Other Transportation	-	-
1A4		Other Sectors		
	1A4a	Commercial/Institutional	Final Energy Consumption, Commercial & Others	#7500
			Non-Energy, ResCom & others (Commercial & Others)	#9800
	1A4b	Residential	Final Energy Consumption, Residential	#7100
			Non-Energy, ResCom & others (Residential)	#9800
	1A4c	Agriculture/Forestry/Fisheries	Final Energy Consumption, Agruculture, Forestry & Fishery	#6110
			Non-Energy, Non-Manufacturing Industry (Agruculture, Forestry & Fishery)	#9610
1A5		Other		
	1A5a	Stationary	Final Energy Consumption, Mining	#6120
			Non-Energy, Non-Manufacturing Industry (Mining)	#9610
	1A5b	Mobile	-	-

Note 1: Non-Energy is subtracted.

Note 2: Non-Manufacturing Industry of Non-Energy are not disaggregated, therefore, values in sub-sectors were allocated based on energy consumption of each fuel type.

-Reporting emissions from waste used as energy

In Japan, GHGs emissions from waste used as energy are reported under waste sector considering actual waste management condition in Japan. Greenhouse gas (CO_2, CH_4, N_2O) emissions from raw material and fuel use of waste are estimated 11.4 milliion t-CO_2eq in 2004. Details are in waste sector (NIR Ch.8).

Table 3-5 GHG emissions from raw material and fuel use of waste

Gas	Unit	1990	1995	2000	2003	2004
CO_2	Gg-CO_2	3,302	5,184	7,479	10,612	11,006
CH_4	Gg-CO_2eq	39	42	55	64	64
N_2O	Gg-CO_2eq	55	120	207	288	290
Total	Gg-CO_2eq	3,397	5,345	7,741	10,964	11,360

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

- ***Background***

Non-CO_2 gases are generated from fuel combustion in stationary sources. CH_4 is generated as a result of incomplete combustion, and as such, if sufficient care is taken to ensure complete combustion, CH_4 will not be generated. N_2O is generated through the reaction of NO, which is generated by combustion, with nitrogen-containing volatile components in fuels. Consequently, the higher the nitrogen content of the fuel used, the more likely it is that N_2O will be generated. However, the reaction that produces N_2O is also dependent on temperature, with N_2O more likely to be generated at lower temperatures. More N_2O will accordingly be generated by furnaces such as fluidized bed boilers that burn fuel at low temperatures in the 800–900°C range. N_2O can also be generated when NOx makes contact with catalysts for NOx removal.

CH_4 emission from coking furnaces is calculated in Industrial Processes.

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

Because it is possible to use fuel-specific, sector-specific and furnace-specific activity data, and also to set country-specific emission factors for Japan, Tier 2 country-specific emission factors were used to calculate emissions in accordance with the *1996 Revised IPCC Guidelines* and *Good Practice Guidance* (2000). However, in residential and other sectors in which activity data for different furnace types cannot be used, Tier 1 IPCC default emission factors were used.

Emissions were calculated by multiplying fuel-specific, furnace-specific and sector-specific activity data by fuel-specific and furnace-specific emission factors.

- ***Emission Factors***

Based on data obtained from surveys conducted in Japan (Table 3-6), chimney flue CH_4, N_2O and O_2 concentrations, and the theoretical (dry) exhaust gas volumes, theoretical air volumes, and higher heating values shown in Table 3-7 were employed to establish emission factors for each kind of facility using the combustion calculation formula[1].

Emission factors for each kind of facility were averaged after dividing facilities according to fuel and furnace types, and CH_4 and N_2O emission factors were established (Table 3-8, Table 3-9). Anomalous values were excluded according to t-testing or expert opinion when calculating average values.

Table 3-6 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

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[1] For CH_4 and N_2O emissions from electric arc furnaces, combustion calculation was carried out using measurement results for CH_4 and N_2O concentrations in exhaust gas, dry exhaust gas volume per unit time, and calorific value per unit time.

Table 3-7 Theoretical exhaust gas and air volumes, higher heating value for different fuels

Fuel type	Fixed unit	Theoretical exhaust gas volume (dry)	Higher heating value	Theoretical air volume	Remarks
		m^3_N/l,kg,m^3N	kJ/l,kg,m^3N,kWh	m^3_N/l,kg,m^3N	
Heavy oil A	l	8.900	39,100	9.500	1
Heavy oil B	l	9.300	40,400	9.900	1
Heavy oil C	l	9.500	41,700	10.100	1
Diesel oil	l	8.800	38,200	9.400	1
Kerosene	l	8.400	36,700	9.100	1
Crude oil	l	8.747	38,200	9.340	1
Naphtha	l	7.550	34,100	8.400	1
Other liquid fuels	l	9.288	37,850	9.687	2
Other liquid fuels (heavy)	l	9.064	37,674	9.453	2
Other liquid fuels (light)	l	9.419	35,761	9.824	2
Steam coal	kg	7.210	26,600	7.800	1
Coke	kg	7.220	30,100	7.300	1
Harvested wood	kg	3.450	14,367	3.720	2
Charcoal	kg	7.600	30,500	7.730	3
Other solid fuels	kg	7.000	33,141	7.000	2
Town gas	m^3	9.850	46,047	10.949	2
Coke oven gas (COG)	m^3	4.500	21,100	4.800	1
Blast furnace gas (BFG)	m^3	1.460	3,410	0.626	1
Liquefied natural gas (LNG)	kg	11.766	54,500	13.093	1
Liquefied petroleum gas (LPG)	kg	11.051	50,200	12.045	1
Linz-Donawitz (LD) gas	m^3	2.200	8,410	1.500	1
Refinery gas (offgas)	m^3	11.200	44,900	12.400	1
Other gaseous fuels	m^3	4.587	28,465	4.096	2
Other gaseous fuels (petroleum)	m^3	7.889	40,307	7.045	2
Other gaseous fuels (steel)	m^3	2.812	19,097	2.511	2
Other gaseous fuels (mining)	m^3	3.396	38,177	3.032	2
Other gaseous fuels (other)	m^3	4.839	23,400	4.321	2
Pulping waste liquor	kg	3.245	13,898	3.499	2
Electricity	kWh		3,600		1

Note 1: Theoretical exhaust gas and air volumes are the standard values given in the from the Ministry of the Environment’s *Research of Air Pollutant Emissions from Stationary Sources* (hereafter MAP Survey),, except for town gas, LNG and LPG, for which values calculated from constituent data were used. For town gas, the constituents of town gas 13A were considered to be representative. Regarding higher heating value, standard calorific values given in General Energy Statistics were used for items marked 1, and standard values given in the MAP Survey (based on the 1992 survey) for items marked 2 in the Remarks column. The higher heating value for steam coal (imported) was used for the higher heating value of steam coal. The item marked 3 in the Remarks column was set by the 2005 Committee based on reference materials etc.

Table 3-8 CH_4 emission factors for different fuels and furnaces (unit: kg-CH_4/TJ)

Furnace type	Fuel type	Emission factor	Remarks
Boiler	Heavy oils B and C, crude oil	0.10	Average of 9 facilities
Boiler	Heavy oil A, diesel oil, kerosene, naphtha, other liquid fuels	0.25	Average of 2 facilities
Boiler	Gaseous fuel	0.22	Average of 5 facilities
Boiler	Steam coal, coke, other solid fuels	0.13	Average of 7 facilities
Boiler	Harvested wood, charcoal	72	Average of 4 facilities
Boiler	Pulping waste liquor	4.3	Average of 2 facilities
Sintering furnace for smelting of metals (except copper, lead, zinc)	Solid fuel, liquid fuel, gaseous fuel	30	Average of 6 facilities
Pelletizing furnace (steel and non-ferrous metal)	Solid fuel, liquid fuel, gaseous fuel	1.6	Average of 2 facilities

Furnace type	Fuel type	Emission factor	Remarks
Metal rolling furnace, metal treating furnace, metal forging furnace	Liquid fuel, gaseous fuel	0.42	Average of 11 facilities
Petroleum and gas furnaces	Liquid fuel, gaseous fuel	0.15	Average of 27 facilities
Catalytic regenerator	Coke, carbon	0.054	Average of 11 facilities
Brick kiln, ceramic kiln, and other kiln	Solid fuel, liquid fuel, gaseous fuel	1.5	Average of 2 facilities
Aggregate drying kiln, cement raw material drying kiln, brick raw material drying kiln	Solid fuel, liquid fuel, gaseous fuel	27	Average of 6 facilities
Other drying kilns	Solid fuel, liquid fuel, gaseous fuel	6.1	Average of 8 facilities
Electric arc furnace	Electricity	13	Average of 6 facilities
Other industrial furnaces	Solid fuel	13	Average of 14 facilities
Other industrial furnaces	Liquid fuel	0.79	Average of 14 facilities
Other industrial furnaces	Gaseous fuel	2.1	Average of 6 facilities
Gas turbine	Liquid fuel, gaseous fuel	0.75	Average of 11 facilities
Diesel engine	Liquid fuel, gaseous fuel	0.67	Average of 8 facilities
Gas engine, petrol engine	Liquid fuel, gaseous fuel	54	Average of 6 facilities
Household equipment	Solid fuel	290	IPCC default value converted to higher heating value
Household equipment	Liquid fuel	9.5	IPCC default value converted to higher heating value
Household equipment	Gaseous fuel	4.5	IPCC default value converted to higher heating value
Household equipment	Biomass fuel	290	IPCC default value converted to higher heating value

Table 3-9 N_2O emission factors for different fuels and furnaces (unit: kg-N_2O/TJ)

Furnace type	Fuel type	Emission factor	Remarks
Boiler	Heavy oils B and C, crude oil	0.21	Average of 10 facilities
Boiler	Heavy oil A, diesel oil, kerosene, naphtha, other liquid fuels	0.18	Average of 2 facilities
Boiler	Gaseous fuel	0.16	Average of 5 facilities
Boiler (other than fluidized bed boilers)	Solid fuel	0.83	Average of 9 facilities
Normal pressure fluidized bed boiler	Solid fuel	53	Average of 11 facilities
Pressurized fluidized bed boiler	Steam coal	5.2	Data from 1 facility
Boiler	Pulping waste liquor	0.17	Average of 2 facilities
Blast furnace	Coke oven gas, blast furnace gas, other gaseous fuel	0.050	Average of 2 facilities
Petroleum furnace, gas furnace	Liquid fuel, gaseous fuel	0.20	Average of 27 facilities
Catalytic regenerator	Coke, carbon	7.3	Average of 12 facilities
Electric arc furnace	Electricity	3.3	Average of 6 facilities
Coke oven	Town gas, coke oven gas, blast furnace gas, converter gas, offgas, other gaseous fuels	0.15	Average of 3 facilities
Other industrial furnace	Solid fuel	1.1	Average of 20 facilities
Other industrial furnace	Liquid fuel	1.7	Average of 31 facilities
Other industrial furnace	Gaseous fuel	1.1	Average of 18 facilities
Gas turbine	Liquid fuel, gaseous fuel	0.54	Average of 12 facilities
Diesel engine	Liquid fuel, gaseous fuel	2.1	Average of 9 facilities
Gas engine, petrol engine	Liquid fuel, gaseous fuel	0.83	Average of 7 facilities

Furnace type	Fuel type	Emission factor	Remarks
Household equipment	Solid fuel	1.3	IPCC default value converted to higher heating value
Household equipment	Liquid fuel	0.57	IPCC default value converted to higher heating value
Household equipment	Gaseous fuel	0.090	IPCC default value converted to higher heating value
Household equipment	Biomass fuel	3.8	IPCC default value converted to higher heating value

• *Activity Data*

Fuel consumption of each sector (Energy Conversion, Industry, Commercial, and Residential) for each type of fuel as given in the General Energy Statistics activity data is divided according to furnace type to obtain activity data.

Because stationary combustion fuel consumption data for the different types of furnace is not available in the General Energy Statistics, data from the MAP Survey, which provides details on fuel consumption for different types of furnace and fuel, was used to estimate fuel consumption for different furnace types. The procedure for calculating activity data is as follows:

1) Fuel consumption data from the MAP Survey is collated respectively for each fuel type, furnace type and sector.

2) The percentage of fuel consumption accounted for by each furnace type is calculated for each fuel type and sector.

3) Fuel consumption for different fuel types and sectors provided in the General Energy Statistics is multiplied by the percentage calculated in (2) to obtain fuel-specific, furnace-specific, and sector-specific activity data.

4) MAP Survey fuel-specific, furnace-specific, and sector-specific fuel consumption is used as activity data for the consumption of fuels (such as charcoal) not included in the General Energy Statistics, and furnaces for which General Energy Statistics fuel consumption data cannot be used (in specific terms, electricity consumption of electric arc furnaces and carbon fuels of catalytic regenerators).

5) In the residential sector, fuel consumption for different fuel types provided in the General Energy Statistics is used as activity data.

For years in which exhaustive MAP surveys were not carried out, data from the nearest exhaustive survey year was used.

• *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.

• *Point to Note*

Up to the 2005 Inventory, Japan corrected for intake gas concentrations by using the difference in GHG concentrations in exhaust gas and intake gas (intake gas correction) when setting emission factors for 1.A.1. Energy Industry (CH_4, N_2O), 1.A.2. Manufacturing and Construction Industries (CH_4, N_2O), and 1.A.4. Other Sectors (CH_4, N_2O), based on the conclusions of earlier studies of estimation methodology (*Reports on Greenhouse Gas Emissions Estimation Methodology* (1996), etc.). As a result, emission factors for some emission sources were given negative values based on measurements showing that due to combustion, the concentrations of methane and nitrous oxide in exhaust gases become lower than their concentrations in intake gas.

However, during the 2003 in-country review, the Expert Review Team (ERT) noted that while intake gas correction is desirable from the viewpoint of obtaining accurate emissions data, negative emission factors are not consistent with the *1996 Revised IPCC Guidelines* and *IPCC Good Practice Guidance* (2000), which from the desirability of ensuring international consistency require the use of positive emission factors based on actual exhaust gas concentrations of methane and nitrous oxide. In order to meet this requirement, Japan now uses actual exhaust gas concentrations as they are to calculate emission factors. (see Chapter 10 Recalculation and Improvements)

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

For emissions from mobile sources, methane and nitrous oxide emissions from aviation, road transportation, railways and navigation are calculated.

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

- ***Background***

Greenhouse gases associated with the domestic operation of Japanese airliners are mainly emitted from jet fuels. In addition, a small amount of aviation gasoline used by light aircraft and helicopters is also a source of methane and nitrous oxide emission.

- ***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.)

Methane and nitrous oxide emissions associated with landing and take-off (LTO) of domestic airliners using jet fuel
= Emission factor per LTO1 cycle per domestic airliner × Number of LTO cycles of aircraft in domestic routes

Methane and nitrous oxide emissions from domestic airliner during cruising using jet fuel
= Emission factor associated with jet fuel consumption × Jet fuel consumption by aircraft during cruising in domestic routes

Methane and nitrous oxide emission associated with flight of gasoline-powered domestic aircraft
= Emission factor associated with consumption of aviation gasoline × Consumption of aviation gasoline by aircraft in domestic routes

- ***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 3-10 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-2006.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.

Table 3-11 Activity Data associated with emissions from aircraft

Item	Unit	1990	1995	2000	2003	2004
number of LTO cycle	LTO	430,654	532,279	667,559	702,650	698,465
Jet fuel comsumption of Cruis	kl	2,330,514	3,223,547	3,537,205	3,655,081	3,504,806
Gasoline comsumption	kl	5,345	6,029	4,287	16,466	10,379

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

- ***Background***

Emissions from automobiles in Japan are calculated for the following vehicle categories:

Table 3-12 Reporting categories and definitions of emissions from automobiles

Vehicle Type	Definition	Fuel type for emission reporting			
		Gasoline	Diesel	LPG	LNG
Light passenger vehicle	Light vehicle used for transportation of people.	○	–	–	–
Light cargo truck	Light vehicle used for transportation of cargo	○	–	–	–
Passenger vehicle	Regular passenger vehicle or small vehicle used for transportation of people, with a capacity of 10 persons or less.	○	○	○	–
Bus	Regular passenger vehicle or small vehicle used for transportation of people, with a capacity of 11 persons or more.	○	○	–	–
Small cargo truck	Small vehicle used for transportation of cargo.	○	○	–	–
Regular cargo truck	Regular vehicle used for transportation of cargo.	○	○	–	–
Special-purpose vehicle	Regular, small or light vehicle used for special purposes, including flushers, advertising vans, hearses, and others.	○	○	–	–
NPG vehicle	Any of the above vehicles that use natural gas as fuel.	–	–	–	○
Motorcycle	Two-wheeled vehicle	○	–	–	–

3.1.3.2.a. Light passenger vehicle, light cargo trucks, passenger vehicle, buses, small cargo trucks, regular cargo trucks, and special-purpose vehicles

- ***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. Detailed method for the determination of the emission factors are described in the *Greenhouse Gases Estimation Methods Committee Report Part 3* (Environmental Agency; September, 2000), the *Greenhouse Gases Estimation Methods Committee Report Part 3* (Ministry of Environment; August, 2002) and the *Greenhouse Gases Estimation Methods Committee Report – Transportation* (Ministry of Environment; February, 2006).

Table 3-13 Methane emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	2000	2003	2004
Gasoline	Light Vehicle	gCH$_4$/km	0.011	0.011	0.011	0.010	0.010
	Passenger Vehicle (including LPG)	gCH$_4$/km	0.011	0.011	0.011	0.010	0.010
	Light Cargo Truck	gCH$_4$/km	0.011	0.011	0.011	0.011	0.011
	Small Cargo Truck	gCH$_4$/km	0.022	0.019	0.017	0.015	0.014
	Regular Cargo Truck	gCH$_4$/km	0.035	0.035	0.035	0.035	0.035
	Bus	gCH$_4$/km	0.035	0.035	0.035	0.035	0.035
	Special Vehicle	gCH$_4$/km	0.035	0.035	0.035	0.035	0.035
Diesel	Passenger Vehicle	gCH$_4$/km	0.0020	0.002	0.002	0.002	0.002
	Small Cargo Truck	gCH$_4$/km	0.0088	0.0091	0.0079	0.0076	0.0076
	Regular Cargo Truck	gCH$_4$/km	0.017	0.016	0.015	0.015	0.015
	Bus	gCH$_4$/km	0.019	0.018	0.017	0.017	0.017
	Special Vehicle	gCH$_4$/km	0.017	0.015	0.013	0.013	0.013
Natural gas vehicle	Small Cargo Truck, Passenger Vehicle, Light Vehicle, Light Cargo Truck	gCH$_4$/km	0.0084	0.0084	0.0084	0.0084	0.0084
	Regular Cargo Truck	gCH$_4$/km	0.366	0.366	0.366	0.366	0.366
	Special Vehicle	gCH$_4$/km	0.414	0.414	0.414	0.414	0.414
	Bus	gCH$_4$/km	1.098	1.098	1.098	1.098	1.098
Gasoline two-wheel vehicle (hot start)	Small motor vehicle: first kind (travel speed 15-20km)	gCH$_4$/km	0.111	0.111	0.094	0.070	0.062
	(travel speed 20-25km)	gCH$_4$/km	0.097	0.097	0.082	0.060	0.053
	(travel speed 25-30km)	gCH$_4$/km	0.097	0.097	0.082	0.061	0.054
	(travel speed 30-40km)	gCH$_4$/km	0.113	0.113	0.096	0.073	0.066
	(travel speed 40-50km)	gCH$_4$/km	0.159	0.159	0.140	0.112	0.103
	Small motor vehicle: second kind	gCH$_4$/km	0.124	0.124	0.111	0.077	0.067
	(travel speed 20-25km)	gCH$_4$/km	0.107	0.107	0.096	0.067	0.059
	(travel speed 25-30km)	gCH$_4$/km	0.095	0.095	0.086	0.060	0.053
	(travel speed 30-40km)	gCH$_4$/km	0.084	0.084	0.076	0.054	0.048
	(travel speed 40-50km)	gCH$_4$/km	0.084	0.084	0.076	0.055	0.049
	(travel speed 50-60km)	gCH$_4$/km	0.084	0.084	0.076	0.054	0.048
	(travel speed 60-80km)	gCH$_4$/km	0.080	0.080	0.072	0.052	0.045
	Light two-wheel vehicle (travel speed 15-20km)	gCH$_4$/km	0.245	0.245	0.204	0.126	0.104
	(travel speed 20-25km)	gCH$_4$/km	0.212	0.212	0.177	0.110	0.090
	(travel speed 25-30km)	gCH$_4$/km	0.188	0.188	0.157	0.098	0.081
	(travel speed 30-40km)	gCH$_4$/km	0.161	0.161	0.134	0.084	0.069
	(travel speed 40-50km)	gCH$_4$/km	0.133	0.133	0.111	0.070	0.058
	(travel speed 50-60km)	gCH$_4$/km	0.111	0.111	0.092	0.058	0.048
	(travel speed 60-80km)	gCH$_4$/km	0.085	0.085	0.071	0.045	0.037
	Small two-wheel vehicle (travel speed 15-20km)	gCH$_4$/km	0.182	0.182	0.167	0.120	0.107
	(travel speed 20-25km)	gCH$_4$/km	0.160	0.160	0.147	0.105	0.094
	(travel speed 25-30km)	gCH$_4$/km	0.143	0.143	0.132	0.095	0.084
	(travel speed 30-40km)	gCH$_4$/km	0.124	0.124	0.113	0.082	0.073
	(travel speed 40-50km)	gCH$_4$/km	0.101	0.101	0.093	0.068	0.061
	(travel speed 50-60km)	gCH$_4$/km	0.080	0.080	0.074	0.055	0.050
	(travel speed 60-80km)	gCH$_4$/km	0.049	0.049	0.046	0.035	0.032
Gasoline two-wheel vehicle (cold start)	Small motor vehicle: first kind controlled by regulation	gCH$_4$/回			0.043	0.041	0.038
	Small motor vehicle: first kind uncontrolled by regulation	gCH$_4$/回	0.039	0.039	0.039	0.039	0.039
	Small motor vehicle: second kind	gCH$_4$/回			0.004	0.004	0.004
	Small motor vehicle: second kind	gCH$_4$/回	0.012	0.012	0.012	0.012	0.012
	Light two-wheel vehicle controlled by regulation	gCH$_4$/回			0.022	0.022	0.022
	Light two-wheel vehicle uncontrolled by regulation	gCH$_4$/回	0.016	0.016	0.016	0.015	0.015
	Small two-wheel vehicle controlled by regulation	gCH$_4$/回			0.033	0.033	0.033
	Small two-wheel vehicle uncontrolled by regulation	gCH$_4$/回	0.043	0.043	0.043	0.043	0.043

Table 3-14 Nitrous oxide emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	2000	2003	2004
Gasoline	Light Vehicle	gN_2O/km	0.019	0.021	0.022	0.022	0.022
	Passenger Vehicle (including LPG)	gN_2O/km	0.027	0.029	0.029	0.029	0.029
	Light Cargo Truck	gN_2O/km	0.021	0.022	0.022	0.022	0.022
	Small Cargo Truck	gN_2O/km	0.027	0.029	0.026	0.026	0.026
	Regular Cargo Truck	gN_2O/km	0.039	0.041	0.039	0.039	0.039
	Bus	gN_2O/km	0.045	0.046	0.043	0.041	0.041
	Special Vehicle	gN_2O/km	0.039	0.042	0.038	0.035	0.035
Diesel	Passenger Vehicle	gN_2O/km	0.007	0.007	0.007	0.007	0.007
	Small Cargo Truck	gN_2O/km	0.009	0.010	0.010	0.009	0.009
	Regular Cargo Truck	gN_2O/km	0.015	0.015	0.015	0.014	0.014
	Bus	gN_2O/km	0.025	0.025	0.025	0.025	0.025
	Special Vehicle	gN_2O/km	0.025	0.025	0.025	0.025	0.025
Natural gas vehicle	Small Cargo Truck, Passenger Vehicle, Light Vehicle, Light Cargo Truck	gN_2O/km	0.0002	0.0002	0.0002	0.0002	0.0002
	Regular Cargo Truck	gN_2O/km	0.0128	0.0128	0.0128	0.0128	0.0128
	Special Vehicle	gN_2O/km	0.0145	0.0145	0.0145	0.0145	0.0145
	Bus	gN_2O/km	0.0384	0.0384	0.0384	0.0384	0.0384
Gasoline two-wheel vehicle (hot start)	Small motor vehicle: first kind	gN_2O/km	0.002	0.002	0.002	0.002	0.002
	Small motor vehicle: second kin	gN_2O/km	0.002	0.002	0.002	0.002	0.002
	Light two-wheel vehicle	gN_2O/km	0.002	0.002	0.002	0.002	0.002
	Small two-wheel vehicle	gN_2O/km	0.002	0.002	0.002	0.002	0.002

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-2006.xls¥car(****)* for the process of estimating activity data).

Table 3-15 Distance traveled per type of vehicle

vehicle type	Unit	1990	1995	2000	2003	2004
Light vehicle	10^6 vehicles km	15,281	39,386	70,055	90,986	97,058
Passenger vehicle	10^6 vehicles km	350,317	407,001	438,204	438,730	429,260
Bus	10^6 vehicles km	7,112	6,768	6,619	6,662	6,665
Light cargo truck	10^6 vehicles km	85,336	84,534	74,914	73,623	74,317
Small cargo truck + Cargo passenger truck	10^6 vehicles km	92,409	87,924	82,209	78,072	72,044
Regular cargo truck	10^6 vehicles km	66,881	78,446	83,024	83,613	81,222
Special vehicle	10^6 vehicles km	11,246	16,224	20,699	21,692	21,145

3.1.3.2.b. Natural gas-powered vehicles

Methodology of Estimating Emissions of GHGs

Emissions were calculated by multiplying the distance traveled per type of natural gas-powered vehicle by the emission factor for the type of vehicle.

- ***Emission Factors***

Emission factors for natural gas-powered small and regular cargo trucks were determined using the average of the emission factors established for each travel speed category based on the actual measurements taken in Japan, weighted by the percentage of distance traveled for each travel speed category reported in the *Road Transport Census* (Ministry of Land, Infrastructure and Transport).

In the absence of actual measurement data in Japan, emission factors for vehicles other than small and regular cargo trucks were determined by adjusting the emissions factors for small and regular cargo trucks as necessary, taking the characteristics of each type of vehicle into consideration.

Table 3-16 Methane and nitrous oxide emission factors for natural gas-powered vehicles

Type	Calculation Method for Emission Factor	Average Methane Emission Factor [g-CH_4/km]	Average Nitrous Oxide Emission Factor [g-N_2O/km]
Small cargo truck	Determined based on actual measurements	0.0084	0.0002
Passenger vehicle, light passenger vehicle, light cargo truck	Used the emission factors for small cargo truck, taking the specifications of each type of vehicle into account.	0.0084	0.0002
Regular cargo truck	Determined based on actual measurements	0.366	0.0128
Special-purpose vehicle	Determined from the percentage of distance traveled per travel speed category which was adjusted by the emission factor per travel speed category for regular cargo trucks, taking travel patterns of natural gas-powered special-purpose vehicles into consideration.	0.414	0.0145
Bus	Determined from the emission factor for regular cargo truck which was adjusted by the ratio of equivalent inertia weight, taking vehicle weight into consideration.	1.098	0.0384

- ***Activity Data***

Annual distance traveled per type of vehicle was determined by multiplying the number of natural gas-powered vehicles by the annual distance traveled per vehicle. The number of these vehicles was taken from the number of registered natural gas-powered vehicles per type in data compiled by the Japan Gas Association. For the annual distance traveled per type of vehicle, the value specific to the natural gas-powered vehicles could not be determined. As a result, the calculation of activity data used the annual distance traveled per vehicle for all fuel types which had been determined from the distance traveled per type of vehicle and the number of registered vehicles per type reported in the *Statistical Yearbook of Motor Vehicle Transport*.

Table 3-17 Annual distance traveled by natural gas-powered vehicles per type of vehicle.

vehicle type	Unit	1990	1995	2000	2003	2004
Passenger vehicle	1,000 vehicle-km	54	104	6,516	12,074	13,216
Bus	1,000 vehicle-km	0	1,860	18,743	42,603	48,708
Truck	1,000 vehicle-km	91	2,459	77,394	291,919	335,833
Small cargo truck	1,000 vehicle-km	184	8,088	32,426	51,571	54,129
Light vehicle	1,000 vehicle-km	0	498	19,217	50,345	61,585
Garbage vehicle	1,000 vehicle-km	0	300	6,955	31,700	35,257

3.1.3.2.c. Motorcycles

• *Methodology of Estimating Emissions of GHGs*

Emissions from motorcycles were estimated based on the method developed in Japan by the Ministry of Environment for the estimation of emissions from vehicles not subject to the PRTR (Pollutant Release and Transfer Register) Program. The emissions were calculated for two emission sources of “Hot start” and “Increment for cold start”, using the equations below. For details of the calculation method, see the *Greenhouse Gases Estimation Methods Committee Report – Transportation* (February, 2006).

Methane and nitrous oxide emissions from hot-starting of motorcycles
= Emission factor for vehicle-km per type of motorcycle × Total annual distance traveled by motorcycles per type

Methane emissions from increment at cold starting of motorcycles
= Emission factor per start per type × Number of engine start-ups per year by each type of motorcycle

• *Emission Factors*

- Hot start

The THC (Total HydroCarbon) emission factor for hot starts, derived from the actual measurement data in Japan, was multiplied by the ratio of the methane emission factor to the THC emission factor, obtained from actual measurements. The THC emission factors for motorcycles were established for each category of vehicle type, stroke, and unregulated/regulated status. Accordingly, the emission factor per travel speed was determined for each type of motorcycle by apportioning the number of motorcycles in operation to these categories based on the estimated component ratio. For nitrous oxide, the default emission factor for *US Motorcycles/European Motorcycles* given in the *Revised 1996 IPCC Guidelines* is used.

- Increment for cold start

The emission factor was determined for each type of motorcycle by multiplying the THC emission factor for cold-start increment, derived from the actual measurement data in Japan, by the methane and THC emission factors for hot start, and apportioning the results based the ownership component ratio. No emission factor is set for nitrous oxide because the increment for cold start for nitrous oxide is assumed to be included in the default emission factor for hot start

• *Activity Data*

- Hot start

Based on the motorcycle operation data in the *Road Transport Census*, annual distance traveled was determined for each type of motorcycle and travel speed category using the ratio of total distance traveled per type, obtained from sources including the *Survey of Motorcycle Market Trends* and the ratio of distance traveled per travel speed category, estimated from the *Road Transport Census*. In the determination of the activity data for this source, the rate of reduction of motorcycle operation due to rain or snow as well as increases in the ownership and the distance traveled during the years outside the survey were taken into consideration.

- Increment for cold start:

The annual number of engine startups (times/year) per type of motorcycle was determined by the following formula:

Number of engine startups

= (Expected operation of new motorcycle in number of days in year)$_{\text{type}}$ × (Operation factor)$_{\text{elapsed years}}$ × (Reduction rate of operation due to rain and snow)$_{\text{prefecture}}$ × (Average number of startups per day)$_{\text{type}}$ × (Number of motorcycles owned)$_{\text{type, prefecture, elapsed years}}$

• *Completeness*

-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.

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

• *Background*

Emissions from railways come mainly from diesel-engine locomotives that use light oil. In addition, there are small amounts of emissions from coal-fired steam locomotives.

• *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 *1A3-2006.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.

Methane and nitrous oxide emissions from diesel locomotives
= Emission factor for diesel engines in railways × Annual consumption of light oil by diesel locomotives

Methane and nitrous oxide emissions from steam locomotives
= Emission factor for coal in rail transportation × Annual consumption of coal by steam locomotives

• *Emission Factors*

For emission factors for diesel-powered locomotives, the default value shown in the *Revised 1996 IPCC Guidelines* under *Diesel engines – Railways* was used after the conversion to a per-liter value using the calorific value of light oil.

For emission factors for steam locomotives, the default value shown in the *Revised 1996 IPCC Guidelines* under *Coal – Railways* was used after the conversion to a per-weight value using the calorific value of imported steam coal.

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

Table 3-18 Default values for railway emission factors

	Diesel Locomotives	Steam Locomotives
Methane emission factor	0.004 [g-CH_4/MJ]	10 [kg-CH_4/TJ]
Nitrous oxide emission factor	0.03 [g-N_2O/MJ]	1.4 [kg-N_2O/TJ]

Source: *Revised 1996 IPCC Guidelines*, Vol. 3, p. 1.91, Table 1-49; p. 1.35, Table 1-7; and p. 1.36, Table 1-8

• *Activity Data*

For the consumption of light oil by diesel locomotives, light oil consumption in the railway sector shown in the *General Energy Statistics* compiled by the Agency for National Resources and Energy was used as the activity data.

Coal consumption by steam locomotives was considered to be the value shown in the Statistical Yearbook of Railway Transport (Ministry of Land, Infrastructure and Transport) in the table "*Cost of Consumption of Operating Electricity, Fuel and Oil*" under *Cost under the Other fuel – Cost*. The cost-based value was divided by the coal price for each year (for imported steam coal) shown in the *Directory of Energy and Economic Statistics* to estimate the coal consumption.

Table 3-19 Activity Data associated with emissions from railways

Fuel type	Unit	1990	1995	2000	2003	2004
Diesel oil	kl	356,224	313,235	269,711	240,865	249,805
Coal	kt	16	20	28	22	15

• *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.

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

- ***Background***

Ships emit methane and nitrous oxide through the use of light oil and fuel oils A, B and C during their navigation.

- ***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 *1A3-2006.xls¥ShipEmissions* for details of the calculation process.)

Methane and nitrous oxide emissions associated with navigation of domestic vessels
= Emission factors for light oil and fuel oils A, B and C relating to domestic vessels × Consumption of each type of fuel by domestic vessels

- ***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 3-20 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.

Table 3-21 Activity Data associated with emissions from ships

Fuel type	Unit	1990	1995	2000	2003	2004
Diesel oil	1000kl	133	208	204	180	206
Heavy oil (A)	1000kl	1,602	1,625	1,728	1,613	1,324
Heavy oil (B)	1000kl	526	215	152	79	59
Heavy oil (C)	1000kl	2,446	3,002	3,055	3,010	2,863

- ***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".

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

Unburned fossil fuels emit carbon dioxide, methane and nitrous oxide during their mining, production, processing and refining, transportation, storage and distribution. Venting and flaring in the oil and natural gas industries also emits carbon dioxide, methane and nitrous oxide. The main source of emissions from solid fuels is methane contained in coal seams, while fugitive emissions, venting, flaring, volatilization and accidents are the main emission sources in the oil and natural gas industries.

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

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

Coal contains methane that formed during the coalification process. Most will have been naturally released from the ground surface before mine development, but mining releases the methane remaining in coal beds into the atmosphere.

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 *1B1-2006.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 *1B1-2006.xls* for the calculation process.)

Emissions were calculated by multiplying the amount of coal mined from coal mines by the emission factor.

- ***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 3-22 Emission factors for mining activities – Underground mines

Item	Unit	1990	1995	2000	2003	2004	Reference
Coal Production of Underground Mines	kt	6,775	5,622	2,364	738	741	Surveyed by J-COAL
CH_4 Total Emissions	$1000m^3$	181,358	80,928	48,110	4,092	2,249	Surveyed by J-COAL
CH_4 Total Emissions	Gg-CH_4	121.5	54.2	32.2	2.7	1.5	=CH_4 [$1000m^3$] / 1000 X 0.67 [$Gg/10^6m^3$]
Emission Factor	kg-CH_4/t	17.9	9.6	13.6	3.7	2.0	CH4 Total Emissions

-Post-Mining Activities

Due to the lack of data for emissions from post-mining activities in Japan, emission factors were calculated by converting the median value (2.45 m^3/t) of the default values (0.9 – 4.0 m^3/t) given in the *Revised 1996 IPCC Guidelines* by the density of methane, 0.67 (thousand $t/10^6$ m^3) at 20°C and 1 atmosphere.

- ***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.

Table 3-23 Trends in coal production

Item	Unit	1990	1995	2000	2003	2004
Total Coal Production	t	7,980	6,317	2,974	1,355	1,272
Surface Mines	t	1,205	695	610	616	531
Underground Mines	t	6,775	5,622	2,364	738	741

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

Coal mining exists in Japan, and, depending on the carbon dioxide concentration in the coal being mined, the carbon dioxide may be released into the atmosphere during mining activity. Although it is believed that coal beds in Japan do not contain carbon dioxide at a concentration level that is higher than that in the atmosphere, emissions cannot be calculated because of the absence of actual measurements. Because of the absence as well of a default value for carbon dioxide emissions associated with coal mining, the emissions from this source are reported as “NE”.

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

-Mining Activities

Methane 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 *1B1-2006.xls* for the calculation process.)

-Post-Mining Activities

Methane 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 *1B1-2006.xls* for the calculation process.)

Both were calculated by multiplying the amount of coal mined from open-cut mining by the relevant emission factors.

• *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]).

-Post-Mining Activities

A value (0.067 [kg-CH_4/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]).

• *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 (Table 3-23).

• *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.

Although a reporting column is provided for carbon dioxide emissions associated with coal mining, in the absence of a default emission factor, emissions from this source were reported as “NE”.

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

In Japan, the production of briquettes is believed to meet the description of the activity of conversion to solid fuel. 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. Carbon dioxide, methane and nitrous oxide emissions associated with the conversion to solid were reported as “NE” in the absence of default values.

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.)

- ***Background***

Fugitive emissions of carbon dioxide, methane and nitrous oxide occur during the exploratory drilling of oil and gas fields and pre-production tests.

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

Carbon dioxide, methane and nitrous oxide emissions associated with oil exploration and pre-production testing were calculated using the Tier 1 Method in accordance with the Decision Tree of *Good Practice Guidance (2000)*. Emissions were calculated by multiplying the number of exploratory wells, and the number of wells tested for oil and gas during pre-production testing, by their respective emission factors.

- ***Emission Factors***

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

Table 3-24 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: Good Practice Guide (2000), p. 2.86, 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 that reason, the number of wells tested for oil and gas used the median values of the number of exploratory wells and the number of successful wells shown in the *Natural Gas Yearbook.*

For both oil and gas, the calendar year values were used as the data for the most recent year.

Table 3-25 Trends in the number of exploratory wells and those tested for oil and gas

Item	Unit	1990	1995	2000	2003	2004
Number of Wells Drilled	wells	8	7	6	2	2
Number of Wells Succeed	wells	1	3	4	5	5
Number of Wells Tested	wells	5	5	5	4	4

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

- ***Background***

Fugitive emissions of carbon dioxide and methane occur during production of crude oil, as well as when measuring instruments are lowered into oil wells during inspection of operating oil fields.

- ***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). Emissions were calculated by multiplying the amount of crude oil production by the emission factor. (Refer to *1B2-2006.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 3-26 EF for fugitive emissions from petroleum production [Gg/10^3kl 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) The default value is 1.4×10^{-3} – 1.5×10^{-3}
2) 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 3-27 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. However, condensates were not included.

-Servicing

Because the number of oil wells and natural gas wells cannot be separated for the entire timeseries, the total fugitive emissions from servicing of oil and natural gas wells are reported in the subcategory *1.B.2.b.i. Exploration* and is so, servicing of oil wells is included there.

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

Fugitive emissions of carbon dioxide and methane occur during the transportation of crude oil and condensate through pipelines, tank trucks, and tank cars to refineries.

- ***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). Emissions were calculated by multiplying the amount of crude oil or condensate production by the emission factors. (Refer to *1B2-2006.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 3-28 Emission factors for transportation of crude oil and condensate [Gg/10^3kl]

	CH_4	CO_2	N_2O 1)
Transportation of crude oil	2.5×10^{-5}	2.3×10^{-6}	0
Transportation of condensate	1.1×10^{-4}	7.2×10^{-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.

Table 3-29 Production of crude oil and condensate in Japan

Item	Unit	1990	1995	2000	2003	2004
Oil Production excluding condensate	kl	420,415	622,679	385,565	343,559	342,751
Condensate Production	kl	234,111	242,859	375,488	486,509	517,648
Oil Production	kl	654,526	865,538	761,053	830,068	860,399

• *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.)

• *Background*

Fugitive emissions of methane occur when crude oil is refined or stored at oil refineries.

• *Methodology for Estimating Emissions of GHGs*

- Oil 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).

- Oil 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 *1B2-2006.xls¥1B2a iii Refining_Storage* for details of the calculation process.)

• *Emission Factors*

- Oil Refining

With respect to the emissions factors for the fugitive emissions during the refining processes, the amount of methane emitted during crude oil refining processes was considered to be negligible because fugitive emission of methane was unlikely to occur in Japan during crude oil refining at normal operation. For that reason, the lower limit of the default values shown in the *Revised 1996 IPCC Guidelines* was adopted.

Table 3-30 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

- Oil 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 3-31 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.

Table 3-32 Amount of crude and NGL refined in Japan

Item	Unit	1990	1995	2000	2003	2004
Oil and LGL Refined	PJ:NCV	7,732	8,907	8,898	8,703	8,566

• *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. Emissions were reported as “NE” in the absence of the default emission factors.

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

Petroleum products are distributed in Japan, and where carbon dioxide and methane are dissolved, it is conceivable that either or both will be emitted as a result of the relevant activity. The level of carbon dioxide or methane 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 carbon dioxide or methane content of petroleum products, it is not currently possible to calculate emissions. Emissions were reported as “NE” in the absence of the default emission factors.

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

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

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, Emissions were reported as “IE” because the calculation was combined with the subcategory of *1.B.2.a.i. Fugitive Emissions Associated with Oil Exploration*.

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

- ***Background***

Fugitive emissions of carbon dioxide and methane occur during the production and conditioning process of natural gas, as well as when measuring instruments are lowered into wells during the inspection of operating gas wells.

- ***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 *1B2-2006.xls¥1B2b i Production_Processing* for detail on the calculation process.).

Fugitive emissions during natural gas production and conditioning processes were estimated by multiplying the amount of natural gas production by their respective emission factors. Fugitive emissions during gas field inspections were calculated by multiplying the number of production wells by the emission factor.

• *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 3-33 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 2.6×10^{-3} – 2.9×10^{-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 3-34 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 6.9×10^{-4} – 10.7×10^{-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 3-35 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

Because the number of oil wells and natural gas wells cannot be separated for the entire timeseries, the total fugitive emissions from servicing of oil and natural gas wells are reported here. The number of oil/natural gas wells shown in the *Yearbook of Natural Gas Information* published by the Japan Natural Gas Association was used. Note that the value for 2003 is used for 2004.

Table 3-36 Natural gas production and the number of producing and capable wells

Item	Unit	1990	1995	2000	2003	2004
Natural Gas Production	$10^6 m^3$	2,066	2,237	2,499	2,814	2,957
Number of Producing and Capable Wells	wells	1,230	1,205	1,137	1,130	1,130

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

- ***Background***

Fugitive emissions of carbon dioxide and methane occur during transmission of natural gas by pipelines.

- ***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 *1B2-2006.xls¥1B2b ii Transmission* for details on the calculation process.) Emissions were calculated by multiplying the total length of installed pipelines by the emission factors.

- ***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 3-37 Emission factors for the fugitive emissions associated with transmission of natural gas [Gg-gas/km-pipeline]

		CH_4	CO_2	N_2O 2)
Fugitive emissions during transmission of natural gas	（Transmission）	2.5×10^{-3} 1)	1.6×10^{-5}	0

Source: *Good Practice Guide* (2000), Table 2.16

1) Default value: 2.1×10^{-3} to 1.9×10^{-3}
2) Excluded from the calculation as the default value is 0.

- ***Activity Data***

For the calculation of activity data for fugitive emissions associated with natural gas transmissions, the total length of installed natural gas pipelines in Japan shown in the *Yearbook of Natural Gas Information* published by the Japan Natural Gas Association was used. However, the calendar year values were used as the data for the most recent year.

Table 3-38 Length of natural gas pipeline installation

Item	Unit	1990	1995	2000	2003	2004
Natural Gas Pipeline length	km	1,984	2,195	2,434	2,615	2,615

3.2.2.2.d. Distribution (1.B.2.b.iv.)

In Japan, liquefied petroleum gas, coal, coke, naphtha, crude oil, and natural gas are refined and blended at gas plants into gas, which, after being conditioned to produce a certain calorific value, is supplied to urban areas through gas lines. Such gas fuel is called “town gas”, of which 93% is LNG-based.

Japan reports the emissions associated with the production of town gas (Natural Gas Supplies) in the category of *1.B.2.b. Natural Gas Distribution*. The town gas production is accounted for in this category, even though it may not meet the definition in the *Revised 1966 IPCC Guidelines* exactly, because of the lack of a category more appropriate for reporting of emissions from town gas production.

1) CO_2

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 emission from this source category was reported as “NE”.

2) CH_4

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

The Tier 1 Method was used in accordance with the Decision Tree of *Good Practice Guidance (2000)* (page 2.82, Fig. 2.14), except that the emissions were calculated by multiplying the amounts of natural gas and liquefied natural gas used as material for town gas by Japan’s country-specific emission factors that were available for use.

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 *1B2-2006.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 (905.41 [kg-CH_4/PJ]) of the raw material input (LNG, natural gas).

- ***Activity Data***

For the calculation of activity data for this emission source, the amounts of LNG and natural gas shown in the *General Energy Statistics* (Agency for Natural Resources and Energy) as used as raw material for town gas.

Table 3-39 Liquefied natural gas used as material for town gas

Item	Unit	1990	1995	2000	2003	2004
LNG Consumption with Town Gas Production	PJ	464	676	864	1,041	1,122
Natural Gas Consumption with Town Gas Production	PJ	40	48	61	73	77

- ***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.

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

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.

Emissions for this category were reported as “NE” in the absence of default emission factors for these sources even though the CRF provides spaces for reporting fugitive emissions of methane and carbon dioxide at factories and power plants as well as at home and business.

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

Fugitive emissions of carbon dioxide and methane occur from venting during oil field development, crude oil transportation, refining processes, and product transportation in the petroleum industry and as well as during gas field development, natural gas production, transportation, and processing in natural gas industry.

Flaring during the above processes also emits carbon dioxide, methane, and nitrous oxide.

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

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

Emissions from flaring in the petroleum industry were calculated using the Tier 1 Method in accordance with the Decision Tree of *Good Practice Guidance (2000)* (Page 2.81, Fig. 2.13) by multiplying the amount of crude oil production by the default emission factors.

- ***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 3-40 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 (seeTable 3-29).

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

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

Carbon dioxide and methane emissions from venting in the natural gas industry were calculated using the Tier 1 Method in accordance with the Decision Tree of *Good Practice Guidance (2000)*. *Good Practice Guidance* (2000) provides emissions factors only for transportation. Accordingly, emissions were calculated only for the amount during transportation by multiplying the length of natural gas pipeline installation by the emission factors.

- ***Emission Factors***

In the absence of actual measurement data or country-specific emission factors in Japan, the default values shown in the *Good Practice Guidance* (2000) were used. It should be noted that the median values were used for methane emissions.

Table 3-41 Emission factors for transmission of natural gas

		CH_4 [1]	CO_2
Respiration of natural gas during transmission (Venting)	[$Gg/10^3\ m^3$]	1.0×10^{-3}	8.5×10^{-6}

Source: Good Practice Guide (2000), Table 2.16

1) Default value: 0.8×10^{-3} to 1.2×10^{-3}

- ***Activity Data***

The length of natural gas pipeline installations shown in the *Natural Gas Yearbook* (Japan Natural Gas Association) was used for the calculation of activity data, except that the calendar year values were used for the most recent year (seeTable 3-38).

3.2.2.3.c. Venting (Oil and Gas) (1.B.2.c.-venting iii.)

Statistical data are reported for two categories of petroleum and natural gas in Japan. As a result, fugitive emissions from venting in the combined petroleum and natural gas industries were reported as “IE” since they were accounted for respectively in the emissions from venting in the petroleum industry (1.B.2.c.i) and the natural gas industry (1.B.2.c.ii.)

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

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

Carbon dioxide, methane, and nitrous oxide emissions from flaring in the petroleum industry were calculated using the Tier 1 Method in accordance with the Decision Tree of *Good Practice Guidance (2000)*, by multiplying the amount of crude oil production in Japan by the default emissions factors.

- ***Emission Factors***

In the absence of actual measurement data or country-specific emission factors in Japan, the default values shown in *Good Practice Guidance* (2000) were used. It should be noted that the median values were used for methane emissions.

Table 3-42 Emission factors for flaring in the oil industry

		CH_4 [1]	CO_2	N_2O [2]
Flaring (Conventional Oil)	$Gg/10^3\ m^3$	1.38×10^{-4}	6.7×10^{-2}	6.4×10^{-7}

Source: Good Practice Guidance (2000), Table 2.16

1) Default value: 0.05×10^{-4} to 2.7×10^{-4}

- ***Activity Data***

For the calculation of activity data for this emission source, the amounts of crude oil production shown in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Natural Resources and Petroleum Products,* both published by Ministry of Economy, Trade and Industry, were used. The production of condensate was excluded from the calculation (seeTable 3-29).

3.2.2.3.e. Flaring (Natural Gas) (1.B.2.c.-flaring ii.)

• *Methodology for Estimating Emissions of GHGs*

Carbon dioxide, methane, and nitrous oxide emissions associated with flaring in the natural gas industry were calculated using the Tier 1 Method in accordance with the Decision Tree of *Good Practice Guidance (2000)*. Emissions were calculated by multiplying the amount of production of natural gas by the emission factors. The total emissions associated with flaring both during gas production and processing were reported as the emissions from flaring in the natural gas industry.

• *Emission Factors*

Table 3-43 Emission factors for flaring in the natural gas industry

		Units	CO_2	CH_4	N_2O
Flaring in the natural gas industry	Gas production	$Gg/10^6m^3$	$1.8*10^{-3}$	$1.1*10^{-5}$	$2.1*10^{-8}$
	Gas processing	$Gg/10^6m^3$	$2.1*10^{-3}$	$1.3*10^{-5}$	$2.5*10^{-8}$

Source: *Good Practice Guidance* (2000), Table 2.16

• *Activity Data*

For the calculation of activity data for this emission source, the amounts of domestic production of natural gas shown in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Natural Resources and Petroleum Products*, both published by Ministry of Economy, Trade and Industry, were used (seeTable 3-36).

3.2.2.3.f. Venting (Oil and Gas) (1.B.2.c.-flaring iii.)

Statistical data are reported for two categories of petroleum and natural gas in Japan. As a result, fugitive emissions from flaring in the combined petroleum and natural gas industries were reported as “IE” since they were accounted for respectively in the emissions from flaring in the petroleum industry (1.B.2.c.i) and the natural gas industry (1.B.2.c.ii.)

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Chapter 4. Industrial Processes (CRF sector 2)

Chemical reactions in industrial processes cause atmospheric GHG emissions. This chapter calculates the emissions of the industrial processes shown in Table 4-1.

Table 4-1 Emission source categories in the industrial process sector

Categories				CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
2.A. Mineral products	2.A.1.	Cement production		○					
	2.A.2.	Lime production		○					
	2.A.3.	Limestone and Dolomite use		○					
	2.A.4.	Soda ash production and use		○					
	2.A.5.	Asphalt roofing		NE					
	2.A.6.	Road paving with asphalt		NE					
	2.A.7.	Other		IE,NO	NA,NO	NA,NO			
2.B. Chemical industry	2.B.1.	Ammonia production		○	NE	NA			
	2.B.2.	Nitric acid production				○			
	2.B.3.	Adipic acid production		NE		○			
	2.B.4.	Silicon carbide production		○	IE				
		Calcium carbide production		○	NA				
	2.B.5.	Carbon black			○				
		Ethylene		○	○	NA			
		Dichloroethane			○				
		Styrene			○				
		Methanol			NO				
		Coke		NE	○	NA			
2.C. Metal production	2.C.1.	Iron and steel		IE	NA				
		Pig iron		IE	NA				
		Sintered steel		IE	IE				
		Coke		NE	IE				
		Other (electric furnace)		○	IE				
	2.C.2.	Ferroalloys production		IE	IE				
	2.C.3.	Aluminum production		IE	NE			○	
	2.C.4.	SF_6 used in Aluminum and Magnesium foundries	Aluminum						NO
			Magnesium						○
	2.C.5.	Other		NO					
2.D. Other production	2.D.1.	Pulp and Paper							
	2.D.2.	Food and Drink		IE					
2.E. Production of halocarbons and SF_6	2.E.1.	By-product emissions in production of HCFC-22					○		
	2.E.2.	Fugitive emissions					○	○	○

Categories						CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
2.F. Consumption of halocarbons and SF_6	2.F.1.	Refrigeration and air conditioning equipment	Domestic Refrigeration		Manufacturing				○	NO	NO
					Stock, Disposal				IE	NO	NO
			Commercial Refrigeration		Manufacturing				○	NO	NO
					Stock, Disposal				IE	NE	NO
			Transport Refrigeration		Manufacturing				IE	NO	NO
					Stock, Disposal				IE	NE	NO
			Industrial Refrigeration		Manufacturing				IE	NO	NO
					Stock, Disposal				IE	NE	NO
			Stationary Air-Conditioning		Manufacturing				○	NO	NO
					Stock, Disposal				IE	NO	NO
			Mobile Air-Conditioning		Manufacturing				○	NO	NO
					Stock, Disposal				IE	NE	NO
	2.F.2.	Foam blowing	Hard Form	Urethane Foam	Manufacturing				○	NO	NO
					Stock				○	NO	NO
					Disposal				IE	NO	NO
				Polyethylene Foam	Manufacturing				○	NO	NO
					Stock, Disposal				NO	NO	NO
				Polystyrene Foam	Manufacturing				○	NO	NO
					Stock				○	NO	NO
					Disposal				IE	NO	NO
			Soft Form						NO	NO	NO
	2.F.3.	Fire extinguishers			Manufacturing				NE	NO	NO
					Stock				NE	NO	NO
					Disposal				NE	NO	NO
	2.F.4.	Aerosols/metered dose inhalers			Manufacturing				○	NO	NO
					Stock				○	NO	NO
					Disposal				IE	NO	NO
	2.F.5.	Solvents			Manufacturing				NE	○	NO
					Stock, Disposal				NE	IE	NO
	2.F.6.	Other applications using ODS substitutes							NE	NE	NE
	2.F.7.	Semiconductor manufacture			Manufacturing				IE	IE	IE
					Stock				○	○	○
					Disposal				NA	NA	NA
	2.F.8.	Electrical equipment			Manufacturing						○
					Stock						○
					Disposal						IE
	Other (for research, healthcare, etc.)								NO	NO	NO

4.1. Mineral Products (2.A.)

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

- ***Background***

CO_2 is emitted by calcinating limestone, the main component of which is calcium carbonate, when producing clinker, an intermediate product of cement.

CO₂ emission mechanism of the cement production process

$$CaCO_3 \rightarrow CaO + CO_2$$

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

The GPG (2000) decision tree was followed in calculating the CO_2 emissions of this source by multiplying the production amount of clinker, an intermediate product of cement production, by an emission factor.

CO_2 emissions (t-CO_2) of cement production

= emission factor (t-CO_2/t-clinker) × clinker production (t) × cement kiln dust correction coefficient

- ***Emission Factors***

Multiplying the CaO content of clinker by the molecular weight ratio of CaO and CO_2 (0.785) yields the emission factor. Because Japan's cement industry takes in large amounts of wastes and byproducts from other industries and recycles them as substitute raw materials for cement, clinker contains CaO other than that from carbonates. This CaO has not been through the limestone calcination stage and has not emitted CO_2 in clinker production. For that reason emission factors were determined by finding the CaO content of clinker from carbonates, from which CaO originating from waste and other sources has been subtracted. We use 1.00 for the cement kiln dust (CKD) correction coefficient because it is deemed likely that CKD is recovered and used again as an input.

Emission factors of CO_2 emitted from cement production were calculated using the following procedure.

1 Estimate dry weight of waste and other materials input in raw material processing.

2 Estimate the amount and content of CaO from waste and other materials in clinker.

3 Estimate the CaO content of clinker, excluding the CaO from waste and other materials.

4 Determine the clinker emission factor.

Emission factors of CO_2 emissions from cement production

= [(CaO content of clinker) – (CaO content of clinker from waste and other materials)] × 0.785

CaO content of clinker from waste and other materials

= dry weight of inputs of waste and other materials × CaO content of waste and other materials ÷ clinker production volume

○ Estimating dry weight of waste and other materials input in raw material processing

We chose these seven kinds of waste and other materials used in calculations: coal ash (incineration residue), blast furnace slag (water granulated), blast furnace slag (slow-cooled), steelmaking slag, nonferrous slag, coal ash (from dust collectors), and particulates/dust (these wastes account for at least 90% of the CaO from waste and other materials). Waste amounts (emission-based) and the content percentages of each waste or other material were determined from studies by the Cement Association of Japan (only for 2000 and thereafter).

○ Estimating the amount and content of CaO from waste and other materials in clinker

The dry weights of each type of waste or other material found above are multiplied by the CaO content for each type as found by the Cement Association, thereby calculating the total CaO amount in clinker derived from waste and other materials. This is divided by clinker production volume to find the CaO content from waste and other materials in clinker. Because data for 1999 and prior years were unavailable, averages for 2000 through 2003 were used.

○ Estimating the CaO content of clinker, excluding the CaO from waste and other materials

CaO content in waste and other materials is subtracted from the average CaO content of clinker as determined by the Cement Association, which yields the proportion of CaO in clinker that is used to set emission factors.

Table 4-2 Emission factors of CO_2 from cement production

Item	Unit	1990	1995	2000	2003	2004
CaO content in clinker	%	65.9	65.9	66.0	65.9	65.9
Waste Origin CaO content in clinker	%	2.5	2.5	2.9	2.2	2.0
CaO content in clinker except waste origin CaO	%	63.4	63.4	63.1	63.7	63.9
CO_2/CaO		0.785	0.785	0.785	0.785	0.785
EF	t/CO_2	0.498	0.498	0.495	0.500	0.501

- ***Activity Data***

Cement Association data are used to find clinker production amount. Due to the lack of statistics on clinker production from 1990 to 1999, estimates are made by extrapolating past (1990–1999) clinker production using the average values of the 2000–2003 ratios of clinker production (Cement Association data) and limestone consumption (Ministry of Economy, Trade and Industry, *Yearbook of Ceramics and Building Materials Statistics*).

Limestone consumption data for FY1993 to FY2003 given in the Yearbook of Ceramics and Building Materials Statistics include limestone consumption for cement hardening agents, which is not included in statistics for 1992 and previous years. For this reason the Ministry of Economy, Trade and Industry has corrected the data for 1990–1992 limestone consumption with the figures showing cement limestone consumption for hardening agent raw material.

To make the corrections, a connection coefficient (0.99) was used to calculate FY1990–FY1992 cement production including hardening agent raw material (cement production ÷ 0.99), and the result was multiplied by the ratio of limestone consumption to cement production (limestone consumption ÷ cement production) to calculate limestone consumption.

Table 4-3 Clinker production

Item	Unit	1990	1995	2000	2003	2004
Consumption of Limestone	kt (dry)	89,366	97,311	81,376	73,869	-
Clinker Production (actual performance)	kt			69,528	62,653	62,653
Clinker Production / Consumption of Limestone		0.853	0.853	0.854	0.848	
Clinker Production afrer correction	kt	76,253	83,032	69,528	62,653	62,653

* Clinker Production / Consumption of Limestone 1990-1999 is the average value 2000-2003

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

• *Background*

CO_2 is emitted when calcinating (thermolyzing) limestone ($CaCO_3$) and other materials used as raw material when producing quicklime.

CO_2 generation mechanism of quicklime production process

$$CaCO_3 \rightarrow CaO + CO_2$$

$$MgCO_3 \rightarrow MgO + CO_2$$

• *Methodology for Estimating Emissions of GHGs*

Following the GPG (2000) decision tree means that emission factors are determined based on the amount of each quicklime type manufactured, but because there is no clear correspondence between the product categories used for the calculation method shown in GPG (2000) and Japan's product categories, this method cannot be used. Accordingly, emissions from quicklime production were calculated by using a Japanese method which involves multiplying the amounts of limestone and dolomite used as quicklime raw materials by emission factors.

CO_2 emissions (kg-CO_2) generated by use of raw materials in quicklime production

= raw material-specific emission factor (kg-CO_2/t) × amount of raw material (limestone, dolomite)

• *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[1], 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] The carbon dioxide remaining in the raw material after the manufacture of quicklime

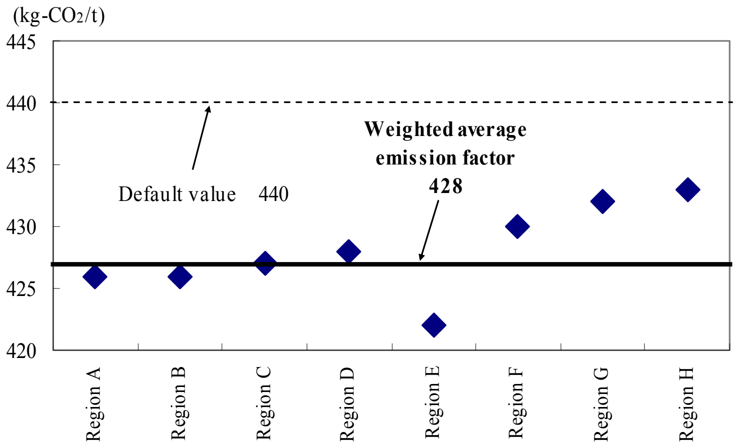

Figure 4-1 Emission factor for limestone used in lime production

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].

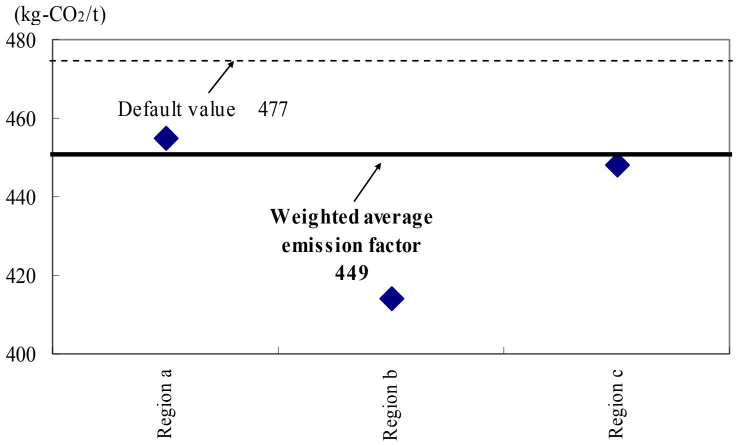

Figure 4-2 Emission factor for dolomite used in lime production

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 value of CY2001 is used for as a substitution.

表 4-4 Amounts of limestone and dolomite consumed when producing quicklime (Calendar year values)

Item	Unit	1990	1995	2000	2003	2004
Limestone	kt	11,735	9,557	10,413	9,798	9,798
Dolomite	kt	67	75	54	99	99

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

- ***Background***

Limestone contains $CaCO_3$ and minute amounts of $MgCO_3$, and dolomite contains $CaCO_3$ and $MgCO_3$. The use of limestone and dolomite releases CO_2 derived from $CaCO_3$ and $MgCO_3$.

Mechanism generating CO_2 when limestone and dolomite are used

$CaCO_3 \rightarrow CaO + CO_2$

$MgCO_3 \rightarrow MgO + CO_2$

- ***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-CO2-2006.xls¥Limestone* and *2-CO2-2006.xls¥dolomite* for details on the calculation process.)

- ***Emission Factors***

-Limestone

The emission factor of limestone used in manufacturing steel and soda-lime glass is calculated by adding the value obtained when multiplying the weight-to-weight ratio of CO_2 and $CaCO_3$ in their reaction formula by the percentage of CaO that can be extracted from limestone (55.4%, the median value of the “54.8% to 56.0%” given in *The Story of Lime* [Japan Lime Association]) and the value obtained when multiplying the weight-to-weight ratio of CO_2 and $MgCO_3$ by the percentage of MgO that can be extracted from limestone (0.5%, the median value of the “0.0% to 1.0%” given in *The Story of Lime* [Japan Lime Association]).

$\mathbf{CaCO_3 \rightarrow CaO + CO_2}$

$\mathbf{MgCO_3 \rightarrow MgO + CO_2}$

- Proportion of CaO extractable from limestone: 55.4%[a]
- Proportion of MgO extractable from limestone: 0.5%[b]
- Molecular weight of $CaCO_3$ (primary constituent of limestone) : 100.0869[c]
- Molecular weight of $MgCO_3$: 84.3139[c]
- Molecular weight of CaO: 56.0774[c]

- Molecular weight of MgO: 40.3044[c]
- Molecular weight of CO_2: 44.0095[c]

- $CaCO_3$content = proportion of CaO extractable from limestone × molecular weight of $CaCO_3$ ÷ molecular weight of CaO

  = (55.4% × 100.0869) ÷ 56.0774 × 100 = 98.88%

- $MgCO_3$content = proportion of MgO extractable from limestone × molecular weight of $MgCO_3$ ÷ molecular weight of MgO

  = 0.5% × 84.3139 ÷ 40.3044 = 1.05%

○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*0.9888+44.0095/84.3139*0.0105

＝0.4348＋0.0055＝0.4402 [t-CO_2/t]

＝440 [kg-CO_2/t]

Sources)

a. Median of 54.8% to 56.0%: Japan Lime Association, The Story of Lime

b. Median of 0.0% to 1.0%: 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)

-Dolomite

The emission factor of dolomite is calculated by adding the value obtained when multiplying the weight-to-weight ratio of CO_2 and $CaCO_3$ in their reaction formula by the percentage of CaO that can be extracted from dolomite (34.5%, the median value of the 33.1% to 35.85% range given in *The Story of Lime* [Japan Lime Association]) and the value obtained when multiplying the weight-to-weight ratio of CO_2 and $MgCO_3$ by the percentage of MgO that can be extracted from dolomite (18.3%, the median value of the 17.2% to 19.5% range given in *The Story of Lime* [Japan Lime Association]).

$CaCO_3 \rightarrow CaO + CO_2$

$MgCO_3 \rightarrow MgO + CO_2$

- Proportion of CaO extractable from dolomite: 34.5%

  (Median value of the 33.1% to 35.85% range given in *The Story of Lime* [Japan Lime Association])

- Proportion of MgO extractable from dolomite: 18.3%18.3%

  (Median value of the 17.2% to 19.5% range given in The Story of Lime [Japan Lime

Association])

- Molecular weight of $CaCO_3$ (major constituent of dolomite): 100.0872
- Molecular weight of $MgCO_3$ (major constituent of dolomite): 84.3142
- Molecular weight of CaO: 56.0774
- Molecular weight of MgO: 40.3044

- $CaCO_3$ content = proportion of CaO extractable from dolomite × molecular weight of $CaCO_3$ ÷ molecular weight of CaO

$$= 34.5\% \times 100.0872 \div 56.0774$$
$$= 61.53\%$$

- $MgCO_3$ content = proportion of MgO extractable from dolomite × molecular weight of $MgCO_3$ ÷ molecular weight of MgO

$$= 18.3\% \times 84.3142 \div 40.3044$$
$$= 38.39\%$$

- Molecular weight of CO_2: 44.0098

○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

$$= 44.0098 \div 100.0872 \times 0.6153 + 44.0098 \div 84.3142 \times 0.3839$$
$$= 0.2706 + 0.2004$$
$$= 0.4709$$
$$= 471\ (\text{kg-}CO_2/\text{t})$$

• *Activity Data*

For the activity of CO_2 emissions from the use of limestone and dolomite the inventory used the amounts of limestone and dolomite sold for use in steel refining and soda glass given in the Ministry of Economy, Trade and Industry's Yearbook of Minerals and Nonferrous Metals Statistics and Yearbook of Mineral Resources and Petroleum Products Statistics.

Table 4-5 Amounts of limestone and dolomite sold for use in steel refining and soda glass

Item	Unit	1990	1995	2000	2003	2004
Limestone (for Steel and Refinement)	kt	22,375	22,371	22,902	22,259	23,066
Limestone (for Soda and Glass)	kt	1,846	1,946	1,722	916	997
Dolomite (for Steel and Refinement)	kt	1,619	771	438	418	461
Dolomite (for Soda and Glass)	kt	228	197	177	142	160

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

4.1.4.1. Soda Ash Production (2.A.4.-)

In Japan the ammonium chloride soda process is used to produce soda ash (Na_2CO_3). The soda ash production process involves calcinating limestone and coke in a lime kiln, which emits CO_2. Almost all lime-derived CO_2 is taken into the product.

In the soda ash production process, purchased CO_2 is sometimes input through a pipeline, but because these CO_2 emissions are from the ammonia industry, they are already included in "Ammonia Production (2.B.1)". Also, the coke consumed is listed as that for heating in statistics on the consumption dynamics of petroleum and other fuels, and thus CO_2 emissions from coke are already counted under "Fuel Combustion (1.A)". Therefore all emissions from this source are already included in other categories, and are reported as "IE". Coke is input as a heat-source and CO_2 source.

The *Revised 1996 IPCC Guidelines* offer a method to calculate CO_2 emissions from calcinating trona ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$), but these emissions are not estimated because in Japan soda ash has never been manufactured by trona calcination.

4.1.4.2. Soda Ash Use (2.A.4.-)

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

  CO_2 emissions from soda ash use are calculated on the basis of the method in the *Revised 1996 IPCC Guidelines* by multiplying the soda ash consumption amount by the default emission factor.

- ***Emission Factors***

  Because Japan does not have its own measured data or emission factor, this inventory uses the default value (0.415 $t\text{-}CO_2/t\text{-}Na_2CO_3$) in the *Revised 1996 IPCC Guidelines* (vol. 3 p. 2.13).

- ***Activity Data***

  Activity data are the total of (1) shipping totals from Japan Soda Industry Association data, (2) imports and exports of soda ash from trade statistics, and (3) imports and exports of other sodium sesquicarbonate (mainly trona ash) from trade statistics.

Table 4-6 Soda ash use

Item	Unit	1990	1995	2000	2003	2004
Soda Ash Shipping	kt	1,098	977	634	434	475
Soda Ash Imported	kt	0.03	11	49	94	90
Other Disodium Carbonate Imported	kt	295	305	346	359	358

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”.

4.2. Chemical Industry (2.B.)

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

1) CO_2

- ***Background***

CO_2 is emitted when hydrocarbon feedstock in ammonia production is broken down to make H_2 feedstock.

Mechanism generating CO_2 in ammonia production

$$0.88CH_4 + 1.26\text{air} + 1.24H_2O \rightarrow 0.88CO_2 + N_2 + 3H_2$$

Ammonia synthesis

$$N_2 + 3H_2 \rightarrow 2NH_3$$

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

CO_2 emissions are calculated by multiplying the consumed amounts of fuel types used as ammonia feedstock by emission factors.

- ***Emission Factors***

For each feedstock listed in Table 4-7, the inventory uses values that are the same as emission factors used to calculate CO_2 emissions from the fuel combustion sector (see Chapter 3).

- ***Activity Data***

The fixed units (including weight and volume) for the fuel types in the table below, which are from the Ministry of Economy, Trade and Industry’s Yearbook of the Current Survey of Energy Consumption, were converted using the calorific values in the Agency for Natural Resources and Energy’s *General Energy Statistics*, and results were used as activity data. Consumption data on some fuel types are confidential.

Table 4-7 Emission factors and calorific values of feedstocks used when producing ammonia

Feedstock	Emission Factors (Gg-C/TJ)	(sources)	Calorific value		(Units)
			1990	2004	
Naphtha	18.2	1992 carbon emission factor	33.5	34.1	MJ/l
Liquefied petroleum gas (LPG)	16.3	1992 carbon emission factor	50.2	50.2	MJ/kg
Petroleum-derived hydrocarbon gases (petrochemical offgases)	14.2	1992 carbon emission factor	39.3	44.9	MJ/m^3
Natural gas	13.9	2006 IPCC estimate	41.0	40.9	MJ/m^3
Coal (thermal coal, imports)	24.7	1992 carbon emission factor	26.0	26.6	MJ/kg
Petroleum coke	25.4	1992 carbon emission factor	35.6	35.6	MJ/kg
Liquefied natural gas (LNG)	13.5	1992 carbon emission factor	54.4	54.5	MJ/kg
Coke oven gas (COG)	11.0	2006 IPCC estimate	20.1	21.1	MJ/m^3

Table 4-8 Amount of feedstocks used for ammonia production

Item	Unit	1990	1995	2000	2003	2004
Naphtha	t	189,714	477,539	406,958	95,773	92,984
LPG	t	226,593	45,932	5,991	0	0
Off gas	t	C	230,972	240,200	184,103	166,616
Natural Gas	t	C	100,468	86,873	79,434	65,843
Coal	t	C	209,839	726	1,030	1,003
Oil Coke	t	C	273,125	420,862	375,297	384,709
LNG	t	C	46,501	23,395	133,412	109,681
COG	t	C	35,860	55,333	0	0

- ***Point to Note***

Fuel consumption in this category has been deducted from energy sector activity data (see 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.)

- ***Background***

N_2O is emitted by nitric acid (HNO_3) production.

Mechanism by which nitric acid production generates N_2O

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

$$2NO + H_2O \rightarrow 2NO_2$$
$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO \quad (\rightarrow N_2O)$$

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

N_2O emissions were estimated by multiplying the nitric acid production volume by an emission factor, based on the method given in GPG (2000) (page 3.31, Equation 3.9). Because emissions data for individual factories is confidential information, nitric acid production volume and emission factors were set for Japan's total production. Due to the current lack of data on the amount of N_2O destroyed, the equation has no term for destruction.

$$\underline{N_2O\ \text{emissions (kg-}N_2O\text{) from nitric acid production}}$$
$$= \text{emission factor [kg-}N_2O\text{/t]} \times \text{nitric acid production volume [t]}$$

- ***Emission Factors***

Because data for individual factories are confidential information, emission factors were set by using each factory's nitric acid production volume to find the weighted average of each factory's emission factor, based on measurements made at 10 factories producing nitric acid in Japan.

Table 4-9 N_2O emission factors for nitric acid production

Item	Unit	1990	1995	2000	2003	2004
EF for Nitric Acid Production	kg-N_2O/t	3.50	3.51	3.92	4.20	4.34

- ***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.

Table 4-10 Amount of Nitric acid production

Item	Unit	1990	1995	2000	2003	2004
Nitric Acid Production	t	705,600	701,460	655,645	617,211	608,523

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

- ***Background***

N_2O is emitted in the adipic acid ($C_6H_{10}O_4$) production process through the reaction of cyclohexanone, cyclohexanol, and nitric acid.

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

Emissions were estimated using the N_2O generation rates, N_2O decomposition volume, and adipic acid production volume of the relevant operating sites, in accordance with the GPG (2000) decision tree (Page 3.32, Fig. 3.4).

N_2O emissions from adipic acid production
= [N_2O generation rate × (1−N_2O generation rate × decomposition unit operating rate)] × adipic acid production rate

• *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[2] 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

• *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 was happened in 2000 because of the low operating ratio of N_2O decomposition units then due to the breakdown of the decomposition units.

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

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

1) CO_2

- ***Background***

CO_2 is emitted by the use of petroleum coke as a raw material in the production of silicon carbide.

Mechanism of CO_2 generation by the silicon carbide production process

$SIO_2 + 3C \rightarrow SiC + 2CO \rightarrow 2CO_2$

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

Emissions are calculated by multiplying the amount of petroleum coke used as silicon carbide feedstock by an emission factor.

- ***Emission Factors***

Because Japan does not have its own measured data or emission factor, this inventory uses the default value 2.3 [t-CO_2/t] for silicon carbide production in the *Revised 1996 IPCC Guidelines* (vol. 3 p. 2.21).

- ***Activity Data***

As the activity data for CO_2 emissions from silicon carbide production, this inventory uses the petroleum coke consumption amount provided by Japan’s only silicon carbide production facility. The data are confidential.

2) CH_4

In Japan silicon carbide is made in electric arc furnaces, and it is believed that CH_4 is generated from the oxidation of coke, which is used as a reducing agent in silicon carbide production. Electric furnaces used to make carbide are covered by Table No. 1-12 of the Air Pollution Control Law’s Execution Ordinance. CH_4 emissions from these furnaces are reported as “IE” because they are already calculated in Combustion of Fuel (1A).

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

1) CO_2

• *Background*

CO_2 is generated in the process of making the quicklime used in calcium carbide production. CO_2 is also emitted by CO combustion when making calcium carbide. Further, calcium carbide is made to react with water, producing calcium hydroxide (slaked lime) and acetylene, and CO_2 is generated when the acetylene is used.

Mechanism by which CO_2 is generated in the calcium carbide production process

(Production)

$CaCO_3 \rightarrow CaO + CO_2$

$CaO + 3C \rightarrow CaC_2 + CO\ (\rightarrow CO_2)$

(Use)

$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2 \rightarrow 2CO_2$

• *Methodology for Estimating Emissions of GHGs*

CO_2 emissions are calculated by multiplying calcium carbide production by the default emission factor, based on the *Revised 1996 IPCC Guidelines*.

CO2 emissions in conjunction with calcium carbide production and consumption

= ∑(emission factors of CO_2 from limestone, from reducing agent, and use) × calcium carbide production volume

• *Emission Factors*

Because Japan does not have its own measured data or emission factors, this inventory uses the default values given in the *Revised 1996 IPCC Guidelines* for the emission factors of CO_2 from limestone, from reducing agent, and use.

Table 4-11 Emission factors of CO_2 generated by calcium carbide production and consumption

Units	From limestone in production	From reducing agent in production	From use
t-CO_2/t	0.760	1.090	1.100

Source: *Revised 1996 IPCC Guidelines*, vol. 3, p. 2.22.

• *Activity Data*

Calcium carbide production data provided by the Carbide Industry Association are used as the calcium carbide production volume. The data are confidential.

2) CH_4

Byproduct gases (mainly CO) generated in carbide reactions include a small amount of CH_4, all of which is recovered and burned as fuel, with none being emitted outside the system.

Therefore emissions from this source are reported as “NA”.

4.2.5. Other (2.B.5.)

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

- ***Background***

Carbon black is made by breaking down acetylene, natural gas, oil mist, and other feedstocks by incomplete combustion at 1,300°C or higher. The CH_4 in the tail gas (offgas) emitted from the carbon black production process is released into the atmosphere.

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

CH_4 emissions from carbon black production are calculated by multiplying the carbon black production volume by Japan’s emission factor, in accordance with the *Revised 1996 IPCC Guidelines*.

- ***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].

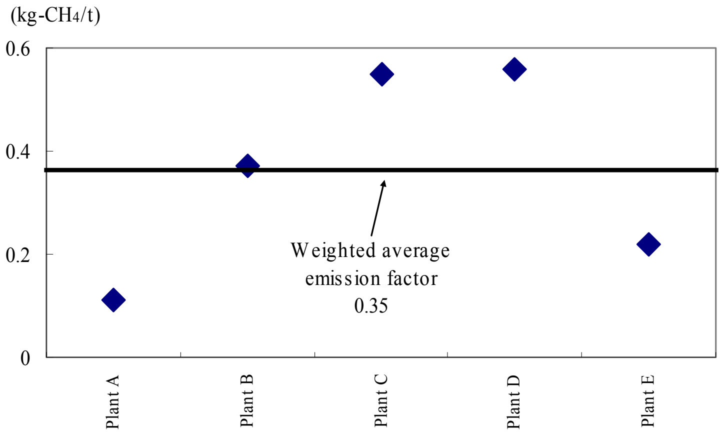

Figure 4-3 CH_4 Emission factor for carbon black production

Source: Data provided by the Carbon Black Association

Table 4-12 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. However, as data for the latest fiscal year were not listed, the calendar-year values were used.

Table 4-13 Carbon black production volume

Item	Unit	1990	1995	2000	2003	2004
Carbon Black Production	t	792,722	758,536	771,875	792,114	809,012

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

1) CO_2, CH_4

- ***Background***

CO_2 is emitted when it is separated in the ethylene production process. CH_4 is emitted by naphtha cracking through stream cracking in the ethylene production process.

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

CH_4 and CO_2 emissions from ethylene production were calculated by multiplying ethylene production by a Japan-specific emission factor, in accordance with the *Revised 1996 IPCC Guidelines*.

- ***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].

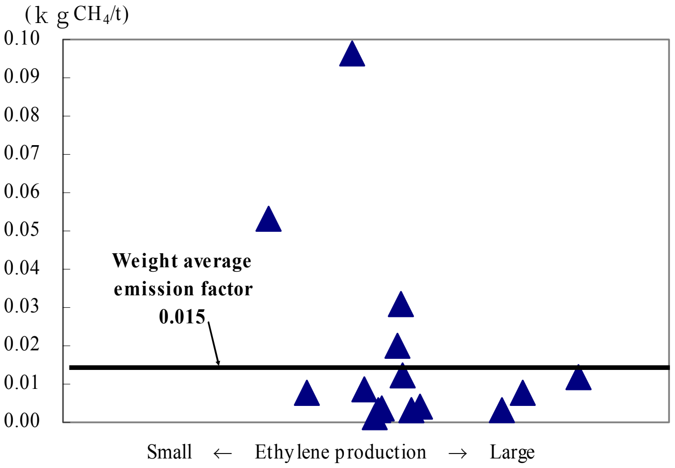

Figure 4-4 Emission factor for methane from manufacturing ethylene

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. This emission factor is confidential.

- ***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. However, as data for the latest fiscal year were not listed, the calendar-year values were used.

Table 4-14 Ethylene production volume

Item	Unit	1990	1995	2000	2003	2004
Ethylene Production	kt	5,966	6,951	7,566	7,419	7,555

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. Emissions are reported as “NA” in accordance with the judgment of experts that in principle there are no N_2O emissions.

