CGER-REPORT

ISSN 1341-4356
CGER-I069-2006

National Greenhouse Gas Inventory Report of JAPAN

August, 2006

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

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Foreword

On the basis of paragraph 2 of Decision 13/CMP.1, the government of Japan submits report on Japan’s assigned amount pursuant to Article 3, paragraph 7 and 8 of the Kyoto Protocol. The report shall contain “Complete inventories” in line with paragraph 7 (a) of annex of decision 13/CMP.1.

This report is complementary information to the “Complete inventories” of the reports on Japan’s assigned amount mentioned above. The report also contains improvements from the Japan’s GHG inventories submitted to the UNFCCC secretariat in May 2006 in accordance with the Article 4 and 12 of the Convention, such as the improved estimation of methodologies based on the latest scientific knowledge. Improvements made after May 2006 are described in the chapter 10 of this report (section 10.4.1.1.b.).

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 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 from and removals by categories described under the *Revised 1996 IPCC guidelines*. Chapter 9 comprises current status of reporting of the emissions from categories not covered by *Revised 1996 IPCC guidelines*. Chapter 10 provides the explanations on improvement and recalculation (data revision, addition of new source, etc.) from since the submission in 2005 and in May, 2006.

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).

August, 2006

Climate Change Policy Division
Global Environment Bureau
Ministry of the Environment

Preface

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.

August, 2006

野尻幸宏

Yukihiro Nojiri
Manager
Greenhouse Gas Inventory Office of Japan (GIO)
Center for Global Environmental Research

Table of Contents

Executive Summary of National GHGs Inventory Report of Japan 2006

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

On the basis of paragraph 2 of Decision 13/CMP.1, the government of Japan submits report on Japan’s assigned amount pursuant to Article 3, paragraph 7 and 8 of the Kyoto Protocol. The report shall contain “Complete inventories” in line with paragraph 7 (a) of annex of decision 13/CMP.1.

This report is complementary information to the “Complete inventories” of the reports on Japan’s assigned amount mentioned above. The report also contains improvements from the Japan’s GHG inventories submitted to the UNFCCC secretariat in May 2006 in accordance withe the Article 4 and 12 of the Convention, such as the improved estimation of methodologies based on the latest scientific knowledge. Improvements made after May 2006 are described in the chapter 10 of this report (section 10.4.1.1.b.).

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 apply the *Good Practice Guidance (2000)* to their inventory reporting from 2001 and onward.

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 apply the *LULUCF-GPG* to their inventory reporting from 2005 and onward.

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][1]; except for carbon dioxide removals) was 1,355 million tons (in CO_2 equivalents), an increase by 12.0% from FY1990. Removals of carbon dioxide in FY2004 were 94.9 million tons[2], an increase by 26.9% 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 7.4%.

It should be noted that actual emissions of HFCs, PFCs and SF_6 in the period from 1990 to 1994 have not been estimated (NE)[3].

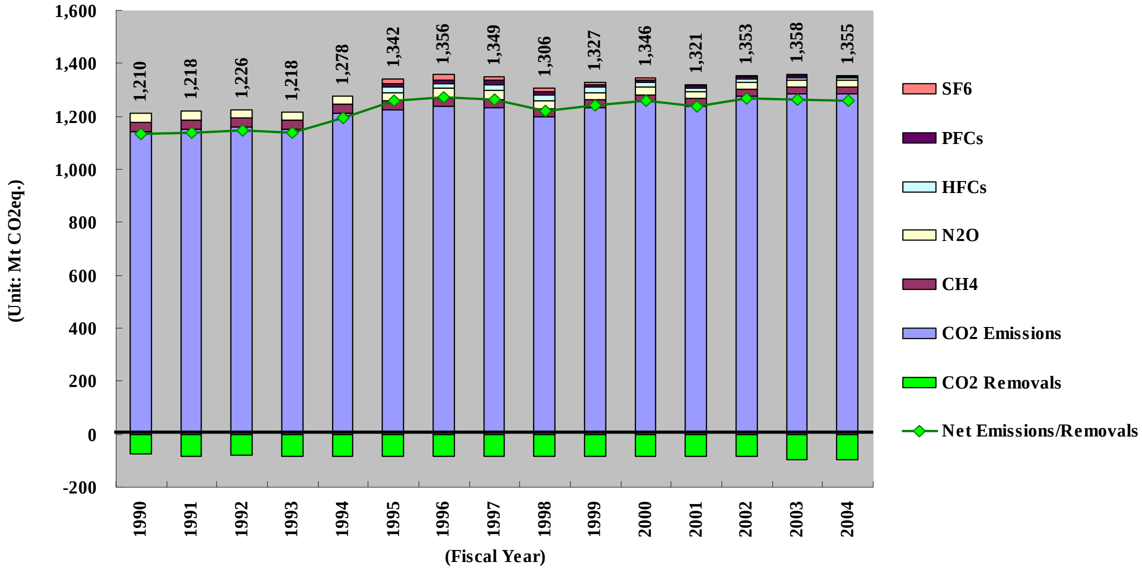

Figure 1 Trends in emission and removals of greenhouse gases in Japan

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[1] 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).

[2] 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 Decision 16/CMP.1 (Land use, land-use change and forestry) adopted in COP/MOP1.

[3] Potential emissions are reported in CRF for 1990-1994.

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

[Mt CO_2 eq.]	GWP	Base year of KP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 Emissions	1	1,144.1	1,144.1	1,153.0	1,160.6	1,153.0	1,212.8	1,226.4	1,239.3	1,234.8	1,198.6	1,233.7
Removals	1	-74.8	-74.8	-81.6	-81.0	-81.6	-81.9	-81.5	-85.4	-85.3	-84.9	-84.9
CH_4	21	33.5	33.5	33.2	33.0	32.7	32.0	31.0	30.3	29.2	28.4	27.7
N_2O	310	32.8	32.8	32.4	32.4	32.1	33.2	33.6	34.7	35.3	33.9	27.4
HFCs	HFC-134a：1,300 etc.	20.2	NE	NE	NE	NE	NE	20.2	19.8	19.8	19.3	19.8
PFCs	PFC-14：6,500 etc.	14.0	NE	NE	NE	NE	NE	14.0	14.5	15.5	12.6	9.7
SF_6	23,900	16.9	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1
Gross Total (excluding LULUCF)		1,261.4	1,210.3	1,218.4	1,225.9	1,217.6	1,277.9	1,342.1	1,356.0	1,349.3	1,306.0	1,327.4
Net Total (including LULUCF)		-	1,135.6	1,137.0	1,145.1	1,136.1	1,196.1	1,260.7	1,270.8	1,264.1	1,221.2	1,242.6

[Mt CO_2 eq.]	GWP	Base year of KP	2000	2001	2002	2003	2004	Emission increase from the base year of KP	Emission increase from 1990 (2004)	Emission increase from previous year (2004)
CO_2 Emissions	1	1,144.1	1,254.6	1,239.3	1,276.8	1,284.4	1,285.8	12.4%	12.4%	0.1%
Removals	1	-74.8	-85.0	-84.9	-85.4	-95.0	-94.9	26.9%	26.9%	-0.1%
CH_4	21	33.5	27.0	26.2	25.3	24.8	24.5	-27.0%	-27.0%	-1.2%
N_2O	310	32.8	29.9	26.4	26.0	25.8	25.8	-21.4%	-21.4%	0.1%
HFCs	HFC-134a：1,300 etc.	20.2	18.6	15.8	13.1	12.5	8.3	-58.7%	-	-33.3%
PFCs	PFC-14：6,500 etc.	14.0	8.6	7.2	6.5	6.2	6.3	-55.0%	-	2.0%
SF_6	23,900	16.9	6.8	5.7	5.3	4.7	4.5	-73.6%	-	-5.7%
Gross Total (excluding LULUCF)		1,261.4	1,345.5	1,320.6	1,353.0	1,358.3	1,355.2	7.4%	12.0%	-0.2%
Net Total (including LULUCF)		-	1,260.6	1,235.8	1,267.7	1,263.3	1,260.3	-	11.0%	-0.2%

*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% of total annual greenhouse gas emissions.

Removals by Land-use land use change and forestry in FY2004 were equivalent to 7.0% of total annual greenhouse gas emissions.

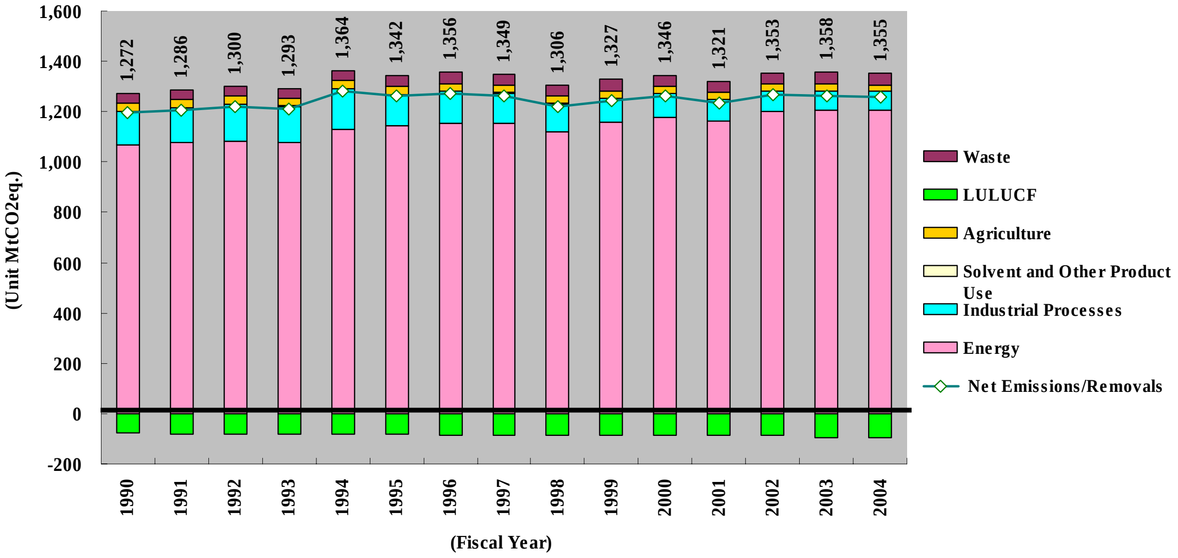

Figure 2 Trends in emissions and removals of greenhouse gases in each category

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
Energy	1,069.5	1,076.5	1,082.9	1,076.2	1,131.5	1,144.1	1,155.9	1,152.0	1,121.5	1,156.4
Industrial Processes	132.8	139.7	145.2	146.0	159.2	124.0	125.4	122.4	110.3	97.1
Solvent and Other Product Use	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Agriculture	32.3	32.3	32.2	32.1	31.6	31.0	30.3	29.7	29.2	28.7
Land Use, Land Use Change and Forestry	-74.6	-81.4	-80.8	-81.5	-81.7	-81.4	-85.2	-85.2	-84.8	-84.8
Waste	37.2	37.5	39.1	38.5	41.7	42.6	44.0	44.9	44.6	44.8
Net Emissions/Removals	1,197.5	1,204.9	1,219.0	1,211.7	1,282.7	1,260.7	1,270.8	1,264.1	1,221.2	1,242.6

[Mt CO_2 eq.]	2000	2001	2002	2003	2004
Energy	1,175.3	1,161.8	1,200.8	1,205.8	1,205.4
Industrial Processes	95.8	85.0	79.0	77.1	74.1
Solvent and Other Product Use	0.3	0.3	0.3	0.3	0.3
Agriculture	28.4	28.1	27.9	27.6	27.5
Land Use, Land Use Change and Forestry	-85.0	-84.8	-85.3	-95.0	-94.9
Waste	45.7	45.3	45.0	47.5	47.9
Net Emissions/Removals	1,260.6	1,235.8	1,267.7	1,263.3	1,260.3

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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 and SO_2)

Under UNFCCC, it is required to report emissions of indirect greenhouse gases (NO_X, CO and 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 3.8% compared to FY1990, and by 3.5% compared to the previous year.

Carbon monoxide (CO) emissions inFY2004 were 3,274 Gg, a decrease by 27.1% compared to FY1990, and by 3.7% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY2004 were 1,714 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.

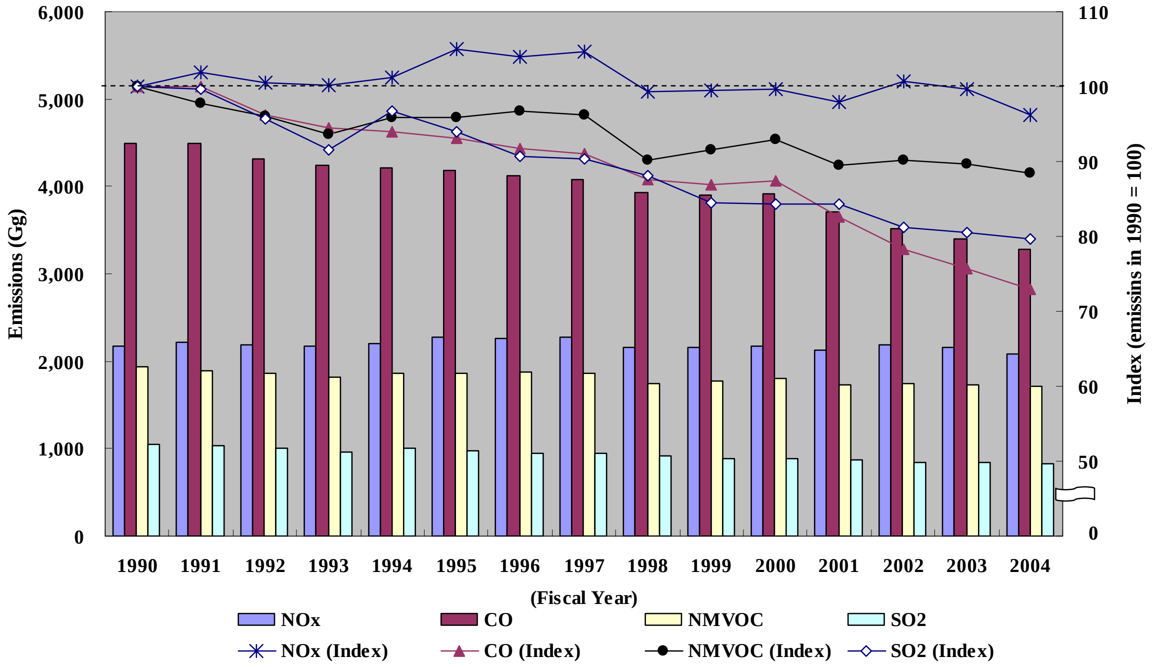

Figure 3 Trends in Emissions of Indirect Greenhouse Gases and SO_2

Chapter 1. Introduction and QA/QC plan

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

On the basis of paragraph 2 of Decision 13/CMP.1, the government of Japan submits report on Japan’s assigned amount pursuant to Article 3, paragraph 7 and 8 of the Kyoto Protocol. The report shall contain “Complete inventories” in line with paragraph 7 (a) of annex of decision 13/CMP.1.

This report is complementary information to the “Complete inventories” of the reports on Japan’s assigned amount mentioned above. The report also contains improvements from the Japan’s GHG inventories submitted to the UNFCCC secretariat in May 2006 in accordance withe the Article 4 and 12 of the Convention, such as the improved estimation of methodologies based on the latest scientific knowledge. Improvements made after May 2006 are described in the chapter 10 of this report (section 10.4.1.1.b.).

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 apply the *LULUCF-GPG* to their inventory reporting for LULUCF sector from 2005 and onward.

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

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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 (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. 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.

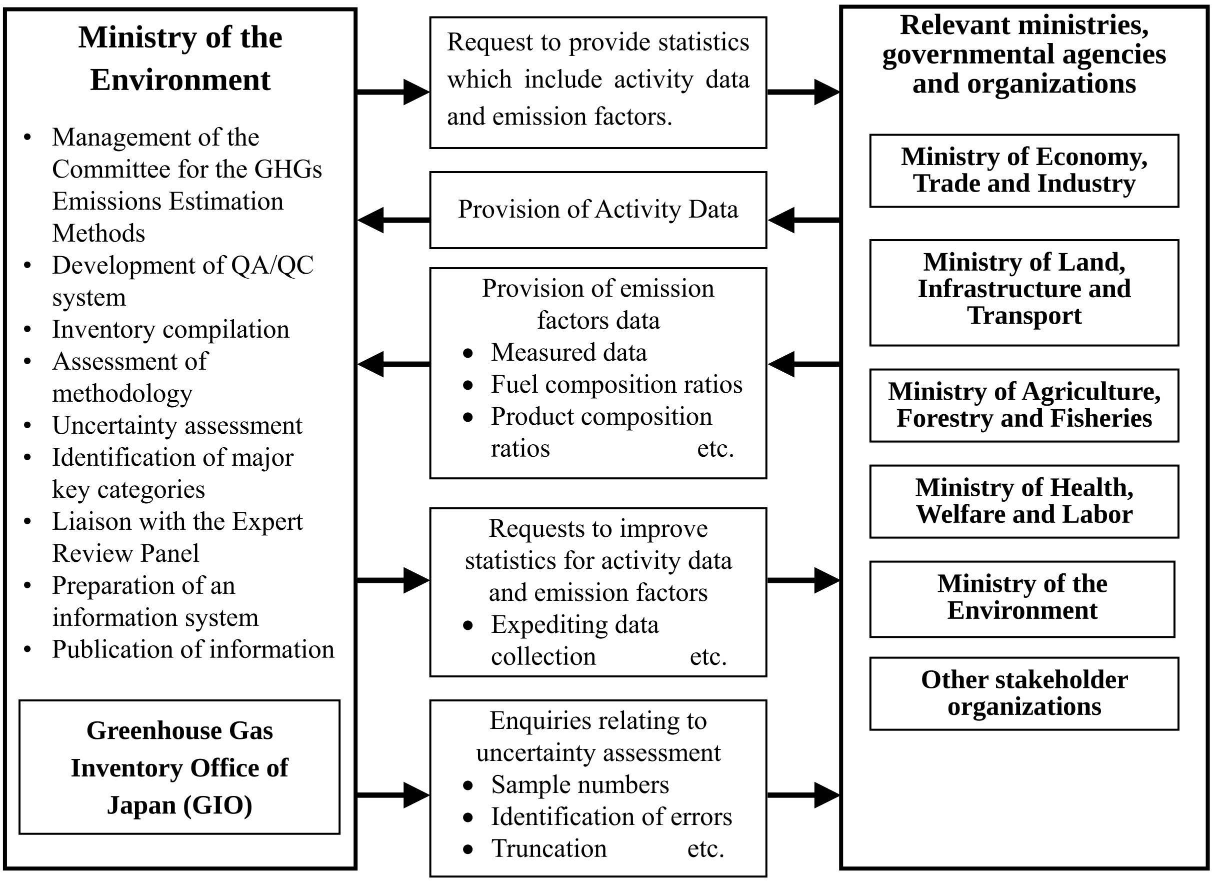

Figure 1-1 Institutional arrangement for the inventory preparation in Japan

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

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,* the *Good Practice Guidance (2000)* and *the LULUCF-GPG*. However, Japan’s country-specific methodologies were used for “4.C. methane emissions from rice cultivation” 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*, the *Good Practice Guidance (2000)* and *LULUCF-GPG* 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.

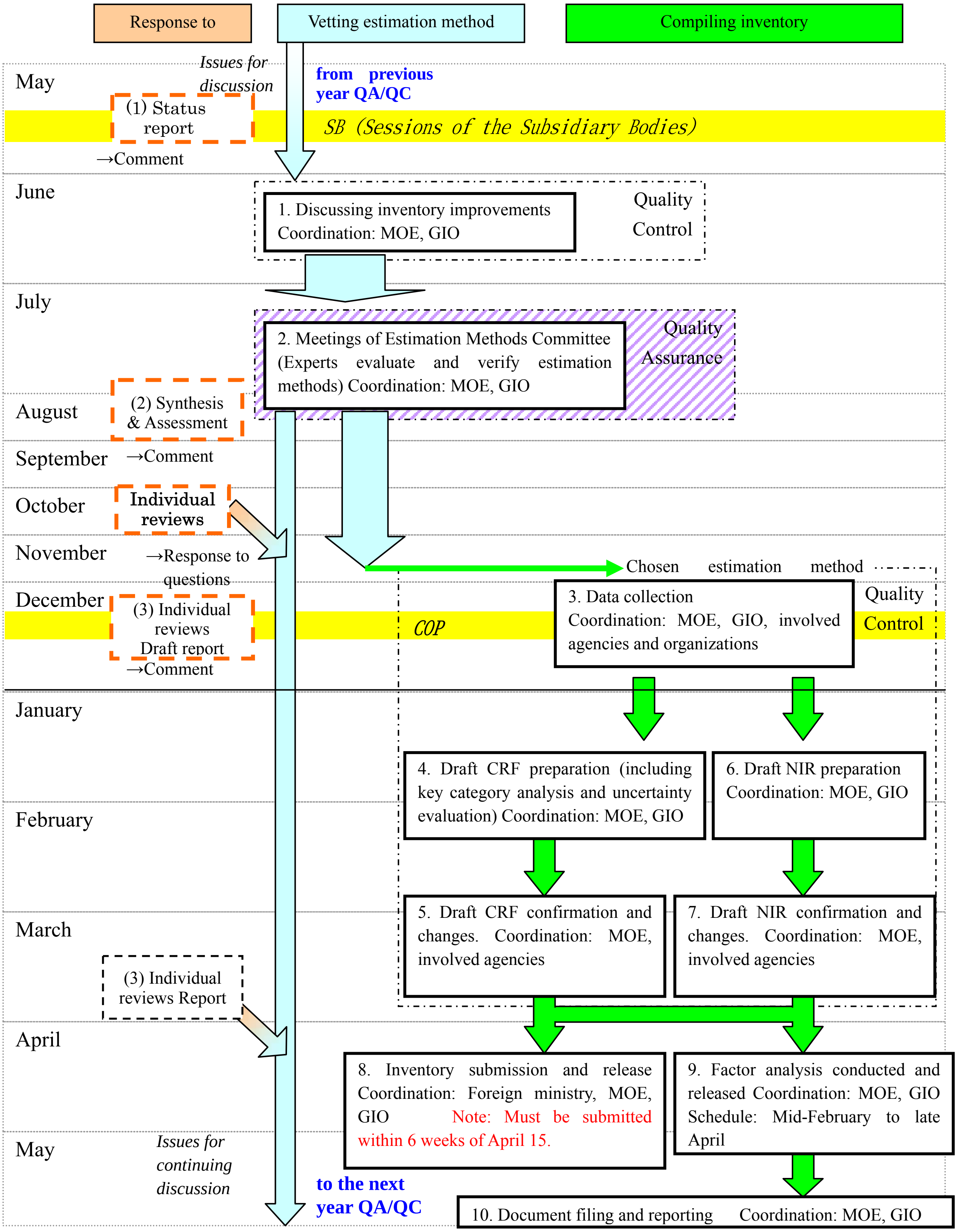

Figure 1-2 Process of the inventory compilation

1.2.4. Brief Description of Key Categories

Key categories were assessed in accordance with the *Good Practice Guidance (2000)* and *LULUCF-GPG* (Tier 1, Tier 2 level assessment and trend assessment, and qualitative analysis).

The assessment using these methods (Tier 1 Level Assessment, Tier 1 Trend Assessment, Tier 2 Level Assessment and Tier 2 Trend Assessment) resulted in the following table 1-2 of 40 sources and sinks, 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 Category		**B Direct GHGs**	**L1**	**T1**	**L2**	**T2**
#1	1A Stationary Combustion	Solid Fuels	CO_2	#1	#2	#3	#10
#2	1A Stationary Combustion	Liquid Fuels	CO_2	#2	#1	#7	#11
#3	1A3 Mobile Combustion	b. Road Transportation	CO_2	#3	#4	#6	#23
#4	1A Stationary Combustion	Gaseous Fuels	CO_2	#4	#3		
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO_2	#5	#5	#5	#13
#6	6C Waste Incineration		CO_2	#6	#7	#2	#5
#7	2A Mineral Product	1. Cement Production	CO_2	#7	#10	#8	#14
#8	1A3 Mobile Combustion	d. Navigation	CO_2	#8	#20		
#9	2A Mineral Product	3. Limestone and Dolomite Use	CO_2	#9		#15	
#10	1A3 Mobile Combustion	a. Civil Aviation	CO_2	#10	#18		
#11	4A Enteric Fermentation		CH_4	#11		#25	
#12	2A Mineral Product	2. Lime Production	CO_2	#12		#21	
#13	6A Solid Waste Disposal on Land		CH_4		#13	#16	#12
#14	4C Rice Cultivation		CH_4		#21	#19	
#15	4B Manure Management		N_2O			#11	#22
#16	4D Agricultural Soils	1. Direct Soil Emissions	N_2O			#4	#8
#17	1A Stationary Combustion		N_2O			#18	#24
#18	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	1. Refrigeration and Air Conditioning Equipment	HFCs		#16	#13	#9
#19	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	PFCs			#9	#27
#20	1A3 Mobile Combustion	b. Road Transportation	N_2O			#12	#17
#21	5A Forest Land	2. Land converted to Forest Land	CO_2		#14		#16
#22	4D Agricultural Soils	3. Indirect Emissions	N_2O			#14	#21
#23	6C Waste Incineration		N_2O			#10	#18
#24	4B Manure Management		CH_4			#17	#25
#25	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	SF_6			#20	
#26	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs		#9		#4
#27	5C Grassland	2. Land converted to Grassland	CO_2		#15		#19
#28	6B Wastewater Handling		N_2O			#22	
#29	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs		#6		#15
#30	2B Chemical Industry	other products except Anmonia	CO_2			#26	
#31	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF_6		#8		#2
#32	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs			#24	
#33	2B Chemical Industry	3. Adipic Acid	N_2O		#11		#20
#34	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF_6		#12	#27	#3
#35	5E Settlements	2. Land converted to Settlements	CO_2		#19		
#36	5B Cropland	2. Land converted to Cropland	CO_2				#26
#37	1A3 Mobile Combustion	d. Navigation	N_2O			#23	
#38	1A3 Mobile Combustion	a. Civil Aviation	N_2O			#1	#6
#39	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH_4		#17		#7
#40	5F Other Land	2. Land converted to Other Land	CO_2				#1

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.

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

- 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)

- Because estimation methods for NMVOC emissions from sources including products other than organic solvents and for emissions from byproduct fuel use have not been examined for a long time, there is a possibility that estimation accuracy is not sufficient. As work has begun in Japan on producing a VOC inventory, this matter will be addressed while verifying the accuracy of current estimation methods.

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

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 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.

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

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

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

- 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)

- Some substances of F-gas are emitted from only a 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)

- 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.

- Because estimation methods for NMVOC emissions from sources including products other than organic solvents and for emissions from byproduct fuel use have not been examined for a long time, there is a possibility that estimation accuracy is not sufficient. 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 information available on which land represents histosol and how much land classified as histosol existed in the past. Discussions are being made while ensuring consistency with the Land Use, Land-Use Change, and Forestry sector.

- Estimation of country specific emission factors is necessary for N_2O emissions from "synthetic fertilizers" and "animal wastes applied to soils".

- It is necessary to discuss how to estimate more accurate data on the amount of nitrogen in tea residues for the estimation of direct soil N_2O emissions from crop residues

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

- In this inventory, annual change in area of land remaining in the same land use category and area of land converted to another land use category are not consistent to each other. Therefore, it is necessary to discuss how to estimate area of land converted to another land use category and ensure the consistency of land area data.

- Currently, data on carbon stock change in both dead organic matter and soils in Forest land is being collected. Therefore, it will be necessary to discuss how to apply a Tier 2 or a higher tier methodology to estimate emissions in the future..

- For the Settlements category, the verification of the land area statistics and the development of various parameters are being implemented, therefore, according to need, these improvements of data should be reflected to subsequent inventories.

- It is necessary to make research on parameters used in estimating emissions from biomass burning (ratio of biomass left on-site, ratio of burned biomass left on-site) and, if more reliable data become available, recalculate these emission estimates.

1.3.7. Waste (Category6)

- At present there is not enough information available on some parameters in calculation of CH_4 emissions from solid waste disposal on land, and default values are used for calculation for such part. Long-term discussions will be held on findings relevant information.

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

- Because CO_2 emissions form utilization of plastics in coke oven are counted under the waste sector, this emissions have to be subtracted from the energy sector. However, the emissions are double counted under the both sectors at present, although the CO_2 emission from this source in 1990 was zero and a double counting does not occur in 1990. Thus, discussions are necessary to solve this issue.

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 net emissions in Japan for fiscal 2004 were approximately 1.26 billion tons (carbon dioxide equivalents). Uncertainty of total emissions has been assessed at 2% and uncertainty introduced into the trend in total national emissions has been assessed at 2%. Refer Annex 7 for details of assessment method and precise results.

Table 1-3 Uncertainty of Japan's Total Emissions

IPCC Category	GHGs	Emissions / Removals [Gg CO2eq.] A	[%]	Combined Uncertainty [%] 1) B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (CO2)	CO2	1,196,376.5	94.9%	1%	10	0.69%	3
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	4,794.1	0.4%	30%	2	0.11%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	3,778.3	0.3%	290%	1	0.87%	1
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	418.8	0.0%	19%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	54,987.4	4.4%	7%	7	0.32%	5
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	19,142.5	1.5%	20%	5	0.30%	6
3. Solvent & other Product Use	N2O	297.5	0.0%	5%	9	0.00%	9
4. Agriculture	CH4、N2O	27,516.8	2.2%	26%	3	0.57%	4
5. LULUCF	CO2、CH4、N2O	▲ 94,879.2	-7.5%	6%	8	-0.43%	10
6. Waste	CO2、CH4、N2O	47,863.0	3.8%	23%	4	0.86%	2
Total Emissions	(D)	1,260,295.8	100.0%	(E) 2) 2%			

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

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

Hereafter, the same method for calculating uncertainty assessment has been used in each sector appearing in Tables 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 actual emissions of HFCs, PFCs, and SF_6, such sources are reported as 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 12.0% compared to emissions (CO_2, CH_4, N_2O, excluding carbon dioxide removals) in 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 7.4%.

It should be noted that actual emissions of HFCs, PFCs, and SF_6 in the period from 1990 to 1994, have not been estimated (NE)[3].

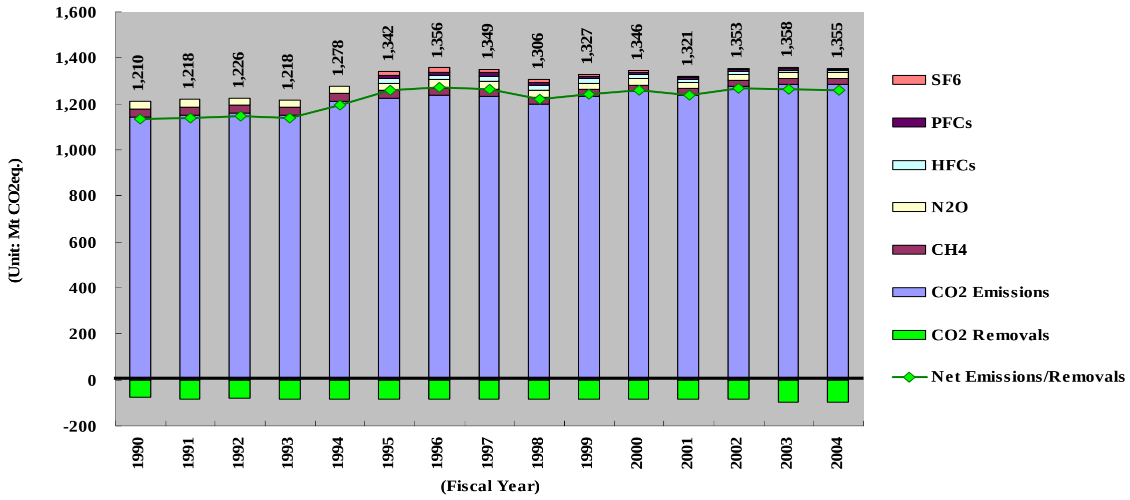

Figure 2-1 Trends in emission and removals of greenhouse gases in Japan

Emissions of carbon dioxide in FY2004 were 1,286 million tons, comprising 94.9% of the total. It represents an increase by 12.4% from fiscal 1990, and an increase by 0.1% in comparison with the previous year. Removals of CO_2 in FY2004 were 94.9 million tons[4], equivalent to 7.0% of total annual greenhouse gas emissions. It represents an increase by 26.9% from FY1990, and a decrease

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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] Potential emissions are reported in CRF for 1990-1994.

[4] 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 Decision 16/CMP.1 (Land use, land-use change and forestry）adopted in COP/MOP1.

by 0.1% in comparison with the previous year. Emissions in FY2004 of CH_4 were 24.5 million tons (in CO_2 eq.), comprising 1.8% of total emissions. The value represents a reduction by 27.0% from FY1990 and 1.2% in comparison with the previous year. Emissions in FY2004 of N_2O were 25.8 million tons (in CO_2 eq.), comprising 1.9% of total emissions. The value represents a reduction by 21.4% from FY1990, and an increase by 0.1% in comparison with the previous year.

Emissions in CY2004 of HFCs were 8.3 million tons (in CO_2 eq.), comprising 0.6% of total emissions. The value represents a reduction by 58.7% on CY1995, and 33.3% in comparison with the previous year. Emissions in CY2004 of PFCs were 6.3 million tons (in CO_2 eq.), comprising 0.5% of total emissions. The value represents a reduction by 55.0% from CY1995, and an increase by 2.0% 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 CO_2 eq.]	GWP	Base year of KP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2 Emissions	1	1,144.1	1,144.1	1,153.0	1,160.6	1,153.0	1,212.8	1,226.4	1,239.3	1,234.8	1,198.6	1,233.7
Removals	1	-74.8	-74.8	-81.6	-81.0	-81.6	-81.9	-81.5	-85.4	-85.3	-84.9	-84.9
CH_4	21	33.5	33.5	33.2	33.0	32.7	32.0	31.0	30.3	29.2	28.4	27.7
N_2O	310	32.8	32.8	32.4	32.4	32.1	33.2	33.6	34.7	35.3	33.9	27.4
HFCs	HFC-134a：1,300 etc.	20.2	NE	NE	NE	NE	NE	20.2	19.8	19.8	19.3	19.8
PFCs	PFC-14：6,500 etc.	14.0	NE	NE	NE	NE	NE	14.0	14.5	15.5	12.6	9.7
SF_6	23,900	16.9	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1
Gross Total (excluding LULUCF)		1,261.4	1,210.3	1,218.4	1,225.9	1,217.6	1,277.9	1,342.1	1,356.0	1,349.3	1,306.0	1,327.4
Net Total (including LULUCF)		-	1,135.6	1,137.0	1,145.1	1,136.1	1,196.1	1,260.7	1,270.8	1,264.1	1,221.2	1,242.6

[Mt CO_2 eq.]	GWP	Base year of KP	2000	2001	2002	2003	2004	Emission increase from the base year of KP	Emission increase from 1990 (2004)	Emission increase from previous year (2004)
CO_2 Emissions	1	1,144.1	1,254.6	1,239.3	1,276.8	1,284.4	1,285.8	12.4%	12.4%	0.1%
Removals	1	-74.8	-85.0	-84.9	-85.4	-95.0	-94.9	26.9%	26.9%	-0.1%
CH_4	21	33.5	27.0	26.2	25.3	24.8	24.5	-27.0%	-27.0%	-1.2%
N_2O	310	32.8	29.9	26.4	26.0	25.8	25.8	-21.4%	-21.4%	0.1%
HFCs	HFC-134a：1,300 etc.	20.2	18.6	15.8	13.1	12.5	8.3	-58.7%	-	-33.3%
PFCs	PFC-14：6,500 etc.	14.0	8.6	7.2	6.5	6.2	6.3	-55.0%	-	2.0%
SF_6	23,900	16.9	6.8	5.7	5.3	4.7	4.5	-73.6%	-	-5.7%
Gross Total (excluding LULUCF)		1,261.4	1,345.5	1,320.6	1,353.0	1,358.3	1,355.2	7.4%	12.0%	-0.2%
Net Total (including LULUCF)		-	1,260.6	1,235.8	1,267.7	1,263.3	1,260.3	-	11.0%	-0.2%

* NE: Not Estimated

* CH_4 and N_2O emissions in Table 2-1 and in the description in this chapter 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).

2.1.2. CO_2 Emissions Per Capita

Total carbon dioxide emissions in fiscal 2004 were 1,286 million tons, giving an emission of 10.07 tons per capita. Compared to fiscal 1990, it represents an increase of 12.4% in total carbon dioxide emissions, and an increase of 8.8% in carbon dioxide emissions per capita. Carbon dioxide emissions compared to the previous year increased by 0.1% in total emissions and by 0.1% per capita.

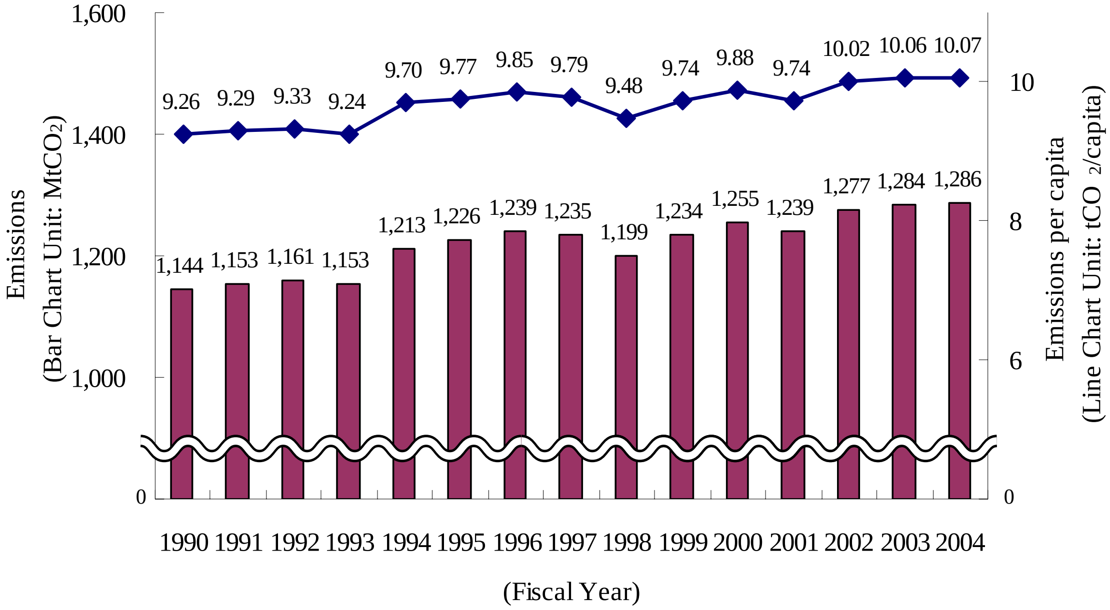

Figure 2-2 Trends in total CO_2 emissions and CO_2 emissions per capita

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 2,420 tons/billion yen, resulting in a decrease by 1.0% since fiscal 1990, and a decrease by 2.0% from the previous year.

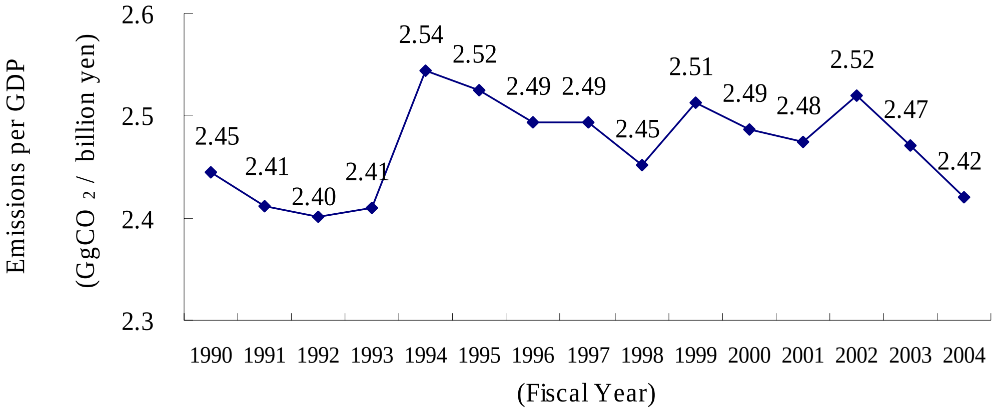

Figure 2-3 Trends in CO_2 emissions per unit of GDP

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

2.2.1. CO_2

CO_2 emissions in FY2004 were 1,286 million tons[5], comprising 94.9% of the total. It represents an increase by 12.4% from fiscal 1990, and an increase by 0.1% in comparison with the previous year.

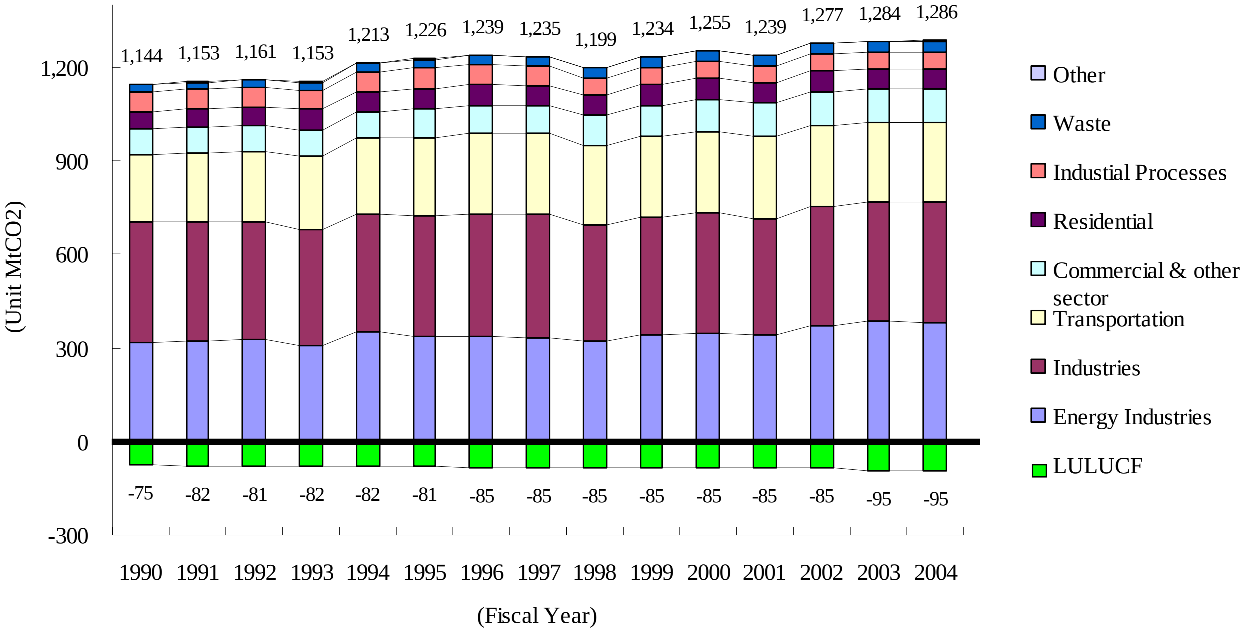

Figure 2-4 Trends in CO_2 emissions

The breakdown of CO_2 emissions in FY2004 shows that carbon dioxide emitted in association with the Fuel combustion accounted for 93.0% of the total, carbon dioxide from the Industrial processes accounted for 4.1%, and carbon dioxide from the Waste sector accounted for 2.8%.The Industries accounts for 30.2% of emissions of CO_2 from the Fuel combustion, making it the single largest source of emissions followed by the Energy industries sector at 29.7% and the Transport sector at 19.8%.

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 20.2% compared to FY1990, and decreased by 0.9% 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 LULUCF sector is excluded

Removals of CO_2 in FY2004 were 94.9 million tons[4], equivalent to 7.4% of total annual CO_2 emissions. It represents an increase by 26.9% from FY1990, and a decrease by 0.1% in comparison with the previous year.

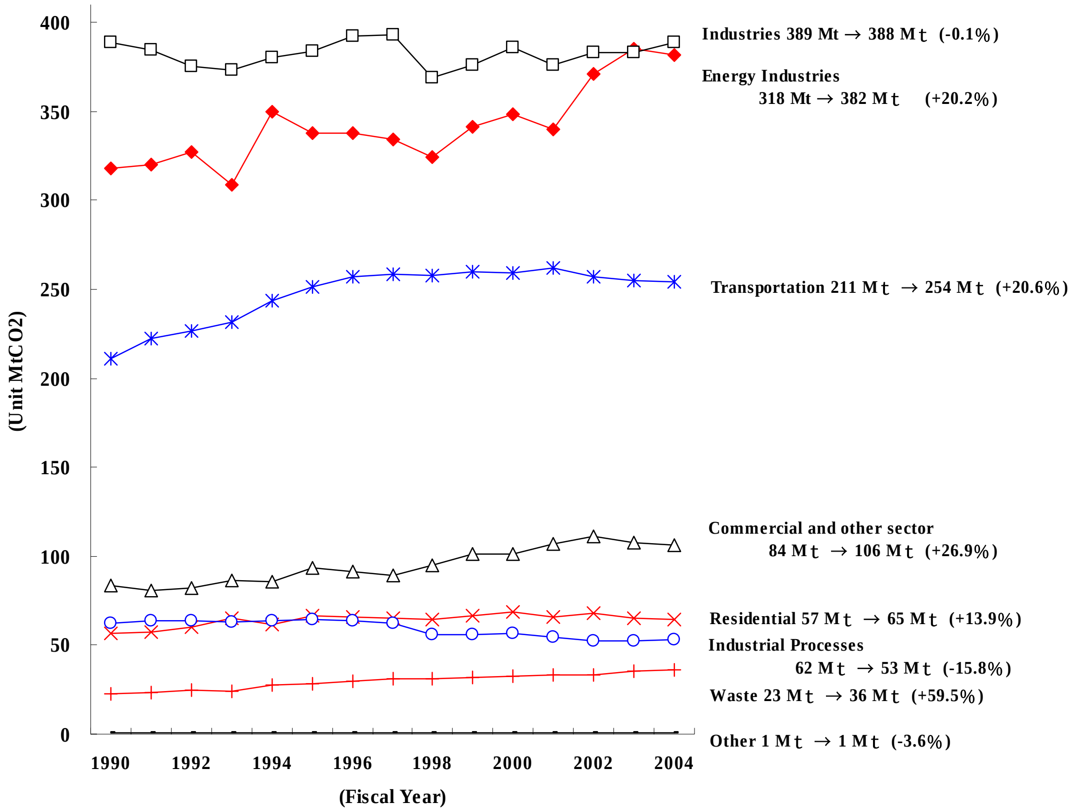

Figure 2-5 Trends in CO_2 emissions in each sector

Table 2-2 Trends in CO_2 emissions and removals in each sector

[Gg CO_2]

Category	1990	1995	2000	2003	2004
1A. Fuel Combustion	1,059,075.87	1,133,604.30	1,164,801.57	1,196,483.62	1,196,376.46
Energy Industry	317,760.48	337,867.69	348,484.03	385,208.36	381,821.90
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	11,286.33	12,592.50	9,411.50	10,499.79	11,539.30
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	36.62	50.92	36.03	34.46	34.99
2. Industrial Processes	62,318.39	64,264.52	56,877.08	52,253.05	53,196.31
Mineral Products	57,448.33	59,381.83	52,450.67	48,603.05	49,630.05
Chemical Industry	4,513.97	4,525.47	4,177.99	3,408.43	3,308.42
Metal Production	356.09	357.22	248.42	241.57	257.84
5. LULUCF	-74,793.94	-81,488.86	-85,036.06	-95,018.52	-94,924.71
6. Waste	22,698.63	28,470.23	32,904.33	35,604.95	36,206.04
Total (including LULUCF)	1,069,335.57	1,144,901.10	1,169,582.95	1,189,357.55	1,190,889.09
Total (excluding LULUCF)	1,144,129.51	1,226,389.96	1,254,619.01	1,284,376.08	1,285,813.80

2.2.2. CH_4

Methane emissions in FY2004 were 24.5 million tons (in CO_2 eq.), comprising 1.8% of total emissions. The value represents a reduction by 27.0% from FY1990 and 1.2% in comparison with the previous year.

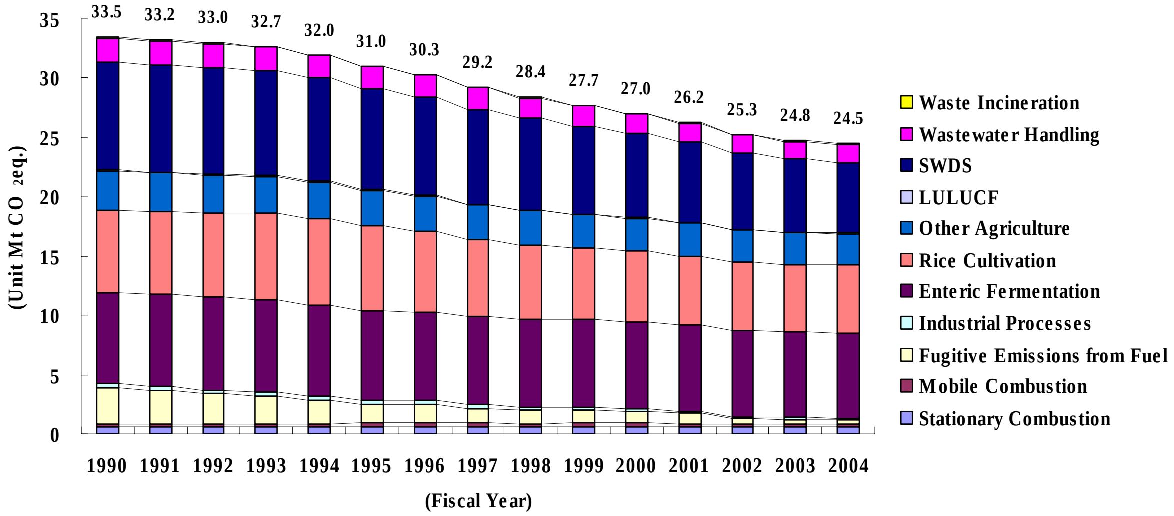

Figure 2-6 Trends in CH_4 emissions

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 methane emissions from rice cultivation at 24%.

Table 2-3 Trends in CH_4 emissions

[Gg CO_2eq.]

Category	1990	1995	2000	2003	2004
1A. Fuel Combustion	829.23	899.59	892.08	839.94	830.08
1A1. Energy Industries	18.37	23.02	31.01	32.97	32.09
1A2. Industries	307.03	314.41	292.43	286.77	289.68
1A3. Transport	296.16	306.24	298.75	273.83	255.96
1A4. Residential / Institutional	207.66	255.93	269.89	246.37	252.36
1B. Fugitive Emissions from Fuels	3,037.14	1,609.87	1,045.91	397.69	383.73
1B1. Solid Fuels	2,806.43	1,344.68	769.13	93.86	66.51
1B2. Oil & Natural Gas	230.71	265.19	276.79	303.83	317.22
2. Industrial Processes	357.58	322.37	181.23	133.88	133.49
4. Agriculture	17,894.84	17,718.38	16,053.79	15,580.65	15,524.99
4A. Enteric Fermentation	7,641.73	7,575.17	7,344.65	7,176.22	7,136.37
4B. Manure Management	3,120.57	2,895.37	2,644.16	2,576.76	2,539.88
4C. Rice Cultivation	7,002.78	7,126.61	5,956.45	5,725.83	5,747.41
4F. Field Burning of Agricultural Residue	129.77	121.22	108.54	101.85	101.33
5. LULUCF	99.33	70.56	46.90	24.46	32.37
6. Waste	11,263.54	10,409.98	8,803.87	7,782.53	7,551.83
6A. SWDS	9,081.13	8,485.01	7,091.00	6,211.80	5,973.93
6B. Wastewater Handling	2,119.61	1,859.63	1,636.74	1,489.85	1,496.95
6C. Waste Incineration	62.80	65.34	76.13	80.87	80.95
Total (including LULUCF)	33,481.67	31,030.75	27,023.79	24,759.14	24,456.50
Total (excluding LULUCF)	33,382.33	30,960.19	26,976.89	24,734.69	24,424.13

2.2.3. N_2O

N_2O emissions in FY2004 were 25.8 million tons (in CO_2 eq.), comprising 1.9% of total emissions. The value represents a reduction by 21.4% from FY1990, and an increase by 0.1% 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.

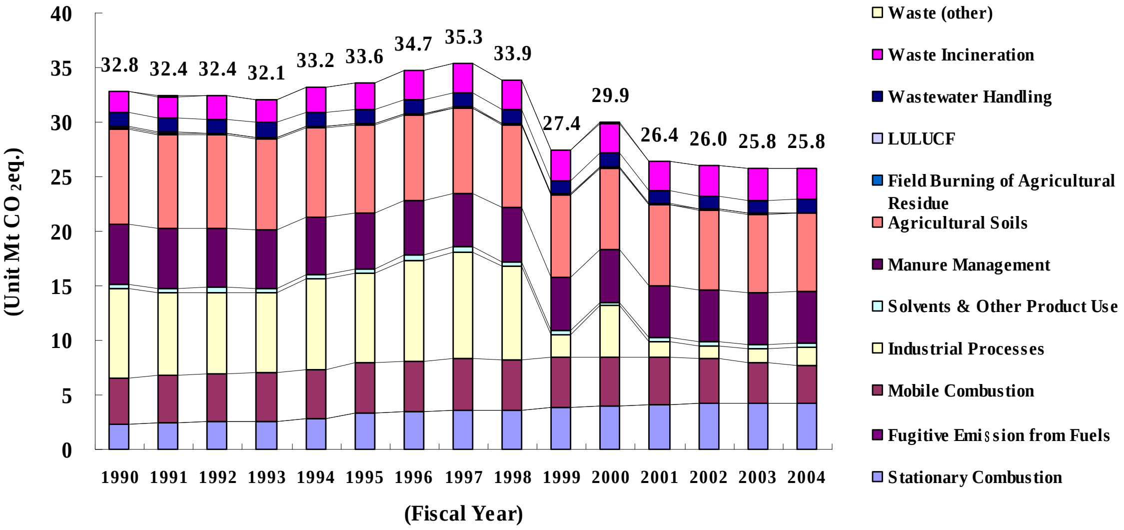

Figure 2-7 Trends in N_2O emissions

The breakdown of nitrous oxide emissions in FY2004 shows that emissions from agricultural soils for 28% of the total, making it the single largest source of emissions. It is followed by emissions from manure management accounted at 18%, and emissions from fuel combustion of motor vehicles and other mobile sources of 14%.

Table 2-4 Trends in N_2O emissions

[Gg CO2eq.]

Category	1990	1995	2000	2003	2004
1A. Fuel Combustion	6,535.76	7,935.48	8,484.02	8,011.65	7,742.36
1A1. Energy Industries	545.63	1,033.30	1,262.55	1,383.48	1,395.52
1A2. Industries	1,495.44	1,896.92	2,276.91	2,426.98	2,447.94
1A3. Transport	4,204.15	4,649.77	4,564.25	3,823.99	3,522.34
1A4. Residential / Institutional	290.53	355.48	380.31	377.21	376.56
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	14,433.52	13,247.54	12,384.35	12,068.31	11,991.86
4B. Manure Management	5,543.05	5,111.81	4,844.14	4,753.43	4,726.30
4D. Agricultural Soils	8,786.55	8,047.03	7,459.04	7,240.16	7,191.93
4F. Field Burning of Agricultural Residue	103.92	88.70	81.18	74.72	73.63
5. LUCF	72.92	47.00	24.46	15.92	13.15
6. Waste	3,220.16	3,713.74	4,016.11	4,093.43	4,105.14
6B. Wastewater Handling	1,289.37	1,246.87	1,213.58	1,172.14	1,188.93
6C. Waste Incineration	1,910.66	2,450.63	2,783.87	2,901.98	2,896.67
6D. Waste (other)	20.12	16.24	18.66	19.31	19.54
Total (including LULUCF)	32,816.48	33,594.20	29,940.13	25,769.80	25,807.77
Total (excluding LULUCF)	32,743.57	33,547.19	29,915.68	25,753.88	25,794.62

2.2.4. HFCs

Emissions of HFCs in 2004[6] were 8.3 million tons (in CO_2 eq.), comprising 0.6% of total emissions. The value represents a reduction by 58.7% on CY1995, and 33.3% in comparison with the previous year.

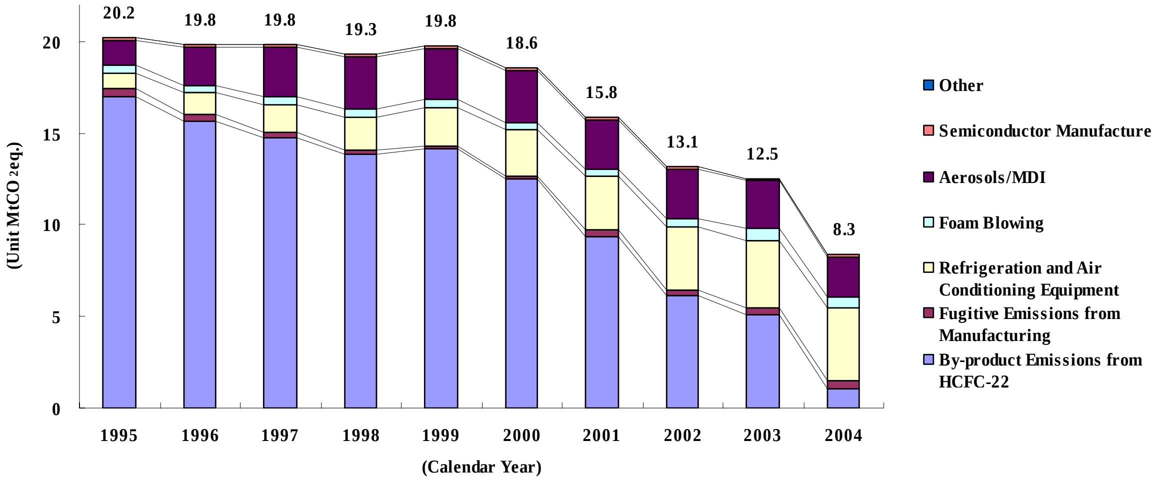

Figure 2-8 Trends in HFCs emissions

The breakdown of HFCs emissions in 2004 shows that emissions from refrigerants of refrigeration and air conditioning equipment accounted for 48% of the total, followed by emissions from aerosols / MDI at 26%, and by-product HFC-23 emission during production of HCFC-22 at 13%.

Table 2-5 Trends in HFCs emissions

[Gg CO_2eq.]

Category	1995	2000	2002	2003	2004
2E. Productions of F-gas	17,442.52	12,654.54	6,452.46	5,453.01	1,466.82
2E1. By-product Emissions from Production of HCFC-22	17,023.50	12,474.54	6,114.42	5,053.23	1,050.66
2E2. Fugitive Emissions	419.02	180.00	338.04	399.78	416.16
2F. Consumption of F-gas	2,769.29	5,930.85	6,695.48	7,066.08	6,883.15
2F1. Refrigeration and Air Conditioning Equipment	807.13	2,498.91	3,447.17	3,710.21	4,011.75
2F2. Foam Blowing	451.76	440.31	446.65	653.19	590.64
2F4. Aerosols/MDI	1,365.00	2,834.22	2,683.21	2,589.82	2,150.98
2F7. Semiconductor Manufacture	145.40	157.41	118.44	112.86	129.78
2F9. Other	0.00	0.00	0.00	0.00	0.00
Total	20,211.80	18,585.39	13,147.94	12,519.09	8,349.96

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

2.2.5. PFCs

PFCs emissions in 2004 were 6.3 million tons (in CO_2 eq.), comprising 0.5% of total emissions. The value represents a reduction by 55.0% from CY1995, and an increase by 2.0% in comparison with the previous year.

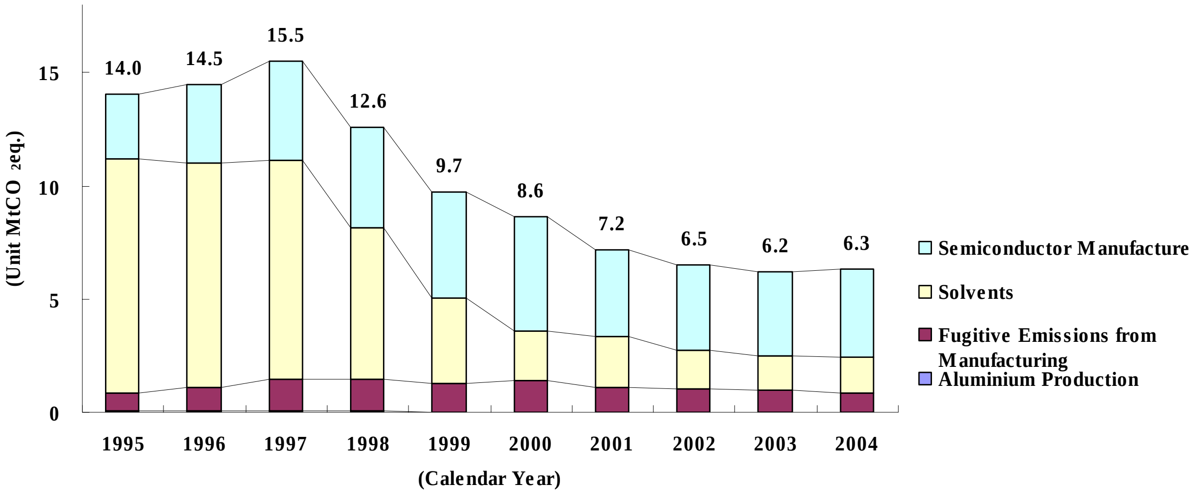

Figure 2-9 Trends in PFCs emissions

The breakdown of PFCs emissions in 2004 shows that emission from semiconductor manufacture accounted for 62% of the total, followed by emissions from solvents in washing metals etc. at 24%, and fugitive emissions from manufacturing at 14%.

Table 2-6 Trends in PFCs emissions

[Gg CO_2eq.]

Category	1995	2000	2002	2003	2004
2C3. Aluminium Production	69.73	17.78	14.82	15.11	14.79
2E2. Fugitive Emissions	762.85	1,382.60	1,006.10	971.40	862.82
2F. Consumption of F-gas	13,213.35	7,210.20	5,500.47	5,207.88	5,440.55
2F5. Solvents	10,356.00	2,157.90	1,723.31	1,509.10	1,535.46
2F7. Semiconductor Manufacture	2,857.35	5,052.30	3,777.16	3,698.78	3,905.09
Total	14,045.93	8,610.59	6,521.39	6,194.39	6,318.17

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.

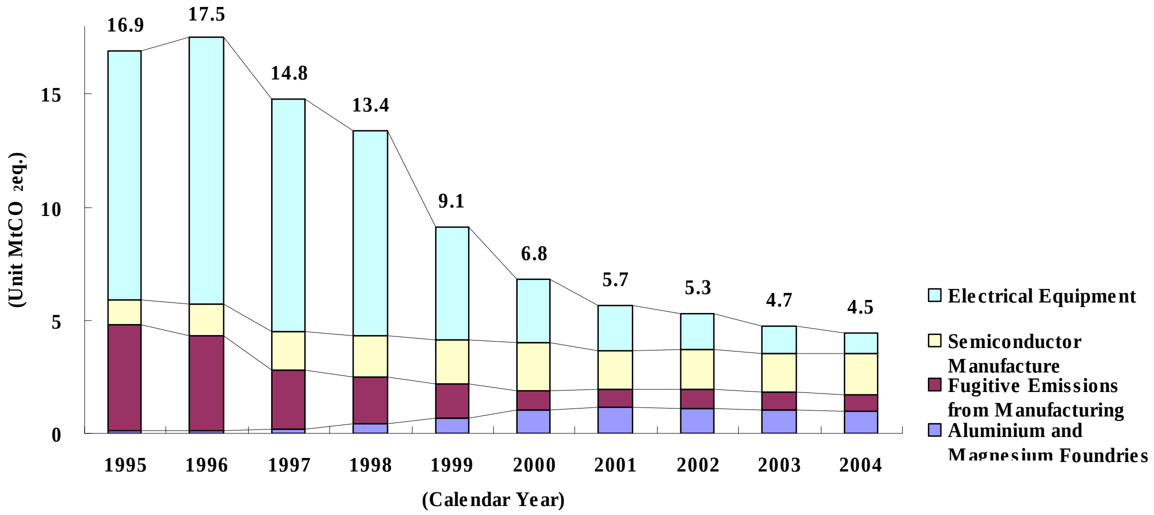

Figure 2-10 Trends in SF_6 emissions

The breakdown of SF_6 emissions in 2004 shows that emissions from semiconductor manufacture accounted for 40%, followed by emissions from the electrical equipment at 22%, and emissions from Magnesium Foundries at 21%.

Table 2-7 Trends in SF_6 emissions

[Gg CO_2eq.]

Category	1995	2000	2002	2003	2004
2C4. SF_6 Used in Aluminium and Magnesium Foundries	119.50	1,027.70	1,123.30	1,013.07	966.76
2E2. Fugitive Emissions	4,708.30	860.40	860.40	812.60	764.80
2F. Consumption of F-gas	12,100.99	4,935.17	3,323.16	2,920.28	2,742.77
2F7. Semiconductor Manufacture	1,099.82	2,141.26	1,779.22	1,715.72	1,784.38
2F8. Electrical Equipment	11,001.17	2,793.91	1,543.94	1,204.56	958.39
Total	16,928.79	6,823.27	5,306.86	4,745.95	4,474.32

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% of total annual greenhouse gas emissions.

Removals by Land Use, Land Use change and forestry in FY2004 were equivalent to 7.0% of total annual greenhouse gas emissions.

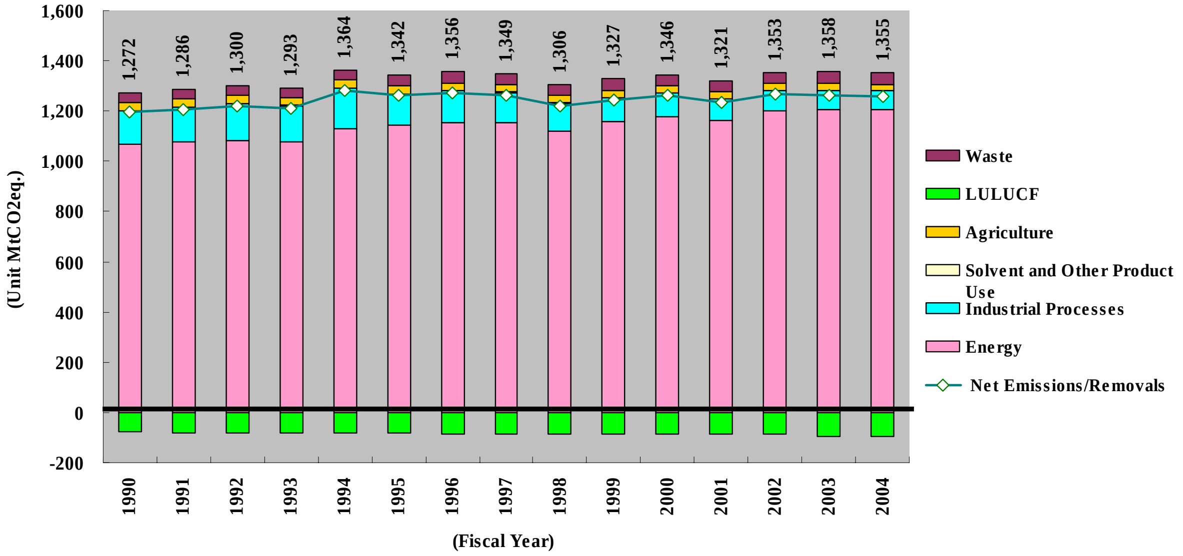

Figure 2-11 Trends in emissions and removals of greenhouse gases in each category

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
Energy	1,069.5	1,076.5	1,082.9	1,076.2	1,131.5	1,144.1	1,155.9	1,152.0	1,121.5	1,156.4
Industrial Processes	132.8	139.7	145.2	146.0	159.2	124.0	125.4	122.4	110.3	97.1
Solvent and Other Product Use	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Agriculture	32.3	32.3	32.2	32.1	31.6	31.0	30.3	29.7	29.2	28.7
Land Use, Land Use Change and Forestry	-74.6	-81.4	-80.8	-81.5	-81.7	-81.4	-85.2	-85.2	-84.8	-84.8
Waste	37.2	37.5	39.1	38.5	41.7	42.6	44.0	44.9	44.6	44.8
Net Emissions/Removals	1,197.5	1,204.9	1,219.0	1,211.7	1,282.7	1,260.7	1,270.8	1,264.1	1,221.2	1,242.6

[Mt CO_2 eq.]	2000	2001	2002	2003	2004
Energy	1,175.3	1,161.8	1,200.8	1,205.8	1,205.4
Industrial Processes	95.8	85.0	79.0	77.1	74.1
Solvent and Other Product Use	0.3	0.3	0.3	0.3	0.3
Agriculture	28.4	28.1	27.9	27.6	27.5
Land Use, Land Use Change and Forestry	-85.0	-84.8	-85.3	-95.0	-94.9
Waste	45.7	45.3	45.0	47.5	47.9
Net Emissions/Removals	1,260.6	1,235.8	1,267.7	1,263.3	1,260.3

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

2.3.1. Energy

Emissions from the Energy sector in FY2004 were 1,205 million tons (in CO_2 equivalents), an increase by 12.7% compared to FY1990, and a decrease by 0.03% in comparison with the previous year.