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

- ***Background***

1,2-dichloroethane is made by reacting ethylene (C_2H_4) and chorine (Cl_2). The product then passes through washing, refining, and thermolysis processes to become a vinyl chloride monomer (C_2H_3Cl). A very small amount of CH_4 is contained in the exhaust gases of the reaction, and of the washing and refining processes.

• *Methodology for Estimating Emissions of GHGs*

CH_4 emissions from 1,2-dichloroethane production are calculated by multiplying production volume by a Japan-specific emission factor, in accordance with the *Revised 1996 IPCC Guidelines*.

• *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].

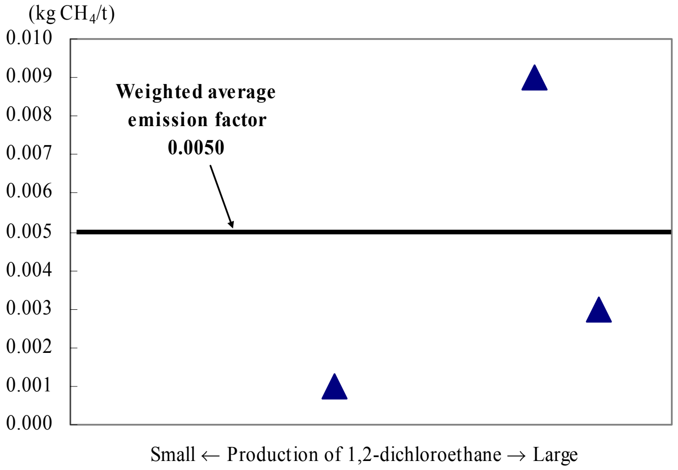

Figure 4-5 Methane emission factors for 1,2-dichloroethane production

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. However, as data for the latest fiscal year were not listed, the calendar-year values were used.

Table 4-15 Ethylene dichloride (1,2-dichloroethane) production volume

Item	Unit	1990	1995	2000	2003	2004
Ethylene dichloride Productio	kt	2,683	3,014	3,346	3,494	3,646

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

- ***Background***

CH$_4$ is emitted in the production of styrene.

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

CH$_4$ emissions from styrene production were calculated by multiplying styrene production volume by a Japan-specific emission factor, based on the method given in the *Revised 1996 IPCC Guidelines*.

- ***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].

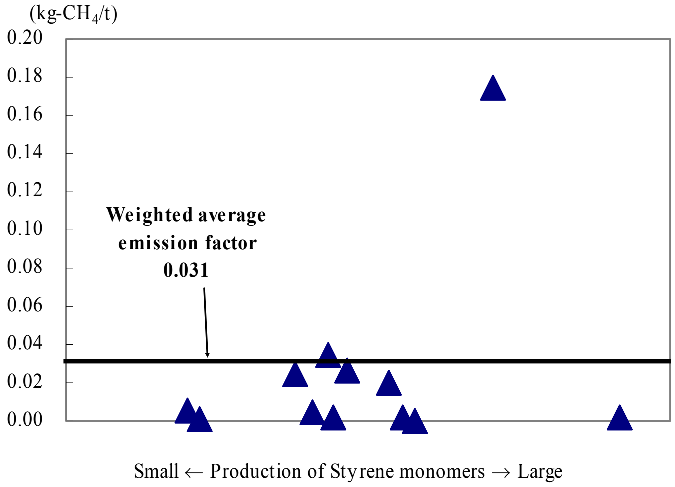

Figure 4-6 Methane emission factors for styrene production

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. However, as data for the latest fiscal year were not listed, the calendar-year values were used.

Table 4-16 Styrene (monomer) production volume

Item	Unit	1990	1995	2000	2003	2004
Styrene Production	kt	2,227	2,952	3,020	3,255	3,324

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

- ***Background***

CH_4 is emitted in the production of methanol.

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

CH_4 emissions from methanol production are calculated using the method given in the *Revised 1996 IPCC Guidelines*.

According to industry organizations, the production (synthesis) of methanol stopped in Japan in 1995 due to the price difference with overseas methanol. Since then all methanol has been imported, and methanol production plants disappeared from Japan in about 1995. According to the Yearbook of Chemical Industries Statistics, beginning in 1997 there was also no production of refined methanol. Because the methanol refining process merely dewaters the synthesized methanol, in principle no CH_4 is generated.

Accordingly, from 1990 to 1995, emissions are reported using the production volumes in industry organization statistics. For 1996 and thereafter, the report is “NO” because it is assumed that methanol has not been produced (synthesized) since 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] (Refer to 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.

Table 4-17 Methanol production volume

Item	Unit	1990	1991	1992	1993	1994	1995
Methanol Production	t	83,851	76,772	23,043	45,426	40,662	75,498

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

1) CO_2

Coke is mainly produced in the iron and steel production in Japan, and it is conceivable that carbon dioxide 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”.

2) CH_4

• *Background*

CH_4 is emitted in coke production.

• *Methodology for Estimating Emissions of GHGs*

CH_4 emissions from coke production were calculated by multiplying coke production volume by a Japan-specific emission factor, based on the method given in the *Revised 1996 IPCC Guidelines*.

• *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].

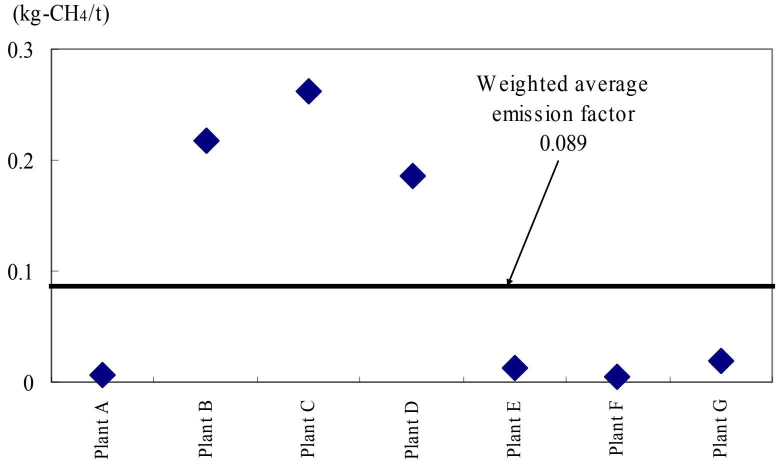

Figure 4-7 Emission factors for methane in combustion exhaust gas from coking furnaces

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 4-18 Emission factor of methane from coking furnace lids, desulfurization towers, and desulfurization recycling towers

Fiscal year	CH_4 emission factors [kg-CH_4/t]	Notes
1990–1996	0.238	Emission factor change is assumed to be small. 1995 data are used for year with no data.
1997–1999	0.180	It is assumed that values for 1998 and 1998 are about the same as those of 1997.
2000	0.101	Actual results
2001	0.062	Actual results
2002	0.052	Actual results
2003～2004	0.042	2003 figures are actual results; data for 2004 and thereafter are assumed to be the same as 2003 figures

Source: Japan Iron and Steel Federation data

-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*

As the activity of CH_4 emissions from coke production the inventory used the coke production volume (fiscal year values) 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.

Table 4-19 Coke production volume

Item	Unit	1990	1995	2000	2003	2004
Coke Production	kt	47,338	42,279	38,511	38,589	38,215

• *Completeness*

The SBDT[3] (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.

3) N_2O

We have no measurements of the concentration of N_2O in the gas leaking from coking furnace lids, but N_2O emissions from this source are reported as “NA,” the reason being that experts say that N_2O is likely not produced because the reducing atmosphere in a coke oven is normally at least 1,000°C.

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”.

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

CO_2 generated when making sinter is all generated by the combustion of coke fines; these emissions come under the Fuel Combustion Sector (1.A.). As they are already calculated in this sector, they are reported as “IE”.

CO_2 emissions from limestone and dolomite used when making sinter are counted under “4.1.3. Limestone and Dolomite Use”.

2) CH_4

CH_4 generated when making sinter is all generated by the combustion of coke fines; these emissions come under the Fuel Combustion Sector (1.A.). As they are already calculated in this sector, they are reported as “IE”.

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.f.)*, and have been reported as “IE”.

4.3.1.5. Use of Electric Arc Furnaces in Steel Production (2.C.1.-)

• *Background*

CO_2 is emitted from carbon electrodes when using electric arc furnaces to make steel.

• *Methodology for Estimating Emissions of GHGs*

CO_2 emissions from arc furnaces for steel production are calculated by multiplying the crude steel production volume from arc furnaces in Japan by the default emission factor given in GPG (2000), and using the method given in GPG (2000).

• *Emission Factor*

The default value [5 kg-CO_2/t] given in GPG (2000) is used (page 3.28).

• *Activity Data*

The inventory uses crude steel production volume by arc furnace given in the *Yearbook of Iron and Steel, Non-ferrous Metals, and Fabricated Metals Statistics* compiled by the Ministry of Economy, Trade and Industry. However, as data for the latest fiscal year are not listed, the calendar-year values are used.

Table 4-20 Crude steel production by electric arc furnace

Item	Unit	1990	1995	2000	2003	2004
Crude Steel Production in electric furnace	kt	35,336	32,665	30,547	29,002	29,762

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*

Estimating emissions involved multiplying the production volume of primary aluminum refining by Japan-specific emission factors calculated using the equation prescribed in the *Revised 1996 IPCC Guidelines*.

• *Emission Factors*

The equation prescribed in the Tier 1b method of the *Revised 1996 IPCC Guidelines* was used to determine emission factors, which appear in the table below.

Table 4-21 PFCs emission factor of aluminum production

Item	Unit	1995	2000	2003	2004
PFC-14 (CF_4)	kgPFC-14/t	0.542	0.377	0.315	0.309
PFC-116 (C_2F_6)	kgPFC-116/t	0.054	0.038	0.031	0.031

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

• *Activity Data*

As the activity data for PFC emissions in conjunction with aluminum refining we used the aluminum production volumes given in the *Yearbook of Minerals and Non-Ferrous Metals Statistics* compiled by the Ministry of Economy, Trade and Industry. Japan’s primary aluminum production is small, at about 0.03% of world production.

2) CO_2

Aluminum refining is conducted in Japan. 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

Aluminum refining is conducted in Japan. 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

Emission from this source was reported as "NO" as it was been confirmed that Japan had no record of the use of SF_6 in aluminum forging processes.

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-2006.xls¥2C* for detail on the calculation process and related indices.)

Table 4-22 Indices related to SF_6 used in magnesium foundries

Item	Unit	1995	2000	2003	2004
Consumption of SF_6	t	5	43	42	40
Molten Magnesium	t	1,840	14,231	18,753	20,782

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-2006.xls¥2E* for details on the calculation process and related indices.)

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

Item	Unit	1995	2000	2003	2004
HCFC-22 production	t	81,000	95,271	77,310	61,900
Generation Factor	%	2.13%	1.70%	1.65%	1.94%
Emission Factor	%	1.79%	1.11%	0.56%	0.14%

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-2006.xls¥2E* for detail on the calculation process and related indices.)

Table 4-24 Indices related to fugitive emissions from HFCs, PFCs, and SF_6 production

GHGs	Item	Unit	1995	2000	2003	2004
HFCs	HFCs production	t	28,280	29,505	49,072	52,182
	Emission Factor	%	1.17%	0.51%	0.54%	0.66%
PFCs	PFCs production	t	1,207	2,337	2,602	2,905
	Emission Factor	%	8.82%	7.87%	4.92%	3.86%
SF_6	SF_6 production	t	2,392	1,556	1,757	1,895
	Emission Factor	%	8.24%	2.31%	1.94%	1.69%

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

*: Calculated from current data

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-2006.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-25 Indices related to emissions of HFCs from domestic refrigeration

Item	Unit	1995	2000	2003	2004
Total HFC Charged in the year	t	520	590	250	157
Fugitive Ratio from Manufacturing	%	1.00%	1.00%	0.21%	0.25%
Device Stock	1000 devices	7,829	33,238	43,183	42,139
Refrigerant contained	g / device	150	125	125	125
Refrigerant filled while using	%	0.3%	0.3%	0.3%	0.3%
Discarded Devices	1000 devices	0	160.472	903.573	903.753
Collect Ratio of HFC under Regulatio	t/year	-	-	20.1	(※20)

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

*: Calculated from current data

2) PFCs

Emission from this source in the “production” category was reported as “NO” as Japan had no record of their use in the production of the products. With respect to household refrigerators, emission was also reported as “NO” in the “use” and “disposal” categories, because it was unlikely that PFCs were used in imported products or refrigerant was refilled.

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

a) Commercial Refrigeration

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-2006.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-26 Indices related to emissions of HFCs from commercial refrigeration

Item	Unit	1995	2000	2003	2004
Device contained HFC Production (Manufacturing)	1000 devices	214	1061	1706	1998
Refrigerant contained from Manufacturing	kg / device	840	476	2598	2610
Fugitive Refrigerant Ratio fromManufacturing	%	-	(0.2%)	0.23%	0.20%
Device contained HFC Production (Application)	%	10	34	659	895
Refrigerant contained from Installation	t	15944	5496	1802	1626
Fugitive Refrigerant Ratio from Installation	1000 devices	1.0%	1.0%	1.0%	1.0%
Device contained HFC Stocks	%	292	3862	8174	9241
Fugitive Refrigerant Ratio fromSupplementation	t	1.0%	1.0%	1.0%	1.0%
Accident Occurrence Ratio	%	0.95%	0.96%	1.00%	1.00%
Used Devices Contained HFC Production	1000 devices	0	40	57	404
Collect Ratio of HFC under Regulation	%	-	-	93.6	(※94)

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

2) PFCs

Emission from this source in the "production" category was reported as "NO" as Japan had no record of their use in the production of the products. It is possible that refrigerant containing PFCs was used in imported products, or mixed refrigerant containing PFCs was used as refill. These amounts, however, were believed to be negligible. As a result, emissions in the "use" and "disposal" categories were reported as "NE".

b) Automatic Vender machine

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-2006.xls ¥2F1* for detail on the calculation process and related indices.)

Table 4-27 Indices related to emissions of HFCs from automatic vender machines

Item	Unit	1995	2000	2003	2004
Device contained HFCs Production (Distribution)	1000 devices	0	272	344	350
Fugitive Ratio from Manufacturing	%	-	300	220	210
Working Devices	1000 devices	-	-	0.32%	0.31%
Annual breakdown Ratio	%	0	284	1,293	1,643
Refrigerant contained	g / device	-	-	0.35%	0.35%
Refrigerant filled while servicing	g / device	-	-	20%	20%
Fugitive Ratio form Servicing	%	-	-	0.54%	0.57%
Discarded Devices	1000 devices	0	0	0	0

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

*: Calculated from current data

2) PFCs

Emission from this source in the "production" category was reported as "NO" as Japan had no record of their use in the production of the products. It is possible that refrigerant containing PFCs was used in imported products, or mixed refrigerant containing PFCs was used as refill. These amounts, however, were believed to be negligible. As a result, emissions in the "use" and "disposal" categories were reported as "NE".

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

1) HFCs

Emission was reported as "IE" since HFCs in this category had been included in the total reported in *4.6.1.2. Commercial Refrigeration and Air-conditioning Equipment* section.

2) PFCs

Emission from this source in the "production" category was reported as "NO" as Japan had no record of their use in the production of the products. It is possible that refrigerant containing PFCs was used in imported products, or that mixed refrigerant containing PFCs was used as refill. These amounts, however, are believed to be negligible. As a result, emissions in the "use" and "disposal" categories were reported as "NE".

4.6.1.4. 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

Emission from this source in the "production" category was reported as "NO" as Japan had no record of their use in the production of the products. It is possible that refrigerant containing PFCs was used in imported products, or that mixed refrigerant containing PFCs was used as refill. These amounts, however, are believed to be negligible. As a result, emissions in the "use" and "disposal" categories were reported as "NE".

4.6.1.5. 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-2006.xls¥2F1* for details on the calculation process and related indices.)

Table 4-28 Indices related to emissions of HFCs from stationary air-conditioning (household)

Item	Unit	1995	2000	2003	2004
Production(distribution) of devices containing HFCs	1000 devices	0	1,053	3,846	4,554
Refrigerant contained	g / device	-	1,000	1,000	1,000
Fugitive Ratio from Manufacturing	%	-	0.15%	0.20%	0.20%
Fugitive Ratio from Installation	%	-	3.0%	1.0%	1.0%
Device contained HFCs Stocks	1000 devices	0	1,700	10,769	17,292
Incidence Rate of accident or breakdown	%	-	0.16%	0.16%	0.16%
Fugitive Ratio from accident	%	-	55%	55%	55%
Collect Ratio of HFC under Regulation	t	-	-	2.2	(※2.2)

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

2) PFCs

Emission from this source in the "production" category was reported as "NO" as Japan had no record of their use in the production of the products. It is possible that refrigerant containing PFCs was used in imported products, or that mixed refrigerant containing PFCs was used as refill. These amounts, however, were believed to be negligible. As a result, emissions in the "use" and "disposal" categories were reported as "NE".

4.6.1.6. 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-2006.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-29 Indices related to emissions of HFC-134a from car air conditioners

Item	Unit	1995	2000	2003	2004
Vehicle used HFCs Production	1000 vehicle	9,770	9,761	9,910	10,196
Assembly Emission Factor	g / vehicle	3.5	3.5	3.5	3.5
Vehicle Stock	1000 vehicle	15,655	42,374	54,057	56,794
Average Refrigerant Weight per Vehicle	g / vehicle	700	615	582	553
Annual Operation Emission Factor (Passenger Vehicle)	g / vehicle / year	15	15	15	15
Ratio of Repairing	%	4%	4%	4%	4%
Ratio of Vehicle leaking Refrigerant	%	50%	50%	50%	50%
Vehicle Collapsed Completely	1000 vehicle	50	136	173	182
Refrigerant Filled in collapsed completely	g / vehicle	681	610	558	559
Vehicle Disassembled	1000 vehicle	116	789	1,552	4,804
Refrigerant Filled in disassembled	g / vehicle	676	593	544	515
Refrigerant Recovered	t	-	-	220	(※220)

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

2) PFCs

Emission from this source in the "production" category was reported as "NO" as Japan had no record of their use in the production of the products. It is possible that refrigerant containing PFCs was used in imported products, or that mixed refrigerant containing PFCs was used as refill. These amounts, however, were believed to be negligible. As a result, emissions in the “use” and “disposal” categories were 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 （HFC-134a）

Emissions from urethane foams were reported on the basis of the values shown in documents of the Chemical and Bio Subgroup of the Industrial Structure Council. Of the types of HFCs listed in the Chemical and Bio Subgroup documents (HFC-134a, HFC-245fa and HFC-365mfc), the calculation covered only HFC-134a for which the value for the Global Warming Potential (GWP) was found in the *Revised 1996 IPCC Guidelines*.

Breakdown of the emissions was determined based on the *Revised 1996 IPCC Guidelines* (closed-cell foams), assuming that 10% of the emission from foam blowing agents used each year occurred within the first year after production, with the remainder emitted over 20 years at the rate of 4.5% per year. For the purpose of the calculation, the emission in the first year was considered to be the emission during production. It is difficult to separate the emission “use” from that at the time of “disposal” because urethane foams were disposed of at various times. Accordingly, the emissions in both the “use” and “disposal” categories were combined and reported under the “use” category, while the emission in the “disposal” category was reported as “IE”.

HFC-134a emission from urethane foam during production and use

= Amount of HFC-134a used in particular year [t] × Leakage during foam blowing [%] + Total amount used to the previous year [t] × Percentage of annual emission during use [%]

= (Emission during production) + (Emission during use)

Table 4-30 Indices related to emissions of HFC-134a from urethane foam

Item	Unit	1995	2000	2003	2004
Total HFC used in the year	t	0	167	233	190
Assembly Emission Rate	%	10.0%	10.0%	10.0%	10.0%
Operational Emission Rate	%	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

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 4-31 Indices related to emissions of HFC-134a and HFC-152a from polyethylene

Item	Unit	1995	2000	2003	2004
HFC-134a used in the year	t	350	320	294	254
HFC-152a used in the year	t	14	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. Polyethylene Foam （HFC-134a）(2.F.2.-)

Emissions of HFC-134a with respect to extruded polystyrene foams were reported on the basis of the values shown in documents of the Chemical and Bio Subgroup of the Industrial Structure Council. Taking into consideration the actual measurement data relating to CFCs and HCFCs in Japan, emissions were calculated on the assumption that 25% of the emission of foam blowing agents occurs within the first year after production with the remainder emitted over 30 years at the rate 2.5% per year. For the purpose of the calculation, the emission in the first year was deemed to be the emission during production. It is difficult to separate the emission "use" from that at the time of "disposal" because urethane foams were disposed of at various times. Accordingly, the emissions in both the "use" and "disposal" categories were combined and reported under the "use" category, while the emission in the "disposal" category was reported as "IE".

HFC-134a emission from extruded polystyrene foam during production and use

= Amount of HFC-134a used in particular year [t] × 25% + Total amount used in the past up to the previous year [t] × Percentage of annual emission during use [%]

= (Emission during production) + (Emission during use)

Table 4-32 Indices related to emissions of HFC-134a from polyethylene foam

Item	Unit	1995	2000	2003	2004
HFC-134a used in the year	t	350	320	294	254
HFC-152a used in the year	t	14	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.

4.6.2.2. 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.)

HFCs emission from this category was reported as "NE" since there is no actual data on emissions. PFCs and SF_6 Emission from this category were reported as “NO” as Japan had no record of their use.

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

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

Emissions of HFC-134a and HFC-152a with respect to aerosols were reported on the basis of the values shown in documents of the Chemical and Bio Subgroup of the Industrial Structure Council. In accordance with the *IPCC Guidelines*, emissions were calculated on the assumption that 50% of the emission from the amount of aerosol filled in the products (potential emissions) occurred in the year of production, with the remaining 50% emitted in the following year. The amount emitted in the year of production was reported in the “production” category, and the amount in the following year in the “use” category. The amount of emission at the time of “disposal” was reported as “IE” as it was included in the calculation for the “use” category. Relevant indices are shown in Table below.

Table 4-33 Indices related to emissions of HFCs from aerosols

Item	Unit	1995	2000	2003	2004
Potential Emissions of HFC-134	t	1,300	2,044	1,598	1,162
Potential Emissions of HFC-152	t	0	34	553	1,077
Ratio of Products containing sin	%	70%	88%	95%	86%
Mixing Rate of products containing single chemical	%	0%	15%	16%	31%
Assembly Fugitive Ratio	%	5%	4%	3%	3%
Executing rate of self-indication	%	0%	8%	80%	※

※ under investigation

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. Emission from this source was estimated to have occurred entirely in the year of production, and the amount of the emission was the total of the amount of HFC-227ea used during production and the amount contained in imported products less the amount recovered and destroyed. The associated indices are given in the table below. (Refer to *2-Fgas-A-2006.xls¥2F4* for details on the calculation process and related indices.)

Table 4-34 Indices related to emissions of HFCs from MDI

GHGs	Item	Unit	1995	2000	2003	2004
HFC-134	Domestic consumption for MDI	t	-	1.4	0.6	0.9
	Imported comsumption for MD	t	-	42.0	47.3	56.5
	Amount of Disposal	t	-	0.2	0.2	2.2
HFC-227	Domestic consumption for MDI	t	-	0.0	25.5	52.3
	Imported comsumption for MD	t	-	3.6	3.6	3.5
	Amount of Disposal	t	-	0.0	0.4	2.2

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, washing, and etc .. Assuming that the total amount of liquid PFC shipment was used in cleaners and for cleaning purposes each year, the entire amount was reported in the "use" category as the amount of emission. Emission during production was reported as "IE" as it was believed to be included in "Fugitive Emissions (2.E.2)". Emission at the time of disposal was reported as "IE" on the assumption, from the point of view of safety, that the entire amount, including that disposed of, was emitted during use, because of the difficulty in determining the status of the disposal of PFCs. The associated indices are given in the table below. (Refer to *2-Fgas-A-2006.xls¥2F5* for details on the calculation process and related indices.)

Apparent GWP value may be below 6,500 in some of the reporting years due to the use of PFCs not listed in the Common Reporting Form (CRF) in the cleaning of general electronic parts.

Table 4-35 Indices related to emissions of PFCs from solvents

Item	Unit	1995	2000	2003	2004
Amount of Shipping PFCs for Solvent	t	1,400	953	610	721

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

4.6.6. Other applications using ODS substitutes (2.F.6.)

Emission from this category was reported as "NE" since there is no actual data on emissions.

4.6.7. Semiconductors (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 PFCs emissions associated with the use of solvents during the manufacture of semiconductors, and the manufacture of liquid crystals. Emissions from semiconductor production were calculated in accordance with the method described in the *IPCC Guidelines*, using the following formula, and reported in the "use" category.

HFC-23, PFCs and SF_6 emissions from semiconductor production

= Amount of each gas purchased [t] × Rate fed to processes × (1 – Fraction of reactive consumption) × (1 – Fraction of gas destroyed due to emission control technologies × Installation rate of emission control equipment)

Emission during production was reported as "IE" since it had been reported in the Fugitive Emissions (2.E.2) section. Emission at time of disposal was reported as "NA" as it was believed that the emission source per se did not exist in Japan. Relevant indices are shown in Table below.

Table 4-36 Indices related to emissions of F-gas from manufacturing of semiconductors

Item	Unit	1995	2000	2003	2004
PFC-14 purchased	t	313.0	299.9	228.2	235.4
PFC-116 purchased	t	209.5	561.2	449.3	434.5
PFC-218 purchased	t	0.0	9.9	126.5	159.2
PFC-c318 purchased	t	0.6	38.6	15.0	21.8
HFC-23 purchased	t	47.8	49.4	37.9	41.9
SF$_6$ purchased	t	90.8	131.9	94.8	104.6
Supply Rate for Process	%	90%	90%	90%	90%
Chemical Reaction Consumption Rate of PFCs e	%	20% - 80%			
Reselection Efficiency of PFCs etc.	%	90%	90%	90%	90%
Generation Rate of by-product CF$_4$	%	C$_2$F$_6$(PFC-116):10%,c-C$_4$F$_8$(PFC-c318):10%			
Desellection Efficiency of CF$_4$	%	90%	90%	90%	90%

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

Table 4-37 Indices related to emissions of F-gas from manufacturing of liquid crystals

Item	Unit	1995	2000	2003	2004
PFC-14 purchased	t	20.7	47.3	46.6	65.0
PFC-116 purchased	t	0.4	2.7	5.3	9.3
PFC-218 purchased	t	0.0	0.0	0.5	0.8
PFC-c318 purchased	t	0.1	0.7	1.3	1.6
HFC-23 purchased	t	11.5	85.3	99.1	101.0
SF$_6$ purchased	t	0.9	0.9	0.9	0.9
Supply Rate for Process	%	90%	90%	90%	90%
Chemical Reaction Consumption Rate of PFCs e	%	20% - 80%			
Reselection Efficiency of PFCs etc.	%	90%	90%	90%	90%
Generation Rate of by-product	%	C$_2$F$_6$(PFC-116):10%,c-C$_4$F$_8$(PFC-c318):10%			
Desellection Efficiency of CF$_4$	%	90%	90%	90%	90%

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

4.6.8. Electrical Equipment (2.F.8.)

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-2006.xls¥2F7* for details on the calculation process and related indices.)

Table 4-38 Indices related to emissions of SF$_6$ from electrical equipment

	Item	Unit	1995	2000	2003	2004
Electorical Equipment Assemble	SF$_6$ purchsed	t	1,380	649	591	557
	SF$_6$ contained	t	1,464	450	459	469
	Stocks of SF$_6$	t	0	105	95	61
	Assembly Fugitive Rate	%	29%	15%	6%	5%
Electorical Equipment Operation	Stocks of SF$_6$	t	6,300	8,000	8,600	8,600
	Operational Fugitive Rate	%	0.1%	0.1%	0.1%	0.1%
	Servicing Collect Rate	%	60%	93%	97%	97%
	Dismantlement Collect Rate	%	0%	94%	98%	99%

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

References

IPCC, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, 1997

IPCC, *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, 2000

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

Emissions of carbon dioxide, nitrous dioxide, and NMVOC are generated following the solvent and other product use. In this chapter, emissions due to the following product uses are estimated:

- Paint solvents
- Degreasing and dry-cleaning
- Chemical products
- Other products (e.g. anesthesia)

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 “NA.”

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 there are no sufficient data available on the actual condition of emissions from degreasing and dry-cleaning 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.

Table 5-1 The volume of shipments of general anesthetics on calendar year basis

Item	Unit	1990	1995	2000	2003	2004
Laughing gas	kg	926,030	1,411,534	1,099,979	1,034,947	959,816

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 "NA".

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. Hence, it is reported as “NE”.

5.4.3. Aerosol Cans (3.D.-)

1) CO_2

Aerosol products, which fills spray cans with carbon dioxide, are manufactured in Japan. It is assumed that the carbon dioxide could be emitted to the atmosphere when the aerosol products are used. However, becuase 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)

Greenhouse gas emissions from the agricultural sector are calculated in five categories: 4A, 4B, 4C, 4D, and 4F. In *4A: Enteric Fermentation*, methane gas generated and emitted by cattle, buffalo, sheep, goats, horses, and swine as the result of enteric fermentation is reported. In *4B: Manure Management*, methane and nitrous oxide generated by treatment of manure excreted by cattle, buffalo, sheep, goats, horses, swine and poultry are reported. In *4C: Rice Cultivation*, methane emissions from paddy fields (continuously flooded and intermittently flooded) cultivated for rice production are reported. In *4D: Agricultural Soils*, methane and nitrous oxide emitted directly and indirectly from agricultural soil as well as pastures, ranges, and paddocks manure are reported. There is NO emission reported for *4E: Prescribed Burning of Savannas*, since Japan has no emission source in this category, while methane and nitrous oxide (as well as carbon monoxide) emissions from field burning of grains, legumes, root crops, and sugar cane during agricultural activities are reported in *4F: Field Burning of Agricultural Residues*.

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.

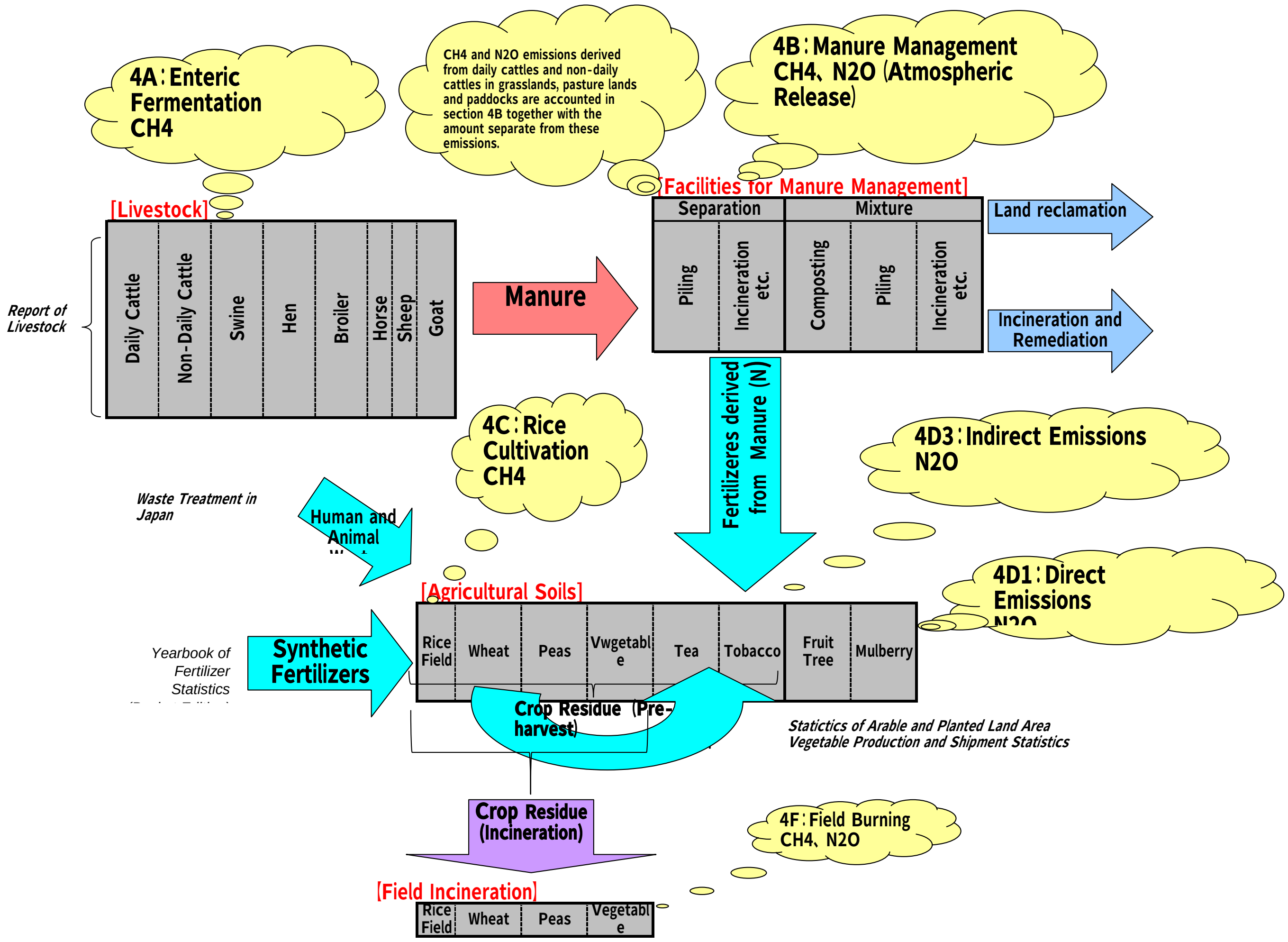

Fig. 6-1 Relationships among the categories in the agricultural sector

6.1. Enteric Fermentation (4.A.)

Cattle, buffalo, sheep, and goats are ruminant animals. Methane, a product of the fermentation, from the activity of microbes residing in their enteric cavity digesting (fermenting) fibers of grass is released into to the atmosphere. Horses and swine generate methane in enteric fermentation, which is also released into the atmosphere. These methane emissions are calculated and reported in the *Enteric Fermentation (4.A.)* section.

6.1.1. Cattle (4.A.1.)

• *Methodology for Estimating Emissions of GHGs*

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. For that reason, a technique similar to the Tier 2 Method but specific to Japan was used for the calculation of methane emissions associated with enteric fermentation by cattle. The emissions were calculated by multiplying the cattle population (dairy and non-dairy) by the emission factors established based on their dry matter intake.

As cattle begin to eat normal feed at the age of five to six months, the calculation of the methane emissions associated with enteric fermentation includes cattle aged five months or older.

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-CH4-2006.xls* for details of the calculation process.)

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

Animal type		Assumptions for Calculation of Emissions
Dairy cattle	Lactating	—
	Non-lactating	—
	Heifers (under 2 years old, excluding 5- and 6-month olds)	Calculation excludes 6/24 of the population which was assumed to be 6 months or younger; therefore actually covering only 18/24 of the population 2 years or younger.
	Heifers (5 to 6 months old)	Calculation covers 5- and 6-month olds comprising 2/24 of the population under 2 years old.

Animal type		Assumptions for Calculation of Emissions
Non-dairy cattle	Breeding cows (1 year and older)	—
	Breeding cows (under 1 year, excluding 5- and 6-month olds)	Calculation excludes 6/12 of the population which was assumed to be 6 months or younger; therefore covering 6/12 of the population under 1 year old.
	Breeding cows (5 and 6 months old)	Calculation covers 5- and 6-month olds comprising 2/12 of the population under 1 year old.
	Japanese cattle (1 year and older)	—
	Japanese cattle (under 1 year, excluding 5- and 6-month olds)	Calculation excludes 6/12 of the population which was assumed to be 6 months or younger; therefore covering 6/12 of the population under 1 year old.
	Japanese cattle (5 to 6 months old)	Calculation covers 5- and 6-month olds comprising 2/12 of the population under 1 year old.
	Dairy breeds (excluding 5- and 6-month olds)	Calculation excludes 6/24 of the population which was assumed to be 6 months or younger; therefore covering 18/24 of the population under 2 year old.
	Dairy breeds (5 to 6 months old)	Calculation covers 5- and 6-month olds comprising 2/24 of the population under 2 years old.

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 emission factors. The dry matter intake was calculated by substituting fat-adjusted milk yield, body weight, and weight gain per day into the equation established for each type of cattle.

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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

Data for the fat-adjusted milk yield was obtained from the *Statistics on Milk and Dairy Products* (Ministry of Agriculture, Fisheries and Forestry; MAFF) and the *Statistics on Livestock* (MAFF), and those for the fat content from the *Survey of Livestock Production Costs* (MAFF). Both sets of the data are updated on a yearly basis. Data for body weight and weight gain per day were obtained from the table of weight by age (months) for each type of cattle included at the back of the *Japanese Feeding Standards* (Japan Livestock Industry Association).

Formula of CH_4 Emission Factor of Enteric Fermentation (kg-CH_4/head)

＝(Methane generated [L/day/head]) / (Volume of 1 mol) × (molecular weight of methane) × (no. of days in year)

＝Y／22.4 (l/mol)×0.016 (kg/mol)×365or 366（day）

• *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*.

Table 6-2 activity data associated with enteric fermentation by cattle (Single yaear)

	Item	Unit	1990	1995	2000	2003	2004	2005
Dairy Cattle	Dairy Cattle (Lactating)	1000 head	1,082	1,035	971	936	910	*910*
	Dairy Cattle (Dry)	1000 head	332	299	249	244	235	*235*
	Dairy Cattle (Heifer: Under Two Year, over six month)	1000 head	600	544	463	468	468	*468*
	Dairy Cattle (Heifer: Five and six month)	1000 head	55	49	42	43	43	*43*
Non-Dairy Cattle	Non-Dairy Cattle (Breeding Cows: One Year and Over)	1000 head	565	676	632	632	636	*636*
	Non-Dairy Cattle (Breeding Cows: Under One Year, over six month)	1000 head	378	396	344	374	365	*365*
	Non-Dairy Cattle (Breeding Cows: Fiveand six month)	1000 head	76	79	69	75	73	*73*
	Non-Dairy Cattle (Fattening: One Year and Over)	1000 head	368	412	385	383	373	*373*
	Non-Dairy Cattle (Fattening: Under One Year, over six manth)	1000 head	125	133	114	127	123	*123*
	Non-Dairy Cattle (Fattening: Fiveand six month)	1000 head	42	44	38	42	41	*41*
	Non-Dairy Cattle (Dairy breed: Over six month)	1000 head	805	808	845	809	787	*787*
	Non-Dairy Cattle (Dairy breed: Five and six month)	1000 head	89	90	94	90	87	*87*

* Data for 2005 are substituted by data for 2004

6.1.2. Buffalo, Sheep, Goats, Horses & Swine (4.A.2., 4.A.3., 4.A.4., 4.A.6., 4.A.8.)

• *Methodology for Estimating Emissions of GHGs*

Methane emissions associated with enteric fermentation by buffalo, sheep, goats, swine, and horses were calculated using the Tier 1 Method in accordance with the Decision Tree of the *Good Practice Guidance (2000)*.

• *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

Animal type	Dry Matter Intake [kg]	CH_4 Generation factor [kg/year/head][a]
Sheep, goats	0.8	4.1
Swine[b]	—	1.1
Horses[c]	—	18.0
Buffalo[c]	—	55.0

a: Calculated by the formula: (Methane generated [L/day/head]) / (Volume of 1 mol) × (molecular weight of methane) × (no. of days in year)

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

c: *Revised 1996 IPCC Guidelines*

• *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*". For buffalo, the number of buffalo in breeding as shown in the *Statistics on Livestock in Okinawa Prefecture* was used.

Table 6-4 Activity data associated with enteric fermentation by buffalo, sheep, goats, swine, and horses

Type of animal	Unit	1990	1995	2000	2003	2004	2005
Sheep	1000 head	31	20	10	11	11	11
Goats	1000 head	35	30	35	34	34	34
Swine	1000 head	188,786	190,634	186,202	178,755	178,755	*178,755*
Horse	1000 head	23	29	25	25	25	25
Buffalo	1000 head	0.21	0.12	0.10	0.10	0.08	*0.08*

** Data for 2005 are substituted by data for 2004*

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

Japan reported "NO" in this subcategory as it was unlikely that these animals were raised for agricultural purposes.

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.)

Livestock manure generates methane when its organic content is converted to methane gas through methane fermentation, or when methane from enteric fermentation dissolved in manure is released by aeration or agitation.

6.2.1. Cattle, Swine and Poultry (4.B.1., 4.B.8., 4.B.9.: CH_4, N_2O)

Manure excreted by cattle in a shed and barn and by pastured cattle generates methane. Emission estimates were conducted separately for each manure type and added up to obtain total emissions.

a） Calculation of Emissions (Cattle, Swine and Poultry in shed and barn)

• *Methodology for Estimating Emissions of GHGs*

Methane emissions associated with the treatment of manure excreted by cattle in a shed and barn (dairy and non-dairy), swine, and poultry (layers and broilers) were calculated by multiplying the volume of organic matter contained in manure from each type of livestock by the emission factor for each type of treatment method.

$$E = \sum \left(EF_n \times A_n\right)$$

E: Methane emissions associated with the management of manure excreted by cattle, swine and poultry (g-CH_4)

EF_n: Emission factor for treatment method n (g-CH_4/g-Organic matter);

A_n: Amount of organic matter contained in manure treated by method n (g-Organic matter).

Nitrous oxide emissions associated with the management of manure excreted by cattle (dairy and non-dairy), swine, and poultry (layers and broilers) were calculated by multiplying the amount of nitrogen contained in manure of each type of animal by the emission factor for each type of treatment method.

$$E = \sum \left(EF_n \times A_n\right) \times 44/28$$

E: Nitrous oxide emission associated with management of manure excreted by cattle, swine and poultry (g-N_2O)

EF_n: Emission factor for treatment method n (g-N_2O/g-N);

A_n: Amount of nitrogen contained in manure treated by method n (g-N)

• *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 after reviewing its validity in accordance with the decision tree shown in Figure 6-2. Actual values are given in the following tables.

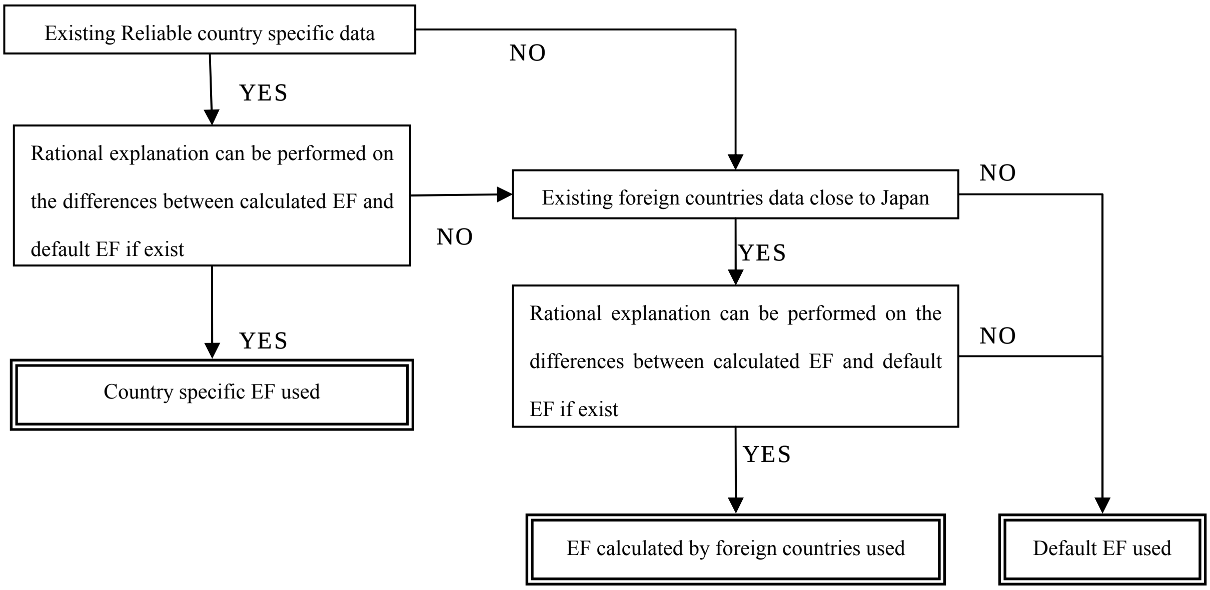

Figure 6-2 Decision tree for determination of EF

Table 6-5 CH_4 Emission factors for each method of treating manure from cattle, Swine, Hen & Broiler

treating method		Daily Cattle		Non-daily cattle		Swine		Hen, Broiler	
12. Pit storage		3.90 %	D	3.00 %	D	8.7 %	D	—	—
13. Sunlight drying		0.20 %	J	0.20 %	J	0.20 %	J	0.20 %	J
14. Other	13a. Thermal drying	0 %	Z	0 %	Z	0 %	Z	0 %	Z
	13b. Composting (feces)	0.044 %	D	0.034 %	D	0.097 %	D	0.14 %	J
	13c. Deposition	3.80 %	J	0.13 %	J	0.16 %	J	0.14 %	J
	13d. Incineration	0.4 %	O	0.4 %	O	0.4 %	O	0.4 %	O
	13e. Composting (feces and urine mixed)	0.044 %	D	0.034 %	D	0.097 %	D	—	—
	13f. Wastewater management	0.0087%	D	0.0067%	D	0.019%	D	—	—

Table 6-6 N_2O Emission factors for each method of treating manure from cattle, Swine Hen & Broiler

treating method		Daily Cattle		Non-daily cattle		Swine		Hen, Broiler	
12. Pit storage		0.10 %							D
13. Sunlight drying		2.0 %							J
14. Other	13a. Thermal drying	2.0 %							J
	13b. Composting (feces)	0.25 %							J
	13c. Deposition	2.40 %	J	1.60 %	J	2.50 %	J	2.0 %	D
	13d. Incineration	0.1 %							O
	13e. Composting (feces and urine mixed)	2.0 %							D
	13f. Wastewater management	5.0 %							J

D: Default value of IPCC Guideline

J: Established by data of Japan

O: Established by data of other countries

Z: Emission can not occur because of mechanism

＊ Manure excreted by hen and broiler was categorized as feces since it contains a very small amount of urine.

References

【CH4】

Treatment Categories		reference
11 Liquid Systems		GPG（2000）
12 Solid Storage ＆Drylot		Ishibashi, Hashiguchi, Koseki: Development of greenhouse gas emission reduction technology on livestock industry
13 Other	13a. Thermal Drying	Japan Livestock Technology Association, GHGs emissions control in livestock Summary, March 2002
	13b. Compsting	[Other than poultry]: GPG（2000） [Poultry]: Takashi Osada, Yasuyuki Fukumoto, Tadashi Tamura, Makoto Shiraihi, Makoto Ishibashi（2005）：Greenhouse gas generation from livestock waste composting,Non-CO_2 Greenhouse Gases (NCGG-4),Proceedings of the Fourth International Symposium NCGG-4,105-111
	13c. Piling	Same as above (poultry)
	13d. Incineration	Japan Livestock Technology Association, GHGs emissions control in livestock Summary, March 2002 IPCC（1995）：IPCC1995Report；Agricultural Options for Mitigation of Greenhouse Gas Emissions,747-771
	13e. Liquid Composting	GPG(2000)
	13f. Purification	GPG(2000)

【N2O】

Treatment Categories		reference
11 Liquid Systems		reviced 1996 IPCC Guideline, GPG（2000）
12 Solid Storage ＆Drylot		reviced 1996 IPCC Guideline, GPG (2000)
13 Other	13a. Thermal Drying	reviced 1996 IPCC Guideline, GPG（2000）
	13b. Compsting	Takeshi Osada,Kazutaka Kuroda,Michihiro Yonaga(2000):Determination of nitrous oxide,methane,and ammonia emissions from a swine waste composting process,J Mater Cycles Waste Manag(2000) 2,51-56
	13c. Piling	[Other than poultry]: Takashi Osada, Yasuyuki Fukumoto, Tadashi Tamura, Makoto Shiraihi, Makoto Ishibashi（2005）：Greenhouse gas generation from livestock waste composting,Non-CO2 Greenhouse Gases (NCGG-4),Proceedings of the Fourth International Symposium NCGG-4,105-111 [Poultry]: GPG(2000)
	13d. Incineration	Japan Livestock Technology Association, GHGs emissions control in livestock Summary, March 2002
	13e. Liquid Composting	GPG（2000）
	13f. Purification	Takashi Osada（2003）：Nitrous Oxide Emission from Purification of Liquid Portion of Swine Wastewater,Greenhouse Gas Control Technologies,J.Gale and Y.Kaya(Eds.)

• *Activity Data*

The values used for the activity data for emissions of methane are 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.

Total annual volumes of organic matter and nitrogen excreted by domestic livestock were calculated by multiplying the population of each type of animal by the amount of manure per head. The volume of organic matter was allocated to each category of manure management by multiplying the total volume by the percentage of manure treated separately and the percentage per treatment method.

Estimating activity data for CH_4 (volume of organic matter excreted)

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*, March 2002
Other elements of the equation are same as for methane.

○ Cattle population

In order to avoid duplication with the cattle under grazing, the cattle population was calculated by subtracting activity data for grazing cattle determined by the formula, “Grazing population × Number of grazing days (190 days) / Number of days in year (365 or 366 days)”, from the total population of dairy and non-dairy cattle.

Table 6-7 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 6-8 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 6-9 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 6-10 Percentage of manure by type of animal

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.

- ***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.

b） **Calculation of Emissions (Cattle under grazing)**

Organic matter contained in manure excreted by livestock during grazing is converted to methane through the methane fermentation process, and emitted into the atmosphere. The nitrogen-containing manure also generates ammonium ions, which in turn generates nitrous oxide in the process of oxidation under aerobic conditions.

Emissions in this category are reported for cattle grazing owing to the unavailability of statistics and other information regarding the grazing of other animals.

• *Methodology for Estimating Emissions of GHGs*

For methane and nitrous oxide emitted from pasture, range, and paddock manure (i.e. methane and nitrous oxide generated by dung and urine deposited onto grazing and watering grounds by the grazing livestock), the amount of emissions was calculated for cattle by multiplying the Japan-specific emission factors by the total grazing population in accordance with the Decision Tree in the *Good Practice Guide (2000)* (page 4.55, Fig. 4.7).

• *Emission Factors*

Data for the amounts (g) of methane and nitrous oxide emitted from manure excreted per head of cattle per day were used as the emission factors. The data were established by multiplying the model output value of carbon content in manure excreted by grazing cattle during the grazing period by the actual measurement values of methane and nitrous oxide generated per amount of carbon contained in the manure of the grazing cattle.

The amount of carbon contained in the manure of the grazing cattle was calculated by a growth model of grazing cattle based on grass production, quality of grass, climatic conditions, and age in days of grazing cattle.

Table 6-11 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 was determined by multiplying the grazing population by the duration of the grazing period. The grazing population was derived from the total grazing population in both public and private pastures reported in the *2004 Livestock Statistics*. For the grazing population in prior years, the percentage of the average grazing population (= Grazing population reported in the *Livestock Statistics* / Total population raised) as in 2003FY and 2004FY was determined first, and then the grazing population for each fiscal year was calculated on the assumption that the percentage was the same in all fiscal years.

The duration of 190 days was established for the grazing period, using the values for seasonal grazing (average grazing period: 172.8 days; the number of pastures 623) and year-round grazing (assumed grazing period: 365 days; the number of pastures 61) indicated in the *Report on National Factual Survey of Cattle Pastures (2000)*, and averaging the grazing days weighted by the number of pastures.

Table 6-12 Trends in the population of grazing cattle

Item	Unit	1990	1995	2000	2003	2004	2005
Amount of grazing daily cattle	head	302,219	281,603	252,088	256,300	232,700	241,816
Amount of grazing non-daily cattle	head	99,723	103,150	99,769	98,400	98,400	97,650

• *c) 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 (11. Anaerobic Lagoons、12. Liquid Systems、13. Solid Storage and Dry Lot、14. Other.

For cattle, swine, and poultry, Japan's country-specific manure management categories and the implementation rates of the management categories have been established for each type of animal. For details, see Table 6-11 below.

The current CRF divides the reporting categories into Anaerobic Lagoons, Liquid Systems, Solid Storage and Dry Lots, and Other. In Japan, however, composting is widely practiced, particularly with respect to domestic livestock feces. Consequently the composting-related subcategories of "Piling" and "Composting" have been established under the Other category. Additional subcategories of "Thermal drying" and "Incineration", which are practiced for the purposes of volume reduction and easier handling of dung, have been also included in the Other category. Urine undergoes purification treatment as sewage with high concentrations of pollutants. Accordingly, a subcategory of "Purification" has been added to the CRF category of Other.

Composting is widely practiced in Japan because, among other things: (1) it is essential for Japanese livestock farmers to facilitate transportation and handling, because the lack of space required for the on-site reduction of manure makes it necessary to direct the manure for uses outside their farms; and (2) compost is in considerably higher demand as a fertilizer for various crops than is slurry or liquid manure in Japan where fertilizers tend to be lost by heavy rain and the expectations of the protection of water quality, prevention of odor, and sanitary management are high.

"11. 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.

Table 6-13 Correspondence between the Japanese and CRF manure management categories

Japan			CRF	Description of Treatment
Manure treatment		Manure management category		
Separate treatment	Feces	Sun drying	13. Solid Storage and Dry Lot	Dried under sunlight to facilitate handling (for storage and odor prevention).
		Thermal drying	14. Other (a. Thermal drying)	Dried by heat to facilitate handling.
		Composting	14. Other (b. Composting)	Fermented for several days to several weeks with forced aeration and agitation in lidded or closed tanks.
		Piling	14. Other (c. Piling)	Piled on compost bed or in shed to ferment for several months with occasional turning.
		Incineration	14. Other (d. Incineration)	For volume reduction or disposal, and use as an energy source (e.g. chicken manure boiler).
	Urine	Composting	14. Other (e. Composting (liquid))	Treated in an aeration storage tank.
		Purification	14. Other (f. Purification)	Separate pollutants using aerobic microbes, such as activated sludge.
		Storage	12. Liquid systems	Stored in a storage tank.
Mixed treatment		Sun drying	13. Solid Storage and Dry Lot	Dried under sunlight to facilitate handling.
		Thermal drying	14. Other (a. Thermal drying)	Dried by heat to facilitate handling.
		Composting	14. Other (e. Composting (liquid))	Solids are fermented for several days to several weeks with forced aeration and agitation in lidded or closed tank. Liquids are treated in an aeration storage tank.
		Piling	14. Other (c. Piling)	Piled on compost bed or in shed to ferment for several months with occasional turning.
		Purification	14. Other (f. Purification)	Separate pollutants using aerobic microbes, such as activated sludge.
		Storage	12. Liquid systems	Stored in a storage tank (e.g. slurry storage).

d) Nitrogen in Livestock Manure Applied to Agricultural Soil

At present, calculation of the percentages of manure-derived organic fertilizer application in *4D2: Indirect Emissions* uses the nitrogen content of livestock manure less the amount of volatilization into the atmosphere and the amount treated by “Incineration” and “Purification” treatments through which nitrogen is completely eliminated. The portion disposed of in landfill as waste was also subtracted from the total nitrogen content in livestock manure. Buffalo, sheep, goats, and horses are excluded from the calculation because they produce very small amounts of manure and details of their management in Japan are unknown.

• *Methodology for Estimating Emissions of GHGs*

The percentage of application of manure-derived organic fertilizers was calculated by subtracting the nitrogen contents in the livestock manure disposed of in the “direct final disposal”, the nitrogen volatized as nitrous oxide, the nitrogen volatilized as ammonia and nitrogen oxides, and the nitrogen eliminated by the “incineration” and “purification”, from the total nitrogen contained in livestock manure excreted in a shed and barn.

$$N_D = N_{all} - N_{N2O} - N_{NH3+NOx} - N_{inc+waa} - N_{waste}$$

$N_{D:}$	Amount of nitrogen in manure-derived fertilizer applied to agricultural soil (kg-N)
$N_{all:}$	Total amount of nitrogen excreted by livestock (deposited in shed and barn) (kg-N)
$N_{N2O:}$	Nitrogen in livestock manure volatilized as nitrous oxide (deposited in shed and barn) (kg-N)
$N_{NH3+NOx:}$	Nitrogen in manure volatilized as NH_3 and NO_X (deposited in shed and barn) (kg-NH_3-N + NO_X-N)
$N_{inc+waa:}$	Nitrogen eliminated by “incineration” and “purification(deposited in shed and barn) (kg-N)
$N_{waste:}$	Amount of nitrogen in manure that is disposed of in the “final direct disposal” (kg-N)

○ Amount of N_2O volatilized into the atmosphere

The amount of N_2O volatilized into the atmosphere was determined from the calculation results of nitrous oxide emissions from livestock manure.

○ Amount volatilized as ammonia and nitrogen oxides

The amount of nitrogen that is volatilized as ammonia and nitrogen oxides from livestock manure was calculated by multiplying the nitrogen excreted by each type of animal by the percentage of nitrogen that is volatilized as ammonia and nitrogen oxides from manure of each type of animal. Because the percentage of nitrogen that is volatilized as nitrogen oxides is unknown, the percentages of the volatilization of ammonia and nitrogen oxides from manure were determined together with the percentage volatilized as ammonia based on the data in the *Estimated Volatilization of Ammonia from Livestock Manure* in the *Control of Greenhouse Gas Emissions in Livestock: Summary* (Japan Livestock Technology Association).

Table 6-14 Estimated percentage of volatilized ammonia from livestock manure

Type of Animal	Value
Dairy and non-dairy cattle	10%
Swine	20%
Layers and broilers	30%

○ Nitrogen eliminated by incineration or purification

The amount was determined from the values of nitrogen disposed of through incineration and purification processes in manure management.

○ Nitrogen in manure disposed of in direct final disposal

Livestock manure disposed of in landfill as waste is either treated before disposal (“treated disposal”) or sent directly to landfill untreated (“direct final disposal”).

Because the manure that is disposed of in “direct final disposal” is detained as a mixture of dung and urine prior to the disposal in landfill, a portion of manure held under the Storage subcategory in the Mixed Treatment category was deemed to have been disposed of in "direct final disposal" (note: manure of layers and broilers was deemed to have been treated under the "Feces - Piling" subcategory. The amount of manure that is disposed of in "treated disposal" is negligible and its treatment method is unknown; therefore, manure that is treated before final disposal was included in the calculation of the manure disposed in the "direct final disposal".

For the amount of nitrogen in manure disposed of in "direct final disposal," the total amounts of manure disposed in the "direct final disposal" and "treated disposal" shown in the *Report on the Survey for Research on the Wide-range Movement of Wastes and the State of Cyclical Use of Wastes* were apportioned to the volume of dung and urine of cattle and swine that was treated under the Storage subcategory of the Mixed Treatment category and the volume of manure of layers and broilers that was treated under the "Feces - Piling" of feces subcategory. The amounts that had been apportioned to the cattle and swine were further apportioned to dung and urine. Finally, the amounts of nitrogen content were calculated by multiplying the apportioned amounts by the nitrogen content in each of dung and urine of each type of animal (Table 6-6).

Nitrogen content in livestock manure disposed in the direct final disposal
= Volume disposed of per type of animal and feces/urine × Nitrogen content in feces/urine of the type of animal

Table 6-15 Nitrogen in livestock manure applied to agricultural soil

Item	Unit	1990	1995	2000	2003	2004	2005
the amount of N in animal manure （N_{all}）	tN	763,882	713,770	677,389	661,084	603,996	603,634
the amount of N2O-N released from animal(except Incineration method and Wastewater manage method)（N_{N2O}）	tN	9,308	8,687	8,200	7,998	7,389	7,384
the amount of NH3-N and Nox-N released from animal manure（$N_{NH3+Nox}$）	tN	139,990	130,300	124,019	120,136	107,695	107,659
the amount of N vanished by Incineration method and Wastewater manage method （$N_{inc+waa}$）	tN	61,037	53,042	51,005	50,390	43,959	43,956
the amount of N vanished by buryying in the ground.（N_{waste}）	tN	15,869	13,792	12,946	23,051	22,780	22,799
the amount of N used as fertilizer（N_D）	tN	537,678	507,948	481,219	459,509	422,174	421,835

6.2.2. Buffalo, Sheep, Goats & Horses (4.B.2., 4.B.3., 4.B.4., 4.B.6.)

1) CH_4

• *Methodology for Estimating Emissions of GHGs*

Methane emissions associated with the management of manure excreted by buffalo, sheep, goats, and horses were calculated using the Tier 1 method in accordance with the Decision Tree of the *Good Practice Guidance (2000)* (Page 4.33, Fig. 4.3).

Methane emissions associated with manure management (kg-CH_4)
= Emission factor for animal (kg-CH_4/year/head) × Population of the animal

• *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*. For buffalo, the default value given for the temperate zone in Asia was used.

Table 6-16 Emission factors for sheep, goats and horses

Type of livestock	Emission Factors [kg CH_4/head/year]	reference
Sheep	0.28	*Revised 1996 IPCC Guidelines* Vol. 2 p. 4.6 Table 4-4
Goats	0.18	
Horses	2.08	
Buffalo	2.0	*Revised 1996 IPCC Guidelines*, Vol. 13, p. 4.13, Table 4-6

• *Activity Data*

Calculation of activity data for sheep, goats and horses used the values shown in the FAO statistics published on the FAO website. Data for buffalo in the calculation used the population of buffalo listed in the *Statistics on Livestock in Okinawa Prefecture* (Table 6-4).

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.)

Nitrous oxide emission associated with livestock manure (kg-N_2O)
= Emission factor per manure management category of each type of animal [kg-N_2O-N/kg-N]) × Nitrogen content of manure [kg-N/head] × Percentage of manure management category × Population of livestock [head]

• *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 Asia & Far East, given in the *Revised 1996 IPCC Guidelines*.

Table 6-17 Emission factors for buffalo, sheep, goats and horses [kg-N_2O-N/kg-N]

Manure Management Category	Emission Factor [kg-N_2O-N/ kg-N]
11. Anaerobic Lagoons	0.1%
12. Liquid Systems	0.1%
13. Solid Storage and Dry Lot	2.0%
14. Other a. Thermal Drying	0.0%
14. Other b. Composting	0.0%
14. Other c. Piling	0.0%
14. Other d. Incineration	0.0%
14. Other e. Liquid Composting	0.0%
14. Other f. Purification	0.0%
14. Other g. Daily Spread	0.0%
14. Other h. Pasture, Range, and Paddock	2.0%
14. Other i. Used as Fuel	0.0%
14. Other j. Other System	0.5%

Source: *Revised 1966 IPCC Guidelines*, Vol. 3, page 4.121, Table B-1

• *Activity Data*

In order to determine the activity data for buffalo, sheep, goats, and horses, first, the total nitrogen was calculated by multiplying the population of each type of animal by the nitrogen content of manure per head of animal. Then, the amount of nitrogen per manure management category was calculated by multiplying the total nitrogen by the percentage of each management category. For the nitrogen contents of manure and the percentage of each manure management category, the default values given in the *Revised 1996 IPCC Guidelines* were used. For the population size per type of livestock, the same values used in the calculation of methane emissions were used.

Table 6-18 Amounts of nitrogen in manure excreted by buffalo, sheep, goats, and horses [kg-N/head/year]

Type of Animal	Emission Factor [kg-N/head/year]
Sheep	12
Goats*	40
Horses*	40
Buffalo*	40

Source: *Revised 1996 IPCC Guidelines*, Vol. 3, page 4.99, Table 4-20, 1

* Value for “Other animals” was used.

Table 6-19 Percentage of each manure management category for buffalo, sheep, goats, and horses

Treatment Category	Percentage of Treatment			
	Buffalo	Sheep	Goats	Horses
11. Anaerobic Lagoons	0%	0%	0%	0%
12. Liquid Systems	0%	0%	0%	0%
13. Solid Storage and Dry Lot	14%	0%	0%	0%
14. Other a. Thermal Drying	0%	0%	0%	0%
14. Other b. Composting	0%	0%	0%	0%
14. Other c. Piling	0%	0%	0%	0%
14. Other d. Incineration	0%	0%	0%	0%
14. Other e. Liquid Composting	0%	0%	0%	0%
14. Other f. Purification	0%	0%	0%	0%
14. Other g. Daily Spread	16%	0%	0%	0%
14. Other h. Pasture, Range and Paddock	29%	83%	95%	95%
14. Other i. Used as Fuel	40%	0%	0%	0%
14. Other j. Other system	0%	17%	5%	5%

6.2.3. Camels and Llamas, Mules and Asses (4.B.5., 4.B.7.)

Japan reported “NO” in this section as these animals were not likely to be raised for agricultural purposes.

6.2.4. Other (4.B.10.)

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

6.3. Rice Cultivation (4.C.)

Methane is generated under anaerobic conditions by the action of microbes. Paddy fields provide favorable conditions for methane generation.

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) were calculated by taking the overall usage of organic fertilizers into account, since the actual measurements of emission factors per soil type for each type of organic fertilizer application existed.

The amount of methane generated per type of soil for each method of organic matter management was calculated by multiplying the area of intermittently flooded paddy fields by the “amount of methane generated per type of soil per unit area for each management method”, “percentage of the area of each type of soil”, and “percentage of each management method”.

Methane emission from intermittently flooded paddy fields (single aeration) (kg-CH_4)

= ∑ (Emission factor for organic matter management method *n* for soil type *m* [kg-CH_4/m^2] × Area of paddy fields [m^2] × Percentage of intermittently flooded paddy field × Percentage of soil type *m* × Percentage of organic matter management method *n*)

• *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 6-20 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 6-21 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*

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[2] *Revised 1996 IPCC Guidelines*, vol.2 Workbook, p4.18, Table 4.9

Table 6-22 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

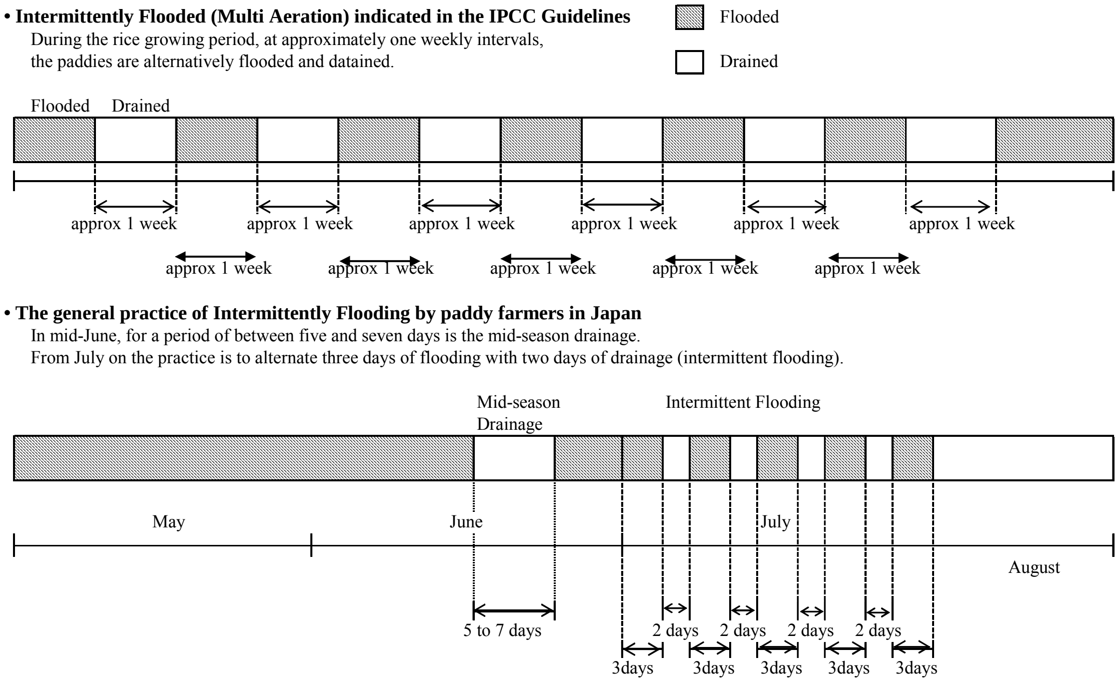
Table 6-23 Area of paddy fields

Item	Unit	1990	1995	2000	2003	2004	2005
Area of paddy field	kha	2,055	2,106	1,763	1,660	1,697	1,702

Source: *Statistics of Cultivated and Planted Area* (MAFF)

- ***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.



- **Intermittently Flooded (Multi Aeration) indicated in the IPCC Guidelines**

During the rice growing period, at approximately one weekly intervals, the paddies are alternatively flooded and datained.

- **The general practice of Intermittently Flooding by paddy farmers in Japan**

In mid-June, for a period of between five and seven days is the mid-season drainage.
From July on the practice is to alternate three days of flooding with two days of drainage (intermittent flooding).

Figure 6-3 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 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 6-24 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”.

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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

6.4. Agricultural Soils (4.D.)

6.4.1. Direct Soil Emissions (4.D.1.)

Application of synthetic fertilizers, organic fertilizers, or use of crop residues for soil amendment generates ammonium ions in the soil. The soil emits nitrous oxide in the process of oxidizing the ammonium ions into nitrate-nitrogen under aerobic conditions.

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”.

6.4.1.1. Synthetic Fertilizers (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-2006.xls¥S-Fertilizer(dry)* for details on the calculation process).

Nitrous oxide emissions associated with the application of synthetic fertilizer in agricultural soil (upland fields) (kg-N_2O)

= Emission factor [kg-N_2O-N/kg-N] × Amount of nitrogen contained in synthetic fertilizer applied in upland farming [kg-N] × 44/28

- ***Emission Factors***

Emission factors for nitrous oxide associated with the application of synthetic fertilizers to farmland soil (field lands) were established based on actual data measurement conducted in Japan. The emission factor is also used for organic Fertilizer

Table 6-25 N_2O emission factor for synthetic fertilizer to agricultural soil

Crop species	Emission Factor（kgN_2O-N/kgN）
Paddy rice	0.31 %
Tea	2.9 %
Other species	0.62 %

（Reference）Akiyama, H., Yagi, K., and Yan, X. (2006): Direct N2O emissions and estimate of N2O emission factors from Japanese agricultural soils. In program and Abstracts of the International Workshop on Monsoon Asia Agricultural Greenhouse Gas Emissions, March 7-9, 2006, Tsukuba, Japan, pp. 27.

Akiyama, H., Yagi, K., and Yan, X. (2006): Direct N2O emissions and estimate of N2O emission factors from agricultural soils in Japan: summary of available data. original paper under preparation.

• *Activity Data*

Activity data for nitrous oxide emission associated with the application of synthetic 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.

Activity data for N_2O emissions from the application of synthetic fertilizers to dry fields

Volume of nitrogen-based fertilizer applied to agricultural soil [t]
＝ Area for each type of crop [ha] × Volume of fertilizer per 10a of rice [kg/10a]

Table 6-26 Amount of synthetic fertilizers application per area by each type of crop (other than rice)

Type of crop	Amount of application [kg N/10a]
Vegetables	21.27
Fruit	14.70
Tea	48.50
Potatoes	12.70
Pulse	3.10
Feed crops	10.00
Sweet potato	6.20
Wheat	10.00
Buckwheat	4.12
Mulberries	16.20
Industrial crops	22.90
Tobacco	15.40

Table 6-27 Amount of synthetic fertilizers application per area (rice)

Item	Unit	1990	1995	2000	2003	2004	2005
Area of paddy field	kha	9.65	8.71	7.34	6.66	6.82	*6.82*

** Data for 2005 are substituted by data for 2004*

Table 6-28 Area of cropping by each type of crop

Item	Unit	1990	1995	2000	2003	2004	2005
Vegetables	ha	620,100	564,400	524,900	493,100	481,700	481,700
Rice	ha	2,055,000	2,106,000	1,763,000	1,660,000	1,697,000	1,702,000
Fruit*	ha	346,300	314,900	286,200	271,600	267,900	*267,900*
Tea	ha	58,500	53,700	50,400	49,500	49,100	48,700
Potatoes*	ha	115,800	104,400	94,600	88,300	87,200	*87,200*
Pulse*	ha	256,600	155,500	191,800	218,000	201,900	*201,900*
Feed crops	ha	1,096,000	1,013,000	1,026,000	1,072,000	1,047,000	1,030,000
Sweet potato	ha	60,600	49,400	43,400	39,700	40,300	40,800
Wheat	ha	366,400	210,200	236,600	275,800	272,400	268,300
Coarse cereal	ha	29,600	23,400	38,400	44,500	44,600	44,700
Mulberries*	ha	59,500	26,300	5,880	3,840	3,840	*3,840*
Industrial crops*	ha	142,900	124,500	116,300	113,000	112,300	*112,300*
Tobacco*	ha	30,000	26,400	24,000	22,500	21,500	*21,500*

** Data for 2005 are substituted by data for 2004*

data	references
Amount of synthetic fertilizers application per area by each type of crop (other than rice）	*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.*
Amount of synthetic fertilizers application per area (rice)	*Yearbook of Fertilizer Statistics (Pocket Edition)*
Area of cropping: Vegetables, rice, Fruit, Tea, Pulse, Feed crops, Sweet potato, Wheat, Buckwheat, Mulberries, Industrial crops	MAFF, *Statistics of Cultivated and Planted Area* Note: The values of “Vegetable” is excluded “Potatoes”, “Industrial crops” is excluded “Tea” and “Tobacco”
Area of cropping: Potatoes	MAFF, *Vegetable Production and Shipment Statistics*
Area of cropping: Tobacco	JT Survey

6.4.1.2. Organic Fertilizer (Application of Animal Waste) (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-2006.xls¥ AnimalWaste* for detail on the calculation process.)

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-N_2O-N）
＝Σ Type of crop ｛Emission factor by type of crop（kg-N_2O-N/kg-N）
×Volume of nitrogen applied, by type of crop（kg N)｝

- ***Emission Factors***

The same country specific emission factor used for synthetic fertilizer is used.

- ***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.

Volume of nitrogen applied, by type of crop（kg-N）
＝ Area of cultivated land by type of crop（ha）
×Volume of nitrogen applied per unit area, by type of crop（kg-N/10a）×10

Table 6-29 Amount of organic fertilizers application per area by each 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

Data	Source
Volume of nitrogen applied per unit area, by type of crop	*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.*

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.-)

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

Nitrous oxide emissions associated with the application of crop residues to agricultural soils were calculated by multiplying the default emissions factors given in the *Revised 1996 IPCC Guidelines* by the nitrogen input through the use of crop residues for soil amendment.

Nitrous oxide emission associated with the use of crop residues for soil amendment (kgN_2O)

= Default emission factor [kg-N_2O-N/kg-N] × Nitrogen input through the use of crop residues for soil amendment [kg-N]

- ***Emission Factors***

The default emission factor, 0.0125 [kg-N_2O-N/kg-N], shown in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidelines (2000)* was used.

• *Activity Data*

[Crops other than rye and oats (for grain)]

The estimated amount of nitrogen contained in crop residues used for soil amendment was calculated by multiplying a value (which was obtained from multiplying Japan's country-specific "nitrogen content of non-harvest aboveground portion" of a crop (unit: kg/10 a) by the cultivated area for each crop) by the percentage of crop residue less the percentage burned in the field (0.1, the default value in the *Revised 1996 IPCC Guidelines*).

Wherever any crop has no available data with respect to nitrogen content of the non-harvest aboveground portion, the value for a similar type of crop was used. Furthermore, the same values were adopted for all fiscal years. For crops cultivated for use as animal feed and fertilizers, the area used for fodder was excluded. On the assumption that field burning is not practiced in Japan, crops which were not included in the calculation for the Field Burning of Crop Residues (4.F) category were excluded from the multiplication by the "percentage less the percentage burned in field."

Amount of nitrogen in crop residue plowed into soil (kg-N) (other than rye and oats)

= $\sum_{crop}$ {Nitrogen content of non-harvest aboveground portion [kg/10 a] × Cultivated area per crop [ha] × (1 – Percentage burned in field)}

Data	Source
Nitrogen content of non-harvest aboveground portion by crop	*New Trends in Technology for Efficient Use of Nutrients – Nutritional Balance of Crops in Japan* (Owa, 1996; 1996 Sixth Kanto-Tokai Agricultural Study Session on Soil Management Technologies for Agricultural Production in Harmony with Environment; National Agriculture and Bio-oriented Research Organization)
Percentage burned in field	*Revised 1996 IPCC Guidelines*
Cultivated area of vegetables	*Vegetable Production and Shipment Statistics* (MAFF)
Cultivated area of crops other than vegetables	*Crop Statistics* (MAFF)

[Rye and oats (for grain)]

In accordance with the default technique described in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guide (2000)*, the amount of nitrogen applied to soil by plowing in crop residues was determined by multiplying the annual production of each type of crop by the default value of each of the percentage of residues in the production of each crop, the average percentage of dry matter in the residues, the percentage less the percentage burned in the field, and the nitrogen content in the residues.

Nitrogen plowed into soil with crop residues (kg-N) (rye and oats)

= (Annual crop yeild) × (Proportion of residue to crop yield) × (Average proportion of dry matter in crop residue) × (1 – Proportion burned in field) × Nitrogen content

The production volumes of rye and oats were calculated by multiplying the planted area by the yield per unit area. The planted area was divided into the area used for grain, for green crops and for others. However, the available statistics were not reported the category of rye for grain, (the survey has been discontinued since 1992 production) and therefore the value of the "total planted area" less the "area planted for green crops" taken from the available statistics was used as the area cultivated for grain expediently, even though the planted area in this report covers the planting for grain only.

Table 6-30 Planted areas of rye and oats

Item	Unit	1990	1995	2000	2003	2004	2005
Rye	ha	4,580	3,340	4,120	3,850	3,820	3,500
Oat	ha	31,300	40,200	54,000	59,200	58,200	58,900

Source: *Statistics of Cultivated and Planted Area* (MAFF)

Table 6-31 Yields of rye and oats per unit area

Crop	Yield per unit area	Note
Rye	424 [kg/10 a]	Data determined by specialists based on the results of rye cultivation tests in Japan
Oats	223 [kg/10 a]	Data available only up to FY 1994. The 1994 figures were used for all fiscal years prior to 1994 since the data were available for major prefectures only for these years.

Table 6-32 Proportion of residue to crop production, average proportion of dry matter in crop residues, nitrogen content

Crop	Proportion of residue	Average proportion of dry matter in residue	Nitrogen content	Proportion burned in field
Rye	2.84	0.90	0.0048	0.10
Oats	2.23	0.92	0.0070	0.10
Source	Determined by specialists	*Good Practice Guidelines (2000),* p. 4.58, Table 4.16		*Revised 1996 Guidelines,* Vol. 3, p. 4.83

6.4.1.5. Plowing of Organic Soil (4.D.1.-)

Nitrous oxide is generated when organic soil containing nitrogen is plowed. Two types of organic soil are said to exist in Japan: Muck soil and peat soil.

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

Emissions of nitrous oxide from the plowing of organic soil were calculated by multiplying the area of the plowed organic soil by the default emission factor in accordance with the *Revised 1996 IPCC Guidelines* and the *Good Practice Guide (2000)*.

<u>*Nitrous oxide emission associated with the plowing of organic soil (kg-N_2O)*</u>
= Emission factor for plowing of organic soil [kg-N_2O/ha/year] × Area of plowed organic soil [ha]

- ***Emission Factors***

The default values for the temperate region (8 kg-N_2O-N/ha/year) shown in the *Good Practice Guide (2000)* was used. (See *Good Practice Guide (2000)*, p. 4.60, Table 4.17)

- ***Activity Data***

The area of plowed organic soil was established by multiplying the cultivated areas of paddy fields and common upland fields, obtained from the *Statistics of Cultivated and Planted Area* (MAFF), by the percentage of organic soils (peat soil and muck soil) in paddy fields and common upland fields in Japan.

Table 6-33 Percentage of organic soil

	Percentage of organic soil	Data Source
Paddy fields	6.4%	Average of values in the *Yearbook of Fertilizer Statistics* (Pocket edition; Association of Agricultural and Forestry Statistics) and the *Basic Survey of Ground Strength* (1959 – 1978; MAFF).
Common upland fields	1.9%	

Table 6-34 Areas of organic soil

Item	Unit	1990	1995	2000	2003	2004	2005
Area of organic soil (paddy field	ha	182,144	175,680	169,024	165,888	164,800	163,584
Area of organic soil (field)	ha	206,369	198,955	191,596	188,080	187,011	185,871

6.4.2. Pasture, Range and Paddock Manure (4.D.2.)

Methane and nitrous oxide emissions from Pasture, Range and Paddock Manure (4.D.2.) are reported under Manure Management category (4.B.2.), and, therefore, it was reported as “IE”.

6.4.3. Indirect Emissions (4.D.3.)

6.4.3.1. Atmospheric Deposition (4.D.3.-)

Nitrogen compounds such as ammonia, that volatilize and are released into the atmosphere from synthetic fertilizers applied to agricultural soils and organic material derived from livestock manure are deposited on soil as the results of various actions, including turbulent diffusion, molecular diffusion, effect of electrostatic forces, chemical reactions, plant respiration, and being washed put of the air by rain. In this section, the amount of nitrous oxide generated by microbe activity on the deposited nitrogen compounds was calculated.

- ***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-2006.xls¥AtmosphericDeposition* for detail on the calculation process.)

Calculation of nitrous oxide emissions associated with atmospheric deposition

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]

• *Emission Factors*

The default value given in the *Revised 1996 IPCC Guidelines* has been used as the emission factor for this source.