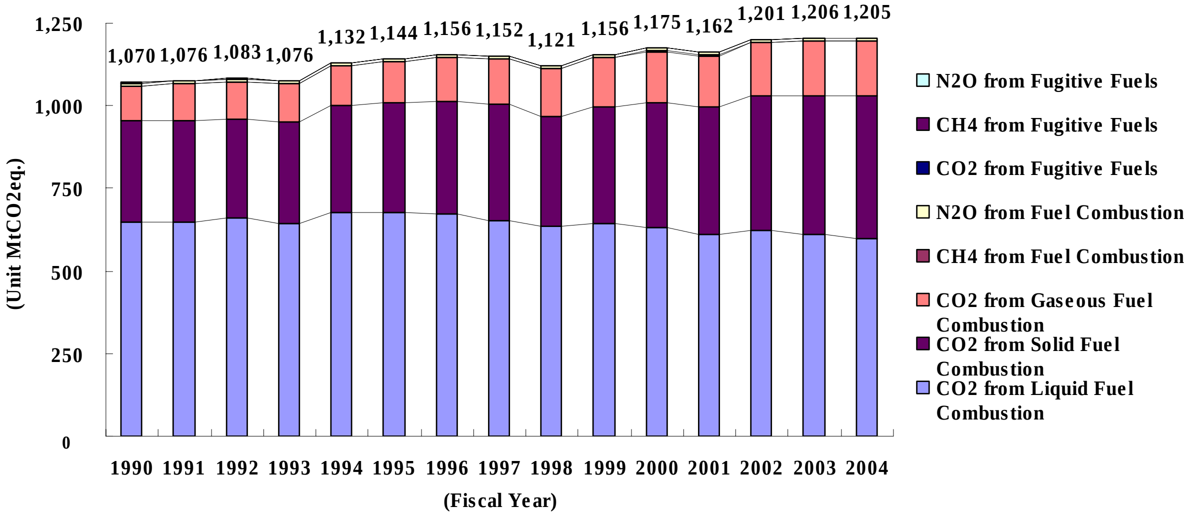

Figure 2-12 Trends in GHGs emissions from the Energy sector

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 36% 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	1,066,440.85	1,142,439.37	1,174,177.67	1,205,335.21	1,204,948.91
Liquid Euel CO_2	646,156.89	675,688.08	633,156.09	609,856.74	598,424.79
Solid Fuel CO_2	308,618.14	331,718.27	376,384.59	419,581.54	431,058.41
Gaseous Fuel CO_2	104,300.83	126,197.95	155,260.89	167,045.34	166,893.26
CH_4	829.23	899.59	892.08	839.94	830.08
N_2O	6,535.76	7,935.48	8,484.02	8,011.65	7,742.36
1B. Fugitive Emissions from Fuel	3,073.88	1,660.95	1,082.05	432.26	418.84
CO_2	36.62	50.92	36.03	34.46	34.99
CH_4	3,037.14	1,609.87	1,045.91	397.69	383.73
N_2O	0.11	0.16	0.11	0.11	0.11
Total	1,069,514.73	1,144,100.31	1,175,259.72	1,205,767.46	1,205,367.74

2.3.2. Industrial Processes

Emissions from the Industrial processes sector in FY2004 were 74.1 million tons (in CO_2 equivalents), an increase by 4.5% compared to FY1990, and a decrease by 3.8% in comparison with the previous year.

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

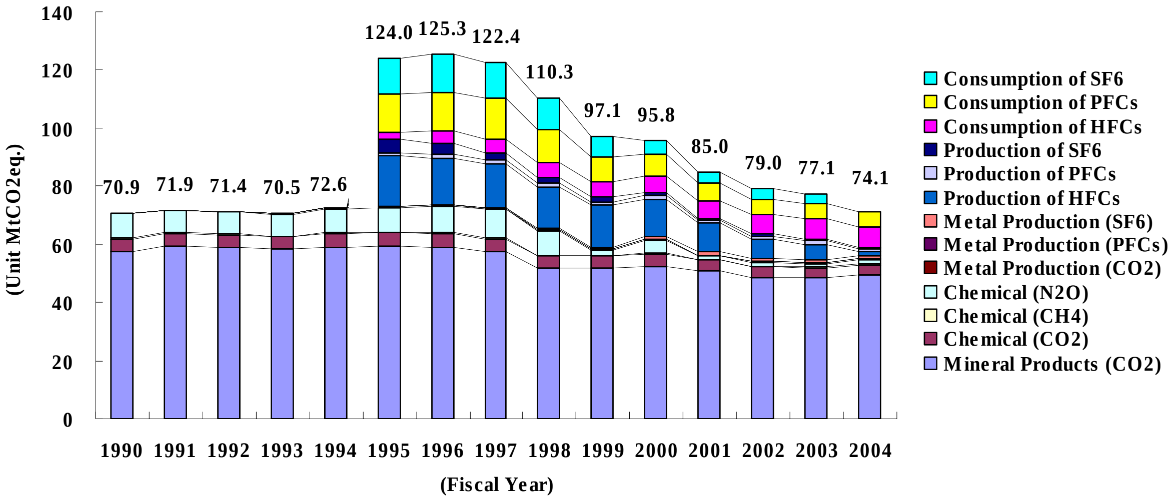

Figure 2-13 Trends in GHGs emissions from the Industrial processes sector

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 67%, making it the single largest source of emissions followed by the emissions from the consumption of HFCs (2.F.) at 9% and the consumption of PFCs (2.F.) at 7%.

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

[Gg CO_2eq.]

Category	1990	1995	2000	2003	2004
2A. Mineral Products (CO_2)	57,448.33	59,381.83	52,450.67	48,603.05	49,630.05
2B. Chemical Industry	13,138.50	13,060.55	9,049.31	4,801.86	5,099.51
CO_2	4,513.97	4,525.47	4,177.99	3,408.43	3,308.42
CH_4	357.58	322.37	181.23	133.88	133.49
N_2O	8,266.95	8,212.71	4,690.09	1,259.55	1,657.60
2C. Metal Production	356.09	546.45	1,293.91	1,269.76	1,239.39
CO_2	356.09	357.22	248.42	241.57	257.84
PFCs	NE	69.73	17.78	15.11	14.79
SF_6	NE	119.50	1,027.70	1,013.07	966.76
2E. Production of F-gas	NE	22,913.67	14,897.54	7,237.01	3,094.44
HFCs	NE	17,442.52	12,654.54	5,453.01	1,466.82
PFCs	NE	762.85	1,382.60	971.40	862.82
SF_6	NE	4,708.30	860.40	812.60	764.80
2F. Consumption of F-gas	NE	28,083.63	18,076.22	15,194.23	15,066.46
HFCs	NE	2,769.29	5,930.85	7,066.08	6,883.15
PFCs	NE	13,213.35	7,210.20	5,207.88	5,440.55
SF_6	NE	12,100.99	4,935.17	2,920.28	2,742.77
Total	70,942.92	123,986.12	95,767.65	77,105.91	74,129.86

2.3.3. Solvent and Other Product Use

Emissions from the Solvents and other product use in FY2004 were 298 thousand tons (in 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.

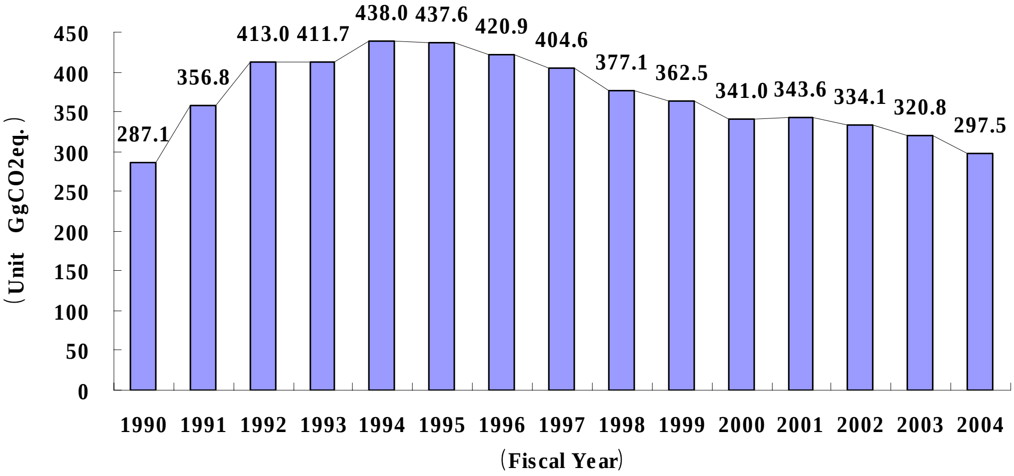

Figure 2-14 Trends in GHGs emissions from the Solvent and other product use sector

2.3.4. Agriculture

Emissions from the Agriculture in FY2004 were 27.5 million tons (in CO_2 equivalents), a decrease by 14.9% compared to FY1990, and by 0.5% in comparison with the previous year.

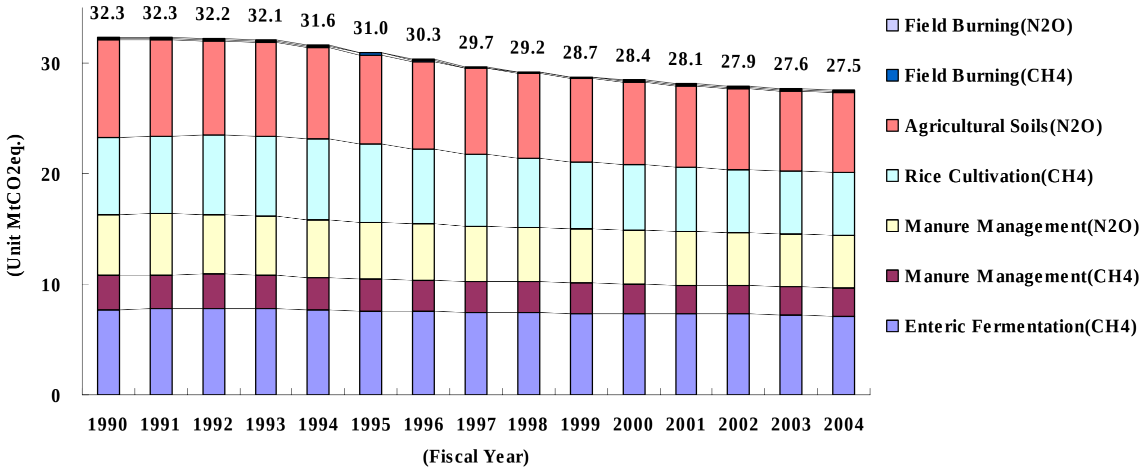

Figure 2-15 Trends in GHGs emissions from the Agriculture sector

The breakdown of emissions of greenhouse gases from the Agriculture in 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(CH_4)	7,641.73	7,575.17	7,344.65	7,176.22	7,136.37
4B. Manure Management	8,663.62	8,007.18	7,488.29	7,330.19	7,266.17
CH_4	3,120.57	2,895.37	2,644.16	2,576.76	2,539.88
N_2O	5,543.05	5,111.81	4,844.14	4,753.43	4,726.30
4C. Rice Cultivation(CH_4)	7,002.78	7,126.61	5,956.45	5,725.83	5,747.41
4D. Agricultural Soils (N_2O)	8,786.55	8,047.03	7,459.04	7,240.16	7,191.93
4F. Field Burning of Agricultural Residues	233.69	209.92	189.71	176.57	174.95
CH_4	129.77	121.22	108.54	101.85	101.33
N_2O	103.92	88.70	81.18	74.72	73.63
Total	32,328.36	30,965.92	28,438.15	27,648.95	27,516.84

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 (LULUCF) in fiscal 2004 was 94.9 million tons (in CO_2 equivalents), an increase by 27.1% on FY1990, and a decrease by 0.1% in comparison with the previous year.

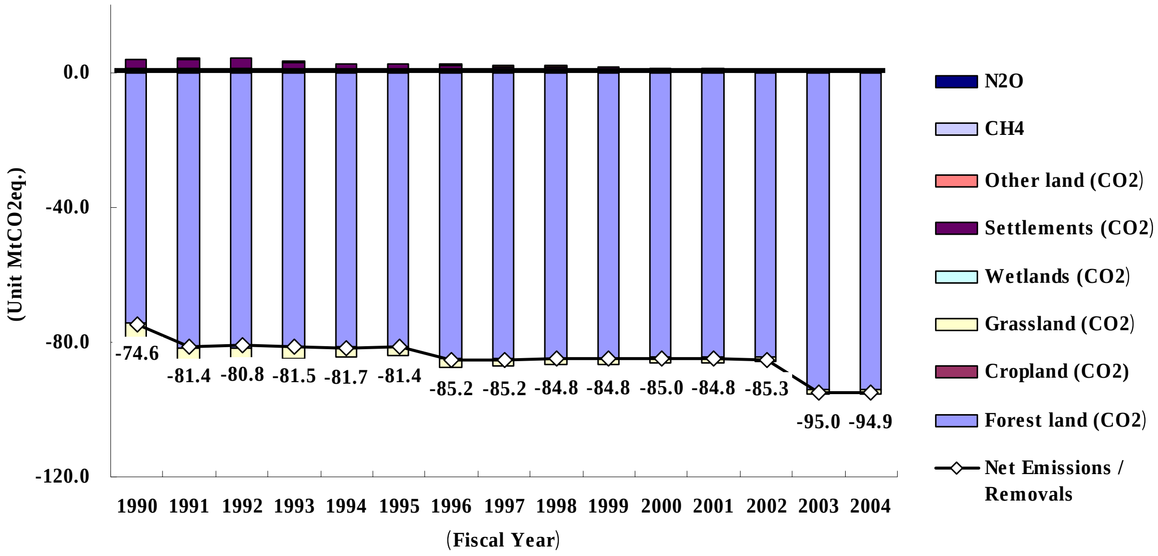

Figure 2-16 Trends in emissions and removals of GHGs from the LULUCF sector

The breakdown of emissions and removals of greenhouse gases from the LULUCF in FY2004 shows that CO_2 removals to forest was 93.9 million tons, accounting for 99% of total removals of LULUCF sector.

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

[Gg CO_2eq.]

排出源	1990	1995	2000	2003	2004
5A. Forest land	-74,328.17	-81,291.10	-84,594.26	-93,927.22	-93,875.63
CO_2	-74,337.32	-81,300.64	-84,602.80	-93,931.51	-93,888.33
CH_4	8.31	8.66	7.75	3.90	11.54
N_2O	0.84	0.88	0.79	0.40	1.17
5B. Cropland	1,366.35	496.95	210.36	167.23	125.51
CO_2	1,279.59	451.49	188.56	152.08	114.06
CH_4	21.72	5.10	1.91	1.56	1.45
N_2O	65.04	40.36	19.89	13.60	10.01
5C. Grassland	-4,187.59	-2,663.00	-1,722.91	-1,471.28	-1,368.88
CO_2	-4,190.96	-2,663.85	-1,723.23	-1,471.54	-1,369.13
CH_4	3.06	0.77	0.29	0.24	0.22
N_2O	0.31	0.08	0.03	0.02	0.02
5D. Wetlands	57.95	188.84	243.66	50.08	49.65
CO_2	56.49	183.96	237.33	48.81	48.50
CH_4	1.32	4.43	5.74	1.15	1.05
N_2O	0.13	0.45	0.58	0.12	0.11
5E. Settlements	2,335.55	1,698.38	764.40	189.62	184.08
CO_2	2,275.37	1,652.29	739.12	177.12	171.24
CH_4	54.63	41.84	22.95	11.35	11.65
N_2O	5.54	4.25	2.33	1.15	1.18
5F. Other land	134.23	198.64	134.05	13.42	6.07
CO_2	122.88	187.89	124.96	6.52	-1.04
CH_4	10.30	9.77	8.25	6.27	6.46
N_2O	1.05	0.99	0.84	0.64	0.66
Total	-74,621.68	-81,371.29	-84,964.70	-94,978.14	-94,879.19

2.3.6. Waste

Emissions from the Waste in FY2004 were 47.9 million tons (in CO_2 equivalents), an increase by 28.7% compared to FY1990, and an increase by 0.8% in comparison with the previous year.

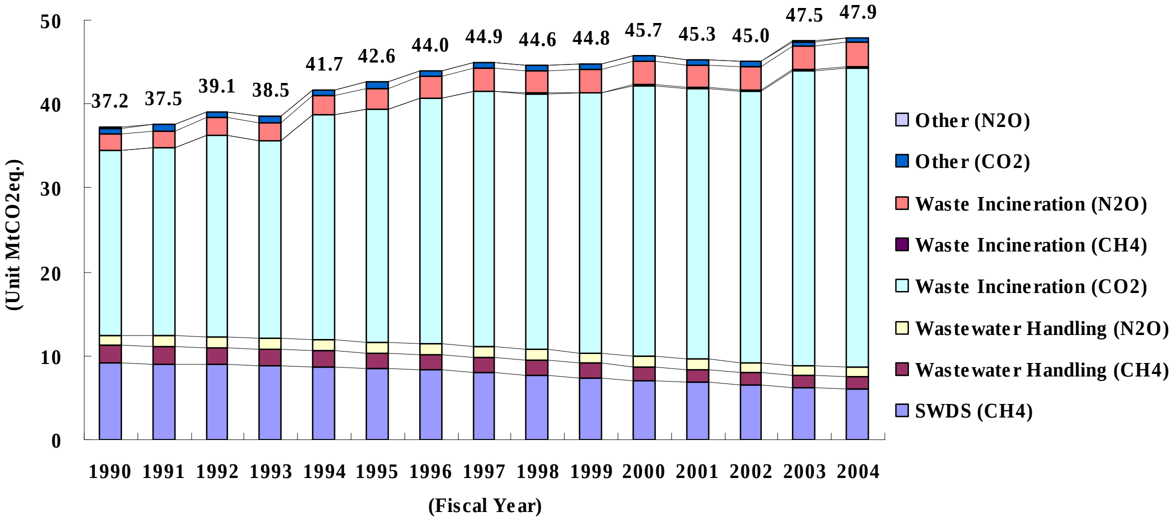

Figure 2-17　Trends in GHGs emissions from the Waste sector

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 75%, 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)	9,081.13	8,485.01	7,091.00	6,211.80	5,973.93
6B. Wastewater Handling	3,408.98	3,106.50	2,850.32	2,661.99	2,685.88
CH_4	2,119.61	1,859.63	1,636.74	1,489.85	1,496.95
N_2O	1,289.37	1,246.87	1,213.58	1,172.14	1,188.93
6C. Waste Incineration	23,969.26	30,318.37	35,108.42	38,071.28	38,675.39
CO_2	21,995.80	27,802.40	32,248.42	35,088.43	35,697.77
CH_4	62.80	65.34	76.13	80.87	80.95
N_2O	1,910.66	2,450.63	2,783.87	2,901.98	2,896.67
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	37,182.33	42,593.94	45,724.31	47,480.91	47,863.01

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 and 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.

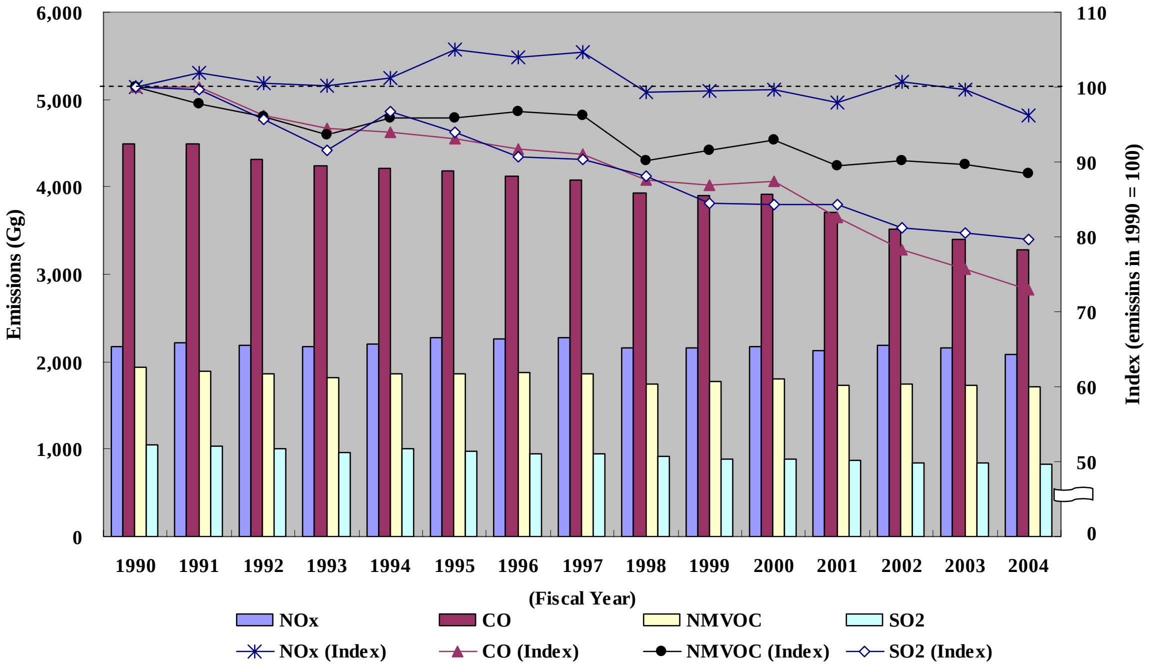

Figure 2-18 Trends in Emissions of Indirect Greenhouse Gases and SO_2

Nitrogen oxide (NO_X) emissions in FY2004 were 2,090 Gg, a decrease by 3.8% compared to FY1990, and by 3.5% compared to the previous year.

Carbon monoxide (CO) emissions inFY2004 were 3,274 Gg, a decrease by 27.1% compared to FY1990, and by 3.7% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY2004 were 1,714 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.

References

IPCC, *Second Assessment Report*, 1995

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

Ministry of Public Management, Home Affairs, Posts and Telecommunications Japan, *Annual Report on Current Population Estimates*

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report* , February 2006

Economic and Social Research Institute (http://www.esri.cao.go.jp/jp/sna/qe044-2/gdemenujb.html)

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 Natura l 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
- Comparison 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 processes. 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 show 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 occur 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] , 'Coal Products' [#2500] , and 'Own Use & Loss' [#2900] are calculated, and other sectors ('Town Gas Production' [#2400] , 'Oil Products' [#2600] , 'Other Conversions & Blending' [#2700], 'Other Input/Output' [#3000] and 'Stock Change' [#3500]) are excluded from calculations.

Energy consumptions 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).

The energy consumption recorded under coal products [#2500] corresponds to the difference between the coke-making carbon input and carbon output. This is the portion that is oxidized in the atmosphere (burned) from the time that red-hot coke is extruded from a coke oven until it enters the coke dry quenching facility. It was considered appropriate to count this as CO_2 emissions, and it was calculated as carbon emissions from this sector.

Energy consumptions reported under 'Oil Products' [#2600] are feedstocks for 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 category change by minor operation. Energy consumption reported under this sector is not for the purpose of combustion; 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. Table 3-3 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

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

Fuel		Code	Unit	1990	1995	2000	2003	2004
Oil Products	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 Natural 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’.

-Consistency 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
	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

Table 3-4 Correspondence between sectors of Japan’s Energy Balance Table and of the CRF (cont.)

CRF			Japan's Energy Balance Table	
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 11.8 million 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	3,341	5,199	7,495	10,699	11,176
CH_4	Gg-CO_2eq	58	150	248	342	342
N_2O	Gg-CO_2eq	56	120	207	288	290
Total	Gg-CO_2eq	3,454	5,469	7,949	11,329	11,808

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.

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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 3-6 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

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 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
Palletizing furnace (steel and non-ferrous metal)	Solid fuel, liquid fuel, gaseous fuel	1.6	Average of 2 facilities
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
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, the percentages of fuel consumption accounted for by each furnace type were interpolated using the data obtained in the years exhaustive survey carried out.

• *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 LTO 1 cycle per domestic airliner × Number of LTO cycles of aircraft in domestic routes

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

<u>*Methane and nitrous oxide emission associated with flight of gasoline-powered domestic aircraft*</u>
= 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 distance travel per type of vehicle by emission factors 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 some category of vehicle, and the default emission factors were used for the other 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 the data shown in table 3-13. "JAMA data": the emission factors were calculated using driving mode test data provided by Japan Automobile

Manufacturers Association, Inc.(JAMA)[2]. "Measured data" were 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. "1996GL" and "GPG(2000)" mean the emission factors were established using the default values in IPCC guidelines.

Detailed method for the determination of the emission factors are described in the *Greenhouse Gases Estimation Methods Committee Report – Transportation* (Ministry of Environment; February, 2006).

Table 3-13 Data source of the emission factors of vehicle

Vehicle Type	Gasoline engine		Diesel engin	
	CH_4	N_2O	CH_4	N_2O
Light passenger vehicle	JAMA data	JAMA data		
Light cargo truck	JAMA data	JAMA data		
Passenger vehicle	JAMA data	JAMA data	JAMA data	JAMA data
Bus	1996GL	GPG(2000)	Measured data	1996GL
Small cargo truck	JAMA data	JAMA data	Measured data	JAMA data
Regular cargo truck	1996GL	GPG(2000)	Measured data	JAMA data
Special-purpose vehicle	1996GL	GPG(2000)	Measured data	1996GL

Table 3-14 Methane emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	2000	2003	2004
Gasoline	Light Vehicle	gCH_4/km	0.008	0.008	0.008	0.007	0.007
	Passenger Vehicle (including LPG)	gCH_4/km	0.015	0.015	0.014	0.013	0.012
	Light Cargo Truck	gCH_4/km	0.020	0.020	0.019	0.016	0.015
	Small Cargo Truck	gCH_4/km	0.022	0.021	0.021	0.018	0.017
	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	0.011	0.012	0.012	0.013	0.013
	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

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[2] JAMA data were provided by test mode. The emission factors were calculated using "combined driving mode". "Combined driving mode" = "10.15 driving mode" ×0.88 + "11 driving mode" ×0.12. "10.15 driving mode" is a hot start driving mode and "11 driving mode" is a cold start driving mode.

Table 3-15 Nitrous oxide emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	2000	2003	2004
Gasoline	Light Vehicle	gN_2O/km	0.015	0.015	0.014	0.011	0.010
	Passenger Vehicle (including LPG)	gN_2O/km	0.024	0.024	0.020	0.015	0.014
	Light Cargo Truck	gN_2O/km	0.024	0.024	0.022	0.017	0.015
	Small Cargo Truck	gN_2O/km	0.020	0.021	0.021	0.017	0.015
	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	0.006	0.005	0.004	0.004	0.004
	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

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 3-16 Distance traveled per type of vehicle

vehicle type	fuel type	Unit	1990	1995	2000	2003	2004
Light vehicle	Gasolin	10^6 vehicles km	15,281	39,386	70,055	90,986	97,058
Passenger vehicle	Gasolin	10^6 vehicles km	289,697	323,022	363,991	378,651	378,767
	Diesel Oil	10^6 vehicles km	42,252	66,787	58,832	45,242	36,389
	LPG	10^6 vehicles km	18,368	17,192	15,382	14,838	14,104
Bus	Gasolin	10^6 vehicles km	95	32	21	29	34
	Diesel Oil	10^6 vehicles km	7,016	6,736	6,598	6,632	6,631
Light cargo truck	Gasolin	10^6 vehicles km	85,336	84,534	74,914	73,623	74,317
Small cargo truck + Cargo passenger truck	Gasolin	10^6 vehicles km	36,981	25,892	24,988	27,058	26,726
	Diesel Oil	10^6 vehicles km	55,428	62,032	57,221	51,014	45,317
Regular cargo truck	Gasolin	10^6 vehicles km	447	361	331	508	642
	Diesel Oil	10^6 vehicles km	66,434	78,086	82,693	83,106	80,580
Special vehicle	Gasolin	10^6 vehicles km	827	851	1,584	1,619	1,619
	Diesel Oil	10^6 vehicles km	10,420	15,373	19,115	20,073	19,526

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*

Methene Emission factors for natural gas-powered light cargo trucks, small cargo trucks, light vehicle and passenger vehicle were determined using JAMA data and the same method used for the same type of gasoline or diesel powered vehicles.

Methene and nitrous oxide emission factors for regular cargo trucks and nitrous oxide emission factors for the vehicles mentioned above 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 bus and special vehicles 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 3-17 Methane and nitrous oxide emission factors for natural gas-powered vehicles

Type	Calculation Method for Emission Factor		Average Emission Factor	
	Methane	Nitrous Oxide	Methane [g-CH_4/km]	Nitrous Oxide [g-N_2O/km]
Small cargo truck	JAMA data	Determined based on actual measurements	0.020	0.0002
Passenger vehicle	JAMA data	Used the emission factors for small cargo truck, taking the specifications of each type of vehicle into account.	0.013	0.0002
light passenger vehicle, light cargo truck	JAMA data		0.013	
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 3-18 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* [0.002(gN_2O/km)]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

Table 3-19 CH_4 emission factors for motorcycles

Fuel	Vehicle Type	Unit	1990	1995	2000	2003	2004
Gasoline two-wheel vehicle (hot start)	Small motor vehicle: first kind	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	0.102
	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	0.008	0.008	0.008	0.007	0.007
	Light two-wheel vehicle	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	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/number of time			0.043	0.041	0.038
	Small motor vehicle: first kind uncontrolled by regulation	gCH_4/number of time	0.039	0.039	0.039	0.039	0.039
	Small motor vehicle: second kind controlled by regulation	gCH_4/number of time			0.004	0.004	0.004
	Small motor vehicle: second kind uncontrolled by regulation	gCH_4/number of time	0.012	0.012	0.012	0.012	0.012
	Light two-wheel vehicle controlled by regulation	gCH_4/number of time			0.022	0.022	0.022
	Light two-wheel vehicle uncontrolled by regulation	gCH_4/number of time	0.016	0.016	0.016	0.015	0.015
	Small two-wheel vehicle controlled by regulation	gCH_4/number of time			0.033	0.033	0.033
	Small two-wheel vehicle uncontrolled by regulation	gCH_4/number of time	0.043	0.043	0.043	0.043	0.043

- ***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 3-20 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 3-21 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 3-22 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 3-23 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.

Table 3-24 Emission source categories for fugitive emissions from fuels (1.B.)

Emission categories				CO_2	CH_4	N_2O
1.B.1 Solid fuels	1.B.1.a. Coal mining	i. Underground mining	During mining	NE	○	
			Post-extraction processes	NE	○	
		ii. Pit mining	During mining	NE	○	
			Post-extraction processes	NE	○	
	1.B.1.b. Solid fuel conversion			NE	NE	NE
	1.B.1.c. Others			NO	NO	NO
1.B.2. Oil and natural gas	1.B.2.a. Oil	i. Exploration		○	○	○
		ii. Production		○	○	
		iii. Transport		○	○	
		iv. Refining/storage		NE	○	NA
		v. Supply		NE	NE	
		vi. Others		NO	NO	
	1.B.2.b. Natural gas	i. Exploration		IE	IE	
		ii. Production/processing		○	○	
		iii. Transport		○	○	
		iv. Supply		NA	○	
		v. Other fugitive emissions		NE	NE	
		Factories and power plants		NE	NE	
		Homes and businesses		NE	NE	
	1.B.2.c. Venting and flaring	Venting	i. Oil industry	○	○	
			ii. Natural gas industry	○	IE	
			iii. Oil and natural gas industry	IE	IE	
		Flaring	i. Oil industry	○	○	○
			ii. Natural gas industry	○	○	○
			iii. Oil and natural gas industry	IE	IE	IE
	1.B.2.d. Others			NO	NO	NO

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 3-25 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	CH_4 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 3-26 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 1 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 3-26).

- ***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 was 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 3-27 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 3-28 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	8
Number of Wells Succeeded	wells	1	3	4	5	4
Number of Wells Tested	wells	5	5	5	4	6

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 3-29 EF for fugitive emissions from petroleum production [Gg/10^3kl]

		CH_4 1)	CO_2	N_2O 2)
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 3-30 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 time series, 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 3-31 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 3-32 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 3-33 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 3-34 Assumptions for calculation of emission factor during oil storage

Methane Emissions [kg-CH_4/year]	Input of Crude Oil to Oil Refining Industry		Emission Factor [kg-CH_4/PJ]
	[PJ: Gross Calorific Value] 1)	[PJ: Net Calorific Value]2)	
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 3-35 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 3-36 Emission factors of fugitive emissions during production of natural gas

[Gg/10^6 m^3]

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

Source: *GPG (2000)* Table 2.16

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

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

-Processing

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

Table 3-37 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 3-38 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 time series, 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 3-39 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	1,106

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

1) CO_2

Approximatly 90% of town gas is based on LNG and is free of carbon dioxide. However, domestically produced natural gas from some of Japan's natural gas formations contains CO_2. Because nearly all of this CO_2 is removed at natural gas production plants before the gas is sent to pipelines, the natural gas provided by town gas suppliers likely contains hardly any CO_2. Emission of CO_2 removed at natural gas production plants is assigned to natural gas production and processing (1.B.2.b.ii). Hence, emissions from this source are reported as "NA."

2) CH_4

• *Background*

Sources of CH_4 emissions in conjunction with transmission of domestically produced natural gas are the release of gas when relocating and building pipelines, and the release of gas used to operate pressure regulators

• *.Methodology for Estimating Emissions of GHGs*

Total natural gas pipeline length is multiplied by a Japan-specific emission factor to calculate CH_4 emissions occurring in conjunction with releases by pipeline construction and relocation, and releases of gas used to operate pressure regulators.

• *Emission Factors*

The amount of CH_4 emitted from a 1-km length of domestic natural gas pipeline over a 1-y period is defined as the emission factor, and is set by dividing the CH_4 emission amount by pipeline length. Due to the insufficiency of past data, it was decided to use a uniform emission factor that was set using FY2004 data for 1990 and subsequent years. Data were provided by the Japan Natural Gas Association.

- CH_4 Emissions
  (i) Gas Releases Due To Pipeline Relocation

The equation below was used as the basis for calculating the CH_4 amount released when in-pipe pressure is reduced for relocating gas pipelines. Further, after relocation work is complete it is necessary to flush the pipeline with natural gas, which is released before introduction into the pipeline. The amount of CH_4 is determined by measuring with a gas meter or calculating it using means such as pipeline pressure when introducing the gas. These were calculated for each pipeline relocation and the annual cumulative total determined.

CH_4 emission amount = volume of pipe section with reduced pressure × pressure before reduction (absolute pressure) / atmospheric pressure (absolute pressure) × CH_4 content (CH_4 per Nm^3)

(ii) Gas Releases Due To Pipeline Installation

After installation work is complete, it is necessary to flush the pipeline with natural gas, which is released before introduction into the pipeline. The amount of methane is determined by measuring with a gas meter or calculating it using means such as pipeline pressure when gas is introduced, and their annual cumulative total determined.

(iii) Release of Gas for Operating Pressure Regulators

Calculated as follows from the amount of natural gas used in accordance with specifications of pressure regulators for reducing gas supply pressure.

CH_4 emission amount = amount used according to pressure regulator specifications × number of regulators installed × methane content (CH_4 per Nm^3)

Table 3-40 FY2004 CH_4 emissions as a concomitant of natural gas transmission

	Amount of gas used (Nm^3/day)	Number of work	Number of establishment	Amount of gas releases (k-Nm^3)	CH_4 conversion factor (t-CH_4/kNm^3)	CH_4 releases (t-CH_4)
Pipeline Relocation & Installation		77		843	0.645	544
Gas for Operating Pressure Regulators	19		48	333	0.643	215
Total						759

- Total Pipeline Length

We used 2090 km as the total length of natural gas pipeline of the main association members covered by an FY2004 study by the Japan Natural Gas Association, which is the pipeline whose emissions are of concern here.

Emission factor = CH_4 release amount / total pipeline length
＝759 t-CH_4 / 2090 km
＝0.363 t-CH_4/km

- ***Activity Data***

The length of natural gas pipeline laid in Japan was used.

Table 3-41 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	2,721

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

Approximatly 90% of town gas is based on LNG and is free of carbon dioxide. However, domestically produced natural gas from some of Japan's natural gas formations contains CO_2. Because nearly all of this CO_2 is removed at natural gas production plants before the gas is sent to pipelines, the natural gas provided by town gas suppliers likely contains hardly any CO_2. Emission of CO_2 removed at natural gas production plants is assigned to natural gas production and processing (1.B.2.b.ii). Hence, emissions from this source are reported as "NA."

2) CH_4

• *Methodology for Estimating Emissions of GHGs*

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 regular maintenance or construction and fugitive methane emissions from town gas pipeline networks.

- LNG Receiving Terminals, Town Gas Production Facilities, and Satellite Terminals

Some of the main emission sources are gas samples taken for analysis and residual gas emitted at times such as regular maintenance of manufacturing facilities. The Tier 1 method is employed in accordance with the *Good Practice Guidance* (2000) decision tree (page 2.82, Fig. 2.14). However, because it is possible to use a Japan-specific emission factor, the amounts of liquefied natural gas and natural gas used as town gas feedstock were multiplied by a Japan-specific emission factor to obtain emissions.

- Town Gas Supply Networks

CH_4 emissions from high-pressure pipelines and from medium- and low-pressure pipelines and holders are calculated by multiplying the total length of city gas pipeline by the emission factor. CH_4 emissions from service pipes are calculated by multiplying the number of users by the emission coefficient.

• *Emission Factor*

- LNG Receiving Terminals, Town Gas Production Facilities, and Satellite Terminals

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).

- Town Gas Supply Networks

Emission sources in the supply of domestically produced town gas are (i) high-pressure pipelines, (ii) medium- and low-pressure pipelines and holders, and (iii) service pipes. FY2004 data were used to calculate CH_4 emissions for each of the minor categories of each of the emission sources shown in Table 3-43. The emission factor for high-pressure pipelines and for medium- and low-pressure pipelines and holders was set using the CH_4 amount emitted from 1 km of the town gas pipeline length during 1 y, while that for service pipes was set using the CH_4 amount emitted from 1000 users' homes during 1 y.

Table 3-42 CH_4 emissions from town gas pipelines and emission factors (Established by FY2004 data)

Emission Sources		CH_4 emissions (t/y) 1)	Source sizes	Emission factors
High-pressure pipelines	New pipeline installation Pipeline relocation	180	Total high-pressure pipeline 1799 km	0.100 t-CH_4/km
Medium- and low-pressure pipelines and holders	Construction and demolition Fugitive emissions Burner and other inspections Holder construction and overhauling	93	Total medium- and low-pressure pipeline 226,016 km	0.411 kg-CH_4/km
Service pipes	Installing service pipes Post-installation purging Removal Changing meters Fugitive emissions, etc. Rounds for opening valves and regular maintenance Equipment repairs (Especially high emissions when doing work at user sites (homes))	19	User homes 27,298,000	0.696 kg-CH_4/1000 homes

1) Data of Japan Gas Association members covered by FY2004 survey.

- ***Activity Data***

- LNG Receiving Terminals, Town Gas Production Facilities, and Satellite Terminals

The amounts of LNG and natural gas shown in *General Energy Statistics* (Agency for Natural Resources and Energy) as used as raw material for town gas.

Table 3-43 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

- Town gas supply networks

Estimates use the high-pressure pipeline length, total medium- and low-pressure pipeline length, and number of users given in the *Gas Industry Yearbook* of the Agency for Natural Resources and Energy Gas Market Division.

Table 3-44 High-pressure pipeline length, total medium- and low-pressure pipeline length, and number of users

Item	Unit	1990	1995	2000	2003	2004
High-pressure pipeline length	km	1,067	1,281	1,443	1,716	1,816
total medium- and low-pressure pipeline length	km	180,239	197,474	214,312	223,476	226,268
number of users	10^3 houses	21,334	23,580	25,858	26,960	27,298

- ***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 3-45 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 (see Table 3-32).

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 considered only for the amount during transportation because. *Good Practice Guidance* (2000) provides emissions factors only for transportation. Intentional CO_2 emissions from natural gas pipelines are reported as “NA” because CO_2 emissions during Transmission of natural gas are considered as “NA” (1.B.2.b.iii.) Intentional CH_4 emissions from natural gas pipelines are reported as “IE” because they are included in emissions during natural gas transmission (1.B.2.b.iii).

• *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.

Table 3-46 Emission factors for transmission of natural gas

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

Source: Good Practice Guide (2000), Table 2.16

• *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 (see Table 3-41).

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 3-47 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 (see Table 3-32).

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 3-48 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 (see Table 3-39).

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.)

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

UNFCCC "*UNFCCC Reporting Guidelines on Annual Inventories*" (FCCC/SBSTA/2004/8)

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

Ministry of the Environment, *Research of Air Pollutant Emissions from Stationary Sources (MAP Survey)*

Environmental Agency, *The Estimation of CO_2 Emissions in Japan*, 1992

Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 1*, September 2000

Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 2*, September 2000

Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 3*, September 2000

Ministry of the Environment, Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 1*, August 2002

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

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 3*, August 2002

Ministry of Economy, Trade and Industry, *Structural Survey of Energy Consumption in Commerce and Manufacturing*

Ministry of Economy, Trade and Industry, *Yearbook of Mineral Resources and Petroleum Products Statistics*

Ministry of Economy, Trade and Industry, *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke*

Ministry of Land, Infrastructure and Transport, *Road Transport Census*

Ministry of Land, Infrastructure, and Transports, *Statistical Yearbook of Air Transport*

Ministry of Land, Infrastructure and Transport, *Statistical Yearbook of Motor Vehicle Transport*

Automobile Inspection and Registration Association (http://www.aira.or.jp/data/data.html)

Japan Gas Association website (http://www.gas.or.jp/default.html)

Japan Sociality Atmospheric Environment, *Reports on Greenhouse gas emissions estimation methodology*, 1996

Natural Gas Mining Association, *Natural Gas Annual Report*

Kazunari Kaino, *Interpretation of General Energy Statistics*, February 2003

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		IE	○	NA			
2.C. Metal production	2.C.1.	Iron and steel		IE	NA				
		Pig iron		IE	NA				
		Sintered steel		IE	IE				
		Coke		IE	IE				
		Other (electric furnace)		○	○				
	2.C.2.	Ferroalloys production		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					○	○	○

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

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
				Phenol Foam					NO	NO	NO
			Soft Form						NO	NO	NO
	2.F.3.	Fire extinguishers			Manufacturing				NO	NO	NO
					Stock				NE	NO	NO
					Disposal				NO	NO	NO
	2.F.4.	Aerosols/metered dose inhalers	Aerosols		Manufacturing				○	NO	NO
					Stock				○	NO	NO
					Disposal				IE	NO	NO
			Metered Dose Inhalers		Manufacturing				○	NO	NO
					Stock				○	NO	NO
					Disposal				IE	NO	NO
	2.F.5.	Solvents			Manufacturing				IE	○	NO
					Stock				IE	IE	NO
					Disposal				IE	IE	NO
	2.F.6.	Other applications using ODS substitutes							NE	NA	NA
	2.F.7.	Semiconductor manufacture			Manufacturing				IE	IE	IE
					Stock				○	○	○
					Disposal				NA	NA	NA
	2.F.8	Electrical equipment			Manufacturing						○
					Stock						○
					Disposal						IE
	2.F.9	Other (for research, healthcare, etc.)							NA	NE	NE

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.

CO_2 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***

CO2 emissions are calculated according to the Tier 1 method in GPG (2000) in which amounts of quicklime and dolomitic quicklime are multiplied by default emission factors.

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

= raw material-specific emission factor (Gg-CO_2/t) × amount of quicklime and dolomitic quicklime)

- ***Emission Factors***

The default values for high calcium lime and dolomitic lime given in GPG (2000) were used.

Table 4-4 Basic parameters for the calculation of emission factors for lime production

Lime Type	Stoichiometric Ratio	Range of CaO Content (%)	Range of MgO Content (%)	Default Value for CaO/CaO-MgO Content	Default Emission Factor （kg-CO_2/t）
High Calcium Lime	0.79	93-98	0.3-2.5	0.95	750
Dolomitic Lime	0.91	55-57	38-41	0.95 or 0.85	860

Source: GPG (2000) page 3.22 Table 3.4

- ***Activity Data***

The volume of quicklime produced according to 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 (high calcium lime). The volume of dolomitic quicklime produced according to the Japan Lime Association’s *Demand Outlook by Application* was used as activity data for dolomitic quicklime.

Table 4-5 Production values of quicklime and dolomitic quicklime

Item	Unit	1990	1995	2000	2003	2004
Quicklime Production	kt	8,983	7,871	8,038	8,065	8,637
Dolomitic lime Production	kt	696	572	499	476	563

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]).

$CaCO_3 \rightarrow CaO + CO_2$
$MgCO_3 \rightarrow MgO + CO_2$
・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% × 100.0872 / 56.0774
= 61.53%

・$MgCO_3$ content = proportion of MgO extractable from dolomite × molecular weight of $MgCO_3$ / molecular weight of MgO
= 18.3% × 84.3142 / 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 / 100.0872×0.6153＋44.0098 / 84.3142×0.3839
＝ 0.2706＋0.2004
＝ 0.4709
＝ 471（kg-CO_2/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 4-6 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 4-7 Soda ash use

Item	Unit	1990	1995	2000	2003	2004
Soda Ash Shipping	kt	1,098	977	634	434	475
Soda Ash Imported	kt	0.00	8.25	53.12	93.37	92.99
Other Disodium Carbonate Imported	kt	308	299	360	362	330

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

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

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 4-8, 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 4-8 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	Kainou (2003)	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	Kainou (2003)	20.1	21.1	MJ/m^3

Table 4-9 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.

N_2O emissions (kg-N_2O) from nitric acid production
= emission factor [kg-N_2O/t] × 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 4-10 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 4-11 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 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

• *Background*

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.

• *Methodology for Estimating Emissions of GHGs*

Emissions were calculated by multiplying an emission factor based on actual figures obtained in Japan by the energy consumption of electric arc furnaces. This is the same method used for calculating CH_4 emissions in the Fuel Combustion Sector (1.A. Solid Fuels).

• *Emission Factor*

The emission factor of energy consumption from electric arc furnaces (12.8 kg-CH4/TJ) was determined by using the formula for calculating fuel combustion and actual data from

Japanese measurement surveys of CH_4 concentrations in gas ducts, concentrations of O_2 and theoretical flue gas amounts (dry), theoretical air demand, and high calorific values. See Chapter 3 3.1.2 Stationary Combustion (1.A.1., 1.A.2., 1.A.4.: CH_4 and N_2O)

- ***Activity Data***

Energy consumption amounts included in the "electric furnace" category for the iron and steel industries of the *General Energy Statistics* were used.

Table 4-12 Energy consumption from electric arc furnaces (for carbide)

Consumption	Unit	1990	1995	2000	2003	2004
Furnaces (for Carbide)	TJ	1,576	4,277	2,454	2,454	2,454

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*.

CO_2 emissions in conjunction with calcium carbide production and consumption

= Σ(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 4-13 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].

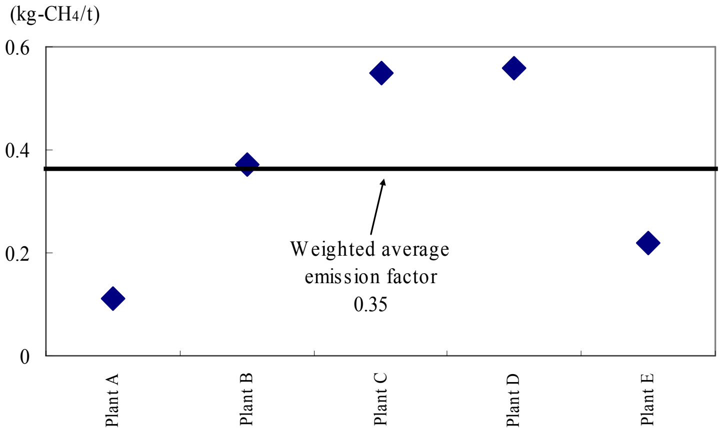

Figure 4-1 CH_4 Emission factor for carbon black production

Source: Data provided by the Carbon Black Association

Table 4-14 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 4-15 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].

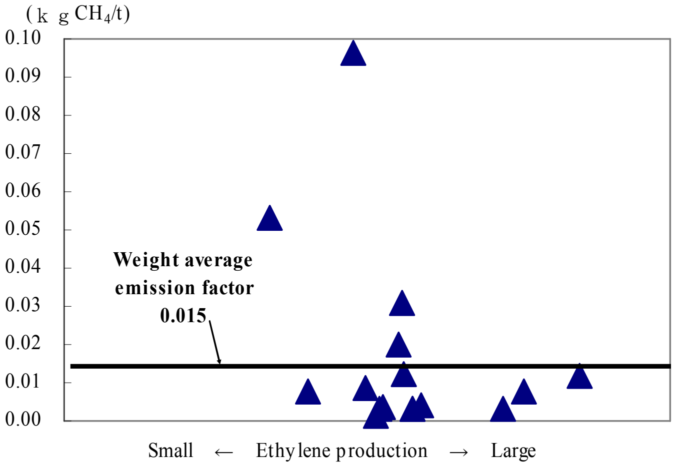

Figure 4-2 Emission factor for methane from manufacturing ethylene

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 4-16 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].

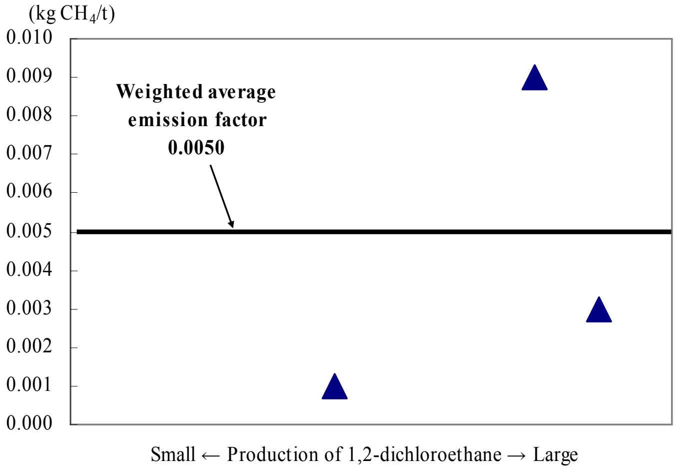

Figure 4-3 Methane emission factors for 1,2-dichloroethane production

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 4-17 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].

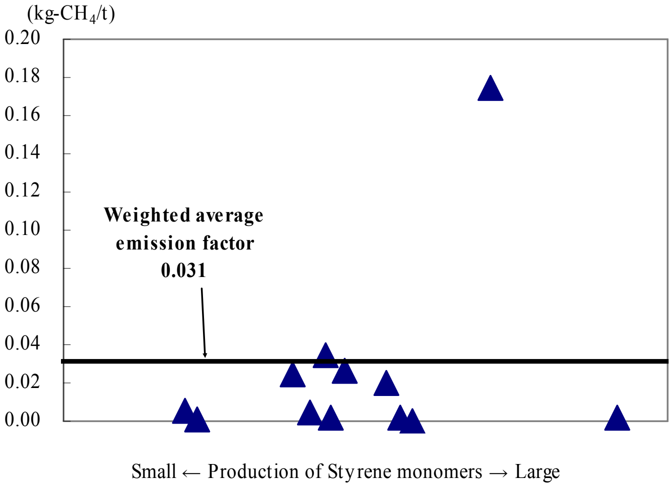

Figure 4-4 Methane emission factors for styrene production

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 4-18 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 4-19 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

This category is reported as IE because the emissions of CO_2 from coke production are included in the coal products and production section of the Fuel Combustion Sector (1.A.).

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].

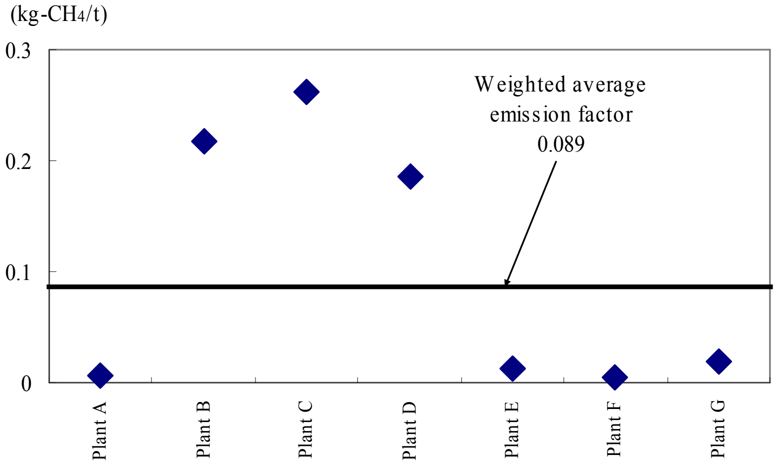

Figure 4-5 Emission factors for methane in combustion exhaust gas from coking furnaces

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 4-20 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 4-21 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[1] (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".

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[1] SBDT: Sectoral Background Data Table

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 iron and steel production in Japan. This category is reported as IE because the emissions of CO_2 from coke production are included in the coal products and production section of the Fuel Combustion Sector (1.A.).

2) CH_4

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

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

1) CO_2

• *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 estimated by amount of carbon calculated by weight of production and import of carbon electrodes minus weight of export of carbon electrodes. This difference of the carbon is assumed to be diffused to atmosphere as CO_2. The carbon include in electric furnaces gas given in the *General Energy Statistics* are subtracted from the CO_2 emission in this source since this emission are included in category 1.A fuel combustion.

- ***Activity Data***

Production of carbon electrodes given in *Yearbook of ceramics and building materials statistics* compiled by the Ministry of Economy, Trade and Industry, and import and export of carbon electrodes given in *Trade Statistics of Japan,* Ministry of Finance are used.

Table 4-22 CO_2 emission from carbon electrodes of furnaces

	Unit	1990	1995	2000	2003	2004
#A Import	t	12,341	18,463	11,363	12,001	15,430
#B Domestic production	t	211,933	186,143	184,728	206,088	206,924
#C Export	t	87,108	92,812	107,998	131,169	130,260
#D Electric furnaces gas	t	39,983	14,300	20,293	20,990	21,725
Domestic consumptions (#A+#B-#C-#D)	t	97,184	97,493	67,800	65,930	70,370
CO_2 emissions	Gg-CO_2	356	357	248	242	258

2) CH_4

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

Emissions were calculated by multiplying an emission factor based on actual figures obtained in Japan by the energy consumption of electric arc furnaces. This is the same method used for calculating CH_4 emissions in the Fuel Combustion Sector (1.A. Solid Fuels).

- ***Emission Factor***

The emission factor of energy consumption from electric arc furnaces (12.8 kg-CH_4/TJ) was determined by using the Japanese measurement surveys. See Chapter 3 3.1.2 and Chapter 4 4.2.4.1)

- ***Activity Data***

Energy consumption amounts included in the "electric furnace" category for the iron and steel industries of the *General Energy Statistics* were used.

Table 4-23 Energy consumption from electric arc furnaces

Consumption	Unit	1990	1995	2000	2003	2004
Furnaces	TJ	57,564	55,986	52,457	51,906	53,107

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

• *Methodology for Estimating Emissions of GHGs*

Ferroalloys are manufactured in Japan in electric arc furnaces, small-scale blast furnaces, and Thermit furnaces. Methane generated in association with ferroalloy production is thought to be generated when the oxidization of coke, a reduction agent, takes place. Methane emissions from ferroalloy production were calculated by multiplying an emission factor based on actual figures obtained in Japan by the energy consumption of electric arc furnaces. This is the same method used for calculating CH4 emissions in the Fuel Combustion Sector (1.A. Solid Fuels).

• *Emission Factor*

The value for the emission factor of electric arc furnaces (12.8 kg-CH4/TJ) was used because these furnaces produce ferroalloys.

• *Activity Data*

Energy consumption amounts included in the "ferroalloy" category for the iron and steel industries of the *General Energy Statistics* were used.

Table 4-24 Energy consumption from ferroalloy production

Consumption	Unit	1990	1995	2000	2003	2004
Furnaces (for Ferroalloy)	TJ	14,456	10,699	10,181	9,487	9,818

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 4-25 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: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, 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 4-26 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: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, 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.-)

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

Estimating emissions involved subtracting the recovery and destruction amount of by-product HFC-23 (measured data) from the amount of by-product HFC-23 generated at HCFC-22 production plants in Japan. The amount of by-product HFC-23 was estimated by multiplying the production of HCFC-22 by the generation rate of HFC-23 (obtained from the results of composition analysis of interior of a reactor).

Emissions of by-product HFC-23 associated with the production of HCFC-22

Emissions of HFC-23 = Production of HCFC-22 (t) ×Rate of generation of HFC-23 (%)
- Amount of recovery and destruction (t)

Table 4-27 Indices related to By-product Emissions of HFC-23: Production of HCFC-22

	unit	1995	2000	2002	2003	2004
Production of HCFC-22	t	81,000	95,271	72,787	77,310	61,900
Rate of generation of HFC-23	%	2.13%	1.70%	1.54%	1.65%	1.94%
Emission rate for production of HCFC-22	%	1.79%	1.11%	0.72%	0.56%	0.14%
Emissions	t	1,455	1,066	523	432	90*
	$MtCO_2$eq.	17.024	12.475	6.114	5.053	1.051

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

*Emissions were decreased because all manufacturing facilities had been equipped with a destruction unit.

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

• *Methodology for Estimating Emissions of GHGs*

Emissions were estimated based on the mass balance of measurement data at each of HFCs, PFCs, SF_6 manufacturing plants in Japan. Fugitive emissions in production from this source category were reported by subtracting the amount of production from the amount of HFCs, PFCs, SF_6 generated at each gas manufacturing facility. Emissions of HFCs for each year were given by the Japan Fluorocarbon Manufactures Association and of PFCs and SF_6 by Japan Chemical Industry Association.

The associated indices are given in the table below.

Table 4-28 Indices related to fugitive emissions from HFCs production

	Unit	1995	2000	2002	2003	2004
production of HFCs	t	28,206	29,423	43,778	49,189	52,106
emissions	t	322	146	278	257	251
	$MtCO_2$eq.	0.419	0.180	0.338	0.400	0.416

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

Table 4-29 Indices related to fugitive emissions from PFCs production

	Unit	1995	2000	2002	2003	2004
production of PFCs	t	1,207	2,337	2,278	2,602	2,905
emissions	t	107	184	129	122	109
	$MtCO_2$eq.	0.763	1.383	1.006	0.971	0.863

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

Table 4-30 Indices related to fugitive emissions from SF_6 production

	Unit	1995	2000	2002	2003	2004
production of SF_6	t	2,392	1,556	1,642	1,757	1,895
emissions	t	197	36.0	36.0	34.0	32.0
	$MtCO_2$eq.	4.708	0.860	0.860	0.813	0.765

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

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

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

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

1) HFCs

• *Methodology for Estimating Emissions of GHGs*

The collected volume of HFC under regulation was subtracted from 1) fugitive refrigerant ratio from production, 2) fugitive refrigerant ratio from use (including failure of devices), and 3) refrigerant contained at the time of disposal, separately, based on production and shipment volumes and refrigerant contained. Then, all there were combined.

Emissions from use and disposal were estimated by summing up the values calculated for each year of production of devices.

<u>*Emissions of HFCs from Domestic Refrigeration*</u>

HFC emissions = total refrigerant contained from manufacturing × fugitive refrigerant ratio from production
+ Σ (number of operated devices containing HFC × refrigerant contained per operated device ×fugitive refrigerant ratio from use)
+ Σ (number of disposed devices containing HFC × refrigerant contained per disposed device - collected volume of HFC

The associated indices are given in the table below.

Table 4-31 Indices related to emissions of HFCs from domestic refrigeration

	Unit	1995	2000	2002	2003	2004
Total HFC Charged in the year	t	520	590	414	250	157
Fugitive refrigerant ratio from production	%	1.00%	1.00%	0.44%	0.21%	0.25%
Number of operated devices	1,000 devices	7,829	33,213	41,312	43,337	43,320
Refrigerant charged during assembly	g	150	125	125	125	125
Operational fugitive ratio (incl. accident)	%	0.3%	0.3%	0.3%	0.3%	0.3%
Disposed device	1,000 devices	0	177	618	959	1,379
Collected volume of HFC in accordance with low	t/year	—	—	10	20	35
Emissions	t	8.7	40	83	114	150
	$MtCO_2$eq.	0.011	0.051	0.108	0.148	0.195

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, 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

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

In accordance with the *IPCC Guidelines,* emissions of each species of F-gases from 1) manufacturing, 2) operation, 3) maintenance, 4) accident and 5) disposal are estimated for devices below.

centrifugal refrigerating machine, screw refrigerating machine, refrigerator-freezer unit, transport refrigerator-freezer unit, separately placed showcase, built-in showcase, ice making machinery, water fountain, commercial refrigerator-freezer, all-in-one air conditioning system, gas heat pump, chilling unit

Emissions of HFCs from Commercial Refrigeration

Methods below are applied to each type of device and refrigerant (HFCs)

1) manufacturing

Emissions from manufacturing = Σ (number of device produced × volume of refrigerant contained × fugitive refrigerant ratio from manufacturing)

2) operation

Emissions from operation = Σ (number of device charged refrigerant in place produced × volume of refrigerant contained × fugitive refrigerant ratio from operation)

3) maintenance

Emissions from maintenance = Σ (number of devices operated × volume of refrigerant contained × fugitive refrigerant ratio from maintenance)

4) accident

Emissions from accident = Σ (number of devices operated × volume of refrigerant contained × incidence rate of all refrigerant released)

5) disposal

(a) until 2001

Emissions from disposal = Σ {number of devices disposal × volume of refrigerant contained × (1-collect rate) }

(b) from 2002 onward

Emissions from disposal = Σ (number of devices disposal × average volume of refrigerant contained) -volume collected

* "number of devices operated" and "number of devices disposal" are estimated with volume of shipment and lifetime of device

The associated indices are given in the table below.

Table 4-32 Indices related to emissions of HFCs from commercial refrigeration

	Unit	1995	2000	2002	2003	2004
number of device produced	1,000	223	386	995	1,188	1,385
volume of refrigerant charged during assemble	g/device	321	545	3,102	3,909	3,850
fugitive refrigerant ratio from manufacturing	%	0.2%	0.2%	0.2%	0.2%	0.2%
number of device charged refrigerant in place produced	1,000	9	35	543	750	844
volume of refrigerant contained from in place	g/device	723	1,049	3,934	5,011	5,093
fugitive refrigerant ratio from operation	%	1%	1%	3%	2%	2%
number of devices operated	1,000	377	1,985	3,298	4,336	5,485
fugitive refrigerant ratio from maintenance	%	24%	14%	13%	13%	13%
incidence rate of all refrigerant released	%	0.10%	0.12%	0.17%	0.19%	0.19%
number of devices disposal	1,000	0	19	64	88	115
collected volume of HFC under regulation	t/year	0	0	65.7	93.7	139.6
Emissions	t	7.1	67	232	282	341
	$MtCO_2$eq.	0.009	0.113	0.385	0.478	0.587

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

* From 2002 onward, “number of device charged refrigerant in place produced” and “fugitive refrigerant ratio from operation” are increase because of device becoming larger with increasing commercial package AC device.

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

• *Methodology for Estimating Emissions of GHGs*

Emissions of F-gases from 1) manufacturing, 2) accident and 3) disposal are estimated.

Emissions of HFCs from Automatic Vender machine

Methods below are applied to each type of device and refrigerant (HFCs)

1) manufacturing

Emissions from manufacturing = Σ (number of device produced × volume of refrigerant contained × fugitive refrigerant ratio from manufacturing)

2) accident

Emissions from accident = Σ (number of devices operated × volume of refrigerant contained × incidence rate × average fugitive rate in accident)

3) disposal

(a) until 2001

Emissions from disposal = Σ {number of devices disposal × volume of refrigerant contained × (1-collect rate) }

(b) from 2002 onward

Emissions from disposal = Σ (number of devices disposal × average volume of refrigerant contained) -volume collected

The associated indices are given in the table below.

Table 4-33 Indices related to emissions of HFCs from automatic vender machines

	Unit	1995	1999	2000	2001	2002	2003	2004
number of device produced	1,000	0	12	272	344	321	344	350
volume of refrigerant charged during assemble	g	-	300	300	280	240	220	220
fugitive refrigerant ratio from manufacturing	%	-	-	-	0.5%	0.3%	0.3%	0.3%
number of devices operated	1,000	0	12	284	628	949	1,293	1,643
incidence rate	%	-	0%	0%	0.35%	0.35%	0.35%	0.35%
fugitive refrigerant ratio in accident	%	-	0%	0%	20%	20%	20%	20%
fugitive refrigerant ratio from servicing	%	-	0%	0%	0.90%	0.59%	0.54%	0.57%
number of devices disposal	1,000	-	0	0	0	0	0	0
emissions	t $MtCO_2eq.$	- -	0 0	0 0	0.58 0.001	0.44 0.001	0.48 0.001	0.53 0.001

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

* Accident on devise charged with HFCs were almost never occurred in 1999 and 2000, then, reported as 0. After 2001 onward, accident occurred are considered with estimation.

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

• *Methodology for Estimating Emissions of GHGs*

In accordance with the *IPCC Guidelines*, emissions of each species of F-gases from 1) manufacturing, 2) operation, 3) accident and 4) disposal are estimated for devices below.

Emissions of HFCs from Stationary Air-Conditioning (Household)

1) manufacturing

Emissions from manufacturing = Σ (number of device produced × volume of refrigerant contained × fugitive refrigerant ratio from manufacturing)

2) operation

Emissions from operation = Σ (number of device for shipment × volume of refrigerant contained × fugitive refrigerant ratio from operation)

3) accident

Emissions from accident =Σ (number of devices operated × volume of refrigerant contained × incidence rate)

4) disposal

(a) until 2001

Emissions from disposal = Σ {number of devices disposal × volume of refrigerant contained × (1-collect rate) }

(b) from 2002 onward

Emissions from disposal = Σ (number of devices disposal × average volume of refrigerant contained) - volume collected

* "number of devices operated" and "number of devices disposal" are estimated with volume of shipment and lifetime of device

The associated indices are given in the table below.

Table 4-34 Indices related to emissions of HFCs(R-410a) from stationary air-conditioning (household)

	Unit	1995	2000	2002	2003	2004
number of device produced	1,000	0	1,077	2,913	4,024	4,546
volume of refrigerant charged during assemble	G	-	1,000	1,000	1,000	1,000
fugitive refrigerant ratio from manufacturing	%	-	0.2%	0.2%	0.2%	0.2%
fugitive refrigerant ratio from operation	%	-	2%	2%	2%	2%
number of devices operated	1,000	0	1,728	7,216	12,093	18,825
incidence rate of all refrigerant released	%	-	0.3%	0.3%	0.3%	0.3%
fugitive refrigerant ratio in accident	%	-	79%	79%	79%	79%
collected volume of HFC under regulation	t/year	-	-	0.5	2.2	4.9
emissions	t	-	27	80	106	184
	$MtCO_2eq.$	-	0.046	0.139	0.182	0.317

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, 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

• *Methodology for Estimating Emissions of GHGs*

In accordance with the *IPCC Guidelines*, emissions of each species of F-gases from 1) manufacturing, 2) operation, 3) maintenance, 4) accident and 5) disposal are estimated.