Table 6-35 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*

The amounts of nitrogen (kg) contained in ammonia and nitrogen oxides that volatilize from synthetic fertilizers applied to agricultural soil and livestock manure were calculated for activity data. For the amount of manure-derived nitrogen applied to agricultural soil, the portion of nitrogen content in the livestock manure in Japan which was returned to agricultural soil, calculated in the *4.B. Manure Management* section, was used to maintain consistency in the nitrogen cycle. Also, the portion of human waste which was returned to agricultural soil as fertilizer was added to the activity data reported in this section.

$$A = N_{FERT} * Frac_{GASF} + N_{ANI}$$
$$= N_{FERT} * Frac_{GASF} + \{N_B + (N_D + N_{FU}) * Frac_{GASM})\}$$

A:	Amount of nitrogen that volatilizes as ammonia and nitrogen oxides from synthetic fertilizers, livestock manure, and human waste (kg-NH_3-N+NO_x-N)
N_{FERT}:	Demand for synthetic nitrogen fertilizers (kg-N)
$Frac_{GASF}$:	Percentage of volatilization as ammonia and nitrogen oxides from synthetic fertilizers (kg-NH_3-N + NO_X-N/kg-N)
N_{ANI}:	Amount of nitrogen that volatilizes as ammonia and nitrogen oxides from livestock manure and human waste (kg-NH_3-N + NO_X-N/kg-N)
N_B:	Amount of nitrogen that volatilizes as ammonia and nitrogen oxides from livestock manure during treatment

	($kg\text{-}NH_3\text{-}N + NO_X\text{-}N/kg\text{-}N$)
N_D:	Amount of manure-derived fertilizer applied to agricultural soil (kg-N)
N_{FU}:	Amount of human waste-derived fertilizer applied to agricultural soil (kg-N)
$Frac_{GASM}$:	Percentage of volatilization as ammonia and nitrogen oxides from nitrogen contained in livestock manure and human waste ($kg\text{-}NH_3\text{-}N + NO_X\text{-}N/kg\text{-}N$)

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 6-36 $Frac_{GASF}$: 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

○ Livestock manure and human waste

Activity data for nitrous oxide emissions associated with atmospheric deposition occured by livestock manure applied to farmland was calculated by multiplying the values determined in the *Manure Management (4B)* section (excluding the amount dispersed in the atmosphere as nitrous oxide as well as the amount treated by the “Incineration” or “Purification” in the *Manure Management (4B)* less the portion not applied to agricultural soils as fertilizer) by the default value for the “$Frac_{GASM}$: fraction of livestock nitrogen excretion that volatilizes as NH_3 and NO_X (Table 6-15).

The activity data derived by human waste was defined by the product of the amount of human waste-derived nitrogen calculated with 「日本の廃棄物処理」and $Frac_{GASM}$.

The amount of nitrogen that eventually converted to NH_3 and NO_2 and volatilized in the process of treating livestock manure was defined by the product of the amount of manure excreted by cattle in a shed and barn and by pastured cattle, and the figures indicated in Table 6-15.

Table 6-37 $Frac_{GASM}$: 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

Table 6-38 Nitrogen returned to agricultural soil

Item	Unit	1990	1995	2000	2003	2004	2005
N applied to agriclutural soil from livestock waste	tN	537,678	507,943	481,244	463,898	459,159	458,797
N applied to agriclutural soil from human waste	tN	10,394	4,734	2,121	1,330	1,334	1,330

6.4.3.2. Nitrogen Leaching and Run-off (4.D.3.-)

Nitrous oxide is generated by the action of microbes on nitrogen that leaches or runs off as nitrate from synthetic fertilizers and manure-derived materials applied to agricultural soil.

• *Methodology for Estimating Emissions of GHGs*

Nitrous oxide emissions associated with leaching and run-off of nitrogen were calculated according to the Decision Tree in the *Good Practice Guide (2000)* (Page 4.69, Fig. 4.8), by multiplying Japan's country-specific emission factors by the amount of nitrogen that leached or ran off.

Nitrous oxide emission associated with nitrogen that leached or ran off (kg-N_2O)

= Emission factor associated with nitrogen leaching and runoff [kg-N_2O-N/kg-N] × Nitrogen that leached or ran off [kg-N]

• *Emission Factors*

The nitrous oxide emission from this source was calculated using the Japan-specific emission factor that had been established by various studies. The same value was used for the nitrous oxide emission factor for nitrogen leaching and run-off for all of the fiscal years covered in the report.

Table 6-39 Emission factor for N_2O emissions associated with nitrogen leaching and run-off

	Emission factor [kg-N_2O-N/kg-N]
Nitrous oxide emission from nitrogen that leaches or runs off	0.0124

Source: Geophysical Research Letters Vol. 32 "Evaluation of emission factors for indirect N2O emission due to nitrogen leaching in agro－ecosystems" Takuji Sawamoto, Yasuhiro Nakajima, Masahiro Kasuya, Haruo Tsuruta and Kazuyuki Yagi

• *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 applied to agricultural soil and synthetic fertilizer derived from atmospheric deposition.

Table 6-40 $Frac_{LEACH}$: 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”.

6.4.4. Other (4.D.4)

Because it is not likely that agricultural sources of methane and nitrous oxide emissions exist in Japan other than the direct soil emissions, and indirect emissions, these sources were reported as “NO” as was the case in previous years.

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.)

Incomplete burning of crop residues in field releases methane and nitrous oxide into the atmosphere. Methane and nitrous oxide emissions from this source are calculated and reported in Category 4.F.

6.6.1. Rice, Wheat, Barley, Rye, and Oats (4.F.1.)

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

Methane and nitrous oxide emissions from field burning of crop residues of rice, wheat, barley, rye, and oats were calculated, using the default technique indicated in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guide (2000)*, by multiplying the amounts of carbon and nitrogen released by field burning by the methane emission rate and nitrous oxide emission rate, respectively.

Wheat, barley, rye, and oats were cultivated either as grain or green crops. The portions of the green crops which were cultivated for use of the entire aboveground mass for cattle feed were excluded from the calculation of emissions.

Methane emission associated with field burning of agricultural residues

= Methane emission rate × Total carbon released × 16/12

<u>*Nitrous oxide emission associated with field burning of agricultural residues*</u>
= Nitrous oxide emission rate × total nitrogen released × 44/28

• *Emission Factors*

The default values shown in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guide (2000)* were used.

Table 6-41 Emission factors for methane and nitrous oxide emissions associated with field burning of rice, wheat, and barley residues

	Value	Unit
CH_4	0.005	[kg CH_4/kg C]
N_2O	0.007	[kg N_2O/kg N]

Source: Revised IPCC Guidelines Vol.2 Table 4-16

• *Activity Data*

Activity data was calculated in accordance with the default technique shown in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guide (2000)*, using the following formula:

<u>*Total carbon/total nitrogen released by field burning of agricultural residues*</u>
= (Annual crop yield) × (Proportion of residue to crop yield) × (Proportion of dry matter in residue) × (Proportion burned in field) × (Oxidation rate) × (Carbon/nitrogen content of residues)

○ Annual crop yield

[Rice, wheat (grain), and barley (grain)]

The values reported in the *Crop Statistics* were used for the yield of rice, wheat, and barley (grain).

[Wheat and barley (green crops)]

Because data of the yields of green crop wheat and barley (excluding those for fodder) were not directly available, the annual yields were calculated by multiplying the area planted with wheat for green crops and other purposes, as shown in the *Statistics of Cultivated and Planted Area*, by the yield per unit area established for green crop rye and oats (excluding those for fodder).

[Rye and oats]

Because data of the yields of rye and oats were not directly available, the total annual yields were calculated by multiplying the area planted with rye or oats, as indicated based on the *Statistics of Cultivated and Planted Area*, by the yield per unit area and proportionally divided by the yield of wheat and barley (grain).

Table 6-42 Yield of rye and oats per unit area

Crop	Yield per unit area	Data Source
Rye	424	Determined by specialists (based on rye crop tests in Japan)
Oats	223	MAFF, *Statistics of Cultivated and Planted Area*
Rye and Oats (for green crops)	1,100	Determined by specialists (based on literature)

○ Proportions of residues to crop yield and dry matter in residue, carbon content, proportion burned in field, and oxidation rate. Table 6-43 shows the parameters for each crop.

Table 6-43 Proportions of residue to crop yield and dry matter in residue, carbon content, proportion burned in field, and oxidation rate

Crop	Proportion of residue[a]	Proportion of dry matter in residue[a]	Carbon content[a]	Proportion burned in field[b]	Oxidation rate[b]
Rice	1.4	0.85	0.4144	0.10	0.90
Wheat (grain)	1.3	0.85	0.4853	0.10	0.90
Barley (grain)	1.2	0.85	0.4567	0.10	0.90
Wheat/barley (green crop)	---	0.17[c]	0.48[d]	0.10	0.90
Rye	2.84[e]	0.90[c]	0.4710[f]	0.10	0.90
Oats	2.23[e]	0.92[c]	0.4710[f]	0.10	0.90
Rye/oats (green crop)	---	0.17[c]	0.4710[f]	0.10	0.90

a) *Good Practice Guide (2000)*, p. 4.58, Table 4.16

b) *Revised 1996 IPCC Guidelines,* Vol. 3, p. 4.83

c) Determined based on the percentage of dry matter in green crop wheat indicated in the *Standard Table of Feed Composition in Japan* (National Agriculture Research Organization, pub. by Japan Livestock Association)

d) Determined based on the values shown in the *Good Practice Guide (2000)* for wheat (grain) and barley (grain) by apportioning for yields

e) Determined based on the results of crop tests for rye and oats in Japan

f) Used the average of the values shown for “wheat” and “barley” in the *Good Practice Guide (2000).*

○ Nitrogen content

The specific nitrogen content value was determined for each of rice, wheat, barley, and oats (green crop), based on the results of various studies carried out in Japan. The nitrogen content of green crop wheat/barley was calculated using the average of nitrogen contents in wheat and barley weighted by yield. The default nitrogen content values in the *Good Practice Guide (2000)* were used for rye and oats (grain). The nitrogen content for rye (green crop) was calculated by multiplying Japan’s country-specific value for oats (green crop) by the value resulting from “rye (grain) / oats (grain)”. For other wheat (grain), the value shown in *Revised 1996 IPCC Guidelines* was used.

Table 6-44 Nitrogen content

Rice	Wheat (grain crop)	Barley[a)] (grain crop)	Wheat/barley (green crop)[a)]	Rye (grain crop)	Rye (green crop)	Oats (grain crop)	Oats (green crop)
0.0068[b]	0.0045[b]	0.016[b]	0.016	0.0048	0.0116	0.007	0.0169[b]

a) Values change over the years

b) *New Trends in Technology for Efficient Use of Nutrients – Nutritional Balance of Crops in Japan* (Owa, 1996, the 1996 Sixth Kanto-Tokai Agricultural Study Session on Soil Management Technologies for Agricultural Production in Harmony with Environment, National Agriculture and Bio-oriented Research Organization)

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*

Methane and nitrous oxide emissions from field burning of crop residues of corn, peas, soy, adzuki beans, kidney beans, peanuts, potatoes and other root crops (sugarbeets), and sugar cane were calculated in accordance with the relevant Decision Tree in the *Good Practice Guide (2000)* (page 4.52, Fig. 4.6), by multiplying the total carbon released, as calculated by the default technique, by the default methane emission rate and nitrous oxide emission rate, respectively.

• *Emission Factors*

Emission factors similar to field burning of rice, wheat, and barley residues were used (See Table 6-41).

• *Activity Data*

Activity data was calculated by multiplying the yield of each crop shown in the *Crop Statistics* and the *Vegetable Production and Shipment Statistics* published by MAFF by the parameters shown in the calculation formula.

Table 6-45 Proportions of residues, dry matter, carbon, and nitrogen relative to crop yield

Crop	Proportion of residues	Proportion of dry matter	Carbon content	Nitrogen content[b]
Corn	1.0	0.86	0.4709	0.0164
Peas	1.5	0.87	0.45[a]	0.0159
Soy	2.1	0.89	0.45[a]	0.0065
Adzuki beans	2.1	0.89	0.45[a]	0.0084
Kidney beans	2.1	0.89	0.45[a]	0.00745
Peanuts	1.0	0.86	0.45[a]	0.00745
Potatoes	0.4	0.6[c]	0.4226	0.0242
Sugarbeets	0.2	0.2	0.4072	0.0192
Sugar cane	1.62	0.83[c]	0.4235	0.0423

Source: *Good Practice Guide (2000)*, p. 4.58, Table 4.16

a. In the absence of default values, the values for dicotyledonous and monocotyledonous plants were used. Murayama, N., et al., *Alimentation of Crops and Fertilizer*, Buneido, p. 26 (Bowen: Trace Elements in Biochemistry, 1966)

b. *New Trends in Technology for Efficient Use of Nutrients – Nutritional Balance of Crops in Japan* (Owa, 1996, the 1996 Sixth Kanto-Tokai Agricultural Study Session on Soil Management Technologies for Agricultural Production in Harmony with Environment, National Agriculture and Bio-oriented Research Organization)

c: *Revised 1996 IPCC Guidelines*, Vol. 2, Table 4-15

d: Although default values are not available, the median value of the values indicated in the *Revised 1996 IPCC Guidelines*, Vol. 2, p. 4.30 (0.001 – 0.02) were used.

Table 6-46 Default values of proportion burned in field and oxidation rate

	Value	Unit
Proportion burned in field	0.10	—
Oxidation rate	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, Land-Use Change and Forestry (CRF sector5)

7.1. Method of determining land use categories

7.1.1. Basic approach

- Land is classified according to the definitions in existing statistics. Subcategories are determined independently for Forest land and Cropland (Forest land: intensively managed forests / semi-natural forests / cut-over forests and lesser stocked forests / bamboo; Cropland: rice fields / crop fields / orchard).
- In accordance with Approach 1, "Land remaining Land" and "Land converted to Land" in each land use category are determined from existing statistics. When partial areas cannot be directly determined from statistics, these are estimated proportionately or by other means.
- The area of "Other land" which does not belong to any of the other five land use categories, is determined by taking the difference between the total area of national land and the total area belonging to the five land use categories.

7.1.2. Method of determining land use categories and areas

Table 7-1 shows the method of determining land use categories and areas in Japan by means of existing statistics.

Table 7-1 Method of determining land use categories and areas

Land use category	Method of determining land use category	Method of determining area
Forest	Forests under Forest Law Article 5 and 7.2.	Intensively managed forests, semi-natural forests, cut-over forests, lesser stocked forests and bamboo according to *Handbook of Forestry Statistics* by the Forestry Agency, excluding non- planted forests.
Cropland	Rice fields, crop fields and orchard.	Rice fields, crop fields and orchard according to *Statistics of Cultivated and Planted Area* by the Ministry of Agriculture, Forestry and Fisheries.
Grassland	Pasture land and grazed meadow land.	Pasture land according to *Statistics of Cultivated and Planted Area* by the Ministry of Agriculture, Forestry and Fisheries, and grazed meadow land according to *World Census of Agriculture and Forestry*, also by the Ministry of Agriculture, Forestry and Fisheries.
Wetlands	Bodies of water (such as dams), rivers, and waterways.	Bodies of water, rivers, and waterways according to *Land Use Status Survey* by the Ministry of Land, Infrastructure and Transport.
Settlements	Urban areas that do not constitute Forest land, Cropland, Grassland or Wetlands. Urban green areas are all wooded and planted areas that do not constitute Forest land.	Roads and residential land identified in *Land Use Status Survey* by the Ministry of Land, Infrastructure and Transport. The included figure for urban green areas is taken from *Urban Parks Status Survey*, also by the Ministry of Land, Infrastructure and Transport.
Other land	Any land that does not belong to the above land use categories.	Determined by subtracting the total area belonging to the other land use categories from the total area of national land according to *Land Use Status Survey* by the Ministry of Land, Infrastructure and Transport.

7.1.3. Survey method and due date of major land area statistics

Survey method and due date of major land area statistics are as below;

Table 7-2 survey method and due date of major land area statistics

Name of the statistics / census	Survey method	Survey due date	Frequency	Presiding ministry
Handbook of Forestry Statistics (Forest Status Survey)	Complete count survey	March, 31th	Approximately5 years	Ministry of Agriculture, Forestry and Fisheries of Japan, （Forestry Agency）
Statistics of Cultivated and Planted Area (Survey of cropland area)	Cropland area: Ground measurement survey (sample) Tabular survey (using documents from relevant agency and aerial photograph, etc.)	Cropland area: - July, 15th expansion area and converted area of cropland - July, 15th in the previous year - July, 14th	Every year	Ministry of Agriculture, Forestry and Fisheries of Japan,
World Census of Agriculture and Forestry (Survey of Forestry regions)	Complete count survey	August, 1st	Every year	Ministry of Agriculture, Forestry and Fisheries of Japan,
Land Use Status Survey	Complete count survey	March, 31th	Every Year	Ministry of Land, Infrastructure and Transport
Urban Parks Status Survey	Complete count survey	March, 31th	Every year	Ministry of Land, Infrastructure and Transport

7.2. Forest land (5.A.)

7.2.1. Forest land remaining Forest land (5.A.1.)

7.2.1.1. Carbon stock change in living Biomass (5.A.1.1)

Carbon stock change in living biomass in Forest land remaining Forest land have been calculated, using method in accordance with the *LULUCF-GPG*.

$$\Delta C_{LB} = \Delta C_G - \Delta C_L$$

ΔC_{LB} : annual change in carbon stocks in living biomass (tC/yr)
ΔC_G : annual increase in carbon stocks due to biomass growth (tC/yr)
ΔC_L : annual decrease in carbon stocks due to biomass loss (tC/yr)

7.2.1.1.a. Carbon stock increase

- ***Methodology***

The carbon stock change due to tree growth is calculated separately 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), using the Tier 3 method in accordance with the decision tree in *LULUCF-GPG* (p. 3.18). The amounts of growth are determined by adding the above-ground biomass and below-ground biomass, using the biomass expansion factors. Biomass expansion factors and wood density, have been estimated for conifer and broadleaf. We have applied conifer for intensively managed forests and broadleaf for semi-natural forests based on major composition of trees.

$$\Delta C_G = \Sigma_j (A_j \times G_{TOTAL}) \times CF$$

$$\Delta G_{TOTAL} = G_{wj} \times (1 + R)$$

$$\Delta Cwj = Ivj \times Dj \times BEFgj$$

ΔC_G : annual increase in carbon stocks due to biomass growth (tC/yr)
A : area of forest land remaining forest land (ha)
j : forest type (Intensively Managed Forests: m, Semi-Natural Forests:s, Others:o)
G_{TOTAL} : average annual biomass increment above and belowground (t-dm/ha/yr)
CF : carbon fraction of dry matter (tC/t-dm)
G_w : average annual above-ground biomass increment (t-dm/ha/yr)
R : root-to-shoot ratio appropriate to increments, dimensionless
I_v : average annual net increment in volume suitable for industrial processing (m^3/ha/yr)
D : basic wood density (t-dm/m^3)
BEFg : biomass expansion factor for conversion of annual net increment to aboveground tree biomass increment, dimensionless

- ***P***

arameters

- Annual biomass growth rates

The annual biomass growth rates are calculated for each type of forest by multiplying the respective values for the wood density, biomass expansion factors and annual volume increment per hectare.

However, [biomass expansion factor for above-biomass * (1 + root-to-shoot ratio)] is assumed to be the biomass expansion factor, because data for some parameters do not exist in Japan.

Table 7-3 Annual biomass growth rates by forest type (dm = dry matter)

Item	Unit	1990	1991	1992	1993	1994	1995
Intensively Managed Forests (sugi cedar etc.)	[t-dm/ha]	5.03	4.96	4.96	4.96	4.96	4.96
Semi-Natural Forests (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

Source: Forestry Agency

Table 7-4 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

Source: Forestry Agency

Table 7-5 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 7-6 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 *Handbook of Forestry Statistics*

-Carbon fraction of dry matter

The default value given in the *LULUCF-GPG* has been adopted as the carbon fraction of dry matter.

Carbon fraction of dry matter
0.5

Source: *LULUCF-GPG, Page 3.25*

• *Activity Data*

- Determining the total forest area

Forest areas and cumulative volumes are the sum of intensively managed forests, semi-natural forests, cut-over forests and lesser stocked forests and bamboo, excluding non-planted forests. Areas for planted forest in 1990 and 1995 are estimated by multiplying the forest area as defined in the Forest Law Article 2 by its respective ratio area of planted forest according to Forest Law Article 2 obtained from the Survey on Current Status of Forest Resources in 2002. In addition, data for 1991 through 1994 are estimated by interpolation.

Table 7-7 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: Intensively Managed 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	–

- Segregation of “Forest land remaining Forest land” and “Land converted to Forest land”

Forest land remaining Forest land is defined as forest area that has not been converted during the past 20 years, in accordance with *LULUCF-GPG*. The proportion of land that was unconverted over 20 years is determined by adding the annual proportions of land areas that were not converted from forest to other uses in each of the past 20 years, and the corresponding area in each year is estimated by multiplying this proportion by the area of forest land 20 years earlier.

“Land converted to Forest land” is determined by subtracting the unconverted forest area from the total forest area in each year. All of the land that was converted to forest land is assumed to be intensively managed forests.

Table7-8 Forest area of Forest land remaining Forest land

		unit	1990	1991	1992	1993	1994
Forest land remaining Forest land		kha	24,504	24,512	24,519	24,532	24,548
	Intensive managed forest	kha	9,834	9,869	9,902	9,942	9,985
	Seminatural forest	kha	13,357	13,329	13,301	13,273	13,245
	Cut-over forest and lesser stocked fore	kha	1,165	1,166	1,167	1,168	1,168
	Bamboo	kha	148	149	149	149	149

7.2.1.1.b. Carbon stock decrease

1) Carbon stock change due to commercial fellings, Shiitake mushurooms cultivation and fuelwood gathering

- ***Methodology***

The carbon stock decrease due to commercial fellings, Shiitake mushurooms cultivation and fuelwood gathering is calculated separately for lumber (softwood and hardwood), logs for shiitake mushrooms and fuelwood, using the computation method given in *LULUCF-GPG*. The Tier 3 method is used because it is possible to estimate the logging volumes, timber densities and biomass expansion factors for Japan's own softwood and hardwood forests.

$$L_{fellings} = FG \times D \times BEF \times CF$$

$L_{fellings}$	: annual carbon loss due to commercial fellings (tC/yr)
FG	: annual volume of fuelwood gathering (m^3/yr)
D	: basic wood density (t-dm/m^3)
BEF	: biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass
CF	: carbon fraction of dry matter (tC/t-dm)

- ***Parameters***

- Wood density and biomass expansion factors

The biomass stock changes due to commercial fellings are calculated by multiplying the wood density and biomass expansion factors determined for softwood or hardwood forests. The values for intensively managed forest are applied for softwood, while the values for semi-natural forest are applied for hardwood, logs for Shiitake mushrooms and fuelwood.

Table 7-9 Wood density and biomass expansion factors used in estimating carbon stock decrease

Type		Wood density [t-dm/m^3]	Biomass expansion factor	Note
lumber	hardwood	0.4	1.7	Use values for intensively managed forest
	softwood	0.6	1.9	Use values for semi-natural forest
logs for Shiitake mushrooms		0.6	1.9	Use values for semi-natural forest
fuelwood		0.6	1.9	Use values for semi-natural forest

Source: Forestry Agency

-Carbon fraction of dry matter

The default value given in the *LULUCF-GPG* has been adopted as the carbon fraction of dry matter.

Carbon fraction of dry matter
0.5

Source: *LULUCF-GPG, Page 3.25*

- ***Activity Data***

The timber supply volume stated in *Handbook of Forestry Statistics* is abated by the yield to determine activity data in cumulative carbon reduction resulting from timber cutting ,etc.

$$FG = H / ER$$

FG	: annual volume of fuelwood gathering (m^3/yr)
H	: annual extracted volume, roundwood (m^3/yr)
ER	: Yield (assumed to correspond to 79% of standing timber (interim value assumed by the Forestry Agency))

Table 7-10 Annual volume of fuelwood gathering.

	Unit	1990	1991	1992	1993	1994	1995
Conifer	$1000m^3$	24,746	24,097	23,924	23,762	24,165	22,870
Broadleaf	$1000m^3$	12,343	11,267	10,397	8,605	6,792	6,114
Shiitake mushrooms	$1000m^3$	1,978	1,801	1,739	1,597	1,501	1,335
Fuelwood	$1000m^3$	462	458	470	444	422	420

2) Carbon stock change due to fires

- ***Methodology***

The Tier 3 method given in *LULUCF-GPG* is used to determine the amount of loss due to fires. For national forest land and private forest land, carbon emissions are calculated from the fire damaged timber volume multiplied by wood density, biomass expansion factor and carbon fraction of dry matter.

$$L_{forestfires} = \Delta C_{fn} + \Delta C_{fp}$$

$L_{\text{forest fires}}$	: carbon emissions due to fires (tC/yr)
ΔC_{fn}	: carbon emissions due to national forest fires (tC/yr)
ΔC_{fP}	: carbon emissions due to private forest fires (tC/yr)

- National forest

$$\Delta C_{fn} = Vf_n \times D_n \times BEF_n \times CF$$

ΔC_{fn}	: carbon emissions due to national forest fires (tC/yr)
Vf_{fn}	: damaged timber volume due to fire in national forest (m^3)
D_n	: wood density for national forest (t-dm/m^3)
BEF_n	: biomass expansion factor for national forest
CF	: carbon fraction of dry matter (tC/t-dm)

➢ Private forest

$$\Delta C_{fP} = Vf_{p} \times D_{P} \times BEF_{P} \times CF$$

ΔC_{fp} : carbon emissions due to private forest fires (tC/yr)
Vf_p : damaged timber volume due to fire in private forest (m^3)
D_p : wood density for private forest (t-dm/m^3)
BEF_p : biomass expansion factor for private forest
CF : carbon fraction of dry matter (tC/t-dm)

• *Parameters*

The values for wood density and biomass expansion factors on national and private forest land are determined as weighted averages using the ratios of intensively managed forest and semi-natural forests.

Table 7-11 Wood density and biomass expansion factors for national and private forest

Type	Wood density [t-dm/m^3]	Biomass expansion factor
National forest	0.53	1.83
Private forest	0.51	1.81

Source: Based on Forestry Agency data

• *Activity Data*

Change in biomass due to fires is separately estimated for national forests and private forests respectively.

With regard to national forests, figures for area damaged annually due to fires and standing timbers damaged due to fires in national forests (area and timber volume) in *Handbook of Forestry Statistics* are used.

With regard to private forests, the activity data is damaged timber volume due to fires which is estimated by using from actual damaged area and damaged timber volume by age class. Damaged timber volume for age class equal to or under 4 is estimated by multiplying the cumulative volume of age class equal to or under 4 per area estimated by the *Survey on Current Status of Forest Resources* 2002 by loss ratio of age class equal to or over 5 in private forests (ratio of damaged timber volume to cumulative volume). The loss ratio is assumed to be constant regardless of age classes.

Table 7-12 Damaged timber volume due to fire in private forest

Age class		1990	1991	1992	1993	1994	1995
>=5	Actual damaged area (ha)	286	237	321	1,059	1,398	943
	Damaged timber volume (m^3)	47,390	24,191	26,348	139,672	123,107	58,129
<=4	Actual damaged area (ha)	271	343	191	735	527	506
	Damaged timber volume (m^3)	11,136	8,682	3,888	24,040	11,508	7,735
Total damaged timber volume (m^3)		58,526	32,873	30,236	163,712	134,615	65,864

Source: Based on Forestry Agency data

Table 7-13 Damaged timber volume due to fire.

	Unit	1990	1991	1992	1993	1994	1995
Damaged timber volume due to fire in national forests	m^3	3,688	13,154	2,931	18,709	3,348	1,014
Damaged timber volume due to fire in private forests	m^3	58,526	32,873	30,236	163,712	134,615	65,864

3) Carbon stock change due to other disturbance

- ***Methodology***

The Tier 3 method given in *LULUCF-GPG* is used to determine the amount of carbon emissions from damage due to disturbances other than fire. For national forest, carbon emissions are calculated from the volume of timber damaged by disturbances other than fire. For private forest, carbon emissions are calculated from the volume of timber damaged by disturbance other than fire and pine weevil .

$$L_{otherlosses} = \Delta C_n + \Delta C_p$$

$L_{\text{other losses}}$: carbon emission from damage due to disturbances other than fire (tC/yr)
ΔC_n : carbon emissions in national forest due to other disturbances (tC/yr)
ΔC_P : carbon emissions in private forest due to other disturbances (tC/yr)

- National forest

$$\Delta C_n = Vf_{dn} \times D_n \times BEF_n \times CF$$

ΔC_n : carbon emissions in national forest due to disturbances other than fire (tC/yr)
Vf_{dn} : damaged timber volume due to disturbances in national forest (m^3)
D_n : wood density for national forest (t-dm/m^3)
BEF_n : biomass expansion factor for national forest
CF : carbon fraction of dry matter (tC/t-dm)

- Private forest

$$\Delta C_P = Vf_{dp} \times D_P \times BEF_P \times CF$$

ΔC_p : carbon emissions in private forest due to disturbances other than fire (tC/yr)
Vf_{dp} : damaged timber volume due to disturbances in private forest (m^3)
D_p : wood density for private forest (t-dm/m^3)
BEF_p : biomass expansion factor for private forest
CF : carbon fraction of dry matter (tC/t-dm)

- ***Parameters***

The values used for average timber volume, wood density and biomass expansion factors on national and private forest are the same as those indicated in “ 2) Carbon stock change due to fires", which describes changes in biomass due to fire.

• *Activity Data*

With regard to national forests, annual figures of damaged timber volume for standing timbers due to disasters excluding natural forests damaged by fire given in Handbook of Forestry Statistics are used. For private forests, annual figures for damaged area in private forests due to meteorological disasters and figures for damaged area due to legal forest diseases and insect injuries in private forests in *Handbook of Forestry Statistics*. As damaged timber volume can not be identified directly except for the damage due to pine weevils, it is estimated by multiplying the average timber volume in private forests by the loss ratio calculated from the extent of damages in national forests.

- National forest

$$Vf_{dn} = Vf_n - Vf_{fn}$$

Vf_{dn} : damaged timber volume due to disturbances in national forest (m^3)
Vf_n : total damaged timber volume in national forest (m^3)
Vf_{fn} : damaged timber volume due to fire in national forest (m^3)

- Private forest

$$Vf_{dp} = A_{dp} \times B_p \times dr + Vf_{pp}$$

Vf_{dp} : damaged timber volume due to disturbances in private forest (m^3)
A_{dp} : area disturbanced in private forest (ha)
B_p : average timber volume of private forest
dr : loss ratio due to disturbances
Vf_{pp} : damaged timber volume due to pine weevil in private forest (m^3)

- Average timber volume of private forest

Average timber volume per 1 hectare is calculated by dividing the total timber volume by total area. Total area and timber volume are obtained by using *Handbook of Forestry Statistics* by the Forestry Agency. No updated figures were available for 1991 to 1994, so these data points are estimated by interpolation.

Table 7-14 Average timber volume for national and private forest

Type	Unit	1990	1991	1992	1993	1994	1995
National forest	m^3/ha	119.18	120.74	122.30	123.86	125.42	126.98
Private forest	m^3/ha	136.95	140.56	144.17	147.78	151.39	155.00

Source: Based on the Forestry Agency's *Handbook of Forestry Statistics*

Table 7-15 Damaged timber volume due to disturbances in national and private forest

	Unit	1990	1991	1992	1993	1994	1995
Damaged timber volume due to disturbances in national forest	1000m^3	87	604	205	220	117	116
Damaged timber volume due to disturbances in private forest	1000m^3	395	5,482	405	839	647	305
Damaged timber volume due to pine weevils in private forest	1000m^3	869	1,019	1,010	902	1,011	918

7.2.1.2. Dead Organic Matter (5.A.1.2)

- ***Methodology***

For dead wood, Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and net change is assumed as “0”, so it is reported as “NA”.

For litter, Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and net change is reported as “0”, so it is reported as “NA”.

7.2.1.3. Soil (5.A.1-)

7.2.1.3.a. Carbon stock change in mineral soils

- ***Methodology***

Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and carbon stock change is assumed constant, reported as “NA” because carbon stock data reflected the effects of forest type, management intensity and disturbance regime is not available.

7.2.1.3.b. Carbon stock change in organic soils

- ***Methodology***

Carbon stock change in organic soils is reported as “NA” because default value of drained soils area is not given in *LULUCF-GPG* and it is assumed that these soils are not found in Japan.

7.2.2. Land converted Forest land (5.A.2)

7.2.2.1. Carbon stock change in Living Biomass (5.A.2.-)

Carbon stock change in living biomass in Land converted to Forest land is calculated, using Tier 2 method in accordance with the *LULUCF-GPG*.

$$\Delta C_{LB} = \Delta C_G + \Delta C_C - \Delta C_L$$

ΔC_{LB} : carbon stock change in living biomass in land converted to Forest land (tC/yr)
ΔC_G : increase in carbon stocks due to biomass growth (tC/yr)
ΔC_C : change in carbon stocks due to land conversion (tC/yr)
ΔC_L : decrease in carbon stocks due to fellings, fuelwood gathering and disturbance (tC/yr)

7.2.2.1.a. Carbon stock change due to biomass growth

- ***Methodology***

Change in biomass is determined by multiplying the area which has been converted to forests within 20 years by the amount of growth in intensively managed forests.

$$\Delta C_G = A \times G_w \times CF$$

ΔC_G : carbon stock change due to biomass growth (tC/yr)
A : area which has been converted to forest (ha)
G_w : annual average growth ratio (t-dm/ha/yr)
CF : carbon fraction of dry matter (tC/t-dm)

- ***Parameters***

The annual biomass growth rates for softwood and hardwood trees are used, since the proportions of softwood and hardwood tree planting are unknown. The carbon fraction is set at 0.50.

Table 7-16 Annual biomass growth rate by forest type (dm = dry matter)

Item	Unit	1990	1991	1992	1993	1994	1995
Intensively Managed Forests (sugi cedar etc.)	[t-dm/ha]	5.03	4.96	4.96	4.96	4.96	4.96
Semi-Natural Forests (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

Source: Forestry Agency

- ***Activity Data***

As stated in 7.2.1.1.a., the total area of “Land converted to Forest land” is derived by taking the difference between the annual area of “Forest land remaining Forest land” (based on the total forest area according to *Handbook of Forestry Statistics* and the area of reduction in forests according to *World Census of Agriculture and Forestry 2000)* and the total forest area.

Table 7-17 Forest area of Land converted to Forest land

	unit	1990	1991	1992	1993	1994	1995
Land converted to Forest land	kha	453	432	413	387	359	326

7.2.2.1.b. Carbon stock change due to land conversion

- ***Methodology***

Carbon stock change due to land conversion has been calculated as below, using method in accordance with the *LULUCF-GPG*.

$$\Delta C_i = A_i \times (Ba - Bb, i) \times CF$$

ΔC_i : annual biomass change in land that has been converted from land use type *i* to forest (tC/yr)

A_i : annual land area that has been converted from land use type *i* to forest (ha/yr)

Ba : dry matter weight immediately following conversion to forest (t-dm/ha)

Bb,i : dry matter weight before land converted from land use type *i* to forest (t-dm/ha)

CF : carbon fraction of dry matter (tC/t-dm)

• *Parameters*

Carbon stock after and before conversion is set as below.

Table 7-18 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
After conversion	Forest		0.00	Assume that biomass stocks immediately after conversion are “0”.
Before conversion	Cropland	rice field	6.31	Use annual growth rate value given in Naoto Owa “*Nutrient Balance in Japan's Crops*”.
		crop field	3.30	Use annual growth rate value given in Naoto Owa “*Nutrient Balance in Japan's Crops*”.
		orchard	30.63	Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* “*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*”
	Grassland		2.7	*LULUCF-GPG* Table 3.4.2 warm temperate wet
	Wetlands, Settlements and Other land		0.0	Assume that biomass stocks are “0”.

• *Activity Data*

As stated in 7.2.1.1.a., the total area of “Land converted to Forest land” is derived by taking the difference between the annual area of “Forest land remaining Forest land” (based on the total forest area according to *Handbook of Forestry Statistics* and the area of reduction in forests according to *World Census of Agriculture and Forestry 2000*)and the total forest land area.

The area of Forest land converted from Cropland and Grassland is determined by using the area of formerly cultivated land which is planted in forests according to *Statistics of Cultivated and Planted Area*. In this reference, the area is only broken down into rice fields and other fields. Therefore, with regard to the area of fields other than rice fields which are planted in forests, the existing area ratios of crop fields, orchards, and pasture land are used to estimate the area of land converted to forests from each of these land uses.

The difference between the total area of Land converted to Forest land and the area converted from Cropland and Grassland to Forest land is considered to be the area converted from Wetlands, Settlements, and Other land, and this is recorded as a combined figure.

Table 7-19 Forest area of Land converted to Forest land

	unit	1990	1991	1992	1993	1994	1995
Land converted to Forest land	kha	453	432	413	387	359	326
Cropland converted to Forest land	kha	122	102	86	74	64	58
Ricefield	kha	54	45	36	31	27	24
Cropfield	kha	47	39	34	30	26	24
Orchard	kha	21	18	16	13	11	10
Grassland converted to Forest land	kha	17	16	15	13	12	11
Wetlands converted to Forest land	kha	IE	IE	IE	IE	IE	IE
Settlements converted to Forest land	kha	IE	IE	IE	IE	IE	IE
Other land converted to Forest land	kha	314	315	313	300	282	257

7.2.2.1.c. Carbon stock change due to fellings, fuelwood gathering and disturbance

Carbon stock change due to fellings, fuelwood gathering and disturbance have been included in “Forest land remaining Forest land”.

7.2.2.2. Carbon stock change in Dead Organic Matter (5.A.2.-)

- ***Methodology and the Results***

For dead wood, Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and carbon stock change has been reported as “0” , so it is reported as “NA”.

For litter, Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and carbon stock change has been reported as “0” , so it is reported as “NA”.

7.2.2.3. Carbon stock change in Soils (5.A.2.-)

7.2.2.3.a. Carbon stock change in mineral soils

- ***Methodology***

Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used because carbon stock data reflected the effects of forest type, management intensity and disturbance regime is not available.

$$\Delta C = (SOC_f - SOC_i)/T \times A(20)$$

ΔC : carbon stock change in mineral soils in land converted to forest (tC/yr)

SOC_f : carbon stocks in forest mineral soils per area (tC/ha)

SOC_i : carbon stocks in mineral soils before land converted from land use type *i* to forest per area (tC/ha)

A(20) : cumulative land area converted to forest for 20 years (ha)

T : transition duration

- ***Parameters***

Parameters used in estimation are as bellows. Soil organic carbon in forests is estimated using average soil carbon stocks for 0-30cm depth. Soil organic carbon in rice field, crop field, orchard and grassland are estimated using average soil carbon stocks which is estimated by observed value collected from various depth (from 5cm to 50cm). Because the forest soil depth taken as samples are not the same, Japan will consider using the appropriate depth for samples used in the cropland and grassland estimation. Soil organic carbon in other lands is applied to the value for volcanic soil given in *LULUCF-GPG*.

Table 7-20 Soil carbon stocks

Category	Values used	Note
Forest land	90 (tC/ha)	Value of soil carbon stocks for 0-30cm depth. Kazuhito Mosisada, Kenji Ono, Hidesato Kanomata “*Organic carbon stock in forest soil in Japan*” Geoderma 119 (2004) p.21-32
Rice field	1990~1993: 39.08 (tC/ha) 1994~2003: 43.19 (tC/ha)	Makoto Nakai, “Carbon accumulation in soils due to soil management” Association for Advancement of Agricultural Science “Survey on method for quantification of amount of GHG emission cuts (2000)” Note: Because forest soil and soil depth taken as samples are not the same, Japan will consider using the values interchangeably.
Crop field	1990~1993: 49.15 (tC/ha) 1994~2003: 51.83 (tC/ha)	
Orchard	1990~1993: 42.90 (tC/ha) 1994~2003: 55.15 (tC/ha)	
Cropland (average)	1990~1993: 43.71 (tC/ha) 1994~2003: 50.06 (tC/ha)	
Grassland	1990~1993: 44.70 (tC/ha) 1994~2003: 41.37 (tC/ha)	
Wetlands	88.0(tC/ha)	*LULUCF-GPG*, Page 3.76, table 3.3.3 warm temperate moist, wetland soil
Settlements	-	-
Other land	80.0(tC/ha)	*LULUCF-GPG*, Page 3.76, table 3.3.3 warm temperate moist, volcanic soils

- Transition duration

Default value (20 years) given in *LULUCF-GPG* is used. It is assumed that soil organic carbon before 20 years is same as values for 1990.

• *Activity Data*

The total converted area which is used to calculate biomass, along with the integrated values of the area converted to Forest land from rice fields, crop fields, orchards and Grassland, respectively, is considered to represent the area of land converted to forests over the past 20 years. The difference between the total converted area and the area converted from rice fields, crop fields, orchards, and Grasslands is considered to be the area converted from Wetlands, Settlements, and Other land (It is assumed that no land subject to new forest planting during the past 20 years has been converted to another use).

Table 7-21 Forest area of Land converted to Forest land

	unit	1990	1991	1992	1993	1994	1995
Land converted to Forest land	kha	453	432	413	387	359	326
Cropland converted to Forest land	kha	122	102	86	74	64	58
Ricefield	kha	54	45	36	31	27	24
Cropfield	kha	47	39	34	30	26	24
Orchard	kha	21	18	16	13	11	10
Grassland converted to Forest land	kha	17	16	15	13	12	11
Wetlands converted to Forest land	kha	IE	IE	IE	IE	IE	IE
Settlements converted to Forest land	kha	IE	IE	IE	IE	IE	IE
Other land converted to Forest land	kha	314	315	313	300	282	257

7.2.2.3.b. Carbon stock change in organic soils

- ***Methodology***

This sub-category is reported as “ NA” same as “Forest land remaining Forest land”. Because organic soils is not existed in Japan.

7.3. Cropland (5.B)

7.3.1. Cropland remaining cropland (5.B.1)

7.3.1.1. Carbon stock change in Living biomass (5.B.1.-)

- ***Methodology***

The amount of change in biomass in perennial tree crops (fruit trees) is subject to calculation under *LULUCF-GPG*. However, in Japan, tree growth is limited by trimming trees for low height and high production, and managed by pruning lateral branches and improving tree shape. Therefore, carbon accumulation due to growth is not anticipated, and the annual carbon fixing volume of perennial tree crops in all orchards is stated as “NA.”

7.3.1.2. Carbon stock change in Dead Organic matter (5.B.1.-)

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as “NE”.

7.3.1.3. Carbon stock change in Soils (5.B.1.-)

- ***Methodology***

According to Tier 1 method given in *LULUCF-GPG*, carbon stock change in soils is reported as “0” because it is assumed that soil carbon stocks do not change due to agricultural management system, so it is reported as “NA”.

7.3.2. Land converted to Cropland (5.B.2)

7.3.2.1. Carbon stock change in Living Biomass (5.B.2.-)

- ***Methodology***

According to *LULUCF-GPG* (page 3.84), only above-ground biomass is subject to calculation. The Tier 2 method is used for Forest land converted to Cropland. The Tier 1 method is used for other uses than Forest land converted to Cropland, using the provisional and default values for the amount of biomass accumulation.

$$\Delta C_i = A_i (CR_a - CR_{b,i}) \times CF$$

$$\Delta C \;= \Delta C_i + \Delta C_c$$

$$\Delta C_c = A_c \times CR_c \times CF$$

C : annual change in biomass in land converted to cropland (tC/yr）
i : land use (forest, grassland, wetland, settlement and other)
c : cropland converted from other land use
A : annual land area that has been converted (ha/yr）
CR_a : dry matter biomass weight immediately following conversion to cropland (t-dm/ha） ,default value=0
CR_b : dry matter biomass weight before land converted from lanu use type *i* to cropland (t-dm/ha）
CR_c : dry matter biomass weight accumulated after land converted to cropland (t-dm/ha）
CF : carbon fraction of dry matter (tC/t-dm）

- ***Parameters***

The following parameters are used to estimate changes in the biomass stock due to conversion and changes in stock due to biomass growth in converted land.

- Carbon ratio (CF)
  Source: 0.5 (default value stated in *LULUCF-GPG*)

- Biomass stock immediately after conversion
  Carbon stock after and before conversion is set as below.

Table 7-22 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
After immediately conversion	Clopland		0.00	Assume that biomass stocks immediately after conversion are "0".
Before conversion	Forest land		1990:112.65 1991:114.76 1992:116.88 1993:119.00 1994:121.12 1995:123.25	Calculated on the basis of "World Census of agriculture and Forestry" by the Ministry of Agriculture, Forestry and Fisheries, and "Handbook of Forestry Statistics" by the Forestry Agency.
	Grassland		2.7	*LULUCF-GPG* Table 3.4.2 warm temperate wet
	Wetlands, Settlements and Other land		0.0	Assume that biomass stocks are "0".
After conversion	Cropland	rice field	6.31	Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".
		crop field	3.30	Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".
		orchard	30.63	Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* "*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*"

- ***Activity Data***

For land that is converted to Cropland, the expansion area values stated in *Statistics of Cultivated and Planted Area* are used. Forest land that has been converted to Cropland is determined using *World Census of Agriculture and Forestry* and statistics based on Forestry Agency records. The respective converted areas are divided proportionately into rice fields, crop fields, orchards, and pasture land according to the current area ratios. The rice fields, crop fields, and orchards are allocated as Cropland, and the pasture land is allocated as Grassland.

Table 7-23 Area of Land converted to Cropland

	unit	1990	1991	1992	1993	1994	1995	1996
Land converted to Cropland	kha	8.8	6.6	6.2	6.3	8.3	5.6	2.8
Forest land converted to Cropland	kha	5.2	2.9	3.2	1.1	1.1	1.1	0.9
Grassland converted to Cropland	kha	0.002	0.002	0.052	0.081	0.116	0.022	0.020
Wetlands converted to Cropland	kha	0.337	0.020	0.081	0.018	0.035	0.032	0.004
Settlements converted to Cropland	kha	IE	IE	IE	IE	IE	IE	IE
Other land converted to Cropland	kha	3.3	3.7	2.9	5.0	7.1	4.5	1.9

	unit	1997	1998	1999	2000	2001	2002	2003	2004
Land converted to Cropland	kha	2.4	2.1	5.5	4.5	1.5	1.7	1.7	3.1
Forest land converted to Cropland	kha	0.6	0.8	0.7	0.4	0.3	0.2	0.3	0.3
Grassland converted to Cropland	kha	0.011	0.017	0.012	0.012	0.014	0.019	0.034	0.009
Wetlands converted to Cropland	kha	NO	0.008	NO	0.073	NO	NO	NO	NO
Settlements converted to Cropland	kha	IE	IE	IE	IE	IE	IE	IE	IE
Other land converted to Cropland	kha	1.8	1.3	4.8	4.0	1.2	1.4	1.4	2.8

7.3.2.2. Carbon stock change in Dead organic Matter (5.B.2.-)

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as “NE”.

7.3.2.3. Carbon stock change in Soils (5.B.2.-)

- ***Methodology***

The Tier 2 method is used in calculation. Japan is not considered to have any soil that constitutes organic soil under *LULUCF-GPG*, so all soil is calculated as mineral soil.

$$\Delta SC = (SC_c(t) - SC_o(t-20))/20 \times A$$

ΔSC : change in soil carbon stock in Land converted to Cropland (tC/yr)
$SC_C(t)$: soil carbon stocks per area at time (t) (tC/yr)
$SC_O(t-20)$: soil carbon stocks per area before (t-20) years (before conversion) (ha/yr)
A : area of Land converted to Cropland over past 20 years (ha)

- ***Parameters***

- Soil carbon stock (SC(t))

Data listed in Table 7-20 are applied. Soil carbon stocks before 20 years is applied values for 1990.

- ***Activity Data***

The area of land that was converted to Cropland during the past 20 years is determined by subtracting the estimated area that was not converted during the past 20 years from the total area of Cropland in those years. In addition, the values of converted area in each land use category during each of the past 20 years are added up to estimate the converted area over 20 years for each land use category.

Table 7-24 Area of Land converted to Cropland within 20 years

	unit	1990	1991	1992	1993	1994	1995	1996
Land converted to Cropland	kha	476	437	407	372	314	279	248
Forest land converted to Cropland	kha	174	167	159	151	127	119	109
Grassland converted to Cropland	kha	11	10	10	9	7	6	3
Wetlands converted to Cropland	kha	11	9	8	8	7	3	3
Settlements converted to Cropland	kha	IE	IE	IE	IE	IE	IE	IE
Other land converted to Cropland	kha	279	251	229	204	173	152	134

	unit	1997	1998	1999	2000	2001	2002	2003	2004
Land converted to Cropland	kha	220	194	176	156	139	127	114	104
Forest land converted to Cropland	kha	96	87	81	72	65	56	50	40
Grassland converted to Cropland	kha	1	1	1	1	1	1	1	1
Wetlands converted to Cropland	kha	2	2	2	2	2	1	1	1
Settlements converted to Cropland	kha	IE	IE	IE	IE	IE	IE	IE	IE
Other land converted to Cropland	kha	120	104	92	81	72	69	62	62

7.4. Grassland (5.C)

7.4.1. Grassland remaining grassland (5.C.1)

7.4.1.1.a. Carbon stock change in Living biomass (5.C.1.-)

- ***Methodology***

According to Tier 1, carbon stock change in living biomass is assumed constant and reported as "NA".

7.4.1.1.b. Carbon stock change in Dead Organic Matter (5.C.1.-)

- ***Methodology***

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as "NE".

7.4.1.1.c. Carbon stock change in Soils (5.C.1.-)

- ***Methodology***

According to Tier 1 method given in *LULUCF-GPG*, carbon stock change in soils is reported as "NA" because it is assumed that soil carbon stocks have not change due to management system during past 20 years.

7.4.2. Land converted to Grassland (5.C.2)

7.4.2.1. Carbon stock change in Living biomass (5.C.2.-)

- ***Methodology***

The Tier 2 method is used for Forest land and Cropland (rice fields) converted to pasture lands. The Tier 1 method is used for other uses than Forest land and Cropland (rice fields) converted to pasture lands.

$$\Delta C = \Delta C_i + \Delta C_g$$

$$\Delta C_i = A_i (CR_a - CR_{b,i}) \times CF$$

$$\Delta C_g = A_g \times CR_g \times CF$$

C	: annual change in biomass in land converted to grassland (tC/yr)
i	: land use (forest, cropland, wetland, settlement and other)
g	: grassland converted from other land use
A	: annual land area that has been converted (ha/yr)
CR_a	: dry matter biomass weight immediately following conversion to grassland (t-dm/ha), default value=0
CR_b	: dry matter biomass weight before land converted from land use type *i* to grassland (t-dm/ha)
CR_g	: dry matter biomass weight accumulated after land converted to grassland (t-dm/ha)
CF	: carbon fraction of dry matter (tC/t-dm)

- ***Parameters***

The following parameters are used to estimate changes in the biomass stock due to conversion and changes in stock due to biomass growth in converted land.

- Carbon ratio (CF)
  Source: 0.5 (default value stated in *LULUCF-GPG*)

- Biomass stock immediately after conversion
  Carbon stock after and before conversion is set as below.

Table 7-25 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
After immediately conversion	Grassland		0.00	Assume that biomass stocks immediately after conversion are "0".
Before conversion	Forest land		1990:112.65 1991:114.76 1992:116.88 1993:119.00 1994:121.12 1995:123.25	Calculated on the basis of "World Census of agriculture and Forestry" by the Ministry of Agriculture, Forestry and Fisheries, and "Handbook of Forestry Statistics" by the Forestry Agency.
	Cropland	rice field	6.31	Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".
		crop field	3.30	Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".
		orchard	30.63	Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* "*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*"
	Wetlands, Settlements and Other land		0.0	Assume that biomass stocks are "0".
After conversion	Grassland		2.7	*LULUCF-GPG* Table 3.4.2 warm temperate wet

- ***Activity Data***

The land that has been converted to pasture land is determined using the field expansion areas stated in *Statistics of Cultivated and Planted Area*. With regard to the land that has been converted from Forest land to Grassland, the area converted to Cropland (determined using *World Census of Agriculture and Forestry* and statistics based on Forestry Agency records) is divided proportionately into rice fields, crop fields, orchards and pasture land according to the area ratios, and the pasture land is allocated as Grassland.

Table 7-26 Area of Land converted to Grassland

	unit	1990	1991	1992	1993	1994	1995	1996
Land converted to Grassland	kha	4.1	3.0	2.9	2.5	2.1	2.0	1.6
Forest land converted to Grassland	kha	0.72	0.41	0.47	0.17	0.16	0.17	0.13
Cropland converted to Grassland	kha	0.9	0.9	0.8	0.6	0.5	0.6	0.6
Wetlands converted to Grassland	kha	0.127	0.008	0.032	0.007	0.014	0.010	0.001
Settlements converted to Grassland	kha	IE	IE	IE	IE	IE	IE	IE
Other land converted to Grassland	kha	2.3	1.7	1.6	1.7	1.3	1.2	0.8

	unit	1997	1998	1999	2000	2001	2002	2003	2004
Land converted to Grassland	kha	1.8	1.8	1.7	1.7	1.5	1.6	1.7	2.3
Forest land converted to Grassland	kha	0.10	0.12	0.11	0.06	0.04	0.04	0.05	0.04
Cropland converted to Grassland	kha	0.9	1.0	1.0	1.0	0.9	1.1	1.1	1.4
Wetlands converted to Grassland	kha	NO	0.004	NO	0.032	NO	NO	NO	NO
Settlements converted to Grassland	kha	IE	IE	IE	IE	IE	IE	IE	IE
Other land converted to Grassland	kha	0.8	0.6	0.6	0.7	0.5	0.5	0.5	0.8

7.4.2.2. Carbon stock change in Dead Organic Matter (5.C.2.-)

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as “NE”.

7.4.2.3. Carbon stock change in Carbon stock change in Soil (5.C.2.-)

- ***Methodology***

The Tier 2 computation method is used. Japan is not considered to have any soil that constitutes organic soil under *LULUCF-GPG*, so all soil is calculated as mineral soil.

$$\Delta SC = \left(SCc(t) - SCo(t-20)\right)/20 * A$$

ΔSC : change in soil carbon stock in Land converted to pasture land (tC/yr)
SCc(t) : soil carbon stocks per area at time (t) (tC/ha)
SCo(t-20) : soil carbon stocks per area before (t-20) years (before conversion) (tC/ha)
A : area of land converted to pasture land over past 20 years (ha)

- ***Parameters***

- Soil carbon content (Sc(t))

The soil carbon content stated in Table 7-20 is used. The 1990 values are used for the values of 20 years ago. For conversion to Grassland in conjunction with restoration, the same values as carbon content in Grassland are used.

- ***Activity Data***

The area of land that was converted to Grassland during the past 20 years is determined by subtracting the estimated area that was not converted during the past 20 years from the total area of grassland in those years. In addition, the values of converted area in each land use category during each of the past 20 years are added up to estimate the converted area over 20 years for each land use category.

Table 7-27 Area of Land converted to Grassland within 20 years

	unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Land converted to Grassland	kha	427	373	353	316	293	268	247	222	197	184	171	160	154	144	133
Forest land converted to Grassland	kha	56	51	49	45	41	38	35	30	27	25	24	22	20	18	14
Cropland converted to Grassland	kha	72	62	59	54	51	48	46	44	42	42	41	41	42	43	44
Wetlands converted to Grassland	kha	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1
Settlements converted to Grassland	kha	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Other land converted to Grassland	kha	297	258	243	215	199	179	164	146	127	115	104	96	91	82	75

7.5. Wetlands (5.D)

7.5.1. Wetlands remaining wetlands (5.D.1)

7.5.1.1. Organic Soils Managed for Peat Extraction (5.D.1.-)

- ***Methodology***

It is assumed that there is no artificial activity that equates to peat extraction. Therefore, carbon stock change in organic soils managed for peat extraction is reported as "NO". (Default value for Japan is not provided in LULUCF- GPG p.3.282 Table 3A3.3).

7.5.1.2. Flooded land remaining Flooded land (5.D.1.-)

- ***Methodology***

This category has not been calculated at the present time, as this will be treated in an appendix, and reported as "NE".

7.5.2. Land converted to Wetlands (5.D.2)

It is assumed that there is no artificial activity that equates to peat extraction. Therefore, the target of estimation in "5.D.2 Land converted to Wetland" is only Flooded land.

7.5.3. Flooded land remaining Flooded land (5.D.2.-)

- ***Methodology***

Changes in biomass stock are calculated for land that has been converted to dams. The Tier 2 method is used, according to the method for biomass stated in "Lands converted to Cropland." No calculations are performed with regard to soil because no relevant method is indicated in *LULUCF-GPG*.

$$\Delta Ci = Ai\left(CRa - CRb,i\right) \times CF$$

ΔCi : annual change in biomass from conversion to dam from forest or cropland (tC/yr)
Ai : flooded land area converted from forest or cropland to dam (ha/yr)
CRa : dry matter biomass weight immediately following conversion to dam (t-dm/ha)
CRb,i : dry matter biomass weight of forest or cropland before conversion to dam (t-dm/ha)
CF : carbon fraction of dry matter (tC/t-dm), default value=0.5

- ***Parameters***

The following parameters are used to estimate changes in the biomass stock due to conversion and changes in stock due to biomass growth in converted land.

- Carbon ratio (CF)

Source: 0.5 (default value stated in *LULUCF-GPG*)

- Biomass stock immediately after conversion

Carbon stock after and before conversion is set as below.

Table 7-28 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
After immediately conversion	Wetland		0.00	Assume that biomass stocks immediately after conversion are “0”.
Before conversion	Forest land		1990:112.65 1991:114.76 1992:116.88 1993:119.00 1994:121.12 1995:123.25	Calculated on the basis of “World Census of agriculture and Forestry” by the Ministry of Agriculture, Forestry and Fisheries, and “Handbook of Forestry Statistics” by the Forestry Agency.
	Cropland	rice field	6.31	Use annual growth rate value given in Naoto Owa “*Nutrient Balance in Japan's Crops*”.
		crop field	3.30	Use annual growth rate value given in Naoto Owa “*Nutrient Balance in Japan's Crops*”.
		orchard	30.63	Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* “*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*”
	Grassland		2.7	*LULUCF-GPG* Table 3.4.2 warm temperate wet
	Settlements and Other land		0.0	Assume that biomass stocks are “0”.

- ***Activity Data***

Figures from *Dam Yearbook* by the Japan Dam Foundation on changes over time in the submerged area of existing dams are used to calculate increases in the area of water bodies in each year. Figures on submerged area in *Dam Yearbook* also include dammed areas of natural lakes, so the water body changes which are not due to changes in land use are excluded.

Concerning the area by land use category (Forest land, Cropland, etc.) prior to dam conversion, the ratios of land that was converted to dams from Cropland (and Grassland) or Settlements are estimated according to the numbers of submerged dwellings and area of submerged Cropland for certain large-scale dams. For the area that was converted to dams from Forest land, comparisons are performed with the estimated values from "*World Census of Agriculture and Forestry*" and statistics based on Forestry Agency records. In the case of inconsistencies, for example if the area of Forest land converted in that year is larger than the total area converted to dams, priority is given to the value for the area of converted Forest land, and discrepancies are adjusted within the scope of the cumulative total dam conversion area since 1990 (because the year of dam completion is not necessarily the same as the actual time of conversion).

As for the other categories, the area of converted Cropland is divided proportionately into Cropland and Grassland according to the current area ratios of land use categories. After deducting the areas converted from Forest land, Cropland, Grassland, and Settlements from the total dam conversion area, the remainder is considered to be the area converted from other land use categories.

Table 7-29 Area of Land converted to Wetland

	unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Land converted to Wetlands	kha	0.8	1.6	1.7	0.5	0.9	1.3	2.4	0.6	2.2	1.7	1.6	1.6	1.0	0.7	1.8
Forest land converted to Wetlands	kha	0.3	0.3	0.9	0.4	0.4	1.0	1.7	0.4	1.6	1.2	1.1	1.2	0.3	0.2	0.2
Cropland converted to Wetlands	kha	0.2	0.3	0.4	0.1	0.2	0.3	0.5	0.1	0.5	0.4	0.4	0.4	0.2	0.2	0.4
Grassland converted to Wetlands	kha	0.04	0.09	0.09	0.03	0.06	0.08	0.14	0.02	0.07	0.06	0.05	0.07	0.04	0.03	0.06
Settlements converted to Wetlands	kha	0.010	0.020	0.022	0.007	0.012	0.017	0.030	0.007	0.028	0.022	0.020	0.021	0.013	0.009	0.024
Other land converted to Wetlands	kha	0.26	0.87	0.38	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.28	1.14

7.6. Settlements (5.E)

7.6.1. Settlements remaining Settlements (5.E.1)

- ***Methodology***

The amount of change in the carbon stock of trees in urban parks and greenery conservation zones, etc. is calculated using the Tier 1a method. At the present time, there is no data available for loss calculations or to distinguish between ages of more than 20 years and less than 20 years, so this was not calculated.

$$\Delta CSSLB = \Delta CSSG - \Delta CSSL$$

$$\Delta CSSG = A \times PW \times BI$$

ΔCSSLB : changes in carbon stocks in living biomass in settlements remaining settlements (tC/yr)
ΔCSSG : changes in carbon stocks due to growth in living biomass in settlements remaining settlements (tC/yr)
ΔCSSL : changes in carbon stocks due to losses in living biomass in settlements remaining settlements (tC/yr) note: not calculated through lack of data
A : crown cover area less than or equal to 20 years since establishment (ha)
PW : forested area rate (forested area rate per park area)
BI : growth per crown cover area (tC/ha crown cover/yr)

• *Parameters*

- Annual growth rate

The annual growth rate of trees in urban parks and greenery conservation zones, etc. is taken as 2.9 [tC/ha crown cover/yr], the default value indicated in *LULUCF-GPG* (p. 3.297).

• *Activity Data*

To determine the amount of activity regarding changes in the amount stored in trees in urban parks and greenery conservation zones, etc., the area of urban parks and greenery conservation zones, etc. as determined by the Ministry of Land, Infrastructure and Transport is multiplied by the forested area rate, which is calculated from the number of trees, park area, and other factors. In greenery conservation zones, etc., the forested area rate is assumed to be 100%.

Table 7-30 Area of Settlements remaining Settlements

(crown cover area less than or equal to 20 years since establishment* forested area rate (forested area rate per park area))

	Unit	1990	1991	1992	1993	1994	1995	1996
1.City block parks	Kha	1.63	1.69	1.73	1.78	1.83	1.87	1.93
2.Neighborhood parks	Kha	1.87	1.91	2.02	2.10	2.17	2.22	2.24
3.Community parks	Kha	1.65	1.67	1.73	1.77	1.83	1.87	1.95
4.Comprehensive parks	Kha	5.56	5.78	5.88	6.12	6.46	6.74	7.01
5.Sport parks	Kha	2.20	2.31	2.45	2.56	2.61	2.68	2.73
6.Large scaled parks	Kha	2.80	2.93	3.28	3.39	3.68	3.76	3.93
7.Specific parks	Kha	4.07	4.15	4.17	4.25	4.35	4.38	4.46
8.National government parks	Kha	0.42	0.48	0.47	0.47	0.49	0.52	0.54
9.Buffer greenbelts	Kha	0.42	0.44	0.44	0.45	0.46	0.47	0.48
10.Ornamental green spaces	Kha	1.74	1.94	2.05	2.16	2.27	2.41	2.67
11.Urban grove parks	Kha	0.00	0.00	0.00	0.00	0.00	0.00	0.01
12.Square parks	Kha	0.00	0.00	0.00	0.00	0.00	0.00	0.01
13.Greenways	Kha	0.31	0.33	0.34	0.34	0.36	0.37	0.39
14.Specified community parks	Kha	0.15	0.17	0.20	0.22	0.27	0.26	0.28
15.Green space conservation zones	Kha	1.90	1.90	3.45	3.52	3.64	3.65	3.89

	Unit	1997	1998	1999	2000	2001	2002	2003	2004
1.City block parks	Kha	1.97	2.02	2.06	2.11	2.15	2.19	2.23	2.28
2.Neighborhood parks	Kha	2.29	2.35	2.42	2.47	2.50	2.55	2.59	2.63
3.Community parks	Kha	2.00	2.06	2.12	2.17	2.22	2.28	2.40	2.44
4.Comprehensive parks	Kha	7.11	7.36	7.82	8.04	8.35	8.54	8.75	8.93
5.Sport parks	Kha	2.86	2.97	3.02	3.11	3.20	3.29	3.35	3.39
6.Large scaled parks	Kha	4.18	4.41	4.41	4.64	4.94	5.11	5.28	5.36
7.Specific parks	Kha	4.51	4.59	4.64	4.67	4.79	4.65	4.67	4.78
8.National government parks	Kha	0.57	0.61	0.67	0.70	0.74	0.80	0.90	0.93
9.Buffer greenbelts	Kha	0.48	0.48	0.49	0.50	0.51	0.52	0.52	0.52
10.Ornamental green spaces	Kha	2.81	3.02	3.17	3.29	3.37	3.51	3.70	3.87
11.Urban grove parks	Kha	0.02	0.02	0.02	0.07	0.07	0.07	0.08	0.10
12.Square parks	Kha	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.06
13.Greenways	Kha	0.40	0.42	0.43	0.45	0.46	0.46	0.48	0.49
14.Specified community parks	Kha	0.29	0.30	0.32	0.34	0.36	0.37	0.39	0.41
15.Green space conservation zones	Kha	3.97	4.72	4.73	4.76	4.85	5.09	5.16	5.22

7.6.2. Land converted to Settlements (5.E.2)

7.6.2.1. Carbon stock change in Living Biomass (5.E.2.-)

- ***Methodology***

According to *LULUCF-GPG*, only living biomass is addressed in this category and methods associated with dead organic matter and soils are not mentioned. Therefore, only carbon stock change in living biomass is estimated.

$$\Delta Ci = Ai\left(CRa - CRb, i\right) \times CF$$

ΔCi : annual change in biomass from conversion to Settlements from initial land use type *i* (tC/yr)
Ai : area of land converted annually to Settlements from land use type *i* (ha/yr)
CRa : carbon reserves immediately following conversion to Settlements (t-dm/ha), default＝0
CRb,i : carbon reserves in land use type *i* immediately before conversion to Settlements (t-dm/ha)
CF : carbon fraction of dry matter (tC/t-dm), default value=0.5

- ***Parameters***

The following parameters are used to estimate changes in the biomass stock due to conversion and changes in stock due to biomass growth in converted land.

- Carbon ratio (CF)
Source: 0.5 (default value stated in *LULUCF-GPG*)

- Biomass stock immediately after conversion
Carbon stock after and before conversion is set as below.

Table 7-31 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
After immediately conversion	Settlements		0.00	Assume that biomass stocks immediately after conversion are "0".
Before conversion	Forest land		1990:112.65 1991:114.76 1992:116.88 1993:119.00 1994:121.12 1995:123.25	Calculated on the basis of "World Census of agriculture and Forestry" by the Ministry of Agriculture, Forestry and Fisheries, and "Handbook of Forestry Statistics" by the Forestry Agency.
	Cropland	rice field	6.31	Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".
		crop field	3.30	Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".
		orchard	30.63	Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* "*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*"
	Grassland		2.7	*LULUCF-GPG* Table 3.4.2 warm temperate wet
	Wetlands and Other land		0.0	Assume that biomass stocks are "0".

- ***Activity Data***

Only the area converted to Settlements from Forest land and Cropland is determined. Since no data is available on the area converted to Settlements from Wetlands or Other land use categories, no figures are reported in those land use categories. Instead, they are reported as "IE" and recorded under "Other land remaining Other land."

- Conversion from Forest land

That portion of the area of converted Forest land (estimated according to "*World Census of Agriculture and Forestry*" and statistics based on Forestry Agency records) which has been converted to Settlements is considered to include land for construction or business sites, land for housing and vacation homes, land for golf courses and other leisure purposes, and land for public uses (excluding land converted to dams).

- Conversion from Cropland

For former rice fields, crop fields, and orchards (according to "*Area Statistics for Cultivated and Commercially Planted Land*"), the land converted to factories, roads, housing, and forest roads is used.

- Conversion from Grassland

For former pasture land and grazed meadow land constituting moved or converted Cropland which is converted to Settlements (according to "*Area Statistics for Cultivated and Commercially Planted Land*"), the land converted to factories, roads, housing, and forest roads is used.

Table 7-32 Area of Land converted to Settlements

	unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Land converted to Settlements	kha	38	41	43	36	33	32	30	28	27	23	21	19	16	14	14
Forest land converted to Settlements	kha	13	15	16	12	9	9	7	6	6	5	5	4	2	2	2
Cropland converted to Settlements	kha	21	22	23	21	20	20	20	19	18	16	14	13	12	11	10
Grassland converted to Settlements	kha	3	3	4	3	3	3	3	3	3	2	2	2	2	2	1
Wetlands converted to Settlements	kha	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Other land converted to settlements	kha	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE

7.6.2.2. Carbon stock change in Dead Organic Matter (5.E.2.-)

- ***Methodology***

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as “NE”.

7.6.2.3. Carbon stock change in Soil (5.E.2.-)

- ***Methodology***

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as “NE”.

7.7. Other land (5.F)

7.7.1. Other land remaining Other land (5.F.1)

According to *LULUCF-CRF*, change in carbon stocks and non-CO_2 emissions and removals are not considered for this category.

7.7.2. Land converted to Other land (5.F.2)

7.7.2.1. Carbon stock change in Living Biomass (5.F.2.-)

- ***Methodology***

According to the method used in “*Land converted to Cropland*”, Tier 2 method is applied.

$$\Delta Ci = Ai\left(CRa - CRb, i\right) \times CF$$

ΔCi : annual change in biomass from conversion to Other land from initial land use type *i* (tC/yr)
Ai : area of land converted annually to Other land from land use type *i* (ha/yr)
CRa : carbon reserves immediately following conversion to Other land (t-dm/ha), default＝0
CRb,i : carbon reserves in land use type *i* immediately before conversion to Other land (t-dm/ha)
CF : carbon fraction of dry matter (tC/t-dm), default value=0.5

- ***Parameters***

The following parameters are used to estimate changes in the biomass stock due to conversion and changes in stock due to biomass growth in converted land.

- Carbon ratio (CF)
Source: 0.5 (default value stated in *LULUCF-GPG*)

- Biomass stock immediately after conversion
Carbon stock after and before conversion is set as below.

Table 7-33 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
After immediately conversion	Settlements		0.00	Assume that biomass stocks immediately after conversion are “0”.
Before conversion	Forest land		1990:112.65 1991:114.76 1992:116.88 1993:119.00 1994:121.12 1995:123.25	Calculated on the basis of “World Census of agriculture and Forestry” by the Ministry of Agriculture, Forestry and Fisheries, and “Handbook of Forestry Statistics” by the Forestry Agency.
	Cropland	rice field	6.31	Use annual growth rate value given in Naoto Owa “*Nutrient Balance in Japan's Crops*”.
		crop field	3.30	Use annual growth rate value given in Naoto Owa “*Nutrient Balance in Japan's Crops*”.
		orchard	30.63	Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* “*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*”
	Grassland		2.7	*LULUCF-GPG* Table 3.4.2 warm temperate wet
	Wetlands and Other land		0.0	Assume that biomass stocks are “0”.

- ***Activity Data***

Only the area converted from Forest land and Cropland to other land use categories is determined. Since no data is available on the area converted from Wetland and Settlements to other land use categories, no figures are reported in those land use categories. Instead, they are reported as “IE” and reported under “Other land remaining Other land.”

- Conversion from Forest land

That portion of the area of converted Forest land (estimated according to “*World Census of Agriculture and Forestry*” and statistics based on Forestry Agency records) which has been used as a source of soil and stone or for other purposes is considered to be the area converted to Settlements.

- Conversion from Cropland

For former rice fields, crop fields, and orchards, the area classified as “other, natural disaster damage” is used according to “*Area Statistics for Cultivated and Commercially Planted Land*”.

- Conversion from Grassland

For former pasture land and grazed meadow land, the area of former pasture land classified as “other, natural disaster damage” (according to “*Area Statistics for Cultivated and Commercially Planted Land*”) and the area of former grazed meadow land which is classified as “other, classification unknown” (“*Moving and Conversion of Cropland*”) are used.

Table 7-34 Area of Land converted to Other land

	unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Land converted to Other land	kha	21	21	21	24	26	28	26	32	31	30	27	29	23	20	17
Forest land converted to Other land	kha	2	3	2	3	2	2	2	3	2	2	2	2	2	1	1
Cropland converted to Other land	kha	15	15	15	17	18	20	18	19	19	19	17	17	14	12	11
Grassland converted to Other land	kha	4	4	4	5	5	6	5	10	10	9	9	10	8	7	5
Wetlands converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Settlements converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE

7.7.2.2. Carbon stock change in Soils (5.F.2.-)

- ***Methodology***

The Tier 2 method is used, according to the method of “Lands converted to Cropland.” Since Japan is not considered to have any soil that constitutes organic soil under *LULUCF-GPG*, all soil is calculated as mineral soil.

$$\Delta C = (SOC_o - SOC_i) \times A$$

ΔC : change in carbon stock in land converted to other land (tC/yr)
SOC_o : carbon stock in soil in other land (tC/ha)
SOC_i : carbon stock in soil per ha before land converted from land use type *i* to other land (tC/ha)
A : area of land converted to other land within past 20 years (ha)

- ***Parameters***

- Soil carbon content (SC(t))

The values stated in Table 7-20 are used for the soil carbon content before and after conversion. Since *LULUCF-GPG* does not give any default values for soil carbon content with regard to other types of land, the same values as Cropland are used for formerly cultivated land, and the default values for Grassland are used for the other types of land.

- ***Activity Data***

The values of converted area in each land use category during each of the past 20 years are added up to estimate the area converted to Other land use during a 20-year period.

Table 7-35 Area of Land converted to Other land within 20 years

	unit	1990	1991	1992	1993	1994	1995	1996
Land converted to Other land	kha	21	21	21	24	26	28	26
Forest land converted to Other land	kha	2	3	2	3	2	2	2
Cropland converted to Other land	kha	15	15	15	17	18	20	18
Grassland converted to Other land	kha	4	4	4	5	5	6	5
Wetlands converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE
Settlements converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE

	unit	1997	1998	1999	2000	2001	2002	2003	2004
Land converted to Other land	kha	32	31	30	27	29	23	20	17
Forest land converted to Other land	kha	3	2	2	2	2	2	1	1
Cropland converted to Other land	kha	19	19	19	17	17	14	12	11
Grassland converted to Other land	kha	10	10	9	9	10	8	7	5
Wetlands converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE	IE
Settlements converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE	IE

7.8. Non-CO_2 gases

7.8.1. Direct N_2O emissions from N fertilization (5. (I))

- ***Methodology***

It is assumed that volume of nitrogen-based fertilizer applied to forest soils is included in demand for nitrogen-based fertilizers in Agriculture sector, although fertilization application in Forest land may not conducted in Japan. Therefore, these sources have been reported as “IE”.

7.8.2. N_2O emissions from drainage of soils (5.(II))

- ***Methodology***

Data on drainage of forest soils and wetlands is not available. Therefore, these sources have been reported as “NE”.

7.8.3. N_2O emissions from disturbance associated with land-use conversion to cropland (5.(III))

- ***Methodology***

According to *LULUCF-GPG*, Tier 1 method is used.

$$N_2O - N_{conv} = N_2O_{net-\min} - N = EF \times N_{net-\min}$$

$$N_{net-\min} = C_{released} \times 1 / C : N_{ratio}$$

N_2O-N_conv : N_2O emission due to land-use conversion to cropland (kgN_2O-N）

N_2O_net-min-N : N_2O emission due to land-use conversion to cropland (kgN_2O-N/ha/yr)

N_net-min : annual N emission from soil disturbance associated with mineralization of soil organic matter (kgN/ha/yr)

EF : emission factor

C:Nratio : CN ratio

C_released : soil carbon stock that has been mineralized within 20 years

- ***Parameters***

- N/C ratio for soils: 15 (default value stated in *LULUCF-GPG*, Page 3.94)

- N-N_2O emission factor for soils: 0.0125 [kg-N_2O-N/kg-N] (default value stated in *LULUCF-GPG*, Page 3.94)

- ***Activity Data***

Area of land converted to Cropland and carbon emissions from soils due to this conversion are used.(Table 7-23 Area of Land converted to Cropland)

7.8.4. Carbon emissions from agricultural lime application (5.(IV))

- ***Methodology***

Data on lime application which is not associated with agricultural activity is not available. Therefore, these sources have been reported as “NE”.

7.8.5. Biomass burning (5.(V))

- ***Methodology***

For CO, CH_4, N_2O, NOx emissions due to fires, Tier 1 method is used.

➢ Forest land

$$bbGHG_f = (Vf_n + Vf_p) \times N / C$$

$bbGHG_f$: GHG emissions due to biomass burning by forest

Vf_n : damaged timber volume due to fires in national forest (m^3)

Vf_p : damaged timber volume due to fires in private forest (m^3)

N/C : emission ratio (CO: 0.06, CH_4: 0.012, N_2O: 0.007, NO_x: 0.121)

- Cropland, Grassland, Wetlands, Settlements, Other land

$$bbGHG = CB\_on\_site \times N / C$$

bbGHG : GHG emissions due to biomass burning associated with land conversion
CB_on-site : loss of carbon due to on-site biomass burning
N/C : emission ratio (CO: 0.06, CH_4: 0.012, N_2O: 0.007, NO_x: 0.121)

• *Parameters*

The following values are applied to emission ratios for open burning of cleared forests.

CO: 0.06, CH_4: 0.012, N_2O: 0.007, NOx: 0.121
(default value stated in *LULUCF-GPG*, Table 3A.1.15)

• *Activity Data*

For activity in Forest land, the timber volume damaged by forest fire is used. For the remaining five categories, activity is determined based on carbon dioxide emissions in conjunction with conversion from Forest land, on the assumption that a certain proportion is burned.

- Forest land

The carbon emissions by due to forest fire is applied.

- Cropland, Grassland, Wetlands, Settlements, Other land

$$CB\_{on-site} = \Delta Ci \times p_{on-site} \times p_{burned-on} \times p_{oxid}$$

CB_on-site : loss of carbon due to on-site biomass burning
ΔCi : annual change in biomass in land before conversion from initial land use (i) (forest, grassland, wetland, residential grounds and other) to cropland (tC/yr)
$\rho_{on\text{-}site}$: biomass ratio- left on-site (0.3 interim value)
$\rho_{burned\ on}$: ratio of burned biomass of biomass left on-site (1 interim value)
ρ_{oxid} : ratio of oxidized biomass when burned (0.9 LULUCF-GPG page 3.88 default value)

Table 7-36 Activity data for Biomass Burning

	Unit	1990	1991	1992	1993	1994	1995
Forest land	Gg-C/yr	-29	-21	-15	-84	-63	-30
Cropland	Gg-C/yr	-78	-44	-51	-18	-18	-18
Grassland	Gg-C/yr	-11	-6	-7	-3	-3	-3
Wetlands	Gg-C/yr	-5	-4	-14	-6	-7	-16
Settlements	Gg-C/yr	-197	-235	-258	-195	-153	-151
Other land	Gg-C/yr	-37	-43	-35	-44	-40	-35

※ Activity data for the period 1996–2004 are reported as “NE” because improvement of the methodology and parameters is being processed for the future inventory submission.

※ Removals : +, Emissions : －

Reference

IPCC, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories,* 1997

IPCC, *Good Practice Guidance and Uncertainty Management for Land Use, Land-Use change and forestry,* 2002

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Ministry of Agriculture, Forestry and Fisheries, *World Census of agriculture and Forestry*

MAFF, *Statistics of Cultivated and Planted Area (Survey of cropland area)*

MAFF, *A move and conversion of Cropland*

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Ministry of Land Infrastructure and Transport, *Land Use Status Survey*

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Makoto Nakai, *"Carbon accumulation in soils due to soil management" Association for Advancement of Agricultural Science "Survey on method for quantification of amount of GHG emission cuts (2000)"*

Kazuhito Morisada, Kenji Ono, Hidesato Kanomata, *" Organic carbon stock in forest soil in Japan ", Geoderma 119 (2004) p.21-32*

UNFCCC, *Guidelines on reporting and review（FCCC/SBSTA/2004/8）*

UNFCCC, *Tables of the common reporting format for land use, land-use change and forestry（FCCC/SBSTA/2005/L.19、FCCC/SBSTA/2005/L.19/Add.1）*

Chapter 8. Waste (CRF sector 6)

This section on the waste sector calculates the amounts of emissions of solid waste disposal on land (6.A.), wastewater handling (6.B.), waste incineration (6.C.), and other (6.D.).[1]

8.1. Solid Waste Disposal on Land（6.A.）

In Japan, waste is categorized into municipal solid waste and industrial waste. Different estimation methods were reviewed and provided for municipal solid waste and industrial waste. Emissions of the waste types in Table 8-1 were estimated for solid waste disposal on land.

Table 8-1 Categories whose emissions are estimated for solid waste disposal on land (6.A.)