Emissions of HFCs from Mobile Air-Conditioning (Car Air Conditioners)

Methods below are applied to each type of cars

1) manufacturing

Emissions from manufacturing = Σ (number of device produced × volume of refrigerant contained × fugitive refrigerant ratio from manufacturing)

2) operation

Emissions from operation = Σ (number of cars × volume of refrigerant contained × fugitive refrigerant ratio from operation)

3) maintenance

Emissions from maintenance =Σ (number of cars operated × volume of refrigerant contained × fugitive refrigerant ratio from maintenance)

4) accident

Emissions from accident =Σ (number of cars in complete collapse × volume of refrigerant contained)

5) disposal

(a) until 2001

Emissions from disposal =Σ {number of cars disposal × volume of refrigerant contained × (1-collect rate) }

(b) from 2002 onward

Emissions from disposal =Σ (number of cars disposal × average volume of refrigerant contained) -volume collected

* "number of devices operated" and "number of devices disposal" are estimated with volume of shipment and lifetime of device

Table 4-35 Indices related to emissions of HFC-134a from car air conditioners

	unit	1995	2000	2002	2003	2004
number of cars produced	1,000	9,745	9,761	9,887	9,909	10,129
fugitive refrigerant ratio from manufacturing	g	4	4	4	4	4
number of cars operated	1,000	15,655	42,374	50,731	54,488	56,153
volume of refrigerant charged	g	700	615	588	582	553
fugitive refrigerant volume from operation per year	g	15	15	15	15	15
accident incidence	%	4%	4%	4%	4%	4%
fugitive refrigerant ratio from accident	%	50%	50%	50%	50%	50%
number of cars in complete collapse	1,000	50	136	162	174	185
average volume of refrigerant charged for cars in complete collapse	g	681	610	573	556	539
number of cars disposal	1,000	116	789	1,290	1,596	1,756
average volume of refrigerant charged for cars disposal	g	676	593	567	560	538
collected volume of HFC under regulation	t/year	-	-	61	246	349
emissions	t	605	1,760	2,170	2,230	2,240
	MtCO$_2$eq.	0.787	2.287	2.816	2.901	2.912

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, 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）

• *Methodology for Estimating Emissions of GHGs*

In accordance with the *IPCC Guidelines* (closed-cell foams), emissions were calculated 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. Because the breakdown of HFC emissions by types (HFC-134a, HFC-245fa and HFC-365mfc) included in the total HFC emissions is indicated in the documents of the Chemical and Bio Subgroup of the Industrial Structure Council, only HFC-134a for which the value for the Global Warming Potential (GWP) was found was estimated. The amount of foam blowing agents used each year was provided by the Japan Urethane Foam Association, Japan Urethane Raw Materials Association.

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”.

Urethane-related HFC-134a emissions

HFC-134a emissions = Amount of HFC-134a used [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 4-36 Indices related to emissions of HFC-134a from urethane foam

	Unit	2000	2001	2002	2003	2004
HFC-134a Use	t	167	177	201	233	190
Leakage during foam blowing	%	10%	10%	10%	10%	10%
Annual emissions rate during use	%	4.5%	4.5%	4.5%	4.5%	4.5%
Emissions within the first year after production	t	17	18	20	23	19
Emission during use	t	0	7.5	15	25	35
Emissions	t	17	25	36	48	54
Emissions during production	$MtCO_2eq$	0.022	0.023	0.026	0.030	0.025
Emissions during use	$MtCO_2eq$.	0.000	0.010	0.020	0.033	0.046
Emissions	$MtCO_2eq$.	0.022	0.033	0.046	0.062	0.070

Source: For HFC-134a Use, leakage during foam blowing, and annual emissions rate during use, Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

*: The amount of HFC-134a used in 1995-1999 was zero.

4.6.2.1.b. High Expanded Polyethylene Foam

In accordance with the *IPCC Guidelines* (open-cell foams), emissions were calculated assuming that all of the emissions from foam blowing agents used occurred at the time of production. The amount of the emissions from foam blowing agents used each year was provided by the High Expanded Polyethylene Foam Industry Association.

Table 4-37 Indices related to emissions of HFC-134a from polyethylene foam

	Unit	1995	2000	2002	2003	2004
HFC-134a Use	t	350	320	299	294	254
Emissions	t	350	320	299	294	254
	$MtCO_2eq$.	0.455	0.416	0.389	0.382	0.330

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

Table 4-38 Indices related to emissions of HFC-152a from polyethylene foam

	Unit	1995	2000	2002	2003	2004
HFC-152a Use	t	14	0	0	0	0
Emissions	t	14	0	0	0	0
	$MtCO_2eq$.	0.002	0	0	0	0

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

4.6.2.1.c. Extruded Polystyrene Foam （HFC-134a）(2.F.2.-)

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

Emissions were calculated assuming 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 of 2.5% per year. The amount of the emissions from foam blowing agents used each year was provided by the Extruded Polystyrene Foam Industry Association. This assumption is consistent with the *IPCC Good Practice Guidance* and the estimating method under PRTR for the amount of transferred HCFC at polystyrene foam production sites.

It is difficult to separate the emission "use" from that at the time of "disposal" because heat insulation material is disposed at various times such as the renovation and dismantle of buildings, and in a time of disaster. Since disposed polyethylene foam is considered to be emitting HFCs as well as that in use, these emissions are combined and reported under "use", while the emissions from "disposal" was reported as "IE"

Extruded polystyrene foam-related HFC-134a emissions

HFC-134a emissions = Amount of HFC-134a used in particular year [t] × Leakage during foam blowing 25% + Total amount used in the past up to the previous year [t] × Annual emission rate during use [%]

Table 4-39 Indices related to emissions of HFC-134a from polyethylene foam

	Unit	2001	2002	2003	2004
HFC-134a Use	t	10	35	638	517
Foam Productization rate	%	75%	75%	75%	75%
Annual emission rate during use	%	2.5%	2.5%	2.5%	2.5%
Emissions during production	t	2.5	8.8	160	129
Emissions during use	t	0	0.25	1.1	17
Emissions	t	2.5	9.0	161	146
Emissions during production	MtCO2eq.	0.003	0.011	0.207	0.168
Emission during use	MtCO2eq.	0.000	0.000	0.001	0.022
Emissions	MtCO2eq.	0.003	0.012	0.209	0.190

Source: For HFC-134a Use, foam productization rate, and annual emissions rate during use, Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

The amount of HFC-134a used in 1995-2000 was zero.

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.)

HFC-23 and HFC-227ea are used for the productions of fire extinguishers. However, as of 2004, only HFC-227ea is filled in the bottles for fire extinguishing equipments, and each company purchases HFC-23 fire extinguishers that HFC-23 is already filled in the bottles.

HFCs emission from this category was reported as “NO” by expert judgment since HFC-227ea was very small amount, 0.0007(t) (= 700g) when emission from production in FY2004 was estimated.

Concerning emission in use, emission in 1995 was reported as no emissions, and the emission from 1996 onward was reported as “NE”, but will be reviewed from now on since HFC filled fire extinguishers were not in the market as of 1995, and it is considered that Japan had no record of their use.

Concerning the emission at the time of disposal of fire extinguishers, is reported as “NO” because the use of HFC for fire extinguishers has been just started, also the expected lifetime of buildings is 30-40 years, so it is unlikely to be disposed as of present time,

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.-)

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

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. Fugitive emissions from manufacturing is considered to the balance of the amount used for production and the actual measurement amount filled in the products, and it is included in the emissions. The amount used for production and the amount filled in the products were the data provided by the Aerosol Industry Association of Japan (AIAJ). HFC is considered to be actually remained in disposed aerosols on some level. However, the amount of emission at the time of “disposal” was reported as “IE” since it is included in the calculation for the “use” category.

F-gas（<u>HFC-134a, HFC-152a</u>）emissions associated with the manufacturing of Aerosol

F-gas emissions in year n = Fugitive emissions during manufacturing (t)
＋ F-gas potential emissions in year (n-1) × 50（%）
＋ F-gas potential emissions in year n × 50（%）

Fugitive emissions during manufacturing = F-gas consumed during manufacturing in year n
- F-gas potential emissions

The associated indices are given in the table below.

Table 4-40 Indices related to emissions of HFC-134a from aerosols

	Unit	1994	1995	2000	2002	2003	2004
Potential Emissions	t	800	1,300	2,044	2,003	1,598	1,162
Fugitive emissions*	t	—	—	80.2	57.5	50.4	39.6
emissions in the year	t	400	650	1,022	1,002	799	581
remaining (emissions in the next year)	t	400	650	1,022	1,002	799	581
emissions	t	—	1050	2,137	1,973	1,851	1,420
	$MtCO_2eq.$	—	1.365	2.778	2.564	2.406	1.845

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

* Fugitive emissions from 1994 to 1997 are concluded in potential emissions.

Table 4-41 Indices related to emissions of HFC-152a from aerosols

	Unit	1995	2000	2001	2002	2003	2004
Potential Emissions	t	0	34	119	189	553	1077
Fugitive emissions*	t	0	1.1	2.5	4.9	27.7	23.3
emissions in the year	t	0	17	59	95	276	538
remaining (emissions in the next year)	t	0	17	59	95	276	538
emissions	t	0	18	79	159	399	838
	$MtCO_2eq.$	0	0.002	0.011	0.022	0.056	0.117

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

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

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

In accordance with the *IPCC Guidelines*, emissions were calculated on the assumption that from the amount used each year, 50% of the emission occurred in the year of production, with the remaining 50% emitted in the following year.

The amount of purchased gas, the amount of the use of domestically produced MDI, and the use of imported MDI, and the amount of disposal of MDI were provided by theFederation of Pharmaceutical Manufacturers' Associations of Japan (FPMAJ). FPMAJ estimates the amount of HFC included mainly in destructed MDI because of defective products.

F-gas （HFC-134a, HFC-227ea） emissions associated with the manufacturing of MDI

F-gas emissions in year n = Fugitive emissions during manufacturing (t)
＋ F-gas potential emissions in year (n-1) × 50（%）
＋ F-gas potential emissions in year n × 50（%）
- amount of disposal of F-gas contained in MDI

Potential emissions of F-gas = F-gas contained in domestic produced MDI + F-gas contained in imported MDI

The associated indices are given in the table below.

Table 4-42 Indices related to emissions of HFC-134a from MDI

	Unit	1995	2000	2002	2003	2004
Purchases of F-gas	t	0	1.4	1.1	0.7	0.9
Usage of domestic MDI	t	0	1.4	0.9	0.6	0.8
Usage of imported MDI	t	0	42	46.5	47.3	56.5
Amount of destroyed	t	0	0.2	0.3	0.2	2.2
Emissions	t	-	37	47	48	51
	$MtCO_2eq.$	-	0.048	0.061	0.062	0.066

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

Table 4-43 Indices related to emissions of HFC-227ea from MDI

	Unit	1995	2000	2002	2003	2004
Purchases of F-gas	t	-	0	8.3	27.7	52.3
Usage of domestic MDI	t	-	0	7.9	25.5	48.3
Usage of imported MDI	t	-	4	5.2	3.6	3.5
Amount of destroyed	t	-	0	0.2	0.4	2.2
Emissions	t	-	1.8	13	23	42
	$MtCO_2eq.$	-	0.005	0.037	0.066	0.123

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, 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 PFCs emissions associated with the use of solvents, washing, and etc. HFCs used as solvents are dealt as confidential data, then, these data are reported together with PFCs. 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. The liquids PFC used were C_5F_{12}（PFC-41-12）and C_6F_{14}（PFC-51-14）. 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 conservativeness, 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; any disposal was not identified in 1995. The associated indices are given in the table below.

Table 4-44 Indices related to emissions of PFCs etc. from solvents

	Unit	1995	2000	2002	2003	2004
emissions	$MtCO_2$eq.	10.356	2.158	1.723	1.509	1.535

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, 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.)

4.6.7.1. Semiconductors

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

Methods of emissions from semiconductors are in line with IPCC guidelines. These emissions are estimated with purchase of F-gases, process supply rate, use rate of F-gas, removal rate, by-product generation ratio and removal ratio for by-products. Calculation on removal equipment is based on installation/or not, removal ratio of each technology.

In addition, regarding to treatment of 10% as residue of process supply rate, these emissions are reported in this category in case of recharging of 90% and shipment. In cases of shipment after decomposition of residual 10% or cleansing containment shell, these emissions are reported in "2.E.2. Production of Halocarbons and SF_6". In case of release to atmosphere, these emissions are almost reported in "2.E.2".

Japan Electronics and Information Technology Industries Association (JEITA) data are used of mass of F-gases purchased.

Emissions from manufacturing (during F-gas charging to containment shell for shipment) are already reported in “2.E.2. Production of Halocarbons and SF$_6$”, then, are reported as “IE” for this category. Emissions from disposal can not be generated theoretically, therefore are reported as “NA”.

F-gas emissions in Semiconductor Manufacturing

Methods below are applied for each F-gas

(i) HFC-23, PFCs(PFC-14, PFC-116, PFC-218, PFC-c318), SF$_6$ emissions
F-gas emissions = purchases of F-gas (t) × process supply rate (%) × (1-use rate of F-gas)
× (1-fraction of F-gas destroyed (%)
× installation fraction of removal equipment (%))

(ii) by-produced PFC-14 emissions
by produced PFC-14 emissions = purchases of PFC (t) × process supply rate (%)
× by-produced rate (%)
× (1-fraction of F-gas destroyed (%)
×installation fraction of removal equipment (%))

Relevant indices are shown in Table below.

Table 4-45 Indices related to emissions of F-gas from manufacturing of semiconductors

	Unit	1995	2000	2002	2003	2004
PFC-14 purchased	t	313.0	299.9	224.2	228.2	235.4
PFC-116 purchased	t	209.5	561.2	447.4	449.3	434.5
PFC-218 purchased	t	0.0	9.9	80.6	126.5	159.2
PFC-c318 purchased	t	0.6	38.6	12.6	15.0	21.8
HFC-23 purchased	t	47.8	49.4	42.6	37.9	41.9
SF$_6$ purchased	t	90.8	131.9	95.0	94.8	104.6
process supply rate	%	90%	90%	90%	90%	90%
use rate of PFC	%	20% - 80% (depending on kinds of F-gases)				
fraction of F-gas destroyed	%	90%	90%	90%	90%	90%
CF$_4$ by-produced rate	%	C$_2$F$_6$（PFC-116）：10%,C$_3$F$_8$（PFC-218）：20%				
by-produced CF$_4$ removal rate	%	90%	90%	90%	90%	90%
HFC-23 emissions	t	12.4	13.3	9.9	9.5	10.8
	Mt-CO$_2$eq.	0.145	0.155	0.116	0.111	0.126
PFCs emissions	t	371.0	601.8	452.7	449.9	476.7
	Mt-CO$_2$eq.	2.758	4.820	3.582	3.518	3.713
SF$_6$ emissions	t	40.8	57.5	41.5	40.6	43.6
	Mt-CO$_2$eq.	0.976	1.375	0.991	0.969	1.041

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

*: use rate of PFC is default value of IPCC guidelines.

4.6.7.2. Liquid Crystals

• *Methodology for Estimating Emissions of GHGs*

Same methods applied to semiconductors are also applied to emissions from manufacturing of liquid crystals. World LCD Industry Cooperation Committee (WLICC) have been established voluntary action plan to reduce PFCs emissions and conducted reducing PFC emissions. In these activities, it should be applied IPCC methods.

Table 4-46 Indices related to emissions of F-gas from manufacturing of liquid crystals

	Unit	1995	2000	2002	2003	2004
PFC-14 purchased	t	20.7	47.3	41.0	46.6	65.0
PFC-116 purchased	t	0.4	2.7	3.4	4.7	9.3
PFC-c318 purchased	t	0	0	0.0	0.5	0.8
HFC-23 purchased	t	0.1	0.7	1.3	1.3	1.6
SF_6 purchased	t	11.5	85.3	93.8	99.1	101.0
process supply rate	%	90%	90%	90%	90%	90%
use rate of PFC	%	20% - 80% (depending on kinds of F-gases)				
fraction of F-gas destroyed	%	90%	90%	90%	90%	90%
CF_4 by-produced rate	%	C_2F_6 （PFC-116）: 10%				
by-produced CF_4 removal rate	%	90%	90%	90%	90%	90%
HFC-23 emissions	t	0.0	0.2	0.2	0.2	0.3
	Mt-CO_2eq.	0.000	0.002	0.002	0.002	0.004
PFCs emissions	t	15.2	35.1	29.3	27.2	28.7
	Mt-CO_2eq.	0.099	0.233	0.195	0.181	0.192
SF_6 missions	t	5.2	32.1	33.0	31.2	31.1
	Mt-CO_2eq.	0.124	0.766	0.788	0.746	0.743

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

*: use rate of PFC is default value of IPCC guidelines.

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

• *Methodology for Estimating Emissions of GHGs*

Emissions from producing electrical equipment were calculated by multiplying the amount of SF6 purchased by assembly fugitive rate. Emissions from the use of electrical equipment were calculated based on the fugitive rate during the use of electrical equipment. Emissions from the inspection and disposal of electrical equipment were obtained by actual measurements of SF_6.

In CRF, the emission was reported as “IE” after including the emission from disposal into the use of electrical equipment.

$\underline{SF_6}$ emissions from the production of electrical equipment

$\underline{SF_6}$ Emissions from the production of electrical equipment ＝ SF_6 purchased（t）×assembly fugitive rate（%）

SF_6 emission from the use of electrical equipment

SF_6 emission from the use of electrical equipment

＝ Stocks of SF_6 × rate of emitted SF_6 to the environment during the use of electrical equipment (0.1%)

SF_6 emission from the inspection of electrical equipment

SF_6 emission from the inspection of electrical equipment＝ actual measurement of SF_6

SF_6 emission from the disposal of electrical equipment

SF_6 emission from the disposal of electrical equipment ＝ actual measurement of SF_6

The associated indices are given in the table below.

Table 4-47 Indices related to emissions of SF_6 from electrical equipment assembly

	Unit	1995	2000	2002	2003	2004
SF_6 purchased	t	1380	649	470	591	557
SF_6 charged to electrical equipment	t	1464	450	348	459	469
stocks in other than electrical equipment	t	0	105	70	95	61
assembly fugitive rate	%	29.0%	14.6%	11.1%	6.3%	5.0%
emissions	t	400	94.9	52.0	37.1	27.7
	$MtCO_2$eq.	9.560	2.268	1.243	0.887	0.662

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council, METI

Table 4-48 Indices related to emissions of SF_6 during the use of electrical equipment

	Unit	1995	2000	2002	2003	2004
stock of SF_6	t	6,300	8,000	8,400	8,600	8,600
operational fugitive rate	%	0.1%	0.1%	0.1%	0.1%	0.1%
emissions	t	60	22	13	13	12
	$MtCO_2$eq.	1.441	0.526	0.301	0.318	0.296

Source: Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, 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

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

Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 2*, September 2000

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 4*, August 2002

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report,* February 2006

Ministry of Economy, Trade and Industry, *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke*

Ministry of Economy, Trade and Industry, *Yearbook of Chemical Industries Statistics*

Ministry of Economy, Trade and Industry, Documents of 13th Group for prevention of global warming, Chemical and Bio Sub-Group, Industrial Structure Council

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

Ministry of Economy, Trade and Industry, *Yearbook of Mineral Resources and Petroleum Products Statistics*

Ministry of Economy, Trade and Industry, *Yearbook of Minerals and Non-Ferrous Metals Statistics*

Ministry of Economy, Trade and Industry, *Yearbook of Current Survey of Energy Consumption*

Ministry of Economy, Trade and Industry, *Yearbook of Ceramics and Building Materials Statistics*

Ministry of Economy, Trade and Industry, *Yearbook of Iron and Steel, Non-ferrous Metals, and Fabricated Metals Statistics*

Ministry of Economy, Trade and Industry, *Yearbook of Iron and Steel Statistics*

Ministry of Finance, *Trade Statistics of Japan*

Japan Lime Association, *The Story of Lime*

Methanol and Formalin Association, *Methanol Supply and Demand*

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

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) 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”.

2) 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 shipped as an anesthetic by pharmaceutical manufacturers or import traders 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

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.

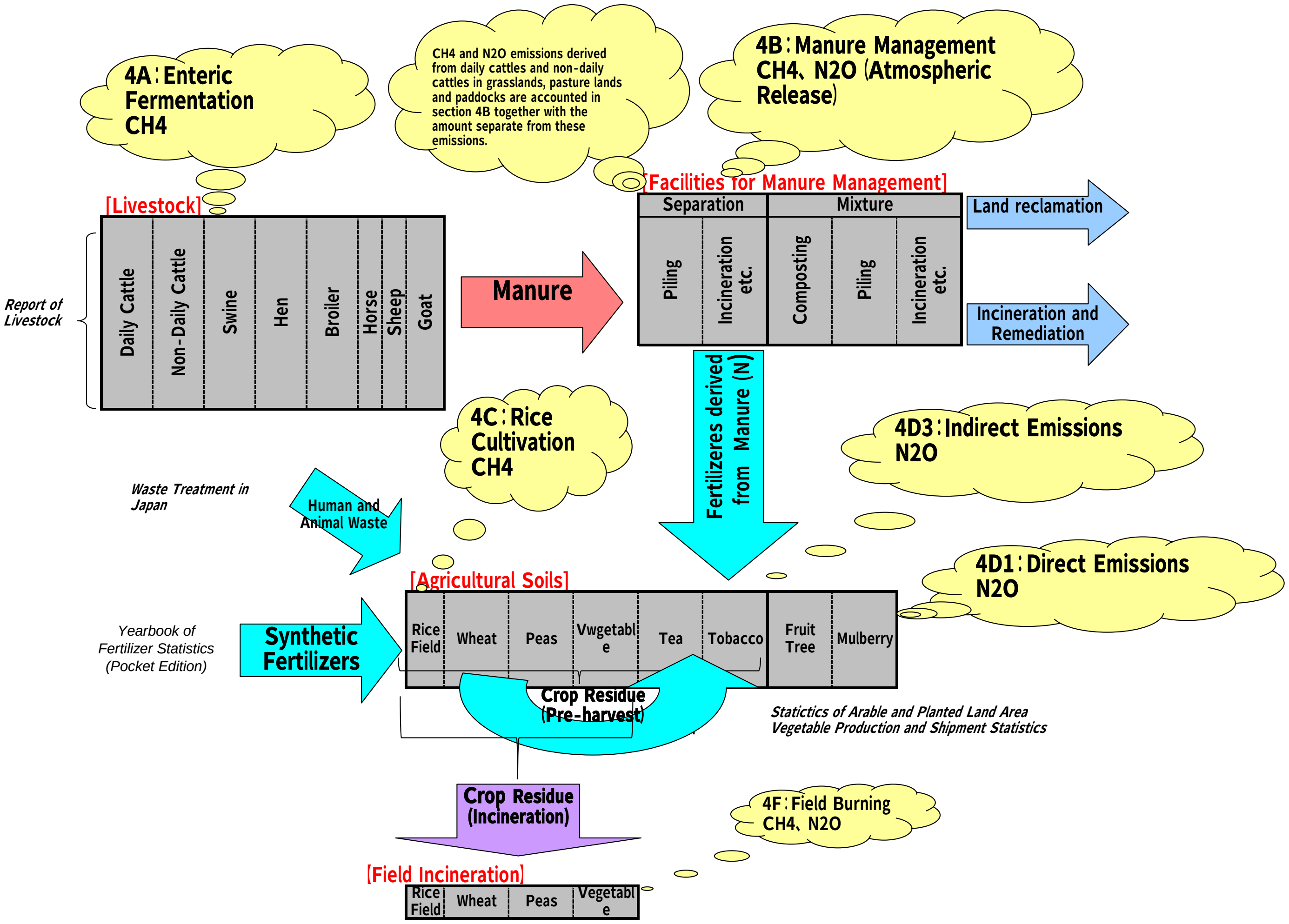

Figure 6-1 Relationships among the categories in the agricultural sector

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 calculated by using 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 year)

Item			Unit	1990	1995	2000	2003	2004	2005
Dairy Cattle		Lactating	1000 head	1,082	1,035	971	936	910	900
		Dry	1000 head	332	299	249	244	235	231
		Heifer: Under Two Year, over six month	1000 head	491	445	379	383	383	379
		Heifer: Five and six month	1000 head	55	49	42	43	43	42
Non-Dairy Cattle	Breeding Cows	One Year and Over	1000 head	679	646	612	601	597	593
		Under One Year, over six month	1000 head	17	13	12	13	13	14
		Fiveand six month	1000 head	6	4	4	4	4	5
	fattening cattle	Wagyu cattle (M): One Year and Over	1000 head	368	412	385	383	373	374
		Wagyu cattle (M): Under One Year, over six manth	1000 head	125	133	114	127	123	119
		Wagyu cattle (M): Fiveand six month	1000 head	42	44	38	42	41	40
		Wagyu cattle (F): One Year and Over	1000 head	197	265	246	249	264	291
		Wagyu cattle (F): Under One Year, over six manth	1000 head	102	105	93	98	96	89
		Wagyu cattle (F): Fiveand six month	1000 head	34	35	31	33	32	30
		Dairy breed: Over six month	1000 head	805	808	845	809	787	789
		Dairy breed: Five and six month	1000 head	89	90	94	90	87	88

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	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	11,335	9,900	9,788	9,724	*9,724*	9,620
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 of swine for 2004: Substituted by data for 2003 because the survey was not conducted.*

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 bred 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.)

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.

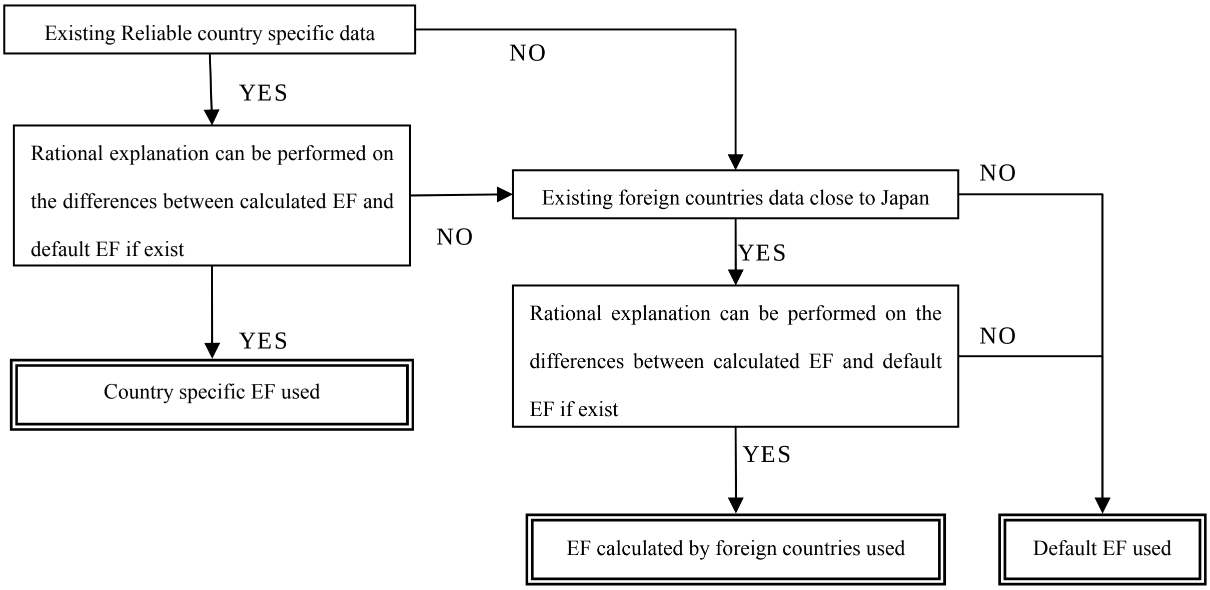

Figure 6-2 Decision tree for determination of EF

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	238,938
Amount of grazing non-daily cattle	head	99,723	103,150	99,769	98,400	98,400	97,945

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 *4.D.2.: 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	713,759	677,417	664,793	658,655	655,608
the amount of N2O-N released from animal(except Incineration method and Wastewater manage method) （N_{N2O}）	tN	9,308	8,687	8,200	8,044	7,958	7,934
the amount of NH3-N and Nox-N released from animal manure （$N_{NH3+Nox}$）	tN	139,990	130,297	124,022	121,227	120,243	119,803
the amount of N vanished by Incineration method and Wastewater manage method （$N_{inc+waa}$）	tN	61,037	53,041	51,005	50,464	50,148	49,958
the amount of N vanished by buryying in the ground. （N_{waste}）	tN	15,869	13,792	12,946	21,161	21,147	21,290
the amount of N used as fertilizer （N_D）	tN	537,678	507,943	481,244	463,898	459,159	456,623

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-CH4-2006.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)

Type of soil	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

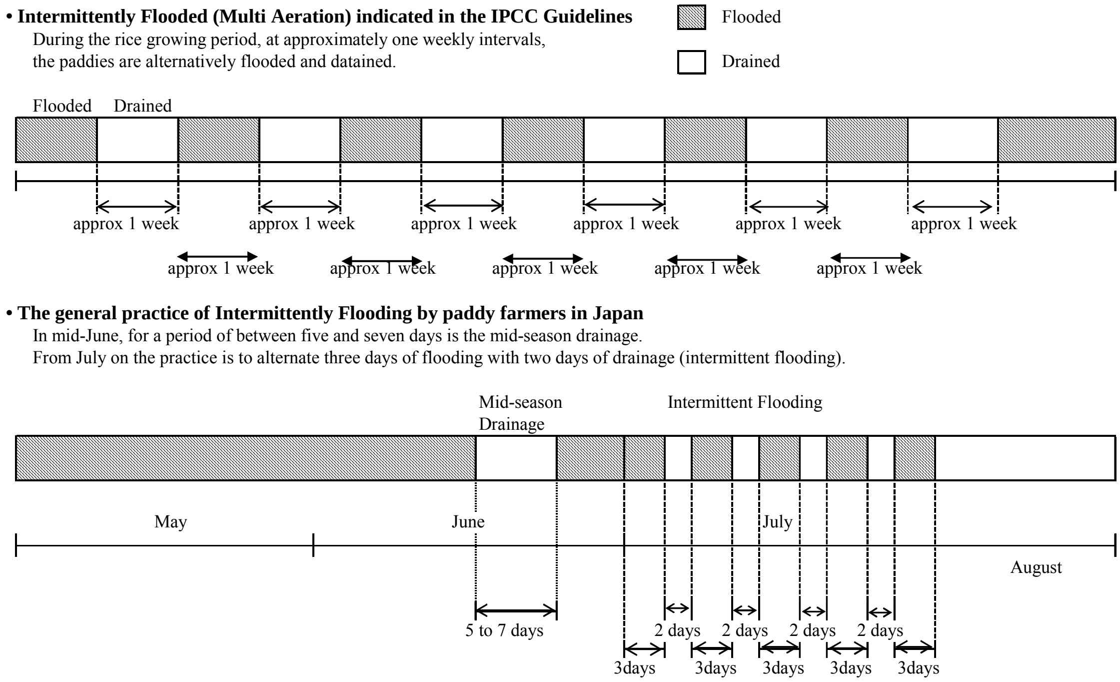
Table 6-23 Area of paddy fields

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-CH4-2006.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 0.565 (1-0.435).

Table 6-24 Emission factor for methane from constantly flooded paddy fields

Type of paddy field	Emission Factors [$gCH_4/m^2/year$]
Intermittently flooded paddy fields (mid-season drainage)	15.98*
Constantly flooded paddy fields	28.29

* : 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
Coarse cereal (including 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	476,300
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	265,400
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	86,900
Pulse	ha	256,600	155,500	191,800	218,000	201,900	193,900
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 (including Buckwheat)	ha	29,600	23,400	38,400	44,500	44,600	45,900
Mulberries	ha	59,500	26,300	5,880	3,840	3,440	2,990
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(-2001), 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
Mulberries(2002-)	MAFF 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）

$$= \Sigma_{\text{Type of crop}} \{\text{Emission factor by type of crop (kg-}N_2O\text{-N/kg-N)} \times \text{Volume of nitrogen applied, by type of crop (kg N)}\}$$

• *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
Coarse cereal (including 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（for others）

Item	Unit	1990	1995	2000	2003	2004	2005
Rye	ha	50	119	110	120	110	120
Oat	ha	4,000	2,517	1,600	1,700	1,000	800

Source: The data are calculated by using *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)*.

Nitrous oxide emission associated with the plowing of organic soil (kg-N_2O)
= 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	24,225	23,275	22,572	22,192	22,211	22,287

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.

$$A = N_{FERT} * Frac_{GASF} + N_{ANI}$$
$$= N_{FERT} * Frac_{GASF} + \{ NB + (ND + NFU) * FracGASM \}$$

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-NH_3-N + NO_X-N/kg-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-NH_3-N + NO_X-N/kg-N)

<u>Synthetic Fertilizers</u>

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 (4.B.)* 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 (4.B.)* 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 *Waste Treatment in Japan* 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	456,614
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 N_2O 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

Nitrous oxide emission associated with field burning of agricultural residues
= 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:

Total carbon/total nitrogen released by field burning of agricultural residues
= (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)

<u>- Proportions of residues to crop yield and dry matter in residue, carbon content, proportion burned in field, and oxidation rate.</u>

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”.