Category	Waste types estimated			Treatment type	CH_4	CO_2[d]	N_2O
6.A.1. (8.1.1)	Municipal solid waste	Kitchen garbage		Anaerobic landfill	○	○	
				Semi-aerobic landfill	○	○	
		Waste paper		Anaerobic landfill	○	○	
				Semi-aerobic landfill	○	○	
		Waste wood		Anaerobic landfill	○	○	
				Semi-aerobic landfill	○	○	
		Waste textiles (natural fiber) [a]		Anaerobic landfill	○	○	
				Semi-aerobic landfill	○	○	
		Sludge	Human waste treatment, septic tank sludge	Anaerobic landfill	○	○	
				Semi-aerobic landfill	○	○	
	Industrial waste	Kitchen garbage		Anaerobic landfill l[e]	○	○	
		Waste paper			○	○	
		Waste wood			○	○	
		Waste textiles (natural fiber) [a]			○	○	
		Sludge	Sewage sludge		○	○	
			Human waste treatment, septic tank sludge		○	○	
			Waterworks sludge		○	○	
			Organic sludge from manufacturing industries		○	○	
			Livestock waste [f]		○	○	
6.A.3. (8.1.2)	Illegal disposal [b]			Anaerobic landfill	○	○	
	Composting organic waste			Composting	○		○[c]

a) Because synthetic textiles hardly biodegrade in landfills, estimates include only natural textiles.

b) Carbon-based, biodegradable illegally dumped waste includes waste wood and waste paper, but because the currently known residual amount of illegally dumped waste paper is very small, only emissions of waste wood were included in the estimate.

c) This source is reported under 6.D. because it cannot be reported with the CRF for 6.A..

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[1] In the waste sector, data input is often performed using estimated values due to data availability, but in some cases this chapter omits descriptions of these estimation methods. For details, see "Report of the Waste Panel on Greenhouse Gas Emission Estimate for 2005" or the JNGI estimate file.

d) 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.

e) Since the ratio of semi-aerobic landfills is uncertain, all the industrial waste landfills were considered to be anaerobic landfills for emission estimates.

f) Although livestock waste does not fall under the category of sludge legally, emissions from livestock waste were estimated under the category of sludge since the characteristic of livestock waste was similar to that of sludge.

8.1.1. Emissions from Controlled Landfill Sites (6.A.1.)

Background

In Japan some of the kitchen garbage, waste paper, waste textiles, waste wood, and sludge in municipal solid waste and industrial waste is landfilled without incineration, producing methane when the organic components biodegrade in landfills. Because Japanese landfill sites are appropriately controlled pursuant to the Wastes Disposal and Public Cleansing Law, the amount of methane released is counted under "Emissions from Controlled Landfill Sites (6.A.1)."

Methodology

Since the country-specific data is available, methane and carbon dioxide emissions from this source were calculated using the country-specific methodology instead of the Tier 2: FOD method in accordance with the decision tree (page 5.6, fig. 5.1) of the *Good Practice Guidance (2000).*

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.

Estimating emissions involved multiplying the emission factor by the amount of previously landfilled waste that biodegraded in the relevant year.

$$E = EF \times A$$

E : Amount of methane emitted from controlled landfill sites (kg-CH_4)
EF : Emission factor for anaerobic landfill or semi-aerobic landfill (dry basis) (kg-CH_4/t)
A : Amount of each type of waste landfilled without incineration until the basic estimation period started and which degraded during the basic estimation period (dry basis) (t)

Emission Factors

-Overview

Emission factors were set by multiplying each of kitchen garbage, waste paper, waste textiles (of natural fibers), waste wood, and sludge by carbon content, disposal site-specific methane correction coefficients, waste-to-gas conversion rate of landfilled waste, and percentages of methane in this landfill gas.

Emission factor = (carbon content) × (methane correction coefficient) × (gas conversion rate) × (percentages of CH_4 in landfill gas)

-Carbon Content

[Kitchen garbage, waste paper, waste wood]

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-2006.xls¥6A-CH4.)

[Waste natural fiber textiles]

Carbon content of the natural fiber used in textile products was used as the carbon content of waste natural fiber textiles. The carbon content of each natural fiber type (cotton, wool, silk, linen, and recycled textiles was calculated from the percentage of each fiber type and the carbon content, then this value’s weighted average was calculated with each textile’s domestic demand to find waste textile carbon content.

[Sludge]

The upper limit values of sewage sludge carbon content shown in the *Good Practice Guidance (2000)* was used as the carbon content of sewage sludge. The sewage sludge carbon content was used as the carbon content of sewage treatment and septic tank sludge, and livestock waste treatment. The intermediate results of analyzing the percentages of organic constituents obtained by FY2005 measurements at several water purification plants was used as the carbon content of waterworks sludge. The carbon content of organic sludge generated by manufacturing industries used here was the value for the papermaking industry, which has the largest final disposal quantity of organic sludge. Because the main constituent of the organic sludge generated by the papermaking industry is paper sludge, we set the carbon content with reference to carbon content of cellulose. The same value is used for every year because it is likely that the properties of sludge do not change much from year to year.

Table 8-2 Carbon content (%) of wastes disposed of in controlled landfill sites

Item	Unit	1990	1995	2000	2003	2004	references
Kitchen Garbage	%	42.4%	42.2%	42.9%	43.2%	43.2%	Data provided by Metropolitan Tokyo, Yokohama City, Kawasaki City, Kobe City, and Fukuoka City
Waste paper	%	40.8%	40.3%	41.4%	41.5%	41.5%	
Waste wood	%	43.7%	43.7%	43.7%	43.7%	43.7%	
Waste natural fiber textiles	%	45.1%	45.1%	44.8%	44.8%	44.7%	"GHGs Emissions Estimation Methodology Investigating Commission (2006)
Sewage sludge	%	40.0%	40.0%	40.0%	40.0%	40.0%	GPG(2000)
Human waste sludge	%	40.0%	40.0%	40.0%	40.0%	40.0%	Substituted for "Sewage sludge" data
Waterworks sludge	%	7.5%	7.5%	7.5%	7.5%	7.5%	"GHGs Emissions Estimation Methodology Investigating Commission (2006)
Organic sludge from manufacturing industries	%	45.0%	45.0%	45.0%	45.0%	45.0%	
Livestock waste	%	40.0%	40.0%	40.0%	40.0%	40.0%	Substituted for "Sewage sludge" data

-Methane Correction Coefficient

These were set to 1.0 for anaerobic landfill sites and 0.5 for semi-aerobic landfill sites.

-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. The same value was used for waste paper, waste wood, waste natural fiber textiles, and sludge.

-Proportions of methane in generated gas

The default value given in the *Revised 1996 IPCC Guidelines* was used and the proportion of methane was set at 50%.. This value was applied to all kitchen garbage, waste paper, waste wood, waste natural fiber textiles, and sludge.

Activity Data

-Overview

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, 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-2006.xls* for details on the calculation process).

Activity data = (volume of biodegradable landfill) × (percentage of waste landfilled by landfill structure type) × (percentage of solids in waste) × (decomposition rate)

-Volume of Biodegradable Landfill

[Kitchen garbage, waste paper, waste wood]

The amounts of directly landfilled kitchen garbage, waste paper, and waste wood were determined from the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes* (*Volume on Cyclical Use*) (Waste Management and Recycling Department of the Ministry of the Environment; below, *Cyclical Use of Waste Report*). The amount of municipal solid waste were obtained by multiplying the volume of direct landfill waste for each classification of waste accumulation (by waste type) by the percentages of kitchen garbage, waste paper, and waste wood contained in the volume of direct landfill waste, and added up by the classification of waste accumulation. For the amount of kitchen garbage from industrial waste, “the volume of direct landfill waste” of animal and plant residue and livestock carcasses and “the volume of landfill after intermediate processing” were used. For the amount of waste paper and waste wood for industrial waste, “the volume of direct landfill waste” was used. To cover years for which solid waste data were unavailable, gaps were filled by means such as interpolation, extrapolation, substitution, and estimating from totals.[2]

[Waste Natural Fiber Textiles]

The amount of waste natural fiber textiles directly landfilled was estimated by multiplying the directly landfilled amount of waste textiles, which was determined expediently from the *Cyclical Use of Waste Report*, by the intermediate values (75%), as defined, of for municipal solid waste, the percentages of natural fiber in textile products of each year as determined from the *Annual Textile Statistics Report*, and for industrial waste, the percentages of natural fiber in the textile waste included in industrial waste, as determined from *Waste Handbook*.

[Sewage Sludge]

Included in the estimation of landfilled sewage sludge amount were the types “raw sludge”, “dewatered sludge (dehydrated cake),” “mechanically dried sludge,” “concentrated sludge,” “dewatering vehicle sludge”, “sun-dried sludge”, “digested sludge”, “screen residue”, and “compost” in the sewage treatment plant categories “directly managed” and “disposal by other departments’ facilities/public corporations or private sector” as reported in annual editions of *Sewage Statistics (Admin. Ed.)* (Japan Sewage Works Association).

[Human Waste Treatment, Septic Tank Sludge]

For landfilled amount of human waste treatment and septic tank sludge, we used the amounts given for “direct final disposal” and “final disposal after treatment” of “human waste treatment and septic tank sludge” in annual editions of *Cyclical Use of Waste Repo*rt. The entire amount is considered as the biodegradable landfill amount. Landfilled amounts in FY1998 and prior years were estimated by taking the amounts of human waste treatment and septic tank sludge for each year in the section “Human Waste Processing Year by Year” of *Waste Treatment in Japan* (Ministry of the Environment, Waste Management and Recycling

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[2] See JNGI calculation file 6A-AD for details on the estimation method.

Department), then multiplying those amounts by the final disposal percentages of human waste and septic tank sludge in FY2000.

[Waterworks Sludge]

The amount of water purification sludge generated and the percentage landfilled were determined from “total amount of soil disposed of” and “landfilled percentage” by each water purification plant given in each year’s *Waterworks Statistics* (Japan Water Works Association).

[Organic Sludge from Manufacturing Industries]

Since there are no sources making it possible to determine the total amount of organic sludge landfilled by manufacturing industries year by year, activity data was determined by calculating for “food manufacturing”, “papermaking”, and “chemicals”, industries which landfill large quantities of organic sludge. The amount landfilled by the papermaking industry was determined by using the final disposal amount of organic sludge in *Results of a Study on Industrial Wastes from Paper and Pulp Plants* (Japan Paper Association, Japan Technical Association of the Pulp and Paper Industry, 2006). The landfill amounts for FY1999 and thereafter of the food manufacturing and chemical industries were determined by using *Report on Results of Trend and Industry-Specific Studies on Industrial Wastes (Mining Industry Waste) and Recyclable Waste (2003 Data)* (Clean Japan Center), while the amount for FY1998 and previous years we used *Voluntary Environmental Report (Waste Control Volume), FY2004 Follow-up Results)*.

[Livestock Waste Treatment]

The amounts used for the amount of livestock waste treated and landfilled were those given in “direct final disposal” and “final disposal after treatment” of “livestock waste” in annual editions of *Report on the Research on the Wide-range Waste Movement and Control*. Data for 1997 and prior years were from the *Study on Direct Landfill Amounts of Livestock Waste* (Ministry of the Environment, Waste Management and Recycling Department), which is conducted every five years. Values for interim years were interpolated from those studies.

-Percentages of Landfill Sites of Each Site Structure Type

Determining the percentages of municipal solid waste landfill sites of each site structure type involved referring to annual editions of *Results of Study on Municipal Solid Waste Disposal* (Ministry of the Environment, Waste Management and Recycling Department), which lists Japan’s municipal solid waste disposal sites in the section “Facility by Type (Final Disposal Sites),” regarding as semi-aerobic those sites which have leachate treatment facilities and subsurface containment structures, and regarding the percentage of semi-aerobic landfill disposal volume to be the percentage of their total landfill capacity (m^3). However, disposal sites where landfilling started before the 1977 joint order, and all coastal and inland water landfills are treated as anaerobic disposal sites. Additionally, because sites where landfilling started between FY1978 and FY1989 likely include both anaerobic and semi-aerobic sites, we followed the judgment of specialists and calculated the percentage of semi-aerobic sites for years between them by multiplying the landfill volume (m^3) of each site by a linearly interpolated correction coefficient.

All industrial waste disposal sites are considered to be anaerobic.

Table 8-3 Landfill percentages of municipal solid waste disposal sites by site structure

Item	Unit	1977	1984	1990	1995	2000	2003	2004
Anaerobic landfill percentage	%	100.0%	85.4%	72.8%	62.4%	53.6%	43.5%	43.5%
Semi-aerobic landfill	%	0.0%	14.6%	27.2%	37.6%	46.4%	56.5%	56.5%

-Percentage of Solids in Waste

Percentage of solids in waste was set from the water percentage of each waste type. Table 8-4 shows the percentage of solids in each waste type, and the sources of the figures.

Table 8-4 Percentage of solids in waste disposed of in controlled landfill sites

Category	Solids (%)	Source
Kitchen garbage	25	Water percentage of kitchen garbage in *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*
Animal and plant residues receiving intermediate processing	30	Set in view of material flow
Waste paper	80 (MSW) 85 (ISW)	Determined by specialists
Waste natural fiber textiles	80 (MSW) 85 (ISW)	Determined by specialists
Waste wood	55	Determined by specialists
Sewage sludge	Specific to each disposal site	Average moisture content of “delivered or final disposal sludge” in *Sewage Statistics (Admin. Ed.)*
Sludge from human waste treatment and septic tanks	15 (direct final disposal)	Moisture content standard of landfill standard (sludge) specified by enforcement ordinance of Wastes Disposal and Public Cleansing Law
	30 (intermediate processing)	Determined by specialists
Waterworks Sludge	100	Because landfill amount data are dry-basis
Livestock waste	16.9 (direct final disposal)	Organic percentage in “Controlling the Generation of Greenhouse Gases in the Livestock Industry”
	30 (intermediate processing)	Determined by specialists
Organic sludge from manufacturing industries	70 (other than paper industry) - (paper industry)	Determined by specialists

-Decomposition Rate

To determine how decomposition of waste in landfill sites proceeds year to year, we followed the assumptions in the Sheldon–Arleta model. The year-on-year change in the rate of methane generation from each type of landfilled waste was directly approximated and the decomposition rate was obtained from the integral value of the linear methane generation rate in each year. The methane generation amount half-time and decomposition period of each type of landfilled waste were set as shown in Table 8-5 in accordance with Matsuzawa, Tanaka, Okamoto, and Kitagori, “Estimation of Methane Amount Released from Final

Disposal Sites," Proceedings of the Fourth Japan Society of Waste Management Experts Research Presentation Convention, p. 433-436 (1993).

Table 8-5 Half-times and decomposition periods for landfilled wastes in the Sheldon–Arleta model

Category	Half time	Decomposition period	Remarks
Kitchen garbage	3y	10y	Matsuzawa, Tanaka, Okamoto, and Kitagori, "Estimation of Methane Amount Released from Final Disposal Sites," Proceedings of the Fourth Japan Society of Waste Management Experts Research Presentation Convention, p. 433-436 (1993)
Waste paper	7y	21y	
Waste natural fiber textiles	7y	21y	
Waste wood	36y	103y	
Sludge	4y	11y	Half-time was set from *IPCC (2000)*; decomposition period was set in accordance with Sheldon-Arleta model conditions.

[Sheldon-Arleta Model]
This model was devised on the basis of results of a sewage sludge anaerobic digestion experiment. The relationship between dimensionless time and gas amount is given by the gasification curve. Under this model, when 35% of the total decomposition period has elapsed, the amount of gas generated will be maximum, and will be 50% of the total generated (half-time).

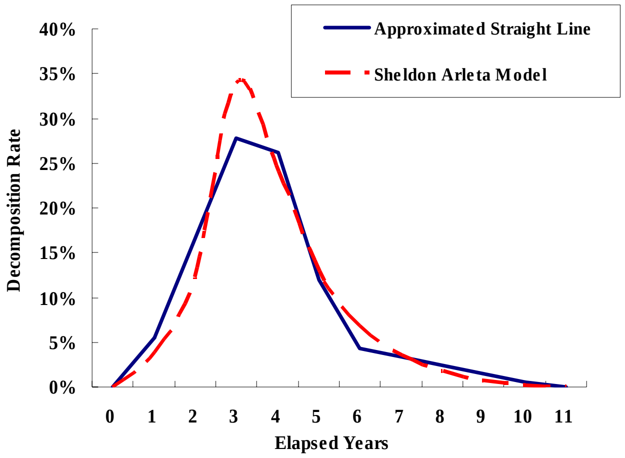

Table 8-1 Rate of decomposition of kitchen garbage

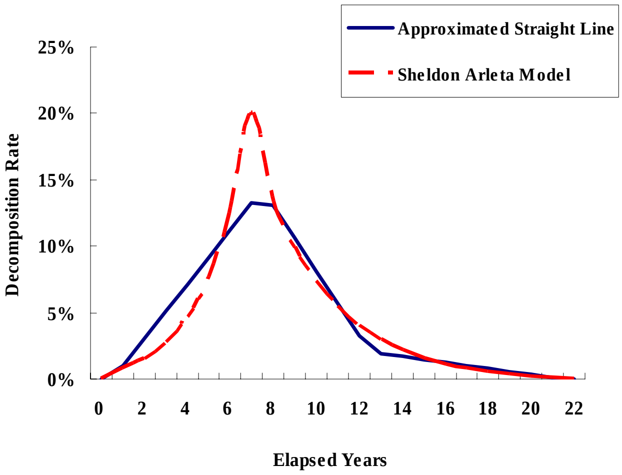

Table 8-2 Rate of decomposition of waste textile

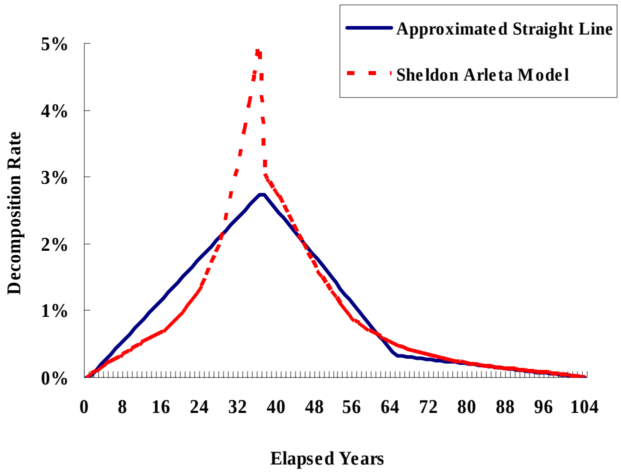

Table 8-3 Rate of decomposition of waste wood

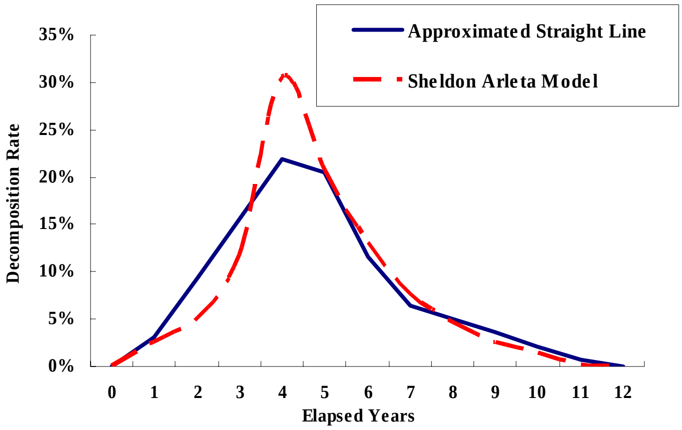

Table 8-4 Rate of decomposition of sludge

Table 8-6 Activity of emissions from controlled disposal sites (kt)

Item	Unit	1990	1995	2000	2003	2004
Kitchen Garbage	kt / year (dry)	494	520	439	344	308
Paper	kt / year (dry)	1,269	1,195	1,021	845	789
Natural fiber	kt / year (dry)	72	66	52	43	41
Wood and Bamboo	kt / year (dry)	336	424	495	527	535
Sewage sludge	kt / year (dry)	294	292	224	171	152
Sludge from human waste treatment and septic tank	kt / year (dry)	52	53	53	51	50
water purification sludge	kt / year (dry)	200	197	158	137	132
organic sludge from manufacturing industries	kt / year (dry)	401	346	174	111	100
livestock waste	kt / year (dry)	181	221	212	182	191
Total	kt / year (dry)	3,297	3,313	2,827	2,413	2,298

8.1.2. Emissions from Other Controlled Landfill Sites (6.A.3)

(a) Emissions from Illegal Disposal

Background

In Japan, waste is disposed of in landfill sites pursuant to the Wastes Disposal and Public Cleansing Law, but a small portion is disposed of illegally. Although this disposal in reality generally satisfies the conditions of controlled disposal sites as defined in the *Revised 1996 IPCC Guidelines*, because it is not appropriate management under the law, methane emissions arising from illegal disposal are put under "Other (6.A.3.)."

Methodology

"Waste wood" and "waste paper" are types of waste which contain biodegradable carbon content and which are illegally disposed without incineration, but because the amount of waste paper that remains is very small, only waste wood is estimated.

Just as with emissions from controlled disposal sites (6.A.1.), a unique Japanese method is used for estimation. Emissions from the part of the wood that is illegally disposed of without incineration are estimated by multiplying an emission factor by the amount of wood (dry basis) that degrades in the estimation year.

Emission Factors

Almost all instances of illegal dumping in Japan are anaerobic landfilling, and therefore the emission factor used is the same as that of anaerobic disposal sites for "waste wood emissions from controlled disposal sites".

Activity Data

The residual portion of illegally disposed of waste wood is multiplied by the percentage of solids and the decomposition rate to arrive at activity data. The amount of illegally disposed of waste wood is determined from Waste Wood (Construction and Demolition) in "*Study on Residual Amounts of Industrial Waste from Illegal Dumping and other Sources*" (Ministry of the

Environment, Waste Management and Recycling Department). However, because the amount of illegal dumping for each year cannot be determined, the residual amount of illegally dumped waste wood was estimated by discovery year using the “Remaining Number of Instances and Residual Amount by Discovery Year” in the same report. The percentage of solids and decomposition rate used are the same as those for waste wood that are used in estimating emissions from controlled disposal sites.

Table 8-7 Activity data (kt) of illegally disposed of waste wood (dry basis)

	Unit	1990	1995	2000	2003	2004
Activity data	kt(dry)	1.0	1.7	3.5	5.7	4.9

(b) Emissions from Composting of Organic Waste

Background

Part of the municipal solid waste and industrial waste generated in Japan is composted, and the methane and nitrous oxide generated in that process are emitted from composting facilities. Because the current CRF has no subcategory for these emissions, they are counted as CH_4 emissions in “Other (6.A.3.).” The N_2O emissions are reported in 6.D. due to the lack of such a category.

Methodology

To calculate emissions, the amount of composted organic waste was multiplied by an emission factor that is determined in accordance with the water percentage of the organic waste. Methane and nitrous oxide emissions are both calculated in the same way.

$$E = EF_{dry} \times A_{dry} + EF_{wet} \times A_{wet}$$

E : Amount of CH_4 (N_2O) emissions generated by composting organic waste
EF_{dry}: Emission factor when the water percentage is “dry” (wet basis)
A_{dry} : Amount of composted organic waste corresponding to “dry” water percentage (wet basis)
EF_{wet} : Emission factor when water percentage is “wet” (wet basis)
A_{wet} : Amount of composted organic waste corresponding to “wet” water percentage (wet basis)

Emission Factors

The factors were set uniformly at 10.0 (kg-CH_4/t), 0.6 (kg-N_2O/t) when water percentage is dry, and 4.0 (kg-CH_4/t), 0.3 (kg-N_2O/t) when it is wet.

Activity Data

The amount of composted municipal solid waste is determined for each type by finding the amount of municipal solid waste in rapid composting facilities from “State of Waste Treatment” in *Waste Treatment in Japan* (Ministry of the Environment, Waste Management and Recycling

Department), and multiplying that by the percentages of constituents of municipal solid waste in rapid composting facilities according to "Percentages of Constituents in Waste to Be Treated According to Facility" in the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*. As the amount of composted industrial waste, we used the sludge input amount given in "Farmland Use (Composting Facilities)" for sewage sludge in *Sewage Statistics*.

Depending on the water percentage of composted organic waste, emission factors are either "dry" or "wet," but as there is no explanation of what water percentage is assumed, "dry" is used for waste paper, waste textiles, and waste wood, which on the average are under 50% water, while "wet" is used for sewage sludge and kitchen garbage, which average over 50%.

Table 8-8 Amounts of composted waste (kt)

	Unit	1990	1995	2000	2003	2004
dry waste	kt(wet)	3,330	3,255	3,073	2,892	2,833
wet waste	kt(wet)	494	520	439	344	308

8.2. Wastewater Handling（6.B.）

For wastewater handling (6.B.), the amount of wastewater was estimated as shown in Table 8-9.

Table 8-9 Categories for which wastewater amount is estimated under wastewater handling (6B)

Category	Type Estimated	Forms of Treatment		CH_4	N_2O
6.B.1. (8.2.1)	Industrial wastewater	(Sewage treatment plants)		○	○
6.B.2. (8.2.2)	Domestic/commercial wastewater	Sewage treatment plants (8.2.2.1)		○	○
		Domestic wastewater treatment facilities (mainly septic tanks) (8.2.2.2)	Community plant	○	○
			Gappei-shori johkasou	○	○
			Tandoku-shori johkasou	○	○
			Vault toilet	○	○
		Human waste treatment facilities (8.2.2.3)	High-load denitrification treatment	○	○
			Membrane separation	○	○
			Anaerobic treatment	○	○
			Aerobic treatment	○	
			Standard denitrification treatment	○	
			Other	○	
	Degradation of domestic wastewater in nature (8.2.2.4)	Discharge of untreated domestic wastewater	*Tandoku-shori johkasou*	○	○
			Vault toilet	○	○
			On-site treatment	○	○
		Sludge disposal at sea	Human waste sludge	○	○

8.2.1. Industrial Wastewater（6.B.1.）

Background

Industrial effluent generated by factories and other facilities in Japan is emitted from those facilities in accordance with regulations based on the Water Pollution Prevention Law and the Sewerage Law. Because methane and nitrous oxide generated in wastewater treatment are usually emitted instead of being recovered, these emissions are counted as “emissions from industrial wastewater treatment (6.B.1.)”.

Methodology

The *Good Practice Guidance (2000)* decision tree is followed in estimating methane emissions on a BOD basis and nitrous oxide emissions on a nitrogen basis for industries that have much organic matter in their wastewater. As the default values set in the *Revised 1996 IPCC Guidelines* seem unsuited to Japan’s situation, methane emissions were estimated by multiplying the annual amount of organic matter in industrial wastewater (BOD basis) by the emission factor per unit BOD, and nitrous oxide emissions were estimated by multiplying the amount of nitrogen in industrial wastewater by the emission factor of nitrous oxide generated when treating industrial wastewater.

$$E = EF \times A$$

E : amount of CH_4 or N_2O emissions generated when treating industrial wastewater (kg-CH_4, kg-N_2O)

EF : Emission factor (kg-CH_4/kg-BOD, kg-N_2O/kg-N)

A : Organic matter amount (kg-BOD) or nitrogen amount (kg-N) in industrial wastewater

Emission Factors

Although there are slight differences in the way this method is applied to industrial and domestic wastewater, there seems to be no great difference in application when compared by per unit BOD (per amount nitrogen). Therefore, the data on methane and nitrous oxide emissions in “8.2.2.1. Sewage Treatment Plant (6.B.2.-)” have been used to calculate the emission factor.

The methane emission factor was set according to the methane amount generated per unit BOD, which was estimated by dividing the methane amount emitted from wastewater treatment facilities of plants by the BOD concentration of the planned runoff water quality. Our value for the BOD concentration of runoff water was obtained from Planned Runoff Water Quality of Municipal Solid Domestic Wastewater in *Guidelines and Explanation of Sewerage Facility Design* (Japan Sewage Works Association, 2001).

The nitrous oxide emission factor was determined by dividing the nitrous oxide emission amount from wastewater treatment facilities of plants by the nitrogen concentration of runoff water, and calculating the amount of nitrous oxide generated per amount of nitrogen. The nitrogen concentration of runoff water used was 37.2 mg-N/L, which was the simple average of the value for total nitrogen concentration of runoff water of sewage treatment plants, which was found in *Sewage Statistics 2003 (Admin. Ed.)*

CH_4 emission factor
$= $ (CH_4 emission amount at wastewater treatment facilities of each plants) / (BOD concentration of the planned runoff water quality)
$= 8.8 \times 10^{-4}$ ($kg\text{-}CH_4/m^3$) / 180 (mg-BOD/L) $\times$ 1000
$= 0.0489$ 0.049 ($kg\text{-}CH_4$/kg-BOD)

N_2O emission factor
$=$ (N_2O emission amount at wastewater treatment facilities of plants) / (N concentration of runoff water)
$= 1.6 \times 10^{-4}$ ($kg\text{-}N_2O/m^3$) / 37.2 (mg-N/L) $\times$ 1000
$= 0.043$ ($kg\text{-}N_2O$/kg-N)

Activity Data

-Overview

CH_4 emission activity data was estimated, with reference to the industries shown in the *Revised 1996 IPCC Guidelines*, by totaling the BOD burdens from industries whose wastewater had high BOD concentrations, and from which large methane emissions arise from treating their wastewater.

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.

CH_4 emission activity
$= \Sigma$[(amount of water used) × (percentage of industrial wastewater treated at treatment facilities emitting CH_4) × (percentage of industrial wastewater treated on-site) × (BOD concentration of runoff water)]

For nitrous oxide emission activity data, the amount of nitrogen in the industrial wastewater of each industrial sub-category was determined by taking the amount of wastewater entering wastewater treatment facilities that generate nitrous oxide, and multiplying it by the total nitrogen concentration of the runoff wastewater, which is done for industries whose wastewater contains much nitrogen.

N_2O emission activity
$= \Sigma$[(amount of water used) × (percentage of industrial wastewater treated at treatment facilities emitting N_2O) × (percentage of industrial wastewater treated on-site) × (nitrogen concentration of runoff water)]

-Amount of Water Used

The amount 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.

-Percentage of Industrial Wastewater Treated at Facilities Generating Methane

Methane arising from industrial wastewater treatment is believed to be generated by the treatment of wastewater with the activated sludge method and by anaerobic treatment. Industrial wastewater treatment percentages for each industry code were set from the percentages of reported wastewater amounts in total wastewater, as given under “active sludge”, “other biological treatment”, and “other advanced treatment” in each year’s *Study on the Control of Burdens Generated* (Environmental Ministry, Water and Air Environment Bureau).

-Percentage of Industrial Wastewater Treated at Facilities Generating Nitrous Oxide

Nitrous oxide arising from industrial wastewater treatment is believed to be generated mainly in biological treatment processes such as denitrification. Nitrous oxide emissions were estimated for the same sources as methane emissions were.

-Percentage of Industrial Wastewater Treated On-Site

Set at 1.0 in all industrial sub-categories because there is no statistical information available making it possible to ascertain this percentage.

-BOD and Nitrogen Concentrations in Runoff Wastewater

For the BOD concentration for industrial sub-categories we used the BOD raw water quality for industrial sub-categories given in the *Guidelines and Analysis of Comprehensive Planning Surveys for the Provision of Water Mains, by Catchment Area 1999 Edition* (Japan Sewage Works Association). For nitrogen concentration for industrial sub-categories, the same survey’s emission intensities (TN) for industrial sub-categories were used.

Table 8-10 Industries whose activity data were estimated and their BOD burdens (kt-BOD/y) (calendar year)

Industry code	Category of Manufacturing	Unit	1990	1995	2000	2003	2004
9	Food Manufacturing	kt-BOD	508.3	544.9	542.1	543.9	543.9
10	Beverage, Tobacco and Feeding Stuff Manufacturing	kt-BOD	137.9	142.7	139.0	121.7	121.7
11	Textile Manufacturing (excluding: Clothing Material,	kt-BOD	156.3	135.7	101.3	85.7	85.7
12	Clothing Material and Other Textile Manufacturing	kt-BOD	3.5	4.0	2.5	1.9	1.9
15	Pulp, Paper and Other Paper Manufacturing	kt-BOD	1,612.4	1,505.4	1,498.3	1,430.4	1,430.4
17	Chemical Industries	kt-BOD	684.1	636.5	656.9	651.5	651.5
18	Petroleum Products and Coal Product Manufacturing	kt-BOD	3.0	2.2	2.6	1.6	1.6
19	Plastic Products Manufacturing	kt-BOD	12.3	11.8	12.4	13.1	13.1
20	Rubber Products Manufacturin	kt-BOD	0.9	0.9	0.6	0.6	0.6
21	Chamois, Chamois Products and Fur Skin Manufacturing	kt-BOD	5.9	5.0	3.7	2.9	2.9
	Total	kt-BOD	3,125	2,989	2,959	2,853	2,853

* Data for the most recent year are substituted with data from the year immediately preceding.

Sources: Calculated from BOD concentration in *Guidelines and Analysis of Comprehensive Planning Surveys for the Provision of Water Mains, by Catchment Area 1999 Edition* (Japan Sewage Works Association) and volume of wastewater in *Table of Industrial Statistics: Land and Water* (Ministry of Economy, Trade, and Industry).

Table 8-11 BOD (kt-BOD) and nitrogen (kt-N) amounts in industrial wastewater

	Unit	1990	1995	2000	2003	2004
BOD load	kt-BOD	1,100	1,060	1,045	1,005	1,005
TN load	kt-N	91	90	78	81	81

8.2.2. Domestic and Commercial Waste water (6.B.2.)

Background

Domestic and commercial waste water generated in Japan is treated at various kinds of wastewater treatment facilities. Because the methane and nitrous oxide generated in wastewater treatment are usually emitted instead of being recovered, these emissions are counted in “emissions from treatment of domestic and commercial wastewater (6B2)”. Because the methane and nitrous oxide emission characteristics differ from one wastewater treatment facility to another, a different emission calculation method is established for each facility.

8.2.2.1. Sewage Treatment Plant (6.B.2.-)

Methodology

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-2006.xls¥6B2-D&C* for details of the calculation process).

$$E = EF \times A$$

E : Amount of CH_4 or N_2O emitted from sewage treatment plants in conjunction with domestic/commercial wastewater treatment (kg-CH_4, kg-N_2O)

EF: Emission factor (kg-CH_4/m^3, kg-N_2O/m^3)

A : Yearly amount of sewage treated at a sewage treatment plant (m^3)

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. (Water treatment process: 528.7 [mg-CH_4/m^3], 160.3 [mg-N_2O/m^3]; sludge treatment process: 348.0 [mg-CH_4/m^3], 0.6 [mg-N_2O/m^3])

Calculation of methane emission factor

= Simple average of emission factor for water treatment processes
+ Simple average of emission factor for sludge treatment processes
= 528.7 [mg CH_4/m^3] + 348.0 [mg CH_4/m^3]
= 8.764×10^{-4} [kg CH_4/m^3]
= 8.8×10^{-4} [kg CH_4/m^3]

Calculation of nitrous oxide emission factor

= Simple average of emission factor for water treatment processes
+ Simple average of emission factor for sludge treatment processes
= 160.3 [mg N_2O/m^3] + 0.6 [mg N_2O/m^3]
= 1.609×10^{-4} [kg N_2O/m^3]
= 1.6×10^{-4} [kg N_2O/m^3]

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.)*.

In order to avoid overestimates of activity data, volumes subject to primary processing was subtracted from the annual volume of water treated because methane and nitrous oxide emitted from this source are primarily emitted from biological reaction tanks although the annual volume of water treated as given in the *Sewage Statistics (Admin. Ed)* includes primary treatment volumes that are only subject to settling.

Activity data
= (Annual volume of water treated at sewage treatment plants)
– (Annual input volume for primary processing at sewage treatment plants)

Table 8-12 Activity data

	Unit	1990	1995	2000	2003	2004
Annual Amounts of Wastewater Treated	$10^6 m^3$	9,857	10,392	12,519	13,185	13,485

8.2.2.2. Domestic Sewage Treatment Plant （Private Sewerage Tank）（6.B.2.-）

Methodology

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-2006.xls¥6B2-D&C* for details of the calculation process).

$$E = \sum \left(EF_i \times A_i \right)$$

E: Emissions of methane and nitrous oxide from the processing of domestic and commercial wastewater at domestic sewage treatment plants (i.e. household septic tanks) (kg-CH_4, kg-N_2O)

EF_i : Emission factor for domestic sewage treatment plant i (kg-CH_4/person, kg-N_2O/person)

A: Population (persons) requiring waste processing at domestic sewage treatment plant i per year.

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. (Table 8-13, Table 8-14)。

"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 8-13 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]	0.195

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 8-14 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 Waste Management and Recycling Department, Ministry of the Environment's *Waste Treatment in Japan*, (belew, *Waste Treatment in Japan*) was used as the activity data for methane and nitrous oxide emitted in association with domestic waste water treatment facilities.

Table 8-15 Activity data (per 1,000 persons)

	Unit	1990	1995	2000	2003	2004
Gappei-shori	1000 person	7,983	8,515	10,806	12,560	12,560
Tandoku-shori	1000 person	25,119	26,105	23,289	19,956	19,956
Vault toilet	1000 person	38,920	29,409	20,353	16,049	16,049
Community plant	1000 person	493	398	414	362	362
Total	1000 person	72,515	64,427	54,862	48,927	48,927

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 2004, more than 79% 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.

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

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-2006.xls¥6B2-D&C* for details of the calculation process).

$$E = \sum \left(EF_i \times A_i \right)$$

E: Emission of methane from the processing of domestic and commercial wastewater at human waste treatment plants (kg-CH_4)

EFi: Emission factor for human waste treatment plants (for treatment process i) (kg-CH_4/m^3)

A: Input volume of human waste and septic tank sludge at human waste treatment plants (for treatment process i) (m^3)

Emission Factors

Methane emission factors were determined by treatment processes type, including anaerobic, aerobic, standard denitrification and high-load denitrification treatments as well as membrane separation systems, for each of the human waste treatment plants.

Table 8-16 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.

Activity Data

Activity data for methane emissions associated with the processing of wastewater at human waste treatment plants was determined from the calculated throughput volume for each of the treatment processes by multiplying the total volume of human waste and septic tank sludge processed at human waste treatment plants that were indicated in *Waste Treatment in Japan*

(Table 8-17), by the percentage throughput of each treatment process (Table 8-18).

Table 8-17 Volume of human waste treated at their treatment plants

	Unit	1990	1995	2000	2003	2004
Vault Toilet	1000kl/year	20,406	18,049	14,673	12,390	12,390
ST aludge	1000kl/year	9,224	11,545	13,234	13,797	13,797
Total	1000kl/year	29,630	29,594	27,907	26,187	26,187

Data from *Waste Treatment in Japan*

Table 8-18 Trends in treatment capacity by treatment process

	Unit	1990	1995	2000	2003	2004
AnaerobicTreatment	kl/day	34,580	19,869	10,996	8,090	8,090
AerobicTreatment	kl/day	26,654	19,716	12,166	10,005	10,005
StandardDenitrogen	kl/day	25,196	30,157	31,908	32,375	32,375
High-IntensityDenitrogen	kl/day	8,158	13,817	16,498	17,177	17,177
MembraneSeparation	kl/day	0	1,616	2,375	4,401	4,401
Other	kl/day	13,777	20,028	25,917	28,716	28,716

Table 8-19 Activity Data

	Unit	1990	1995	2000	2003	2004
AnaerobicTreatment	1000kl/year	9,455	5,589	3,073	2,102	2,102
AerobicTreatment	1000kl/year	7,288	5,546	3,400	2,600	2,600
StandardDenitrogen	1000kl/year	6,889	8,483	8,917	8,414	8,414
High-IntensityDenitrogen	1000kl/year	2,231	3,887	4,611	4,464	4,464
MembraneSeparation	1000kl/year	0	455	664	1,144	1,144
Other	1000kl/year	3,767	5,634	7,243	7,463	7,463
Total	1000kl/year	29,630	29,594	27,907	26,187	26,187

2) N_2O

Methodology

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-2006.xls¥6B2-D&C* for details of the calculation process).

$$E = \sum \left(EF_i \times A_i \right)$$

E: Emission of nitrous oxide from the processing of domestic and commercial wastewater at human waste treatment plants (kg-N_2O)

EF_i: Emission factor for human waste treatment plants (by treatment process i) (kg-N_2O/kg-N)

A_i: Amount of nitrous oxide in human waste and septic tank sludge input at human waste treatment plants (by treatment process i) (kg-N)

Emission Factors

Emission factor for nitrous oxide was determined for each of the various treatment processes, including high-load denitrification treatment and membrane separation systems.

Table 8-20 Nitrous oxide emission factors by each treatment process

Treatment method	N_2O 排出係数[kg N_2O-N/kg-N]		
	FY1990-1994	FY1995-2002	FY2003 -
high load de-nitrification treatment	0.021[a]	Calculated by interpolation using the values of FY1994 and FY 2003	0.0019[b]
membrane separation	0.021[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).

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 *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.

Activity data
= [(Input volume of human waste at human waste treatment plants) × (Nitrogen concentration in human waste)
+ (Input volume of septic tank sludge at human waste treatment plants) × (Nitrogen concentration in septic tank sludge)]
× (percentage throughput of treatment process *i*)

○ Input volume of human waste and septic tank sludge at human waste treatment plants:

Refer to the data used for the calculation of methane emissions from human waste treatment plants (Table 8-17).

○ Percentage throughput of the human waste treatment processes:

Refer to the data used for the calculation of methane emission from human waste treatment plants (Table 8-18).

○ Nitrogen concentration in human waste and septic tank sludge input at treatment plants:

See Table 8-21.

Table 8-21Concentration of nitrogen contained in collected human waste and sewage in sewerage tank

	Unit	1990	1995	2000	2003	2004
Vault Toilet	mg-N/l	3,940	3,100	2,700	2,700	2,700
ST aludge	mg-N/l	1,060	300	580	580	580
Weighted average	mg-N/l	3,043	2,008	1,695	1,583	1,583

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 8-22 Activity data: Amount of nitrogen in human waste and septic tank sludge processed at human waste treatment plants

	Unit	1990	1995	2000	2003	2004
AnaerobicTreatment	kt-N	28.8	11.2	5.2	3.3	3.3
AerobicTreatment	kt-N	22.2	11.1	5.8	4.1	4.1
StandardDenitrogen	kt-N	21.0	17.0	15.1	13.3	13.3
High-IntensityDenitrog	kt-N	6.8	7.8	7.8	7.1	7.1
MembraneSeparation	kt-N	0.0	0.9	1.1	1.8	1.8
Other	kt-N	11.5	11.3	12.3	11.8	11.8
Total	kt-N	90.2	59.4	47.3	41.5	41.5

8.2.2.4. Emission from the Natural Decomposition of Domestic Wastewater (6.B.2.-)

Background

Although most of the domestic wastewater generated by Japanese households is processed at wastewater treatment plants, some is discharged untreated into public waters. The domestic wastewater thus disposed of decomposes naturally and emits methane and nitrous oxide. The amounts of methane and nitrous oxide emitted from this source are reported in the *Emissions from Processing of Domestic and Commercial Wastewater (6.B.2.)*.

Methodology

Methane emissions were calculated by multiplying the volume of organic matter contained in the untreated domestic wastewater that was discharged into public waters by the emission factor. The nitrous oxide emission was calculated by multiplying the volume of nitrogen contained in the wastewater by the emission factor.

$$E = EF \times A$$

E: Emission of methane or nitrous oxide from the natural decomposition of domestic wastewater (kg-CH_4; kg-N_2O)

EF: Emission factor (kg-CH_4/kg-BOD; kg-N_2O/kg-N)

A: Volume of organic matter (kg-BOD) or nitrogen (kg-N) in domestic wastewater

Emission Factors

The emission factor for methane was established by multiplying the maximum methane generation potential by a methane correction factor (MCF). The maximum methane generation potential was set to 0.6 kg-CH4/kg-BOD, and the MCF was set to the amount of wastewater discharged to seas, rivers and lakes (0.1) from “Untreated systems”. The emission factor for nitrous oxide was calculated from the value (0.0125 kg-N2O-N/kg-N) after conversion of the units.

Activity Data

Activity data were calculated for the categories of “domestic wastewater from households using tandoku-shori johkasou (a system developed in Japan for on-site treatment of human waste only) and vault toilets”, “domestic wastewater from households using on-site disposal systems”, and “human waste dumped into ocean”, by the following method:

Table 8-23 Calculation method for activity data used for the calculation of GHG emissions from the natural decomposition of domestic wastewater

	Methane emission activity data	Nitrous oxide emission activity data
Tandoku-shori johkasou	User population (persons) × Unit BOD from domestic wastewater (g-BOD/person·day)	User population (persons) × Unit nitrogen from domestic wastewater (g-N/person·day)
Vault toilet		
On-site disposal [a)]	Population using on-site disposal system (person) × Unit BOD from domestic wastewater (g-BOD/person·day)	Population using on-site disposal system (person) × Unit nitrogen from domestic wastewater (g-N/person·day)
Ocean dumping	Human waste dumped in ocean (kL) × Unit BOD from human waste (g-BOD/person·day) / human waste discharge per capita (L/person·day)	Human waste dumped in ocean (kL) × Unit nitrogen from human waste (g-N/person·day) / human waste discharge per capita (L/person·day)

Source: Volumes for *tandoku-shori johkasou*, vault toilets, on-site disposal systems and ocean dumping, and human waste discharge per capita – *Waste Treatment in Japan*

Unit BOD and unit nitrogen from domestic wastewater – *1999 Survey of Comprehensive Sewerage System Development Program by Watershed – Guidelines and Commentaries*

a) A portion of the human waste in on-site disposal systems is utilized as fertilizer on farmlands in Japan. The nitrous oxide emission from this portion of human waste is already included in the “Direct emission from soil (4D)” category in the Agriculture section, and therefore, not included in the calculation for this source.

Table 8-24 Activity data: Emission from natural decomposition of domestic wastewater

	Unit	1990	1995	2000	2003	2004
Tandoku-shori	kt-BOD	367	381	341	291	292
Vault Toilet	kt-BOD	568	429	298	234	235
On-site disposal	kt-BOD	46	21	9	6	6
Ocean dumping	kt-BOD	33	21	12	7	7
Total	kt-BOD	1,014	853	661	538	540

	Unit	1990	1995	2000	2003	2004
Tandoku-shori	kt-N	18	19	17	15	15
Vault Toilet	kt-N	28	21	15	12	12
On-site disposal	kt-N	2	1	0	0	0
Ocean dumping	kt-N	16	11	6	3	3
Total	kt-N	65	52	39	30	30

8.3. Waste Incineration（6.C.）

Japan classifies waste into municipal solid waste and industrial waste. Statistics are compiled according to these classifications. A method for the calculation of emissions from waste incineration was developed for each of the categories shown in Table 8-25.

Table 8-25 Categories for the calculation of emissions from waste incineration (6C)

Category		Item		CO_2	CH_4	N_2O
Simple incineration (8.3.1)	Municipal solid waste	Plastics		○	○ (by incinerator)	○ (by incinerator)
		Synthetic textile scraps		○		
		Other biomass-derived waste a)				
	Industrial waste	Waste oil		○	○	○
		Waste plastics		○	○	○
		Synthetic textile scraps		○	○	○
		Other biomass-derived waste a)			○	○
	Specially controlled industrial waste	Waste oil		○	○	○
		Infectious waste	Plastics	○	○	○
			Non-plastics		○	○
Used as raw material or fuel (8.3.2)	Municipal solid waste as raw material or fuel	Plastics		○	○	○
	Industrial waste as raw material or fuel	Waste plastics		○	○	○
		Waste oil		○	○	○
		Wood scraps			○	○
	Waste tires as raw material or fuel			○	○	○
	Refuse-derived solid fuel (RDF and RPF) as fuel			○	○	○

a) 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. 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.*

Reporting of Waste Used as Alternative Fuels

The IPCC Guidelines indicate that waste used as an alternative fuel is to be accounted for in the Energy section. In Japan, however, all emissions from the incineration of waste, including those from the use as raw material or fuel, are accounted for in the Waste section, because the incineration of waste is a main treatment system of waste handling in Japan, etc.. The emissions from waste incinerated as raw material or fuel are estimated separately as constituents of the waste.

8.3.1. Incineration of Municipal Solid Waste, Industrial Waste, and Specially controlled Industrial Waste (6.C.-)

Background

Japan uses incinerators to reduce the volume of much of the municipal solid waste, waste oil from industry, some waste plastics, much of the synthetic textile scraps, and much of the specially controlled industrial waste. Emissions of carbon dioxide, methane, and nitrous oxide from the incineration of these wastes are accounted for in the category of the Emissions from Waste Incineration (6.C.).

Because municipal solid waste contains both biogenic and non-biogenic waste, methane and nitrous oxide emissions are estimated as the total that includes biogenic waste, and is reported in the “Plastic and other non-biogenic waste” category. The methane and nitrous oxide emissions from the incineration of industrial waste are reported in either the “biogenic” or “plastics and other non-biogenic waste” category, depending on the type of waste.

8.3.1.1. Municipal Solid Waste Incineration (6.C.-)

CO_2

Methodology

Emissions of carbon dioxide from this source were derived by using the volume of waste plastic incinerated (dry base) and emission factor calculated Japan’s country-specific data, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 5.24, Fig 5.5). The calculation covered the waste plastics and synthetic textile scraps included in municipal solid waste. The portions of the waste used for heat recovery and power generation are included in the calculation of emissions from this source, since it is difficult to account for activity data separately from the data for simple incineration.

$$E = EF \times A$$

E: Emission of carbon dioxide from the incineration of various types of waste (kg-CO_2)

EF: Emission factor for the incineration of various types of waste (dry base) (kg-CO_2/t)

A: Volume of each type of waste incinerated (dry basis) (t)

Emission Factors

○ Outline

Based on the approach taken by the *Revised 1996 IPCC Guidelines*, the emission factor for this source was calculated by multiplying the carbon content of each type of waste by the rate of combustion at each incinerator.

CO_2 emission factor (dry basis)
= 1000 [kg] × Carbon content × Rate of combustion × 44/12

○ Carbon content

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.

For the carbon content of synthetic textile scraps contained in municipal solid waste, the carbon content of the synthetic fibers in the textile products was used, with the average content calculated from the molecular formulas of polymers for each type of synthetic textile weighted by the volume of synthetic textile consumption.

○ Incineration rate

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.

Table 8-26 Carbon content

Item	Unit	1990	1995	2000	2003	2004
Plastics	%	70.4%	72.7%	74.2%	74.9%	74.9%
Synthetic textile	%	63.0%	63.0%	63.0%	63.0%	63.0%

Activity Data

Activity data for carbon dioxide emission from the incineration of waste plastics in municipal solid waste was calculated by multiplying the volume of plastics incinerated by the percentage of solid plastics. Similarly, activity data for synthetic textile scraps was calculated by multiplying the incinerated volume of textile scraps in municipal solid waste by the percentage of solids in textile scraps and the percentage of synthetic fibers in the textile scraps.

The percentage of the waste used for power generation was determined from the value calculated by multiplying the volume that was incinerated at a municipal solid waste incinerator with a generation efficiency of 10% or more by the total volume of municipal solid waste incinerated.

Activity data for incineration of plastics (MSW) (dry basis)
= Volume of plastics incinerated × percentage of solid plastics content

Activity data for incineration of synthetic textile scraps (MSW) (dry basis)
= Volume of textile scraps incinerated × percentage of solid content in textile scraps × percentage of synthetic fiber content in textile scraps

○ Incineration volume by type of municipal solid waste

The values were extracted from the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*.

○ Percentage of solid content

The percentage of solid plastics contained in municipal solid waste was calculated using the water content (20%) indicated in the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*. The percentage of solid content in the textile scraps contained in municipal solid waste was calculated using the water content (20%) determined by specialists on the basis of existing studies in Japan.

○ Percentage of synthetic textile scraps in textile scraps

The percentage of synthetic textile scrap content in textile scraps contained in the municipal solid waste was calculated using the percentage of synthetic textile products in textile products, which was determined using the ratio of the demand for synthetic textile to the demand for all textiles in Japan for each year for which the data were available in the Textile Statistics Yearbooks.

Table 8-27 Incineration of plastics and synthetic textile scraps (MSW)

Item	Unit	1990	1995	2000	2003	2004
Plastics	kt / year (dry)	3,998	4,160	4,919	4,844	4,844
Synthetic textile	kt / year (dry)	476	531	473	513	522

CH_4

Methodology

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-2006.xls¥MSW* for details of the calculation process.)The emissions from the portion of waste used for power generation were included in the emissions from this source in the same manner as in the calculation of carbon dioxide emissions.

$$E = \sum \left(EF_i \times A_i \right)$$

E: Emission of methane from the incineration of the municipal solid waste (kg-CH_4)

EF_i: Emission factor for incineration method i for municipal solid waste (wet basis) (kg-CH_4/t)

A_i: Volume of municipal solid waste incinerated by method i (wet basis) (t)

Emission Factors

The emission factor for methane from this source was determined for individual facilities according to the actual measurement data of the methane concentration in flue gas from the facilities. The emission factors were not adjusted for atmospheric concentration of methane. A weighted average was estimated 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 8-28 CH_4 emission factors, by type of incineration facility, for municipal solid waste

Item	Unit	1990	1995	2000	2003	2004
Continuous Incinerator	g-CH_4/t	8.212	8.212	8.281	8.396	8.396
Semi-Continuous Incinerator	g-CH_4/t	70	70	75	82	82
Batch type Incinerator	g-CH_4/t	81	81	84	86	86

* Data 2004 has been substituted for 2003 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 , *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 , 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 , Ministry of the Environment *Waste Treatment in Japan.*

Table 8-29 Amount of incineration, by type of incineration facility, for MSW

Item	Unit	1990	1995	2000	2003	2004
Continuous Incinerator	kt / year (wet)	26,215	29,716	32,729	35,220	35,220
Semi-Continuous Incinerator	kt / year (wet)	4,810	5,455	5,813	4,871	4,871
Batch type Incinerator	kt / year (wet)	5,643	4,328	3,094	1,842	1,842

N_2O

Methodology

Emissions of nitrous oxide from the incineration of municipal solid waste were determined in accordance with the Decision Tree in the Good Practice Guidance (2000) (Page 5.27, Fig. 5.6). Specifically, the emissions were calculated by multiplying the volume of the municipal solid waste incinerated (wet basis) by Japan's country-specific emission factor that was determined from the nitrous oxide concentration of flue gas from the incinerators of municipal solid waste. The emissions from the portion of waste used for power generation were included in the emissions from this source in the same manner as in the calculation of carbon dioxide emissions.

Emission Factors

Emission factors for nitrous oxide were calculated for individual incineration facilities based on the actual measurement data of nitrous oxide concentration in flue gas from these facilities. Emission factors were established for each type of incinerator by using the same weighted average method used for determining the methane emission factors.

Table 8-30 N_2O emission factors by type of facility for incinerating municipal solid wastes

Item	Unit	1990	1995	2000	2003	2004
Continuous Incinerator	g-N_2O/t	58.8	58.8	59.1	59.7	59.7
Semi-Continuous Incinerator	g-N_2O/t	56.8	56.8	57.3	57.9	57.9
Batch type Incinerator	g-N_2O/t	71.4	71.4	74.8	76.2	76.2

* Data 2004 has been substituted for 2003 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 , 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.

8.3.1.2. Industrial Wastes Incineration (6.C.-)

CO_2

Methodology

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 5.26, Fig. 5.5)

Emission Factors

○ Outline

In accordance with the approach taken by the *Revised 1996 IPCC Guidelines*, an emission factor was calculated by multiplying the carbon content of each type of waste by the rate of combustion at incineration facilities.

Carbon dioxide emission factor
= 1000 [kg] × Carbon content × rate of combustion × 44/12

○ 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)*.

On the assumption that the carbon content of synthetic textile scraps contained in industrial waste was similar to the carbon content of synthetic textile scraps contained in municipal solid waste, the carbon content of synthetic textile scraps contained in industrial waste was determined on the same basis as for the carbon content of synthetic textile scraps contained in municipal solid waste (dry basis).

○ 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*.

Activity Data

The volume of waste oil and plastics in industrial waste that was incinerated was used unchanged for the activity data for the carbon dioxide emissions from the incineration of the waste in these categories. Waste oil was deemed to be entirely derived from fossil fuel. Activity data for synthetic textile scraps was calculated by multiplying the incinerated volume of textile scraps in industrial waste by the percentage of solid content of textile scraps and the percentage of synthetic fiber content in the textile scraps.

Activity data for the incineration of waste oil and plastics (ISW) (wet basis)
= Volume of waste oil and plastics incinerated

Activity data for the incineration of synthetic textile scraps (ISW) (dry basis)
= Incinerated volume of textile scraps × percentage of solid content of textile scraps × percentage of synthetic fiber content in textile scraps

○ Incinerated volume by type of industrial solid waste:

The values were extracted from the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*.

○ Percentage of solid content in textile scraps

Percentage of solid content of textile scraps contained in industrial waste was calculated using a moisture content (15%) determined by specialists.

○ Percentage of synthetic textile scrap content in textile scraps

The percentage of synthetic textile scraps in the textile scraps contained in industrial waste was expediently taken as the intermediate values (25%) of the percentages of synthetic fiber content in the textile scraps contained in industrial waste defined in the *Waste Handbook*.

Table 8-31 Incinerated ISW (waste oil, waste plastics, and synthetic textile scraps)

Item	Unit	1990	1995	2000	2003	2004
Waste Oil	kt / year (wet)	1,555	1,948	2,309	2,569	2,569
Waste Plastics	kt / year (wet)	920	1,922	1,947	1,964	1,964
Synthetic textile scraps	kt / year (dry)	6.6	10.4	10.6	8.5	8.5

CH_4

Methodology

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-2006.xls¥ISW* for details of the calculation process).

$$E = \sum \left(EF_j \times A_j \right)$$

E: Emission of methane from the incineration of industrial waste (kg-CH_4)

EF_j: Emission factor for waste type j (wet basis) (kg-CH_4/t)

A_j: Incinerated volume of waste type j (wet basis) (t)

Emission Factors

Emission factors were calculated for individual incineration facilities based on the existing survey data of the methane concentration in flue gas. No adjustments were made for the atmospheric methane drawn into the facilities. The calculation of the emission factors used a weighted average of volumes by type of industrial waste incinerated at each facility.

Table 8-32 Methane emission factors for type of industrial waste

Type of waste	Emission factor [g CH_4 / t]	Remarks
Paper or wood scraps	0.022	Weighted average of data from 5 facilities
Waste oil	0.0048	Weighted average of data from 5 facilities
Waste plastics	0.030	Weighted average of data from 4 facilities
Sludge	0.014	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)

- For textile scraps and animal and plant residues or animal carcasses, the emission factors for paper or wood scraps were used.

Activity Data

The incinerated volume (wet basis) for each type of waste was used for the determination of activity data for methane emissions from the incineration of industrial waste.

○ Paper and wood scraps, waste oil, textile scraps, animal and plant residues or animal carcasses:

The incinerated volume was extracted from the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes* for each type.

○ Sludge

Activity data was taken as the aggregate of the values extracted from the *Volume of Other Incinerated Organic Sludge* section in the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes* and the *Volume of Incinerated Sewage Sludge* reported in a survey by the Ministry of Lands, Infrastructure, and Transport.

○ Waste oil and Waste plastics

The activity data determined for carbon dioxide emission from the types of waste oil and waste plastics in industrial waste was used.

Table 8-33 Incinerated ISW, by waste types

Item	Unit	1990	1995	2000	2003	2004
Waste paper, waste wood	kt / year (wet)	3,119	5,628	4,057	2,902	2,902
Sludge	kt / year (wet)	5,032	5,850	6,341	6,810	6,724
Waste textile	kt / year (wet)	31	49	50	40	40
Plant residues or animal carcasses	kt / year (wet)	77	125	272	187	187

N_2O

Methodology

Nitrous oxide emissions from this source were calculated by multiplying the incinerated volume of the industrial waste by Japan's country-specific emission factor. For sewage sludge, a separate emission factor was calculated for each type of flocculant and incinerator used, and where high-molecular-weight flocculants and fluidized-bed incinerators were used, separate emission factors were calculated for different combustion temperatures.

Emission Factors

○ Waste other than sewage sludge

Emission factors were calculated in Japan using the nitrous oxide concentration in flue gas based on existing survey data. No adjustments were made for atmospheric nitrous oxide drawn into incineration facilities. The final emission factors were calculated for each type of industrial waste using the weighted average of volumes incinerated at individual incineration facilities. It should be noted that the value for paper and wood scraps were used as a substitute for the values for textile scraps and animal and plant residues or animal carcasses.

$$ef_{i,j} = \frac{M_{i,j} \times G_{i,j} \times 1000 \times 44}{I_{i,j} \times 22.4}$$

$M_{i,j}$: Average nitrous oxide concentration in flue gas at incineration facility *j* that incinerates industrial waste *i* (ppm).

$G_{i,j}$: Dry volume of flue gas from incineration facility *j* that incinerated industrial waste *i* at the time of nitrous oxide concentration measurement (m^3N/h).

Table 8-34 Emission factor for nitrous oxide, by type of industrial waste

Type of industrial waste	Emission factor (g-N_2O/t)
Waste Paper, Waste Wood	20.92
Waste Oil	11.83
Waste Plastics	179.75
Sludge	456.22

The same emission factors are applied every year.

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 ⑵001⑶

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 ⑴996⑵

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 ⑴994⑵

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 for nitrous oxide from sewage sludge were calculated based on the actual measurement data. Specifically, the calculation weighted the average emission factor for each incineration facility by the volume of sewage sludge incinerated at the facility. As the emission factors vary depending on types of flocculants or incinerators used and the temperatures inside incinerators, the emission factors were determined separately for the categories shown in Table 8-35.

Table 8-35 Nitrous oxide emission factor for sewage sludge incineration

Type of flocculant	Type of incinerator	Combustion Temperature	Emission Factor （g-N_2O/t）
High-molecular-weight flocculant	Fluidized Bed Incinerator	normal temperature combustion（around 800℃）	1,508
	Fluidized Bed Incinerator	high temperature combustion（around 850℃）	645
	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)

Public Works Research Institute, Ministry of Construction and Nagoya City Water Authority, Report on Joint Research into the Behavior and Reduction of Waste Gas Components in Flux Furnaces (1994)

Public Works Research Institute, Ministry of Construction and Nagoya City Water Authority, Report on Joint Research into the Behavior and Reduction of Waste Gas Components in Flux Furnaces (1996)

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)

Activity Data

○ Industrial waste other than sewage sludge

Activity data (wet basis) was determined in the same manner as for the methane emissions from industrial waste with the exception that the “volume of other incinerated organic sludge” was used as activity data for the sludge (excluding sewage sludge).

○ Sewage sludge

The values in the “volume of incinerated sewage sludge, by flocculants and by incinerator types” reported in *Sewage Statistics (Admin. Ed.)* (Japan Sewage Works Association), were used for activity data (wet basis) for this source.

表 Table 8-36 Activity data for nitrous oxide emissions from incineration of sewage sludge

	Unit	1990	1995	2000	2003	2004
High-molecular-weight flocculant Fluidized Bed Incinerator (nomal temp.)	kt / year (wet)	1,112	1,869	2,397	2,693	2,671
High-molecular-weight flocculant Fluidized Bed Incinerator (high temp.)	kt / year (wet)	128	219	723	1,219	1,424
High-molecular-weight flocculant Multiple Hearth	kt / year (wet)	560	656	572	208	118
Lime Sludge	kt / year (wet)	1,070	767	341	527	333
Other	kt / year (wet)	190	316	267	188	202

8.3.1.3. Incineration of Specially controlled Industrial Waste (6.C.-)

CO_2

Methodology

Emissions of carbon dioxide from the incineration of waste oil and infectious plastic waste contained in specially controlled industrial waste were calculated in accordance with the Decision Tree included in the *Good Practice Guidance (2000)* (Page 5.26, Fig 5.5) using Japan’s country-specific emission factors and the incinerated volume.

Emission Factors

The emission factors for waste oil and plastics in industrial waste were used as the emission factor for waste oil and plastics in specially controlled industrial waste as it was believed that there was little difference between them in terms of carbon contents and rates of combustion.

Activity Data

On the assumption that the entire volume of waste oil and infectious plastic waste contained in specially controlled industrial waste was incinerated, carbon emission activity data was calculated using the output volume of the waste oil indicated in the Report on Survey of Organizations in Industrial Waste Administration (Water Supply Division, Health Service Bureau, the Ministry of Health and Welfare) for the waste oil. For the plastics in infectious waste, the activity data was calculated by multiplying the output volume of infectious waste reported by the same survey by the percentage of plastic content in infectious waste indicated in the Waste Handbook as the result of a composition analysis of infectious waste.

Activity data for incineration of waste oil (specially controlled ISW) (wet basis) = Output volume of waste oil
Activity data for incineration of plastics in infectious waste (specially controlled ISW)(wet basis) = Output volume of infectious waste × percentage of plastic content in infectious waste

CH_4

Methodology

Emissions of methane from the incineration of waste categorized as “waste oil” and “infectious waste” of specially controlled industrial waste were calculated by multiplying the volume of incinerated waste by type (wet basis) by Japan’s country-specific emission factor.

Emission Factors

Because actual measurement data were not available, the emission factors for the incineration of industrial waste were used as substitutes for determining the emission factor for each type of specially controlled industrial waste. Specifically, the substitute emission factors used were the waste oil in industrial waste for the waste oil; the waste plastics in industrial waste for the infectious waste plastics; and paper and wood scraps in industrial waste for non-plastic infectious waste.

Activity Data

Activity data for the waste oil and infectious waste plastics were calculated using the same values as those used in the calculation of activity data associated with carbon dioxide emission. The volume of non-infectious waste plastics incinerated was deemed to be the same as the output volume, and calculated by multiplying the output volume of infectious waste by the percentage of non-plastic content in infectious waste.

N_2O

Methodology

Emissions of nitrous oxides from the incineration of the waste oil and infectious waste in specially controlled industrial waste were calculated by multiplying the incinerated volume of each type of waste (wet basis) by Japan’s country-specific emission factor.

Emission Factors

Because actual measurement data were not available, the nitrous oxide emission factors for the incineration of industrial waste were used as substitutes for determining the emission factor for each type of specially controlled industrial waste. Specifically, the substitute emission factors used were the waste oil in industrial waste for the waste oil; the waste plastics in industrial waste for the infectious waste plastics; and the paper and wood scraps in industrial waste for non-plastic infectious wastes.

Activity Data

Activity data was calculated by using the same values used in the calculation of activity data associated with methane emissions.

Table 8-37 Incineration of specially controlled industrial waste

	Unit	1990	1995	2000	2003	2004
Waste oil	kt(wet)	256	380	560	623	623
Infections Wast (plastic)	kt(wet)	78	128	167	168	168
Infections Wast (non-plastic)	kt(wet)	105	172	225	227	227

8.3.2. Waste Used as Alternative Fuels (6.C.-)

CO_2

Methodology

Carbon dioxide emissions were calculated by multiplying the incinerated volume of each type of waste used as raw material or fuel by Japan’s country-specific emission factor. The wastes included in the calculation were the portions used as raw material or fuel of: plastics in municipal solid waste; waste plastics, oil in industrial waste; waste tires; and refuse-derived solid fuels (RDF and RPF).

Emission Factors

New emission factors were established for the plastics from municipal solid waste that were used as chemical raw material in coke ovens, waste tires, and the refuse-derived solid fuels (RDF and RPF). The remaining emission sources used the emission factors for simple incineration without raw material or fuel use (Ch 8.3.1.).

New emission factors	Plastics from municipal solid waste (as chemical raw material in coke ovens), waste tires, and refuse-derived solid fuels (RDF and RPF).
Emission factors for simple incineration	Plastics from municipal solid waste (other than those used as chemical material in coke ovens) and industrial waste

[Use of plastics as chemical raw material in coke ovens]

The emission factor for plastics used as chemical raw material in coke ovens was set by multiplying the emission factor for plastics not used as chemical raw material by the percentage of carbon in the plastics that migrates to hydrocarbon oil in the coke oven (47.9%) excluding the volume of hydrocarbon that is used as chemical raw material and from which no carbon dioxide is emitted into the air. The fraction of carbon in the plastics that migrates to hydrocarbon oil in the coke oven was determined from the average molecular weight and the weight-based transition rate obtained from existing survey data.

Calculation of the emission factor for plastics used as raw material in coke ovens (dry basis)
= (Emission factor for the incineration of plastics in municipal solid waste)
× [1 – (fraction of carbon in plastics used as chemical raw material for coke ovens that migrates to hydrocarbon)]

[Waste tires]

The emission factor for waste tires was calculated by multiplying the fossil fuel-derived carbon content of the waste tires by the rate of combustion of the waste tires at the facilities that use waste tires as fuel. The volume of the fossil fuel-derived carbon in the waste tires was calculated by the material contents of new tires. The rate of combustion for waste tires was set to 99.5% based on the maximum default value for hazardous waste in the *Good Practice Guidance (2000)*.

Calculation of emission factor for the incineration of waste tires (dry basis)
= (Fossil fuel-derived carbon content in waste tires) × (rate of combustion of waste tires) × 1000× 44 / 12

[Refuse-derived solid fuel (RDF, RPF)]

The emission factor associated with the use of the refuse-derived solid fuels (RDF and RPF) was calculated separately for RDF and RPF by the equation shown below. For the RPF (refuse paper and plastic fuel), the emission factors were calculated separately for the coal-equivalent and coke-equivalent fuels, and also calculated their average weighted by the percentage used as fuel.

Calculation of emission factor for the use of RDF and RPF as fuel (dry basis)
= 1000 × (average percentage of solids) × (percentage of plastic-derived constituents, dry basis) × (carbon content of plastics, dry basis) × (rate of combustion) × 44 / 12

○ Average percentage of solid content

The percentage of solids in the RDF was set to 94.5%, based on the simple average of moisture content in the RDF manufactured by the facilities listed in the *Proper Management of Refuse-derived Fuels* compiled by the Study Group for Proper Management of RDF.

The percentage of solids in the RPF was set to 97.4%, based on the moisture contents of coal-equivalent and coke-equivalent products indicated by the RPF quality standards set by the Japan RPF Industry Association with their average weighted by the manufacturing ratio of these products.

○ Percentage of plastic-derived content

The calculation of the percentage of the plastics-derived constituents (dry basis) used the wet-based moisture content of the constituents of municipal solid waste determined in the *Emission from Controlled Disposal Sites (6.A.1.)* section, which was converted to a dry-based value. The results of the content analysis of the wet-based refuse were obtained from the *Results of Content Analysis of Refuse* for each facility listed in the *Proper Management of Refuse-derived Fuels*.

The percentage of plastics-derived constituents in the RPF (dry basis) was set at 50% for the coal-equivalent product and 90% for the coke-equivalent product based on the results of a fact-finding survey by the Japan RPF Industry Association.

○ Carbon content in plastics

The average carbon content used in the *Incineration of Municipal Solid Waste (Plastics) (6C)* section was applied to the carbon content in plastics contained in the RDF (dry basis).

The carbon content (73.7%) of plastics contained in the RPF (dry basis) was determined from the carbon content value (70%) used in the *Incineration of Industrial Waste (Waste Plastics)* (Table 8-26), which was converted to a dry basis using the moisture content in waste plastics in industrial waste.

○ Rate of combustion

The rate of combustion of the RDF was set to 99%, applying the default value in the *Good Practice Guidance (2000)* in the same manner as for municipal solid waste (plastics). The rate for the RPF was set to 99.5%, using the default value in the *Good Practice Guidance (2000)* in the same manner as for industrial waste (waste plastics).

Table 8-38 Carbon dioxide emission factors associated with the incineration of RDF and RPF (kg-CO_2/t)

	Unit	1990	1995	2000	2003	2004
MSW-coke oven	kgCO_2/t(dry)	1,331	1,374	1,404	1,417	1,417
Waste tire	kgCO_2/t(dry)	1,858	1,785	1,790	1,770	1,753
RDF	kgCO_2/t(dry)	1,023	1,020	1,025	1,026	1,026
RPF (Coal)	kgCO_2/t(dry)	1,419	1,419	1,419	1,419	1,419
RPF (Coke)	kgCO_2/t(dry)	2,445	2,445	2,445	2,445	2,445
RPF	kgCO_2/t(dry)	1,627	1,627	1,627	1,627	1,627

Activity Data

[Municipal solid waste used as raw material and fuel]

The portion of the plastics in municipal solid waste used as raw material or fuel (dry basis) was determined by multiplying the total amount collected by designated legal bodies and municipalities and processed as raw material and fuel (wet basis) under the Containers and Packaging Recycling Law by the percentage of solids.

1. Processing of plastics collected by designated legal bodies

The amount of the plastics collected by designated legal bodies and processed into raw material and fuel was determined from the amount reported in the *Plastic Containers and Packaging (Other Plastics, Food Trays)* section of the *Statistics of Commercial Recycling of Plastics (Recycling)* compiled by the Japan Containers and Packaging Recycling Association. Usage in products that do not emit carbon dioxide was deducted.

2. Processing of plastics collected by municipalities

The amount of plastics collected by municipalities and processed into raw material and fuel was calculated by first subtracting the amount of plastics (wet basis) that was commercially recycled through designated legal bodies from the amount of all plastics that were commercially recycled under the *Plastic Containers and Packaging Recycling Law* (wet basis), and multiplying the result by the recycling rate of plastics by various methods and the percentage of recycled products in the total amount of the product.

(a). Amount of plastics commercially recycled under the *Plastic Containers and Packaging Recycling Law* (wet basis)

The results of the selective collections by municipalities and commercial recycling under the *Plastic Containers and Packaging Recycling Law* were determined from *Annual Recycling Statistics* by the Waste Management and Recycling Department of the Ministry of the Environment.

(b). Amount of plastics commercially recycled through designated legal body channels (wet basis)

The amount was determined from the *Actual Collection of Plastic Containers and Packages* section of the *Statistics of Commercial Recycling of Plastics (Recycling).*

(c). Percentage of commercially recycled plastics by recycling method

The rates were obtained from the percentages for various methods of commercial recycling of the plastics collected through municipal channels in the *Results of the 2001 Questionnaire to Municipalities on Waste Plastics Processing* compiled by the Plastic Waste Management Institute.

(d). Percentage of commercially recycled plastic products by recycling method

The values for the commercial recycling of the plastics collected through the municipal channels were substituted for the percentage of commercially recycled plastic products collected through designated legal body channels. The percentages were calculated by dividing the amounts of commercially recycled plastic products by various recycling methods, which were established in the activity data for recycling through designated legal body channels, by the amount of commercially recycled plastics. The amount of commercially recycled plastics by each of the recycling methods was calculated by multiplying the amount of plastics commercially recycled through designated legal body channels, which was calculated in (b), by the percentage of commercially recycled plastics by recycling method obtained from reference documents *Assessment and deliberation of the Plastic Containers and Packaging Recycling Law* by the Japan Containers and Packaging Recycling Association.

[Industrial waste plastics used as raw materials and fuels]

The calculation covered the amount (wet basis) of waste plastics in industrial waste that was used as raw material or fuel in the Steel Industry and the Cement Manufacturing Industry categories. Usage of raw material or fuel in the steel industry was obtained from the Current State of Plastic Waste Recycling and Future Tasks published by the Japan Iron and Steel Federation. Usage in the cement manufacturing industry was obtained from the Cement Handbook published by Japan Cement Association.

[Industrial waste oil used as raw materials and fuels]

The amount of waste oil used as raw material or fuel was extracted from the “fuel usage” in the “direct recycle usage” and the “fuel usage” in the “recycle usage after treatment” in the Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes. The values before 1998 are estimated by using the amount of incineration all industrial waste oil.

[Waste tires used as raw materials and fuels]

Activity data (dry basis) was calculated by multiplying the amount of waste tires used as raw material or fuel (wet basis), published in the Tire Industry of Japan of the Japan Automobile Tire Manufacturers Association, by the percentage of solids calculated using the average moisture content in the waste tires determined from analyses of three constituents of divided tires reported in the Basic Waste Data (*FactBook 2000*) published by Japan Environmental Sanitation Center.

[Refuse-derived solid fuels (RDF and RPF)]

The amount of RDF production was used as the substitute for the usage of the RDF fuel. The activity data was calculated by multiplying the percentage of solids in the RDF by the amount of fuel produced by refuse-based fuel production facilities (wet basis) indicated in the Report on Survey of State of Treatment of Municipal Solid Waste compiled by the Waste Management and Recycling Department of the Ministry of the Environment. The values for the years for which data were unavailable were estimated using the refuse processing capacity.

Determining the usage of RPF covered the paper and cement manufacturing industries which consumed a significant amount of the RPF. The usage of the RPF was calculated by multiplying the average percentage of solids in the RPF by the value in the statistical data compiled by the Japan Paper Association (dry basis) for the paper industry and by the statistical data compiled by the Japan Cement Association (wet basis) for the cement industry.

Table 8-39 Usage as raw materials and fuels (kt)

	Unit	1990	1995	2000	2003	2004
MSW-plastics-oilification	kt(dry)	0	0	3	5	5
MSW-plastics-reducer in blast furnace	kt(dry)	0	0	20	48	45
MSW-plastics-chemical material in coke-oven	kt(dry)	0	0	9	98	111
MSW-plastics-gasification	kt(dry)	0	0	1	22	42
ISW-waste plastics (Iron and steel)	kt(wet)	0	0	57	130	155
ISW-waste plastics (Cement)	kt(wet)	0	0	102	255	283
ISW-waste oil (cement baking furnace)	kt(wet)	141	233	359	411	450
ISW-waste oil (boiler)	kt(wet)	569	657	482	712	673
Waste tire	kt(dry)	282	471	580	428	445
RDF	kt(dry)	0	37	140	309	309
RPF	kt(dry)	0	8	25	172	289

CH_4、N_2O

Methodology

Emissions of methane and nitrous oxide from the combustion of the wastes used as raw material or fuel were determined by multiplying the amount used as fuel by Japan’s country-specific emission factors. The calculations covered the following that were used as raw material or fuel: plastics in municipal solid waste; waste plastics, waste oil, and wood scraps in industrial waste; waste tires; and refuse-based solid fuels (RDF and RPF). The portions of the waste used as raw material included in the calculations were determined as shown in Table 8-40 by taking into account the status of use in combustion and the availability of data.

Table 8-40 Calculation of methane and nitrous oxide emissions from the use of waste as raw material or fuel

		Usage included in calculation	Usage excluded from calculation
Plastics from municipal solid waste		Petrochemicals	Blast furnace reducing agents, chemical raw material for coke ovens, gasification
Industrial waste	Waste plastics	Cement kilns	Blast furnace reducing agents, petrochemical, gas
	Waste oil	Cement kilns, boilers	—
	Wood scraps	Boilers	—
Waste tires		Cement kilns, boilers, carbonization, gasification	Steel manufacturing
RDF and RPF		Cement kilns, boilers	—

Emission Factors

The emission factors for waste used as raw material and fuel were determined by multiplying the emission factor for applicable types of furnaces by the calorific value of each waste type, and converting the result to the weight-based values. Table 8-41 shows the data used in the calculation.

Calculation of emission factor (wet basis)

= (Emission factor for each type of furnace (kg-CH_4/TJ, kg-N_2O/TJ)) × (Calorific value of each waste type (MJ/kg)) / 1000

Table 8-41 Data used for the calculation of the methane and nitrous oxide emission factors for wastes used as raw material and fuel.

Item			Emission factor for furnaces and ovens	Calorific value
Plastics from municipal solid waste		Petrochemicals	Boilers (Fuel oil A, gas oil, kerosene, naphtha, other liquid fuels)	Calorific value of waste plastics
Industrial waste	Waste plastics	Cement kilns	Other industrial furnaces (solid fuel)	Calorific value of waste plastics
	Waste oil	Cement kilns, boilers	Other industrial furnaces (solid fuel)	Specific gravity of reclaimed oil/waste oil [a)]
		Boilers	Boilers (Fuel oil A, gas oil, kerosene, naphtha, other liquid fuels)	
	Wood scraps	Boilers	CH_4: Boilers (wood, charcoal) N_2O: Boilers (other than fluidized-bed) (solid fuel)	Calorific value of wood [b)]
Waste tires		Cement kilns	Other industrial furnaces (solid fuel)	Calorific value of waste tires
		Boilers	CH_4: Boilers (Steam coal, coke, other solid fuels) N_2O: Boilers (other than fluidized-bed) (solid fuel)	
		Carbonization	Boilers (gas fuels)	
		Gasification	Other industrial furnaces (gas fuels) and other industrial furnaces (liquid fuels) [c)]	
RDF		Boilers	CH_4: Boilers (Steam coal, coke, other solid fuels) N_2O: Boilers (other than fluidized-bed) (solid fuel)	Calorific value of RDF
RPF		Cement kilns, boilers	Other industrial furnaces (solid fuel)	Calorific value of RPF [d)]
		Boilers	CH_4: Boilers (Steam coal, coke, other solid fuels) N_2O: Boilers (other than fluidized-bed) (solid fuel)	

a) Calorific value per unit volume was determined by dividing by the specific gravity of waste oil (0.9 kg/L) obtained from the *Waste Handbook (1997)*.

b) Source: *1997 General Survey of Emissions of Air Pollutants*

c) The percentage of substances recovered during the gasification of waste tires. A weighted average was calculated using the proportions of gas and oil (22% and 43%) reported in the *Hyogo Eco-town* documents.

d) The average calorific value of the coal-equivalent and coke-equivalent RPFs, found in a document by the Japan RPF Industry Association, was weighted by the rate of production.

Table 8-42 Emission factors and calorific values for the use of waste as raw material and fuel by furnace type

Furnace type/Fuel type	Methane emission factor ($kg-CH_4/TJ$)	Nitrous oxide emission factor ($kg-N_2O/TJ$)	Source of fuel	Calorific value (TJ/kg)
Boilers (Fuel oil A, gas oil, kerosene, naphtha, other liquid fuels)	0.26	0.19	Waste plastics	29.3
Boilers (gas fuels)	0.23	0.17	Reclaimed oil*	40.2 (TJ/l)
Boilers (steam coal, coke, other solid fuels)	0.13		Waste tires	20.9
Boilers (wood, charcoal)	74.9		RDF	18.0
Boilers (other than fluidized-bed) (solid fuels)		0.85	RPF	26.8
Other industrial furnaces (liquid fuel)	0.83	1.8	Wood	14.4
Other industrial furnaces (solid fuel)	13.1	1.1		
Other industrial furnaces (gas fuel)	2.3	1.2		

Emission factors are from the documents relating to each furnace type. Calorific values are obtained from the *2003 General Energy Statistics*.

* Basic unit of calorific value of oil is “TJ/l”.

Activity Data

Activity data were determined for each category using the wet-basis values.

[Municipal solid waste used as raw material or fuel]

The activity data determined during the calculation of the carbon dioxide emissions was used on a wet basis.

[Industrial waste used as raw material or fuel]

The calculation of the usage of wastes plastics as raw material or fuel associated with the source of methane and nitrous oxide emissions covered cement kilns. The activity data determined during the calculation of carbon dioxide emissions relevant to cement kilns was used.

The volume of usage of waste oil as raw material or fuel is calculated separately for cement kilns and boilers. The volume of use of reclaimed oil, which was produced from the waste oil contained in industrial waste and other waste oil, was determined for each of the subject facilities. The volume of waste oil and reclaimed oil used as fuel for cement kilns was determined from the annual data in the Cement Handbook. The volume used as fuel for boilers was determined by subtracting the volume used as fuel for cement kilns from the volume of waste oil used as raw material or fuel, which was determined during the calculation of the carbon dioxide emission from this source.

The amount of usage of waste wood waste oil as raw material or fuel was extracted from the “fuel usage” in the “direct recycle usage” and the “fuel usage” in the “recycle usage after treatment” in the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*. The values before 1998 are used the average value in the period of 1998-2002.

[Waste tires used as raw materials and fuels]

The “volume of waste tires used as raw material or fuel by usage” that was determined during the calculation of the carbon dioxide emissions from this source was used. For the activity data, the volume of waste tires recorded in the following categories were used: “Cement kilns” for use in cement kilns; “Medium to small boilers”, “Use by tire factories”, “Use by paper manufacturers”, and “Power generation” for use in boilers; and “Gasification” for use in gasification processes.

[Refuse-based solid fuels (RDF and RPF)]

The total production volume of RDF (wet basis) determined during the calculation of the carbon dioxide emissions from this source was used as the volume of RDF burnt as boiler fuel.

Of the total production volume of the RPF determined during the calculation of carbon dioxide emission from this source, the volume used by the paper industry was used as the volume for the boiler fuel usage, and the volume used by the cement industry was used as the volume for the fuel usage by cement kilns. The fuel usage of the RPF in the paper industry was reported on a dry basis; this was converted to the wet-basis weight by dividing the value by the percentage of solids in the RPF determined during the calculation of the carbon dioxide emission.

Table 8-43 Fuel usage of the waste associated with methane and nitrous oxide emissions

	Unit	1990	1995	2000	2003	2004
MSW-oilification	kt(wet)	0	0	3	6	6
ISW-waste wood	kt(wet)	1,635	1,635	2,061	1,563	1,563
Waste tire-cement baking furnace	kt(wet)	111	275	361	240	213
Waste tire-boiler	kt(wet)	119	184	163	143	184
Waste tire-pyrolysis furnace	kt(wet)	67	37	30	20	11
Waste tire-gasification	kt(wet)	0	0	0	0	8
RDF	kt(wet)	0	34	150	336	336
RPF	kt(wet)	0	8	25	177	297

8.4. Emissions from the Decomposition of Petroleum-Derived Surfactants (6.D.)

Background

Surfactants are used for various cleaning activities in homes and factories in Japan. Petroleum-derived surfactants discharged into wastewater treatment facilities and nature decompose and emit carbon dioxide. As this emission source did not correspond to any of the existing waste categories (6.A. to 6.C.), it was included in the Other (6.D.) section.

Methodology

As neither the Revised *1996 IPCC Guidelines* nor the Good Practice Guidance (2000) specified a method for determining carbon dioxide emissions, a method specifically established in Japan was applied to the calculation. Because carbon contained in surfactants that emitted into wastewater treatment facilities and into the environment is eventually oxidized to carbon dioxide and emitted into the atmosphere as a result of surfactants decomposition, carbon dioxide emissions were estimated based on the amount of carbon contained in surfactants that emitted into wastewater treatment facilities and into the environment. Statistical information on surfactants can be obtained from the *Chemical Industry Statistical Yearbook* (the Ministry of Economy, Trade and Industry). However, it is inappropriate to use it as activity data because in Chemical Industry Statistical Yearbook, the sales amount of surfactants for household use is not included in sales amount data, and the amount of products made from surfactants is included in production amount data; this results in the double counting of surfactants production amount in total. Statistics of raw material was obtained by accumulating the consumption amount of surfactants raw material provided by surfactants production companies, and this enables obtaining the amount of petroleum-derived carbon used to produce surfactants.

Based on the facts stated above, the carbon dioxide emissions were calculated by multiplying the volume of the petroleum-derived surfactant for each type of raw material by the carbon content of each of the materials. The calculation covered synthetic alcohols, alkylbenzenes, alkylphenols, and ethylene oxide.

Emission Factors

The emission factor was determined for each type of material by calculating the amount of carbon dioxide, expressed in kg, that was emitted from the decomposition of 1 t of a surfactant, using the average carbon content in the molecules.

$$EF_j = C_i \times 1000 / 12 \times 44$$

C_i: Average carbon content of petroleum-derived raw material *i* used in a surfactant

Table 8-44 Average carbon content of surfactants, by petroleum-derived raw material

Raw material	Carbon number	Molecular weight	Carbon content	Basis for determination
Synthetic alcohol	12	186	77.4%	C12-alcohol as the main constituent.
Alkylbenzene	18	250	86.4%	C12-alkylbenzene as the main constituent.
Alkylphenol	15	210	85.7%	C9-alkylphenol as the main constituent.
Ethylene oxide	2	44	54.5%	Based on ethylene oxide molecules (C_2H_4O)

Activity Data

As some of the surfactants produced in Japan are exported, the activity data were determined by multiplying the volume of raw materials used in the surfactants, obtained from the statistical data for surfactant use, by an import/export adjustment factor.

○ Volume of surfactants used

The volumes of the use of surfactant by material were extracted from the consumption of raw materials for surfactants indicated in the *Chemical Industry Statistical Yearbook*. As there was no compilation of usage since 2002, the volume of use was estimated using the simple averages of ratio of consumption and production in the period from 1990 to 2001.

○ Export/import correction factor

The correction factor was calculated from the export/import statistics in International Trade Statistics by the Customs Bureau of the Ministry of Finance for categories of anionic surfactants, cationic surfactants, non-ionic surfactants, and other organic surfactants and the volume of surfactants used. As some of the materials for surfactants were used in several types of surfactants, an average of the export/import correction factor was weighted by surfactant production volume as necessary to calculate the correction factor for each classification of surfactant.

Export/Import correction factor
= (Surfactant production + Surfactants imported – surfactants exported) / surfactant production

Table 8-45 Activity data associated with decomposition of petroleum-based surfactants

	Unit	1990	1995	2000	2003	2004
Synthetic alcohol	t	29,239	16,253	28,285	30,842	30,706
Alkylbenzene	t	105,432	102,794	80,832	49,507	49,426
Alkylphenol	t	10,141	8,798	7,454	3,853	3,838
Ethylene oxide	t	124,984	132,175	146,509	129,015	125,228

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Chapter 9. Other (CRF sector 7)

They have been reported as “NO.” *UNFCCC Reporting Guidelines (FCCC/SBSTA/2004/8) 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 *7-2006.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 2006).

In accordance with the *Good Practice and Uncertainty Management in National Greenhouse Gas Inventories (2000)* (hereafter, *the Good Practice Guidance (2000)*) and the *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereafter, *LULUCF-GPG*), recalculations of previously reported emissions and removals are recommended in the cases of 1) application of new estimation methods, 2) addition of new categories for emissions and removals and 3) data refinement. Major changes in the inventory submitted last year are indicated below.

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.

The 2006 inventory includes many emission sources for which the calculation methods have changed or new emission sources have been added as the result of a review of the status of greenhouse gas emissions and the calculation methods for the categories for which the 2005 report returned “Not Estimated (NE)”, as well as an across-the-board review of the methodology for estimating emissions.

10.1.2. Energy sector

10.1.2.1. 1.A. Fuel Combustion Activities (Stationary Sources): CO_2

1) Emission Factors for Fuels

Some of the emission factors used in the prior inventories deviated from the IPCC default values by 2% or more. As the result of validation, the following categories were identified for revision of emission factors:

Table 10-1 Revision of emission factors for fuels

	Fuel	Unit	Value	Emission Factor in the 2005 Inventory (for FY2003)
Coal	Coking	kg-C/GJ	24.5	23.6
	Anthracite	kg-C/GJ	25.5	24.7
Coal Products	Coal coke	kg-C/GJ	29.4	24.8
	Coal tar	kg-C/GJ	20.9	24.8
	Coke-oven gas	kg-C/GJ	11.0	24.8
	Blast furnace gas*	kg-C/GJ	26.5	24.8
	Converter gas	kg-C/GJ	38.4	24.8
Crude oil	NGL/Condensate	kg-C/GJ	18.4	18.7
Combustible Natural Gas	Other combustible gases	kg-C/GJ	13.9	13.5
Other	Utility gas*	kg-C/GJ	13.7	13.3

* Variable from year to year. The values for the FY2004 were used.

2) Revision of the Energy Balance Sheet

As a result of a review of the values reported in the *Energy Balance Sheet* (the *General Energy Statistics*) over fiscal years 1990 to 2004, which were used as the basis for activity data in the category of *1.A. Fuel Combustion Activities (Stationary Source): CO_2*, the emissions for these years were recalculated.

As a result of the revision of the energy balance sheet, the energy and carbon balances concerning the coal products and oil products sector were revised, making improvements to the balances by a yearly revision of calorific values per energy source (i.e. shift to actual calorific values) and the use of a model specific to each process in the oil refining sector.

3) Examination of Oxidation Factors

The oxidation factor for gas and oil was set to 1.0 for both on the basis of the actual status of combustion of gas, oil, and coal, because the actual combustion data confirmed that gas could be deemed to have been completely burned, and oil also could be considered to have been completely burned based on the conditions of combustion. The oxidation factor of 1.0 for coal was concluded to be appropriate based on the amount of unburned fixed carbon estimated from the proportion of unburned carbon in coal ash, and the amount of coal ash generated and the amount effectively used. The revision did not result in changes to reported emissions.

4) Reporting of Waste Used as Source of Energy

The *IPCC Guidelines* indicate that waste used as an alternative fuel is to be accounted for in the Energy section. In Japan, however, all emissions from the incineration of waste, including those from use as raw material or fuel, are accounted for in the Waste section., because the incineration of waste is a main treatment system of waste handling in Japan, etc.

The emissions from waste incinerated as raw material or fuel are estimated separately as constituents of the waste.

10.1.2.2. 1.A. Fuel Combustion Activities (Stationary Source): CH_4 and N_2O

1) Elimination of adjustments for atmospheric intake and review of emission factors

Methane and nitrous oxide emission factors associated with fuel combustion were adjusted for methane or nitrous oxide intake from atmosphere in past reports to take account of the difference between the concentrations in exhaust gas and the gas drawn into facilities. The adjustments have been eliminated in the 2006 report in compliance with the *IPCC Guidelines*. The emission factors are calculated on the basis of the actual measurements of exhaust.

Outlier tests of actual measurements data are conducted again when the emission factors are altered.

2) Activity data of non-CO_2 emission calculation

The fuel consumption of *Comprehensive Survey on Air Pollutant* had been used as the activity data of non-CO_2 emission calculation from stationary sources until 2005 inventory submission. A part of these data were inconsistent to the activity data used for CO_2 emission calculation from the same sources. Thus, the activity data used for non-CO_2 emission calculation are changed and be consistent to the data used for CO_2 emission calculation.

3) Calculation of emissions associated with consumption of biomass fuels (wood and charcoal) in the household sector

Methane and nitrous emissions from this source, which were not estimated in past reports, were calculated by multiplying the value for the *Direct Use of Biomass* given in the household sector category of the *General Energy Statistics* by the default values given for wood in the *Revised 1996 IPCC Guidelines*.

10.1.2.3. 1.A.3. Fuel Combustion Activities (Mobile Sources): CH_4 and N_2O

10.1.2.3.a. Emission Sources with New Estimation Methods

1) 1.A.3.b. Natural Gas-Powered Vehicles: CH_4 and N_2O

In response to annual increases in the number of natural gas-powered vehicles, methane and nitrous oxide emissions from this source are calculated by establishing the emission factors on the basis of the results of the actual measurements of emissions.

2) 1.A.3.b. Motorcycles: CH_4 and N_2O

Methane emissions are calculated by establishing the methane emission factor and activity data, using a calculation method for emissions from mobile sources which are subject to the PRTR Law (Pollutant Release and Transfer Register Law) of Japan. The default emission factor given in the *Revised 1996 IPCC Guidelines* is used for the calculation of nitrous oxide emissions.

3) 1.A.3.c. Steam Locomotives: CH_4 and N_2O

Methane and nitrous oxide emissions are calculated by multiplying the newly estimated coal consumption of steam locomotives by the default values given in the *Revised 1996 IPCC Guidelines*.

10.1.2.3.b. Emission Sources with Revised Estimation Method

1) 1.A.3.b. Gasoline-Powered Small Cargo Trucks, Diesel-Powered Small/Regular Cargo Trucks: CH_4 and N_2O

Using newly obtained data on methane and nitrous oxide emission factors, the methane emission factor for gasoline-powered small cargo trucks and the nitrous oxide emission factors for diesel-powered small and regular cargo trucks were changed from the default values to Japan’s country-specific values based on actual measurement data.

10.1.2.4. 1.B. Fugitive Fuel Emissions

10.1.2.4.a. Emission Sources with New Estimation Methods

1) 1.B.2.c. Venting in the Natural Gas Industry: CO_2, CH_4

In the absence of the default values in the *IPCC Guidelines*, emissions from the vents in gas fields are not reported. Emissions from the respiration of natural gas during transmission, which were accounted for in the Natural Gas Transmission (1.B.2.b.ii.)[1] category in past reports, have been moved to this source.

2) 1.B.2.c. Flaring in the Natural Gas Industry: CO_2, CH_4, and N_2O

Emissions are calculated by the Tier 1 Method described in the *Good Practice Guidance (2000)* using the default emission factors for flaring.

3) 1.B.2.c. Flaring in the Petroleum Industry: CO_2, CH_4, and N_2O

Emissions are calculated by the Tier 1 Method described in the *Good Practice Guidance (2000)* using the default emission factors for flaring.

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[1] This category is “1.B.2.b.iii” in the CRF used 2006 submission.

10.1.3. Industrial process sector

10.1.3.1. Emission Sources with New Estimation Methods

1) 2.A.4. Soda Ash Production and Use: CO_2

In accordance with the technique described in the *Revised 1996 IPCC Guidelines*, emissions are calculated by multiplying the soda ash consumption by the default emission factor (i.e. carbon dioxide emission per amount of soda ash consumption).

2) 2.B.4. Calcium Carbide Production: CO_2

In accordance with the technique described in the *Revised 1996 IPCC Guidelines*, emissions are calculated by multiplying the calcium carbide production by the default emission factor (i.e. limestone-derived, reducing agent-derived, and “during use” carbon dioxide emission from calcium carbide per amount of calcium carbide production.)

3) 2.B.4. Silicon Carbide Production: CO_2

In accordance with the technique described in the *Revised 1996 IPCC Guidelines*, emissions are calculated by multiplying the consumption of petroleum coke as raw material for silicon carbide by the default emission factor (i.e. carbon dioxide emission per amount of petroleum coke consumed as raw material for silicon carbide).

4) 2.C.1. Iron and Steel Production (Emissions from Electrodes of Electric Arc Furnaces): CO_2

Emissions of carbon dioxide generated by the carbon electrodes of electric arc furnaces are calculated by multiplying the amount of crude steel production by electric furnace by the default value shown in the GPG(2000) (i.e. carbon dioxide emissions per amount of crude steel production by electric furnace).

5) 2.F.3. Fire Extinguishers: HFCs, PFCs, SF_6

Emission of HFCs at time of disposal is reported as “NO” on the assumption that there is no disposal because of the short history of the use of HFCs in fire extinguishers. Emissions of PFCs and SF_6 are also reported as “NO” as there is no record of use in Japan.

10.1.3.1.b. Emission Sources with Revised Estimation Methods

1) 2.A.1. Cement Production: CO_2

The limestone method used in past reports for the calculation of carbon dioxide emissions from cement production (i.e. multiplication of the consumption of limestone in cement production by the carbon dioxide emissions per limestone consumption) has been replaced in the 2006 report by the clinker method shown in the *Good Practice Guidance (2000)* (i.e. multiplication of the production of clinker, an intermediate product created during the manufacture of cement, by the carbon dioxide emission factor calculated from calcium oxide content in clinker).

2) 2.F.1. Refrigeration and Air Conditioning Equipment: PFCs

A survey on the emission status of PFCs confirmed that PFCs were not used in Japan for the manufacture of refrigeration/air conditioning products. As a result, the emission is reported as "NO" for "production". Emissions from "use" and "disposal" are also reported as "NO" for household refrigerators and stationary air-conditioning equipment, after adjustments for the status of PFC use in the imported products.

3) 2.F.2. Foam Blowing: HFCs

In past reports, the total emissions, including those from use and disposal, were reported for "production", with the indication of "NE" for "use" and "disposal". The 2006 report separates the total emissions between "production" and "use". Emission from "disposal" is reported as "IE" as this subcategory is combined with "use", and the amount for "disposal" is deemed to be included in the amount calculated for "use".

Emissions from certain HFCs (HFC-245fa and HFC-365mfc) are excluded from the reporting under "urethane foam" as their GWPs are not provided in the *IPCC Guidelines*.

4) 2.F.4. Aerosols/Medical Devices (Metered Dose Inhalers) : HFCs

In past reports, the total emissions, including those from production and disposal, were reported for "use", with the indication of "NE" for "production" and "disposal". The 2006 report separates the total emissions for aerosols between "production" and "use". Emissions from "disposal" are reported as "IE" as the entire amount for "disposal" is included in "use". Emission from "disposal" of medical devices (metered dose inhalers) is reported as "IE" as it is deemed to be included in the amount calculated for "use".

10.1.3.1.c. Emission Sources with Revised Emission Factors

1) 2.A.3. Limestone and Dolomite Use: CO_2

The determination of carbon dioxide emissions factors associated with the use of limestone took into consideration the magnesium carbonate content in limestone in addition to calcium carbonate content.

2) 2.B.3. Adipic Acid Production: N_2O

The rate of nitrous oxide generation by adipic acid production has been changed to reflect the actual measurement results.

10.1.3.1.d. Change in data used for calculation of HFCs, PFCs, and SF_6 emissions

The emission estimates of HFCs, PFCs, and SF_6 were changed due to change in the data and actual emission data.

10.1.4. Agricultural sector

10.1.4.1. Emission Sources with New Estimation Methods

1) 4.A.2. Enteric Fermentation (Buffalo): CH_4

In accordance with the technique described in the *Revised 1996 IPCC Guidelines*, emissions are calculated by multiplying the number of buffaloes being kept for agricultural purposes by the default emission factor (i.e. bodily methane emission per head of buffalo per year).

2) 4.B.2. Manure Management (Buffalo): CH_4 and 4.B.11.–13. Manure Management (Buffalo): N_2O

In accordance with the technique described in the *Revised 1996 IPCC Guidelines*, emissions were calculated by multiplying the number of buffaloes being kept for agricultural purposes by the default emission factors (i.e. methane and nitrous oxide emissions associated with manure management per head of buffalo per year).

3) 4.D.1. Agricultural Residues: N_2O

Nitrous oxide emissions from crop residues plowed into the soil are calculated by multiplying the amount of nitrogen contained in the crop residues used for soil amendment by the default emission factor given in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)* (i.e. the amount of nitrogen contained in nitrous oxide emission from 1 kg of nitrogen fertilizer applied), based on Japan’s country-specific technique.

4) 4.D.1. Plowing of Organic Soil: N_2O

In accordance with the technique described in the *Revised 1996 IPCC Guidelines*, emissions are calculated by multiplying the area of organic soil by the default emission factor (i.e. the amount of nitrous oxide emitted from the plowing of 1 hectare of organic soil).

10.1.4.2. Emission Sources with Revised Estimation Methods

1) 4.A.1. Enteric Fermentation (Cattle): CH_4

Five- and six-month-old cattle are newly included in the scope of the calculation. Emission factors were revised by using the data published in the *Japanese Feeding Standards,* which are revised every several years, as the amount of dry matter intake.

2) 4.B. Manure Management : CH_4 and N_2O

The double counting of emissions between manure management and pasture, range and paddock manure was eliminated for cattle. Emission factors for composted mixed manure of non-dairy cattle, which were reported at the same value as for composted urine in past reports, were revised to use the same value as for the composted dung. According to the result of an investigation of validity of the all emission factors for cattle, swine and poultry, some emission factors were revised where appropriate.

The reporting category of the emission from grazing was reallocated from the category of *Pasture, Range and Paddock Manure (4.D.2.)* to *Manure Management (4.B.1.)*. Activity data was determined by using the grazing population in both public and private pastures, and also using the new data for grazing period.

3) 4.D.1. Direct Soil Emissions (Synthetic Fertilizer, Organic Fertilizer): N_2O

As a result of new findings that led to new emissions factors, emissions were calculated on the basis of the new emission factor.

4) 4.D.3. Indirect Emissions (Atmospheric Deposition and Leaching/Run-off of Nitrogen): N_2O

For nitrogen excretions by cattle, swine, and poultry which were used for the calculation of activity data, the default values given in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)* were replaced by Japan's country-specific nitrogen excretion data used in the *Manure Management (4.B.)* category. As a result of new findings that led to new emissions factors, amounts for "leaching and run-off" of nitrogen were calculated on the basis of 190 days of grazing.

5) 4.F.1. Field Burning of Agricultural Residues: CH_4 and 4.F.1.–3. Field Burning of Agricultural Residues: N_2O

In the calculation of methane and nitrous oxide emissions associated with the burning of "rice and wheat" crop residues, the default technique established in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)* as a method for the estimation of emissions was used instead of Japan's country-specific method that was used in past reports. In addition, country-specific data that became available in Japan were used for the "nitrogen content" parameter required for the calculation of activity data for the Other Crops category.

10.1.5. Land Use, Land-Use Change, and Forestry (LULUCF) Sector

1) 5.A. , and 5.B.2.-5.F.2. Categories of forest distribution

Japan defined forest for estimation based on Forest Law Article 2 so far. Forest definition for "Forest land" is redefined from 2006 inventory submission based on Forest Law Article 5 and Article 7.2. . The activity data were changed accordingly.

2) 5.A.1. Forest land remaining Forest land :CO_2

In the carbon stock change in biomass due to fires in private forests in "5.A.1. Forest land remaining forest land: CO_2", Japan had estimated the damaged timber volume in private forests using the data for damaged timber volume in national forests. Because data for damaged timber volume in private forests were obtained the activity data for private forest fire were changed.

3) 5.E.1. Settlements remaining Settlements :CO_2 ”

Because data for “Urban grove park” and “Square park” were obtained, these data are added to the activity data for estimating carbon stock change in biomass in "5.E.1. Settlements remaining Settlements.

10.1.6. Waste Sector

10.1.6.1. New and Revised Estimation Methods

10.1.6.1.a. Emission Sources with New Estimation Methods

1) 6.A.1. Managed Waste Disposal on Land (Sludge): CH_4

Methane emission associated with sludge disposed in landfill sites was added to subcategory and newly calculated. The types of sludge included in the calculation are divided into the subcategories of “sewage sludge”, “sewage treatment and septic tank sludge”, “water purification sludge”, “organic sludge from manufacturing”, and “livestock waste treatment sludge”. Methane emission is calculated for each type of the sludge using the same method used for the *Emissions from Managed Waste Disposal on Land (6.A.1.)* category.

2) 6.A.3. Illegal Disposal on Land: CH_4

Methane emission associated with industrial waste that was illegally disposed of on land was recalculated. The scope of the calculation includes wood scraps contained in the industrial waste illegally discarded. Methane emission for this category is calculated using the same method used in the *Emissions from Managed Waste Disposal on Land (Wood Scraps) (6.A.1.)* category.

3) 6.A.3. Composting of Organic Waste: CH_4 and N_2O

Methane and nitrous oxide emissions associated with the composting of organic waste were recalculated. The types of organic waste included in the calculation are divided into the subcategories of “paper scraps”, “textile scraps”, “wood scraps”, “kitchen garbage”, and “sewage sludge”. Emissions are calculated for methane and nitrous oxide using the method described in the *2006 IPCC Guidelines (Draft)*.

4) 6.B.1. Industrial Waste Water: N_2O

Nitrous oxide emissions associated with the treatment of industrial wastewater were recalculated. The scope of the calculation covers industrial wastewater that is treated at facilities using activated sludge or other advanced treatments. Emission is calculated by determining the nitrous oxide emission factor per amount of nitrogen contained in industrial wastewater.

5) 6.B.2. Decomposition of Domestic and Commercial Waste Water in Nature: CH_4 and N_2O

Amounts of methane and nitrous oxide emitted from the natural decomposition of domestic wastewater discharged untreated into public waters were recalculated. The scope of the calculation covers the subcategories of domestic wastewater discharged from households using septic tanks or vault toilets, domestic wastewater from households using on-site disposal systems, and human waste dumped into the ocean. Methane and nitrous emissions are calculated by the method shown in the *2006 IPCC Guidelines (Draft)*.

6) 6.C. Municipal Waste Incineration (Synthetic Textile Scraps): CO_2 and 6.C. Industrial Waste Incineration (Synthetic Textile Scraps): CO_2

Carbon dioxide emissions associated with the incineration of synthetic textile scraps contained in municipal and industrial wastes were recalculated. Carbon dioxide emissions are calculated by establishing the carbon dioxide emission factors from the proportion of petroleum-derived carbon in synthetic textiles, and using the proportion of synthetic textile scraps contained in textile scraps that are incinerated.

7) 6.C. Special Management Waste Incineration: CO_2, CH_4, and N_2O

Carbon dioxide, methane, and nitrous oxide emissions associated with the incineration of special management industrial waste were recalculated. The scope of the calculation covers the subcategories of “waste oil” and “infectious waste”. Emissions are calculated using the same method as for the *Waste Incineration (6.C.)* category.

8) 6.C. Use of “Waste: CO_2, CH_4, and N_2O” as Alternative Fuels: CO_2, CH_4, and N_2O

Carbon dioxide, methane, and nitrous oxide emitted when municipal and industrial wastes are used as raw material or fuel (excluding those used as material for products) were added to the scope of the calculation. Methane and nitrous oxide emissions are calculated by establishing emission factors according to the status of usage as raw material or fuel of the waste that is covered by the scope of the calculation.

- 6.C. Emissions associated with the use of municipal waste (plastics) as raw material or fuel: CO_2, CH_4, and N_2O

Carbon dioxide, methane, and nitrous oxide emissions were added to the scope of the calculation with respect to amounts of plastic containers and packaging (*Other Plastics*, *Food Trays*) that are recycled under the *Plastic Containers and Packaging Recycling Law*. Carbon dioxide emissions are calculated with respect to the plastics that are used in “chemical raw material for coke ovens”, “blast furnace reducing agents”, and “gasification” and “petrochemicals”, while methane and nitrous oxide are calculated with respect to those used in “petrochemicals”.

- 6.C. Emissions associated with the use of industrial waste (waste oil) as raw material or fuel: CO_2, CH_4, and N_2O

Carbon dioxide, methane, and nitrous oxide emissions associated with the use of waste oil contained in industrial waste as raw material or fuel were added to the scope of the calculation.

- 6.C. Emissions associated with the use of industrial waste (waste plastics) as raw material or fuel: CO_2, CH_4, and N_2O

Carbon dioxide, methane and nitrous oxide emissions were added to the scope of the calculation with respect to those associated with the use of waste plastics as raw material or fuel in the iron and steel industry and the cement industry, for which the statistical data are available at present.

- 6.C. Emissions associated with the use of industrial waste (wood scraps) as raw material or fuel: CO_2 and CH_4

Carbon dioxide and methane emissions associated with the use of wood scraps contained in industrial waste used as raw material or fuel were added to the scope of the calculation.

- 6.C. Emissions associated with the use of waste tires as raw material or fuel: CO_2, CH_4, and N_2O

Carbon dioxide, methane, and nitrous oxide emissions associated with the use of waste tires as raw material or fuel were added to the scope of the calculation. Carbon dioxide emissions are calculated using the emission factor established by deducting the percentage of carbon from natural rubber contained in the tires.

- 6.C. Emissions associated with the use of refuse-derived solid fuels (RDF/RPF) as raw material for fuel: CO_2, CH_4, and N_2O

Carbon dioxide, methane, and nitrous oxide emissions associated with the use of refuse-derived solid fuels (RDF/RPF) as raw material or fuel were added to the scope of the calculation. Carbon dioxide emissions are calculated using emission factors which are established by taking the plastic components in RDF and RPF into consideration.

9) 6.D. Emissions Associated with Decomposition of Petroleum-Derived Surfactants: CO_2

Carbon dioxide emissions were added to the scope of the calculation with respect to those associated with the decomposition of petroleum-derived surfactants that are discharged into wastewater treatment facilities and nature. Petroleum-derived carbon content of surfactants is determined from the amount of petroleum-derived raw material used in surfactants.

10.1.6.1.b. Emission Sources with Revised Estimation Methods

1) 6.A. Solid Waste Disposal on Land (Kitchen Garbage, Paper Scraps, Textile Scraps, Wood Scraps): CH_4

A new methane emission factor was established for disposal in semi-aerobic landfill. Municipal waste was divided into disposal in semi-aerobic and anaerobic landfills for the calculation of methane emissions.

The calculation of methane emissions, which were calculated for paper and textile scraps combined in past reports, was divided into two categories. For textile scraps, the volume of synthetic textile disposed of in landfill has been excluded from the activity data because there is little biological decomposition.

Contents of paper, textile, and wood scraps have been revised to more realistic values.

2) 6.B.1. Industrial Waste Water Handling: CH_4

Activity data for this source in past reports covered the entire volume of industrial wastewater that was treated. In the 2006 report, activity data covers only the portion of industrial waste that was treated at facilities using activated sludge and advanced treatments.

3) 6.C. Municipal Waste Incineration: CH_4 and N_2O

Adjustments for atmospheric intake were eliminated from emissions factors for the calculation of methane and nitrous oxide emissions from this source. (See Paragraph 1. of 10.1.2.2. – *1.A. Fuel Combustion Activities (Stationary Sources):* CH_4 *and* N_2O*.*)

4) 6.C. Industrial Waste Incineration: CH_4 and N_2O

The adjustments for atmospheric intake were eliminated from emissions factors for the calculation of methane and nitrous oxide emissions from this source.

Methane and nitrous oxide emissions from incineration of “textile scraps” and “animal and plant residues or animal carcasses” contained in industrial waste were added to the scope of the calculation.

10.1.6.2. Sector Reorganization for Reporting of Waste Used as Alternative Energy

Emissions from incineration of waste were reported in the Waste sector regardless of whether they were used as an alternative source of energy. The review by the UNFCCC Secretariat, however, found that that classification did not comply with the *IPCC Guidelines*. As the result of new estimations calculated for emissions from the use of waste as an alternative source of energy and raw material, sectors for which various emissions sources should be reported, including the use as alternative energy, have been reorganized. Specifically:

- All emissions from incineration of waste, including those from the use of waste as fuel and raw material, are reported in the Waste sector.

- From the point of view of the incentive for industry operators, however, emissions from waste used as alternative energy are accounted for as breakdown items in the incineration category. In addition, these emissions are reported separately for those from waste recycled for use as raw material in chemical recycling and those from heat recovery through use as alternative fuel.
- A note has been added to the *Energy Sector* section of the CRF, stating that the “emissions associated with the use of waste as a source of energy and raw material are accounted for in the Waste sector.” The emissions reported in the subcategory of the use of waste as an alternative source of energy and material are included as reference information in the *Energy Sector* of the *National Inventory Report*.
- From the point of view of promoting waste as an alternative energy source, it is very important to account for incinerated waste in different categories corresponding to levels of energy recovery because other types of waste incineration also recover energy at various stages. At present, emissions from this source are accounted for at least on the basis of power generation at municipal waste incinerators because some data (generation capacity, generation efficiency, and total power generated) are available in this field. The categorical reporting of emissions from other forms of the recovery of energy from waste will be promoted with an increased effort to improve the availability of statistical data.

10.2. Implications for Emission Levels

Table 10-2 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 CO_2 in LULUCF sector in the base year (1990) under the UNFCCC increased by 1.55%, and the total emissions in year 2003 increased by 1.43% compared to the data reported in last year.

Table 10-2 Difference between the inventories submitted in 2005 and 2006 for emissions

[Mt CO_2eq.]

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO_2	JNGI2005 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	1,213.6	1,247.8	1,259.4
with LULUCF 3)	JNGI2006 2)	1,066.7	1,086.0	1,084.8	1,071.4	1,122.8	1,131.4	1,233.7	1,227.9	1,191.9	1,229.2	1,251.1	1,236.1	1,269.3	1,279.4
	difference	*2.73%*	*3.68%*	*2.01%*	*2.17%*	*1.64%*	*1.35%*	*-0.09%*	*-1.14%*	*-0.27%*	*0.06%*	*0.98%*	*1.86%*	*1.73%*	*1.58%*
CO_2	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	1,259.4
without LULUCF	JNGI2006	1,138.8	1,148.1	1,158.0	1,149.8	1,206.4	1,219.5	1,233.7	1,227.9	1,191.9	1,229.2	1,251.1	1,236.1	1,269.3	1,279.4
	difference	*1.47%*	*1.48%*	*0.79%*	*0.97%*	*0.69%*	*0.53%*	*-0.09%*	*-1.14%*	*-0.27%*	*0.06%*	*0.98%*	*1.86%*	*1.73%*	*1.58%*
CH_4	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	19.3
	JNGI2006	33.4	33.1	32.9	32.7	32.1	31.4	30.7	29.6	28.7	28.0	27.3	26.4	25.4	24.8
	difference	*34.42%*	*33.98%*	*33.75%*	*33.22%*	*33.28%*	*33.92%*	*33.84%*	*33.92%*	*33.40%*	*32.73%*	*31.72%*	*30.90%*	*30.14%*	*28.55%*
N_2O	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	34.6
	JNGI2006	33.6	33.1	33.4	33.0	34.2	34.6	35.9	36.4	35.0	28.9	31.4	28.2	28.1	28.1
	difference	*-16.54%*	*-16.70%*	*-16.41%*	*-16.69%*	*-15.77%*	*-14.94%*	*-13.55%*	*-13.06%*	*-13.71%*	*-17.66%*	*-16.13%*	*-18.56%*	*-18.98%*	*-18.76%*
HFCs	JNGI2005	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3
	JNGI2006	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.01%*	*-0.01%*	*-0.04%*	*-0.05%*	*-0.21%*
PFCs	JNGI2005	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0
	JNGI2006	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.01%*	*-0.01%*	*0.06%*	*-0.01%*	*-0.58%*
SF_6	JNGI2005	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.5
	JNGI2006	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.7
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.03%*	*0.03%*	*-0.03%*	*0.00%*	*-0.02%*	*-0.02%*	*-0.08%*	*0.00%*	*5.82%*
Total	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	1,339.1
with LULUCF	JNGI2006	1,133.7	1,152.2	1,151.0	1,137.1	1,189.0	1,247.1	1,352.9	1,345.4	1,305.0	1,329.9	1,348.9	1,323.7	1,350.8	1,358.3
	difference	*2.74%*	*3.62%*	*2.05%*	*2.18%*	*1.69%*	*1.38%*	*0.08%*	*-0.89%*	*-0.13%*	*0.11%*	*0.95%*	*1.72%*	*1.57%*	*1.43%*
Total	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	1,339.1
with LULUCF	JNGI2006	1,205.7	1,214.3	1,224.2	1,215.5	1,272.7	1,335.2	1,352.9	1,345.4	1,305.0	1,329.9	1,348.9	1,323.7	1,350.8	1,358.3
	difference	*1.55%*	*1.55%*	*0.89%*	*1.05%*	*0.78%*	*0.62%*	*0.08%*	*-0.89%*	*-0.13%*	*0.11%*	*0.95%*	*1.72%*	*1.57%*	*1.43%*

1) JNGI2005: Japan National GHG Inventory submitted in 2005

2) JNGI2006: Japan National GHG Inventory submitted in 2006

3) LULUCF: Land Use, Land-Use Change and Forestry

10.3. Implication for Emission Trends, including Time Series Consistency

Table 10-3 shows the changes made to the emission trends during a period from 1990 to 2003 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 2003 was performed.

Total emissions excluding CO_2 in LULUCF sector increased by approximately 0.8 million tons (in CO_2 equivalents) and decreased by 0.1 points compared to the data reported in last year.

Table 10-3 Comparison of emissions trends between the inventories submitted in 2005 and 2006 excluding CO_2 in LULUCF sector

		Trend [Mt CO_2eq.]			Trend (%)		
		JNGI2005	JNGI2006	Difference	JNGI2005	JNGI2006	Difference
CO_2	1)	137.1	140.6	3.5	12.2%	12.3%	0.1%
CH_4	1)	-5.5	-8.6	-3.0	-22.3%	-25.7%	-3.4%
N_2O	1)	-5.6	-5.4	0.2	-13.9%	-16.2%	-2.3%
HFCs	2)	-7.9	-8.0	0.0	-39.2%	-39.3%	-0.1%
PFCs	2)	-3.5	-3.6	-0.1	-28.2%	-28.6%	-0.4%
SF_6	2)	-12.4	-12.2	0.3	-73.6%	-72.0%	1.5%
Total	3)	102.1	102.9	0.8	8.3%	8.2%	-0.1%

1) Comparison of emissions between FY1990 and FY2003

2) Comparison of emissions between CY1995 and CY2003

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 2003

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

1. 1.A. Fuel Combustion Activities (Stationary Sources): CO_2 – emission factors were revised, and improvements were made to the carbon and energy balance.
2. The determination of oxidation factors for the combustion of gas, petroleum, and coal was revised on the basis of actual conditions in Japan.
3. As the result of a review of methods for accounting for the use of waste as alternative energy, estimations of emissions from this source were reported in the Waste sector under separate categories.
4. 1.A. Fuel Combustion Activities (Stationary Sources) – adjustments for atmospheric intake were eliminated from the calculation of methane and nitrous oxide emissions factors. The emission factors are now calculated based on the actual measurement of exhaust gas.
5. 1.A. Fuel Combustion Activities (Stationary Sources) – the activity data used for non-CO_2 emission calculation are changed and be consistent to the data used for CO_2 emission calculation.
6. Methane and nitrous oxide emissions associated with the consumption of biomass fuels (wood and charcoal) in the household sector were recalculated.
7. 1.A.3.b. Natural Gas-powered Automobiles: CH_4 and N_2O – Estimations were recalculated.
8. 1.A.3.b. Motorcycles: CH_4 and N_2O – Estimations were recalculated.
9. 1.A.3.c. Steam Locomotives: CH_4 and N_2O – Estimations were recalculated.
10. 1.A.3.b. Gasoline-powered Small Cargo Trucks, Diesel-powered Small/Regular Cargo Trucks: CH_4 and N_2O – The new estimation method was adopted to reflect actual conditions in Japan.
11. Emissions from the respiration of natural gas in transmission, which had been reported in the subcategory of Natural Gas Transmission (1.B.2.b.ii), was moved to the subcategory of 1.B.2.c. Venting (Gas): CH_4 and N_2O.
12. 1.B.2.c. Flaring (Gas): CO_2, CH_4 and N_2O – Estimations were recalculated.
13. 1.B.2.c. Flaring (Oil): CO_2, CH_4 and N_2O – Estimations were recalculated.
14. 2.A.4. Soda Ash Production and Use: CO_2 – Estimations were recalculated.
15. 2.B.4. Calcium Carbide Production: CO_2 – Estimations were recalculated.
16. 2.B.4. Silicon Carbide Production: CO_2 – Estimations were recalculated.
17. 2.C.1. Iron Steel Production (Carbon Dioxide Emissions from Electrodes in Electric

Arc Furnaces: CO_2 – Estimations were recalculated.

18. The notation keys relating to the disposal of HFCs, as well as PFCs and SF6 were revised.
19. 2.A.1. Cement Production: CO_2 – The calculation method was changed from a limestone method to clinker method for estimation.
20. 2.F.2. Foam Blowing: HFCs – The accounting method of emissions was changed to reflect the stages of production, use, and disposal. HFCs were excluded from estimations for urethane foam due to the absence of GWP.
21. 2.F.4. Aerosols and Medical Devices (Metered Dose Inhalers): HFCs – The accounting method of emissions was changed to reflect the stages of production, use, and disposal of the products.
22. 2.A.3. Limestone and Dolomite Use: CO_2 – the values of emissions factors for carbon dioxide associated with the use of limestone were determined with consideration of the magnesium carbonate content in limestone in addition to calcium carbonate.
23. 2.B.3. Adipic Acid Production: N_2O – The basis for the calculation of rate of nitrous oxide generation by adipic acid production was changed to actual measurements.
24. Data used for the calculation of emissions of HFCs, PFCs, and SF_6 were revised.
25. 4.A.2. Enteric Fermentation (Buffalo): CH_4 – Estimations were recalculated.
26. 4.B.2. Manure Management (Buffalo): CH_4 and 4.B.11.–13: Manure Management (Buffalo): N_2O – Estimations were recalculated.
27. 4.D.1. Direct Soil Emissions (Agricultural Residues): N_2O – Estimations were recalculated.
28. 4.D.1. Direct Soil Emissions (Plowing of Organic Soil): N_2O – Estimations were recalculated.
29. 4.A.1. Enteric Fermentation (Cattle): CH4 – Five- and six-month-old cattle were added to the scope of the calculation. In addition, the method for the calculation of emission factors was changed to take year-to-year changes into account.
30. 4.B. Manure Management: CH_4 and N_2O. – Double counting was eliminated for cattle. According to the result of an investigation of validity of the all emission factors for cattle, swine and poultry, some emission factors were revised where appropriate. For grazing, the reporting category was changed from 4.D.2. to 4.B. and the activity data were revised.
31. 4.D.1. Direct Soil Emissions (Synthetic Fertilizer, Organic Fertilizer): N_2O –Emission factors were revised.
32. 4.D.2. Pasture, Range, and Paddock Manure: CH_4 and N_2O – Activity data were revised.
33. 4.D.3 Indirect Emissions (Atmospheric Deposition and Leaching/Run-off of Nitrogen): N_2O – Data used for the determination of activity data and emission factors were changed to better reflect the actual conditions in Japan.
34. 4.F.1. Field Burning of Agricultural Residues: CH_4 and 4.F.1.–3. Field Burning of Agricultural Residues: N_2O – Calculation methods were changed to the default methods. In addition, Japan's country-specific data were reflected in the parameters

used in the calculation of activity data.

35. Activity data used for estimating CO_2 emissions from LULUCF category (category 5), were revised.
36. 5.A.1. Forest land remaining forest land: activity data used for estimating CO_2 emissions from forest fires were revised.
37. 5.E.1. Settlements remaining settlements: activity data used for estimating CO_2 emissions from were revised.
38. 6.A.1. Managed Waste Disposal on Land (Sludge): CH_4 – Methane emissions associated with landfill disposal of sludge were recalculated.
39. 6.A.3. Illegal Disposal on Land: CH_4 – Estimations were recalculated.
40. 6.A.3. Composting of Organic Waste: CH_4 and N_2O – Estimations were recalculated.
41. 6.B.1. Industrial Waste Water: N_2O – Estimations were recalculated
42. 6.B.2. Decomposition of Domestic and Commercial Waste Water in Nature: CH_4 and N_2O – Estimations were recalculated.
43. 6.C. Municipal Waste Incineration (Synthetic Textile Scraps): CO_2 and 6.C Industrial Waste Incineration (Synthetic Textile Scraps): CO_2 – Estimations were recalculated.
44. 6.C. Waste Incineration (Special Management Waste): CO_2, CH_4 and N_2O – Estimations were recalculated.
45. 6.C. Use of “Waste: CO_2, CH_4 and N_2O” as Alternative Fuels: CO_2, CH_4 and N_2O – Carbon dioxide, methane, and nitrous oxide emissions from the use of municipal and industrial wastes as raw material or fuel were recalculated. The calculation methods for waste used as raw material or fuel were established in the subcategories of CO_2, CH_4, and N_2O emissions from “Municipal Waste (Plastics)”, “Industrial Waste (Waste Oil)”, “Industrial Waste (Waste Plastics)”, “Industrial Waste (Wood Scraps)”, “Waste Tires” and “Refuse-derived Solid Fuels (RDF/RPF).
46. 6.D. Emissions Associated with Decomposition of Petroleum-derived Surfactants: CO_2 – Estimations were recalculated.
47. New methane emission factors were established for semi-aerobic landfill under the subcategories of “Kitchen Garbage”, “Paper Scraps”, “Textile Scraps” and “Wood Scraps” 6.A. Solid Waste Disposal on Land: CH_4. In addition, the scope of calculation was revised for textile scraps, as well as data used for the calculation of emission factors.
48. 6.B.1. Industrial Waste Water Handling: CH_4 – Activity data was revised
49. 6.C. Municipal Waste Incineration: CH_4 and N_2O and 6.C. Industrial Waste Incineration: CH_4 and N_2O – Adjustments for atmospheric intake have been eliminated from the calculation of emissions factors. Methane and nitrous oxide emissions from incineration of “textile scraps” and “animal and plant residues or animal carcasses” contained in industrial waste were added to the scope of the calculation.

* For further information, please see “10.1 Explanation and justification of recalculation”.

10.4.1.2. National Inventory Report (NIR)

1. Descriptions of estimating methods were updated based on the results of the current

review of the methodology for estimating emissions of greenhouse gases.

2. Tables showing trends in activity data were added to the description of the methodology in each sector. Background information was also provided as necessary.
3. Explanation of the Japanese reporting categories was added to each of the chapters (or paragraphs) that contained the description of estimation techniques.
4. Description of the process of inventory preparation in *Chapter 1: Outline of Inventory* was updated.
5. Detailed descriptions of the inventory preparation system and the QA/QC plan were updated in *Appendix 6: Additional Information to be Considered as Part of the NIR Submission or Other Useful Reference Information.*
6. The content of *Appendix 9: Hierarchical Structure of Japan's National GHG Inventory File System* was updated based on the reorganization of inventory calculation files for the current reporting year.

10.4.1.3. Common Reporting Format (CRF)

(a) Notation keys were revised as follows.

Table 10-4 Notation keys changed in 2006 inventory

Sheet name	Emission classification	Pre-change	Post-change
Table 1.A(a)s3	1.A.3.b.Road transportation (Gaseous fuels): CH_4, N_2O emissions	NE	calculated value
	1.A.3.b. Railways (Solid Fuels): CO_2 emissions	IE	NO
	1.A.3.b. Railways (Solid Fuels): CH_4, N_2O emissions	NE	calculated value
Table 1.B.2	1.B.2.c.ii. Venting (Gas): CO_2, CH_4 emissions	NE	calculated value
	1.B.2.c.i Flaring (Oil): CO_2, CH_4, N_2O emissions	NE	calculated value
	1.B.2.c.i Flaring (Gas): CO_2, CH_4, N_2O emissions	NE	calculated value
Table 2(I).A-Gs1	2.A.4. Soda Ash Production: CO_2 emissions	NE	IE
	2.A.4. Soda Ash Production: CO_2 emissions	NE	calculated value
	2.B.4. Silicon Carbide: CO_2 emissions	NE	C
	2.B.4. Silicon Carbide: CO_2 emissions	NE	C
	2.B.4. Silicon Carbide: CH_4 emissions	NE	NA
	2.B.5. Ethylene: CO_2 emissions	calculated value	C
Table 2(I).A-Gs2	2.C.1. Iron and Steel Production Sinter: CO_2 emissions	IE	NO
	2.C.1. Iron and Steel Production Other: CO_2 emissions	NO	calculated value
	2.C.1. Iron and Steel Production Other: CH_4 emissions	NO	IE
Table 2(II).C	2.C. PFCs and SF_6 from Metal Production Aluminium Foundries: SF_6 emissions	NE	NO
Table 2(II).Fs1	2.F.1. Refrigeration and Air Conditioning Equipment, Commercial Refrigeration: HFCs emissions from disposal	0.00	IE
	2.F.1. Refrigeration and Air Conditioning Equipment, Stationary Air-Conditioning: HFCs emissions from disposal	0.00	IE

Table 10-4 Notation keys changed in 2006 inventory (continue)

Sheet name	Emission classification	Pre-change	Post-change
Table 2(II).Fs2	2.F.4. Aerosols, Metered Dose Inhalers: HFCs emissions from disposal	NE	IE
	2.F.4. Aerosols, Other: HFCs emissions from disposal	NE	IE
	2.F.5. Solvent: PFCs emissions from disposal	NE	IE
	2.F.6. Semiconductors: HFCs, PFCs, SF_6 emissions from manufacturing	NE	IE
	2.F.6. Semiconductors: HFCs, PFCs, SF_6 emissions from disposal	NE	NA
Table 3.A-D	3.D. Other, Aerosol Cans	NE	NA
Table 4s1	4.A.2. Enteric Fermentation (Buffalo): CH_4 emissions	NE	calculated value
	4.A.5. Enteric Fermentation (Camels and Llamas): CH_4 emissions	NE	NO
	4.A.7. Enteric Fermentation (Mules and Asses): CH_4 emissions	NE	NO
	4.B.2. Manure Management (Buffalo): CH_4 emissions	NE	calculated value
	4.B.5. Manure Management (Camels and Llamas): CH_4 emissions	NE	NO
	4.B.7. Manure Management (Mules and Asses): CH_4 emissions	NE	NO
Table 4s2	4.D.2. Agricultural Soils, Pasture, Range and Paddock Manure: N_2O emissions	calculated value	IE
	4.F.5 Field Burning of Agricultural Residues, Other: CH_4, N_2O emissions	NO	NE
Table 4.A	4.A. Buffalo: Activity data	NE	calculated value
	4.A. Camels and Llamas: Activity data	NE	NO
	4.A. Mules and Asses: Activity data	NE	NO
	Additional information (except Milk yield for Daily Cattle)	NE	NA
	Additional information (Milk yield for Daily Cattle)	NE	calculated value
Table 4.B(a)s1	4A: activity data and other related information	NE	NA
Table 4.B(a)s2	4.B. Daily Cattle, Non-Daily Cattle, Swine: animal waste management system for cool and warm climate region	NO	NA
Table 4Ds1	4.D.1. N-fixing Crops: N_2O emissions	IE	NE
	4.D.1. Crop residue: N_2O emissions	NE	calculated value
	4.D.1. Cultivation of Histosols	NE	calculated value
	4.D.2. Pasture, Range and Paddock Manure: N_2O emissions	calculated value	IE
	4.D.4. Other : N_2O emissions	0.00	NO
Table 4.Ds2	4.D. Additional Information (used to be NE)	NE	NA or calculated value
Table 4.F	4.F.1. Cereals (Wheat, Barley, Oats, Rye): CH_4, N_2O emissions, and activity data and other related information	IE	calculated value
	4.F.1. Cereals (Rice): activity data and other related information	NE	calculated value
	4.F.2. Pulse (Dry bean): Activity data (part)	IE	NA

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, Tier.1 trend assessment, Tier 2 level assessment and Tier.2 trend assessment).

The results of an analysis using methods above (Tier1 Level Assessment, Tier1 Trend Assessment and Qualitative Analysis) are summarized in the following table 1 of 34 sources, which were Japan's key categories in fiscal year 2004.

The categories in which mitigation techniques have been employed, emissions and removals have been newly estimated, and estimation methods have been changed, were recognized as the key categories according to the Qualitative Analysis. In this fiscal year, given that a number of categories with smaller emissions could be identified as the key categories in accordance with the existing qualitative analysis method since emissions were newly estimated or the estimation methods were changed in many categories in the fiscal year 2005, the key categories were identified following the results of the quantitative analysis mentioned above for this fiscal year. Those categories which can be recognized as the key categories in accordance with the existing qualitative analysis, are listed in "1.2.4 Qualitative Analysis".

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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.

Table 1 Japan’s Key Categories

	A IPCC Source Category		B Direct GHGs	D Current Year Estimate (Gg CO_2eq.)	Level Tier.1	Trend Teir.1	Level Tier.2	Trend Teir.2
#1	1A Stationary Combustion	Solid Fuels	CO2	427,547.48	#1	#2	#1	#2
#2	1A Stationary Combustion	Liquid Fuels	CO2	343,946.42	#2	#1	#5	#7
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	230,273.39	#3	#4	#6	#16
#4	1A Stationary Combustion	Gaseous Fuels	CO2	166,893.26	#4	#3	#3	#6
#5	6C Waste Incineration		CO2	35,394.80	#5	#6	#2	#5
#6	2A Mineral Product	1. Cement Production	CO2	31,415.59	#6	#8	#8	#14
#7	1A3 Mobile Combustion	d. Navigation	CO2	12,893.54	#7	#16		
#8	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,879.82	#8		#14	
#9	1A3 Mobile Combustion	a. Civil Aviation	CO2	10,663.39	#9	#14	#23	
#10	4A Enteric Fermentation		CH4	7,141.03	#10		#26	
#11	6A Solid Waste Disposal on		CH4	5,832.26	#11	#12	#18	#15
#12	4C Rice Cultivation		CH4	5,807.29	#12		#19	#23
#13	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	1,017.90		#5	#22	#1
#14	2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF6	958.39		#7		#3
#15	2B Chemical Industry	3. Adipic Acid	N2O	838.90		#9		#12
#16	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	5,101.00		#10	#12	#11
#17	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	764.80		#11	#27	#4
#18	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	4,016.28		#13	#13	#13
#19	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	57.18		#15		#8
#20	1A Stationary Combustion		N2O	4,199.57		#17	#15	#17
#21	1A3 Mobile Combustion	a. Civil Aviation	N2O	106.49			#4	#9
#22	4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,251.62			#7	#10
#23	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	3,917.21			#9	#21
#24	1A3 Mobile Combustion	b. Road Transportation	N2O	5,710.93			#10	#22
#25	4B Manure Management		N2O	4,732.22			#11	#18
#26	4B Manure Management		CH4	2,549.06			#16	#20
#27	4D Agricultural Soils	3. Indirect Emissions	N2O	2,948.83			#17	#19
#28	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF6	1,784.38			#20	#24
#29	6B Wastewater Handling		N2O	1,302.98			#21	
#30	1A Stationary Combustion		CH4	517.03			#24	
#31	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	882.00			#25	
#32	2F(a) Consumption of Halocarbons	4. Aerosols/Metered Dose Inhalers	HFCs	2,190.01			#28	
#33	1A3 Mobile Combustion	d. Navigation	N2O	106.55			#29	
#34	6B Wastewater Handling		CH4	1,499.75				#25

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

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 uses emissions from each category directly and Tier 2 level assessment analyzes the emissions of each category, multiplied by the uncertainty of each category.

Tier 1 level assessment of the latest emissions (FY2004) gives the following 12 sub-categories as the key categories (Table 2). Tier 2 level assessment of the latest emissions (FY2004) gives the following 29 sub-categories as the key categories (Table 3).

Table 2 Results of Tier.1 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	427,547.48	31.6%	31.6%
#2	1A Stationary Combustion	Liquid Fuels	CO2	343,946.42	25.4%	56.9%
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	230,273.39	17.0%	73.9%
#4	1A Stationary Combustion	Gaseous Fuels	CO2	166,893.26	12.3%	86.3%
#5	6C Waste Incineration		CO2	35,394.80	2.6%	88.9%
#6	2A Mineral Product	1. Cement Production	CO2	31,415.59	2.3%	91.2%
#7	1A3 Mobile Combustion	d. Navigation	CO2	12,893.54	1.0%	92.1%
#8	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,879.82	0.8%	92.9%
#9	1A3 Mobile Combustion	a. Civil Aviation	CO2	10,663.39	0.8%	93.7%
#10	4A Enteric Fermentation		CH4	7,141.03	0.5%	94.3%
#11	6A Solid Waste Disposal on		CH4	5,832.26	0.4%	94.7%
#12	4C Rice Cultivation		CH4	5,807.29	0.4%	95.1%

Table 3 Results of Tier.2 Level Assessment

	A IPCC Source Category		B Direct GHGs	D Current Year Estimate (Gg CO_2eq.)	I Source Uncertinty	K Contribution to Total L2	Cumulative
#1	1A Stationary Combustion	Solid Fuels	CO2	427,547.48	7.2%	25.5%	25.5%
#2	6C Waste Incineration		CO2	35,394.80	31.0%	9.1%	34.6%
#3	1A Stationary Combustion	Gaseous Fuels	CO2	166,893.26	6.0%	8.2%	42.8%
#4	1A3 Mobile Combustion	a. Civil Aviation	N2O	106.49	8213.5%	7.2%	50.1%
#5	1A Stationary Combustion	Liquid Fuels	CO2	343,946.42	2.3%	6.4%	56.5%
#6	1A3 Mobile Combustion	b. Road Transportation	CO2	230,273.39	3.3%	6.2%	62.7%
#7	4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,251.62	145.8%	5.1%	67.9%
#8	2A Mineral Product	1. Cement Production	CO2	31,415.59	10.4%	2.7%	70.6%
#9	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	3,917.21	64.0%	2.1%	72.6%
#10	1A3 Mobile Combustion	b. Road Transportation	N2O	5,710.93	43.8%	2.1%	74.7%
#11	4B Manure Management		N2O	4,732.22	45.4%	1.8%	76.5%
#12	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	5,101.00	40.0%	1.7%	78.2%
#13	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	4,016.28	48.7%	1.6%	79.8%
#14	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,879.82	16.6%	1.5%	81.3%
#15	1A Stationary Combustion		N2O	4,199.33	43.0%	1.5%	82.8%
#16	4B Manure Management		CH4	2,549.06	65.0%	1.4%	84.1%
#17	4D Agricultural Soils	3. Indirect Emissions	N2O	2,948.83	55.1%	1.3%	85.5%
#18	6A Solid Waste Disposal on		CH4	5,832.26	26.0%	1.3%	86.7%
#19	4C Rice Cultivation		CH4	5,807.29	23.1%	1.1%	87.8%
#20	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF6	1,784.38	64.0%	0.9%	88.8%
#21	6B Wastewater Handling		N2O	1,302.98	81.1%	0.9%	89.6%
#22	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	1,017.90	100.1%	0.8%	90.5%
#23	1A3 Mobile Combustion	a. Civil Aviation	CO2	10,663.39	9.0%	0.8%	91.3%
#24	1A Stationary Combustion		CH4	517.03	182.0%	0.8%	92.1%
#25	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	882.00	100.5%	0.7%	92.8%
#26	4A Enteric Fermentation		CH4	7,141.03	12.1%	0.7%	93.5%
#27	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	764.80	100.5%	0.6%	94.1%
#28	2F(a) Consumption of Halocarbons	4. Aerosols/ Metered Dose Inhalers	HFCs	2,190.01	35.1%	0.6%	94.8%
#29	1A3 Mobile Combustion	d. Navigation	N2O	106.55	718.6%	0.6%	95.4%

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 level assessment uses emissions from each category directly and Tier 2 level assessment analyzes the emissions of each category, multiplied by the uncertainty of each category.

Tier 1 trend assessment of the latest emissions (FY2004) gives the following 17 sub-categories as the key categories (Table 4). Tier 2 trend assessment of the latest emissions (FY2004) gives the following 29 sub-categories as the key categories (Table 5).

Table 4 Results of Tier.1 Trend Assessment

	A IPCC Source Category		B Direct GHGs	C Base Year Estimate (Gg CO$_2$eq.)	D Current Year Estimate (Gg CO$_2$eq.)	H % Contribution to Trend	Cumulative
#1	1A Stationary Combustion	Liquid Fuels	CO2	435,103.20	343,946.42	31.1%	31.1%
#2	1A Stationary Combustion	Solid Fuels	CO2	305,990.32	427,547.48	24.0%	55.0%
#3	1A Stationary Combustion	Gaseous Fuels	CO2	104,300.83	166,893.26	13.4%	68.4%
#4	1A3 Mobile Combustion	b. Road Transportation	CO2	189,227.88	230,273.39	6.4%	74.8%
#5	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	1,017.90	4.3%	79.1%
#6	6C Waste Incineration		CO2	21,754.02	35,394.80	2.9%	82.0%
#7	2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF6	10,994.00	958.39	2.7%	84.7%
#8	2A Mineral Product	1. Cement Production	CO2	37,966.28	31,415.59	2.4%	87.1%
#9	2B Chemical Industry	3. Adipic Acid	N2O	7,501.25	838.90	1.8%	88.9%
#10	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	8,880.00	5,101.00	1.1%	90.0%
#11	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4,708.30	764.80	1.1%	91.1%
#12	6A Solid Waste Disposal on		CH4	8,881.48	5,832.26	0.9%	92.0%
#13	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	809.13	4,016.28	0.8%	92.8%
#14	1B Fugitive Emission	1a i. Coal Mining and Handling(under	CH4	2,785.23	57.18	0.7%	93.5%
#15	1A3 Mobile Combustion	a. Civil Aviation	CO2	7,162.41	10,663.39	0.7%	94.2%
#16	1A3 Mobile Combustion	d. Navigation	CO2	13,730.95	12,893.54	0.5%	94.7%
#17	1A Stationary Combustion		N2O	2,152.65	4,199.33	0.5%	95.2%

Table 5 Results of Tier.2 Trend Assessment

	A IPCC Source Category		B Direct GHGs	D Current Year Estimate (Gg CO$_2$eq.)	I Source Uncertinty	K Contribution to Total L2	Cumulative
#1	1A Stationary Combustion	Solid Fuels	CO2	427,547.48	7.2%	25.5%	25.5%
#2	6C Waste Incineration		CO2	35,394.80	31.0%	9.1%	34.6%
#3	1A Stationary Combustion	Gaseous Fuels	CO2	166,893.26	6.0%	8.2%	42.8%
#4	1A3 Mobile Combustion	a. Civil Aviation	N2O	106.49	8213.5%	7.2%	50.1%
#5	1A Stationary Combustion	Liquid Fuels	CO2	343,946.42	2.3%	6.4%	56.5%
#6	1A3 Mobile Combustion	b. Road Transportation	CO2	230,273.39	3.3%	6.2%	62.7%
#7	4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,251.62	145.8%	5.1%	67.9%
#8	2A Mineral Product	1. Cement Production	CO2	31,415.59	10.4%	2.7%	70.6%
#9	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	3,917.21	64.0%	2.1%	72.6%
#10	1A3 Mobile Combustion	b. Road Transportation	N2O	5,710.93	43.8%	2.1%	74.7%
#11	4B Manure Management		N2O	4,732.22	45.4%	1.8%	76.5%
#12	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	5,101.00	40.0%	1.7%	78.2%
#13	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	4,016.28	48.7%	1.6%	79.8%
#14	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,879.82	16.6%	1.5%	81.3%
#15	1A Stationary Combustion		N2O	4,199.33	43.0%	1.5%	82.8%
#16	4B Manure Management		CH4	2,549.06	65.0%	1.4%	84.1%
#17	4D Agricultural Soils	3. Indirect Emissions	N2O	2,948.83	55.1%	1.3%	85.5%
#18	6A Solid Waste Disposal on		CH4	5,832.26	26.0%	1.3%	86.7%
#19	4C Rice Cultivation		CH4	5,807.29	23.1%	1.1%	87.8%
#20	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF6	1,784.38	64.0%	0.9%	88.8%
#21	6B Wastewater Handling		N2O	1,302.98	81.1%	0.9%	89.6%
#22	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	1,017.90	100.1%	0.8%	90.5%
#23	1A3 Mobile Combustion	a. Civil Aviation	CO2	10,663.39	9.0%	0.8%	91.3%
#24	1A Stationary Combustion		CH4	517.03	182.0%	0.8%	92.1%
#25	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	882.00	100.5%	0.7%	92.8%
#26	4A Enteric Fermentation		CH4	7,141.03	12.1%	0.7%	93.5%
#27	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	764.80	100.5%	0.6%	94.1%
#28	2F(a) Consumption of Halocarbons	4. Aerosols/ Metered Dose Inhalers	HFCs	2,190.01	35.1%	0.6%	94.8%
#29	1A3 Mobile Combustion	d. Navigation	N2O	106.55	718.6%	0.6%	95.4%

Table 6 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	I Source Uncertinty	J Level Uncertainty (x 1000)	K Contribution to Total L2	L Trend Uncertainty (x 1000)	M Contribution to Total T2
#1	1A Stationary Combustion	Liquid Fuels	CO2	435,103.20	343,946.42	0.254	25.4%	0.0860	31.1%	2.3%	5.73	6.4%	1.94	4.3%
#2	1A Stationary Combustion	Solid Fuels	CO2	305,990.32	427,547.48	0.316	31.6%	0.0664	24.0%	7.2%	22.82	25.5%	4.80	10.8%
#3	1A Stationary Combustion	Gaseous Fuels	CO2	104,300.83	166,893.26	0.123	12.3%	0.0371	13.4%	6.0%	7.35	8.2%	2.21	5.0%
#4	1A Stationary Combustion		CH4	369.78	517.03	0.000	0.0%	0.0001	0.0%	182.0%	0.69	0.8%	0.15	0.3%
#5	1A Stationary Combustion		N2O	2,152.65	4,199.33	0.003	0.3%	0.0013	0.5%	43.0%	1.33	1.5%	0.55	1.2%
#6	1A3 Mobile Combustion	a. Civil Aviation	CO2	7,162.41	10,663.39	0.008	0.8%	0.0020	0.7%	9.0%	0.71	0.8%	0.18	0.4%
#7	1A3 Mobile Combustion	b. Road Transportation	CO2	189,227.88	230,273.39	0.170	17.0%	0.0177	6.4%	3.3%	5.58	6.2%	0.58	1.3%
#8	1A3 Mobile Combustion	c. Railways	CO2	932.45	648.04	0.000	0.0%	0.0002	0.1%	3.2%	0.02	0.0%	0.01	0.0%
#9	1A3 Mobile Combustion	d. Navigation	CO2	13,730.95	12,893.54	0.010	1.0%	0.0013	0.5%	3.3%	0.32	0.4%	0.04	0.1%
#10	1A3 Mobile Combustion	a. Civil Aviation	CH4	2.94	4.83	0.000	0.0%	0.0000	0.0%	183.3%	0.01	0.0%	0.00	0.0%
#11	1A3 Mobile Combustion	b. Road Transportation	CH4	219.40	198.01	0.000	0.0%	0.0000	0.0%	32.8%	0.05	0.1%	0.01	0.0%
#12	1A3 Mobile Combustion	c. Railways	CH4	1.18	0.84	0.000	0.0%	0.0000	0.0%	14.0%	0.00	0.0%	0.00	0.0%
#13	1A3 Mobile Combustion	d. Navigation	CH4	26.33	25.48	0.000	0.0%	0.0000	0.0%	144.5%	0.03	0.0%	0.00	0.0%
#14	1A3 Mobile Combustion	a. Civil Aviation	N2O	69.75	106.49	0.000	0.0%	0.0000	0.0%	8213.5%	6.46	7.2%	1.75	3.9%
#15	1A3 Mobile Combustion	b. Road Transportation	N2O	4,255.13	5,710.93	0.004	0.4%	0.0008	0.3%	43.8%	1.85	2.1%	0.33	0.7%
#16	1A3 Mobile Combustion	c. Railways	N2O	121.38	84.48	0.000	0.0%	0.0000	0.0%	11.2%	0.01	0.0%	0.00	0.0%
#17	1A3 Mobile Combustion	d. Navigation	N2O	111.31	106.55	0.000	0.0%	0.0000	0.0%	718.6%	0.57	0.6%	0.07	0.1%
#18	1B Fugitive Emission	1a i. Coal Mining and Handling(under	CH4	2,785.23	57.18	0.000	0.0%	0.0020	0.7%	89.4%	0.04	0.0%	1.80	4.0%
#19	1B Fugitive Emission	1a ii. Coal Mining and Handling (surface)	CH4	21.20	9.33	0.000	0.0%	0.0000	0.0%	184.9%	0.01	0.0%	0.02	0.0%
#20	1B Fugitive Emission	2a. Oil	CO2	0.14	0.12	0.000	0.0%	0.0000	0.0%	20.7%	0.00	0.0%	0.00	0.0%
#21	1B Fugitive Emission	2a. Oil	CH4	28.32	28.16	0.000	0.0%	0.0000	0.0%	17.3%	0.00	0.0%	0.00	0.0%
#22	1B Fugitive Emission	2a. Oil	N2O	0.00	0.00	0.000	0.0%	0.0000	0.0%	26.9%	0.00	0.0%	0.00	0.0%
#23	1B Fugitive Emission	2b. Natural Gas	CO2	0.28	0.40	0.000	0.0%	0.0000	0.0%	18.7%	0.00	0.0%	0.00	0.0%
#24	1B Fugitive Emission	2b. Natural Gas	CH4	272.87	387.04	0.000	0.0%	0.0001	0.0%	15.3%	0.04	0.0%	0.01	0.0%
#25	1B Fugitive Emission	2c. Venting & Flaring	CO2	36.25	34.52	0.000	0.0%	0.0000	0.0%	19.0%	0.00	0.0%	0.00	0.0%
#26	1B Fugitive Emission	2c. Venting & Flaring	CH4	56.12	67.34	0.000	0.0%	0.0000	0.0%	22.3%	0.01	0.0%	0.00	0.0%
#27	1B Fugitive Emission	2c. Venting & Flaring	N2O	0.11	0.11	0.000	0.0%	0.0000	0.0%	18.5%	0.00	0.0%	0.00	0.0%
#28	2A Mineral Product	1. Cement Production	CO2	37,966.28	31,415.59	0.023	2.3%	0.0065	2.4%	10.4%	2.41	2.7%	0.68	1.5%
#29	2A Mineral Product	2. Lime Production	CO2	5,052.59	4,238.20	0.003	0.3%	0.0008	0.3%	5.0%	0.16	0.2%	0.04	0.1%
#30	2A Mineral Product	3. Limestone and Dolomite Use	CO2	11,527.41	10,879.82	0.008	0.8%	0.0011	0.4%	16.6%	1.34	1.5%	0.18	0.4%
#31	2A Mineral Product	4. Soda Ash Production and Use	CO2	578.03	383.49	0.000	0.0%	0.0002	0.1%	16.3%	0.05	0.1%	0.03	0.1%
#32	2B Chemical Industry	1. Ammonia Production	CO2	3,384.68	2,307.30	0.002	0.2%	0.0009	0.3%	13.3%	0.23	0.3%	0.12	0.3%
#33	2B Chemical Industry	other products except Anmonia	CO2	1,129.29	1,001.11	0.001	0.1%	0.0001	0.1%	73.2%	0.54	0.6%	0.11	0.2%
#34	2B Chemical Industry	2. Nitric Acid	N2O	765.70	818.71	0.001	0.1%	0.0000	0.0%	23.3%	0.14	0.2%	0.00	0.0%
#35	2B Chemical Industry	3. Adipic Acid	N2O	7,501.25	838.90	0.001	0.1%	0.0050	1.8%	23.3%	0.14	0.2%	1.16	2.6%
#36	2B Chemical Industry	5. Carbon Black, Ethylene, Ethylene Dichloride, Styrene, Methanol, Coke	CH4	337.80	115.92	0.000	0.0%	0.0002	0.1%	89.5%	0.08	0.1%	0.15	0.3%
#37	2C Metal Production	1 Iron and Steel Production	CO2	176.68	148.81	0.000	0.0%	0.0000	0.0%	7.1%	0.01	0.0%	0.00	0.0%
#38	2C Metal Production	3. Aluminium Production	PFCs	72.46	14.78	0.000	0.0%	0.0000	0.0%	33.4%	0.00	0.0%	0.01	0.0%
#39	2C Metal Production	4. SF6 Used in Aluminium and Magnesium Foundries	SF6	119.50	956.00	0.001	0.1%	0.0006	0.2%	33.4%	0.24	0.3%	0.19	0.4%
#40	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	1,017.90	0.001	0.1%	0.0118	4.3%	100.1%	0.75	0.8%	11.84	26.5%
#41	2E Production of Halocarbons and SF6	2. Fugitive Emissions	HFCs	491.50	555.90	0.000	0.0%	0.0000	0.0%	100.5%	0.41	0.5%	0.02	0.0%
#42	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	809.13	4,016.28	0.003	0.3%	0.0021	0.8%	48.7%	1.44	1.6%	1.05	2.3%
#43	2F(a) Consumption of Halocarbons	2. Foam Blowing	HFCs	456.96	590.64	0.000	0.0%	0.0001	0.0%	63.1%	0.28	0.3%	0.04	0.1%
#44	2F(a) Consumption of Halocarbons	4. Aerosols/ Metered Dose Inhalers	HFCs	1,365.00	2,190.01	0.002	0.2%	0.0005	0.2%	35.1%	0.57	0.6%	0.17	0.4%
#45	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	HFCs	145.40	129.78	0.000	0.0%	0.0000	0.0%	64.0%	0.06	0.1%	0.01	0.0%
#46	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	762.90	882.00	0.001	0.1%	0.0000	0.0%	100.5%	0.65	0.7%	0.04	0.1%
#47	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	8,880.00	5,101.00	0.004	0.4%	0.0031	1.1%	40.0%	1.51	1.7%	1.23	2.7%
#48	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	2,857.80	3,917.21	0.003	0.3%	0.0006	0.2%	64.0%	1.85	2.1%	0.36	0.8%
#49	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4,708.30	764.80	0.001	0.1%	0.0030	1.1%	100.5%	0.57	0.6%	2.97	6.6%
#50	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF6	1,099.82	1,784.38	0.001	0.1%	0.0004	0.1%	64.0%	0.84	0.9%	0.26	0.6%
#51	2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF6	10,994.00	958.39	0.001	0.1%	0.0075	2.7%	39.8%	0.28	0.3%	2.97	6.6%
#52	3 Solvent & Other Product Use	Using Laughing Gas in Hospital	N2O	287.07	297.54	0.000	0.0%	0.0000	0.0%	5.0%	0.01	0.0%	0.00	0.0%
#53	4A Enteric Fermentation		CH4	7,641.73	7,141.03	0.005	0.5%	0.0008	0.3%	12.1%	0.64	0.7%	0.09	0.2%
#54	4B Manure Management		CH4	3,120.57	2,549.06	0.002	0.2%	0.0006	0.2%	65.0%	1.22	1.4%	0.36	0.8%
#55	4B Manure Management		N2O	5,542.94	4,732.22	0.003	0.3%	0.0009	0.3%	45.4%	1.59	1.8%	0.39	0.9%
#56	4C Rice Cultivation		CH4	7,075.73	5,807.29	0.004	0.4%	0.0013	0.5%	23.1%	0.99	1.1%	0.29	0.6%
#57	4D Agricultural Soils	1. Direct Soil Emissions	N2O	5,110.74	4,251.62	0.003	0.3%	0.0009	0.3%	145.8%	4.58	5.1%	1.26	2.8%
#58	4D Agricultural Soils	3. Indirect Emissions	N2O	3,675.81	2,948.83	0.002	0.2%	0.0007	0.3%	55.1%	1.20	1.3%	0.38	0.9%
#59	4F Field Burning of Agricultural Residues		CH4	129.77	101.48	0.000	0.0%	0.0000	0.0%	140.9%	0.11	0.1%	0.04	0.1%
#60	4F Field Burning of Agricultural Residues		N2O	103.92	73.94	0.000	0.0%	0.0000	0.0%	181.1%	0.10	0.1%	0.05	0.1%
#61	6A Solid Waste Disposal on		CH4	8,881.48	5,832.26	0.004	0.4%	0.0026	0.9%	26.0%	1.12	1.3%	0.67	1.5%
#62	6B Wastewater Handling		CH4	2,133.41	1,499.75	0.001	0.1%	0.0005	0.2%	39.3%	0.44	0.5%	0.22	0.5%
#63	6B Wastewater Handling		N2O	1,550.99	1,302.98	0.001	0.1%	0.0003	0.1%	81.1%	0.78	0.9%	0.21	0.5%
#64	6C Waste Incineration		CO2	21,754.02	35,394.80	0.026	2.6%	0.0081	2.9%	31.0%	8.11	9.1%	2.53	5.7%
#65	6C Waste Incineration		CH4	62.90	80.99	0.000	0.0%	0.0000	0.0%	86.3%	0.05	0.1%	0.01	0.0%
#66	6C Waste Incineration		N2O	1,910.88	2,896.71	0.002	0.2%	0.0006	0.2%	6.9%	0.15	0.2%	0.04	0.1%
#67	6C Other		CO2	702.83	508.26	0.000	0.0%	0.0002	0.1%	24.4%	0.09	0.1%	0.04	0.1%
#68	6C Other		N2O	20.12	19.54	0.000	0.0%	0.0000	0.0%	97.5%	0.01	0.0%	0.00	0.0%
	TOTAL			1,254,830.79	1,354,868.94	1.00	100.0%	0.28	100.00%		89.33		44.68	

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, were identified as key in terms of the quantitative analysis. However, in the inventory submitted in 2006, the key categories were identified only based on the quantitative results of the level and trend assessments, including both Tier 1 and Tier 2, since there existed a large number of categories in which emissions were newly estimated or the estimation methods were changed, as indicated below, and these could be recognized as the key categories if the existing method was followed.

- 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.b. CH_4 and N_2O emissions from Road Transportation (Natural Gas-Powered Vehicles and Motorcycles)
  - 1.A.3.b. CH_4 and N_2O emissions from Railways (Steam Locomotives)
  - 1.B.2.c. CO_2, CH_4 and N_2O emissions from Venting, Flaring (Gas)
  - 1.B.2.c. CH_4 and N_2O emissions from Flaring (Oil)
  - 2.A.4. CO_2 emissions from Soda Ash Production and Use
  - 2.B.4. CO_2 emissions from Calcium Carbide Production
  - 2.B.4. CO_2 emissions from Silicon Carbide Production
  - 2.C.1. CO_2 emissions from Iron and Steel Production (Emissions from Electrodes of Electric Arc Furnaces)
  - 2.F.3. HFCs, PFCs, SF_6 emissions from Fire Extinguishers
  - 4.A.2. CH_4 emissions from Enteric Fermentation (Buffalo)
  - 4.B.2., 11.-13. N_2O emissions from Manure Management
  - 4.D.1. N_2O emissions from Agricultural Soils (Direct Soil Emission)
  - 6.A. CH_4 emissions from Managed Waste Disposal on Land (Sludge, Illegal Disposal on land, Composting of Organic Waste)
  - 6.B. CH_4 and N_2O emissions from Wastewater Handling (Industrial Wastewater, Domestic and Commercial Wastewater)
  - 6.C. CO_2, CH_4 and N_2O emissions from Waste Incineration (Synthetic Fabric scrap, Specially Controlled Industrial Waste, Use of waste as Raw materials or Fuels)
  - 6.D. CO_2 and N_2O emissions from Others (Decomposition of Petroleum-Derived Surfactants and Composting of Organic Waste)
- categories in which estimation methods have been changed
  - 1.A. CH_4 and N_2O emissions from Stationary Combustion
  - 1.A.3.b. CH_4 and N_2O emissions from Road Transportation
  - 2.A.1. CO_2 emissions from Cement Production
  - 2.A.3. CO_2 emissions from Limestone and Dolomite Use
  - 2.F.1. PFCs emissions from Refrigeration and Air Conditioning Equipment
  - 2.F.2. HFSs emissions from Foam Blowing
  - 4.A.1. CH_4 emissions from Enteric Fermentation (Cattle)
  - 4.B.1., 11.-13. CH_4 and N_2O emissions from Manure Management
  - 4.B. CH_4 and N_2O emissions from Agricultural Soils (Pasture, Range and Paddock Manure)
  - 4.D.3. N_2O emissions from Agricultural Soils (Indirect Emissions)
  - 6.A. CH_4 emissions from Managed Waste Disposal on Land (MSW)
  - 6.B. CH_4 emissions from Wastewater Handling (Industrial Wastewater)
  - 6.C. CH_4 and N_2O emissions from Waste Incineration

Annex 2. Detailed Discussion on Methodology and Data for estimating CO_2 Emissions from Fossil Fuel Combustion

2.1. Emission Factors for Coke, Coke Oven Gas, and Blast Furnace Gas, etc.

Emission factor for BFG [$172][1] was established with annually calculated value in order to keep carbon balance in blast furnace and L.D. converter during iron and steel procution process. The amount of carbon excluded carbon contained in LDG [$173] from carbon (contained in ‘Coke’ [$161] and ‘PCI coal’ [$112]) injected to blast furnace indicated under ‘Steel process gas’ [#2550] is considered to be carbon contained in BFG. emissions factor for BFG was established as carbon described above divided by calorific values of BFG generated. Equation for emission factor and the overview of carbon flow for iron & steel and calculation process are shown below.