References

Food and Agriculture Organization of the United Nations, *FAOSTAT Database (http://apps.fao.org/page/collections?subset=agriculture)*

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

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

International Rice Research Institute, *World Rice Statistics 1993-94*

Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *Review of Greenhouse Gases Emissions Estimation Methods Part 1*, September 2000

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *Review of Greenhouse Gases Emissions Estimation Methods Part 3*, August 2002

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *Review of Greenhouse Gases Emissions Estimation Methods, February 2006*

Ministry of the Environment, Waste Management and Recycling Department, report of the research on the state of wide-range movement and cyclical use of wastes (the volume on cyclical use)

Ministry of the Environment, Waste Management and Recycling Department, *Waste Treatment in Japan*

Japan Meteorological Agency, *Climate Charts of Japan*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Survey on Public ranches farms*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Statistics of Cultivated and Planted Area*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Crop Statistics*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Livestock Statistics*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Basic Survey of Ground Strength*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Yearbook of Fertilizer Statistics (Pocket Edition)*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Vegetable Production and Shipment Statistics*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Statistics on Milk and Dairy Products*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Statistics of Livestock Production Costs*

Ministry of Agriculture, Forestry and Fisheries of Japan, *Summary of Survey on Agriculture of Environmental Conservation Type, Livestock Part.*

Japan Agriculture Technology Association, *Report of Survey on Method of Quantifying Reduction of Emissions of Greenhouse Gases (2000 FY)*, March 2001

Japan Livestock Industry Association, *Japanese Feed Standard*

Japan Livestock Technology Association, *GHGs emissions control in livestock Part4*, March 1999

Japan Livestock Technology Association, *GHGs emissions control in livestock Part6*, March 2001

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

Society for the Study of Agricultural Technology, *A report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000 F.Y.*

National Institute of Animal Health *"Research of the actual situation of pastures in Japan."*

Okinawa prefecture, *Livestock Statistics of Okinawa*

Crutzen, P.J., et al. *"Methane production by domestic animals, wild ruminants, other herbivorous fauna, and humans"*, *Tellus 33B*, pp271-284, 1986

National Institute for Agro-Environmental Sciences, *Study report of branch for management of resource and ecosystem* vol.13 supplementary volume

Haruo Tsuruta, *"Establishment of GHGs reduction model"*, Society for the Study of Agricultural Technology, *A Report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000F.Y.*

Mamoru Saito, *"Methane emissions from fattening swine and expectant swine"*, Japan Society of Animal Science, *Animal Science Journal 59*, pp773-778, 1998

Noboru Murayama, et al. *"Alimentation of Crops and Fertilizer"*, Buneido, p26

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

Owa, "*New Trends in Technology for Efficient Use of Nutrients – Nutritional Balance of Crops in Japan"* 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 ,1996

Makoto Ishibashi, Jyunya Hashiguchi, Morihiro Koga, *"Development of technology of reducing GHG on the livestock industry (second report)" the experiment and study of environmental safeguards on the livestock industry, Report of the research institute of livestock(2003)* Kumamoto Prefecture Agricultural Research Center, The research institute of livestock

Takuji Sawamoto, Yasuhiro Nakajima, Masahiro Kasuya, Haruo Tsuruta and Kazuyuki Yagi " Evaluation of emission factors for indirect N2O emission due to nitrogen leaching in agro－ecosystems " GEOPHYSICAL RESEARCH LETTERS VOL.32

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 Manage (2000) 2,51-56

Takashi Osada（2003）:Nitrous Oxide Emission from Purification of Liquid Portion of Swine Wastewater, Greenhouse Gas Control Technologies, J.Gale and Y.Kaya (Eds.)

Takashi Osada, Yasuyuki Fukumoto, Tadashi Tamura, Makoto Shiraihi, Makoto Ishibashi：Greenhouse gas generation from livestock waste composting,Non-CO2 Greenhouse Gases (NCGG-4),Proceedings of the Fourth International Symposium NCGG-4,105-111（2005）

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.

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* in the forests which are included in the regional forests plan according to *Forestry Status Survey* by the Forestry Agency
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, Survey of Forestry regions*, also 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.

* Intensively managed forests, semi-natural forests, cut-over forests, lesser stocked forests and bamboo are defined as below,

Intensively managed forests：

Forest land that is subject to artificial regeneration such as tree planting and seeding, and no less than 50% of tree species in the land are subject to artificial regeneration.

Semi-natural forests：

Forest stand (forest land that is over 30% of tree crown cover) except Intensively managed forests

Cut-over forests, lesser stocked forests ：

Forest unit other than “forest stand” and “bamboo”

Bamboo ：Forest unit other than “forest stand” where bamboo (excluding bamboo grass) is prior

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
Forest Status Survey	Complete count survey	March, 31st	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 ~2000)	Complete count survey	August, 1st	Every 10 years	Ministry of Agriculture, Forestry and Fisheries of Japan,
Land Use Status Survey	Complete count survey	March, 31st	Every Year	Ministry of Land, Infrastructure and Transport
Urban Parks Status Survey	Complete count survey	March, 31st	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.-)

Carbon stock change in living biomass in Forest land remaining Forest land have been calculated, using Tier 3 Stock change method in accordance with the *LULUCF-GPG*. In this method biomass stock change is the difference between the absolute amount biomass at two times.

$$\Delta C_{LB} = \sum_k (C_{t2} - C_{t1})/(t_2 - t_1)_k$$

ΔC_{LB} : annual change in carbon stocks in living biomass (tC/yr)
t_1,t_2 : biomass carbon stock inventories for a given forest area at two points in time
C_{t2} : total carbon in biomass calculated at time t_2 (tC)
C_{t1} : total carbon in biomass calculated at time t_1 (tC)
k : type of forest management

7.2.1.1.a. Carbon stocks

- ***Methodology***

The carbon stock in living biomass is calculated from the volume multiplied by wood density, biomass expansion factor, root-to shoot ratio and carbon fraction. These parameters except carbon fraction of dry matter are separately for tree species.

$$C_j = [V_j \cdot D_j \cdot BEF_j] \cdot (1 + R_j) \cdot CF$$

C : carbon stock in living biomass(t-C)
V : volume(m^3)
D : basic wood density(t-dm/m^3)
BEF : biomass expansion factor for conversion of merchantable volume
R : root-to-shoot ratio
CF : carbon fraction of dry matter(= 0.5[t-C/t-dm])
j : tree species

- ***Parameters***

Volume

To estimate carbon removals, Forest Agency has developed National Forest Resources Database (NFRDB) that makes a database of "Forest registers" information (sub-compartment, area, forest management type, tree species, age, , etc.).

Volume of Japanese cedar, Hinoki cypress and Japanese larch which are major tree species of intensively managed forests (private forest) is calculated by applying new yield tables by region and tree type to forest area stored in this database or the Forest Status Survey .

The other Volume is calculated by applying yield tables which prefectures or Regional Forests Offices developed.

$$V = \sum_{m} (A_m \cdot v)$$

V : merchantable volume(m^3)
A : area(ha)
v : merchantable volume per area(m^3/ha)
m : age class

Table 7-3 Yield tables used to estimate merchantable volume

Tree species			Yield tables	
			Private Forest	National Forest
Intensively managed forests	Conifer	Japanese cedar, Hinoki cypress, Japanese larch	New Yield Tables	Yield tables developed by Regional Forest Offices
		Japanese pine, Sakhalin fir, Yezo spruce, other conifer	Yield tables developed by prefectures	Yield tables developed by Regional Forest Offices
	Broad leaf(Quercus acutissima, Japanese oak, other broad leaf)		Yield tables developed by prefectures	Yield tables developed by Regional Forest Offices
Semi-natural forests	Conifer		Yield tables developed by prefectures	Yield tables developed by Regional Forest Offices
	Broad leaf		Yield tables developed by prefectures	Yield tables developed by Regional Forest Offices

- Yield tables developed by prefectures or Regional Forest Offices, and Forest register

When regional forest planning is established for each prefectures or Regional Forest Offices of National forests, these forests are surveyed to develop Forest register which include area, Forest management types, age, and volume by tree species and so on for each sub-compartments.

Volume data for each sub-compartments in the Forest register are estimated from area by using yield tables which provide stand growth when typical practices are implemented for each regions, tree species and site classes.

Yield tables provide relationship between stand age or age class and volume per area.

Forest register is developed every fifth year (private forests by prefectures, national forests by Regional Forest Office) and reflects change in volume due to felling and disturbance (update data such as age).

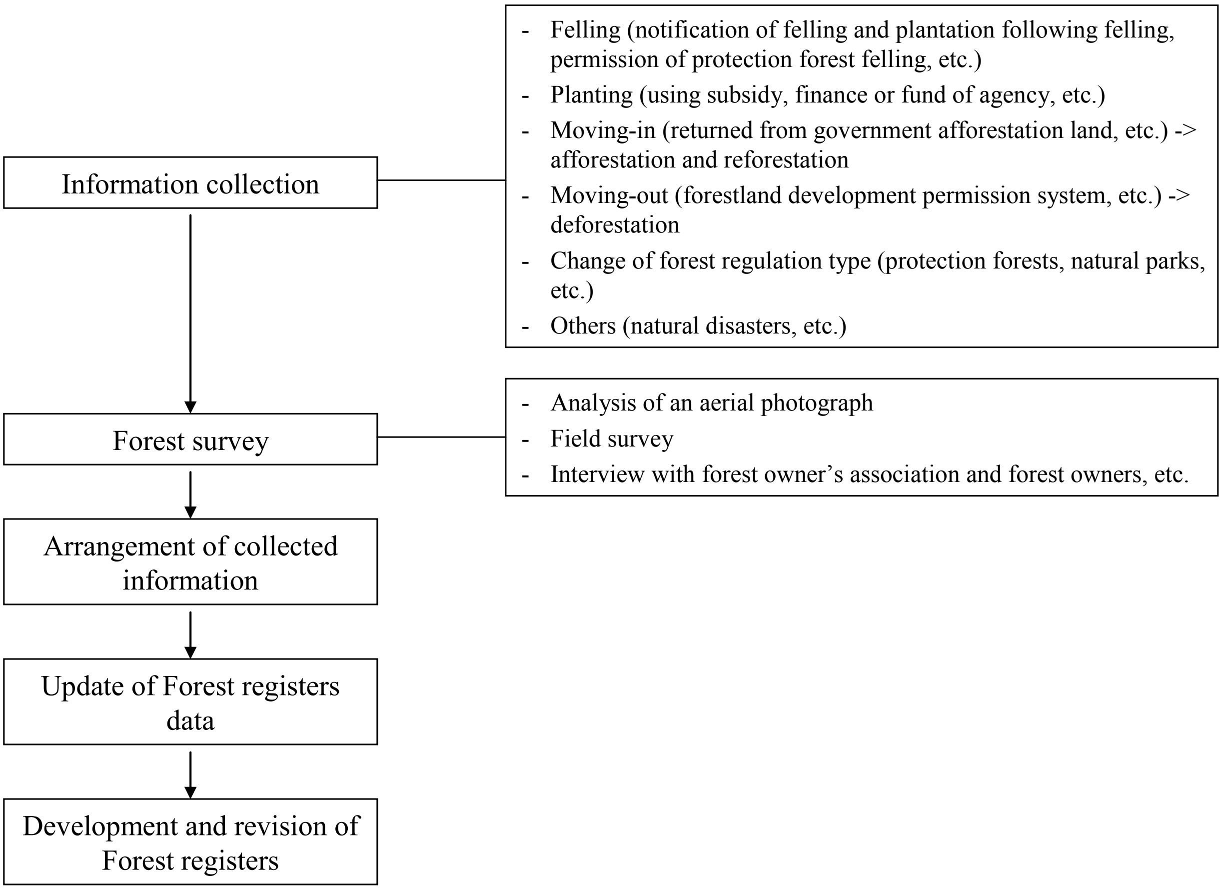

Figure 7-1 Procedures of Forest register development (in the case of private forests)

- New Yield Tables(Japanese cedar, Hinoki cypress, Japanese larch)

In 2006, The Forestry and Forest Products Research Institute (FFPRI) developed new yield tables for Japanese cedar, Hinoki cypress and Japanese larch based on the results from field survey over the country. Area for these three tree types cover 82% of intensively managed forests (private forests).

Yield tables for Japanese cedar are established for 7 regions, Hinoki cypress for 4 regions and Japanese larch for 2 regions.

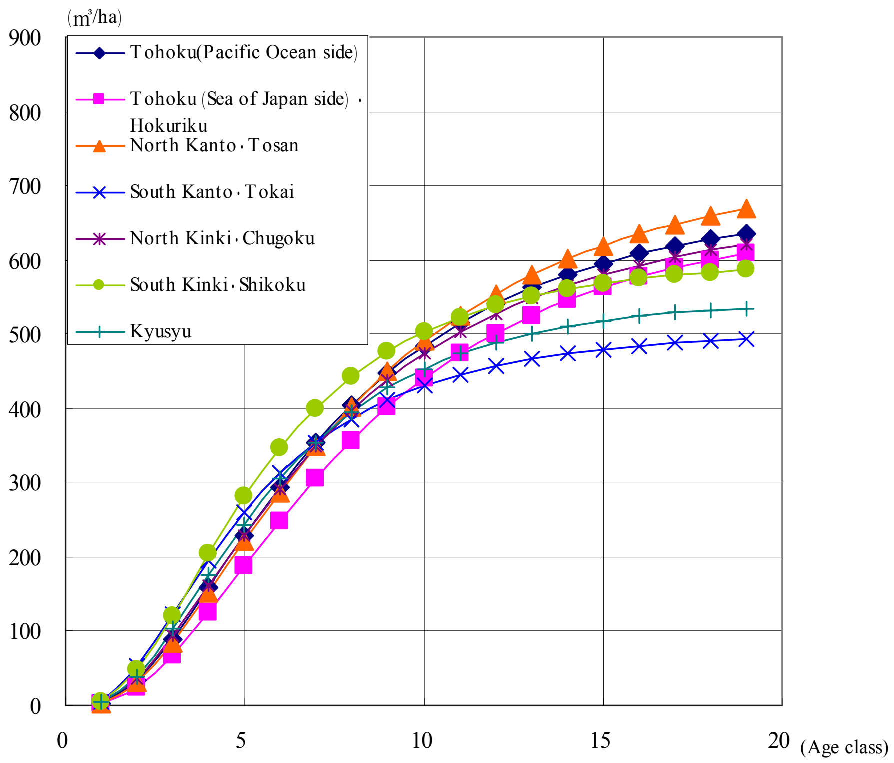

Figure 7-2 Yield tables made by forest resources monitoring survey data, (Japanese cedar：7 areas)

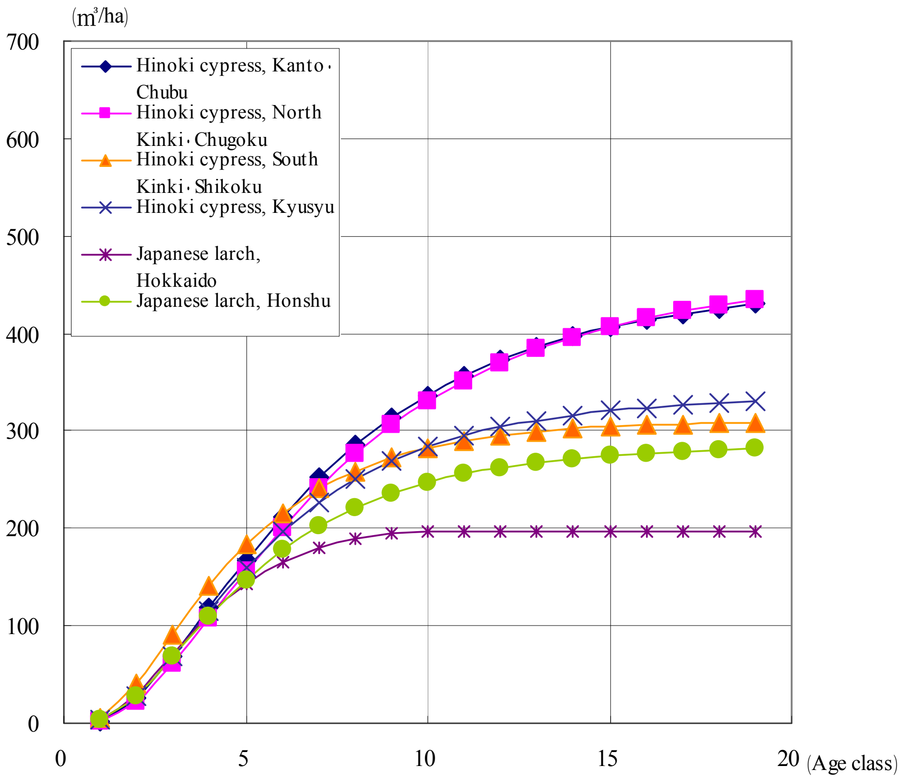

Figure 7-3 Yield tables made by forest resources monitoring survey data,

(Hinoki cypress：4 areas, Japanese larch：2 areas)

- Biomass expansion factor and Root-to-shoot ratio

Biomass expansion factor (BEF) and root-to-shoot ratio data were updated based on the results from biomass survey on dominant tree species and existing research reports which were implemented by the Forestry and Forest Products Research Institute.

BEFs were calculated for two age classes (20 years and below / 21 years and above), because it was identified that BEFs differ between young forests and mature forests.

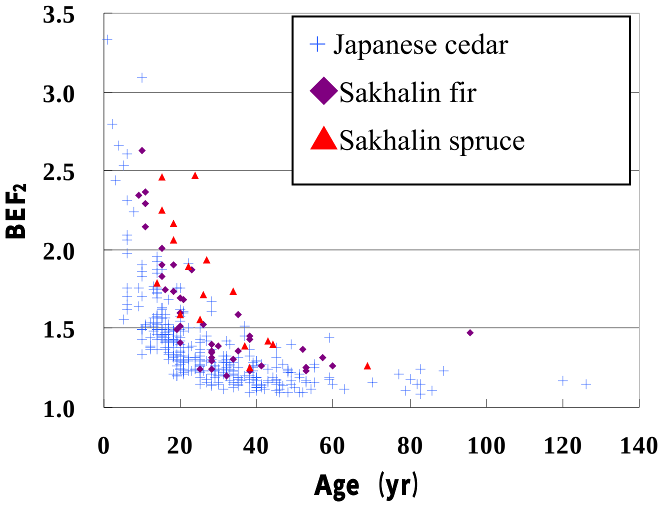

Figure 7-4 Biomass expansion factor related with age

These Root-to-shoot ratio values were established for each tree types, because root-to-shoot ratio was not correlated with age.

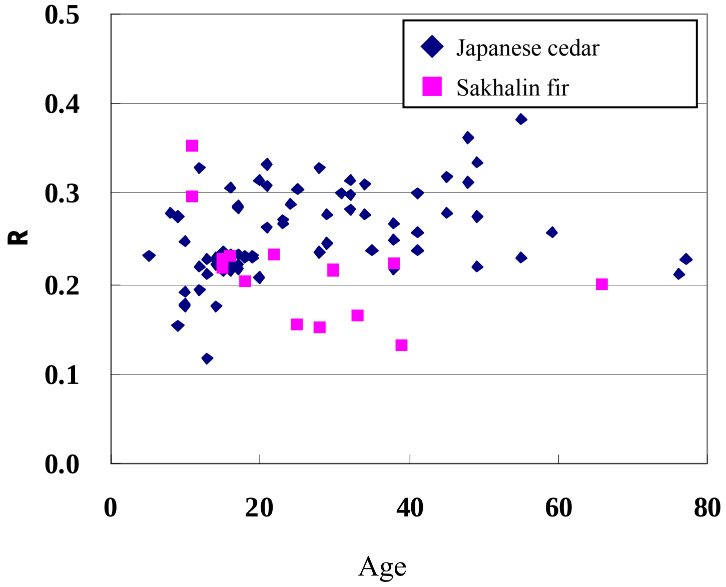

Figure 7-5 Aboveground biomass/belowground biomass(R) , tree species, age

Table 7-4 BEF and Root-to-shoot ratio (R) by species

Tree species			BEF（Above ground）		R
			≦20	＞20	
Intensively managed forests	Conifer	Japanese cedar	1.57	1.23	0.25
		Hinoki cypress	1.55	1.24	0.26
		Japanese pine	1.63	1.23	0.27
		Japanese larch	1.50	1.15	0.29
		Sakhalin fir	1.88	1.38	0.21
		Yezo spruce	2.15	1.65	0.21
		Other conifer	1.80	1.36	0.30
	Broad leaf	Quercus acutissima	1.36	1.33	0.25
		Japanese oak	1.40	1.26	0.25
		Other broad leaf	1.43	1.27	0.25
Semi-natural forests	Conifer		1.81	1.32	0.26
	Broad leaf		1.41	1.27	0.25

※BEF and Root-to-shoot ratio are dimensionless number.

(Source)Forestry and Forest Products Research Institute

-Wood density

Wood density (D) data were updated based on the results from biomass survey on dominant tree species and existing research reports which were implemented by the Forestry and Forest Products Research Institute.

These D values were established for each tree types, because wood density was not correlated with age.

Table 7-5 Wood density (D) by species(t-dm/m^3)

Tree species			D
Intensively managed forests	Conifer	Japanese cedar	0.314
		Hinoki cypress	0.407
		Japanese pine	0.416
		Japanese larch	0.404
		Sakhalin fir	0.319
		Yezo spruce	0.363
		Other conifer	0.416
	Broad leaf	Quercus acutissima	0.668
		Japanese oak	0.619
		Other broad leaf	0.587
Semi-natural forests	Conifer		0.381
	Broad leaf		0.601

-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*

Activity data is calculated by summing planted forest area provided in "Forest Status Survey" (Forest Agency) which includes intensively managed forests, semi-natural forests, cut-over forests, lesser stocked forests and bamboo.

When forest area data are not available (e.g. 1991-1994), data for these years are interpolated based on available data.

- Determining the total forest area

Forest areas is the sum of intensively managed forests, semi-natural forests, cut-over forests and lesser stocked forests and bamboo under the forest planning system from the Survey on Status Forest Resources (Forest Agency). Data for 1991 through 1994, 1996 through 2001, and 2003 through 2004 are estimated by interpolation. In addition, there are no area data of Sakhalin fir, Yezo spruce, Quercus autissima and Japanese Oaks on 1990. Note, however, that these area data are estimated from "other conifer" and "other broad leaf" area divided by area ratio in 1995.

Table 7-6 Classifications in *Survey on Status Forest Resources*

Intensively managed forests	Managed single layered forests	Conifer	Japan cedar
			Hinoki cypress
			Japanese Pine
			Japanese larch
			Sakhalin fir
			Yezo spruce
			Other conifer
		Broad leaf	Quercus acutissima
			Japanese Oak
			Other broad leaf
	Managed multi layered forests	Conifer	Japan cedar
			Hinoki cypress
			Japanese Pine
			Japanese larch
			Sakhalin fir
			Yezo spruce
			Other conifer
		Broad leaf	Quercus acutissima
			Japanese Oak
			Other broad leaf
Semi-natural forests	Managed single layered forests	Conifer	
		Broad leaf	
	Managed multi layered forests	Conifer	
		Broad leaf	
	Naturally regenerated forests	Conifer	
		Broad leaf	

- 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.

Table 7-7 Area of Forest land remaining Forest land (Single year)

Category		Unit	1990	1995	2000	2003	2004
Forest land remaining Forest land		kha	23583.4	23849.8	24140.9	24322.1	24389.4
	Intensive managed forest	kha	8921.0	9308.5	9595.4	9738.8	9769.9
	Seminatural forest	kha	13354.5	13220.3	13195.2	13228.7	13272.2
	Cut-over forest and lesser stocked forest	kha	1159.0	1171.0	1197.4	1200.7	1193.3
	Bamboo	kha	149.0	150.0	152.9	154.0	154.0

Source: Forest Status Survey (Forest Agency)

7.2.1.2. Dead Organic Matter (5.A.1-)

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

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

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 to 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 have been calculated, using Tier 3 Stock change method in accordance with the LULUCF-GPG. In this method, biomass stock change is estimated by the difference between the biomass at time t2 and time t1, additionally subtracted biomass stock change due to land conversion.

$$\Delta C_{LB} = \Delta C_{SC} - \Delta C_{L}$$

ΔC_{LB} : Carbon stock changes in living biomass (tC/yr)

ΔC_{SC} : Carbon stock changes due to biomass growth, fellings, fuelwood gathering, disturbance after land conversion (tC/yr)

ΔC_{L} : Carbon stock changes due to land conversion(tC/yr)

7.2.2.1.a. Carbon stock change due to biomass growth, fellings, fuelwood gathering and disturbance after land conversion

- ***Methodology***

According to the method used in "Forest land remaining forest land", Tier 3 method is applied.

$$\Delta C_{LB} = \sum_{k} (C_{t2} - C_{t1}) / (t_2 - t_1)_k$$

ΔC_{LB} : annual change in carbon stocks in living biomass (tC/yr)

t_1, t_2 : points in time carried out biomass carbon stock survey.

C_{t2} : total carbon in biomass calculated at time t_2 (tC)

C_{t1} : total carbon in biomass calculated at time t_1 (tC)

k : type of forest management

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.

$$\Delta C_{L} = \sum_{i} A_i \times (Ba - Bb,i) \times CF$$

ΔC_{i} : annual biomass carbon stock 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 7-8 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
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".
After immediately conversion	Forest		0.00	Assume that biomass stocks immediately after conversion 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 "Forest Status Survey" (Forest Agency)and the area of reduction in forests according to World Census of Agriculture and Forestry)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 7-9 Land converted to Forest land (single year)

Category		Unit	1990	1995	2000	2003	2004
Land converted to Forest land		kha	67.6	6.9	4.7	50.3	50.3
	Cropland converted to Forest land	kha	2.7	1.2	1.1	0.6	0.5
	Ricefield	kha	0.9	0.5	0.4	0.2	0.2
	Cropfield	kha	1.3	0.6	0.5	0.3	0.3
	Orchard	kha	0.5	0.2	0.2	0.1	0.1
	Grassland converted to Forest land	kha	0.7	0.3	0.3	0.2	0.1
	Wetlands converted to Forest land	kha	IE	IE	IE	IE	IE
	Settlements converted to Forest land	kha	IE	IE	IE	IE	IE
	Other land converted to Forest land	kha	64.2	5.4	3.3	49.6	49.6

Table 7-10 Land converted to Forest land within 20 years

Category		Unit	1990	1995	2000	2003	2004
Land converted to Forest land		kha	1366.8	1047.1	735.2	587.0	561.3
	Cropland converted to Forest land	kha	121.9	57.7	40.6	33.7	31.8
	Ricefield	kha	53.8	23.7	15.9	12.7	11.9
	Cropfield	kha	46.8	23.7	17.7	15.4	14.7
	Orchard	kha	21.4	10.3	6.9	5.7	5.3
	Grassland converted to Forest land	kha	17.4	11.3	9.0	8.0	7.6
	Wetlands converted to Forest land	kha	IE	IE	IE	IE	IE
	Settlements converted to Forest land	kha	IE	IE	IE	IE	IE
	Other land converted to Forest land	kha	1227.5	978.1	685.6	545.4	521.8

7.2.2.2. Carbon stock change in Dead Organic Matter (5.A.2.-)

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*

-Soil carbon stocks in forest land

As soil carbon stocks per unit area vary from one soil group to another (such as andosols, Gray lowland soils and Gley soils), the average soil carbon stocks in forest land is calculated by weighted averaging of soil carbon stock data at 30cm depth by area for each soil groups.

- Soil carbon stocks in Rice field, Crop field, Orchard and Grassland

For the carbon stocks in rice fields, crop fields and orchard soils, the country specific soil survey data is applied. As soil carbon stocks per unit area vary from one soil group to another (such as andosols, Gray lowland soils and Gley soils), the average soil carbon stocks in rice field, crop field and orchard are calculated by weighted averaging of soil carbon stock data at 30cm depth by area for each soil groups.

Table 7-11 Soil carbon stocks in rice field

Soil type	Area [ha]	Share	Carbon stock/ha [t-C/ha]	Carbon stock [t-C/yr]
Lithosol	*	—	*	—
Sand-dune Regosols	*	—	89.04	—
Andosols	17,169	0.6%	125.24	2,150,246
Wet Andosols	274,319	9.5%	113.68	31,184,584
Gleyed Andosols	50,760	1.8%	101.74	5,164,322
Brown forest soil	6,640	0.2%	59.48	394,947
Gray upland soils	79,236	2.7%	60.37	4,783,477
Gley upland soils	40,227	1.4%	60.71	2,442,181
Red soils	*	—	*	—
Yellow soils	144,304	5.0%	63.21	9,121,456
Dark red soils	1,770	0.1%	56.26	99,580
Brown lowland soils	141,813	4.9%	59.71	8,467,654
Gray lowland soils	1,056,571	36.6%	61.59	65,074,208
Gley soils	889,199	30.8%	64.83	57,646,771
Muck soils	75,944	2.6%	91.89	6,978,494
Peat soils	109,465	3.8%	114.95	12,583,002
Summary	2,887,417	100.0%		206,090,923
Simple average			80.19	
Weighted average			71.38	←Applied Value

*: It is difficult to obtain high accuracy data.

Table 7-12 Soil carbon stocks in cropfield

Soil type	Area [ha]	Share	Carbon stock/ha [t-C/ha]	Carbon stock [t-C/yr]
Lithosol	7,148	0.4%	69.25	494,999
Sand-dune Regosols	22,297	1.2%	21.49	479,163
Andosols	851,061	46.5%	109.15	92,893,308
Wet Andosols	72,195	3.9%	149.51	10,793,874
Gleyed Andosols	1,850	0.1%	120.98	223,813
Brown forest soil	287,464	15.7%	65.16	18,731,154
Gray upland soils	71,855	3.9%	79.77	5,731,873
Gley upland soils	4,324	0.2%	*	—
Red soils	25,243	1.4%	42.23	1,066,012
Yellow soils	105,641	5.8%	47.13	4,978,860
Dark red soils	29,130	1.6%	45.15	1,315,220
Brown lowland soils	231,051	12.6%	50.05	11,564,103
Gray lowland soils	75,095	4.1%	53.75	4,036,356
Gley soils	13,163	0.7%	65.94	867,968
Muck soils	1,673	0.1%	78.72	131,699
Peat soils	32,316	1.8%	184.91	5,975,552
Summary	1,831,506	100.0%		159,283,954
Simple average			78.88	
Weighted average			86.97	←Applied Value

*: It is difficult to obtain high accuracy data.

Table 7-13 Soil carbon stocks in Orchard

Soil type	Area [ha]	Share	Carbon stock/ha [t-C/ha]	Carbon stock [t-C/yr]
Lithosol	7,682	1.9%	66.48	510,699
Sand-dune Regosols	1,897	0.5%	27.77	52,680
Andosols	86,083	21.3%	119.03	10,246,459
Wet Andosols	2,530	0.6%	103.82	262,665
Gleyed Andosols	*	—	115.08	—
Brown forest soil	148,973	36.9%	68.35	10,182,305
Gray upland soils	6,424	1.6%	70.55	453,213
Gley upland soils	*	—	*	—
Red soils	19,937	4.9%	63.68	1,269,588
Yellow soils	75,973	18.8%	64.48	4,898,739
Dark red soils	6,141	1.5%	54.61	335,360
Brown lowland soils	35,261	8.7%	69.32	2,444,293
Gray lowland soils	10,075	2.5%	57.35	577,801
Gley soils	2,065	0.5%	*	—
Muck soils	135	0.0%	59.44	8,024
Peat soils	130	0.0%	*	—
Summary	403,306	100.0%		31,241,826
Simple average			72.30	
Weighted average			77.46	←Applied Value

*: It is difficult to obtain high accuracy data.

-Soil carbon stocks in grassland

As is the case with the carbon stocks in rice field soils, data from the country specific soil survey data is applied for the carbon stocks in grassland soils. Although it is difficult to obtain area data by soil types for grassland, it could be viewed that the area by soil types and the numbers of samples by soil types have a high correlation; therefore, it is calculated by weighted averaging of soil carbon stock data at 30cm depth by the number of samples for each soil groups.

Table 7-14 Soil carbon stocks in grassland

Soil type	Area [ha]	Share	Carbon stock/ha [t-C/ha]	Carbon stock [t-C/yr]
Lithosol	*	—	*	—
Sand-dune Regosols	140	0.6%	79.28	11,099
Andosols	11364	48.8%	152.19	1,729,487
Wet Andosols	459	2.0%	207.40	95,197
Gleyed Andosols	*	—	*	—
Brown forest soil	4071	17.5%	101.27	412,270
Gray upland soils	2008	8.6%	126.44	253,892
Gley upland soils	228	1.0%	110.51	25,196
Red soils	*	—	*	—
Yellow soils	796	3.4%	74.36	59,191
Dark red soils	695	3.0%	54.55	37,912
Brown lowland soils	2658	11.4%	107.69	286,240
Gray lowland soils	215	0.9%	78.76	16,933
Gley soils	*	—	*	—
Muck soils	*	—	*	—
Peat soils	663	2.8%	325.18	215,594
Summary	23297	100.0%		3,143,012
Simple average			128.88	
Weighted average			134.91	←Applied Value

*: It is difficult to obtain high accuracy data.

-Soil organic carbon in other lands is applied to the value for volcanic soil given in LULUCF-GPG.

Table 7-15 Soil carbon stocks

Category	Values used	Note
Forest land	90.06 (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	71.38 (tC/ha)	Value of soil carbon stocks for 0-30cm depth. Data provided from Dr. Makoto Nakai , National Institute for Agro-Environmental Sciences (Undisclosed)
Crop field	86.97 (tC/ha)	
Orchard	77.46 (tC/ha)	
Cropland (average)	78.60(tC/ha)	
Grassland	134.91(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). For Activity data, refer to Table 7-10.

7.2.2.3.b. Carbon stock change in organic soils

This sub-category is reported as " NA" same as "Forest land remaining Forest land". Because organic soils are 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.-)

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.-)

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 fraction

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 7-16 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
Before conversion	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 immediately conversion	Cropland		0.00	Assume that biomass stocks immediately after conversion 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*"

Table 7-17 Biomass stock data before conversion in forest land

	unit	1990	1995	2000	2003	2004	Note
Forest land	t-dm/ha	92.9	101.8	111.1	116.6	118.4	Calculate by Forest Status Survey(Forestry Agency)and Provided Data by Forest Agency

- ***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 7-18 Area of Land converted to Cropland (single year)

Category		Unit	1990	1995	2000	2003	2004
Land converted to Cropland		kha	8.8	5.6	4.5	1.7	3.1
	Forest land converted to Cropland	kha	5.2	1.1	0.4	0.3	0.3
	Grassland converted to Cropland	kha	0.0	0.0	0.0	0.0	0.0
	Wetlands converted to Cropland	kha	0.3	0.0	0.1	0.0	0.0
	Settlements converted to Cropland	kha	IE	IE	IE	IE	IE
	Other land converted to Cropland	kha	3.3	4.5	4.0	1.4	2.8

Table 7-19 Area of Land converted to Cropland within 20 years

Category		Unit	1990	1995	2000	2003	2004
Land converted to Cropland		kha	475.9	279.5	155.9	114.1	104.1
	Forest land converted to Cropland	kha	174.2	118.7	72.5	49.6	39.9
	Grassland converted to Cropland	kha	11.2	5.7	1.0	1.0	1.0
	Wetlands converted to Cropland	kha	11.4	3.4	1.7	1.2	1.2
	Settlements converted to Cropland	kha	IE	IE	IE	IE	IE
	Other land converted to Cropland	kha	279.1	151.7	80.8	62.3	62.0

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.

$$\Delta SOC = (SOC_c(t) - SOC_o(t-20)) / 20 \times A$$

ΔSOC : change in soil carbon stock in Land converted to Cropland (tC/yr)
$SOC_C(t)$: soil carbon stocks per area at time (t) (tC/yr)
$SOC_O(t-20)$: 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

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. For activity data, refer to Table 7-19.