Calculation to establish emission factor for BFG is conducted every year.

$$EF_{BFG} = \left[\left(A_{coal} * EF_{coal} + A_{coke} * EF_{coke}\right) - A_{LDG} * EF_{LDG}\right] / A_{BFG}$$

EF : Carbon content of the fuel [tC/TJ]
A : Fuel consumption [TJ]
BFG : Blast Furnace Gas ［$172］
coal : PCI coal ［$112］
coke : coke ［$161］
LDG : L.D converter gas ［$172］

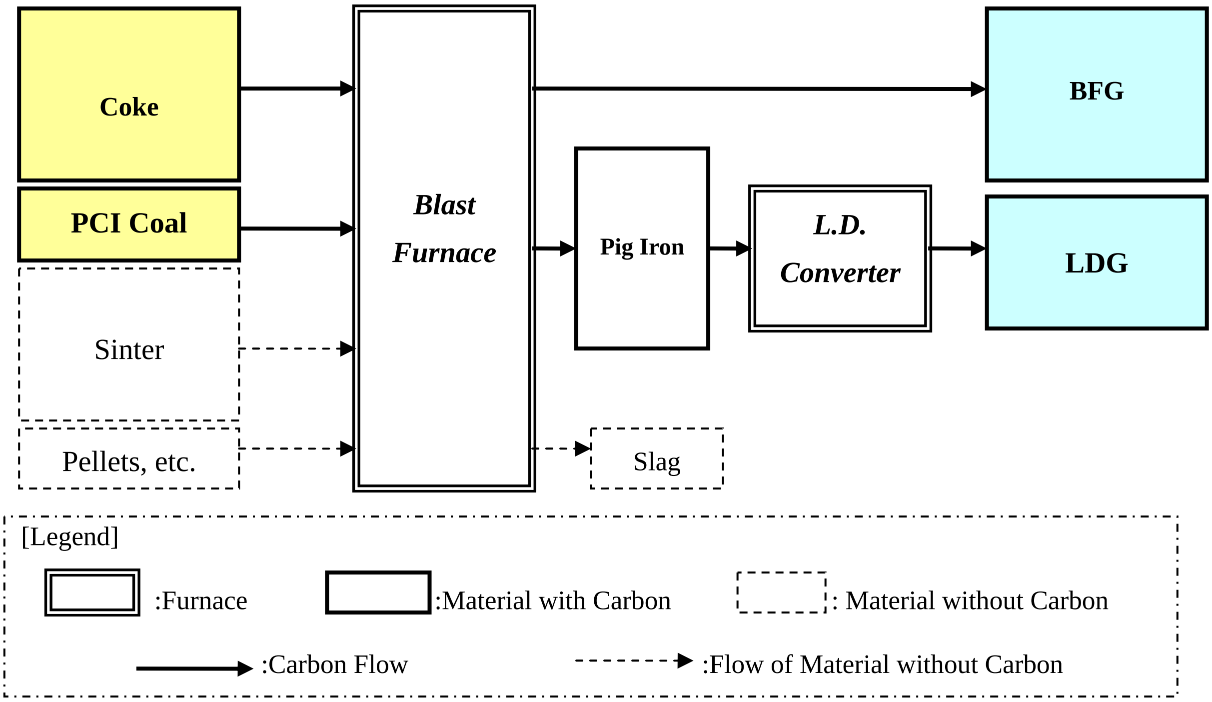

Figure 1 Overview of carbon flow for iron & steel

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[1] Codes in brackets indicate column and row number indicated in the *Yearbook of the Current Survey of Energy Consumption*.

Table 1 Calculation of Emission Factors for BFG

#2550 Steel Process Gas		1990	1995	2000	2003	2004	Note
Input							
$112 PCI Coal	Gg-C	1,574	2,593	3,518	3,566	3,389	A
$161 Coke	Gg-C	12,830	11,432	12,021	12,089	12,371	B
Input Total	Gg-C	14,404	14,024	15,539	15,655	15,760	C: A + B
Output							
$173 LDG	Gg-C	2,541	2,359	2,726	2,840	2,934	D
Difference	Gg-C	11,863	11,665	12,813	12,815	12,826	E: C - D
Output							
$172 BFG	TJ	434,801	433,504	481,768	483,071	483,016	F

EF $172 BFG	t-C/TJ	27.28	26.91	26.60	26.53	26.55	E / F

2.2. Emission Factor for Town Gas

‘Town gas’ [$450] consists of ‘Town gas’ [$460] provided by town gas supplier and ‘Small scale town gas’ [$470] provided by small scale town gas supplier.

Because most part of small scale town gas is LPG provision without blending, the same emission factor for town gas was adopted for LPG.

Emission factors for town gas were established based on carbon balance in ‘Town gas production’ [#2400]. To calculate town gas emission factors, the total carbon in fossil fuel inputs used as raw materials (COG [$171], Kerosene [$330], Refinery gas [$380], LPG [$390], LNG [$410] and Indigenous natural gas [$420]) was divided by the total calorific value of the town gas production.

Calculation to establish emission factor for town gas is conducted every year.

$$EF_{TG} = \sum \left(A_i * EF_i \right) / P_{TG}$$

EF : Carbon content of the fuel [tC/TJ]
A : Fuel consumption [TJ]
TG : Town gas［$460］
i : Feedstocks (COG [], Kerosine [], [], LPG [], LNG [], Indigenous natural gas［$420］

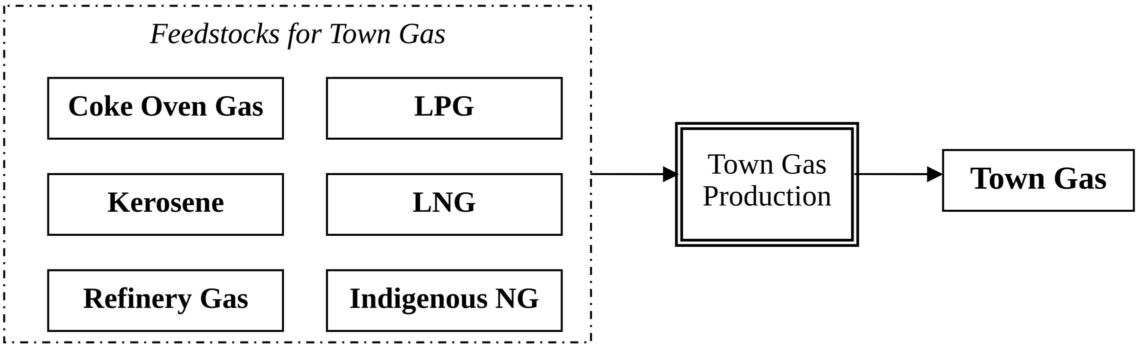

Figure 2 Manufacturing Flow for Town Gas

Table 2 Calculation of Emission Factors for BFG

#2400 Town Gas Production		1990	1995	2000	2003	2004	Note
Input							
$171 COG	Gg-C	211	134	105	63	30	a1
$330 Kerosene	Gg-C	200	275	69	30	16	a2
$380 Refinergy Gas	Gg-C	186	199	186	200	157	a3
$390 LPG	Gg-C	1,931	2,104	1,791	1,276	1,232	a4
$410 LNG	Gg-C	6,253	9,107	11,642	14,018	15,114	a5
$420 Indigenous NG	Gg-C	551	661	848	1,013	1,065	a6
Input Total	Gg-C	9,331	12,480	14,641	16,601	17,614	A: ∑a
Output							
$460 Town Gas	TJ	664,661	892,307	1,061,122	1,209,968	1,274,254	B

EF $460 Town Gas	t-C/TJ	14.04	13.99	13.80	13.72	13.82	A/B

2.3. Duplication adjustment for Energy Balance Table

Data set of manufacturing sector indicated in Japan’s Energy Balance Table (*General Energy Statistics*) and used as the reference of activity data are based on the Ministry of Economy, Trade and Industry’s *Yearbook of the Current Survey of Energy Consumption. Yearbook of the Current Survey of Energy Consumption* is a statistical survey on factories and business institutions of key manufacturing. Factories and business institutions which produce items indicated in Table 3 are surveyed.

In Japan, it is rare that single factory or business institution produces single item. Most factories and business institutions produce various items extending across categories of industry utilizing by-products and surplus business resources. For example, most integrated steelworks produce not only steel products falling into iron & steel industry but also coke and slag cement falling into cement & ceramics industry and chemical products delivered from coal tar and industrial gas falling into chemical industry; i.e. one factory can conduct three different categories of industries and produces many kinds of items at the same time.

Because single factory may report duplicated energy consumption data which can not be classified to certain sector or item, total energy consumption summed up by sector or by item can be larger than actual total energy consumption when totalizing by sector or by item is conducted under *Yearbook of the Current Survey of Energy Consumption.*

Hence, to avoid duplication adjustment and to adjust the data in the *Yearbook of the Current Survey of Energy Consumption*, the following steps were taken: (1) to calculate total energy consumption by factory and business institution, (2) to calculate total energy consumption by sector and by item including duplication among sectors and items, (3) to express the difference between total energy consumption by sector and item and total energy consumption by factory and business as negative values as “duplication adjustment”.

In the *Yearbook of the Current Survey of Energy Consumption*, the adjustment stated above is applied indicating values for “duplication adjustment” when total energy consumption is calculated by sector or by item for Auto Power Generation, Industrial Steam Generation, and Manufacturing

Calculation method for duplication adjustment

Values of duplication adjustment $= E_p - E_t$

E_p : Total energy consumption of designated sectors and items by factories and business institutions

E_t : Total energy consumption by factories and business institutions

Subjects to be surveyed to obtain the data for the *Yearbook of the Current Survey of Energy Consumption* were changed in December, 1997. As shown in Figure 3, the survey for the industries of Dyeing、Rubber Product, and Non-ferrous Metals has been discontinued since 1998. Also, since 1998, business institutions or designated items to be surveyed for the industries of Chemical、Ceramics, Clay and Stone Products、Glass Products、Iron and Steel, Non-ferrous Metals, and Machinery has been changed. Therefore, energy consumption for the said industries during 1990-1997 is chronologically inconsistent comparing to that from 1998 and onward. Also, the classification of industries was revised during this period. Because of these changes, energy consumption for duplication adjustment, other industries, and small-to-medium-sized manufacturing significantly fluctuates.

Table 3 Surveyed industries and products in *Yearbook of the Current Survey of Energy Consumption*

Surveyed industry	from 1990 to 1997		after 1997	
	Products	Scope of survey	Products	Scope of survey
Pulp and paper industry	* Pulp	All	* Pulp	All
	* Paper	Establishments with 50 or more employees	* Paper	Establishments with 50 or more employees
	* Sheet paper	Establishments with 50 or more employees	* Sheet paper	Establishments with 50 or more employees
Chemical industry (except chemical fiber industry)	* Petrochemical products	All	* Petrochemical products	All
	* Ammonia and amonia-derived products	All	* Ammonia and amonia-derived products	
	* Soda industries chemicals	All	* Soda industries chemicals	
	* High pressure gas (O_2, N_2, Ar)	All (except high pressure gas products by air fraction method(gas container))		
	* Inorganic chemicals and colorant (titanic oxide, active char, chinese white, iron oxide)	All		
	* Oil and fat products and surfactant	Establishments with 30 or more employees		
Chemical fiber industry	* Chemical fibers	Establishments with 30 or more employees	* Chemical fibers	Establishments with 30 or more employees
Petroleum products industry	* Petroleum products (except grease)	All	* Petroleum products (except grease)	All
Ceramics, clay and stone products industry (except glass product industry, with the exception of sheet glass industry)	* Cement	All	* Cement	All
	* Sheet glass	All	* Sheet glass	All
	* Lime	Establishments with 30 or more employees	* Lime	Establishments with 30 or more employees
	* Fire brick	Establishments with 30 or more employees		
	* Carbon products	All		
Glass product industry (except sheet glass industry)	* Glass products	Establishments with 10 or more employees	* Glass products	Establishments with 100 or more employees
Iron and steel industry	Manufacturers of pig iron, ferroalloys, crude steel, semi-finished steel products, forged steel products, cast steel products, general steel and hot-rolled steel materials, cold-rolled wide steel strips, cold-rolled electrical steel strips, plated steel materials, special steel hot-rolled	All	Manufacturers of pig iron, ferroalloys, crude steel, semi-finished steel products, forged steel products, cast steel products, general steel and hot-rolled steel materials, cold-rolled wide steel strips, cold-rolled electrical steel strips, plated steel materials, special steel hot-rolled steel	All
Non-ferrous metal industry	* Non-ferrous metals	all	* Copper	All
			* Lead	All
			* Zinc	All
			* Aluminum	All
			* Alminum secondary ground metal	Establishments with 30 or more employees
Machinery industry	* Machinery and appliances	Establishments with 500 or more employees	* Civli engineering machinery, tractors, metal working and metal processing machinery, parts and accessories for communication and electrictronics equipment, electron tubes, semiconductors, ICs, electronics applied equipment, automobiles and parts (including motorcycles)	Establishments with 500 or more employees which are designated by the Minister of International Trade and Industry
	* cast and forged products	Establishments with 100 or more employees		
Dyeing	* Dyeing wool * Dyeing fablic	Establishments with 20 or more employees	demise	
Rubber product	* Tires and tube	Establishments with 30 or more employees	demise	
Non-ferrous metal product	* Copper and brass	All	demise	
	* Flat-rolled aluminum	All		
	* Electric cable	Establishments with 30 or more employees		
	* Alminum secondary bare metal	Establishments with 30 or more employees		

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.

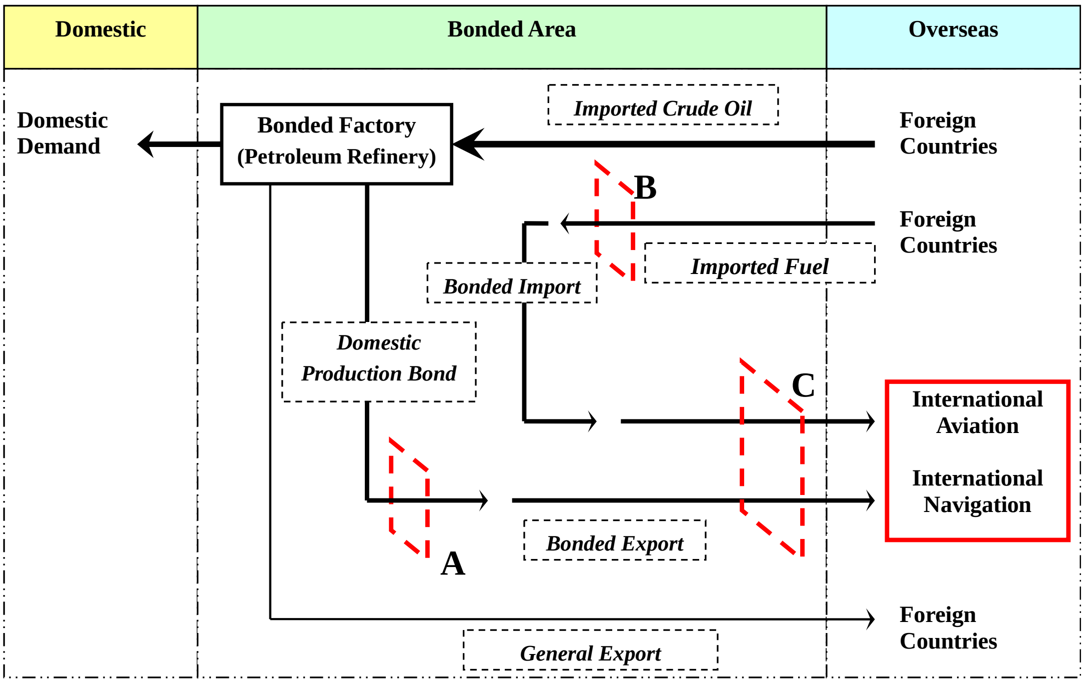

Figure 1 Activity data for international bunkers

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***

Energy consumption according to facility type determined from General Energy Statistics was used for 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 *report on Screening Survey Regarding Measures to Counter Global Warming* (Japan Environmental Sanitation Center) and *Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions* (Institute of Behavioral Science).

- ***Activity data***

Energy consumption according to facility type determined from General Energy Statistics was used for 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 *report on Screening Survey Regarding Measures to Counter Global Warming* (Japan Environmental Sanitation Center) and *Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions* (Institute of Behavioral Science).

- ***Activity data***

To determine NO_X and SO_X, 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.

Energy consumption from General Energy Statistics was used for CO and NMVOCs.

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 total hydrocarbon (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	Vehicle Type	Unit	1990	1995	2000	2003	2004
Gasoline	Light Vehicle	gNOx/km	0.230	0.159	0.157	0.119	0.119
	Passenger Vehicle (including LPG)	gNOx/km	0.237	0.203	0.199	0.118	0.118
	Light Cargo Truck	gNOx/km	0.873	0.658	0.375	0.280	0.280
	Small Cargo Truck	gNOx/km	1.115	0.897	0.478	0.152	0.152
	Regular Cargo Truck	gNOx/km	1.833	1.093	0.560	0.183	0.183
	Bus	gNOx/km	4.449	3.652	2.438	0.181	0.181
	Special Vehicle	gNOx/km	1.471	0.873	0.429	0.173	0.173
Diesel	Passenger Vehicle	gNOx/km	0.636	0.526	0.437	0.491	0.491
	Small Cargo Truck	gNOx/km	1.326	1.104	1.005	1.016	1.016
	Regular Cargo Truck	gNOx/km	5.352	4.586	4.334	4.548	4.548
	Bus	gNOx/km	4.226	3.830	3.597	4.265	4.265
	Special Vehicle	gNOx/km	3.377	2.761	2.152	3.574	3.574

* 2004 data were used for 2003.

Source: Environment Management Bureau, Ministry of the Environment

Table 3 CO emission factors for automobiles

Fuel	Vehicle Type	Unit	1990	1995	2000	2003	2004
Gasoline	Light Vehicle	gCO/km	1.749	1.549	1.543	1.320	1.320
	Passenger Vehicle (including LPG)	gCO/km	2.325	2.062	2.034	1.310	1.310
	Light Cargo Truck	gCO/km	10.420	8.540	5.508	4.086	4.086
	Small Cargo Truck	gCO/km	9.656	10.079	8.309	3.452	3.452
	Regular Cargo Truck	gCO/km	12.624	10.601	8.950	4.346	4.346
	Bus	gCO/km	26.209	25.079	21.938	3.854	3.854
	Special Vehicle	gCO/km	12.466	10.666	8.924	2.737	2.737
Diesel	Passenger Vehicle	gCO/km	0.480	0.432	0.429	0.406	0.406
	Small Cargo Truck	gCO/km	0.975	0.896	0.808	0.674	0.674
	Regular Cargo Truck	gCO/km	3.221	2.988	2.440	2.446	2.446
	Bus	gCO/km	2.579	2.534	2.200	2.349	2.349
	Special Vehicle	gCO/km	2.109	1.893	1.297	1.828	1.828

* 2004 data were used for 2003.

Source: Environment Management Bureau, Ministry of the Environment

Table 4 NMVOC emission factors for automobiles

Fuel	Vehicle Type	Unit	1990	1995	2000	2003	2004
Gasoline	Light Vehicle	gHC/km	0.128	0.050	0.048	0.048	0.048
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.077	0.030	0.029	0.029	0.029
	Passenger Vehicle (including LPG)	gHC/km	0.189	0.112	0.104	0.042	0.042
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.113	0.067	0.062	0.025	0.025
	Light Cargo Truck	gHC/km	1.058	0.610	0.274	0.209	0.209
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.635	0.366	0.165	0.125	0.125
	Small Cargo Truck	gHC/km	1.188	0.882	0.346	0.116	0.116
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.713	0.529	0.208	0.069	0.069
	Regular Cargo Truck	gHC/km	1.658	0.959	0.471	0.132	0.132
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.995	0.575	0.283	0.079	0.079
	Bus	gHC/km	3.604	3.164	2.193	0.152	0.152
		%	60%	60%	60%	60%	60%
		gNMVOC/km	2.162	1.899	1.316	0.091	0.091
	Special Vehicle	gHC/km	1.619	0.786	0.317	0.096	0.096
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.972	0.472	0.190	0.058	0.058
Diesel	Passenger Vehicle	gHC/km	0.109	0.098	0.097	0.094	0.094
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.065	0.059	0.058	0.056	0.056
	Small Cargo Truck	gHC/km	0.389	0.343	0.258	0.240	0.240
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.233	0.206	0.155	0.144	0.144
	Regular Cargo Truck	gHC/km	1.634	1.488	1.040	1.019	1.019
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.980	0.893	0.624	0.611	0.611
	Bus	gHC/km	1.273	1.255	0.995	1.020	1.020
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.764	0.753	0.597	0.612	0.612
	Special Vehicle	gHC/km	1.101	0.965	0.526	0.729	0.729
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.661	0.579	0.316	0.437	0.437

Top row: THC emission factors;

Middle row: Percentage of NMVOC in the THC emission;

* 2004 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	2003	2004
Gasolin	%	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).

- ***Completeness***

Emissions of NOx, CO, NMVOCs, and SO_2 from natural gas vehicles and motorcycles are reported as "NE".

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 civil aviation

Gas	EF ［g/MJ］
NO_X	0.29
CO	0.12
NMVOC	0.018

Source: Revised 1996 IPCC Guidelines, Vol. 3; Page 1.90, 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.

- ***Completeness***

Emissions of NOx, CO, and NMVOCs from aviation fuel consumption are reported as "NE".

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 [a)]	0.00033
Aromatics hydrocarbon [a)]	0.00108
Alcohol solvent [a)]	0.00105
Ester, ether solvent [b)]	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 ratio of 1983 and each year about 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 (Rye and oats were excluded from the estimate because there are no Japan-specific emission factors for them):

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-CH_4］

$=\Sigma_{\text{rice straw, wheat straw, chaff}}$ (amount of rice or wheat straw or chaff burnt ［t］

×carbon content (dry weight) × percentage of carbon released as CO

×mol ratio of CO to 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 mean 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: Y Miura and T Kan’no, "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: Y Miura and T Kan'no, "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 to CO2 in gases emitted from burning rice and wheat straw and chaff

	Mol ratio of CO to CO_2 in emitted gas	Note
Rice straw	0.219	Adopted the mean 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: Y Miura and T Kan'no, "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*

Amounts of rice straw, chaff, and wheat straw burned were obtained by using the following equations, which were used in 4F.1. to calculate CH_4 and N_2O emissions from the burning of agricultural residue, to allocate the amounts of rice plants, wheat (for seed), and barley (for seed) burned to the amounts of rice straw, chaff, and wheat straw burned.

Amount of rice straw burned = amount of rice plants burned × 0.5
Amount of chaff burned = amount of rice plants burned × 0.5
Amount of wheat/barley straw burned = (amounts of wheat and barley burned) × 0.5

Note: Based on the judgment of specialists, the ratios of straw to chaff and rice plants to wheat/barley were set to 1:1

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 solid waste; continuous system)] and [1302: Waste incinerator (municipal solid waste; batch system)]). The incineration material was [53: Municipal solid 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.

Table 20 NO_x and SO_2 emission factors for municipal waste incineration by facility type

	Item	Unit	1990	1995	2000	2003	2004
NOx	Municipal Waste Incinerator(Cont.)	kg-NOx/t	1.238	1.213	1.127	1.127	1.127
	Municipal Waste Incinerator(Semi-Cont.	kg-NOx/t	1.055	1.226	1.226	1.226	1.226
	Municipal Waste Incinerator(Batch)	kg-NOx/t	1.137	1.918	1.850	1.850	1.850
SO_2	Municipal Waste Incinerator(Cont.)	kg-SO_2/t	0.555	0.539	0.361	0.361	0.361
	Municipal Waste Incinerator(Semi-Cont.	kg-SO_2/t	0.627	1.141	0.712	0.712	0.712
	Municipal Waste Incinerator(Batch)	kg-SO_2/t	1.073	1.625	1.714	1.714	1.714

The data after 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

.

Table 21 CO emission factors for municipal waste incineration by facility type

	Furnace Type	Unit	1990	1995	2000	2003	2004
CO	Continuous Incinerator	gCO/t	557	557	555	552	552
	Semi-Continuous Incinerator	gCO/t	550	550	567	589	589
	Batch type Incinerator	gCO/t	8,239	8,239	8,298	8,323	8,323

* 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

	Furnace Type	Unit	1990	1995	2000	2003	2004
NMVOC	Continuous Incinerator	gNMVOC/t	0.925	0.925	0.925	0.925	0.925
	Semi-Continuous Incinerator	gNMVOC/t	7.9	7.9	7.9	7.9	7.9
	Batch type Incinerator	gNMVOC/t	9.1	9.1	9.1	9.1	9.1

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 , the Ministry of the Environment. The incineration rate was calculated in the *Waste Treatment in Japan* published by the Waste Management and Recycling Department , 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 solid waste using the emission volume and volume of treated industrial solid waste identified by the *MAP Survey*. The categories of incinerator types included: [1303: Waste incinerator (industrial solid waste; continuous system)] and [1304: Waste incinerator (industrial solid waste; batch system)]. The incinerator fuel covered the categories [23: Fuel Wood] and [54: Industrial solid waste]). The six types of industrial waste were “Waste paper or waste wood”, “Sludge”, “Waste oil”, “Waste plastics”, “Waste textiles”, and “Animal/plant residue, livestock carcasses”. Category [23: Sawn Timber] was used for “Waste paper or waste wood”, “Waste textiles”, and “Animal/plant residues, livestock carcasses”, while category [54: Industrial waste] was used for “Sludge”, “Waste oil”, and “Waste plastics”. However, no emission factor was set for the mixed burning of multiple waste types.

Table 23 NO_x and SO_2 emission factors for industrial waste by facility type

	Item	Unit	1990	1995	2000	2003	2004
NOx	"Fuel Wood 23"	kg-NOx/t	1.545	1.312	5.828	5.828	5.828
	"Industrial Waste 54"	kg-NOx/t	0.999	1.158	1.415	1.415	1.415
SO_2	"Fuel Wood 23"	kg-SO_2/t	1.528	1.274	2.118	2.118	2.118
	"Industrial Waste 54"	kg-SO_2/t	1.179	1.882	1.352	1.352	1.352

* The data for 1999 were used for 2000 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 solid waste. The six types of industrial waste were “Waste paper or waste wood”, “Sludge”, “Waste oil”, “Waste plastics”, “Waste textiles”, and “Animal/plant residues, livestock carcasses”. The emission factor for “wood waste” was used for “Waste textiles” and “Animal/plant residues, livestock carcasses”, for which there are no measurements. No emission factor was set for the mixed burning of multiple waste types.

Table 24 CO emission factors for industrial waste incinerators by operation type

Item	Unit	1990	1995	2000	2003	2004
Waste Paper, Waste Wood	gCO/t	1,334	1,334	1,334	1,334	1,334
Waste Oil	gCO/t	127	127	127	127	127
Waste Plastics	gCO/t	1,790	1,790	1,790	1,790	1,790
Sludge	gCO/t	2,285	2,285	2,285	2,285	2,285
Waste textile	gCO/t	1,334	1,334	1,334	1,334	1,334
Animal and Plant residues	gCO/t	1,334	1,334	1,334	1,334	1,334

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

Item	Unit	1990	1995	2000	2003	2004
Waste Paper, Waste Wood	gNMVOC/t	2.48	2.48	2.48	2.48	2.48
Waste Oil	gNMVOC/t	0.54	0.54	0.54	0.54	0.54
Waste Plastics	gNMVOC/t	3.40	3.40	3.40	3.40	3.40
Sludge	gNMVOC/t	1.61	1.61	1.61	1.61	1.61
Waste textile	gNMVOC/t	2.48	2.48	2.48	2.48	2.48
Animal and Plant residues	gNMVOC/t	2.48	2.48	2.48	2.48	2.48

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 , the Ministry of the Environment.

3.2.5.1.c. Incineration in Conjunction with Use of Waste as Fuel and Raw Material (6.C.-)

- ***Methodology for Estimating Emissions***

CO and NMVOC emissions from this source were estimated by multiplying the amounts of fuel/raw material burned for each waste type by a Japan-specific emission factor. These emissions are included in the total emissions from waste incineration. NOx and SO_2 are reported as “IE” because they are included in combustion from 1A Stationary Sources.

- ***Emission Factors***

・CO

The CO emission factors (fixed unit basis) for furnace types, which are used for counting emissions from 1A Stationary Sources, were determined by using the calorific values in General Energy Statistics to convert to weight-based emission factors.

Table 26 CO emission factors from incineration in conjunction with use of waste as fuel and raw material

Application	Units	Waste oil	RDF	RPF	Waste tires	Waste plastics	Waste wood
Simple incineration	kgCO/t	0.13	1.79	1.79	1.79		
Boilers	kgCO/t	0.052	0.24	0.36	0.28	0.034	3.64
Cement kilns	kgCO/t	49.1	19.8	29.4	23.0	32.2	
Other furnaces	kgCO/t	0.052	0.24	0.36	0.28		
Pyrolysis furnaces	kgCO/t				0.021		
Gasification	kgCO/t				0.015		

・NMVOC

Just as for the incineration of municipal solid waste and industrial waste, emission factors were determined from documents with estimates of emissions of CH_4 and NMVOCs per unit calorific values.

Table 27 NMVOC emissions factors from incineration in conjunction with use of waste as fuel and raw material

Application	Units	Waste oil	RDF	RPF	Waste tires	Waste plastics	Waste wood
Boilers	kgNMVOC/t	0.015	0.00027	0.00039	0.00031	0.000	0.00
Cement kilns	kgNMVOC/t	0.0	0.0	0.0	0.0	0.0	
Other furnaces	kgNMVOC/t	0.000	0.00	0.00	0.01		
Pyrolysis furnaces	kgNMVOC/t				0.009		
Gasification	kgNMVOC/t				0.000		

- ***Activity data***

We used the same activity data that were used when estimating CH_4 emissions from the use of waste as fuel and raw material.

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[1].

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 1990-2004 ranges between -0.72% and 0.94%. The revision of the Energy Balance Table (*General Energy Statistics*) made difference under 1%, and difference range become smaller than that of inventory submitted in the last year (between -1.17% and 2.46%). It is relatively low compared to the inventories from other countries.

The difference can be explained by ‘Stock Change’ [#3500], ‘Statistical Discrepancy’ [#4000], and energy loss during process of ‘Coal Products’ [#2500] and ‘Oil Products’ [#2600] of the Energy Balance Table. Difference of solid fuels in 2004 was quite large value, because of coal (Imported Steam Coal [$130]) stock change increasing.

Table 1 Comparison of Energy Consumption

[10^18J]

	1990	1991	1995	1996	2000	2001	2002	2003	2004
Reference Approach									
Liquid fuels	9,528	9,656	10,091	9,998	9,403	9,134	9,139	9,044	8,768
Solid fuels	3,291	3,376	3,626	3,719	4,186	4,278	4,422	4,549	4,980
Gaseous fuels	2,088	2,238	2,526	2,670	3,125	3,121	3,206	3,355	3,342
Total RA	**14,907**	**15,271**	**16,244**	**16,387**	**16,714**	**16,532**	**16,767**	**16,949**	**17,090**
Sectoral Approach									
Liquid fuels	9,549	9,598	10,031	9,976	9,425	9,113	9,254	9,076	8,910
Solid fuels	3,329	3,305	3,594	3,702	4,103	4,206	4,432	4,580	4,688
Gaseous fuels	2,106	2,257	2,548	2,679	3,136	3,137	3,238	3,371	3,358
Total	**14,984**	**15,160**	**16,173**	**16,357**	**16,664**	**16,455**	**16,924**	**17,027**	**16,956**
Difference (%)									
Liquid fuels	0.22%	-0.60%	-0.60%	-0.22%	0.23%	-0.23%	1.26%	0.35%	1.62%
Solid fuels	1.15%	-2.12%	-0.89%	-0.46%	-1.99%	-1.67%	0.23%	0.67%	-5.86%
Gaseous fuels	0.89%	0.85%	0.88%	0.31%	0.38%	0.50%	0.98%	0.48%	0.46%
Total	**0.52%**	**-0.72%**	**-0.43%**	**-0.19%**	**-0.30%**	**-0.47%**	**0.94%**	**0.46%**	**-0.79%**

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 1990-2004 ranges between -1.02% and 0.84%. The revision of the Energy Balance Table (*General Energy Statistics*) made difference under about 1%, and difference range become smaller than that of inventory submitted in the last year (between -1.44% and 1.80%). It is relatively low compared to the inventories from other countries.

The difference can be explained by ‘Stock Change’ [#3500], ‘Statistical Discrepancy’ [#4000], and carbon unbalance during process of ‘Coal Products’ [#2500] and ‘Oil Products’ [#2600] of the

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[1] FCCC/SBSTA/2004/8, paragraph 31

Energy Balance Table. Difference of solid fuels in 2004 was quite large value, because of coal (Imported Steam Coal [$130]) stock change increasing.

Table 2 Comparison of CO_2 Emissions

[Tg CO_2]

	1990	1991	1995	1996	2000	2001	2002	2003	2004
Reference Approach									
Liquid fuels	648.1	656.9	685.3	679.4	639.8	621.5	621.5	615.3	596.8
Solid fuels	296.2	303.4	326.0	335.1	378.5	386.4	399.9	411.4	451.0
Gaseous fuels	103.2	110.7	124.9	132.0	154.5	154.3	158.5	165.9	165.3
Total RA	**1,048**	**1,071**	**1,136**	**1,146**	**1,173**	**1,162**	**1,180**	**1,193**	**1,213**
Sectoral Approach									
Liquid fuels	646.2	649.0	675.8	671.8	633.2	611.5	621.3	610.0	598.7
Solid fuels	306.0	302.8	327.3	337.9	375.0	383.4	404.1	417.0	427.5
Gaseous fuels	104.3	111.8	126.2	132.7	155.3	155.3	160.4	167.0	166.9
Total	**1,056**	**1,064**	**1,129**	**1,142**	**1,163**	**1,150**	**1,186**	**1,194**	**1,193**
Difference (%)									
Liquid fuels	-0.31%	-1.20%	-1.39%	-1.12%	-1.03%	-1.60%	-0.04%	-0.86%	0.30%
Solid fuels	3.30%	-0.17%	0.40%	0.84%	-0.92%	-0.76%	1.06%	1.36%	-5.20%
Gaseous fuels	1.03%	0.99%	1.04%	0.48%	0.51%	0.63%	1.15%	0.69%	0.98%
Total	**0.84%**	**-0.68%**	**-0.61%**	**-0.36%**	**-0.79%**	**-1.02%**	**0.49%**	**0.12%**	**-1.65%**

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 2004, regarding to fuel consumption and CO_2 emissions, value of reference approach quite bigger than that of sectoral approach, because of coal stock change increasing already mentioned.

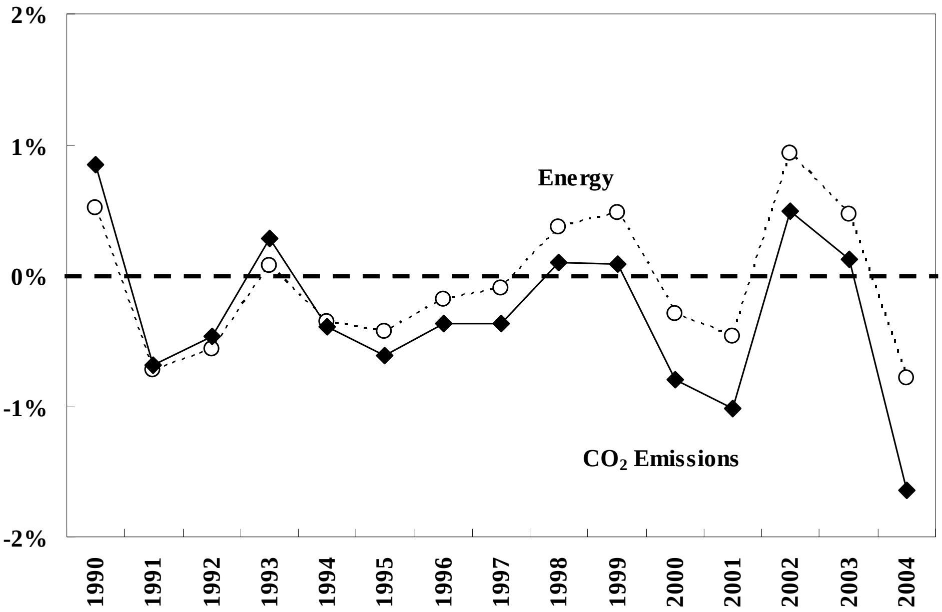

Figure 1 Trends in Difference of Energy Consumption and CO_2 Emissions

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.

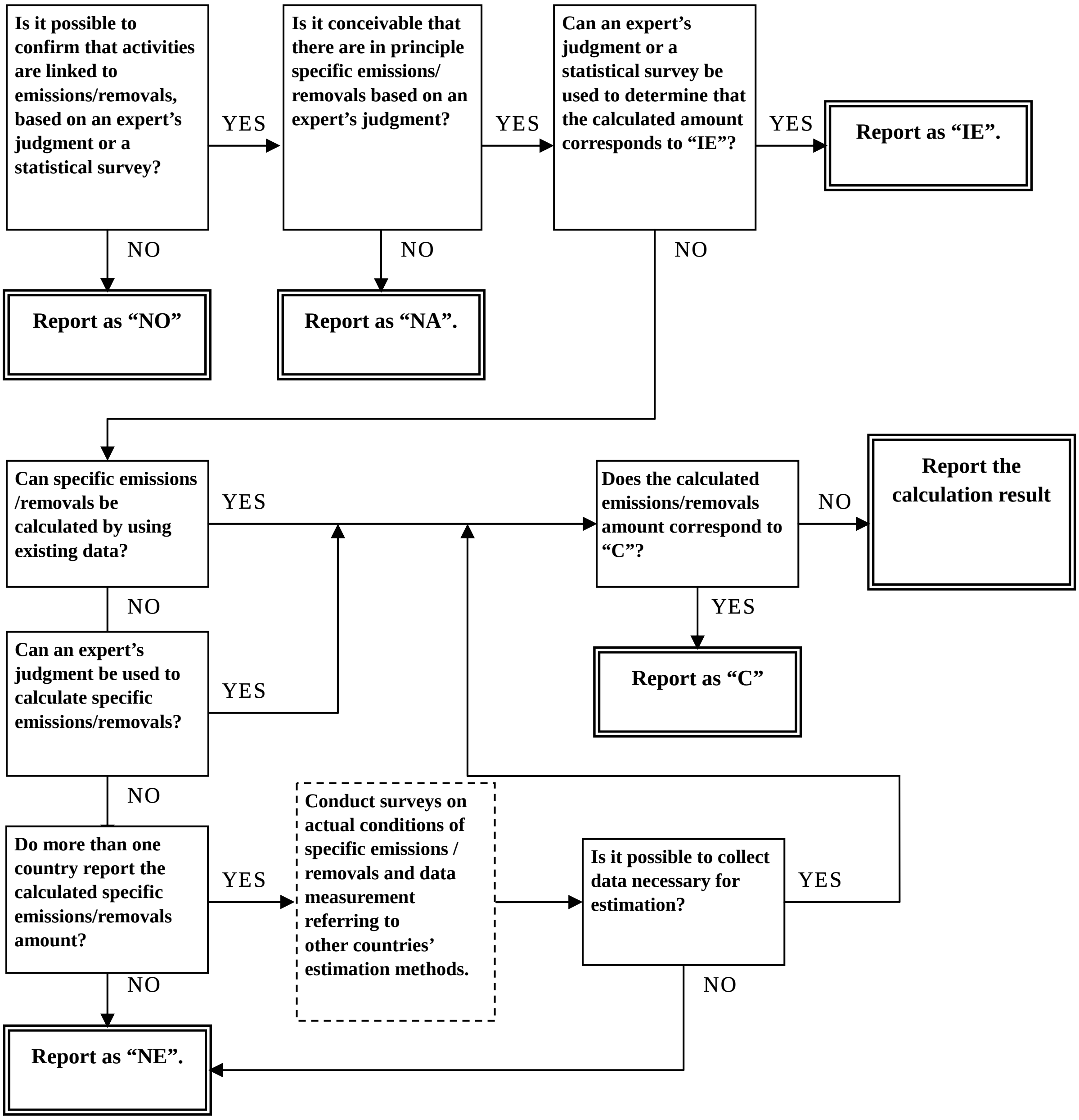

Figure 1 Decision tree for application of notation keys

5.4. Source categories not estimated in Japan’s inventory

Source categories dissolved not estimate status in this year and categories still not estimated in Japan’s inventory are listed below. Note that the emissions 1990-1994 of HFCs, PFCs and SF_6 and the emissions and removals 1996-2004 of LULUCF are not estimated.

Dissolution of "NE" Categories (2004)

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	Railways	Solid Fuels	CH_4
6	Energy	Fuel Combustion	Mobile Combustion	Railways	Solid Fuels	N_2O
7	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Venting	Gas	CO_2
8	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Venting	Gas	CH_4
9	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	CO_2
10	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	CH_4
11	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	N_2O
12	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	CO_2
13	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	CH_4
14	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	N_2O
15	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	CO_2
16	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	CH_4
17	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	N_2O
18	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Production		CO_2
19	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Use（Including desulfurization equipment）		CO_2
20	Industrial Processes	Chemical Industry	Carbide Production	Silicon Carbide		CO_2
21	Industrial Processes	Chemical Industry	Carbide Production	Calcium Carbide		CO_2
22	Industrial Processes	Chemical Industry	Carbide Production	Calcium Carbide		CH_4
23	Industrial Processes	Chemical Industry	Other	Ethylene		N_2O
24	Industrial Processes	Chemical Industry	Other	Coke		N_2O
25	Industrial Processes	Metal Production	Aluminium Production			PFCs
26	Industrial Processes	Metal Production	SF_6 Used in Aluminium and Magnesium Foundries	Aluminium Foundries		SF_6
27	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Commercial Refrigeration	Manufacturing	PFCs
28	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Automatic Vender Machine	Manufacturing	PFCs
29	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing/Stocks/Disposal	HFCs
30	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing	PFCs
31	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Industrial Refrigeration	Manufacturing	PFCs
32	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Stationary Air-Conditioning	Manufacturing/Stocks/Disposal	PFCs
33	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Mobile Air-Conditioning	Manufacturing	PFCs
34	Industrial Processes	Consumption of Halocarbons and SF_6	Foam Blowing	Hard Form	Stocks and Disposal of Urethane Foam	HFCs
35	Industrial Processes	Consumption of Halocarbons and SF_6	Foam Blowing	Hard Form	Stocks and Disposal of Polystyrene Foam	HFCs
36	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Stocks/Disposal	HFCs
37	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	PFCs
38	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	SF_6
39	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Aerosols	Manufacturing/Disposal	HFCs
40	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Metered Dose Inhalers	Disposal	HFCs
41	Industrial Processes	Consumption of Halocarbons and SF_6	Solvents		Manufacturing/Disposal	PFCs
42	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	HFCs
43	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	PFCs
44	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	SF_6
45	Agriculture	Enteric Fermentation	Buffalo			CH_4
46	Agriculture	Enteric Fermentation	Camels and Llamas			CH_4
47	Agriculture	Enteric Fermentation	Mules and Asses			CH_4
48	Agriculture	Enteric Fermentation	Poultry			CH_4
49	Agriculture	Manure Management	Buffalo			CH_4
50	Agriculture	Manure Management	Camels and Llamas			CH_4
51	Agriculture	Manure Management	Mules and Asses			CH_4
52	Agriculture	Manure Management	Sheep, Goats & Horses			N_2O
53	Agriculture	Agricultural Soils	Direct Soil Emissions	Crop Residue		N_2O
54	Agriculture	Agricultural Soils	Direct Soil Emissions	Cultivation of Histosols		N_2O
55	Waste	Solid Waste Disposal on Land	Managed Waste Disposal on Land			CO_2
56	Waste	Solid Waste Disposal on Land	Unmanaged Waste Disposal Sites			CO_2
57	Waste	Solid Waste Disposal on Land	Unmanaged Waste Disposal Sites			CH_4
58	Waste	Wastewater Handling	Industrial Wastewater			N_2O

Categories not estimated

Code	Sector	Source category				Gas
1	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Other Fuels (Methanol)	CH_4
2	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Other Fuels (Methanol)	N_2O
3	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	CO_2
4	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	CH_4
5	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	N_2O
6	Energy	Fugitive Emissions from Fuels	Solid Fuels	Coal Mining		CO_2
7	Energy	Fugitive Emissions from Fuels	Solid Fuels	Coal Mining		N_2O
8	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		CO_2
9	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		CH_4
10	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		N_2O
11	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Refining/Storage	CO_2
12	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Distribution of Oil Products	CO_2
13	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Distribution of Oil Products	CH_4
14	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(at industrial plants and power station)	CO_2
15	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(at industrial plants and power station)	CH_4
16	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(in residential and commercial sectors)	CO_2
17	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(in residential and commercial sectors)	CH_4
18	Energy	International Bunkers	Marine・Diesel Oil			CO_2
19	Energy	International Bunkers	Marine・Diesel Oil			CH_4
20	Energy	International Bunkers	Marine・Diesel Oil			N_2O
21	Energy	International Bunkers	Marine・Heavy Oil			CO_2
22	Energy	International Bunkers	Marine・Heavy Oil			CH_4
23	Energy	International Bunkers	Marine・Heavy Oil			N_2O
24	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Use（Including desulfurization equipment）		CO_2
25	Industrial Processes	Mineral Products	Asphalt roofing			CO_2
26	Industrial Processes	Mineral Products	Road Paving with Asphalt			CO_2
27	Industrial Processes	Chemical Industry	Ammonia Production			CH_4
28	Industrial Processes	Chemical Industry	Other	Coke		CO_2
29	Industrial Processes	Metal Production	Iron and Steel Production	Coke		CO_2
30	Industrial Processes	Metal Production	Aluminium Production			CH_4
31	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Commercial Refrigeration	Stocks/Disposal	PFCs
32	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Automatic Vender Machine	Stocks/Disposal	PFCs
33	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Stocks/Disposal	PFCs
34	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Industrial Refrigeration	Stocks/Disposal	PFCs
35	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Mobile Air-Conditioning	Stocks/Disposal	PFCs
36	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks	HFCs
37	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Metered Dose Inhalers	Manufacturing	HFCs
38	Industrial Processes	Consumption of Halocarbons and SF_6	Solvents		Manufacturing/Stocks/Disposal	HFCs
39	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	HFCs
40	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	PFCs
41	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	SF_6
42	Solvent and Other Product Use	Degreasing and Dry-Cleaning				CO_2
43	Solvent and Other Product Use	Other	Fire Extinguishers			N_2O
44	Solvent and Other Product Use	Other	Other Use of N_2O			CO_2
45	Solvent and Other Product Use	Other	Other Use of N_2O			N_2O
46	Agriculture	Enteric Fermentation	Poultry			CH_4
47	Agriculture	Field Burning of Agricultural Residues	Other			CH_4
48	Agriculture	Field Burning of Agricultural Residues	Other			N_2O
49	Land - use Change and Forestry	Forest Land	Drainage of Soils	Mineral Soils		N_2O
50	Land - use Change and Forestry	Cropland	Agricultural lime apprication	Limestone		CO_2
51	Land - use Change and Forestry	Cropland	Agricultural lime apprication	Dolomite		CO_2
52	Land - use Change and Forestry	Cropland	Cropland remaining Cropland	Dead Organic Matter		CO_2
53	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Dead Organic Matter		CO_2
54	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Biomass Burning	Wildfires	CO_2
55	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Biomass Burning	Wildfires	CH_4
56	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Biomass Burning	Wildfires	N_2O
57	Land - use Change and Forestry	Grassland	Agricultural lime apprication	Limestone		CO_2
58	Land - use Change and Forestry	Grassland	Agricultural lime apprication	Dolomite		CO_2
59	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Dead Organic Matter		CO_2
60	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	CO_2
61	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	CH_4
62	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	N_2O
63	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	CO_2
64	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	CH_4
65	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	N_2O
66	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Dead Organic Matter		CO_2
67	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	CO_2
68	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	CH_4
69	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	N_2O
70	Land - use Change and Forestry	Wetlands	Drainage of Soils	Mineral Soils		N_2O
71	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Living Biomass		CO_2
72	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Dead Organic Matter		CO_2
73	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Soils		CO_2
74	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	CO_2
75	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	CH_4
76	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	N_2O
77	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	CO_2
78	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	CH_4
79	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	N_2O
80	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Dead Organic Matter		CO_2
81	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	CO_2
82	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	CH_4
83	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	N_2O
84	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Living Biomass Decrease		CO_2
85	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Dead Organic Matter		CO_2
86	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Soils		CO_2
87	Land - use Change and Forestry	Other Land	Land Converted to Other Land	Dead Organic Matter		CO_2
88	Land - use Change and Forestry	Harvested Wood Product				CO_2
89	Land - use Change and Forestry	Harvested Wood Product				CH_4
90	Land - use Change and Forestry	Harvested Wood Product				N_2O
91	Waste	Wastewater Handling	Domestic and Commercial Wastewater			CH_4
92	Waste	Wastewater Handling	Domestic and Commercial Wastewater			N_2O
93	Waste	Waste Incineration				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)

- ***Overview***

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").

- ***Main Processes***

Implementation process		Description	Implementing agency
1	Identify inventory problem areas for improvement	Inventory problem areas for improvement are identified using information such as: ・ Problem areas needing correction discovered in the inventory calculation process ・ Problem areas noted in Estimation Methods Committee meetings ・ Problem areas noted in the inventory review ・ Etc.	GIO$^{1)}$
2	Decide schedule for preparing inventory	・ Decide the overall schedule for preparing that year's inventory, taking into account matters including scheduled examination of estimation methods.	MOE$^{2)}$, GIO
3	Decide policy (proposed) and meeting schedule of the Committee for the Greenhouse Gas Emissions Estimation Methods	・ Decide policy for holding committee meetings, the agenda, and schedule.	MOE, GIO
QC activities		・ Preparing corrected inventory list ・ English-language version of inventory review report ・ Table of planned inventory improvements	GIO

1) Greenhouse Gas Inventory Office of Japan

2) The Ministry of Environment

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[1] GIO keeps a corrections list and records the information to address needed corrections discovered when working on the inventory.

6.1.2. Expert review of previous inventories (Committee for the Greenhouse Gases Emissions Estimation Methods) (Step 2)

• *Overview*

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 GPG(2000) 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.

Table 1 Overview of Committee for the Greenhouse Gases Emissions Estimation Methods

Implementing body	Ministry of the Environment
Meetings held	(1) Feb-Mar 1999(2) Nov 1999 to Sep 2000(3) Dec 2001 to Jul 2002(4) Aug 2003(5) Dec 2004 to 2006
Main purposes	(1) Preparing inventory based on the IPCC *Good Practice Guidance* (2000) (analyzing key categories, assessing uncertainty, etc.) (2) Examining issues that need continuing discussion (carbon balance in the petroleum refining process, etc.) (3) Responding to problem areas pointed out by the 2003 inventory in-country review (developing quality assurance/quality control [QA/QC] plan, etc.), examining estimation methods meant to confirm baseline year emissions
Regime	Create inventory working groups to discuss crossover issues, breakout groups to consider issues by sector, and a parent committee to oversee the working groups and breakout groups (Refer to Figure 1)
Members	Researchers from universities, research institutes, incorporated administrative agencies, and other organizations; experts from industry organizations; and involved government ministries and agencies (about 70 experts attended meetings in FY2005)

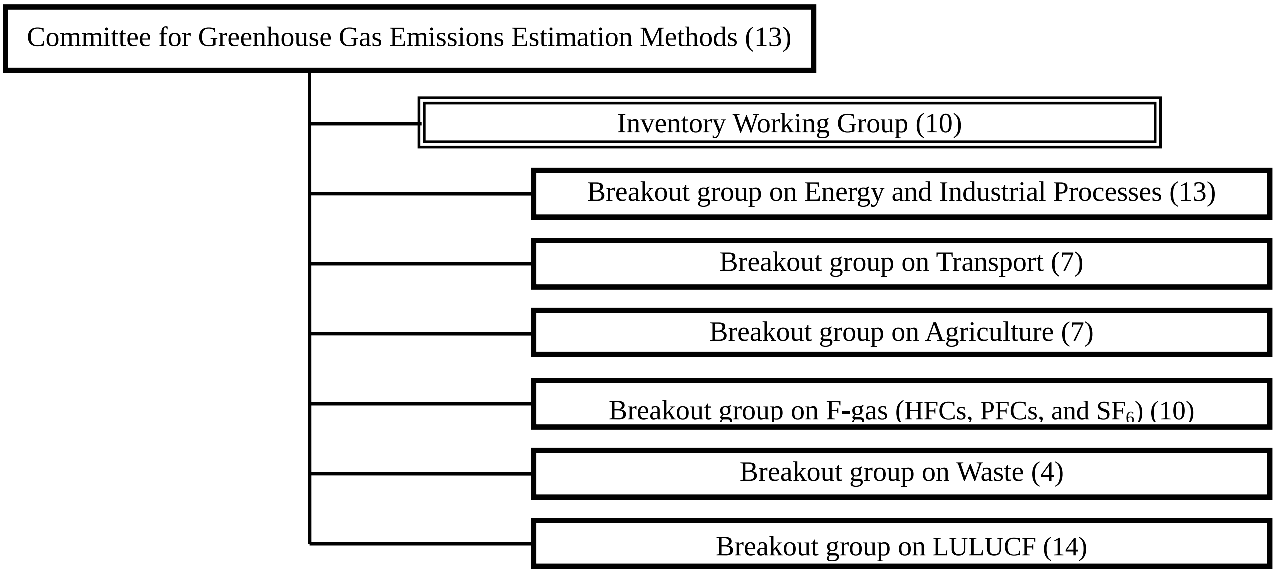


Figure 1 Organization of Committee for the Greenhouse Gases Emissions Estimation Methods (Parentheses show numbers of experts in FY2005)

- ***Main Processes***

Implementation process		Description	Implementing agency
1	Prepare committee meeting materials	• Preparation of committee meeting materials	MOE, GIO, subcontractors
2	Hold meetings of parent committee and breakout groups according to schedule	• Holding committee meetings • Feedback on problem areas	MOE (GIO, subcontractors)
		• Discussions of inventory quality, and specifying places that can be improved (QA activities	Outside experts
3	Prepare minutes after committee meetings	• Preparation of committee meeting minutes	GIO, subcontractors
QC activities		• Preservation of committee meeting materials and minutes	GIO

6.1.3. Data Collection (Step 3)

- ***Overview***

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.

• *Main Processes*

Implementation process		Description	Implementing agency
1	Confirm data that must be collected	・ Confirming data needed to update inventory. Confirm collection processes for categories whose estimation methods changed, and for newly estimated categories.	GIO, subcontractors
2	Collect data using government statistics	・ Obtaining government statistics needed to prepare inventory.	GIO, subcontractors
		・ Making hard copies of pages with data used, put them in the specified binders, and file. When making hard copies, use marker pens to show data.	GIO, subcontractors
3	Request data from relevant government agencies and private organizations	・ Preparing letters requesting data and files for entering data.	GIO
		・ Sending request letters and data input files to relevant agencies and organizations.	MOE, GIO
4	Provide data depending on type of request	・ Entering prescribed data into files and send to MOE or GIO. ・ When sending files, also noting if there are changes in past data.	Relevant agencies or organizations
QC activities		・ Preparing list of assembled data. ・ Managing data collection progress and prepare list. ・ Filing commercially available government statistics and hard copies of them. ・ Retaining electronic files into which data have been entered. ・ Filing the data request letters	GIO, subcontractors

6.1.4. Compilation of Draft CRF (Including Key Category Analysis and Uncertainty Assessment) (Step 4)

• *Overview*

In Japan estimation files having a linked structure based on estimation equations for emissions and removals (JNGI：Japan National Greenhouse Gas Inventory files) are used to perform data entry and estimation of emissions and removals all at the same time. And because key category analyses and uncertainty assessments are interlocked with estimation of emissions and removals, they are performed more or less simultaneously. This section therefore puts data entry and estimation of emissions and removals into step 4 with key category analysis and uncertainty assessment, and explains each activity.

• *Main Processes*

Implementation process		Description	Implementing agency
1	Prepare estimation files for years concerned	・ Preparing estimation files for years concerned based on factors including results of considering inventory improvements.	GIO, subcontractors
2	Update files for entering activity data and emission factors	・ Entering data collected in step 3.	GIO, subcontractors
3	Update background data files	・ Updating activity data and emission factors automatically updates background data files.	GIO, subcontractors
4	Transfer to CRF Reporter	・ Transferring estimation results into CRF reporter.	GIO, subcontractors
5	Prepare verification files	・ Making verification files and compare with estimation results.	GIO, subcontractors
6	Prepare CRF	・ Preparing CRF using CRF Reporter.	MOE, GIO, subcontractors
QC activities		・ Checking for errors in transferring entered data. ・ Making sure emission estimation was properly done. ・ Making sure parameters and emission factors were properly used. ・ Checking completeness of database files. ・ Checking to see if consistent data were used in multiple emission source categories. ・ Making sure data are correctly linked. ・ Estimating uncertainty and checking it. ・ Making sure citations are properly shown. ・ Checking completeness. ・ Managing processes. ・ Filing related documents.	GIO, subcontractors

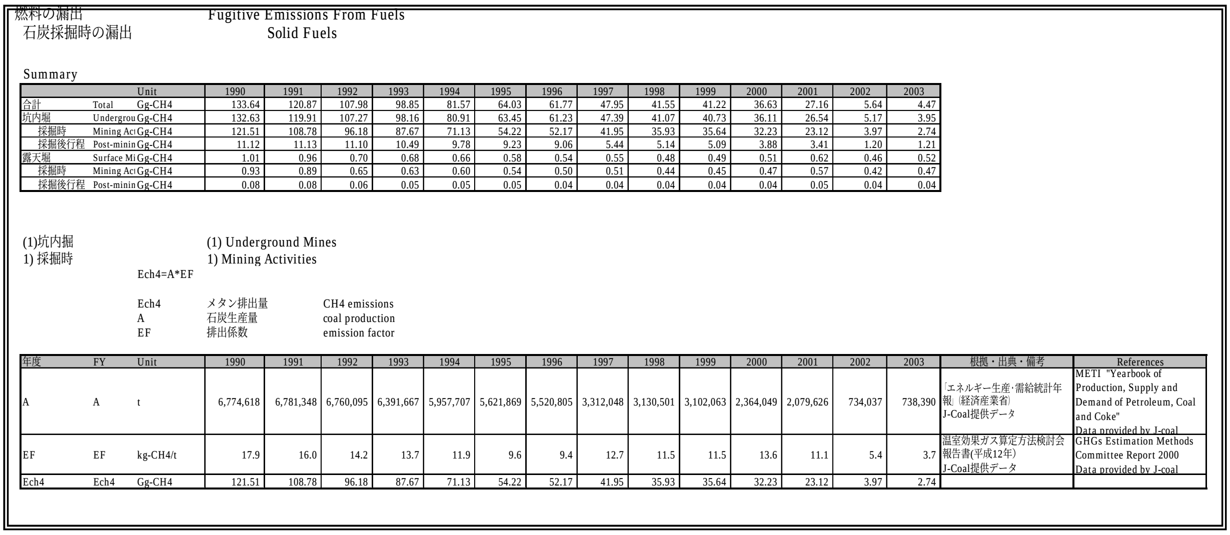
• *Individual Tasks*

-Data Entry and Estimation of Emissions and Removals

In Japan the JNGI files, which comprise activity data input files, emission factor input files, and estimation files, are used to estimate GHG emissions and removals (see Figures 2 and 3). The activity data input files and emission factor input files are linked to the estimation files, which are in turn linked to the CRF Reporter transfer file. The CRF Reporter transfer file has the same structure as the CRF Reporter input sheet, so that entering data into the activity data input files and the emission factor input files automatically updates the emissions and removals estimates, and the CRF Reporter transfer file. After the CRF Reporter transfer file data are entered into the CRF Reporter input sheet, the CRF Reporter is compiled to prepare the CRF.

Because the estimation files basically have the same structure every year, the files of any one year are made using copies of the previous year's files. However, in situations such as when estimation methods or the like change, or when the inventory submission method changes, it may be necessary to join or eliminate files, change the link structure, or make other changes.

In addition to the estimation files, CRF link file, and CRF, Japan prepares files that refer to the estimation files (verification files) for estimating emissions and removals. Verification files are used to calculate total emissions using a system and integration method that are different from those of the estimation files and CRF Reporter transfer file. Therefore, if the total emission amounts of the CRF and verification files match, it means there are no problems with data entry or inter-file links, or no calculation errors such as double counting emissions or 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	2002	2003
合計	Total	Gg-CH4	133.64	120.87	107.98	98.85	81.57	64.03	61.77	47.95	41.55	41.22	36.63	27.16	5.64	4.47
坑内堀	Undergrou	Gg-CH4	132.63	119.91	107.27	98.16	80.91	63.45	61.23	47.39	41.07	40.73	36.11	26.54	5.17	3.95
採掘時	Mining Ac	Gg-CH4	121.51	108.78	96.18	87.67	71.13	54.22	52.17	41.95	35.93	35.64	32.23	23.12	3.97	2.74
採掘後行程	Post-minin	Gg-CH4	11.12	11.13	11.10	10.49	9.78	9.23	9.06	5.44	5.14	5.09	3.88	3.41	1.20	1.21
露天堀	Surface Mi	Gg-CH4	1.01	0.96	0.70	0.68	0.66	0.58	0.54	0.55	0.48	0.49	0.51	0.62	0.46	0.52
採掘時	Mining Ac	Gg-CH4	0.93	0.89	0.65	0.63	0.60	0.54	0.50	0.51	0.44	0.45	0.47	0.57	0.42	0.47
採掘後行程	Post-minin	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	0.04	0.04

(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	2002	2003	根拠・出典・備考	References
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	2,079,626	734,037	738,390	「エネルギー生産･需給統計年報」(経済産業省) J-Coal提供データ	METI "Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke" Data provided by J-coal
EF	EF	kg-CH4/t	17.9	16.0	14.2	13.7	11.9	9.6	9.4	12.7	11.5	11.5	13.6	11.1	5.4	3.7	温室効果ガス算定方法検討会報告書(平成12年) J-Coal提供データ	GHGs Estimation Methods Committee Report 2000 Data provided by J-coal
Ech4	Ech4	Gg-CH4	121.51	108.78	96.18	87.67	71.13	54.22	52.17	41.95	35.93	35.64	32.23	23.12	3.97	2.74		

Figure 1　An estimation file (emission/removal estimation sheet) (“Coal” in 1B1-2005.xls)

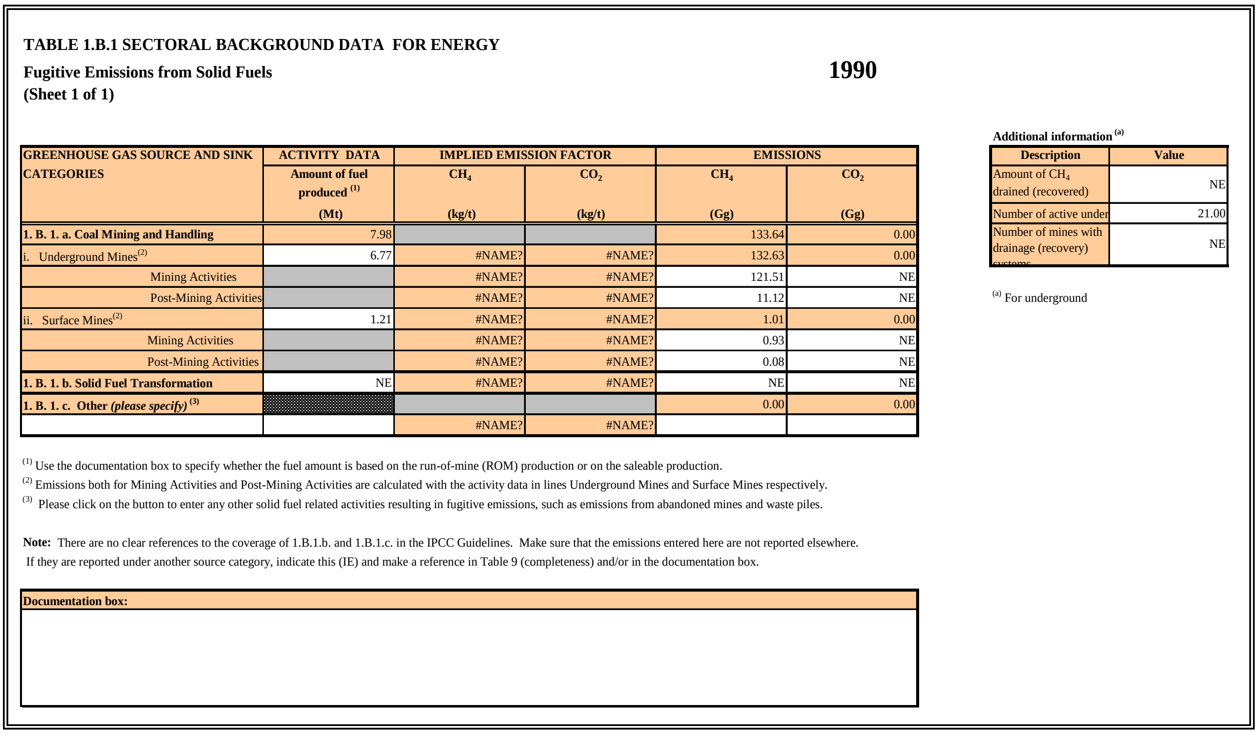


TABLE 1.B.1 SECTORAL BACKGROUND DATA FOR ENERGY
Fugitive Emissions from Solid Fuels
(Sheet 1 of 1)

1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA	IMPLIED EMISSION FACTOR		EMISSIONS	
	Amount of fuel produced (1) (Mt)	CH_4 (kg/t)	CO_2 (kg/t)	CH_4 (Gg)	CO_2 (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?		

Additional information (a)

Description	Value
Amount of CH_4 drained (recovered)	NE
Number of active under	21.00
Number of mines with drainage (recovery) systems	NE

(a) For underground

(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:

Figure 2　An estimation file (CRF link sheet) (“CRF1990” in 1B1-2005.xls)

- CRF Preparation Using the CRF Reporter

The CRF Reporter is software developed by the UNFCCC secretariat at the request of the COP.

Its purpose is to facilitate the submission of each country's inventory, and inter-country comparisons when conducting reviews. Annex I countries are required to use the CRF Reporter for CRF preparation and inventory submission starting with the 2006 inventory.

The inventory to be submitted in FY2006 is the first opportunity to use the CRF Reporter software, making it necessary to watch out for bugs and other problems. Further, it has poor compatibility with the estimation system that has been used in Japan, thereby necessitating the manual entry of data into the CRF Reporter. In view of these factors, in preparing the 2006 inventory we are reviewing the preparation process, moving up the schedule, and otherwise dealing with the situation.

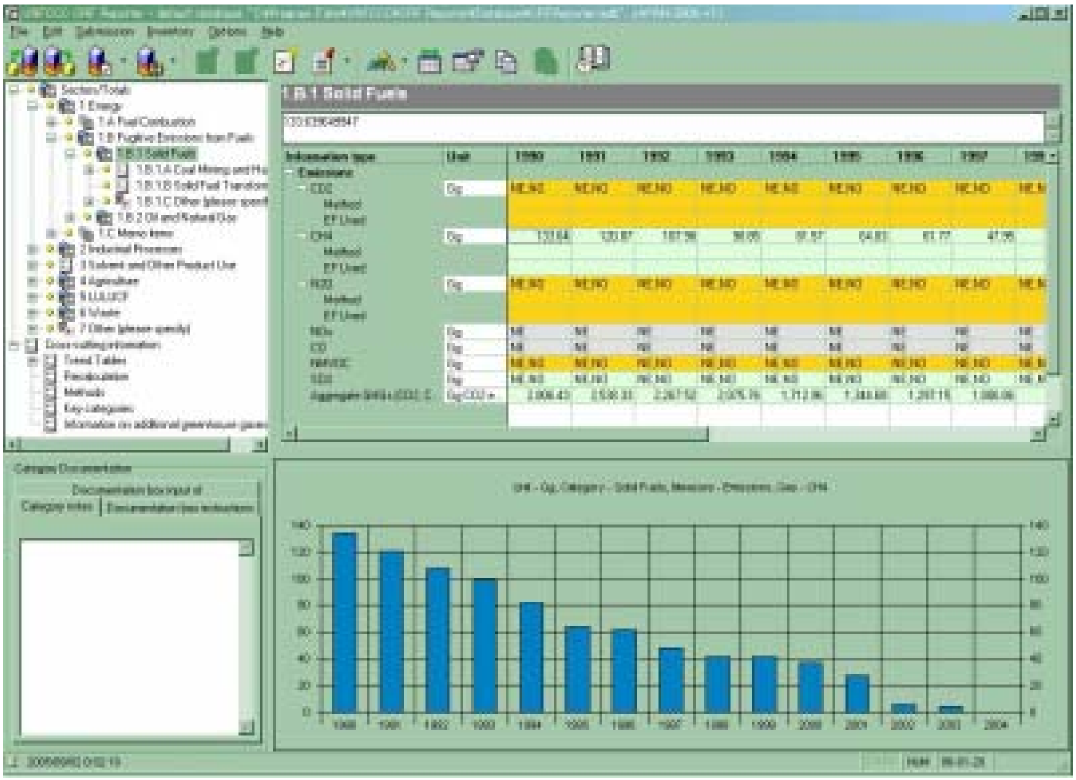


Figure 3 CRF Reporter screen shot (1B1 Solid Fuels)

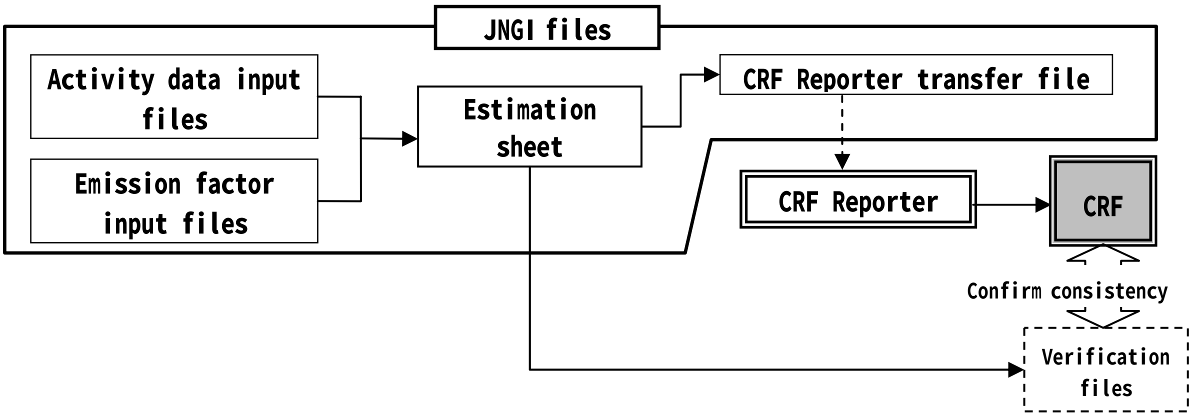


Figure 4 Link structure of estimation files, CRF Reporter, CRF, and verification files

- 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.

- 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)

• *Overview*

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.

• *Main Processes*

Implementation process		Description	Implementing agency
1	Send JNGI first draft	・ Submitting JNGI first draft file to MOE and other involved agencies.	MOE, GIO, subcontractors
2	Involved government agencies confirm JNGI first draft	・ Checking of JNGI first draft by involved agencies and if necessary sending correction requests to MOE.	MOE, other relevant government agencies
3	Prepare JNGI second draft	・ Making appropriate responses to correction requests from other agencies; preparing JNGI second draft file.	GIO, subcontractors
QC activities		・ Making sure provided data are correctly entered ・ Making sure emissions are correctly estimated ・ Making sure parameters and emission factors are correctly used ・ Checking completeness of database file ・ Making sure that consistent data are used in multiple emission source categories ・ Making sure data are correctly linked ・ Estimating uncertainty and checking it ・ Making sure citations are properly shown ・ Checking completeness.	MOE, other relevant government agencies
		・ Managing processes ・ Filing related documents	MOE, GIO

6.1.6. Compilation of Draft NIR (Step 6)

• *Overview*

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.

• *Main Processes*

Implementation process		Description	Implementing agency
1	Determine NIR structure	・ Determining NIR structure in response to factors including results of inventory improvement discussions.	MOE, GIO
2	Update NIR	・ Writing explanatory text for estimation methods. ・ Updating information on trends, key category analyses, uncertainty assessment, etc.	MOE, GIO
QC activities		・ Managing processes ・ Filing related documents	GIO

6.1.7. Check the accuracy of Draft NIR (Step 7)

• *Overview*

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.

• *Main Processes*

Implementation process		Description	Implementing agency
1	Send NIR first draft	• Submitting NIR first draft file to MOE and other involved agencies.	MOE, GIO
2	Involved government agencies confirm NIR first draft	• Checking of NIR first draft by involved agencies and if necessary sending correction requests to MOE	MOE, other relevant government agencies
3	Prepare NIR second draft	• Making appropriate response to correction requests from other agencies; preparing NIR second draft file.	GIO
QC activities		• Confirming accuracy of text.	MOE, other relevant government agencies
		• Managing processes • Filing related documents	GIO

6.1.8. Submitting and Releasing the Inventory (Step 8)

• *Overview*

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).

• *Main Processes*

Implementation process		Description	Implementing agency
1	Prepare documents for public release	• Preparing documents and Excel files showing emissions	MOE, GIO, subcontractors
2	Submit inventory to convention secretariat	• Submitting inventory to convention secretariat	MOE, Foreign Ministry, GIO
3	Release inventory	• Releasing estimates of GHG emissions and removals for most recent year. • Releasing NIR	MOE, GIO

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

• *Overview*

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.)

• *Main Processes*

Implementation process		Description	Implementing agency
1	Send related documents	• Mailing by post to GIO the related documents that subcontractors have provisionally held	Subcontractors
2	File related documents	• Filing in prescribed folders	GIO

6.1.11. Review Response

Respond appropriately each time reviews are conducted. GIO holds documents on the state of responses.

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.

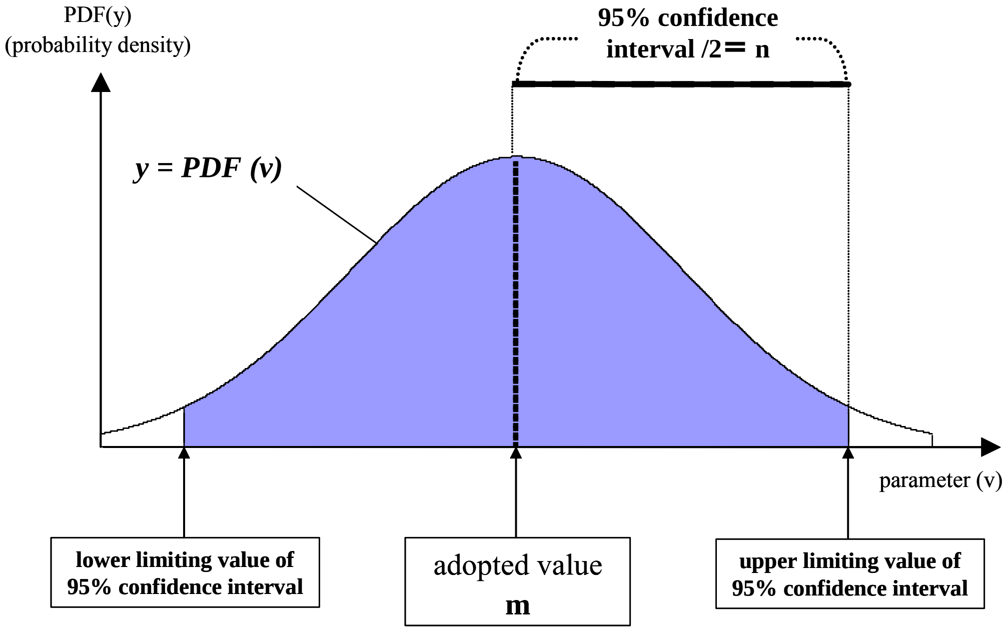
$$U = \sqrt{U_{EF}^2 + U_A^2}$$

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.

$$\text{Uncertainty of EF or A} = \frac{95\%\ \text{confidential interval} \ / \ 2\ (n)}{|\ \text{Adaoped Value of EF or A}\ (m)\ |}$$



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.

$$E\ (\text{Emissions}) = EF\ (\text{Emission Factor}) \times A\ (\text{Activity Data})$$

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.

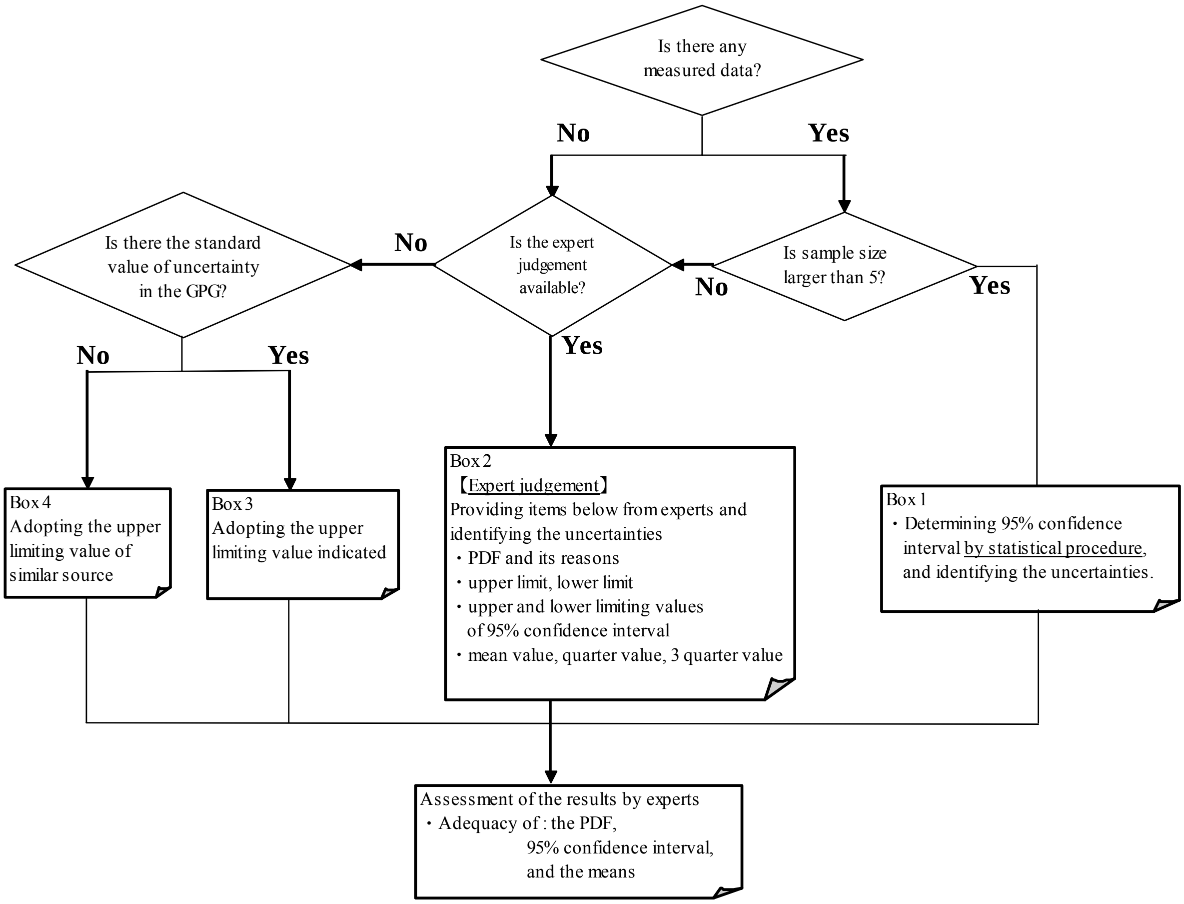


Figure 1 Decision tree for assessing uncertainty associated with emission factors established by the *Committee for the GHGs Emissions Estimation Methods*

- 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.

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[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.

$$Uncertainty\ of\ Emission\ Factor\ (\%) = \frac{1.96 \times \sigma_{EF}}{|\ EF\ |} \qquad \text{… Equation 1.1.}$$

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 :

$$\sigma_{EF}^2 = \sum \left\{ w_i \times \left(EF_i - \overline{EF} \right)^2 \right\} \Big/ \left(1 - \sum w_i^2 \right) \times \sum w_i^2$$

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*.

$$EF = \frac{\sum_i EF_i \times A_i}{\sum_i A_i} = \frac{\sum_i EF_i \times A_i}{A}$$

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

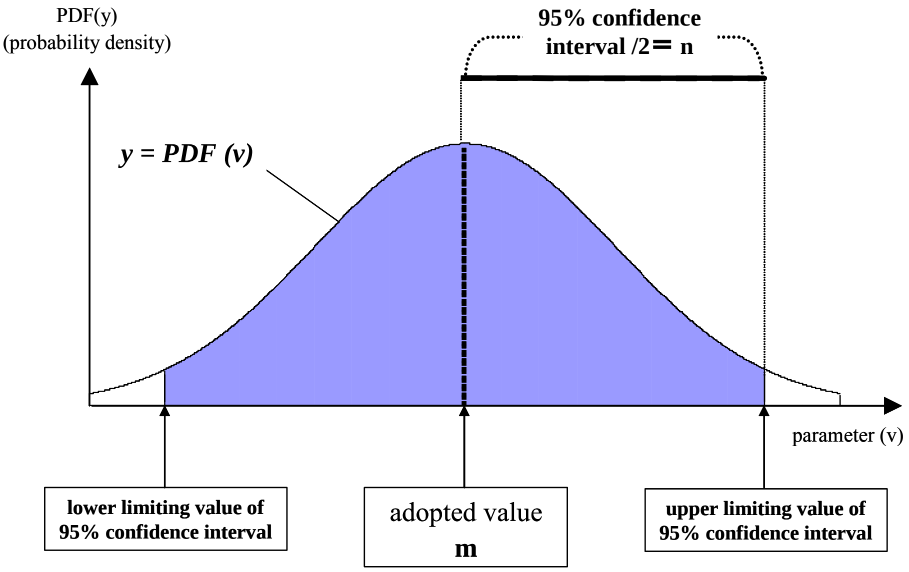
When there is no actual measurement data, or there are less than five samples, uncertainty shall be assessed by expert judgment.

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



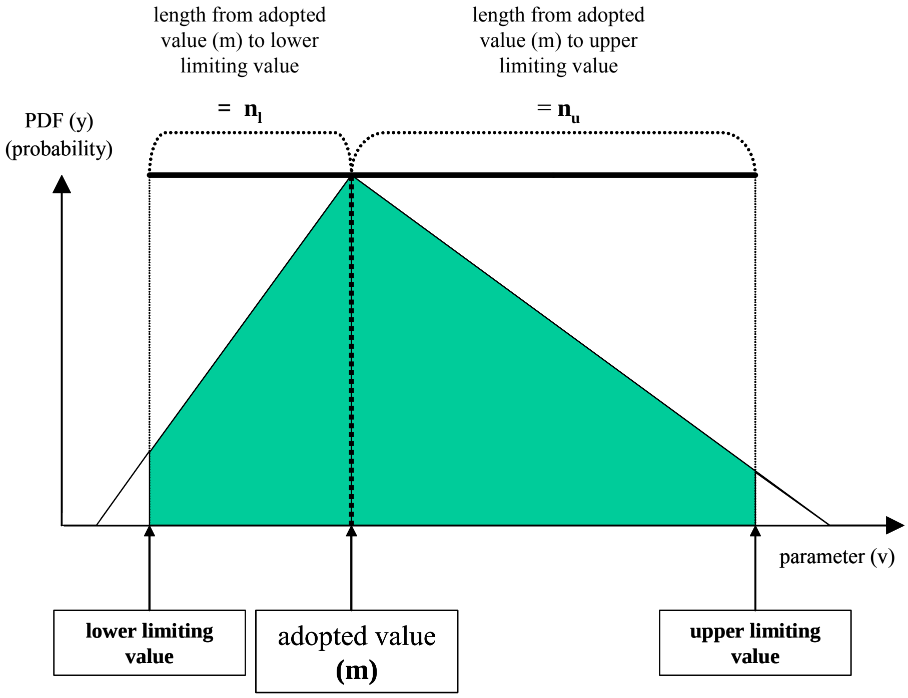
$$\text{Uncertainty of EF or A} = \frac{95\%\ \textit{confidential interval} \ / \ 2\ (n)}{\left|\ \textit{Adaoped Value of}\ \text{EF}\ \textit{or}\ \text{A}\ (m)\ \right|}$$

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.

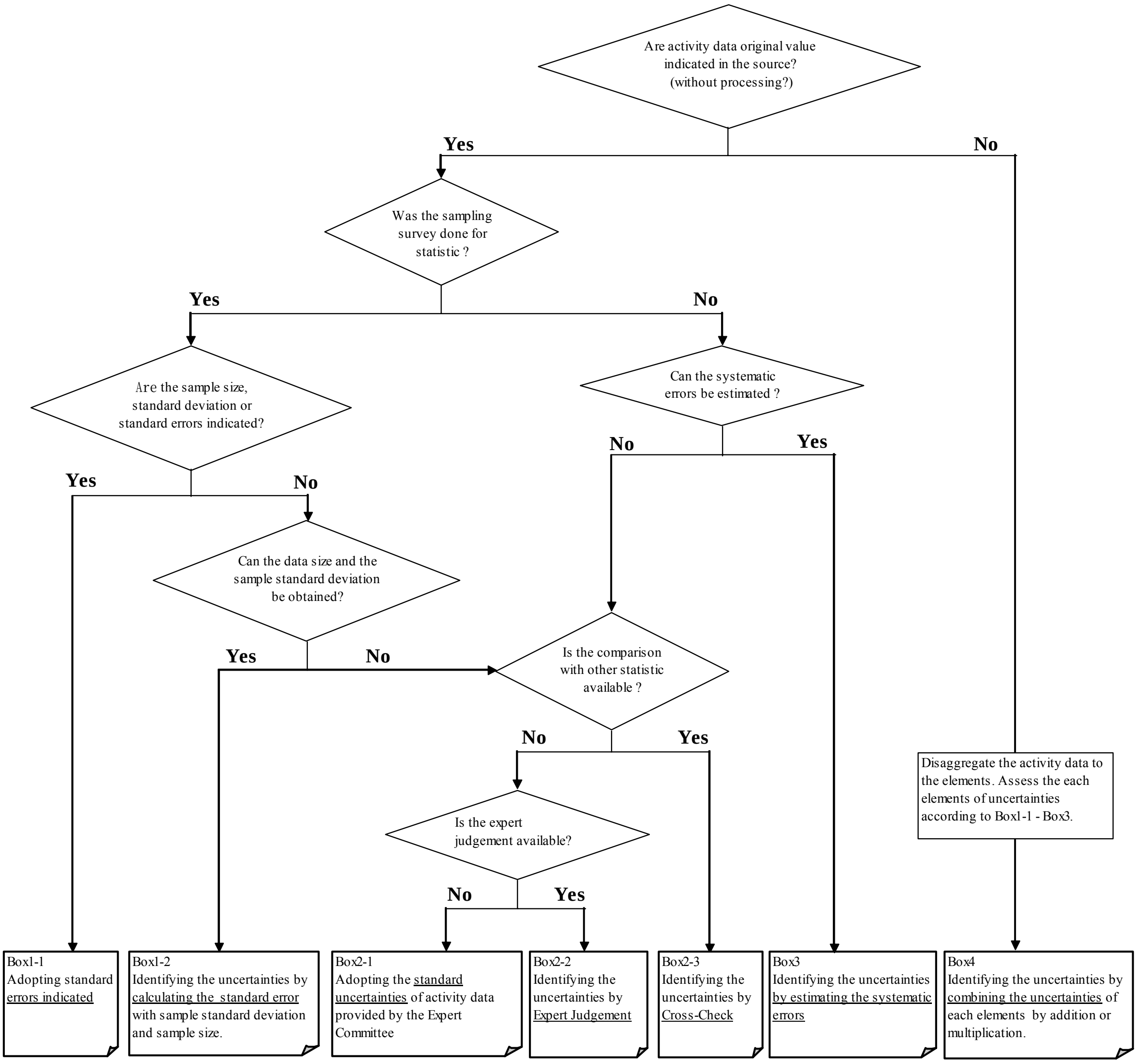


Figure 2 Decision tree for assessing uncertainty associated with activity data established by the *Committee for the GHGs Emissions Estimation Methods*

- 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.

$$Uncertainty\ U = \left(1.96 \times s / \sqrt{n}\right) / X_{ad}$$

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)*.

$$Uncertainty\ U = \left(1.96 \times s\right) / X_{ap}$$

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 results of uncertainty assessment in Committee for the Greenhouse Gases Emissions Estimation Methods in FY2005.

7.2.2. Uncertainty of Japan's Total Emissions

Fiscal 2004 total emissions in Japan were approximately 1.355 billion tons (carbon dioxide equivalents). Uncertainty of total emissions has been assessed at 3% and uncertainty introduced into the trend in total national emissions has been assessed at 4%.

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	1,192,865.5	88.0%	3%	9	2.60%	1
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	4,716.4	0.3%	43%	2	0.15%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	6,237.6	0.5%	146%	1	0.67%	3
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	584.2	0.0%	14%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	52,147.9	3.8%	7%	7	0.28%	6
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	22,879.1	1.7%	19%	5	0.32%	5
3. Solvent & other Product Use	N2O	297.5	0.0%	5%	8	0.00%	9
4. Agriculture	CH4、N2O	27,605.5	2.0%	26%	3	0.53%	4
6. Waste	CO2、CH4、N2O	47,535.3	3.5%	23%	4	0.82%	2
Total Emissions	(D)	1,354,868.9	100.0%	(E) **3%**			

1) $C = A \times B / D$

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 2 and the following tables.

7.2.3. Energy Sector

7.2.3.1. Fuel Combustion (CO_2)

In assessing uncertainty in the fuel sector, the emission factors that are based on measurement data and those that are not, were assessed by applying statistical methods and the upper and lower limiting values of a 95 percent confidence intervals. Activity data were assessed by focusing on consumptions of energy in TJ. The uncertainty of energy consumption in TJ given in the *General Energy Statistics* was assessed based on the given statistical error of solid fuels, liquid fuels, and gaseous fuels, since it was difficult to set uncertainty by fuel types and industry.

Table 4 Results of uncertainty assessment of fuel combustion (CO_2)

IPCC Source Category			GHGs	Emissions [Gg CO2eq.]	EF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
				A	a	b	B		C	
1A. Fuel Combustion	Solid Fuels	Steel Making Coal	CO2	14,068.0	14.4%	1.0%	14%	11	0.15%	16
		Steam Coal (imported)	CO2	244,697.3	9.6%	1.0%	10%	13	1.74%	1
		Steam Coal (indigenous)	CO2	0.0	5.3%	1.0%	5%	22	0.00%	31
		Hard Coal	CO2	0.0	5.7%	1.0%	6%	19	0.00%	31
		Coke	CO2	93,840.0	19.4%	1.0%	19%	8	1.35%	2
		Coal Tar	CO2	2,149.2	18.2%	1.0%	18%	10	0.03%	20
		Coal Briquette	CO2	0.0	19.4%	1.0%	19%	8	0.00%	31
		Coke Oven Gas	CO2	14,892.5	24.0%	1.0%	24%	3	0.26%	10
		Blast Furnace Gas	CO2	47,028.3	13.7%	1.0%	14%	12	0.48%	6
		Converter Furnace Gas	CO2	10,759.7	23.9%	1.0%	24%	4	0.19%	12
	Liquid Fuels	Crude Oil for Refinery	CO2	224.3	5.0%	0.9%	5%	23	0.00%	25
		Crude Oil for Power Generatio	CO2	16,420.8	5.0%	0.9%	5%	23	0.06%	19
		Vitumous Mixture Fuel	CO2	117.2	6.9%	0.9%	7%	17	0.00%	27
		NGL & Condensate	CO2	50.3	1.7%	0.9%	2%	34	0.00%	29
		Naphtha	CO2	699.5	5.5%	0.9%	6%	21	0.00%	23
		Reformed Material Oil	CO2	0.0	4.9%	0.9%	5%	25	0.00%	31
		Gasoline	CO2	142,340.1	4.9%	0.9%	5%	25	0.52%	5
		Jet Fuel	CO2	12,088.9	9.0%	0.9%	9%	14	0.08%	17
		Kerosene	CO2	67,584.0	3.2%	0.9%	3%	31	0.17%	15
		Gas Oil or Diesel Oil	CO2	99,079.4	3.1%	0.9%	3%	32	0.24%	11
		Heating Oil A	CO2	80,156.5	6.3%	0.9%	6%	18	0.38%	7
		Heating Oil B	CO2	168.1	4.7%	0.9%	5%	28	0.00%	28
		Heating Oil C	CO2	86,901.6	4.1%	0.9%	4%	29	0.27%	9
		Lubricating Oil	CO2	202.8	4.9%	0.9%	5%	25	0.00%	26
		Asphalt	CO2	8,995.7	28.3%	0.9%	28%	1	0.19%	14
		Non Asphalt Heavy Oil Produc	CO2	0.1	28.3%	0.9%	28%	1	0.00%	30
		Oil Coke	CO2	11,317.6	22.5%	0.9%	23%	6	0.19%	13
		Galvanic Furnace Gas	CO2	79.7	23.9%	0.9%	24%	5	0.00%	24
		Refinary Gas	CO2	35,374.4	21.6%	0.9%	22%	7	0.56%	4
		LPG	CO2	31,367.2	2.8%	0.9%	3%	33	0.07%	18
	Gaseous Fuels	LNG	CO2	104,245.1	8.4%	1.9%	9%	15	0.66%	3
		Indigenous Natural Gas	CO2	2,113.0	5.3%	1.9%	6%	20	0.01%	21
		Town Gas*	CO2	64,583.7	7.5%	1.9%	8%	16	0.37%	8
		Small Scale Town Gas*	CO2	1,320.2	2.8%	1.9%	3%	30	0.00%	22
	Sub Total			1,192,865.5			3%		2.60%	
Total Emissions			(D)	1,354,868.9			3%			

* Reported in Gaseous Fuels according to the main material; LNG

7.2.3.2. Stationary Combustion (CH_4 and N_2O)

Table 5 Results of uncertainty assessment of fuel combustion (CO_2)

IPCC Source Category	GHGs	Emissions [Gg CO2eq.]	EF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
		A	a	b	B		C	
1A. Fuel Combustion (Stationary)	CH4	517.0	—	—	182%	1	0.07%	2
	N2O	4,199.3	—	—	43%	2	0.13%	1
Sub Total		4,716.4			43%		0.15%	
Total Emissions	(D)	1,354,868.9			3%			

7.2.3.3. Mobile Combustion (CH_4 and N_2O)

Table 6 Results of uncertainty assessment of mobile combustion (CH_4 and N_2O)

IPCC Source Category		GHGs	Emissions [Gg CO2eq.]	EF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
			A	a	b	B		C	
1A.Fuel Combustion (Transport)	a. Civil Aviation	CH4	4.8	183.1%	9.2%	183%	**3**	0.00%	7
		N2O	106.5	8213.5%	8.2%	8213%	**1**	0.65%	**1**
	b. Road Transportation	CH4	198.0	23.3%	23.1%	33%	6	0.00%	**4**
		N2O	5,710.9	31.0%	31.0%	44%	**5**	0.18%	**2**
	c. Railways	CH4	0.8	4.5%	13.2%	14%	7	0.00%	8
		N2O	84.5	5.0%	10.0%	11%	8	0.00%	6
	d. Navigation	CH4	25.5	144.1%	11.3%	145%	**4**	0.00%	**5**
		N2O	106.6	718.5%	11.3%	719%	**2**	0.06%	**3**
	Sub Total		6,237.6			146%		0.67%	
Total Emissions		(D)	1,354,868.9			3%			

7.2.3.4. Fugitive Emissions from Fuel

Table 7 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	31.6	–	–	5%	27	0.00%	12
				Post-Mining Activities	CH4	25.5	200.0%	5.0%	200%	3	0.00%	1
			ii. Surface Mines	Mining Activities	CH4	8.6	200.0%	10.0%	200%	1	0.00%	4
				Post-Mining Activities	CH4	0.7	200.0%	10.0%	200%	1	0.00%	13
	2. Oil and Natural Gas	a. Oil		i. Exploration	CO2	0.0	25.0%	10.0%	27%	10	0.00%	23
					CH4	0.0	25.0%	10.0%	27%	9	0.00%	24
					N2O	0.0	25.0%	10.0%	27%	4	0.00%	27
				ii. Production	CO2	0.1	25.0%	5.0%	25%	12	0.00%	18
					CH4	10.4	25.0%	5.0%	25%	12	0.00%	10
				iii. Transport	CO2	0.0	21.1%	4.2%	22%	24	0.00%	26
					CH4	1.4	22.0%	4.4%	22%	23	0.00%	15
				iv. Refining / Storage	CH4	16.3	25.0%	0.9%	25%	22	0.00%	8
		b. Natural Gas		ii. Production / Processing	CO2	0.4	20.2%	4.0%	21%	25	0.00%	17
					CH4	227.0	19.8%	4.0%	20%	26	0.00%	2
				iii. Transmission	CO2	0.0	25.0%	10.0%	27%	4	0.00%	20
					CH4	137.3	25.0%	10.0%	27%	4	0.00%	3
				iv. Distribution	CH4	22.8	25.0%	8.7%	26%	11	0.00%	6
		c. Venting and Flaring		Venting	CO2	0.0	25.0%	5.0%	25%	12	0.00%	25
				i. oil	CH4	9.9	25.0%	5.0%	25%	12	0.00%	11
				ii. Gas	CO2	0.0	25.0%	10.0%	27%	4	0.00%	22
					CH4	54.9	25.0%	10.0%	27%	4	0.00%	5
				Flaring	CO2	23.0	25.0%	5.0%	25%	12	0.00%	7
				i. oil	CH4	1.0	25.0%	5.0%	25%	12	0.00%	16
					N2O	0.1	25.0%	5.0%	25%	12	0.00%	19
				ii. Gas	CO2	11.5	25.0%	5.0%	25%	12	0.00%	9
					CH4	1.5	25.0%	5.0%	25%	12	0.00%	14
					N2O	0.0	25.0%	5.0%	25%	12	0.00%	21
	Sub Total					584.2			14%		0.01%	
Total Emissions					(D)	1,354,868.9			3%			

7.2.4. Industrial Processes

7.2.4.1. 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 8 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	31,415.6	2.8%	10.0%	10%	12	0.24%	1
		2. Lime Production	Limestone	CO2	4,193.5	0.6%	5.0%	5%	16	0.02%	6
			Dolomite	CO2	44.7	2.0%	5.0%	5%	14	0.00%	13
		3. Limestone & Dolomite Use	Limestone	CO2	10,587.6	16.4%	4.8%	17%	9	0.13%	2
			Dolomite	CO2	292.2	3.5%	3.9%	5%	15	0.00%	10
		4. Soda Ash Production and Use		CO2	383.5	15.0%	6.5%	16%	10	0.00%	9
	B. Chemical Industries	1. Ammonia Production		CO2	2,307.3	13.0%	3.0%	13%	11	0.02%	5
		Chemical Industries other than		CO2	1,001.1	72.8%	7.2%	73%	6	0.05%	3
		2. Nitric Acid,		N2O	818.7	46.0%	5.0%	46%	8	0.03%	4
		3. Adipic Acid		N2O	838.9	9.0%	2.0%	9%	13	0.01%	8
		5. Other	Carbon Black	CH4	5.9	54.8%	5.0%	55%	7	0.00%	11
			Ethylene	CH4	2.4	77.2%	5.0%	77%	5	0.00%	14
			Dichloroethylene	CH4	0.4	100.7%	5.0%	101%	2	0.00%	15
			Styrene	CH4	2.2	113.2%	5.0%	113%	1	0.00%	12
			Methanol	CH4	0.0	100.0%	5.0%	100%	3	0.00%	16
			Coke	CH4	105.0	98.5%	5.0%	99%	4	0.01%	7
	C. Metal Production	1. Iron and steel		CO2	148.8	5.0%	5.0%	7%	14	0.00%	11
	Sub Total				52,147.9			7%		0.28%	
Total Emissions				(D)	1,354,868.9			3%			

7.2.4.2. F-gas

Table 9 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 Production	3. Aluminium			PFCs	14.8	33.0%	5.0%	33%	31	0.00%	21
		4. SF6 Used in Aluminium and Magnesium Foundries			SF6	956.0	33.0%	5.0%	33%	31	0.02%	13
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	1,017.9	100.0%	5.0%	100%	**4**	0.08%	**5**
		2. Fugitive Emissions			HFCs	555.9	100.0%	10.0%	100%	**1**	0.04%	9
					PFCs	882.0	100.0%	10.0%	100%	**1**	0.07%	6
					SF6	764.8	100.0%	10.0%	100%	**1**	0.06%	7
	F. Consumption of F-gas	1. Refrigeration and Air Conditioning Equipment	Domestic Refrigerator	manufacturing	HFCs	138.5	50.0%	40.0%	64%	7	0.01%	17
				stock	HFCs	IE	50.0%	40.0%	64%	7	0.00%	22
				disposal	HFCs	IE	－	40.0%	40%	21	0.00%	22
			Commercial Refrigerator	manufacturing	HFCs	685.3	50.0%	40.0%	64%	7	0.03%	10
				stock	HFCs	IE	50.0%	40.0%	64%	7	0.00%	22
				disposal	HFCs	IE	－	40.0%	40%	21	0.00%	22
			Stationary Air-Conditioning	manufacturing	HFCs	225.1	50.0%	40.0%	64%	7	0.01%	15
				stock	HFCs	IE	50.0%	40.0%	64%	7	0.00%	22
				disposal	HFCs	IE	－	40.0%	40%	21	0.00%	22
			Mobile Air-Conditioning	manufacturing	HFCs	2,967.4	50.0%	40.0%	64%	7	0.14%	**3**
				stock	HFCs	IE	50.0%	40.0%	64%	7	0.00%	22
				disposal	HFCs	IE	－	40.0%	40%	21	0.00%	22
		2. Foam Blowing		manufacturing	HFCs	522.9	50.0%	50.0%	71%	**5**	0.03%	11
				stock	HFCs	67.7	50.0%	50.0%	71%	**5**	0.00%	19
		4. Aerosols / MDI	MDI	stock	HFCs	227.2	－	40.0%	40%	21	0.01%	16
			Other	manufacturing	HFCs	57.9	－	40.0%	40%	21	0.00%	20
				stock	HFCs	1,904.9	－	40.0%	40%	21	0.06%	8
		5. Solvents			PFCs	5,101.0	－	40.0%	40%	21	0.15%	**2**
		7. Semiconductor Manufacture			HFCs	129.8	50.0%	40.0%	64%	7	0.01%	18
					PFCs	3,917.2	50.0%	40.0%	64%	7	0.19%	**1**
					SF6	1,784.4	50.0%	40.0%	64%	7	0.08%	**4**
		8. Electrical Equipment		manufacturing	SF6	662.0	30.0%	40.0%	50%	20	0.02%	12
				stock	SF6	296.4	50.0%	40.0%	64%	7	0.01%	14
				Maintenance	SF6	IE	－	40.0%	40%	21	0.00%	22
				disposal	SF6	IE	－	40.0%	40%	21	0.00%	22
		9. Other (for Studies etc.)			HFCs	0.0	50.0%	40.0%	64%	7	0.00%	22
	Sub Total					22,879.1			19%		0.32%	
Total Emissions					(D)	1,354,868.9			3%			

*: Uncertainty assessment of F-gas is currently being discussed.

7.2.5. Solvents and Other Product Use

Table 10 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	297.5	－	5.0%	5%	1	0.00%	1
	Sub Total			297.5			5%		0.00%	
Total Emissions			(D)	1,354,868.9			3%			

7.2.6. Agriculture

Table 11 Results of uncertainty assessment of Agriculture

IPCC Source Category				GHGs	Emissions [Gg CO2eq.]	EF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
					A	a	b	B		C	
4. Agriculture	A. Enteric Fermentation	Dairy Cattle		CH4	3,512.6	—	0.5%	15%	63	0.04%	15
		Non-Dairy Cattle		CH4	3,391.2	—	0.5%	20%	62	0.05%	14
		Buffalo		CH4	0.1	50.0%	0.7%	50%	54	0.00%	59
		Sheep		CH4	1.0	50.0%	0.7%	50%	54	0.00%	53
		Goat		CH4	3.0	50.0%	0.4%	50%	58	0.00%	42
		Swine		CH4	223.8	50.0%	0.7%	50%	54	0.01%	20
		Horse		CH4	9.5	50.0%	0.7%	50%	54	0.00%	35
	B. Manure Management	Dairy Cattle		CH4	2,101.6	—		77%	47	0.12%	2
				N2O	756.3	—		98%	44	0.05%	13
		Non-Dairy Cattle		CH4	92.4	—		74%	50	0.01%	25
				N2O	800.4	—		126%	31	0.07%	8
		Buffalo		CH4	0.0	100.0%	0.7%	100%	36	0.00%	63
				N2O	0.0	100.0%	0.7%	100%	36	0.00%	62
		Swine		CH4	286.1	—	0.4%	106%	34	0.02%	17
				N2O	1,415.0	—	0.4%	75%	49	0.08%	7
		Hen		CH4	39.5	—	0.7%	73%	51	0.00%	28
				N2O	942.5	—	0.7%	103%	35	0.07%	10
		Broiler		CH4	28.2	—	0.7%	76%	48	0.00%	30
				N2O	794.7	—	0.7%	125%	32	0.07%	9
		Sheep		CH4	0.1	100.0%	0.7%	100%	36	0.00%	58
				N2O	1.1	100.0%	0.7%	100%	36	0.00%	45
		Goat		CH4	0.1	100.0%	0.7%	100%	36	0.00%	57
				N2O	12.8	100.0%	0.7%	100%	36	0.00%	32
		Horse		CH4	1.1	100.0%	0.7%	100%	36	0.00%	47
				N2O	9.4	100.0%	0.7%	100%	36	0.00%	34
	C. Rice Cultivation	Continuously Flooded		CH4	260.2	116.3%	0.3%	116%	33	0.02%	18
		Intermittently Flooded	Straw amendment	CH4	3,778.8	—	0.3%	32%	61	0.09%	5
			Various compost	CH4	982.4	—	0.3%	46%	59	0.03%	16
			No-amendment	CH4	785.9	—	0.3%	32%	60	0.02%	19
	D. Agricultural Soils	1. Direct Soil Emissions	Synthetic Fertilizers	N2O	1,495.3	—	—	72%	52	0.08%	6
			Animal Waste Applied to Soils	N2O	1,096.7	—	—	83%	46	0.07%	11
			Crop residues	N2O	930.9	—	—	166%	27	0.11%	3
			Organic soil	N2O	728.7	—	—	801%	1	0.43%	1
		3. Indirect Emissions	Atmospheric Deposition	N2O	1,269.8	—	—	59%	53	0.06%	12
			N Leaching & Run-off	N2O	1,679.0	—	—	86%	45	0.11%	4
	F. Field Burning of Agricultural Residue	1. Cereals	Wheat	CH4	5.9	—	—	180%	20	0.00%	33
				N2O	1.3	—	—	180%	19	0.00%	39
			Barley	CH4	1.1	—	—	179%	22	0.00%	40
				N2O	1.0	—	—	181%	17	0.00%	41
			Maize	CH4	23.6	418.1%	0.1%	418%	8	0.01%	21
				N2O	20.0	423.1%	0.1%	423%	3	0.01%	24
			Oats	CH4	0.6	—	—	152%	29	0.00%	49
				N2O	0.5			167%	26	0.00%	50
			Rye	CH4	0.0	—	—	134%	30	0.00%	60
				N2O	0.0			157%	28	0.00%	61
			Rice	CH4	52.9	178.0%	0.1%	178%	23	0.01%	23
				N2O	21.2	175.2%	0.1%	175%	25	0.00%	27
		2. Pulse	Peas	CH4	0.2	417.9%	20.0%	418%	7	0.00%	48
				N2O	0.2	423.1%	20.0%	424%	2	0.00%	51
			Soybeans	CH4	2.2	175.7%	0.1%	176%	24	0.00%	37
				N2O	0.8	181.6%	0.1%	182%	16	0.00%	44
			Other (Adzuki beans)	CH4	0.8	178.9%	0.1%	179%	21	0.00%	43
				N2O	0.4	179.8%	0.1%	180%	18	0.00%	52
			Other (kidney beans)	CH4	0.3	417.9%	0.1%	418%	10	0.00%	46
				N2O	0.1	417.8%	0.1%	418%	12	0.00%	54
			Other (peanuts)	CH4	0.1	417.9%	0.1%	418%	10	0.00%	55
				N2O	0.0	417.8%	0.1%	418%	12	0.00%	56
		3. Tuber & Roots	Potatoes	CH4	3.7	417.6%	20.0%	418%	9	0.00%	31
				N2O	5.2	418.6%	20.0%	419%	5	0.00%	29
			Other: Sugarbeet	CH4	0.9	417.4%	0.1%	417%	15	0.00%	38
				N2O	1.0	418.9%	0.1%	419%	6	0.00%	36
		4. Sugar Cane		CH4	9.2	417.6%	0.1%	418%	14	0.00%	26
				N2O	22.3	423.1%	0.1%	423%	3	0.01%	22
	Sub Total				27,605.5			26%		0.53%	
Total Emissions				(D)	1,354,868.9			3%			

7.2.7. Waste

Table 12 Results of uncertainty assessment of Waste

IPCC Source Category				GHGs	Emissions [Gg CO2eq.]	EF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
					A	a	b	B		C	
6. Waste	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	Kitchen Garbage	CH4	807.6	44.3%	26.9%	52%	30	0.03%	11
			Waste Paper	CH4	1,905.1	46.8%	10.4%	48%	32	0.07%	7
			Waste Textile	CH4	107.7	42.7%	11.1%	44%	35	0.00%	28
			Waste Wood	CH4	1,524.8	53.9%	15.6%	56%	29	0.06%	8
			Sewage Sludge	CH4	425.0	14.1%	13.1%	19%	47	0.01%	24
			Human Waste Sludge	CH4	107.9	34.8%	17.4%	39%	37	0.00%	29
			Water Purification Sludge	CH4	69.4	14.1%	12.8%	19%	49	0.00%	36
			Organic Sludge from Manufacture	CH4	316.5	41.2%	17.6%	45%	34	0.01%	20
			Livestock Waste	CH4	535.3	126.5%	47.7%	135%	9	0.05%	9
		3. Other	Illegal Disposal	CH4	14.2	56.6%	29.0%	64%	26	0.00%	39
			Composting of Organic Waste	CH4	19.0	74.3%	6.1%	75%	22	0.00%	35
	B. Wastewater Handling	1. Industrial Wastewater		CH4	102.8	60.0%	37.1%	71%	24	0.01%	26
				N2O	108.7	300.0%	50.3%	304%	**2**	0.02%	12
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant	CH4	248.4	30.9%	10.4%	33%	38	0.01%	25
				N2O	673.1	145.7%	10.4%	146%	6	0.07%	6
			Private Sewerage Tank	CH4	441.8	59.5%	7.0%	60%	27	0.02%	13
				N2O	330.7	45.9%	5.7%	46%	33	0.01%	18
			Human-Waste Treatment Plant	CH4	26.8	89.7%	11.0%	90%	20	0.00%	32
				N2O	7.8	470.8%	28.4%	472%	**1**	0.00%	30
			Degradation of domestic wastewater in nature	CH4	680.1	72.5%	22.0%	76%	21	0.04%	10
				N2O	182.7	63.5%	32.0%	71%	23	0.01%	21
	C. Waste Incineration	Municipal Solid Waste	Plastics	CO2	13,176.2	12.5%	16.0%	20%	45	0.20%	**5**
			Waste textile	CO2	1,194.3	12.5%	12.3%	18%	51	0.02%	14
				CH4	17.9	57.5%	8.6%	58%	28	0.00%	37
				N2O	782.8	23.7%	8.6%	25%	42	0.01%	15
		Industrial Solid Waste		CO2	7,498.1	12.6%	104.4%	105%	13	0.58%	**1**
				CO2	5,015.7	12.6%	100.0%	101%	16	0.37%	**2**
				CO2	19.4	12.5%	141.4%	142%	7	0.00%	31
				CH4	5.0	85.7%	54.8%	102%	15	0.00%	41
				N2O	2,069.9	0.0%	0.0%	0%	52	0.00%	52
		Specially Contorolled Industrial Solid Waste		CO2	2,249.1	10.4%	164.4%	165%	**4**	0.27%	**3**
				CH4	0.3	73.6%	120.8%	141%	8	0.00%	47
				N2O	13.1	47.1%	153.1%	160%	**5**	0.00%	33
		Raw material and fuel use of MSW		CO2	407.3	12.5%	16.0%	20%	45	0.01%	23
				CH4	0.0	179.4%	10.0%	180%	**3**	0.00%	51
				N2O	0.0	111.2%	10.0%	112%	11	0.00%	50
		Raw material and fuel use of ISW	Waste Oil	CO2	3,277.7	12.6%	104.4%	105%	13	0.25%	**4**
				CH4	0.5	59.3%	29.0%	66%	25	0.00%	48
				N2O	12.7	37.2%	14.6%	40%	36	0.00%	40
			Waste Plastics	CO2	1,118.2	12.6%	12.3%	18%	50	0.01%	16
				CH4	2.3	91.7%	10.0%	92%	18	0.00%	42
				N2O	3.0	29.7%	10.0%	31%	40	0.00%	45
			Waste Wood	CH4	53.7	80.2%	100.0%	128%	10	0.01%	27
				N2O	9.0	45.3%	100.0%	110%	12	0.00%	38
		Raw material and fuel use of Waste tire		CO2	779.3	12.6%	14.5%	19%	48	0.01%	19
				CH4	1.2	90.6%	9.9%	91%	19	0.00%	44
				N2O	2.6	24.7%	7.1%	26%	41	0.00%	46
		Fuel use of RDF and RPF		CO2	659.4	22.9%	7.6%	24%	44	0.01%	17
				CH4	0.1	48.5%	6.1%	49%	31	0.00%	49
				N2O	3.7	31.7%	7.0%	32%	39	0.00%	43
	D. Oher	Decomposition of petroleum-derived surface-active agent		CO2	508.3	0.1%	24.4%	24%	43	0.01%	22
		Composting of Organic Waste		N2O	19.5	97.2%	8.0%	97%	17	0.00%	34
	Sub Total				47,535.3			23%		0.82%	
Total Emissions				(D)	1,354,868.9			3%			

7.2.8. Consideration of the results

The result of uncertainty assessment shows that Japan's uncertainty of national total emissions is approximately 3%. 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 13 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

7.2.9. 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.）

7.2.10. 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	2004 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				1,254,830.79	1,354,868.94				3%					4%
1A. Fuel Combustion	Solid Fuels	Coking Coal	CO_2	9,244.05	14,067.99	14.4%	1.0%	14%	0.1%	0.3%	1.1%	0.0%	0.2%	0.2%
		Steam Coal (imported)	CO_2	88,401.29	244,697.34	9.6%	1.0%	10%	1.7%	11.9%	19.5%	0.1%	2.6%	2.7%
		Steam Coal (indigenous)	CO_2	20,125.86	0.00	5.3%	1.0%	5%	0.0%	-1.7%	0.0%	0.0%	0.0%	0.0%
		Hard Coal	CO_2	0.00	0.00	5.7%	1.0%	6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Coke	CO_2	115,162.38	93,840.03	19.4%	1.0%	19%	1.3%	-2.4%	7.5%	0.0%	2.1%	2.1%
		Coal Tar	CO_2	3,171.30	2,149.23	18.2%	1.0%	18%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.0%
		Coal Briquette	CO_2	310.20	0.00	19.4%	1.0%	19%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Coke Oven Gas	CO_2	15,976.84	14,892.48	24.0%	1.0%	24%	0.3%	-0.2%	1.2%	0.0%	0.4%	0.4%
		Blast Furnace Gas	CO_2	43,496.15	47,028.33	13.7%	1.0%	14%	0.5%	0.0%	3.7%	0.0%	0.7%	0.7%
		Converter Furnace Gas	CO_2	9,303.92	10,759.73	23.9%	1.0%	24%	0.2%	0.1%	0.9%	0.0%	0.3%	0.3%
	Liquid Fuels	Crude Oil for Refinery	CO_2	1.91	224.31	5.0%	0.9%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Crude Oil for Power Generation	CO_2	58,483.38	16,420.84	5.0%	0.9%	5%	0.1%	-3.7%	1.3%	0.0%	0.1%	0.1%
		Vitumous Mixture Fuel	CO_2	0.00	117.22	6.9%	0.9%	7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		NGL & Condensate	CO_2	1,380.12	50.30	1.7%	0.9%	2%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		Naphtha	CO_2	1,297.82	699.46	5.5%	0.9%	6%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
		Reformed Material Oil	CO_2	0.00	0.00	4.9%	0.9%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Gasoline	CO_2	103,913.39	142,340.12	4.9%	0.9%	5%	0.5%	2.4%	11.3%	0.0%	0.8%	0.8%
		Jet Fuel	CO_2	9,140.23	12,088.93	9.0%	0.9%	9%	0.1%	0.2%	1.0%	0.0%	0.1%	0.1%
		Kerosene	CO_2	64,049.60	67,583.98	3.2%	0.9%	3%	0.2%	-0.1%	5.4%	0.0%	0.2%	0.2%
		Gas Oil or Diesel Oil	CO_2	98,847.94	99,079.36	3.1%	0.9%	3%	0.2%	-0.6%	7.9%	0.0%	0.3%	0.3%
		Heating Oil A	CO_2	74,790.57	80,156.53	6.3%	0.9%	6%	0.4%	0.0%	6.4%	0.0%	0.6%	0.6%
		Heating Oil B	CO_2	1,865.42	168.13	4.7%	0.9%	5%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		Heating Oil C	CO_2	143,715.21	86,901.65	4.1%	0.9%	4%	0.3%	-5.4%	6.9%	0.0%	0.4%	0.4%
		Lubricating Oil	CO_2	67.74	202.80	4.9%	0.9%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Asphalt	CO_2	5,444.29	8,995.73	28.3%	0.9%	28%	0.2%	0.2%	0.7%	0.0%	0.3%	0.3%
		Non Asphalt Heavy Oil Products	CO_2	7.76	0.15	28.3%	0.9%	28%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Oil Coke	CO_2	9,505.00	11,317.58	22.5%	0.9%	23%	0.2%	0.1%	0.9%	0.0%	0.3%	0.3%
		Galvanic Furnace Gas	CO_2	146.60	79.66	23.9%	0.9%	24%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Refinary Gas	CO_2	27,354.02	35,374.39	21.6%	0.9%	22%	0.6%	0.5%	2.8%	0.0%	0.9%	0.9%
		LPG	CO_2	37,373.48	31,367.20	2.8%	0.9%	3%	0.1%	-0.7%	2.5%	0.0%	0.1%	0.1%
	Gaseous Fuels	LNG	CO_2	76,303.80	104,245.11	8.4%	1.9%	9%	0.7%	1.7%	8.3%	0.0%	1.0%	1.0%
		Indigenous Natural Gas	CO_2	2,225.86	2,112.99	5.3%	1.9%	6%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
		Town Gas*	CO_2	34,211.10	64,583.72	7.5%	1.9%	8%	0.4%	2.2%	5.1%	0.0%	0.5%	0.5%
		Small Scale Town Gas*	CO_2	1,130.79	1,320.23	2.8%	1.9%	3%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
1A. Fuel Combustion (Stationary)			CH_4	369.78	517.03	10.0%	181.7%	182%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
			N_2O	2,152.65	4,199.33	10.0%	41.8%	43%	0.1%	0.1%	0.3%	0.1%	0.0%	0.1%
1A.Fuel Combustion (Transport)	a. Civil Aviation		CH_4	2.94	4.83	183.1%	9.2%	183%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			N_2O	69.75	106.49	8213.5%	8.2%	8213%	0.6%	0.0%	0.0%	0.0%	1.0%	1.0%
	b. Road Transportation		CH_4	219.40	198.01	23.3%	23.1%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			N_2O	4,255.13	5,710.93	31.0%	31.0%	44%	0.2%	0.1%	0.5%	0.0%	0.2%	0.2%
	c. Railways		CH_4	1.18	0.84	4.5%	13.2%	14%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			N_2O	121.38	84.48	5.0%	10.0%	11%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	d. Navigation		CH_4	26.33	25.48	144.1%	11.3%	145%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			N_2O	111.31	106.55	718.5%	11.3%	719%	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%

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	2004 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						1,254,830.79	1,354,868.94				3%					4%
1B. Fugitive Emissions from Fuels	1. Solid Fuels	a. Coal Mining	i. Underground Mines	Mining Activities	CH_4	2,551.70	31.64	5.0%	2.0%	5%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%
				Post-Mining Activities	CH_4	233.53	25.54	200.0%	5.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ii. Surface Mines	Mining Activities	CH_4	19.50	8.59	200.0%	10.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				Post-Mining Activities	CH_4	1.70	0.75	200.0%	10.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2. Oil and Natural Gas	a. Oil	i. Exploration		CO_2	0.03	0.02	25.0%	10.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	0.03	0.02	25.0%	10.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.00	0.00	25.0%	10.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ii. Production		CO_2	0.11	0.09	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	12.80	10.44	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			iii. Transport		CO_2	0.00	0.00	21.1%	4.2%	22%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	0.76	1.38	22.0%	4.4%	22%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			iv. Refining / Storage		CH_4	14.73	16.32	25.0%	0.9%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		b. Natural Gas	i. Production / Processing		CO_2	0.25	0.36	20.2%	4.0%	21%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	159.12	226.96	19.8%	4.0%	20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ii. Transmission		CO_2	0.03	0.04	25.0%	10.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	104.17	137.29	25.0%	10.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Distribution		CH_4	9.58	22.79	25.0%	8.7%	26%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		c. Venting and Flaring	Venting	i. oil	CO_2	0.01	0.00	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	12.19	9.94	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				ii. Gas	CO_2	0.02	0.02	25.0%	10.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	41.67	54.92	25.0%	10.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Flaring	i. oil	CO_2	28.17	22.96	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	1.22	0.99	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.08	0.07	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				ii. Gas	CO_2	8.06	11.53	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	1.04	1.49	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.03	0.04	25.0%	5.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2. Industrial Processes	A. Mineral Products	1. Cement Production			CO_2	37,966.28	31,415.59	2.8%	10.0%	10%	0.2%	-0.8%	2.5%	-0.1%	0.1%	0.1%
		2. Lime Production		Limestone	CO_2	5,022.48	4,193.53	0.6%	5.0%	5%	0.0%	-0.1%	0.3%	0.0%	0.0%	0.0%
				Dolomite	CO_2	30.11	44.67	2.0%	5.0%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Limestone & Dolomite Use		Limestone	CO_2	10,657.49	10,587.64	16.4%	4.8%	17%	0.1%	-0.1%	0.8%	0.0%	0.2%	0.2%
				Dolomite	CO_2	869.92	292.19	3.5%	3.9%	5%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		4. Soda Ash Production and Use			CO_2	578.03	383.49	15.0%	6.5%	16%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Chemical Industries	1. Ammonia Production			CO_2	3,384.68	2,307.30	13.0%	3.0%	13%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.0%
		Chemical Industries other than Anmonia Production			CO_2	1,129.29	1,001.11	72.8%	7.2%	73%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%
		2. Nitric Acid			N_2O	765.70	818.71	10.0%	45.2%	46%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		3. Adipic Acid			N_2O	7,501.25	838.90	9.0%	2.0%	9%	0.0%	-0.6%	0.1%	0.0%	0.0%	0.0%
		5. Other	Carbon Black		CH_4	5.83	5.95	54.8%	5.0%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Ethylene		CH_4	1.88	2.38	77.2%	5.0%	77%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Dichloroethylene		CH_4	0.28	0.38	100.7%	5.0%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Styrene		CH_4	1.45	2.16	113.2%	5.0%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Methanol		CH_4	3.52	0.00	100.0%	5.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Coke		CH_4	324.84	105.05	98.5%	5.0%	99%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Metal Production	1. Iron and steel			CO_2	176.68	148.81	5.0%	5.0%	7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2. Industrial Processes (F-gas)	C. Metal Prod.	3. Aluminium			PFCs	72.46	14.78	33.0%	5.0%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. Magnesium			SF_6	119.50	956.00	33.0%	5.0%	33%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	16,965.00	1,017.90	100.0%	5.0%	100%	0.1%	-1.4%	0.1%	-0.1%	0.1%	0.1%
		2. Fugitive Emissions			HFCs	491.50	555.90	100.0%	10.0%	100%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
					PFCs	762.90	882.00	100.0%	10.0%	100%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%
					SF_6	4,708.30	764.80	100.0%	10.0%	100%	0.1%	-0.3%	0.1%	0.0%	0.1%	0.1%
	F. Consumption of F-gas	1. Refrigeration and Air	Domestic Refrigerator		HFCs	11.34	138.50	50.0%	40.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Commercial Refrigerator		HFCs	11.10	685.34	50.0%	40.0%	64%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
			Stationary Air-Conditioning		HFCs	0.00	225.06	50.0%	40.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Mobile Air-Conditioning		HFCs	786.70	2,967.38	50.0%	40.0%	64%	0.1%	0.2%	0.2%	0.1%	0.2%	0.2%
		2. Foam Blowing		manufacturing	HFCs	456.96	522.93	50.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				Stock	HFCs	0.00	67.71	50.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. Aerosols / MDI	MDI	stock/disposal	HFCs	0.00	227.20	—	40.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other	manufacturing	HFCs	0.00	57.92	—	40.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock/disposal	HFCs	1,365.00	1,904.90	—	40.0%	40%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%
		5. Solvents			PFCs	8,880.00	5,101.00	—	40.0%	40%	0.2%	-0.4%	0.4%	-0.1%	0.0%	0.1%
		7. Semiconductor Manufacture			HFCs	145.40	129.78	50.0%	40.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					PFCs	2,857.80	3,917.21	50.0%	40.0%	64%	0.2%	0.1%	0.3%	0.0%	0.2%	0.2%
					SF_6	1,099.82	1,784.38	50.0%	40.0%	64%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%
		8. Electrical Equipment		manufacturing	SF_6	9,560.00	662.03	30.0%	40.0%	50%	0.0%	-0.8%	0.1%	-0.3%	0.0%	0.3%
				stock	SF_6	1,434.00	296.36	50.0%	40.0%	64%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		9. Other			SF_6	0.00	0.00	50.0%	40.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3. Solvent	D. Other	Anaesthesia			N_2O	287.07	297.54	—	5.0%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4. Agriculture	A. Enteric Fermentation	Dairy Cattle			CH_4	4,042.62	3,512.55	10.0%	11.2%	15%	0.0%	-0.1%	0.3%	0.0%	0.0%	0.0%
		Non-Dairy Cattle			CH_4	3,322.59	3,391.20	10.0%	17.3%	20%	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%
		Buffalo			CH_4	0.25	0.10	50.0%	0.7%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Sheep			CH_4	2.64	0.96	50.0%	0.7%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Goat			CH_4	3.12	2.96	50.0%	0.4%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Swine			CH_4	261.74	223.81	50.0%	0.7%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Horse			CH_4	8.77	9.45	50.0%	0.7%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Manure Management	Dairy Cattle			CH_4	2,609.46	2,101.58	10.0%	76.8%	77%	0.1%	-0.1%	0.2%	0.0%	0.0%	0.0%
					N_2O	939.09	756.32	10.0%	97.3%	98%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
		Non-Dairy Cattle			CH_4	93.78	92.40	10.0%	73.2%	74%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	812.28	800.45	10.0%	125.1%	126%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
		Buffalo			CH_4	0.01	0.00	100.0%	0.7%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.04	0.01	100.0%	0.7%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Swine			CH_4	334.57	286.07	10.0%	105.5%	106%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1,654.93	1,415.02	10.0%	74.3%	75%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
		Hen			CH_4	42.25	39.49	10.0%	72.3%	73%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1,008.51	942.48	10.0%	102.5%	103%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
		Broiler			CH_4	39.18	28.23	10.0%	75.3%	76%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1,102.87	794.69	10.0%	124.6%	125%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
		Sheep			CH_4	0.18	0.06	100.0%	0.7%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	3.09	1.12	100.0%	0.7%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Goat			CH_4	0.14	0.13	100.0%	0.7%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	13.44	12.75	100.0%	0.7%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Horse			CH_4	1.01	1.09	100.0%	0.7%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	8.70	9.38	100.0%	0.7%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Rice Cultivation	Continuously Flooded			CH_4	317.08	260.24	116.3%	0.3%	116%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Intermittently Flooded	Straw amendment		CH_4	4,604.13	3,778.76	10.0%	30.1%	32%	0.1%	-0.1%	0.3%	0.0%	0.0%	0.1%
			Various compost amendment		CH_4	1,196.96	982.38	10.0%	45.2%	46%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			No-amendment		CH_4	957.56	785.90	10.0%	30.3%	32%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%

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	2004 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						1,254,830.79	1,354,868.94				3%					4%
4. Agriculture	D. Agricultural Soils	1. Direct Soil Emissions	Synthetic Fertilizers		N_2O	1,918.10	1,495.32	10.0%	71.5%	72%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
			Animal Waste Applied to Soils		N_2O	1,317.10	1,096.66	10.0%	82.6%	83%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
			Crop residues		N_2O	1,071.25	930.92	10.0%	165.4%	166%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
			Organic soil		N_2O	804.28	728.72	10.0%	800.8%	801%	0.4%	0.0%	0.1%	-0.1%	0.0%	0.1%
		3. Indirect Emissi	Atmospheric Deposition		N_2O	1,536.83	1,269.79	10.0%	58.6%	59%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
			N Leaching & Run-off		N_2O	2,138.99	1,679.04	10.0%	85.2%	86%	0.1%	-0.1%	0.1%	0.0%	0.0%	0.0%
	F. Field Burning of Agricultural Residue	1. Cereals	Wheat		CH_4	6.08	5.85	10.0%	179.3%	180%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1.38	1.33	10.0%	179.4%	180%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Barley		CH_4	1.96	1.14	10.0%	178.5%	179%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1.79	0.98	10.0%	180.6%	181%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Maize		CH_4	33.03	23.58	418.1%	0.1%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	28.02	20.00	423.1%	0.1%	423%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Oats		CH_4	0.26	0.58	10.0%	151.2%	152%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.18	0.49	0.0%	0.0%	167%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Rye		CH_4	0.03	0.04	10.0%	133.3%	134%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.01	0.02	0.0%	0.0%	157%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Rice		CH_4	62.81	52.94	178.0%	0.1%	178%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	25.10	21.16	175.2%	0.1%	175%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Pulse	Peas		CH_4	0.42	0.21	417.9%	20.0%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.36	0.18	423.1%	20.0%	424%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Soybeans		CH_4	2.44	2.20	175.7%	0.1%	176%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.86	0.77	181.6%	0.1%	182%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (Adzuki beans)		CH_4	1.11	0.81	178.9%	0.1%	179%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.50	0.37	179.8%	0.1%	180%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (kidney beans)		CH_4	0.40	0.27	417.9%	0.1%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.16	0.11	417.8%	0.1%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (peanuts)		CH_4	0.17	0.11	417.9%	0.1%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.07	0.04	417.8%	0.1%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Tuber & Roots	Potatoes		CH_4	4.58	3.71	417.6%	20.0%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	6.39	5.18	418.6%	20.0%	419%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other: Sugarbeet		CH_4	0.81	0.89	417.4%	0.1%	417%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.92	1.02	418.9%	0.1%	419%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. Sugar Cane			CH_4	15.69	9.16	417.6%	0.1%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	38.18	22.28	423.1%	0.1%	423%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6. Waste	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	Kitchen Garbage		CH_4	1,347.41	807.56	44.3%	26.9%	52%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
			Waste Paper		CH_4	3,440.52	1,905.10	46.8%	10.4%	48%	0.1%	-0.1%	0.2%	0.0%	0.1%	0.1%
			Waste Textile		CH_4	216.63	107.69	42.7%	11.1%	44%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Waste Wood		CH_4	1,025.17	1,524.80	53.9%	15.6%	56%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%
			Sewage Sludge		CH_4	821.80	424.96	14.1%	13.1%	19%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Human Waste Sludge		CH_4	132.37	107.91	34.8%	17.4%	39%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Water Purification Sludge		CH_4	105.03	69.36	14.1%	12.8%	19%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Organic Sludge from Manufacture		CH_4	1,262.57	316.45	41.2%	17.6%	45%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
			Livestock Waste		CH_4	506.96	535.26	126.5%	47.7%	135%	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%
		3. Other	Illegal Disposal		CH_4	3.21	14.18	56.6%	29.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Composting of Organic Waste		CH_4	19.82	18.98	74.3%	6.1%	75%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Wastewater Handling	1. Industrial Wastewater			CH_4	112.56	102.79	60.0%	37.1%	71%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	122.37	108.71	300.0%	50.3%	304%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant		CH_4	181.54	248.36	30.9%	10.4%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	491.97	673.05	145.7%	10.4%	146%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%
			Private Sewerage Tank		CH_4	451.67	441.76	59.5%	7.0%	60%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	468.72	330.71	45.9%	5.7%	46%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Human-Waste Treatment Plant		CH_4	110.14	26.76	89.7%	11.0%	90%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	69.56	7.80	470.8%	28.4%	472%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Degradation of domestic wastewater in nature		CH_4	1,277.50	680.08	72.5%	22.0%	76%	0.0%	-0.1%	0.1%	0.0%	0.1%	0.1%
					N_2O	398.36	182.71	63.5%	32.0%	71%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Waste Incineration	Municipal Solid Waste		Plastics	CO_2	10,219.35	13,176.24	12.5%	16.0%	20%	0.2%	0.2%	1.1%	0.0%	0.2%	0.2%
				Waste textile	CO_2	1,087.80	1,194.32	12.5%	12.3%	18%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
					CH_4	21.19	17.92	57.5%	8.6%	58%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Industrial Solid Waste		Waste Oil	N_2O	687.45	782.76	23.7%	8.6%	25%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
				Plastics	CO_2	4,538.53	7,498.05	12.6%	104.4%	105%	0.6%	0.2%	0.6%	0.2%	0.1%	0.2%
				Waste textile	CO_2	2,349.53	5,015.73	12.6%	100.0%	101%	0.4%	0.2%	0.4%	0.2%	0.1%	0.2%
					CO_2	15.06	19.44	12.5%	141.4%	142%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	3.74	4.97	85.7%	54.8%	102%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1,204.85	2,069.87	0.0%	0.0%	0%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%
		Specially Contorolled Industrial Solid Waste			CO_2	946.78	2,249.14	10.4%	164.4%	165%	0.3%	0.1%	0.2%	0.2%	0.0%	0.2%
					CH_4	0.12	0.27	73.6%	120.8%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	5.95	13.13	47.1%	153.1%	160%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of MSW			CO_2	0.00	407.35	12.5%	16.0%	20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	0.00	0.00	179.4%	10.0%	180%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.00	0.01	111.2%	10.0%	112%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of ISW		Waste Oil	CO_2	2,072.74	3,277.66	12.6%	104.4%	105%	0.3%	0.1%	0.3%	0.1%	0.0%	0.1%
					CH_4	0.25	0.52	59.3%	29.0%	66%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	4.90	12.69	37.2%	14.6%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				Waste Plastics	CO_2	0.00	1,118.22	12.6%	12.3%	18%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
					CH_4	0.00	2.27	91.7%	10.0%	92%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.00	2.95	29.7%	10.0%	31%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				Waste Wood	CH_4	36.94	53.72	80.2%	100.0%	128%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	6.18	8.98	45.3%	100.0%	110%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of Waste tire			CO_2	524.23	779.27	12.6%	14.5%	19%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
					CH_4	0.65	1.23	90.6%	9.9%	91%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1.55	2.65	24.7%	7.1%	26%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Fuel use of RDF and RPF			CO_2	0.00	659.38	22.9%	7.6%	24%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
					CH_4	0.00	0.07	48.5%	6.1%	49%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.00	3.66	31.7%	7.0%	32%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	D. Other	Decomposition of petroleum-derived surface-active agent			CO_2	702.83	508.26	0.1%	24.4%	24%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Composting of Organic Waste			N_2O	20.12	19.54	97.2%	8.0%	97%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Annex 8. National Greenhouse Gas Emissions in Fiscal Year 2004 (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

- Greenhouse gas emission estimates reported in this submission were projected based on the current emission estimating methods which have been in the process of improvements. Greenhouse gas emission estimates are required to be annually submitted to the UNFCCC secretariat.
    - ➢ Since the assigned amount for the first commitment period (2008-2012) needs to be reported to the UNFCCC secretariat by September 1, 2006 after determining the base year emissions, improvements process on greenhouse gas emissions estimating methods has been still underway. Therefore, due to future improvements, recalculations may be conducted afterward on the emissions reported in this submission.
- Total greenhouse gas emission in fiscal 2004 was 1,355 million tons (in CO_2 equivalents)[2] .
- Compared to that in the base year under the Kyoto Protocol (in principle: 1990), it increased by 8.0% and have decreased by 0.2% from the previous year due to an improvement in nuclear power plant capacity utilization ratio.
- Carbon Dioxide emissions from energy use which accounts for about 90% of the total greenhouse gas emissions is increased by 12.9% compared to that in the base year. Sectoral breakdown of Carbon Dioxide (CO_2) emissions is as follows.
- Assuming that the actual nuclear power plant capacity utilization ratio in FY2004 is equivalent to the ratio planned before a nuclear power plant shutdown in FY2002, the ratio of total greenhouse gas emissions in FY2004 compared to the base year increased by 5.2% and also exceeded the ratio of total emissions in FY2003 compared to the base year by 1.8%.

<Industrial Sector (Factories)>
Decrease of 3.4% over fiscal 1990 (increase of 0.1% over previous fiscal year)
<Transportation Sector (Automobiles and Ships, etc.)>
Increase of 20.3% over fiscal 1990 (decrease of 0.1% over previous fiscal year)
<Commercial and Other Sector (Commerce, Service, Office, etc.)>
Increase of 37.9% over fiscal 1990 (decrease of 0.6% over previous fiscal year)

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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.

<Residential Sector>

Increase of 31.5% over fiscal 1990 (and 0.1% over previous fiscal year)

<Energy Industries Sector (Electric Power Plants, etc.)>

Increase of 17.4% over fiscal 1990 (and 0.0% over previous fiscal year)

- Assuming that actual nuclear power plant capacity utilization ratio is equivalent to planned ratio (84.1%), the ratio of total emissions compared to the base year emissions have increased by 1.7% over the previous year in FY2004.

National Total Greenhouse Gas Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Chaneges from FY2003	FY2004 (compared to base year)
Total	1,255	1,358 +8.2%	→ -0.2% →	**1,355** **+8.0%**
Carbon Dioxide（CO_2）	1,139	1,279 +12.3%	→ -0.01% →	**1,279** **+12.3%**
Carbon Dioxide from energy use	1,056	1,194 +13.0%	→ -0.1% →	**1,193** **+12.9%**
Carbon Dioxide from other than energy use	82.3	85.4 +3.8%	→ +1.0% →	**86.3** **+4.9%**
Methane（CH_4）	33.2	24.8 -25.3%	→ -1.5% →	**24.4** **-26.4%**
Nitrous Oxide（N_2O）	33.2	28.1 -15.5%	→ +1.2% →	**28.4** **-14.4%**
F-gas	49.7	26.0 -47.7%	→ -12.0% →	**22.9** **-54.0%**
Hydrofluorocarbons（HFCs）	20.2	12.3 -39.3%	→ -30.8% →	**8.5** **-58.0%**
Perfluorocarbons (PFCs)	12.6	9.0 -28.6%	→ +10.5% →	**9.9** **-21.1%**
Sulfur Hexafluoride（SF_6）	16.9	4.7 -72.0%	→ -5.7% →	**4.5** **-73.6%**

(Unit：Mt-CO_2)

CO_2 emissions from energy use in each sector (obtained by allocating CO_2 emissions derived from power generation and steam generation to each final demand sector)

	FY1990	FY2003 (compared to base year)	Changes from FY2003	FY2004 (compared to base year)
Total	1,056	1,194 +13.0%	→ -0.1% →	**1,193** **+12.9%**
Industries (Factories, etc.)	482	465 -3.5%	→ +0.1% →	**466** **-3.4%**
Transport (Automobiles, ships, etc.)	217	262 +20.4%	→ -0.1% →	**262** **+20.3%**
Commercial and Other (Commerce, Service, Office, etc.)	164	228 +38.8%	→ -0.6% →	**227** **+37.9%**
Residential	127	167 +31.4%	→ +0.1% →	**168** **+31.5%**
Energy Industries (Electric Power Plants, etc.)	65.6	77 +17.3%	→ +0.0% →	**77** **+17.4%**

(Unit：Mt-CO_2)

Note: CO2 emissions from energy use in each sector were obtained by allocating CO2 emissions derived from power generation and steam generation to each final demand sector.

<Overview of Sector Emissions>

(1) Industrial Sector (Factories, etc.)

Total carbon dioxide emissions from the industrial sector (factories, etc.) were resulted in a decrease of 3.4% compared to the base year emissions. This decrease compared to the base year emissions was caused by the factors that emissions from primary industries[1] remained the same level and also emissions from other type of industries, small-to-medium-sized manufacturing, and non-manufacturing industries[2] have decreased.

(2) Transport Sector (Automobiles, Ships, etc.)

Total carbon dioxide emissions from the transport sector (Automobiles, Ships, etc.) were resulted in an increase of 20.3% compared to the base year emissions and a decrease of 0.1% compared to the previous year. This increase compared to the base year was caused by the fact that while emissions from the freight sector decreased (-3.2% compared to the base year), emissions from passengers sector increased (+45.2% compared to the base year). Particularly, emissions from automobiles for personal use in the passengers sector increased (+52.6% compared to the base year).

(3) Commercial and Other Sector (Commerce, Service, Office, etc.)

Total carbon dioxide emissions from the commercial and other sector (commerce, service, office, etc.) were resulted in an increase of 37.9% compared to the base year emissions. These were caused by the facts that while the total floor space of industrial institutions considerably increased, carbon dioxide emissions per floor space remained the same level.

(4) Residential Sector

Total carbon dioxide emissions from the residential sector were resulted in an increase of 31.5% compared to the base year. The increased compared to the base year was caused by the fact that the number of households increased and also carbon dioxide emissions per household increased. Carbon dioxide emissions from electricity consumption which accounts for 60% of total emissions from the residential sector considerably increased.

(5) Energy Industries Sector (Electric Power Plants, etc.)

Total carbon dioxide emissions from the energy industries sector (electric power plants, etc.) were resulted in an increase of 17.4% compared to the base year emissions. Self-consumption and electric heat loss due to electric power distribution and transmission along with an increase of energy demand have increased by 17% compared to the base year.

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[1] Food; Pulp and paper; Chemical fiber; Petroleum products; Chemical; Glass product; Ceramics, clay and stone products; Iron and steel; Non-ferrous metal; and Machinery industries

[2] Agriculture, Forestry and fisheries; Mining; and Construction industries

8.1. National Total Greenhouse Gas Emissions

Total greenhouse gas emissions (calculated by multiplying each greenhouse gas emission by Global Warming Potential (GWP)[1], and adding them up) in FY 2004 were 1,355 million tons of carbon dioxide equivalents. Total emissions have increased by 8.0% compared to the total emissions (1,255million 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) and have decreased by 0.2% from the previous year. For estimating methods for greenhouse gas emissions, refer to Chapter 8.3.

Table 1 National Total Greenhouse Gas Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Chaneges from FY2003	FY2004 (compared to base year)
Total	1,255	1,358 +8.2%	→ -0.2% →	**1,355** **+8.0%**
Carbon Dioxcide（CO_2）	1,139	1,279 +12.3%	→ -0.01% →	**1,279** **+12.3%**
Carbon Dioxide from energy use	1,056	1,194 +13.0%	→ -0.1% →	**1,193** **+12.9%**
Carbon Dioxide from other than energy use	82.3	85.4 +3.8%	→ +1.0% →	**86.3** **+4.9%**
Methane（CH_4）	33.2	24.8 -25.3%	→ -1.5% →	**24.4** **-26.4%**
Nitrous Oxide（N_2O）	33.2	28.1 -15.5%	→ +1.2% →	**28.4** **-14.4%**
F-gas	49.7	26.0 -47.7%	→ -12.0% →	**22.9** **-54.0%**
Hydrofluorocarbons（HFCs）	20.2	12.3 -39.3%	→ -30.8% →	**8.5** **-58.0%**
Perfluorocarbons (PFCs)	12.6	9.0 -28.6%	→ +10.5% →	**9.9** **-21.1%**
Sulfur Hexafluoride（SF_6）	16.9	4.7 -72.0%	→ -5.7% →	**4.5** **-73.6%**

(Unit：Mt-CO_2)

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[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).

Table 2 Trends of Greenhouse Gas Emissions

[Mt CO_2eq.]

	GWP	Base year of KP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 Emissions	1	1,139	1,139	1,148	1,158	1,150	1,206	1,219	1,234	1,228	1,192	1,229
CH_4	21	33.2	33.2	32.9	32.6	32.5	31.9	31.3	30.7	29.6	28.7	28.0
N_2O	310	33.2	33.2	32.7	33.0	32.7	33.9	34.4	35.7	36.3	34.9	28.8
HFCs	HFC-134a： 1,300 etc.	20.2						20.2	19.9	19.8	19.3	19.8
PFCs	PFC-14： 6,500 etc.	12.6						12.6	15.3	16.9	16.6	14.9
SF_6	23,900	16.9						16.9	17.5	14.8	13.4	9.1
Total		1,255	1,205	1,214	1,224	1,215	1,272	1,335	1,353	1,345	1,305	1,330

	GWP	Base year of KP	2000	2001	2002	2003	2004
CO_2 Emissions	1	1,139	1,251	1,236	1,269	1,279	1,279
CH_4	21	33.2	27.3	26.4	25.4	24.8	24.4
N_2O	310	33.2	31.3	28.1	28.0	28.1	28.4
HFCs	HFC-134a： 1,300 etc.	20.2	18.5	15.8	12.9	12.3	8.5
PFCs	PFC-14： 6,500 etc.	12.6	13.7	11.5	9.8	9.0	9.9
SF_6	23,900	16.9	6.8	5.7	5.3	4.7	4.5
Total		1,255	1,349	1,324	1,351	1,358	1,355

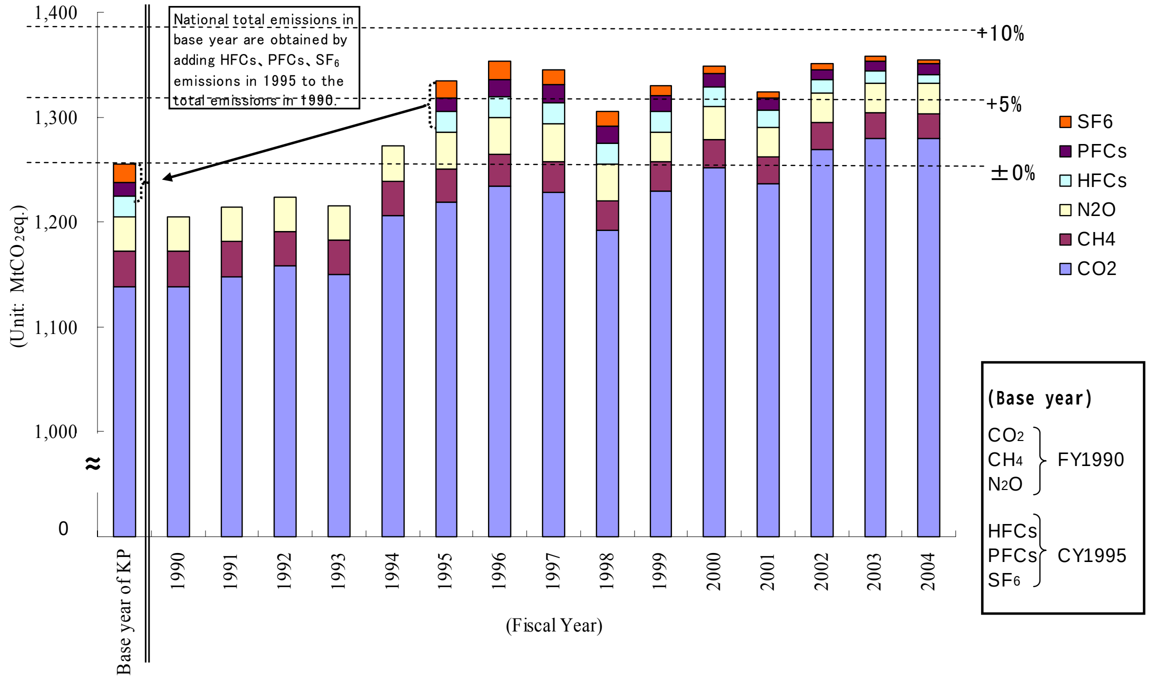

Figure 1 Trends of Total Greenhouse Gas Emissions

8.2. Overview of Emissions and Trends

8.2.1. Carbon Dioxide (CO_2)

8.2.1.1. Overview of Carbon Dioxide Emissions (CO_2)

Total Carbon dioxide emissions in FY 2004 were 1,279 million tons. Total CO_2 emissions have increased by 12.3% compared to the total CO_2 emissions in the base year and remained nearly the same level as the previous year. An increase in CO_2 emissions from energy use was the primary contributor to the increase compared to the base year.

Table 3 Changes in Total Carbon Dioxide Emissions

		Base Year of Kyoto Protocol	FY2003 (compared to base year)	Chaneges from FY2003	FY2004 (compared to base year)
Total		**1,139**	**1,279** **(+12.3%)**	→ **-0.0%** →	**1,279** **(+12.3%)**
Energy use	Sub Total	1,056	1,194 (+13.0%)	→ **-0.1%** →	**1,193** **(+12.9%)**
	Industries (Factories, etc.)	482	465 (-3.5%)	→ **+0.1%** →	**466** **(-3.4%)**
	Transport (Cars, ships, etc.)	217	262 (+20.4%)	→ **-0.1%** →	**262** **(+20.3%)**
	Commercial and Other (Commerce, Service, Office, etc.)	164	228 (+38.8%)	→ **-0.6%** →	**227** **(+37.9%)**
	Residential	127	167 (+31.4%)	→ **+0.1%** →	**168** **(+31.5%)**
	Energy Industries (Electric Power Plants, etc.)	65.6	77.0 (+17.3%)	→ **+0.0%** →	**77** **(+17.4%)**
Other than energy use	Sub Total	82.3	85.4 (+3.8%)	→ **+1.0%** →	**86.3** **(+4.9%)**
	Industrial Process	59.8	49.9 (-16.6%)	→ **+0.9%** →	**50.4** **(-15.8%)**
	Waste (Incineration, etc.)	22.5	35.5 (+58.1%)	→ **+1.1%** →	**35.9** **(+59.9%)**
	Fugitive Emissions	0.04	0.03 (-5.9%)	→ **+1.5%** →	**0.04** **(-4.4%)**

(Unit : Mt-CO_2)

Note: CO_2 emissions from energy use in each sector were obtained by allocating CO_2 emissions derived from power generation and steam generation to each final demand sector.

According to the estimates projected by the Federation of Electric Power Companies, comparing the plan (Nuclear power supply plan for FY2002) established before the shutdown in 2002 with the actual nuclear power plant operation results, the influence of a long term shutdown of a nuclear power plant is equivalent to an increase of approximately 35 million tons of carbon dioxide equivalents in FY2004,. It resulted in a remarkable improvement in CO_2 emissions compared to CO_2 emissions in FY2003 (60 million tons of CO_2 equivalents). Assuming that actual nuclear power plant capacity utilization ratio in FY2003 and 2004 are equivalent to the planned ratio, the influence on total emissions can be summarized in Table 4 (see the table below). The ratio of total emissions in FY2003 and FY2004 compared to the base year have increased from +3.4% in FY2003 to +5.2% in FY2004; therefore, total emissions compared to the base year have increased by 1.8% over the previous year because of factors other than the long term shutdown of nuclear power plant.

Table 4 Influence of Nuclear Power Plant Capacity Utilization Ratio on Total Emissions

	Change of total emissions compared to the base year	Actual nuclear power plant capacity utilization ratio	In the case of assuming that actual nuclear power plant capacity utilization ratio is equivalent to planned ratio (84.1%)		
			Decrease of CO_2 emissions	Decrease of CO_2 emissions compared to the base year	Change of total emissions compared to the base year
FY2003	+8.2%	59.7%	60Mt-CO_2	-4.8%	+3.4%
FY2004	+7.9%	68.9%	35Mt-CO_2	-2.8%	+5.1%

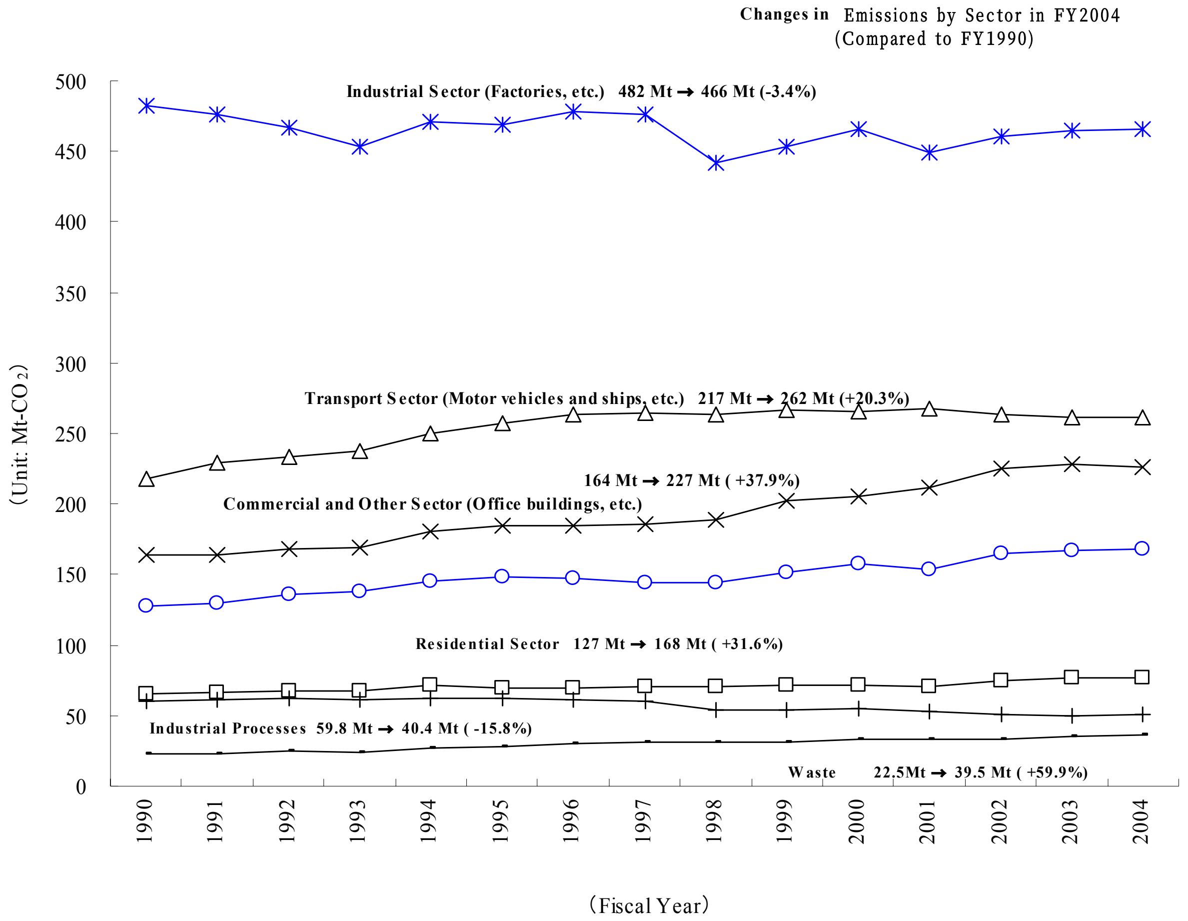

Figure 2 Trends in Carbon Dioxide Emissions by Sector

Note: CO_2 emissions from energy use in each sector were obtained by allocating CO_2 emissions derived from power generation and steam generation to each final demand sector.

8.2.1.2. Overview of Sector Emissions

(1) Industrial Sector (Factories, etc.)

Total carbon dioxide emissions from the industrial sector (factories, etc.) in FY2004 were 466 million tons of CO_2 equivalents and resulted in a decrease of 3.4% compared to the base year emissions and an increase of 0.1% compared to the previous year. A decrease of 3.4% compared to the base year emissions was caused by the factors that emissions from primary industries[1] remained the same level and also emissions from other type of industries, small-to-medium-sized manufacturing, and non-manufacturing industries[2] have decreased.

(2) Transport Sector (Automobiles, Ships, etc.)

Total carbon dioxide emissions from the transport sector (Automobiles, Ships, etc.) in FY2004 were 262 million tons of CO_2 equivalents and resulted in an increase of 20.3% compared to the base year emissions and a decrease of 0.1% compared to the previous year. This increase compared to the base year was caused by the fact that while emissions from the freight sector decreased (-3.2% compared to the base year), emissions from passengers sector increased (+42.5% compared to the base year). Particularly, emissions from automobiles for personal use in the passengers sector increased (+52.6% compared to the base year).

(3) Commercial and Other Sector (Commerce, Service, Office, etc.)

Total carbon dioxide emissions from the commercial and other sector (Commerce, Service, Office, etc.) in FY2004 were 227 million tons of CO_2 equivalents and resulted in an increase of 37.9% compared to the base year emissions and a decrease of 0.6% compared to the previous year. These were caused by the facts that while the total floor space of industrial institutions considerably increased (+35.5% compared to the base year), carbon dioxide emissions per floor space remained the same level.

(4) Residential Sector

Total carbon dioxide emissions from the residential sector in FY2004 were 168 million tons of CO_2 equivalents and resulted in an increase of 31.5% compared to the base year and an increase of 0.1% compared to the previous year. The increased compared to the base year was caused by the fact that the number of households considerably increased (+20.5% compared to the base year) and also carbon dioxide emissions per household increased (+8.6% compared to the base year). Carbon dioxide emissions from electricity consumption which accounts for 60% of total emissions from the residential sector considerably increased (+45.8% compared to the base year).

(5) Energy Industries Sector (Electric Power Plants, etc.)

Total carbon dioxide emissions from the energy industries sector (electric power plants, etc.) in FY2004 were 77 million tons of CO_2 equivalents and resulted in an increase of 17.4% compared to the base year emissions and remained the same level as the previous year. Self-consumption and

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[1] Food; Pulp and paper; Chemical fiber; Petroleum products; Chemical; Glass product; Ceramics, clay and stone products; Iron and steel; Non-ferrous metal; and Machinery industries

[2] Agriculture, Forestry and fisheries; Mining; and Construction industries

electric heat loss due to electric power distribution and transmission along with an increase of energy demand have increased by 17% compared to the base year.

8.2.1.3. Carbon Dioxide Emissions Per Capita

Carbon dioxide emissions per capita in FY2004 were 10 tons of CO_2 equivalents per person and resulted in an increase of 8.7% compared to the base year and a decrease of 0.1% compared to the previous year.

Table 5 Carbon Dioxide Emissions Per Capita

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Chaneges from FY2003	FY2004 (compared to base year)
CO_2 emissions (Mt-CO_2)	1,139	1,279 (+12.3%)	→ -0.0% →	**1,279** **(+12.3%)**
Population (1000 person)	123,611	127,619 (+3.2%)	→ +0.1% →	**127,687** **(+3.3%)**
CO_2 Emissions per capita (tCO_2/person)	9.21	10.02 (+8.8%)	→ -0.1% →	**10.02** **(+8.7%)**

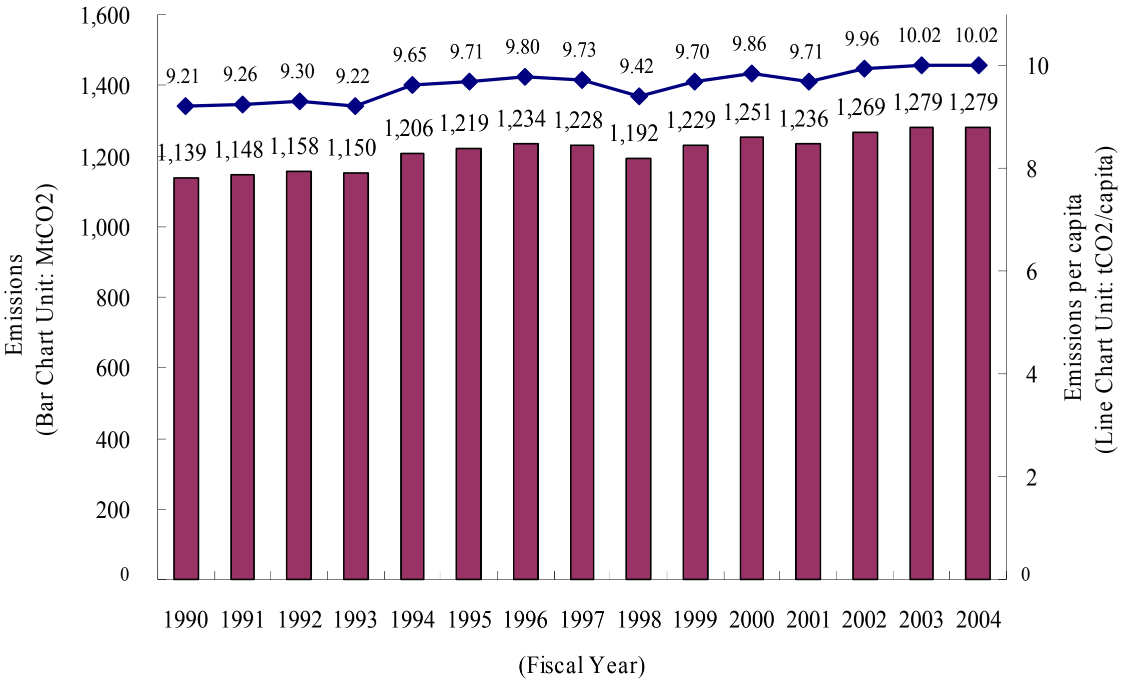

Figure 3 Trends in Carbon Dioxide Emissions Per Capita

8.2.2. CH_4

Total methane emissions in FY2004 were 24.4 million tons of CO_2 equivalents and resulted in a decrease of 26.4% compared to the base year emissions and a decrease of 1.5% compared to the previous year. Primary factor to the decrease compared to the base year is a decrease of emissions from SWDS (Solid Waste Disposal Site) and coal mining.

Table 6 Trends in Methane (CH_4) Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Changes from FY2003	FY2004 (compared to base year)
Total	33.2	24.8 (-25.3%)	→ -1.5% →	**24.4** **(-26.4%)**
Agriculture （Enteric Fermentation, Rice Cultivation, etc.）	18.0	15.6 (-13.0%)	→ -0.3% →	**15.6** **(-13.2%)**
Waste （SWDS,Wastewater Handling, etc.）	11.1	7.7 (-30.2%)	→ -4.1% →	**7.4** **(-33.1%)**
Fuel Combustion	0.6	0.7 (+20.0%)	→ +0.3% →	**0.7** **(+20.4%)**
Fugitive Emissions from Fuels (Production of Natural Gas, Coal Mining, etc.)	3.2	0.6 (-82.2%)	→ -2.7% →	**0.5** **(-82.6%)**
Industrial Process	0.3	0.1 (-65.4%)	→ -0.7% →	**0.1** **(-65.7%)**

(Unit: Mt-CO_2)

8.2.3. Nitrous Oxide (N_2O)

Total N_2O emissions in FY2004 were 28.4 million tons of CO_2 equivalents and resulted in a decrease of 14.4% compared to the base year and an increase of 1.2% compared to the previous year. Primary factor to this decrease compared to the base year is a decrease of emissions from adipic acid production.