7.4. Grassland (5.C)

7.4.1. Grassland remaining grassland (5.C.1)

7.4.1.1. Carbon stock change in Living biomass (5.C.1.-)

According to Tier 1, carbon stock change in living biomass is assumed constant and reported as “NA”.

7.4.1.2. Carbon stock change in Dead Organic Matter (5.C.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”.

7.4.1.3. Carbon stock change in Soils (5.C.1.-)

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 fraction

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 7-20 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
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*"
	Wetlands, Settlements and Other land		0.0	Assume that biomass stocks are "0".
After immediately conversion	Grassland		0.00	Assume that biomass stocks immediately after conversion are "0".
After conversion	Grassland		2.7	*LULUCF-GPG* Table 3.4.2 warm temperate wet

Table 7-21 Biomass stock data before conversion in forest land

	unit	1990	1995	2000	2003	2004	Note
Forest land	t-dm/ha	92.9	101.8	111.1	116.6	118.4	Calculate by Forest Status Survey(Forestry Agency)and Provided Data by Forest Agency

• *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 7-22 Area of Land converted to Grassland (single year)

Category	Unit	1990	1995	2000	2003	2004
Land converted to Grassland	kha	4.1	2.0	1.7	1.7	2.3
Forest land converted to Grassland	kha	0.7	0.2	0.1	0.0	0.0
Cropland converted to Grassland	kha	0.9	0.6	1.0	1.1	1.4
Wetlands converted to Grassland	kha	0.127	0.010	0.032	0.000	0.000
Settlements converted to Grassland	kha	IE	IE	IE	IE	IE
Other land converted to Grassland	kha	2.3	1.2	0.7	0.5	0.8

Table 7-23 Area of Land converted to Grassland within 20 years

Category	Unit	1990	1995	2000	2003	2004
Land converted to Grassland	kha	427.3	267.7	170.8	144.3	133.3
Forest land converted to Grassland	kha	56.3	38.2	23.6	17.6	13.9
Cropland converted to Grassland	kha	71.8	48.2	41.3	43.3	43.6
Wetlands converted to Grassland	kha	2.5	2.0	1.5	1.1	1.1
Settlements converted to Grassland	kha	IE	IE	IE	IE	IE
Other land converted to Grassland	kha	296.7	179.3	104.4	82.3	74.7

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.

$$\Delta SOC = \left(SOCc(t) - SOCo(t-20)\right)/\,20 * A$$

ΔSOC : change in soil carbon stock in Land converted to pasture land (tC/yr)
SOCc(t) : soil carbon stocks per area at time (t) (tC/ha)
SOCo(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 stocks

The soil carbon stocks stated in Table 7-15 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 stock 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. For activity data, refer to Table 7-23.

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.-)

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.-)

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.

7.5.2.1. 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 fraction

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 7-24 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
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
	Settlements and Other land		0.0	Assume that biomass stocks are "0".
After immediately conversion	Wetland		0.00	Assume that biomass stocks immediately after conversion are "0".

Table 7-25 Biomass stock data before conversion in forest land

	unit	1990	1995	2000	2003	2004	Note
Forest land	t-dm/ha	92.9	101.8	111.1	116.6	118.4	Calculate by Forest Status Survey(Forestry Agency)and Provided Data by Forest Agency

- ***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 7-26 Area of Land converted to Wetland (single year)

Category		Unit	1990	1995	2000	2003	2004
Land converted to Wetlands		kha	0.8	1.3	1.6	0.7	1.8
	Forest land converted to Wetlands	kha	0.3	1.0	1.1	0.2	0.2
	Cropland converted to Wetlands	kha	0.2	0.3	0.4	0.2	0.4
	Grassland converted to Wetlands	kha	0.0	0.1	0.1	0.0	0.1
	Settlements converted to Wetlands	kha	0.0	0.0	0.0	0.0	0.0
	Other land converted to Wetlands	kha	0.3	0.0	0.0	0.3	1.1

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 7-27 Area of Settlements remaining Settlements

[(Crown cover area less than or equal to 20 years since establishment)

x (forested area rate (forested area rate per park area))]

	Unit	1990	1995	2000	2003	2004
1.City block parks	Kha	1.63	1.87	2.11	2.23	2.28
2.Neighborhood parks	Kha	1.87	2.22	2.47	2.59	2.63
3.Community parks	Kha	1.65	1.87	2.17	2.40	2.44
4.Comprehensive parks	Kha	5.56	6.74	8.04	8.75	8.93
5.Sport parks	Kha	2.20	2.68	3.11	3.35	3.39
6.Large scaled parks	Kha	2.80	3.76	4.64	5.28	5.36
7.Specific parks	Kha	4.07	4.38	4.67	4.67	4.78
8.National government parks	Kha	0.42	0.52	0.70	0.90	0.93
9.Buffer greenbelts	Kha	0.42	0.47	0.50	0.52	0.52
10.Ornamental green spaces	Kha	1.74	2.41	3.29	3.70	3.87
11.Urban grove parks	Kha	0.00	0.00	0.07	0.08	0.10
12.Square parks	Kha	0.00	0.00	0.02	0.02	0.06
13.Greenways	Kha	0.31	0.37	0.45	0.48	0.49
14.Specified community parks	Kha	0.15	0.26	0.34	0.39	0.41
15.Green space conservation zones	Kha	1.90	3.65	4.76	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 fraction 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
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 and Other land		0.0	Assume that biomass stocks are "0".
After immediately conversion	Settlements		0.00	Assume that biomass stocks immediately after conversion are "0".

Table 7-29 Biomass stock data before conversion in forest land

	unit	1990	1995	2000	2003	2004	Note
Forest land	t-dm/ha	92.9	101.8	111.1	116.6	118.4	Calculate by Forest Status Survey(Forestry Agency)and Provided Data by Forest Agency

• *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 7-30 Area of Land converted to Settlements (single year)

Category		Unit	1990	1995	2000	2003	2004
Land converted to Settlements		kha	37.5	31.7	21.2	14.2	13.5
	Forest land converted to Settlements	kha	13.0	9.1	4.6	2.1	2.2
	Cropland converted to Settlements	kha	21.4	19.5	14.5	10.6	9.9
	Grassland converted to Settlements	kha	3.2	3.1	2.2	1.5	1.5
	Wetlands converted to Settlements	kha	IE	IE	IE	IE	IE
	Other land converted to settlements	kha	IE	IE	IE	IE	IE

7.6.2.2. Carbon stock change in Dead Organic Matter (5.E.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”.

7.6.2.3. Carbon stock change in Soil (5.E.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”.

7.7. Other land (5.F)

7.7.1. Other land remaining Other land (5.F.1)

According to LULUCF-GPG, 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 fraction

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
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 and Settlements		0.0	Assume that biomass stocks are “0”.
After immediately conversion	Other land		0.00	Assume that biomass stocks immediately after conversion are “0”.

Table 7-32 Biomass stock data before conversion in forest land

	unit	1990	1995	2000	2003	2004	Note
Forest land	t-dm/ha	92.9	101.8	111.1	116.6	118.4	Calculate by Forest Status Survey(Forestry Agency)and Provided Data by Forest Agency

• *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 7-33 Area of Land converted to Other land (single year)

Category		Unit	1990	1995	2000	2003	2004
Land converted to Other land		kha	21.47	27.95	27.36	19.62	16.98
	Forest land converted to Other land	kha	2.4	2.1	1.6	1.2	1.2
	Cropland converted to Other land	kha	15.2	20.0	16.8	11.8	10.7
	Grassland converted to Other land	kha	3.8	5.8	9.0	6.6	5.1
	Wetlands converted to Other land	kha	IE	IE	IE	IE	IE
	Settlements converted to Other land	kha	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 stocks

The values stated in Table 7-15 are used for the soil carbon stocks before and after conversion. Since LULUCF-GPG does not give any default values for soil carbon stocks 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 7-34 Area of Land converted to Other land within 20 years

Category		Unit	1990	1995	2000	2003	2004
Land converted to Other land		kha	557.9	475.6	468.1	484.8	484.7
	Forest land converted to Other land	kha	70.2	64.4	56.2	49.5	47.4
	Cropland converted to Other land	kha	419.4	336.7	313.2	320.0	319.3
	Grassland converted to Other land	kha	68.3	74.6	98.6	115.3	118.0
	Wetlands converted to Other land	kha	IE	IE	IE	IE	IE
	Settlements converted to Other land	kha	IE	IE	IE	IE	IE

7.8. Non-CO_2 gases

7.8.1. Direct N_2O emissions from N fertilization (5. (I))

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))

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***

- C:N ratio for soils: 11.3 (Country specific data (Undisclosed))

- 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))

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

$$bbGHG_f = L_{forestfires} \times ER \qquad (CH_4, CO)$$

$$bbGHG_f = L_{forestfires} \times ER \times N/C \qquad (N_2O, NOx)$$

$bbGHG_f$	: GHG emissions due to biomass burning by forest
$L_{forest\ fires}$	: Carbon released due to forest fires(tC/yr)
ER	: Emission ratio (CO：0.06, CH_4：0.012, N_2O：0.007, NO_x：0.121)
N/C	: N/C ratio

➢ Cropland, Grassland, Wetlands, Settlements, Other land

$$bbGHG = CB\_on\_site \times ER \qquad (CH_4, CO)$$
$$bbGHG = CB\_on\_site \times ER \times N/C \qquad (N_2O, NOx)$$

bbGHG	: GHG emissions due to biomass burning associated with land conversion
CB_on-site	: Loss of carbon due to on-site biomass burning
ER	: Emission ratio (CO：0.06, CH_4：0.012, N_2O：0.007, NO_x：0.121)
N/C	: N/C ratio

- ***Parameters***

-Emission ratio

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)

-N/C ratio

The following values are applied to N/C ratio.
N/C ratio : 0.01 (default value stated in LULUCF-GPG p.3.50)

• *Activity Data*

- Forest land

For activity in Forest land, carbon released by forest fire is used. Carbon released by forest fire is estimated by the Tier 3 method in LULUCF-GPG. 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)

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 7-35 Wood density and biomass expansion factors for national and private forest

Type	Wood density [t-dm/m^3]	Biomass expansion factor
National forest	0.49	1.61
Private forest	0.47	1.61

Source: Based on Forestry Agency 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 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 7-36 Damaged timber volume due to fire in private forest

Age class	Item	Unit	1990	1995	2000	2003	2004
>=5	Actual damaged area	[ha]	286	943	482	128	993
	Damaged timber volume	[m3]	47,390	58,129	54,487	19,626	86,219
<=4	Actual damaged area	[ha]	271	506	164	221	163
	Damaged timber volume	[m3]	16,179	10,186	5,641	9,964	4,122
Total damaged timber volume		[m3]	63,569	68,315	60,128	29,590	90,341

Source: Based on Forestry Agency data

Table 7-37 Damaged timber volume due to fire.

	Unit	1990	1995	2000	2003	2004
Damaged timber volume due to fire in national forest	m^3	3,688	1,014	1,599	1,323	1,323
Damaged timber volume due to fire in private forest	m^3	62,009	67,771	60,012	29,590	90,341

- Cropland, Grassland, Wetlands, Settlements, Other land

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.

$$CB\_{on-site} = \Delta Ci \times p_{on-site} \times p_{burned-on} \times p_{oxid}$$

CB_on-site	: carbon loss due to on-site biomass burning
ΔCi	: change in carbon stocks as a result of a clearing biomass in a land use conversion (tC)
$\rho_{on-site}$	: fraction of biomass that is left on-site (0.3 interim value)
$\rho_{burned\ on}$	: fraction of biomass that is burned on-site (1 interim value)
ρ_{oxid}	: proportion of biomass oxidized as a result of burning (0.9 LULUCF-GPG page 3.88 default value)

Table 7-38 Change in carbon stock due to biomass burning for each land use categories

	Unit	1990	1995	2000	2003	2004
Forest land	Gg-C/yr	-25	-26	-23	-12	-34
Cropland	Gg-C/yr	-65	-15	-6	-5	-4
Grassland	Gg-C/yr	-9	-2	-1	-1	-1
Wetlands	Gg-C/yr	-4	-13	-17	-3	-3
Settlements	Gg-C/yr	-163	-125	-68	-34	-35
Other land	Gg-C/yr	-31	-29	-25	-19	-19

* Negative value means carbon loss.

Reference

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

IPCC, *Good Practice Guidance for Land Use, Land-Use Change and Forestry,* 2003

Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *Review of Greenhouse Gases Emissions Estimation Methods Part 1*, September 2000

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *Review of Greenhouse Gases Emissions Estimation Methods Part 3*, August 2002

Ministry of Agriculture, Forestry and Fisheries, *World Census of agriculture and Forestry*

Ministry of Agriculture, Forestry and Fisheries, *Statistics of Cultivated and Planted Area (Survey of cropland area)*

Ministry of Agriculture, Forestry and Fisheries, *A move and conversion of Cropland*

Forestry Agency, *Handbook of Forestry Statistics*

Ministry of Land Infrastructure and Transport, *Land Use Status Survey*

Ministry of Land Infrastructure and Transport, *Urban Park Status Survey*

Japan Dam Foundation, *Dam Yearbook*

Ministry of Internal Affairs and Communications, *Housing and Land Survey of Japan*

Naoto Owa, *"Nutrient Balance in Japan's Crops"*

Daiyu Ito et al, *"Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan"*

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 a)	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) b)		Anaerobic landfill	○	○	
				Semi-aerobic landfill	○	○	
		Sludge	Human waste treatment, septic tank sludge	Anaerobic landfill	○	○	
				Semi-aerobic landfill	○	○	
	Industrial waste	Kitchen garbage		Anaerobic landfill c)	○	○	
		Waste paper			○	○	
		Waste wood			○	○	
		Waste textiles (natural fiber) b)			○	○	
		Sludge	Sewage sludge		○	○	
			Human waste treatment, septic tank sludge		○	○	
			Waterworks sludge		○	○	
			Organic sludge from manufacturing industries		○	○	
			Livestock waste d)		○	○	
6.A.3. (8.1.2)	Inappropriate disposal e)			Anaerobic landfill	○	○	
	Composting organic waste			Composting	○		○f)

a) 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.

b) Because synthetic textiles hardly biodegrade in landfills, estimates include only natural textiles.

c) Since the ratio of semi-aerobic landfills is uncertain, all the industrial waste landfills were considered to be anaerobic landfills for emission estimates.

d) 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.

e) Carbon-based, biodegradable inappropriately dumped waste includes waste wood and waste paper, but because the currently known residual amount of inappropriately dumped waste paper is very small, only emissions of waste wood were included in the estimate.

f) 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.

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 for Estimating Emissions of GHGs***

In accordance with the decision tree in the *2006 IPCC guidelines,* Methane and carbon dioxide emissions are calculated by using the IPCC-specified method (FOD method) in Tier 3, and by employing the parameters based on Japan's own research results.

In Japan, the emission factor is defined as "the amount of CH_4 generated by biodegraded waste", and the activity is defined as "the amount of waste biodegraded in the calculated year".

$$E = \left\{ \sum \left(EF_{ij} \times A_{ij} \right) - R \right\} \times \left(1 - OX \right)$$

Where:

E = CH_4 emissions from landfills (kg-CH_4),

EF_{ij} = emission factor of waste i (the amount of CH_4 generated by biodegraded waste i) of landfill type j,

A_{ij} = activity of waste i (amount of waste i biodegraded in the calculated year) of landfill type j,

R = amount of recovered landfill CH_4 (t), and

OX = oxidation rate of CH_4 related to soil cover

- ***Emission Factors***

-Overview

Emission factors were defined as the amount of CH_4 (kg) generated through decomposition of one dry ton of unburned biodegraded landfill wastes. The emission factors were set with each type of biodegraded waste and each type of landfill (anaerobic or semiaerobic landfill).

Emission factors were calculated by multiplying each of kitchen garbage, waste paper, waste natural fibers, waste wood, sewage sludge, human waste, waterworks sludge, organic sludge from manufacturing industries and livestock waste by carbon content of biodegraded wastes, disposal site-specific methane correction factor, waste-to-gas conversion rate of landfilled biodegraded waste, and percentages of methane in this landfill gas.

Emission factor = (carbon content) × (gas conversion rate) × (methane correction factor) × (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 all years from 1990 to 2004, by using actual results from the carbon content data in each type of municipal solid waste (MSW) gathered in cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka. These calculated values are set as uniform percentage of carbon content for each type of waste during the estimation period. For industrial solid waste (ISW), each type of carbon content was set the same value used for MSW.

[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, then an uniform percentage used during estimation period was set by average of each year of carbon content from 1990 to 2004.

[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 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
Kitchen Garbage	%	43.4%	43.4%	43.4%	43.4%	43.4%
Waste paper	%	40.9%	40.9%	40.9%	40.9%	40.9%
Waste wood	%	45.0%	45.0%	45.0%	45.0%	45.0%
Waste natural fiber textiles	%	45.2%	45.2%	45.2%	45.2%	45.2%
Sewage sludge	%	40.0%	40.0%	40.0%	40.0%	40.0%
Human waste sludge	%	40.0%	40.0%	40.0%	40.0%	40.0%
Waterworks sludge	%	7.5%	7.5%	7.5%	7.5%	7.5%
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%

-Rate of conversion of waste to gas

The rate of conversion to gas from carbon in biodegradable waste in landfill was set at 50%, on the basis of ITO *"A study on estimating amounts of landfill gas", Metropolitan Tokyo Sanitation Engineering Journal* No. 18, 1992..

-Methane Correction factor

These were set to 1.0 for anaerobic landfill sites and 0.5 for semi-aerobic landfill sites using the default values of *IPCC 2006 Guidelines*.

-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%.

• *Activity Data*

-Overview

Activity data is defined as the amount of waste biodegraded during the calculated year (dry base). The amount of waste i remaining in a landfill in the calculated year (*T*) is the amount determined by adding the amount of waste i landfilled in year *T* to the amount of waste i remaining in year *T–1* multiplied by a certain percentage, while activity is determined by subtracting the amount of waste i remaining in year *T* from the amount of waste i remaining in a landfill in year *T–1*. These data has been calculated for municipal solid waste and industrial waste, type of waste, and type of landfill (anaerobic and semiaerobic landfill), respectively. The amount of waste landfilled in each year has been derived by multiplying the volume of biodegradable landfill (volume of landfill by type of waste [wet basis], provided by the Waste Management and Recycling Department, Ministry of the Environment) by the percentage of solids in waste by type of waste.

Japan uses 1954 as the starting year in which the former Public Cleansing Law (now the Waste Disposal and Public Cleansing Law) was enacted.

$$W_i(T) = W_i(T-1) \times e^{-k} + w_i(T)$$
$$A_i(T) = W_i(T-1) \times \left(1 - e^{-k}\right)$$
$$k = \ln(2) / H$$

Where:

Ai(T) = the amount of waste *i* degraded in the calculated year (year *T*) (activity data: dry base),
Wi(T) = the amount of waste *i* remaining in a landfill in year *T*,
wi(T) = the amount of waste *i* landfilled in year *T*,
k = decomposition rate constant (1/year), and
H = Decomposition half-life of waste *i* (the time taken by landfilled waste *i* to reduce in amount by half)

The amount of waste *i* landfilled in year *T*
= (Amount of biodegraded waste *i* landfilled in year *T*)
× （percentages of landfill sites of each site type）×（percentage of solids in waste *i*）

-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. Landfilled amounts of both municipal solid waste and industrial waste are determined back to 1980 (some years are interpolated). The 1980 amount is used for years prior to 1980.

[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 percentages of natural fiber scrap in waste textile. For municipal solid waste, the percentages of natural fiber scrap was set by 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 scrap in the textile waste was regarded as 100% according to the regulation of the Waste Disposal and Public Cleansing Law that waste textile of ISW does not include synthetic fabrics. The landfill amount in the past year was estimated using the same method used for Kitchen garbage, waste paper, waste wood

[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). Landfilled amounts are determined back to 1985 (some years are estimated). The 1985 amount is used for years prior to 1985.

[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 Report*.

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 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). Landfill amounts are determined back to 1980. The 1980 amount is used for years prior to 1980.

[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).* Landfill amounts are determined back to 1990 for “food manufacturing” and “chemicals” and to 1989 for “papermaking”. The 1990 amounts are used for years prior to 1990 for “food manufacturing” and “chemicals”, 1989 amount is used for years prior to 1990 for “papermaking”.

[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 set from the “direct final disposal” amount provided every five years by the studies of Ministry of the Environment, Waste Management and Recycling Department for interim years were interpolated from those studies. Landfill amounts are found back to 1980 (some years are interpolated). The 1980 amount is used for years prior to 1980.

-Percentage of Solids in Waste

Percentage of solids in waste was set from the water percentage of each waste type. Table 8-3 shows the percentage of solids in each waste type, and the sources of the figures.

Table 8-3 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	77 (food manufacturing) 57 (chemical industries) - (paper industry)	Reference of Clean Japan Center Survey

-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 8-4 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%	86.1%	74.2%	64.2%	54.4%	45.4%	45.4%
Semi-aerobic landfill percentage	%	0.0%	13.9%	25.8%	35.8%	45.6%	54.6%	54.6%

-Decomposition half-life

Decomposition half-life means the number of years needed for 50% of waste landfilled in a certain year to degrade. According to Ito ("A study on estimating amounts of landfill gas," Metropolitan Tokyo Sanitation Engineering Journal No. 18, 1992), the half-lives of kitchen waste, waste paper, waste natural fiber textiles, and waste wood are, respectively, 3 , 7 , 7 , and 36 year. As we have found no research making it possible to set a half-life for sludge specific to Japan, we use the default value given in the 2006 IPCC guidelines and set it at 4 year (however, spreadsheets in the *2006 IPCC guidelines* use 3.7 year, so we set it to 3.7 year).

-Delay time

Delay time means the time lag from the time that the waste is landfilled until decomposition occurs. As we have found no research making it possible to set a delay time specific to Japan, we used the default value given in the 2006 IPCC guidelines and set it at 6 months.

Table 8-5 Activity of emissions from controlled disposal sites (kt)

Item	Unit	1990	1995	2000	2003	2004
Kitchen Garbage	kt / year (dry)	517	511	444	359	335
Paper	kt / year (dry)	1,246	1,175	995	881	840
Natural fiber	kt / year (dry)	73	65	56	49	47
Wood and Bamboo	kt / year (dry)	344	377	373	363	359
Sewage sludge	kt / year (dry)	297	277	223	172	158
Sludge from human waste treatment and septic tank	kt / year (dry)	51	52	52	51	50
Waterworks sludge	kt / year (dry)	192	185	157	143	130
organic sludge from manufacturing industries	kt / year (dry)	363	292	182	142	133
livestock waste	kt / year (dry)	251	240	200	213	232
Total	kt / year (dry)	3,336	3,175	2,682	2,373	2,285

• *Amount of CH_4 recovered from landfill*

The amount of CH_4 recovered from landfills can only be obtained from the landfill inside the Metropolitan Tokyo Central Breakwater (hereinafter, "Inside Breakwater Landfill"), where recovered CH_4 is used for electric power generation. Thus, the CH_4 amount recovered there is accounted for the amount of CH_4 recovered from landfills in Japan. Because CO_2 emitted from the combustion of recovered CH_4 is from biomass, and it is not included in the total emissions.

$$R = r \times f \times 16 / 22.4 / 1000$$

r : Amount of recovered landfill gas used for electric power generation in Inside Breakwater Landfill（m^3N）
f : Ratio of CH_4 to recovered gas（-）

- Amount of recovered landfill gas used for electric power generation in Inside Breakwater Landfill

The amount of recovered gas used for electric power generation was provided by the Waste Disposal Management Office of Tokyo.

- Ratio of CH_4 ratio to the recovered gas

CH_4 ratios were set based on the results of a fact finding survey by the Waste Disposal Management Office of Tokyo because any statistical data concerning the CH_4 ratios to recovered landfill gas in the Inside Breakwater Landfill were not available.

The CH_4 ratio in 1987, when the recovery of landfill gas was started is established as 60%, and the ratio in 1996 is established as 40%. The ratio between 1988 and 1995 were obtained by interpolating. The rations from 1997 onward were obtained using the data in 1996.

Table 8-6 Recovery amount of CH_4 at landfill sites in Japan (Gg CH_4)

	Unit	1987	1990	1995	2000	2003	2004
Amount of Gaseous use	km^3N	4,067	1,985	2,375	2,372	1,544	1,561
CH_4 ratio	%	60.0%	53.3%	42.2%	40.0%	40.0%	40.0%
Amount of CH_4 use	km^3N	2,440	1,059	1,003	949	618	624
CH_4 unit conversion	$GgCH_4$	1.74	0.76	0.72	0.68	0.44	0.45

The consumption of gas used for electric power generation during 1991-1994 had decreased compared to the preceding year and the following year because recovered gas was used for the purposes other than electric power generation. The consumption of recovered gas used for electric power generation had decreased compared to 1996 because no electric power generation using recovered gas was conducted between late 1994 and early 1995 due to the relocation of electric power generation facilities.

Because the amount of CH_4 recovered from landfills other than the Inside Breakwater Landfill is considered to be relatively small (determined by the Waste Management and Recycling Department, Ministry of the Environment), it is not estimated

• *CH_4 oxidation rate related to soil cover*

There are not sufficient findings to set a coefficient specific to Japan. For that reason, we used the default value in the *2006 IPCC guidelines* and set the coefficient to 0.

8.1.2. Emissions from Other Controlled Landfill Sites (6.A.3.)

8.1.2.1. Emissions from Inappropriate Disposal (6.A.3.-)

- ***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 inappropriate disposal are put under "Other (6.A.3.)."

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

"Waste wood" and "waste paper" are types of waste which contain biodegradable carbon content and which are inappropriately 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 FOD method with unique Japanese parameters is used for estimation. Emissions from the part of the wood that is inappropriately 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 inappropriate disposal 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 inappropriately disposed of waste wood is multiplied by the percentage of solids and the decomposition rate to arrive at activity data. The amount of illegally dumped 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 disaggregated data of the amount of illegal dumping for each discover year cannot be determined, the residual amount of inappropriately disposed waste wood was estimated by discovery year. 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 inappropriately disposed of waste wood (dry basis)

	Unit	1990	1995	2000	2003	2004
Activity data	kt(dry)	1.4	4.7	15.2	18.4	14.8

8.1.2.2. Emissions from Composting of Organic Waste (6.A.3.-, 6.D.)

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

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)	39	22	28	32	32
wet waste	kt(wet)	138	130	144	144	147

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 (6.B.)

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 for Estimating Emissions of GHGs*

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-CH_4/m^3) / 180 (mg-BOD/L) × 1000

$= 0.0489 \fallingdotseq 0.049$ (kg-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-N_2O/m^3) / 37.2 (mg-N/L) × 1000

$= 0.043$ (kg-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
= Σ[(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
= Σ[(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: Total Nitrogen) 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	530.3
10	Beverage, Tobacco and Feeding Stuff Manufacturing	kt-BOD	137.9	142.7	139.0	121.7	121.3
11	Textile Manufacturing (excluding: Clothing Material, Other Textile)	kt-BOD	156.3	135.7	101.3	85.7	83.4
12	Clothing Material and Other Textile	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	1,440.1
17	Chemical Industries	kt-BOD	684.1	636.5	656.9	651.5	665.1
18	Petroleum Products and Coal	kt-BOD	3.0	2.2	2.6	1.6	1.9
19	Plastic Products Manufacturing	kt-BOD	12.3	11.8	12.4	13.1	14.9
20	Rubber Products Manufacturing	kt-BOD	0.9	0.9	0.6	0.6	0.7
21	Chamois, Chamois Products and Fur Skin Manufacturing	kt-BOD	5.9	5.0	3.7	2.9	2.8
	Total	kt-BOD	3,125	2,989	2,959	2,853	2,862

* 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	1,002
TN load	kt-N	91	90	78	81	82

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 (6.B.2.)". 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 for Estimating Emissions of GHGs***

Emissions of methane and nitrous oxide from this source have been calculated using Japan's 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 for Estimating Emissions of GHGs*

Methane and nitrous oxide emitted from this source were calculated using Japan's 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 Report[1)]

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 Annual treatment population by type of domestic sewage treatment plant

(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 for Estimating Emissions of GHGs*

Methane emitted from this source has been calculated using Japan’s 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)

EF_i: Emission factor for human waste treatment plants (for treatment process i) (kg-CH_4/m^3)

A_i: 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 for Estimating Emissions of GHGs*

Nitrous oxide emitted from this source has been calculated using Japan's 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 emission factors [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-N_2O/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 8-21 Concentration 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-IntensityDenitrogen	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 for Estimating Emissions of GHGs*

The calculation method was established in accordance with the method described in the *2006 IPCC Guidelines*. In the natural decomposition of wastewater, both the volume of organic matter extracted as sludge and recovered methane were zero. Accordingly, 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*

Emission factors were determined in accordance with the *2006 IPCC Guidelines*. 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-CH_4/kg-BOD, given in the 2006 IPCC Guidelines, 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 (0.005 kg-N_2O-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 and septic tank sludge 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) × BOD concentration in human waste (mg-BOD/L) + septic tank sludge dumped in ocean (kL) × BOD concentration in septic tank sludge (mg-BOD/L)	Human waste dumped in ocean (kL) × nitrogen concentration in septic tank sludge (mg-N/L) + septic tank sludge dumped in ocean (kL) × nitrogen concentration in septic tank sludge (mg-N/L)

Source: Volumes for *tandoku-shori johkasou*, vault toilets, on-site disposal systems and ocean dumping – *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*

BOD concentration and nitrogen concentration in human waste and septic tank sludge: Okazaki, Shimizu, and Morita. Study of Operation Records Based on Precision Function Inspection of Human Waste Management Plant. Japan Environmental Sanitation Center Report, 28

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 (4.D.)” 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	22	14	9	5	5
Total	kt-BOD	1,003	845	658	536	538

	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	7	3	2	1	1
Total	kt-N	56	45	35	28	28

8.2.2.5. Recovery of CH_4 emitted from treating domestic and commercial wastewater (6.B.2.)

• *Background*

When treating domestic and commercial wastewater in Japan, the methane generated by fermentation of sludge in sewage treatment plants and human waste treatment facilities is thought to be recovered, but due to the lack of statistics making it possible to determine the amount of methane recovered at human waste treatment facilities, the amount of methane recovered at sewage treatment plants is calculated and reported as the recovered amount of CH_4 generated in the treatment of domestic and commercial wastewater.

GPG (2000) and *2006 IPCC guidelines* give a calculation method which determines methane emissions by subtracting the amount of recovered methane from the amount generated in domestic and commercial wastewater treatment facilities. However, Japan’s “Emissions arising from domestic and commercial wastewater treatment (6.B.2.) CH_4” directly calculates the amount of methane generated by domestic and commercial wastewater treatment at sewage treatment plants by multiplying the emission factor set according to the measured amount of methane discharged into the atmosphere from the water and sludge treatment processes at sewage treatment plants by the amount of wastewater treated. (There are no atmospheric emissions of methane generated in sludge digesters because it is all recovered.) Thus, the recovered methane amount calculated in this estimate is reported for reference purposes, not used in calculating the amount of methane emitted from the treatment of domestic and commercial wastewater at sewage treatment plants.

• *Methodology for Estimating Emissions of GHGs*

The amount of methane recovered from sludge digesters at sewage treatment plants is calculated by multiplying the amount of digester gas recovered from digesters by an emission factor that takes into account the concentration of methane in digester gas.

• *Emission Factors*

The emission factor is set by finding the weight equivalent of the average methane concentration in digester gas.

$$EF = F_{CH_4} \times 16/22.4$$

Where:

F_{CH4} = concentration of methane in digester gas (volumetric base)

The CH_4 concentration in digester gas (volumetric base) was set at 60% with reference to the "Manual for Developing Plans for Biosolids Utilization (Draft)", Ministry of Land, Infrastructure, and Transport.

• *Activity Data*

The amount of methane recovered from sewage treatment plant sludge digesters is determined from "amount of digester gas generated by sludge treatment facilities" in Sewerage Statistics, Administrative Volume, Japan Sewerage Works Association. Because all the digester gas generated at Japanese sewage treatment plants is recovered, the total amount of generated digester gas is treated as the amount of digester gas recovered. The amount of digester gas used for energy that is to be included in the energy category is determined from the amount of digester gas listed in "amount of digester gas used in sludge digester facilities" of Sewerage Statistics.

Table 8-25 Amount of methane recovered from sewage treatment plant sludge digesters (Gg CH_4)

Year	Unit	1990	1995	2000	2003	2004
Recovered CH_4 amount	GgCH_4	88.7	110.5	113.3	124.5	125.0
Portion used as energy	GgCH_4	65.3	73.9	75.3	92.2	92.6

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 8-26.

Table 8-26 Categories for the calculation of emissions from waste incineration (6.C.)

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		○	○	○
		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 Revised 1996 IPCC Guidelines and *GPG (2000)* indicate that waste used as an alternative fuel is to be accounted for in the Energy section. In Japan, however, because use of waste as an alternative fuel is conducted under the 3R policy, and from the view point of promoting incentive for industry business to use waste as an alternative fuel, emissions associated with waste used as an alternative fuel were accounted for in the Waste sections and reported in the Energy section as reference information.

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.-)

1) CO_2

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

Emissions of carbon dioxide from this source were derived by using the volume of waste plastic incinerated (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. The emissions at a municipal solid waste incinerator with a generation efficiency of 10% or more are considered to be emissions from the waste used for power generation, and calculated as reference value.

$$E = EF \times A$$

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 8-27 Carbon content of plastics and synthetic textile scrap in MSW

Item	Unit	1990	1995	2000	2003	2004
Plastics	%	72.0%	73.4%	74.2%	75.2%	76.2%
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.