Table 7 N_2O Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Changes from FY2003	FY2004 (compared to base year)
Total	33.2	28.1 (-15.5%)	→ +1.2% →	**28.4** **(-14.4%)**
Agriculture (Manure Management, Agricultural Soils, etc.)	14.4	12.1 (-16.4%)	→ -0.5% →	**12.0** **(-16.8%)**
Fuel Combustion	6.7	10.2 (+51.9%)	→ +0.1% →	**10.2** **(+52.1%)**
Waste （Wastewater Handling, Incineration）	3.5	4.2 (+20.9%)	→ +0.2% →	**4.2** **(+21.2%)**
Industrial Process （Production of Adipic Acid, Nitric Acid）	8.3	1.3 (-84.8%)	→ +31.6% →	**1.7** **(-79.9%)**
Solvent & Other Product Use	0.3	0.3 (+11.8%)	→ -7.3% →	**0.3** **(+3.6%)**
Fugitive Emissions from Fuels	0.0001	0.0001 (-4.1%)	→ +1.7% →	**0.0001** **(-2.4%)**

(Unit: Mt-CO_2)

8.2.4. Hydrofluorocarbons (HFCs),

Total HFCs emissions in FY2004 were 8.5 million tons of CO_2 equivalents and resulted in a decrease of 58.0% compared to the base year (FY1995) and a decrease of 30.8% compared to the previous year. Primary factor to these decreases is a considerable decrease of emissions from by-product from HCFC-22 production.

Table 8 HFCs Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Changes from FY2003	FY2004 (compared to base year)
Total	20.2	12.3 (-39.3%)	→ -30.8% →	**8.5** **(-58.0%)**
By-product Emissions from Production of HCFC-22	17.0	5.0 (-70.4%)	→ -79.7% →	**1.0** **(-94.0%)**
Aerosols/MDI	1.4	2.6 (+91.5%)	→ -16.2% →	**2.2** **(+60.4%)**
Refrigeration and Air Conditioning Equipment	0.8	3.4 (+324.4%)	→ +17.0% →	**4.0** **(+396.4%)**
Foam Blowing	0.5	0.7 (+42.9%)	→ -9.6% →	**0.6** **(+29.3%)**
Productions of HFCs	0.5	0.4 (-10.6%)	→ +26.5% →	**0.6** **(+13.1%)**
Semiconductor Manufacture	0.1	0.1 (-22.4%)	→ +15.0% →	**0.1** **(-10.7%)**

(Unit: Mt-CO_2)

Note: MDI: Metered dose Inhalers

8.2.5. Perfluorocarbons (PFCs)

Total PFCs emissions in FY2004 were 9.9 million tons of CO_2 equivalents and resulted in a decrease of 21.1% compared to the base year (FY1995) and an increase of 10.5% from the previous year. Emissions from the use of solvent increased from the previous year.

Table 9 PFCs Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Changes from FY2003	FY2004 (compared to base year)
Total	12.6	9.0 (-28.6%)	→ +10.5% →	**9.9** **(-21.1%)**
Solvent	8.9	4.2 (-52.3%)	→ +20.4% →	**5.1** **(-42.6%)**
Semiconductor Manufacture	2.9	3.7 (+29.7%)	→ +5.7% →	**3.9** **(+37.1%)**
Productions of PFCs	0.8	1.0 (+33.2%)	→ -13.2% →	**0.9** **(+15.6%)**
Metal Production	0.1	0.02 (-79.2%)	→ -2.2% →	**0.01** **(-79.6%)**

(Unit: Mt-CO_2)

8.2.6. Sulfur Hexafluoride (SF_6)

Total SF_6 emissions in FY2004 were 4.5 million tons of CO_2 equivalents and resulted in a decrease of 73.6% from the base year (1995) and a decrease of 5.7% from the previous year.

Table 10 SF_6 Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Changes from FY2003	FY2004 (compared to base year)
Total	16.9	4.7 (-72.0%)	→ -5.7% →	**4.5** **(-73.6%)**
Electrical Equipment	11.0	1.2 (-89.1%)	→ -20.3% →	**1.0** **(-91.3%)**
Productions of SF_6	4.7	0.8 (-82.7%)	→ -5.9% →	**0.8** **(-83.8%)**
Semiconductor Manufacture	1.1	1.7 (+56.0%)	→ +4.0% →	**1.8** **(+62.2%)**
Metal Production	0.1	1.0 (+740.0%)	→ -4.8% →	**1.0** **(+700.0%)**

(Unit: Mt-CO_2)

8.3. Improvements on Greenhouse Gas Emissions Estimating Methods

National greenhouse gas inventory is required to be submitted annually to the secretary of the United Nations Framework Convention on Climate Change (UNFCCC). Emissions inventories provided in this report are the emission estimates for FY2004.

The assigned amount[1] for the first commitment period needs to be reported to the secretariat of UNFCCC by September 1, 2006 after determining the base year emissions. Greenhouse gas emissions provided in this report are the basis for the amount to be fixed (no changes will be accepted afterward) as the assigned amount.

In order to prepare for the assigned amount, improvements on estimating methods for greenhouse gas emissions have been conducted since August of 2005, and the emissions indicated in this report reflect that process (for details, see the next page). For that reason, some of the emissions data (data for 1990-2003) provided in the previous submission have been revised due to recalculations. This improvements process of estimating methods has been still underway, and recalculations may be also conducted on the emissions data for FY2004.

The removals estimates of greenhouse gases from all of forestry in FY 1990-2004 are planned to be conducted and provided in an assigned amount report to be submitted by September 1, 2006. The removals provided in the assigned amount report will not be the same as the amount based on the Kyoto Protocol (the amount which can be included as part of the emissions over the first commitment

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[1] Assigned amount is the amount of greenhouse gas emissions to which an Annex I Party must reduce its emissions over the first commitment period (2008-2012). This amount can be obtained by multiplying the

period), and the removals from forestry management are planned to be estimated and provided in the national greenhouse gas inventory report for FY2005 to be submitted in April or May of 2007 as supplementary information[1] based on the Kyoto Protocol.

8.3.1. Details of Improvements on Estimating Methods (Parentheses indicate the changes in emissions of CO_2 equivalents for the base year)

(1) Carbon Dioxide Emissions from Energy Use (Increase of approximately 8 million tons of CO_2 equivalents)

Emission factors for fuels were reviewed based on the improvements on the petroleum and coal products manufacturing sectors, and the revisions of the *Energy Balance Sheet* (the *General Energy Statistics*) including new categories added to the sectoral breakdown for non-manufacturing, and commercial and other sectors.

(2) Carbon Dioxide Emissions from Other than Energy Use (Increase of approximately 8 million tons of CO_2 equivalents)

The following improvements were made:

- The limestone method, estimating methods of industrial process origin carbon dioxide emissions from cement production was replaced by internationally standard, the clinker method (increase of approximately 1 million tons of CO_2 equivalents).
- Emissions from the use of soda ash and calcium carbide production were newly reported (increase of approximately 2 million tons of CO_2 equivalents).
- Emissions from synthetic textile scraps (municipal and industrial waste) incineration and special management waste incineration were newly reported (increase of approximately 2 million tons of CO_2 equivalents).
- Emissions from the use of waste as raw material or fuel were newly reported (increase of approximately 2 million tons of CO_2 equivalents).
- Emissions from the decomposition of petroleum-derived surfactants were newly reported (increase of approximately 1 million tons of CO_2 equivalents).

(3) Methane (Increase of approximately 8 million tons of CO_2 equivalents)

The following improvements were made:

- Emission factors for manure management were reviewed based on the latest scientific knowledge (increase of approximately 2 million tons of CO_2 equivalents).
- Determining emission factors for semi-aerobic landfill and reviewing moisture percentages for emissions from kitchen garbage and wood scraps in managed waste disposal on land were conducted (increase of 1 million ton of CO_2 equivalents).
- Emissions from landfill disposal of sludge were newly reported (increase of 3 million tons of CO_2 equivalents).
- Emissions from the decomposition of domestic and commercial waste water in nature were

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emissions equivalent to 94 % of total emissions for the base year by five.

[1] Information to be submitted along with greenhouse gas inventories to provide additional information

newly reported (increase of 1 million tons of CO_2 equivalents).

(4) Dinitrogen Monoxide (decrease of approximately 7 million tons of CO_2 equivalents)

- Emission factors for manure management were reviewed based on the latest scientific knowledge (decrease of approximately 9 million tons of CO_2 equivalents).
- Emission factors for emissions from adipic acid production were reviewed based on the actual measurement data (increase of 1 million tons of CO_2 equivalents).

Note: Because items listed above are not all of improvements made, total of each increase and decrease indicated above may not equal the sum of increases and decreases of each gas reported.

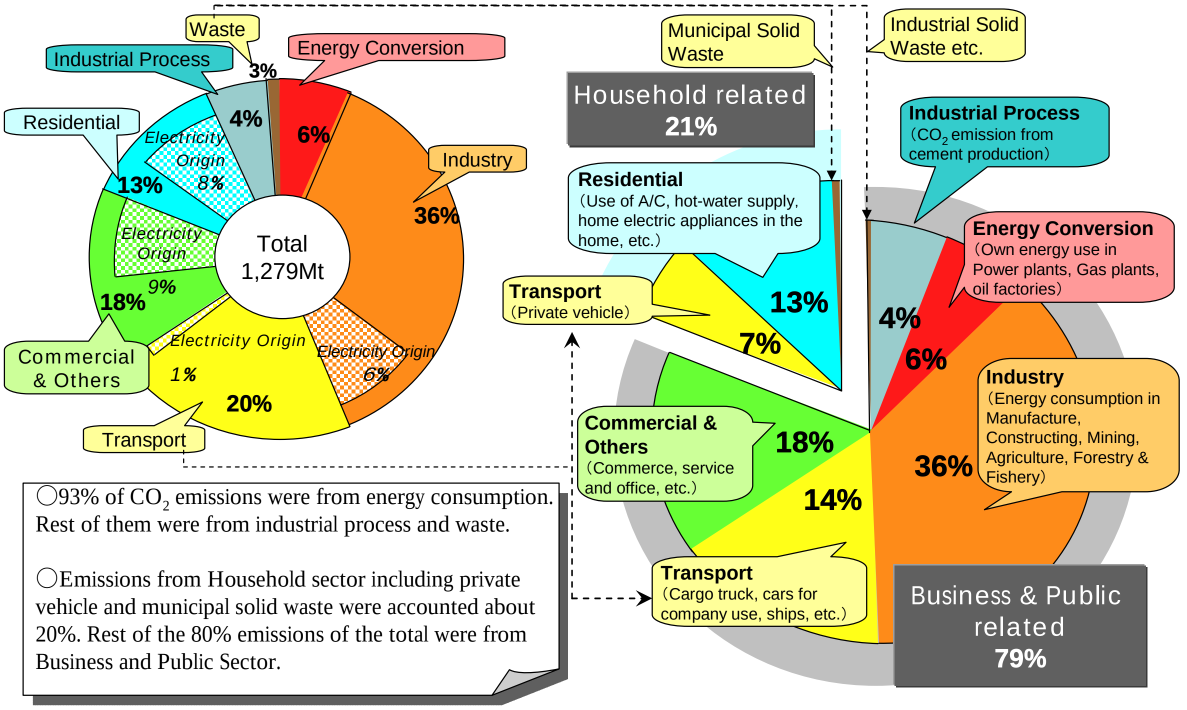
8.4. Reference Data

8.4.1. Climate (Average temperature in Japan)

	FY2003	FY2004
Summer (Jun.-Aug.)	Below the average across the country (except exceeded the average in the South-West Islands and south Kyushu region, and exceeded the average by 1 Celsius degrees in the northern part of Japan).	Exceeded the average by 1 Celsius degrees in most areas. Exceeded the average by 1.5 Celsius degrees in the Sea of Okhotsk side in Hokkaido and some parts of the Kanto, Toukai, and Kyushu regions.
Winter (Dec.-Feb.)	Exceeded the average in the northern, eastern and western part of Japan. Exceeded the average by 1 Celsius degrees in some parts of the northern and eastern part of Japan. Exceeded the average by 1.5-2.0 Celsius degrees in Hokkaido and the northern part of Tohoku region.	Average temperature in the northern and western part of Japan. Exceeded the average by 0.5 Celsius degrees in most areas of the South-West Islands and eastern part of Japan.

Resources: *Climate in the Summer (June-August), Climate in the Winter (December-February)*, Japan Meteorological Agency

8.4.2. Carbon Dioxide Emissions by Emission Origin Type and Emissions Management Type in FY2004

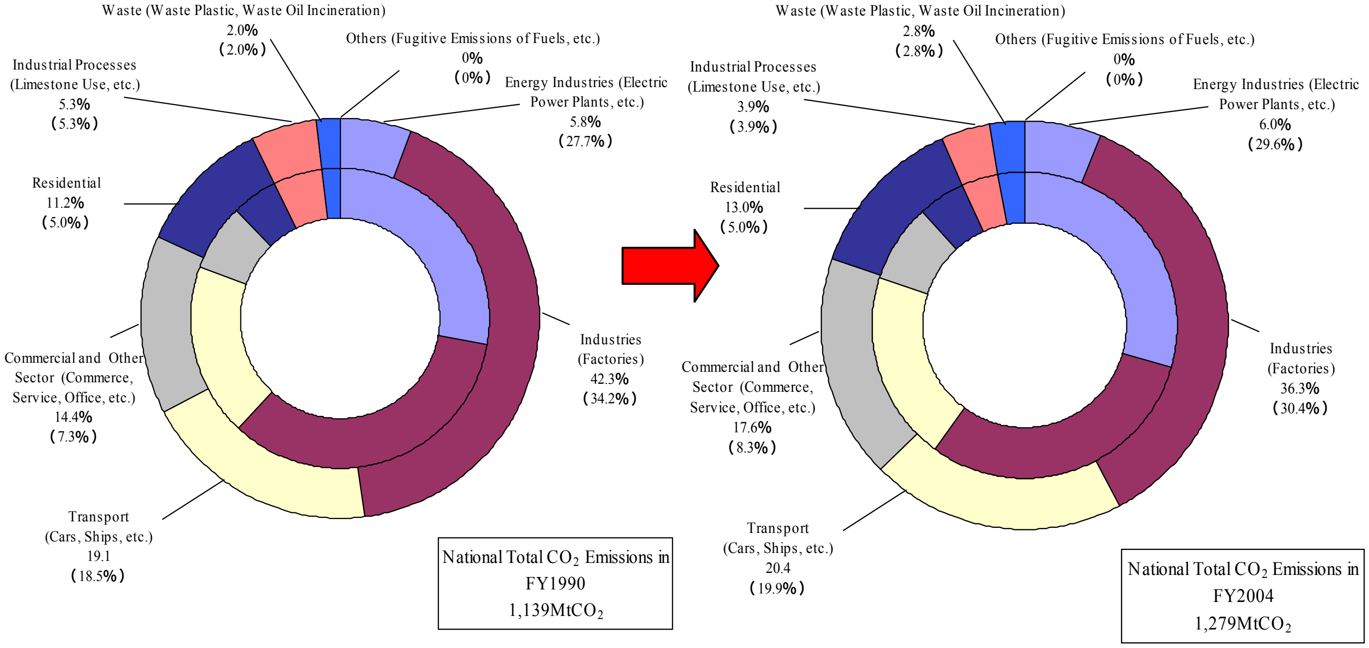


○93% of CO$_2$ emissions were from energy consumption. Rest of them were from industrial process and waste.

○Emissions from Household sector including private vehicle and municipal solid waste were accounted about 20%. Rest of the 80% emissions of the total were from Business and Public Sector.

8.4.3. Sectoral Breakdown of Greenhouse Gas Emissions in FY2004

- **Carbon Dioxide (CO$_2$)**

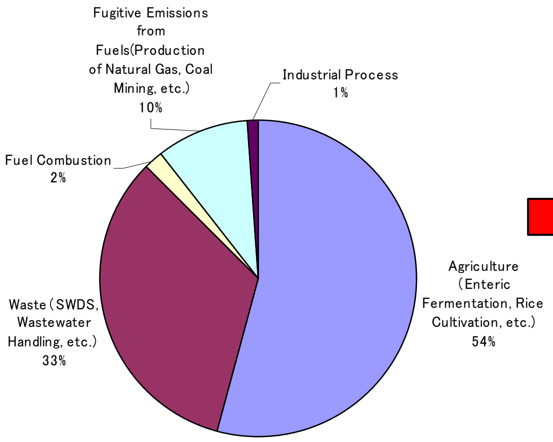


Note 1: The inner circle shows the proportion of the direct emissions by each sector (values in parentheses), and the outer circle shows the proportion of the emissions including the direct emissions and indirect emissions from power generation by electric utilities and steam generation (industrial steam generation and district heat supply) allocated to final

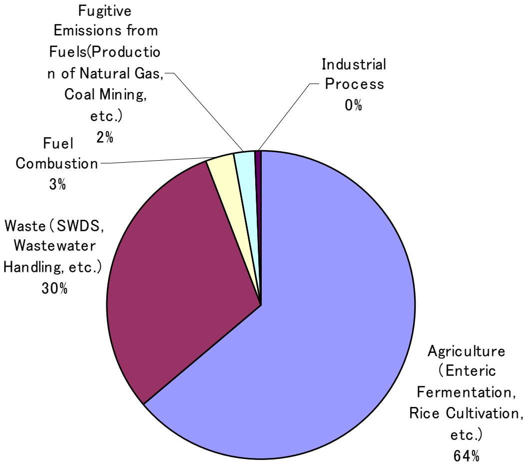
demand sector in accordance with the electric and heat consumption (values without parenthesis).

Note 2: Total for sectoral breakdown may not sum to 100% due to statistical error and rounding off.

- **Methane (CH_4)**

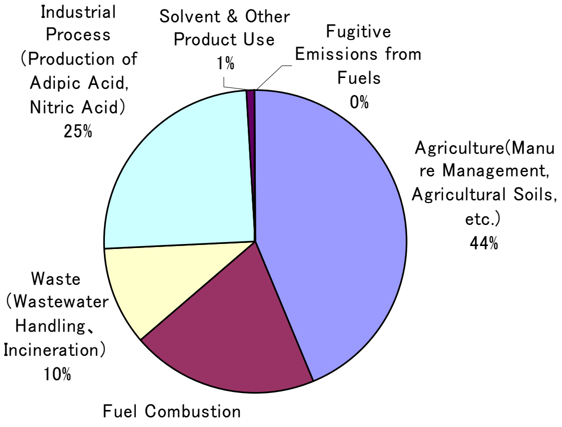


National Total CH_4 Emissions in FY1990 33.2Mt （CO_2eq.）

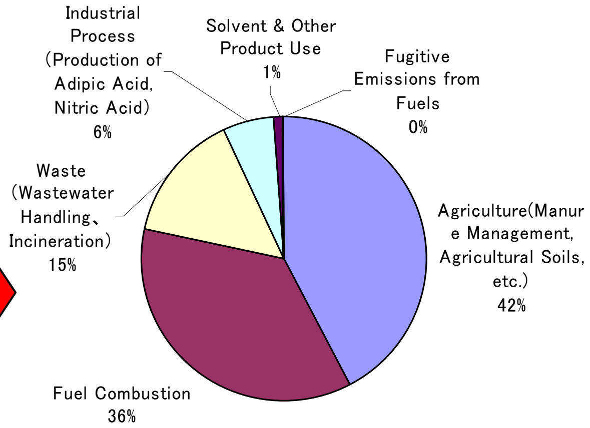


National Total CH_4 Emissions in FY2004 24.4Mt （CO_2eq.）

- **Nitrous Oxide (N_2O)**

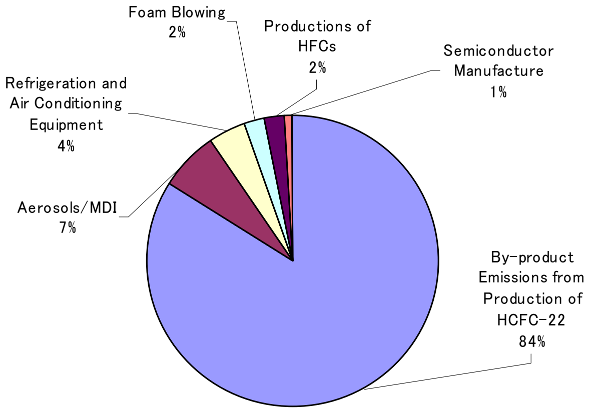


National Total N_2O Emissions in FY1990 33.2Mt （CO2eq.）

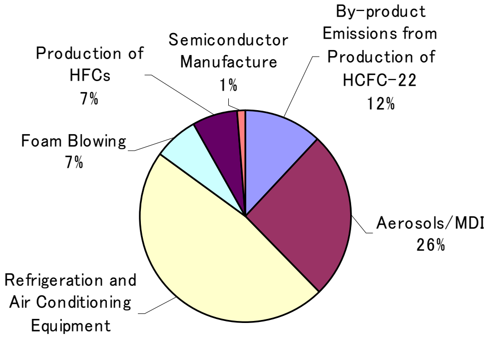


National Total N_2O Emissions in FY2004 28.4Mt （CO2eq.）

- **Hydrofluorocarbons (HFCs)**

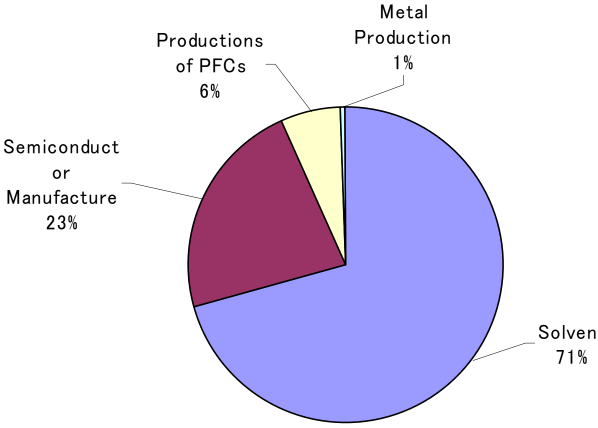


National Total HFC
Emissions in 1995
20.2Mt（CO_2eq）

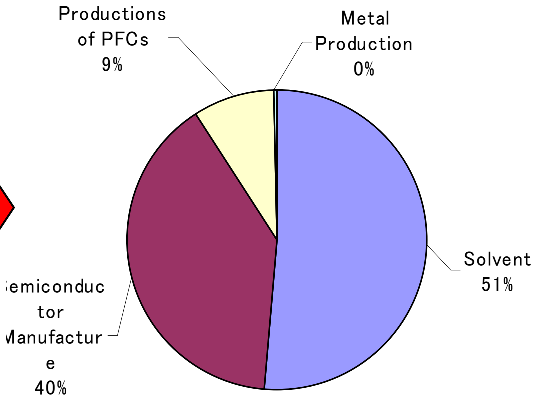


National Total HFC
Emissions in 2004
8.5Mt（CO_2eq）

- **Perfluorocarbons (PFCs)**

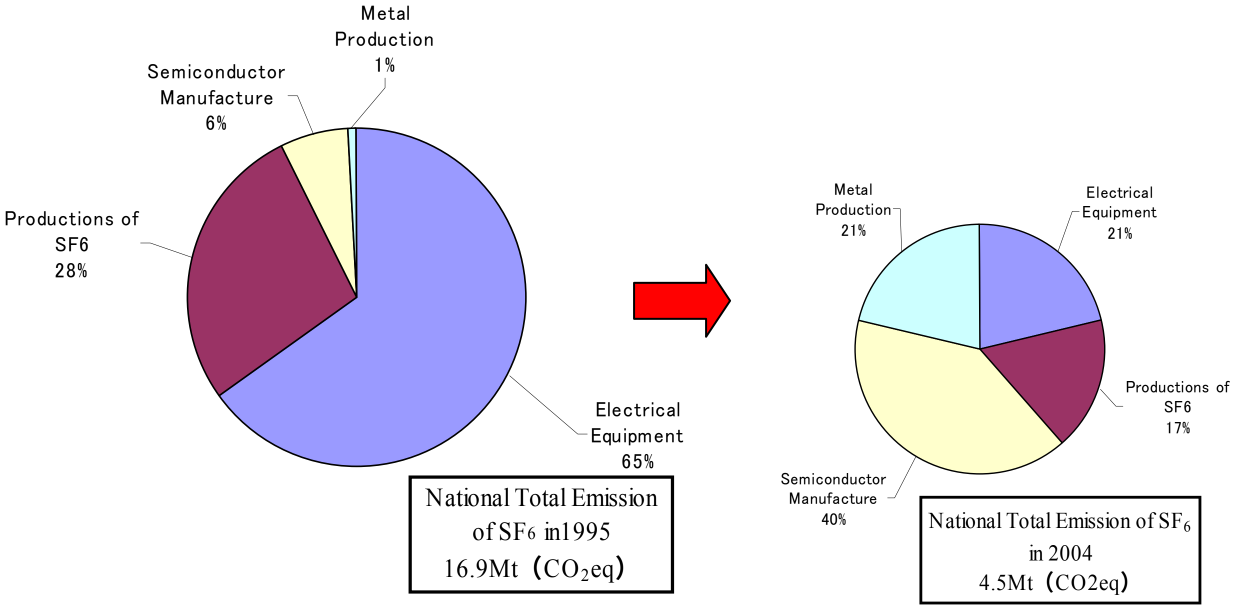


National Total PFC
Emissions in 1995
12.6Mt（CO_2eq）



National Total PFC
Emissions in 2004
9.9Mt（CO_2eq）

- **Sulfur Hexafluoride (SF_6)**



National Total Emission of SF6 in1995
16.9Mt （CO_2eq）

National Total Emission of SF_6 in 2004
4.5Mt （CO2eq）

Annex 9. Hierarchical Structure of Japan’s National GHG Inventory File System

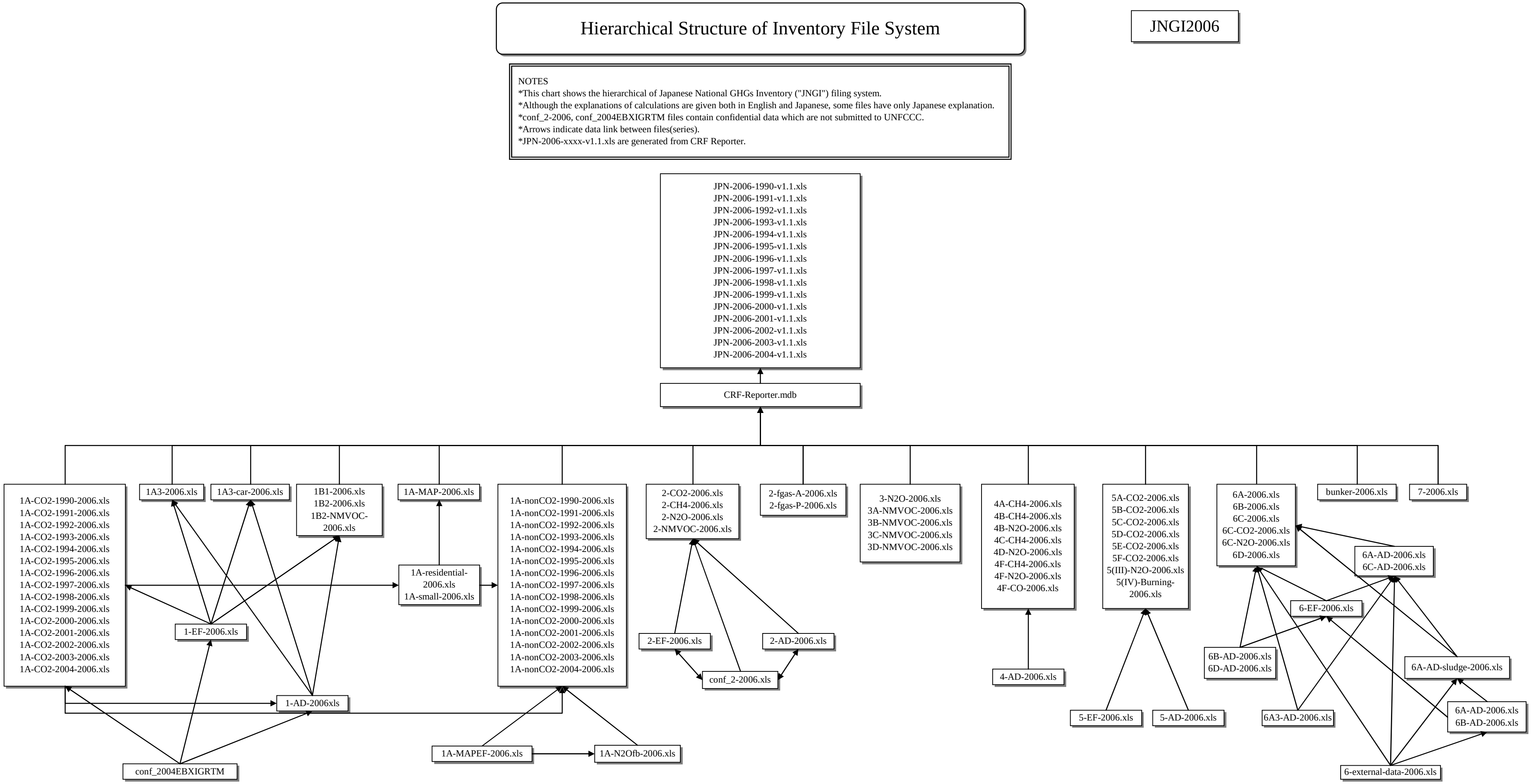
Multiple MS Excel files have been used when estimating Japanese inventory. The explanation of each MS Excel file and the hierarchical structure of Japanese National GHGs Inventory (JNGI) file system are shown below.

Table 1 Explanation of each MS Excel file

category	file name	contents
	CRF-1990-v01-JPN-2006.xls ～ CRF-2004-v01-JPN-2006.xls	Common reporting format provided by UNFCCC secretariat
1. Energy	1A3-2006.xls	GHGs emissions from transport sector (except Non-CO_2 from Car)
	1A3-car-2006.xls	Non-CO_2 emissions from car
	1A-nonCO2-1990-2006.xls ～ 1A-nonCO2-2004-2006.xls	Non-CO_2 emissions from stationary facilities
	1A-CO2-1990-2006.xls ～ 1A-CO2-2004-2006.xls	CO_2 emissions from fuel combustions at stationary facilities
	1-AD-2006.xls	Activity Data of Caotegory1 (except Energy Balance Sheet)
	1A-MAP-2006.xls	Emissions of Non-CO_2 from stationary combustion
	1A-MAPEF-2006.xls	Emission Factors of Non-CO2 from stationary combustion
	1A-N2Ofb-2006.xls	N_2O Emissions from fluidized-bed boilers
	1A-residential-2006.xls	Emissions of Non-CO_2 from Residential Sector
	1A-small-2006.xls	Emissions of Non-CO_2 from Commercial and other sector
	1B1-2006.xls	GHGs fugitive emissions from coal production
	1B2-2006.xls	GHGs fugitive emissions from oil & gas production
	1B2-NMVOC-2006.xls	NMVOC fugitive emissions from oil facilities
	1-EF-2006.xls	Emission Factors of Category1
	conf_2004EBXIGRTM.xls	Energy balance sheet
2. Industrial Processes	CONF_2-2006.xls	Confidential Data of Category2 (Industrial Processes)
	2-AD-2006.xls	Activity Data of Caotegory2 (except F-gas)
	2-CH4-2006.xls	CH_4 emissions from Category2 (Industrial Processes)
	2-CO2-2006.xls	CO_2 emissions from Category2 (Industrial Processes)
	2-EF-2006.xls	Emission Factors of Category2
	2-Fgas-A-2006.xls	F-gas (HFCs, PFCs, SF_6) actual emissions
	2-Fgas-P-2006.xls	F-gas (HFCs, PFCs, SF_6) potential emissions
	2-N2O-2006.xls	N_2O emissions from Category2 (Industrial Processes)
	2-NMVOC-2006.xls	NMVOC emissions from Category2 (Industrial Processes)
3. Solvent and Other Product Use	3A-NMVOC-2006.xls	NMVOC emissions from paint application use
	3B-NMVOC-2006.xls	NMVOC emissions from dry cleaning & Degreasing
	3C-NMVOC-2006.xls	NMVOC emissions from paint production, ink production & use, polyethylene laminate, solvent-type adhesive use and gum solvent use
	3D-NMVOC-2006.xls	NMVOC emissions from other solvent
	3-N2O-2006.xls	N_2O emissions from anesthesia

Table 2 Explanation of each MS Excel file (continued)

category	file name	contents
4. Agriculture	4A-CH4-2006.xls	CH_4 emissions from enteric fermentation
	4-AD-2006.xls	Activity Data of Caotegory4
	4B-CH4-2006.xls	CH_4 emissions from manure management
	4B-N2O-2006.xls	N_2O emissions from manure management
	4C-CH4-2006.xls	CH_4 emissions from rice cultivation
	4D-N2O-2006.xls	N_2O emissions from agricultural soils
	4F-CH4-2006.xls	CH_4 emissions from field burning of agricultural residues
	4F-CO-2006.xls	CO emissions from field burning of agricultural residues
	4F-N2O-2006.xls	N_2O emissions from field burning of agricultural residues
5. LULUCF	5(III)-2006.xls	N_2O emissions from disturbance associated with land use conversion to cropland
	5(V)-2006.xls	GHGs (CH_4, N_2O, CO, NO_x) emission from biomass burning
	5A-CO2-2006.xls	CO_2 emissions and removals from forest land
	5-AD-2006.xls	Area of land and land use change (Activity data for Category 5)
	5B-CO2-2006.xls	CO_2 emissions and removals from cropland
	5C-CO2-2006.xls	CO_2 emissions and removals from grassland
	5D-CO2-2006.xls	CO_2 emissions and removals from wetlands
	5E-CO2-2006.xls	CO_2 emissions and removals from settlements
	5-EF-2006.xls	Emission Factors of Category5
	5F-CO2-2006.xls	CO_2 emissions and removals from other land
6. Waste	6A3-AD-2006.xls	Activity data of solid waste disposal on land (other)
	6A-2006.xls	GHGs emissions from solid waste disposal on land
	6A-AD-2006.xls	Activity data of solid waste disposal on land
	6A-AD-sludge-2006.xls	Activity data of solid waste disposal on land (sludge)
	6B-2006.xls	GHGs emissions from wastewater handling
	6B-AD-2006.xls	Activity data of wastewater handling
	6C-2006.xls	GHGs emissions from waste incineration (exclude CO_2, N_2O)
	6C-AD-2006.xls	Activity data of waste incineration
	6C-CO2-2006.xls	CO_2 emissions from waste incineration
	6C-N2O-2006.xls	N_2O emissions from waste incineration
	6D-2006.xls	GHGs emissions from other waste
	6A-AD-2006.xls	Activity data of other waste
	6-EF-2006.xls	Emission Factors of Category6
	6-external data.xls	Summary of individual background data for waste sector
7. Other	7-2006.xls	CO Emissions from tobaccos
Memo Item	bunker-2006.xls	GHGs emissions from bunker fuels



Hierarchical Structure of Inventory File System

JNGI2006

NOTES
*This chart shows the hierarchical of Japanese National GHGs Inventory ("JNGI") filing system.
*Although the explanations of calculations are given both in English and Japanese, some files have only Japanese explanation.
*conf_2-2006, conf_2004EBXIGRTM files contain confidential data which are not submitted to UNFCCC.
*Arrows indicate data link between files(series).
*JPN-2006-xxxx-v1.1.xls are generated from CRF Reporter.

Figure 1 Hierarchical structure of Japan’s National GHG Inventory File System

Annex 10. Summary of Common Reporting Format

10.1. Emissions[1] and Removals in 1990

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1990
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,066,728.74**	**33,365.66**	**33,558.04**	**17,930.00**	**5,670.00**	**38,240.00**	**1,195,492.44**
1. Energy	**1,056,484.71**	**3,783.36**	**6,710.34**				**1,066,978.42**
A. Fuel Combustion (Sectoral Approach)	1,056,448.04	619.62	6,710.23				1,063,777.89
1. Energy Industries	315,132.65	17.65	643.86				315,794.17
2. Manufacturing Industries and Construction	367,576.51	152.56	1,232.14				368,961.21
3. Transport	211,053.69	249.85	4,557.57				215,861.11
4. Other Sectors	161,675.49	199.13	258.36				162,132.98
5. Other	1,009.70	0.44	18.29				1,028.42
B. Fugitive Emissions from Fuels	36.67	3,163.74	0.11				3,200.53
1. Solid Fuels	NE,NO	2,806.43	NE,NO				2,806.43
2. Oil and Natural Gas	36.67	357.31	0.11				394.10
2. Industrial Processes	**59,814.95**	**337.80**	**8,266.95**	**17,930.00**	**5,670.00**	**38,240.00**	**130,259.70**
A. Mineral Products	55,124.30	NA,NO	NA,NO				55,124.30
B. Chemical Industry	4,513.97	337.80	8,266.95	IE,NE,NO	IE,NE,NO	IE,NE,NO	13,118.72
C. Metal Production	176.68	IE,NA,NE,NO	NO	IE,NE	IE,NA,NE	IE,NA,NE	176.68
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				17,930.00	5,670.00	38,240.00	61,840.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**287.07**				**287.07**
4. Agriculture		**17,967.80**	**14,433.41**				**32,401.21**
A. Enteric Fermentation		7,641.73					7,641.73
B. Manure Management		3,120.57	5,542.94				8,663.51
C. Rice Cultivation		7,075.73					7,075.73
D. Agricultural Soils(3)		NA	8,786.55				8,786.55
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		129.77	103.92				233.69
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-72,027.77**	**198.91**	**378.28**				**-71,450.58**
A. Forest Land	-82,733.49	9.58	0.97				-82,722.94
B. Cropland	4,276.63	26.37	360.77				4,663.77
C. Grassland	2,446.74	3.71	0.38				2,450.83
D. Wetlands	67.93	1.61	0.16				69.70
E. Settlements	2,747.96	132.64	13.46				2,894.07
F. Other Land	1,166.45	25.01	2.54				1,194.00
G. Other		NE	NE				NE
6. Waste	**22,456.85**	**11,077.79**	**3,481.99**				**37,016.63**
A. Solid Waste Disposal on Land	NA,NE,NO	8,881.48					8,881.48
B. Waste-water Handling		2,133.41	1,550.99				3,684.40
C. Waste Incineration	21,754.02	62.90	1,910.88				23,727.79
D. Other	702.83	IE,NE,NO	20.12				722.95
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**5,112.90**						**5,112.90**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,266,943.03
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,195,492.44

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

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[1] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

10.2. Emissions[2] and Removals in 1991

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1991
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
SINK CATEGORIES	**CO_2 equivalent (Gg)**						
Total (Net Emissions) (1)	**1,086,010.35**	**33,132.69**	**33,080.86**	**18,070.00**	**6,370.00**	**43,498.00**	**1,220,161.91**
1. Energy	**1,063,678.10**	**3,551.41**	**6,989.83**				**1,074,219.34**
A. Fuel Combustion (Sectoral Approach)	1,063,624.38	629.62	6,989.67				1,071,243.66
1. Energy Industries	317,370.41	18.16	658.87				318,047.44
2. Manufacturing Industries and Construction	362,459.38	164.14	1,322.17				363,945.69
3. Transport	222,466.79	250.93	4,735.02				227,452.75
4. Other Sectors	160,323.71	195.96	255.28				160,774.95
5. Other	1,004.09	0.43	18.31				1,022.84
B. Fugitive Emissions from Fuels	53.72	2,921.80	0.16				2,975.68
1. Solid Fuels	NE,NO	2,538.33	NE,NO				2,538.33
2. Oil and Natural Gas	53.72	383.47	0.16				437.35
2. Industrial Processes	**61,432.75**	**328.47**	**7,539.75**	**18,070.00**	**6,370.00**	**43,498.00**	**137,238.97**
A. Mineral Products	56,769.09	NA,NO	NA,NO				56,769.09
B. Chemical Industry	4,500.16	328.47	7,539.75	IE,NE,NO	IE,NE,NO	IE,NE,NO	12,368.37
C. Metal Production	163.50	IE,NA,NE,NO	NO	IE,NE	IE,NA,NE	IE,NA,NE	163.50
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				18,070.00	6,370.00	43,498.00	67,938.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**356.85**				**356.85**
4. Agriculture		**18,089.52**	**14,299.22**				**32,388.74**
A. Enteric Fermentation		7,751.70					7,751.70
B. Manure Management		3,116.81	5,499.34				8,616.16
C. Rice Cultivation		7,094.10					7,094.10
D. Agricultural Soils(3)		NA	8,701.51				8,701.51
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		126.91	98.37				225.28
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-62,077.36**	**212.12**	**351.20**				**-61,514.04**
A. Forest Land	-72,295.92	7.18	0.73				-72,288.00
B. Cropland	3,561.77	14.91	331.18				3,907.86
C. Grassland	2,102.28	2.12	0.22				2,104.62
D. Wetlands	65.09	1.46	0.15				66.70
E. Settlements	3,253.42	157.75	16.01				3,427.18
F. Other Land	1,235.99	28.70	2.91				1,267.61
G. Other		NE	NE				NE
6. Waste	**22,976.86**	**10,951.17**	**3,544.01**				**37,472.04**
A. Solid Waste Disposal on Land	NA,NE,NO	8,799.91					8,799.91
B. Waste-water Handling		2,088.29	1,560.52				3,648.81
C. Waste Incineration	22,290.41	62.96	1,967.18				24,320.55
D. Other	686.45	IE,NE,NO	16.31				702.76
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**5,146.62**						**5,146.62**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,281,675.94
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,220,161.91

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

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[2] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

10.3. Emissions[3] and Removals in 1992

SUMMARY 2 SUMMARY REPORT FOR CO$_2$ EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1992
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO$_2$ (1)	CH$_4$	N$_2$O	HFCs (2)	PFCs (2)	SF$_6$ (2)	Total
	CO$_2$ equivalent (Gg)						
Total (Net Emissions) (1)	**1,084,753.31**	**32,863.39**	**33,356.89**	**19,750.00**	**6,370.00**	**47,800.00**	**1,224,893.59**
1. Energy	**1,071,776.62**	**3,316.47**	**7,374.58**				**1,082,467.67**
A. Fuel Combustion (Sectoral Approach)	1,071,719.62	662.14	7,374.41				1,079,756.17
1. Energy Industries	325,098.08	20.45	647.25				325,765.77
2. Manufacturing Industries and Construction	354,303.06	175.03	1,418.13				355,896.23
3. Transport	226,859.69	251.25	4,995.65				232,106.60
4. Other Sectors	164,472.68	214.95	295.41				164,983.04
5. Other	986.11	0.46	17.97				1,004.54
B. Fugitive Emissions from Fuels	57.00	2,654.33	0.17				2,711.50
1. Solid Fuels	NE,NO	2,267.52	NE,NO				2,267.52
2. Oil and Natural Gas	57.00	386.81	0.17				443.98
2. Industrial Processes	**61,775.86**	**303.51**	**7,452.41**	**19,750.00**	**6,370.00**	**47,800.00**	**143,451.77**
A. Mineral Products	57,236.94	NA,NO	NA,NO				57,236.94
B. Chemical Industry	4,380.50	303.51	7,452.41	IE,NE,NO	IE,NE,NO	IE,NE,NO	12,136.41
C. Metal Production	158.42	IE,NA,NE,NO	NO	IE,NE	IE,NA,NE	IE,NA,NE	158.42
D. Other Production	IE						IE
E. Production of Halocarbons and SF$_6$				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF$_6$ (2)				19,750.00	6,370.00	47,800.00	73,920.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**413.01**				**413.01**
4. Agriculture		**18,175.56**	**14,115.71**				**32,291.27**
A. Enteric Fermentation		7,793.32					7,793.32
B. Manure Management		3,089.85	5,447.13				8,536.98
C. Rice Cultivation		7,176.75					7,176.75
D. Agricultural Soils(3)		NA	8,577.86				8,577.86
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		115.64	90.72				206.36
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-73,225.52**	**227.47**	**331.46**				**-72,666.59**
A. Forest Land	-83,565.85	5.11	0.52				-83,560.22
B. Cropland	3,457.99	17.07	310.11				3,785.16
C. Grassland	2,010.33	2.49	0.25				2,013.07
D. Wetlands	195.45	4.67	0.47				200.60
E. Settlements	3,562.35	174.76	17.74				3,754.85
F. Other Land	1,114.21	23.37	2.37				1,139.96
G. Other		NE	NE				NE
6. Waste	**24,426.34**	**10,840.40**	**3,669.72**				**38,936.46**
A. Solid Waste Disposal on Land	NA,NE,NO	8,730.13					8,730.13
B. Waste-water Handling		2,046.98	1,544.17				3,591.15
C. Waste Incineration	23,727.45	63.29	2,108.79				25,899.52
D. Other	698.90	IE,NE,NO	16.76				715.66
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**5,023.44**						**5,023.44**

Total CO$_2$ Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,297,560.18
Total CO$_2$ Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,224,893.59

(1) For CO$_2$ from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO$_2$ from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO$_2$ emissions from LULUCF.

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[3] Potential emissions of HFCs, PFCs and SF$_6$ are reported due to the generation of CRF Reporter

10.4. Emissions[4] and Removals in 1993

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1993
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,071,385.40**	**32,660.53**	**33,015.27**	**21,310.00**	**8,860.00**	**45,410.00**	**1,212,641.19**
1. Energy	**1,065,138.73**	**3,135.04**	**7,455.90**				**1,075,729.67**
A. Fuel Combustion (Sectoral Approach)	1,065,085.47	664.48	7,455.74				1,073,205.69
1. Energy Industries	308,144.34	19.85	644.25				308,808.44
2. Manufacturing Industries and Construction	351,973.54	179.91	1,512.47				353,665.93
3. Transport	231,727.93	242.08	4,975.58				236,945.59
4. Other Sectors	172,320.58	222.20	305.74				172,848.53
5. Other	919.08	0.43	17.69				937.20
B. Fugitive Emissions from Fuels	53.27	2,470.56	0.16				2,523.99
1. Solid Fuels	NE,NO	2,075.76	NE,NO				2,075.76
2. Oil and Natural Gas	53.27	394.80	0.16				448.22
2. Industrial Processes	**60,722.07**	**302.84**	**7,302.85**	**21,310.00**	**8,860.00**	**45,410.00**	**143,907.75**
A. Mineral Products	56,413.96	NA,NO	NA,NO				56,413.96
B. Chemical Industry	4,156.65	302.84	7,302.85	IE,NE,NO	IE,NE,NO	IE,NE,NO	11,762.33
C. Metal Production	151.46	IE,NA,NE,NO	NO	IE,NE	IE,NA,NE	IE,NA,NE	151.46
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				21,310.00	8,860.00	45,410.00	75,580.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**411.66**				**411.66**
4. Agriculture		**18,261.91**	**13,870.83**				**32,132.74**
A. Enteric Fermentation		7,748.30					7,748.30
B. Manure Management		3,026.51	5,347.49				8,374.00
C. Rice Cultivation		7,368.45					7,368.45
D. Agricultural Soils(3)		NA	8,432.91				8,432.91
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		118.65	90.43				209.08
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-78,402.90**	**196.99**	**304.61**				**-77,901.30**
A. Forest Land	-86,941.08	28.10	2.85				-86,910.12
B. Cropland	2,794.22	6.06	285.23				3,085.51
C. Grassland	1,736.99	0.90	0.09				1,737.97
D. Wetlands	84.35	2.04	0.21				86.59
E. Settlements	2,656.30	130.63	13.26				2,800.19
F. Other Land	1,266.33	29.27	2.97				1,298.56
G. Other		NE	NE				NE
6. Waste	**23,927.49**	**10,763.75**	**3,669.42**				**38,360.66**
A. Solid Waste Disposal on Land	NA,NE,NO	8,706.08					8,706.08
B. Waste-water Handling		1,994.33	1,536.55				3,530.88
C. Waste Incineration	23,246.75	63.34	2,115.39				25,425.48
D. Other	680.75	IE,NE,NO	17.48				698.23
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**4,791.47**						**4,791.47**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,290,542.49
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,212,641.19

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

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[4] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

10.5. Emissions[5] and Removals in 1994

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1994
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,122,781.81**	**32,108.08**	**34,152.48**	**28,840.00**	**12,274.00**	**45,410.00**	**1,275,566.37**
1. Energy	**1,117,350.58**	**2,781.91**	**7,884.72**				**1,128,017.20**
A. Fuel Combustion (Sectoral Approach)	1,117,299.37	666.89	7,884.56				1,125,850.82
1. Energy Industries	345,713.37	21.52	701.65				346,436.53
2. Manufacturing Industries and Construction	359,766.54	194.00	1,685.09				361,645.63
3. Transport	243,681.03	243.33	5,181.24				249,105.59
4. Other Sectors	167,275.64	207.64	299.11				167,782.38
5. Other	862.80	0.41	17.47				880.68
B. Fugitive Emissions from Fuels	51.20	2,115.02	0.16				2,166.37
1. Solid Fuels	NE,NO	1,712.96	NE,NO				1,712.96
2. Oil and Natural Gas	51.20	402.05	0.16				453.41
2. Industrial Processes	**61,811.65**	**302.31**	**8,298.10**	**28,840.00**	**12,274.00**	**45,410.00**	**156,936.07**
A. Mineral Products	57,217.22	NA,NO	NA,NO				57,217.22
B. Chemical Industry	4,433.31	302.31	8,298.10	IE,NE,NO	IE,NE,NO	IE,NE,NO	13,033.73
C. Metal Production	161.12	IE,NA,NE,NO	NO	IE,NE	IE,NA,NE	IE,NA,NE	161.12
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				28,840.00	12,274.00	45,410.00	86,524.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**438.02**				**438.02**
4. Agriculture		**18,117.55**	**13,530.65**				**31,648.20**
A. Enteric Fermentation		7,660.50					7,660.50
B. Manure Management		2,956.18	5,220.04				8,176.22
C. Rice Cultivation		7,384.52					7,384.52
D. Agricultural Soils(3)		NA	8,222.37				8,222.37
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		116.35	88.24				204.59
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-83,609.02**	**159.91**	**214.35**				**-83,234.76**
A. Forest Land	-90,732.82	21.13	2.14				-90,709.54
B. Cropland	1,990.07	5.94	198.72				2,194.72
C. Grassland	1,783.95	0.89	0.09				1,784.93
D. Wetlands	93.35	2.23	0.23				95.80
E. Settlements	2,064.71	103.07	10.46				2,178.25
F. Other Land	1,191.72	26.66	2.71				1,221.09
G. Other		NE	NE				NE
6. Waste	**27,228.60**	**10,746.40**	**3,786.64**				**41,761.65**
A. Solid Waste Disposal on Land	NA,NE,NO	8,754.89					8,754.89
B. Waste-water Handling		1,926.93	1,485.90				3,412.83
C. Waste Incineration	26,526.69	64.58	2,284.97				28,876.24
D. Other	701.91	IE,NE,NO	15.77				717.68
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**4,855.47**						**4,855.47**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,358,801.13
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,275,566.37

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

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[5] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

10.6. Emissions and Removals in 1995

SUMMARY 2 SUMMARY REPORT FOR CO$_2$ EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1995
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO$_2$ (1)	CH$_4$	N$_2$O	HFCs (2)	PFCs (2)	SF$_6$ (2)	Total
	CO$_2$ equivalent (Gg)						
Total (Net Emissions) (1)	**1,131,439.04**	**31,414.57**	**34,560.23**	**20,232.99**	**12,573.16**	**16,921.62**	**1,247,141.60**
1. Energy	**1,129,246.95**	**2,506.34**	**8,547.46**				**1,140,300.75**
A. Fuel Combustion (Sectoral Approach)	1,129,195.98	756.64	8,547.30				1,138,499.92
1. Energy Industries	333,459.37	23.07	1,140.94				334,623.37
2. Manufacturing Industries and Construction	364,516.67	240.31	1,684.83				366,441.81
3. Transport	251,175.26	251.56	5,344.88				256,771.70
4. Other Sectors	179,175.77	240.82	357.36				179,773.95
5. Other	868.90	0.89	19.30				889.09
B. Fugitive Emissions from Fuels	50.98	1,749.70	0.16				1,800.83
1. Solid Fuels	NE,NO	1,344.68	NE,NO				1,344.68
2. Oil and Natural Gas	50.98	405.01	0.16				456.14
2. Industrial Processes	**61,846.66**	**303.30**	**8,212.71**	**20,232.99**	**12,573.16**	**16,921.62**	**120,090.43**
A. Mineral Products	57,157.86	NA,NO	NA,NO				57,157.86
B. Chemical Industry	4,525.47	303.30	8,212.71	IE,NE,NO	IE,NE,NO	IE,NE,NO	13,041.47
C. Metal Production	163.32	IE,NA,NE,NO	NO	IE,NE	72.46	119.50	355.28
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)				2,776.49	11,737.80	12,093.82	26,608.11
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**437.58**				**437.58**
4. Agriculture		**17,792.62**	**13,247.33**				**31,039.95**
A. Enteric Fermentation		7,575.17					7,575.17
B. Manure Management		2,895.37	5,111.60				8,006.97
C. Rice Cultivation		7,200.86					7,200.86
D. Agricultural Soils(3)		NA	8,047.03				8,047.03
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		121.22	88.70				209.92
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-88,041.46**	**147.70**	**191.35**				**-87,702.42**
A. Forest Land	-94,892.34	10.23	1.04				-94,881.08
B. Cropland	1,822.00	6.18	176.98				2,005.16
C. Grassland	1,624.09	0.93	0.09				1,625.12
D. Wetlands	221.99	5.37	0.55				227.91
E. Settlements	2,011.50	101.30	10.28				2,123.09
F. Other Land	1,171.30	23.68	2.40				1,197.38
G. Other		NE	NE				NE
6. Waste	**28,386.89**	**10,664.61**	**3,923.81**				**42,975.31**
A. Solid Waste Disposal on Land	NA,NE,NO	8,729.71					8,729.71
B. Waste-water Handling		1,869.46	1,456.51				3,325.97
C. Waste Incineration	27,719.06	65.44	2,451.07				30,235.57
D. Other	667.83	IE,NE,NO	16.24				684.06
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**5,042.00**						**5,042.00**

Total CO$_2$ Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,334,844.02
Total CO$_2$ Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,247,141.60

(1) For CO$_2$ from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO$_2$ from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO$_2$ emissions from LULUCF.

10.7. Emissions and Removals in 1996

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1996
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,236,609.35**	**30,674.54**	**35,895.20**	**19,866.14**	**15,262.30**	**17,504.34**	**1,355,811.87**
1. Energy	**1,142,278.79**	**2,490.80**	**9,006.35**				**1,153,775.94**
A. Fuel Combustion (Sectoral Approach)	1,142,229.36	786.13	9,006.20				1,152,021.69
1. Energy Industries	334,693.36	25.11	1,161.77				335,880.24
2. Manufacturing Industries and Construction	372,505.35	277.01	1,931.11				374,713.47
3. Transport	256,806.58	256.04	5,592.52				262,655.15
4. Other Sectors	177,312.16	227.11	300.91				177,840.18
5. Other	911.91	0.87	19.87				932.65
B. Fugitive Emissions from Fuels	49.42	1,704.67	0.15				1,754.24
1. Solid Fuels	NE,NO	1,297.15	NE,NO				1,297.15
2. Oil and Natural Gas	49.42	407.52	0.15				457.09
2. Industrial Processes	**61,522.68**	**292.73**	**9,220.07**	**19,866.14**	**15,262.30**	**17,504.34**	**123,668.26**
A. Mineral Products	56,859.92	NA,NO	NA,NO				56,859.92
B. Chemical Industry	4,495.60	292.73	9,220.07	IE,NE,NO	IE,NE,NO	IE,NE,NO	14,008.39
C. Metal Production	167.16	IE,NA,NE,NO	NO	IE,NE	65.78	143.40	376.34
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 [2]				3,795.86	14,188.53	13,178.44	31,162.83
G. Other	NO	NO	NO	NE,NO	NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**420.94**				**420.94**
4. Agriculture		**17,392.63**	**13,003.48**				**30,396.12**
A. Enteric Fermentation		7,518.23					7,518.23
B. Manure Management		2,851.35	5,044.00				7,895.35
C. Rice Cultivation		6,906.99					6,906.99
D. Agricultural Soils [3]		NA	7,874.07				7,874.07
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		116.06	85.41				201.47
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry [1]	**2,916.90**	**NE**	**157.60**				**3,074.50**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	1,419.84	NE	157.60				1,577.44
C. Grassland	1,450.22	NE	NE				1,450.22
D. Wetlands	8.52	NE	NE,NO				8.52
E. Settlements	-60.75	NE	NE				-60.75
F. Other Land	99.07	NE	NE				99.07
G. Other		NE	NE				NE
6. Waste	**29,890.98**	**10,498.38**	**4,086.77**				**44,476.12**
A. Solid Waste Disposal on Land	NA,NE,NO	8,599.05					8,599.05
B. Waste-water Handling		1,833.03	1,466.70				3,299.72
C. Waste Incineration	29,250.51	66.30	2,603.38				31,920.19
D. Other	640.47	IE,NE,NO	16.69				657.16
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: [4]							
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	**5,058.41**						**5,058.41**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry [5]	1,352,737.37
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry [5]	1,355,811.87

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

[4] See footnote 8 to table Summary 1.A.

[5] These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

10.8. Emissions and Removals in 1997

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS (Sheet 1 of 1)

Inventory 1997
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,230,531.68**	**29,578.40**	**36,422.95**	**19,787.80**	**16,945.83**	**14,778.36**	**1,348,045.02**
1. Energy	**1,136,818.64**	**2,220.73**	**9,167.63**				**1,148,207.00**
A. Fuel Combustion (Sectoral Approach)	1,136,770.61	795.69	9,167.48				1,146,733.78
1. Energy Industries	329,643.92	25.51	1,173.73				330,843.17
2. Manufacturing Industries and Construction	370,905.55	289.86	2,070.13				373,265.55
3. Transport	258,799.14	257.13	5,604.63				264,660.90
4. Other Sectors	176,523.19	222.30	299.23				177,044.72
5. Other	898.80	0.88	19.76				919.45
B. Fugitive Emissions from Fuels	48.03	1,425.04	0.15				1,473.22
1. Solid Fuels	NE,NO	1,006.86	NE,NO				1,006.86
2. Oil and Natural Gas	48.03	418.18	0.15				466.36
2. Industrial Processes	**60,029.98**	**241.64**	**9,742.87**	**19,787.80**	**16,945.83**	**14,778.36**	**121,526.47**
A. Mineral Products	55,420.95	NA,NO	NA,NO				55,420.95
B. Chemical Industry	4,443.09	241.64	9,742.87	IE,NE,NO	IE,NE,NO	IE,NE,NO	14,427.60
C. Metal Production	165.94	IE,NA,NE,NO	NO	IE,NE	60.52	191.20	417.66
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 [(2)]				4,712.31	15,468.31	12,005.96	32,186.58
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**404.60**				**404.60**
4. Agriculture		**16,934.72**	**12,808.73**				**29,743.45**
A. Enteric Fermentation		7,472.96					7,472.96
B. Manure Management		2,802.40	4,989.02				7,791.42
C. Rice Cultivation		6,547.69					6,547.69
D. Agricultural Soils[(3)]		NA	7,736.53				7,736.53
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		111.66	83.18				194.84
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[(1)]	**2,605.02**	**NE**	**140.14**				**2,745.16**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	1,263.16	NE	140.14				1,403.30
C. Grassland	1,281.76	NE	NE				1,281.76
D. Wetlands	1.95	NE	NE,NO				1.95
E. Settlements	-78.69	NE	NE				-78.69
F. Other Land	136.84	NE	NE				136.84
G. Other		NE	NE				NE
6. Waste	**31,078.04**	**10,181.30**	**4,158.99**				**45,418.34**
A. Solid Waste Disposal on Land	NA,NE,NO	8,329.63					8,329.63
B. Waste-water Handling		1,786.03	1,467.12				3,253.14
C. Waste Incineration	30,422.81	65.65	2,674.46				33,162.92
D. Other	655.23	IE,NE,NO	17.41				672.64
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: [(4)]							
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	**5,211.03**						**5,211.03**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry [(5)]	1,345,299.86
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry [(5)]	1,348,045.02

[(1)] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[(2)] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

[(3)] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

[(4)] See footnote 8 to table Summary 1.A.

[(5)] These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

10.9. Emissions and Removals in 1998

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS (Sheet 1 of 1)

Inventory 1998
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 [(1)]**	**CH_4**	**N_2O**	**HFCs [(2)]**	**PFCs [(2)]**	**SF_6 [(2)]**	**Total**
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,194,174.58**	**28,740.96**	**35,015.77**	**19,269.26**	**16,626.94**	**13,392.55**	**1,307,220.07**
1. Energy	**1,106,424.85**	**2,063.94**	**9,131.90**				**1,117,620.68**
A. Fuel Combustion (Sectoral Approach)	1,106,382.06	775.67	9,131.77				1,116,289.50
1. Energy Industries	319,283.34	25.46	1,168.38				320,477.18
2. Manufacturing Industries and Construction	351,555.81	280.15	2,021.40				353,857.36
3. Transport	257,779.33	247.59	5,623.77				263,650.69
4. Other Sectors	176,917.54	221.68	298.83				177,438.04
5. Other	846.04	0.80	19.40				866.23
B. Fugitive Emissions from Fuels	42.79	1,288.26	0.13				1,331.18
1. Solid Fuels	NE,NO	872.46	NE,NO				872.46
2. Oil and Natural Gas	42.79	415.81	0.13				458.72
2. Industrial Processes	**54,390.76**	**226.58**	**8,577.87**	**19,269.26**	**16,626.94**	**13,392.55**	**112,483.97**
A. Mineral Products	50,339.77	NA,NO	NA,NO				50,339.77
B. Chemical Industry	3,905.71	226.58	8,577.87	IE,NE,NO	IE,NE,NO	IE,NE,NO	12,710.16
C. Metal Production	145.29	IE,NA,NE,NO	NO	IE,NE	54.49	406.30	606.08
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 [(2)]				5,219.67	15,182.45	10,883.05	31,285.17
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**377.05**				**377.05**
4. Agriculture		**16,625.04**	**12,654.64**				**29,279.68**
A. Enteric Fermentation		7,438.25					7,438.25
B. Manure Management		2,744.51	4,940.29				7,684.80
C. Rice Cultivation		6,333.03					6,333.03
D. Agricultural Soils[(3)]		NA	7,631.30				7,631.30
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		109.24	83.05				192.30
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[(1)]	**2,263.29**	**NE**	**123.95**				**2,387.24**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	1,117.75	NE	123.95				1,241.70
C. Grassland	1,124.62	NE	NE				1,124.62
D. Wetlands	7.21	NE	NE,NO				7.21
E. Settlements	-118.05	NE	NE				-118.05
F. Other Land	131.76	NE	NE				131.76
G. Other		NE	NE				NE
6. Waste	**31,095.68**	**9,825.41**	**4,150.36**				**45,071.44**
A. Solid Waste Disposal on Land	NA,NE,NO	8,023.86					8,023.86
B. Waste-water Handling		1,739.01	1,437.65				3,176.66
C. Waste Incineration	30,486.56	62.54	2,695.24				33,244.33
D. Other	609.12	IE,NE,NO	17.47				626.59
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: [(4)]							
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	**4,788.16**						**4,788.16**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry [(5)]	1,304,832.82
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry [(5)]	1,307,220.07

[(1)] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[(2)] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

[(3)] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

[(4)] See footnote 8 to table Summary 1.A.

[(5)] These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

10.10. Emissions and Removals in 1999

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1999
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,231,121.51**	**28,033.92**	**28,903.55**	**19,764.83**	**14,926.87**	**9,112.95**	**1,331,863.63**
1. Energy	**1,143,605.44**	**2,071.90**	**9,730.87**				**1,155,408.20**
A. Fuel Combustion (Sectoral Approach)	1,143,567.32	786.00	9,730.75				1,154,084.07
1. Energy Industries	339,054.18	31.15	1,328.52				340,413.85
2. Manufacturing Industries and Construction	358,649.35	242.31	2,154.82				361,046.48
3. Transport	260,013.80	247.55	5,894.09				266,155.43
4. Other Sectors	185,032.12	264.50	334.90				185,631.51
5. Other	817.87	0.49	18.43				836.79
B. Fugitive Emissions from Fuels	38.12	1,285.90	0.12				1,324.14
1. Solid Fuels	NE,NO	865.69	NE,NO				865.69
2. Oil and Natural Gas	38.12	420.21	0.12				458.45
2. Industrial Processes	**53,983.12**	**219.48**	**2,000.86**	**19,764.83**	**14,926.87**	**9,112.95**	**100,008.11**
A. Mineral Products	49,594.65	NA,NO	NA,NO				49,594.65
B. Chemical Industry	4,241.98	219.48	2,000.86	IE,NE,NO	IE,NE,NO	IE,NE,NO	6,462.32
C. Metal Production	146.49	IE,NA,NE,NO	NO	IE,NE	33.13	645.30	824.92
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 (2)				5,507.83	13,620.04	6,938.05	26,065.92
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**362.53**				**362.53**
4. Agriculture		**16,297.95**	**12,512.34**				**28,810.29**
A. Enteric Fermentation		7,379.06					7,379.06
B. Manure Management		2,685.52	4,887.89				7,573.41
C. Rice Cultivation		6,125.26					6,125.26
D. Agricultural Soils(3)		NA	7,542.49				7,542.49
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		108.11	81.96				190.06
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**1,966.53**	**NE**	**111.64**				**2,078.17**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	980.51	NE	111.64				1,092.16
C. Grassland	1,027.24	NE	NE				1,027.24
D. Wetlands	5.65	NE	NE,NO				5.65
E. Settlements	-160.50	NE	NE				-160.50
F. Other Land	113.62	NE	NE				113.62
G. Other		NE	NE				NE
6. Waste	**31,566.42**	**9,444.60**	**4,185.31**				**45,196.32**
A. Solid Waste Disposal on Land	NA,NE,NO	7,689.26					7,689.26
B. Waste-water Handling		1,689.94	1,388.68				3,078.62
C. Waste Incineration	30,913.84	65.39	2,779.07				33,758.30
D. Other	652.58	IE,NE,NO	17.56				670.13
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**4,980.02**						**4,980.02**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,329,785.45
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,331,863.63

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

10.11. Emissions and Removals in 2000

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2000
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 (1)**	**CH_4**	**N_2O**	**HFCs (2)**	**PFCs (2)**	**SF_6 (2)**	**Total**
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,252,855.59**	**27,292.79**	**31,422.69**	**18,546.30**	**13,684.52**	**6,818.49**	**1,350,620.39**
1. Energy	**1,163,439.73**	**1,987.93**	**9,741.62**				**1,175,169.28**
A. Fuel Combustion (Sectoral Approach)	1,163,403.65	786.91	9,741.51				1,173,932.07
1. Energy Industries	347,086.10	31.44	1,373.38				348,490.93
2. Manufacturing Industries and Construction	369,907.25	248.37	2,168.97				372,324.59
3. Transport	259,230.32	248.39	5,842.58				265,321.29
4. Other Sectors	186,312.04	258.18	337.85				186,908.07
5. Other	867.93	0.53	18.74				887.20
B. Fugitive Emissions from Fuels	36.08	1,201.02	0.11				1,237.21
1. Solid Fuels	NE,NO	769.13	NE,NO				769.13
2. Oil and Natural Gas	36.08	431.89	0.11				468.09
2. Industrial Processes	**54,796.77**	**163.74**	**4,690.09**	**18,546.30**	**13,684.52**	**6,818.49**	**98,699.91**
A. Mineral Products	50,466.05	NA,NO	NA,NO				50,466.05
B. Chemical Industry	4,177.99	163.74	4,690.09	IE,NE,NO	IE,NE,NO	IE,NE,NO	9,031.81
C. Metal Production	152.73	IE,NA,NE,NO	NO	IE,NE	18.29	1,027.70	1,198.72
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 (2)				5,891.76	12,283.63	4,930.39	23,105.78
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**340.99**				**340.99**
4. Agriculture		**16,115.86**	**12,384.23**				**28,500.09**
A. Enteric Fermentation		7,344.65					7,344.65
B. Manure Management		2,644.16	4,844.01				7,488.17
C. Rice Cultivation		6,018.51					6,018.51
D. Agricultural Soils(3)		NA	7,459.04				7,459.04
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		108.54	81.18				189.72
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**1,706.08**	**NE**	**98.16**				**1,804.24**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	868.26	NE	98.16				966.42
C. Grassland	934.42	NE	NE				934.42
D. Wetlands	5.21	NE	NE,NO				5.21
E. Settlements	-188.41	NE	NE				-188.41
F. Other Land	86.60	NE	NE				86.60
G. Other		NE	NE				NE
6. Waste	**32,913.01**	**9,025.27**	**4,167.60**				**46,105.89**
A. Solid Waste Disposal on Land	NA,NE,NO	7,308.40					7,308.40
B. Waste-water Handling		1,640.77	1,365.12				3,005.89
C. Waste Incineration	32,257.09	76.10	2,783.83				35,117.02
D. Other	655.91	IE,NE,NO	18.66				674.57
7. Other ***(as specified in Summary 1.A)***	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	36,605.54	44.90	332.18				36,982.62
Aviation	19,543.48	11.61	191.78				19,746.88
Marine	17,062.06	33.29	140.40				17,235.75
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**5,139.83**						**5,139.83**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,348,816.15
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,350,620.39

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

10.12. Emissions and Removals in 2001

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2001
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 (1)**	**CH_4**	**N_2O**	**HFCs (2)**	**PFCs (2)**	**SF_6 (2)**	**Total**
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,237,671.82**	**26,407.26**	**28,212.01**	**15,759.90**	**11,507.12**	**5,666.24**	**1,325,224.35**
1. Energy	**1,150,261.40**	**1,773.50**	**10,031.30**				**1,162,066.20**
A. Fuel Combustion (Sectoral Approach)	1,150,228.90	769.00	10,031.20				1,161,029.10
1. Energy Industries	338,893.40	31.13	1,400.24				340,324.77
2. Manufacturing Industries and Construction	360,116.49	239.68	2,309.67				362,665.85
3. Transport	261,885.74	239.98	5,964.20				268,089.93
4. Other Sectors	188,428.41	257.66	338.12				189,024.19
5. Other	904.86	0.55	18.96				924.37
B. Fugitive Emissions from Fuels	32.50	1,004.50	0.10				1,037.10
1. Solid Fuels	NE,NO	570.30	NE,NO				570.30
2. Oil and Natural Gas	32.50	434.20	0.10				466.80
2. Industrial Processes	**53,078.61**	**130.98**	**1,414.89**	**15,759.90**	**11,507.12**	**5,666.24**	**87,557.74**
A. Mineral Products	49,081.14	NA,NO	NA,NO				49,081.14
B. Chemical Industry	3,857.00	130.98	1,414.89	IE,NE,NO	IE,NE,NO	IE,NE,NO	5,402.86
C. Metal Production	140.47	IE,NA,NE,NO	NO	IE,NE	16.26	1,147.20	1,303.93
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 (2)				6,050.48	10,367.16	3,730.34	20,147.98
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**343.60**				**343.60**
4. Agriculture		**15,943.67**	**12,250.11**				**28,193.78**
A. Enteric Fermentation		7,305.16					7,305.16
B. Manure Management		2,622.92	4,807.01				7,429.93
C. Rice Cultivation		5,907.16					5,907.16
D. Agricultural Soils(3)		NA	7,363.17				7,363.17
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		108.43	79.93				188.36
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**1,525.76**	**NE**	**87.13**				**1,612.89**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	790.18	NE	87.13				877.31
C. Grassland	857.11	NE	NE				857.11
D. Wetlands	5.50	NE	NE,NO				5.50
E. Settlements	-222.99	NE	NE				-222.99
F. Other Land	95.97	NE	NE				95.97
G. Other		NE	NE				NE
6. Waste	**32,806.05**	**8,559.12**	**4,084.98**				**45,450.15**
A. Solid Waste Disposal on Land	NA,NE,NO	6,910.57					6,910.57
B. Waste-water Handling		1,586.46	1,328.78				2,915.24
C. Waste Incineration	32,175.52	62.08	2,735.85				34,973.46
D. Other	630.53	IE,NE,NO	20.35				650.88
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**4,692.00**						**4,692.00**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,323,611.47
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,325,224.35

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

10.13. Emissions and Removals in 2002

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2002
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,270,588.67**	**25,393.02**	**28,100.93**	**12,896.31**	**9,844.19**	**5,282.98**	**1,352,106.10**
1. Energy	**1,185,775.72**	**1,359.58**	**10,151.37**				**1,197,286.68**
A. Fuel Combustion (Sectoral Approach)	1,185,744.72	780.16	10,151.28				1,196,676.16
1. Energy Industries	365,941.29	32.72	1,457.35				367,431.36
2. Manufacturing Industries and Construction	366,908.21	240.02	2,319.59				369,467.82
3. Transport	256,758.85	238.65	6,006.07				263,003.57
4. Other Sectors	195,241.67	268.20	349.41				195,859.27
5. Other	894.70	0.57	18.86				914.14
B. Fugitive Emissions from Fuels	31.00	579.42	0.10				610.52
1. Solid Fuels	NE,NO	118.34	NE,NO				118.34
2. Oil and Natural Gas	31.00	461.08	0.10				492.18
2. Industrial Processes	**50,651.43**	**124.34**	**1,238.77**	**12,896.31**	**9,844.19**	**5,282.98**	**80,038.03**
A. Mineral Products	46,846.41	NA,NO	NA,NO				46,846.41
B. Chemical Industry	3,657.13	124.34	1,238.77	IE,NE,NO	IE,NE,NO	IE,NE,NO	5,020.24
C. Metal Production	147.89	IE,NA,NE,NO	NO	IE,NE	15.10	1,123.30	1,286.29
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 (2)				6,411.89	8,785.49	3,323.18	18,520.56
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**334.05**				**334.05**
4. Agriculture		**15,769.38**	**12,152.36**				**27,921.74**
A. Enteric Fermentation		7,271.70					7,271.70
B. Manure Management		2,604.77	4,779.67				7,384.44
C. Rice Cultivation		5,788.92					5,788.92
D. Agricultural Soils(3)		NA	7,295.22				7,295.22
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		103.98	77.48				181.46
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**1,297.11**	**NE**	**77.78**				**1,374.89**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	704.43	NE	77.78				782.21
C. Grassland	800.78	NE	NE				800.78
D. Wetlands	3.50	NE	NE,NO				3.50
E. Settlements	-249.09	NE	NE				-249.09
F. Other Land	37.49	NE	NE				37.49
G. Other		NE	NE				NE
6. Waste	**32,864.40**	**8,139.73**	**4,146.59**				**45,150.71**
A. Solid Waste Disposal on Land	NA,NE,NO	6,530.02					6,530.02
B. Waste-water Handling		1,546.67	1,303.93				2,850.60
C. Waste Incineration	32,287.36	63.04	2,823.30				35,173.70
D. Other	577.05	IE,NE,NO	19.35				596.40
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
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	**4,886.56**						**4,886.56**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry (5)	1,350,731.21
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,352,106.10

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

10.14. Emissions and Removals in 2003

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2003
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,280,432.35**	**24,791.72**	**28,122.42**	**12,275.58**	**8,974.52**	**4,734.31**	**1,359,330.89**
1. Energy	**1,193,954.78**	**1,307.87**	**10,195.07**				**1,205,457.72**
A. Fuel Combustion (Sectoral Approach)	1,193,920.25	743.84	10,194.96				1,204,859.06
1. Energy Industries	382,645.00	33.42	1,494.27				384,172.69
2. Manufacturing Industries and Construction	367,366.25	241.63	2,319.06				369,926.94
3. Transport	254,621.01	234.30	6,030.44				260,885.75
4. Other Sectors	188,352.32	233.90	332.07				188,918.29
5. Other	935.67	0.59	19.13				955.39
B. Fugitive Emissions from Fuels	34.52	564.03	0.11				598.66
1. Solid Fuels	NE,NO	93.86	NE,NO				93.86
2. Oil and Natural Gas	34.52	470.17	0.11				504.80
2. Industrial Processes	**49,904.82**	**116.72**	**1,259.55**	**12,275.58**	**8,974.52**	**4,734.31**	**77,265.51**
A. Mineral Products	46,382.43	NA,NO	NA,NO				46,382.43
B. Chemical Industry	3,377.39	116.72	1,259.55	IE,NE,NO	IE,NE,NO	IE,NE,NO	4,753.66
C. Metal Production	145.01	IE,NA,NE,NO	NO	IE,NE	15.10	1,003.80	1,163.91
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 [2]				6,813.37	7,943.02	2,917.91	17,674.30
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**320.83**				**320.83**
4. Agriculture		**15,640.24**	**12,068.34**				**27,708.58**
A. Enteric Fermentation		7,176.15					7,176.15
B. Manure Management		2,576.76	4,753.35				7,330.11
C. Rice Cultivation		5,785.48					5,785.48
D. Agricultural Soils[3]		NA	7,240.27				7,240.27
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		101.85	74.72				176.57
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[1]	**1,070.15**	**NE**	**69.71**				**1,139.86**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	631.20	NE	69.71				700.91
C. Grassland	721.68	NE	NE				721.68
D. Wetlands	2.26	NE	NE,NO				2.26
E. Settlements	-281.44	NE	NE				-281.44
F. Other Land	-3.55	NE	NE				-3.55
G. Other		NE	NE				NE
6. Waste	**35,502.59**	**7,726.88**	**4,208.91**				**47,438.38**
A. Solid Waste Disposal on Land	NA,NE,NO	6,153.58					6,153.58
B. Waste-water Handling		1,492.39	1,287.56				2,779.95
C. Waste Incineration	34,986.06	80.91	2,902.04				37,969.01
D. Other	516.53	IE,NE,NO	19.31				535.84
7. Other ***(as specified in Summary 1.A)***	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: [4]							
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	**4,990.68**						**4,990.68**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry [5]	1,358,191.03
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry [5]	1,359,330.89

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

[4] See footnote 8 to table Summary 1.A.

[5] These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

10.15. Emissions and Removals in 2004

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2004
Submission 2006 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,280,031.74**	**24,423.04**	**28,450.55**	**8,500.51**	**9,914.98**	**4,463.57**	**1,355,784.39**
1. Energy	**1,192,900.57**	**1,295.25**	**10,207.89**				**1,204,403.71**
A. Fuel Combustion (Sectoral Approach)	1,192,865.53	746.19	10,207.78				1,203,819.50
1. Energy Industries	378,310.97	32.51	1,506.28				379,849.76
2. Manufacturing Industries and Construction	372,595.10	245.00	2,341.13				375,181.23
3. Transport	254,478.37	229.16	6,008.45				260,715.98
4. Other Sectors	186,507.02	238.87	332.58				187,078.47
5. Other	974.08	0.65	19.33				994.06
B. Fugitive Emissions from Fuels	35.04	549.05	0.11				584.21
1. Solid Fuels	NE,NO	66.51	NE,NO				66.51
2. Oil and Natural Gas	35.04	482.54	0.11				517.69
2. Industrial Processes	**50,374.33**	**115.92**	**1,657.60**	**8,500.51**	**9,914.98**	**4,463.57**	**75,026.92**
A. Mineral Products	46,917.11	NA,NO	NA,NO				46,917.11
B. Chemical Industry	3,308.42	115.92	1,657.60	IE,NE,NO	IE,NE,NO	IE,NE,NO	5,081.94
C. Metal Production	148.81	IE,NA,NE,NO	NO	IE,NE	14.78	956.00	1,119.58
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				1,573.80	882.00	764.80	3,220.60
F. Consumption of Halocarbons and SF_6 [2]				6,926.71	9,018.21	2,742.77	18,687.68
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**297.54**				**297.54**
4. Agriculture		**15,598.86**	**12,006.61**				**27,605.47**
A. Enteric Fermentation		7,141.03					7,141.03
B. Manure Management		2,549.06	4,732.22				7,281.28
C. Rice Cultivation		5,807.29					5,807.29
D. Agricultural Soils[3]		NA	7,200.44				7,200.44
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		101.48	73.94				175.43
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[1]	**853.76**	**NE**	**61.68**				**915.44**
A. Forest Land	IE,NA,NE	NE	IE,NE,NO				IE,NA,NE,NO
B. Cropland	549.50	NE	61.68				611.18
C. Grassland	631.24	NE	NE				631.24
D. Wetlands	6.00	NE	NE,NO				6.00
E. Settlements	-299.57	NE	NE				-299.57
F. Other Land	-33.40	NE	NE				-33.40
G. Other		NE	NE				NE
6. Waste	**35,903.07**	**7,413.01**	**4,219.23**				**47,535.30**
A. Solid Waste Disposal on Land	NA,NE,NO	5,832.26					5,832.26
B. Waste-water Handling		1,499.75	1,302.98				2,802.73
C. Waste Incineration	35,394.80	80.99	2,896.71				38,372.50
D. Other	508.26	IE,NE,NO	19.54				527.81
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA**	**NA**	**NA,NO**	**NA,NO**

Memo Items: [4]							
International Bunkers	39,089.79	47.51	355.21				39,492.51
Aviation	21,191.15	12.59	207.95				21,411.69
Marine	17,898.65	34.91	147.26				18,080.82
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**4,958.61**						**4,958.61**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry [5]	1,354,868.94
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry [5]	1,355,784.39

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.