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 to be 80% 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 to be 80% 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 8-28 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

2) CH_4

• *Methodology for Estimating Emissions of GHGs*

Emissions of methane from this source were derived by multiplying the volume of municipal solid waste incinerated by type of waste incineration facility, and by the emission factors defined for individual facility. (Refer to *6C-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 8-29 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 8-30 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

3) N_2O

• *Methodology for Estimating Emissions of GHGs*

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 8-31 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

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.-)

1) CO_2

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

Emissions of carbon dioxide from this source have been calculated using the volume of waste oil and waste plastics incinerated, and Japan's country-specific emission factor, in accordance with Decision Tree of the Good Practice Guidance (2000) (Page 5.26, Fig. 5.5). Since industrial waste textile dose not include synthetic fabrics scrap under the regulation of the Waste Disposal and Public Cleansing Law, industrial waste textile is regarded as waste natural fiber. Thus the CO_2 emissions from incineration of industrial waste textile do not include national total because of the emissions are from biogenic source.

• *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

The carbon content in waste oil has been deemed to be 80%, from the factor of 0.8 (t-C/t) given in the Environmental Agency's *Report on a Survey of Carbon Dioxide Emissions (1992)*.

The carbon content in waste plastic has been deemed to be 70%, from the factor of 0.7 (t-C/t) given in the Environmental Agency's *Report on a Survey of Carbon Dioxide Emissions (1992)*.

- Rate of combustion

In light of the actual situation of emissions in Japan, the rate of combustion in facilities for the incineration of waste oil and waste plastics from fossil fuels was deemed to be 99.5% on the basis of the maximum default value for dangerous wastes given in the *Good Practice Guidance*.

• *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 used in the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*. Waste oil was deemed to be entirely derived from fossil fuel.

Activity data for the incineration of waste oil and plastics (ISW) (wet basis)
= Volume of waste oil and plastics incinerated

Table 8-32 Incinerated ISW (waste oil and waste plastics)

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

2) CH_4

• *Methodology for Estimating Emissions of GHGs*

Emissions of methane from this source have been calculated by multiplying the volume of industrial waste incinerated by Japan's 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 8-33 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 8-34 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

3) N_2O

• *Methodology for Estimating Emissions of GHGs*

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 8-35 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（2001）

Takeishi, Watanabe, Matsubara, Hirayama, Maebashi, Koma, Wakasugi, and Yoshikawa *Report on Joint Research into the Behavior and Reduction of Waste Gas Components in Flux Furnaces* Public Works Research Institute, Ministry of Construction and Nagoya City Water Authority（1996）

Takeishi, Watanabe, Matsubara, Sato, Maebashi, Tanaka, Miwa, Wakasugi, and Yamashita *Report on Joint Research into the Behavior and Reduction of Waste Gas Components in Flux Furnaces* Public Works Research Institute, Ministry of Construction and Nagoya City Water Authority（1994）

Ishikawa Prefecture, City of Osaka, Kanagawa Prefecture, City of Kyoto, Hiroshima Prefecture, Hyogo Prefecture, *Survey of Compilation of Emission Units of Greenhouse Gas from Stationary Sources* (1991-1999)

- Sewage sludge

Emission factors 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 8-36.

Table 8-36 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.

Table 8-37 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.-)

1) CO_2

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

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

2) CH_4

• *Methodology for Estimating Emissions of GHGs*

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.

3) N_2O

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

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 8-38 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.-)

1) CO_2

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

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 and waste 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 as the volume of hydrocarbon that is used as chemical raw material and from which no carbon dioxide is emitted into the air by subtracting the percentage of carbon in the plastics that migrates to hydrocarbon oil in the coke oven (47.9%) from emission factor for plastics (MSW)

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)* (Table 8-27) 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)* (95%), 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 8-39 Carbon dioxide emission factors associated with the incineration of RDF and RPF Plastics from municipal solid waste(as chemical raw material in coke ovens),waste tires (kg-CO_2/t)

	Unit	1990	1995	2000	2003	2004
MSW-coke oven	kgCO_2/t(dry)	1,362	1,387	1,404	1,422	1,441
Waste tire	kgCO_2/t(dry)	1,858	1,785	1,790	1,770	1,753
RDF	kgCO_2/t(dry)	1,029	1,029	1,029	1,029	1,029
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. The percentage of solids was established 96% by using the data provided by the Japan Containers and Packaging Recycling Association.

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) in the *Tire Industry of Japan,* published by the Japan Automobile Tire Manufacturers Association, Inc. 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 8-40 Usage as raw materials and fuels (kt)

	Unit	1990	1995	2000	2003	2004
MSW-plastics-oilification	kt(dry)	0	0	3	6	6
MSW-plastics-reducer in blast furnace	kt(dry)	0	0	24	57	54
MSW-plastics-chemical material in coke-oven	kt(dry)	0	0	10	118	133
MSW-plastics-gasification	kt(dry)	0	0	1	27	50
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)	32	37	140	309	309
RPF	kt(dry)	0	8	25	172	289

2) CH_4, N_2O

• *Methodology for Estimating Emissions of GHGs*

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 8-41 by taking into account the status of use in combustion and the availability of data.

Table 8-41 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		Plastic oil	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 8-42 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 8-42 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		Plastic oil	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 8-43 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 8-44 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	2,377	2,377
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)	34	39	148	327	327
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 for Estimating Emissions of GHGs*

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 8-45 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 8-46 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

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

Contracting Survey of Environmental Agency, *Comprehensive Survey on Air Pollutant* (1995)

Environmental Agency, *Report on a Survey of Carbon Dioxide Emissions*, 1992

Environmental Agency, *Results of Review of Calculation of Emissions of Greenhouse Gas Part 2*, 2000

Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 1*, September 2000

Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *Review of Greenhouse Gases Emissions Estimation Methods Part 2*, September 2000

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, R*eview of Greenhouse Gases Emissions Estimation Methods Part 3*, August 2002

Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, R*eview of Greenhouse Gases Emissions Estimation Methods*, February 2006

Ministry of the Environment, Water Environment Department of the Environmental Management Bureau, *Comprehensive Survey of Emissions of Water Quality Contaminants*

Ministry of the Environment, Waste Management and Recycling Department , *Japan's Waste Disposal (CD-ROM)*

Ministry of the Environment, Waste Management and Recycling Department report of the research on the state of wide-range movement and cyclical use of wastes (the volume on cyclical use)

Ministry of the Environment, Waste Management and Recycling Department , *Waste Treatment in Japan*

Ministry of the Environment, Waste Management and Recycling Department , *Study on Residual Amounts of Industrial Waste from Illegal Dumping and other Sources*

Ministry of the Environment, Waste Management and Recycling Department , *Annual Recycling Statistics* under the *Plastic Containers and Packaging Recycling Law*

Japan Containers and Packaging Recycling Association, *Statistics of Commercial Recycling of Plastics (Recycling).*

Japan Containers and Packaging Recycling Association, *Assessment and deliberation of the Plastic Containers and Packaging Recycling Law*

Ministry of Health, Labor and Welfare, Water Supply Division, Health Service Bureau, *Report on Survey of Organizations in Industrial Waste Administration*

Ministry of Economy, Trade and Industry, *Table of Industrial Statistics - Land and Water*

Ministry of Economy, Trade and Industry, *Chemical Industry Statistical Yearbook*

Ministry of Economy, Trade and Industry, *Annual Textile Statistics Report*

Clean Japan Centre, *Report on Results of Trend and Industry-Specific Studies on Industrial Wastes (Mining Industry Waste) and Recyclable Waste*

Japan Chemical Fibers Association, *Textile Handbook*

Japan Society of Waste Management Experts, *Waste Handbook*

Society for the Study of autonomous control of Local Authorities, *Directory of national municipalit*

Japan Iron and Steel Federation, *Current State of Plastic Waste Recycling and Future Tasks*

Japan Cement Association, *Cement Handbook*

Japan Automobile Tire Manufacturers Association, *Tire Industry of Japan*

The Chemical Daily, *Chemical manufactured of 14705*

Ministry of Land, Infrastructure and Transport, *Statistical Yearbook of Motor Vehicle Transport*

Ministry of Land, Infrastructure and Transport, *Sewage Sludge Incineration Volumes, by Flocculant*

Ministry of Land Infrastructure and Transport, National Institute for Land and Infrastructure Management, *2000 Annual Report of Investigation and Research for Sewer*, NILIM Report 10: pp93-96, 2001

Ministry of Land Infrastructure and Transport, National Institute for Land and Infrastructure Management, *2001 Annual Report of Investigation and Research for Sewer*, NILIM Report 64: pp116-122, 2002

Japan Water Works Association, *Wateworksr Statistics*

Hyogo Prefecture, *Report of GHG Emission Factors from Stationary Combustion*, 1994

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*, 1991-1999

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

Kanagawa Prefecture, *Report of GHG Emission Factors from Stationary Combustion*, 1994

Japan Environmental Sanitation Center, *Report of Analytical Survey of Methane Emissions*, FY1989 Commissioned by the Environmental Agency

Japan Sewage Works Association, *Guidelines and Analysis of Comprehensive Planning Surveys for the Provision of Water Mains, Catchment Area 1999 Edition*

Japan Sewage Works Association, *Sewage Statistics (Admin. Ed.)*

Japan Society of Atmospheric Environment, *Method of Estimating Greenhouse Gas Emissions -Survey Report*, 1996

Inamori and Mizuochi, *"B-16(8) On-Site Surveys of Balance of Methane and Nitrous Oxide from Sewage and Waste"*, FY1998 Global Environment Research Fund Outcome Report

Iwasaki, Tatsuichi, Ueno, *"Review of Causes of Emissions of Nitrous Oxide and Methane from Waste Incinerators"*, Annual Report of the Tokyo Metropolitan Research Institute for Environmental Protection, 1992

Kyosai and Mizuochi, *"B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants"*, FY1990 Global Environment Research Fund Outcome Report

Sato Mizuochi and Suzuki, *"B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants"*, FY1992 Global Environment Research Fund Outcome Report

Masaru Tanaka, *Compendium of Waste*, Maruzen, 1998

Matsubara and Mizuochi, *"Survey of Emissions of Nitrous Oxide from Sewage Treatment Plants"*, Environmental and Sanitary Engineering Research, 8(3), 1994

Matsuzawa et al., *“Estimates of Volume of Methane Released from Sewage Treatment Plants”*, Collection of research papers presented to the 4th Academic Conference on Waste, 1993

Nakamura et al., *“Emission of Nitrous Oxide from Incineration of Sewage Sludge”*, Proceedings of the 20th Japan Urban Cleaning Research Conference, pp391-393, 1998

Nakamura, Suzuki, Sonemura, Ochi, and Harada, *“B-51(2) Sewage Treatment System Technology for Limiting Greenhouse Gases”*, FY1997 Global Environment Research Fund Outcome Report

Okazaki, Shimizu, and Morita, *“Study of Operation Records Based on Precision Function Inspection of Human Waste Management Plant”*, Japan Environmental Sanitation Center Report 28

Omura, Kawakubo, and Yamada, *“Study of Emission Factors for N2O from High-load Human Waste Management”*, Journal of Waste Management 57, p260

Suzuki, Ochi, Miyata, *“Continuous Measurement of Nitrous Oxide Emissions from Sewage Sludge Flux Furnaces”*, Proceedings of the 11th Environmental Engineering Symposium 2001, pp387-390, 2001

Takeishi, Suzuki, and Matsubara, *“B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants”*, FY1993 and FY1994 Global Environment Research Fund Outcome Reports

Takeishi, Suzuki, and Matsubara, *“B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants”*, FY1993 Global Environment Research Fund Outcome Report

Takeishi, Watanabe, Matsubara, Hirayama, Maebashi, Koma, Wakasugi and Yoshikawa, *“Report on Joint Research into the Behavior and Reduction of Waste Gas Components in Flux Furnaces”*, Public Works Research Institute, Ministry of Construction and Nagoya City Water Authority, 1996

Takeishi, Watanabe, Matsubara, Sato, Maebashi, Tanaka, Miwa, Wakasugi and Yamashita, *Report on Joint Research into the Behavior and Reduction of Waste Gas Components in Flux Furnaces*, Public Works Research Institute, Ministry of Construction and Nagoya City Water Authority, 1994

Tanaka, Inoue, Matsuzawa, Osako, and Watanabe, *“B-2(1) Research into Volumes Released from Waste Treatment Plants”*, 1994 Global Environment Research Fund Outcome Report

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

Ueno et al., *“Review of Measures to Reduce Nitrous Oxide in Sewage Treatment Plants”*, Tokyo Metropolitan Research Institute for Environmental Protection, 1995

Watanabe et al. *“Primary Screening of Greenhouse Gases Generated in Association with the Biological Breakdown of Organic Wastes”*, Collection of papers presented to the 13th Japan City Cleaning Research Conference, 1992

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

Iwata, Kato, Sawada and Mori, *Study on the Utilization of Sludge from Purification Plant for Agriculture II. Effects of application of sludge as soil amendment matter on rice plants,* Aichi-ken Agricultural Research Center Report, 14, 46-52, 1982

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 inventory submitted in May 2006 as well as in the inventory submitted in August 2006 as an attachment to the report on emission quota.

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. Items that were revised between May and August 2006 are identified by the addition of an appropriate remark to their headings. Items with no remarks are a reiteration of the values reported in the NIR submitted in May 2006, which remain unchanged since the submission.

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: CO_2

1) Reporting of Coal Products Manufacturing Sector (Revised, August 2006)

A reexamination of energy and carbon balances in the coal products manufacturing sector in *General Energy Statistics* resulted in improvements with the elimination of carbon imbalances. The improvements include a review of the standard calorific values of coking coal, a review of material input in coking, and the exclusion of imported coke from the amount received. The difference between the amount of carbon input into coke making and the amount produced, including the portion oxidized (burnt) during the transition of hot coke from the extrusion from coke ovens to the dry quenching process (CDQ), was reported as carbon dioxide emission from this sector. This decision is believed to be appropriate, although there is room for further refinement.

2) 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.

3) 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.

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 (Stationary Combustion): 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*.

4) Establishment of share by furnace type (Revised, August 2006)

For years in which exhaustive MAP surveys were not carried out, share by furnace type was established by estimation using the data obtained in the years exhaustive survey carried out. The data completion method of establishment of has changed from substitution using nearest data to interpolating.

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

10.1.2.3.a. 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. 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.

2) 1.A.3.b. Revision of Emission Factors for Automobiles (Revised, August 2006)

Using newly obtained data, some methane and nitrous oxide emission factor were changed to Japan’s new country-specific values based on JAMA data. For gasoline-powered light passenger vehicle, gasoline-powered light cargo truck, gasoline-powered passenger vehicle, diesel-powered passenger vehicle and gasoline-powered small cargo trucks, the methane and nitrous oxide emission factor were changed. For natural gas-powered light passenger vehicle, light cargo truck, passenger vehicle and small cargo truck, methane emission factors were changed. For diesel-powered small cargo truck, and regular cargo truck, nitrous oxide emission factors were changed.

10.1.2.4. 1.B. Fugitive Emissions from Fuels

10.1.2.4.a. 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.iii.) 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.

4) 1.B.2.b.iv. Emissions from Natural Gas Distribution: CH_4 (Revised, August 2006)

After the reorganization of the methane emission sources in the town gas distribution sector in Japan, the emissions were recalculated by establishing new emission factors for each of the emission sources based on the actual state of methane emissions in Japan.

10.1.2.4.b. Sources with Revised Estimation Method

1) 1.B.2.b.iii Emissions from Natural Gas Transmission: CH_4 (Revised, August 2006)

After the reorganization of the methane emission sources associated with natural gas transmission in Japan, the new emission factors established for each of the emission sources based on the actual state of methane emissions in the country replaced the previously used default emission factors given by *Good Practice Guidance (2000)* resulting in recalculation of the emissions.

10.1.3. Industrial Process Sector

10.1.3.1.a. 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). After the submission of inventory in May 2006, the activity data (import of soda ash and other sodium carbonate) were changed from calendar year values to fiscal year value.

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). It should be noted that this method has been reviewed in the August 2006 inventory report.

5) 2.F.3. Fire Extinguishers: HFCs, PFCs, SF_6 (Revised, August 2006)

Emission of HFCs during manufacturing is reported as "NO" according to the expert judgments that the emission of this source is negligible because the calculated emission from this source in 2004 was really small. 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.

6) 2.F.5. Solvents: HFCs (Revised, August 2006)

The past reports returned "Not Estimated (NE)" for this category because of the lack of usage data. The August 2006 revision reports the emissions of HFC-43-10mee. It should be noted that the data are treated as confidential, and the emissions were incorporated into the reported emissions of PFCs. The emissions of HFCs from manufacturing, use, and disposal were reported as "Included Elsewhere (IE)".

7) 2.F.6. Use of Alternative Fluorocarbons for Products Other Than Refrigerants and Foaming Agents: HFCs, PFCs, SF_6 (Revised, August 2006)

This is a new category for reporting the emissions form use of alternative fluorocarbons for products other than refrigerants and foaming agents that was added to the 2006 inventory requirements. Japan, however, reported "NE" because the extent of HFCs emissions was yet to be fully understood. PFCs and SF_6 emissions are reported as "NA" because alternative fluorocarbons do not contain PFCs and SF_6.

10.1.3.1.b. Sources with Revised Estimation Methods

1) 2.A.1. Cement Production: CO_2

The limestone method (original method in Japan) 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 a Tier.2 method (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.A.2. Lime Production: CO_2 (Revised, August 2006)

Because the data used for activity data could no longer be updated owing to the elimination of limestone and dolomite for lime production from the statistics, the calculation method was changed to a Tier 1 method prescribed in *Good Practice Guidance (2000)*. As a result, the emissions were reported using the default emission factors and the activity data based on the production volumes of limestone and soft-burned dolomite.

3) 2.B.4. Carbide Production: CH_4 (Revised, August 2006)

The methane emissions from furnaces for carbide production had been counted under the category of *fuel combustion* (1.A. Stationary Combustion). The emission category was changed, however, because the emissions from furnaces for carbide production could not be considered to have originated from the combustion of fossil fuels.

4) 2.C.1. Use of Electric Arc Furnaces in Iron and Steel Production: CO_2 (Revised, August 2006)

In order to report carbon dioxide emissions from the carbon electrodes of electric arc furnaces used for purposes other than steel production, which had previously been unreported, the calculation method, which multiplied the amount of crude steel production by electric furnaces by the emission factors, was modified to a method which assumed that the amount of carbon equal to the total weight of manufactured and imported carbon electrodes less the weight of exported electrodes was discharged into the atmosphere as carbon dioxide.

5) 2.C.1. Use of Electric Arc Furnaces in Iron and Steel Production: CH_4 (Revised, August 2006)

The methane emissions from this sector were previously reported in the category of *Fuel Combustions* (1.A. Stationary combustion). The emission category was changed, however, because the emissions from electric arc furnaces could not be considered to have originated from the combustion of fossil fuels. The basis for activity data was also changed from the previously used data for power consumption by electric furnaces, reported in *Research of Air Pollutant Emissions from Stationary Sources* (the MAP survey), to the power consumption which was reported in *General Energy Statistics* because the MAP survey data could no longer be updated.

6) 2.C.2. Ferroalloys Production: CH_4 (Revised, August 2006)

The methane emissions from this sector were previously reported in the category of *Fuel Combustion* (1.A. Stationary combustion). The emission category was changed, however, since the emissions of CH_4 from the production of ferroalloys could not be considered to have originated from the combustion of fossil fuels. The basis for activity data was also changed from the previously used data for power consumption in ferroalloy production reported in the MAP survey to the power consumption reported in *General Energy Statistics* because the MAP survey data could no longer be updated.

7) 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.

8) 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 Second Assessment Report*.

9) 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 50% under “production” and rest of 50% under “use” in accordance with IPCC guideline. 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) 2.F.5. Solvent : PFCs

The identified PFC that the GWP is not indicated in the IPCC Second Assessment Report (SAR) was excluded. Calculation only for the PFC with GWP indicated in SAR was conducted. Given that reporting of emissions for the PFC that the GWP is not indicated in SAR, apart from the national total emissions, is strongly recommended, Japan continues to estimate emissions domestically.

11) 2.F.9. Other : HFCs

The notation key of HFCs emission in this category was changed to “NA” from “NE” according to the requirement of reporting that emissions form use of alternative fluorocarbons for products other than refrigerants and foaming agents are to be reported under the 2.F.6. category.

10.1.3.1.c. 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.a. 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).

10.1.4.1.b. 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.

10.1.4.1.c. Sources with Revised Emission Factors

1) 4.C.1. Continuously Flooded Paddy Fields: CH_4 (Revised, August 2006)

The equation for establishing emission factors contained an error (division by “0.435” rather than “(1–0.435)”). The error was corrected and the emission factors were recalculated using the correct formula.

10.1.5. Land Use, Land-Use Change, and Forestry (LULUCF) Sector

10.1.5.1.a. Reporting emissions and removals after 1995 (August 2006, Revised)

Previously, Japan reported emissions and removals for the LULUCF sector except urban parks and greenery conservation zones, etc after 1995 as “NE”. However, Expert Review Team recommended that Japan report emissions and removals for all inventory years to keep time series consistency. Therefore, Japan estimated and reported emissions and removals after 1995.

10.1.5.1.b. Sources and Sinks with Revised Estimation Methods

1) 5.A. Forest land (living biomass) :CO_2 (August 2006, Revised)

Previously, Japan had used "Default method" (requires the biomass carbon loss to be subtracted from the biomass carbon increment) for estimating carbon stock change in living biomass. However, Japan changed estimation method to "Stock change method" (requires the difference between the biomass at time t1 and time t2, divided by the number of years between the inventories) and changed parameters, because uncertainties relevant to estimating carbon loss due to felling are not insignificant.

In Japan, biomass carbon loss is estimated by dividing timber supply volume provided in "*Report on the wood demand and supply*" (Ministry of Agriculture, Forestry and Fisheries) by yield. However, it was difficult to improve accuracy of these data for the reasons mentioned below.

- "*Report on the wood demand and supply*" used in estimating biomass carbon loss assumes that the timber volume received in timber production plants (saw mills, laminated wood plants and wood chip plants) is regarded as timber supply volume (timber demand volume). Therefore, it is impossible to verify these data statistically, although hearing investigation has been implemented. Additionally, it would not be expected to improve data accuracy, because survey on timber volume transferred between prefectures has been abolished since 2005 in accordance with simplification of national statistics.
- Biomass carbon loss for personal consumption is not accounted in statistics.

2) 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.

3) 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.

4) 5.B. Cropland (soils), 5.C. Grassland (soils) :CO_2 (August 2006, Revised)

Previously, Japan had established soil carbon stock for rice field, crop field, orchard and grassland by using data from "Basic survey on soil environment (Stationary measurement)" provided in "Survey on method for quantification of amount of GHG emission cuts (2000)". However, Breakout group on LULUCF (Committee for Greenhouse Gas Emissions Estimation Methods) concluded as follows.

1. Depth of the observed layer for each soil carbon stock data is not consistent.
2. It is not considered that soil carbon stocks vary by soil type.

3. Time series variation of established soil carbon stocks differ from the actual circumstances of Japan.

Therefore, Japan changed soil carbon stock data for rice field, crop field, orchard and grassland.

5) 5.B.2. Land converted to Cropland :N_2O (August 2006, Revised)

Previously, Japan had used the default C:N ratio provided in the LULUCF-GPG for estimating N_2O emissions from disturbance associated with land-use conversion to cropland. However, Breakout group on LULUCF (Committee for Greenhouse Gas Emissions Estimation Methods) concluded that the default value might not reflect the circumstances of Japan correctly. Therefore, Japan changed C:N ratio to the country specific value based on “Basic survey on soil environment (Stationary measurement)”.

6) 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. Emissions from Managed Waste Disposal on Land: CH_4 (Revised, August 2006)

The amount of methane recovered from landfill sites was calculated for the first time.

2) 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.

3) 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 (Waste Wood) (6.A.1.)* category.

4) 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*.

5) 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.

6) 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*.

7) 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.

8) 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.

9) 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.

10) 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.1. Emissions from Managed Waste Disposal on Land: CH_4 (Revised, August 2006)

Methane emissions from managed waste disposal on land were previously calculated by a Japan-specific method using a decomposition curve based on the Sheldon-Arleta model. In the revised report, the method was changed to the first order decomposition (FOD) method prescribed in the *2006 IPCC Guidelines* according to the recognition that the validity of applying the model to landfill sites in Japan needed further examination.

2) 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.

3) 6.A.1. Emissions from Managed Waste Disposal on Land (Kitchen Garbage, Paper Scraps, Wood Scraps): CH_4 (Revised, August 2006)

Municipalities measure annually the carbon contents of kitchen garbage, paper scraps, and wood scraps contained in municipal waste. The carbon contents of these items were previously determined by averaging, weighted by population, the moving averages of these measured values over five-year periods before and after any particular year. Before the August 2006 inventory, the calculation method was reviewed because the data were collected by the municipalities at different times and the coverage of the data used for weighted averaging was not necessarily on a national scale.

Because the carbon contents of these items were likely to remain virtually unchanged over time, the August revision has applied an average carbon content, which was calculated as a simple average of all data that are currently (2006) available, to all relevant calculations throughout the covered period.

4) 6.A.1. Emissions from Managed Waste Disposal on Land (Textile Scraps): CH_4 (Revised, August 2006)

With respect to textile scraps disposed of on land, natural textile was the only item covered because synthetic textiles would not be broken down biologically in landfill. Since it was impossible to determine the percentage of natural textile among the textile scraps contained in industrial waste, the emissions were calculated using the median value between the upper and lower limits that were inferred from the definition of “textile scraps”. Under the *Waste Disposal and Pubic Cleansing Law*, however, synthetic textile scraps are not included in the industrial waste category. As a result, the definition was changed to treat all textile scraps contained in industrial waste as natural textile.

5) 6.A.1. Emissions from Managed Waste Disposal on Land (Kitchen Garbage, Organic Sludge from Manufacturing): CH_4 (Revised, August, 2006)

With respect to organic sludge generated by food manufacturing and chemical industries, the established values for solid contents of sludge were revised because new data became available.

6) 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.

7) 6.B.2. Emissions from the Treatment of Domestic and Commercial Waste Water: CH_4 (Revised, August 2006)

In response to a request for a determination of the portions of methane generated by the treatment of domestics and commercial waste water which were not emitted into the atmosphere but were recovered or effectively utilized, the amount of methane recovered from final treatment plants was calculated for the first time. It should be noted that the calculated value for the methane recovery is for reference purposes only because Japan calculates and reports the actual amount of methane that is emitted into the atmosphere, and the amount calculated as recovered is already included in the reported emissions.

8) 6.B.2. Emissions from the Treatment of Domestic and Commercial Waste Water (Emissions from the Decomposition of Domestic Waste Water in Nature): CH_4 (Revised, August 2006)

Owing to the difference in the methods used to determine the nitrogen concentration in human waste, there were variances between the value reported in the *Emissions from the Decomposition of Domestic Waste Water in Nature:* N_2O and the value reported in the *Emissions from the Treatment of Domestic and Commercial Waste Water (Human Waste Treatment Plant):* N_2O, which should be identical. As a result, the calculation method used to determine the concentrations of nitrogen and organic matter for the *Emissions from the Decomposition of Domestic Waste Water in Nature* was changed to use the same method as that used in the *Emissions from the Treatment of Domestic and Commercial Waste Water (Human Waste Treatment Plant)* for the determination of nitrogen concentration. N_2O emission factor was also changed because of the replacement of the referred value in the reference.

9) 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.)

10) 6.C. Emissions from Municipal Waste Incineration: CO_2 (Revised, August 2006)

Municipalities measure the carbon contents of plastics in their municipal waste each year. The carbon contents of plastics was previously determined by averaging, weighted by population, the moving averages of these measured values over five-year periods before and after any particular year. However, taking into consideration that the timing for the measurements varies among the municipalities, and that the data used to calculate the weighted average does not necessarily provide a high national coverage, the calculation method was revised to use the average carbon content calculated by a simple averaging of moving averages over a five-year period including the current reporting year.

11) 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.

12) 6.C. Emissions from Industrial Waste Incineration (Industrial Waste, Textile Scraps): CO_2 (Revised, August 2006)

The carbon dioxide emissions from the incineration of textile scraps contained in industrial waste were removed from the total emissions of biomass-derived carbon in Japan to reflect the change which deems that all textile scrap in industrial waste is natural textile (See Item (4)).

13) 6.C. Emissions from Industrial Waste Incineration (RDF): CO_2, CH_4, and N_2O (Revised, August 2006)

The amounts of RDF incineration for the 1990–1992 period, which were yet to be estimated, were calculated using the capacities of RDF manufacturing plants.

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.

10.1.7. Other

1) Emissions from International Marine Bunkers: CO_2, CH_4, and N_2O (Revised, August 2006)

Provided that Japan reported emissions related to propulsion of international water-borne vessels, it had estimated emissions only for heavy oil A, B, and C, reported as bonded imports and exports. However, bonded imports and exports reported include diesel oil and kerosene, which means that emissions associated with diesel oil and kerosene had not been estimated. Therefore, emissions for diesel oil and kerosene were reported as part of emissions from marine bunkers.

10.2. Implications for Emission Levels

Table 10-2 and Table 10-3 show the changes made to the overall emission estimates due to the recalculations indicated in “Section 10.1. Explanation and Justification for Recalculations”.

Compared to the values reported in the previous year’s inventory, total emissions excluding CO_2 in the LULUCF sector in the base year (1990) under the UNFCCC increased by 1.93%, and the total emissions in year 2003 increased by 1.43% compared to the data reported in last year (Table 10-2). Compared with the May 2006 inventory values, the total emissions in the base year (1990) showed an increase of 0.38%, and the 2004 emissions showed an increase of 0.02% (Table 10-3).

Table 10-2 Comparison of the inventories submitted in 2005 and August 2006

[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[4]	JNGI2006.8[3]	1,069.3	1,071.4	1,079.7	1,071.3	1,130.9	1,144.9	1,154.0	1,149.5	1,113.7	1,148.8	1,169.6	1,154.4	1,191.4	1,189.4
	difference	*2.98%*	*2.28%*	*1.53%*	*2.17%*	*2.38%*	*2.56%*	*-6.54%*	*-7.45%*	*-6.82%*	*-6.48%*	*-5.60%*	*-4.88%*	*-4.52%*	*-5.56%*
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	JNGI2006.8	1,144.1	1,153.0	1,160.6	1,153.0	1,212.8	1,226.4	1,239.3	1,234.8	1,198.6	1,233.7	1,254.6	1,239.3	1,276.8	1,284.4
	difference	*1.95%*	*1.91%*	*1.02%*	*1.25%*	*1.22%*	*1.10%*	*0.37%*	*-0.58%*	*0.28%*	*0.44%*	*1.26%*	*2.12%*	*2.32%*	*1.98%*
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
with LULUCF	JNGI2006.8	33.5	33.2	33.0	32.7	32.0	31.0	30.3	29.2	28.4	27.7	27.0	26.2	25.3	24.8
	difference	*34.89%*	*34.43%*	*34.27%*	*33.41%*	*32.81%*	*32.28%*	*32.36%*	*32.37%*	*31.71%*	*31.21%*	*30.42%*	*30.02%*	*29.47%*	*28.38%*
CH_4	JNGI2005	24.8	24.6	24.5	24.4	24.0	23.4	22.9	22.1	21.5	21.1	20.7	20.2	19.5	19.3
without LULUCF	JNGI2006.8	33.4	33.1	32.9	32.6	31.9	31.0	30.2	29.2	28.3	27.7	27.0	26.2	25.2	24.7
	difference	*34.78%*	*34.48%*	*34.30%*	*33.47%*	*32.95%*	*32.47%*	*31.99%*	*32.00%*	*31.42%*	*30.96%*	*30.20%*	*29.77%*	*29.25%*	*28.26%*
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
with LULUCF	JNGI2006.8	32.8	32.4	32.4	32.1	33.2	33.6	34.7	35.3	33.9	27.4	29.9	26.4	26.0	25.8
	difference	*-18.38%*	*-18.49%*	*-18.71%*	*-19.03%*	*-18.10%*	*-17.32%*	*-16.39%*	*-15.65%*	*-16.53%*	*-21.83%*	*-20.08%*	*-23.65%*	*-24.90%*	*-25.56%*
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
without LULUCF	JNGI2006.8	32.7	32.3	32.4	32.0	33.2	33.5	34.7	35.3	33.8	27.4	29.9	26.4	26.0	25.8
	difference	*-18.55%*	*-18.65%*	*-18.86%*	*-19.18%*	*-18.22%*	*-17.42%*	*-16.49%*	*-15.72%*	*-16.60%*	*-21.91%*	*-20.15%*	*-23.72%*	*-24.96%*	*-25.60%*
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
	JNGI2006.8	NE	NE	NE	NE	NE	20.2	19.8	19.8	19.3	19.8	18.6	15.8	13.1	12.5
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*-0.10%*	*-0.11%*	*0.10%*	*0.12%*	*0.11%*	*0.20%*	*0.45%*	*1.90%*	*1.77%*
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
	JNGI2006.8	NE	NE	NE	NE	NE	14.0	14.5	15.5	12.6	9.7	8.6	7.2	6.5	6.2
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*11.71%*	*-5.25%*	*-8.60%*	*-24.34%*	*-34.78%*	*-37.08%*	*-37.47%*	*-33.76%*	*-31.38%*
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
	JNGI2006.8	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*	*0.07%*	*-0.03%*	*-0.03%*	*0.11%*	*-0.09%*	*0.05%*	*0.14%*	*0.45%*	*6.08%*
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	JNGI2006.8	1,135.6	1,137.0	1,145.1	1,136.1	1,196.1	1,260.7	1,270.8	1,264.1	1,221.2	1,242.6	1,260.6	1,235.8	1,267.7	1,263.3
	difference	*2.92%*	*2.25%*	*1.53%*	*2.10%*	*2.30%*	*2.48%*	*-5.99%*	*-6.88%*	*-6.53%*	*-6.46%*	*-5.66%*	*-5.04%*	*-4.69%*	*-5.66%*
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
without LULUCF	JNGI2006.8	1,210.3	1,218.4	1,225.9	1,217.6	1,277.9	1,342.1	1,356.0	1,349.3	1,306.0	1,327.4	1,345.5	1,320.6	1,353.0	1,358.3
	difference	*1.93%*	*1.89%*	*1.03%*	*1.22%*	*1.20%*	*1.14%*	*0.31%*	*-0.60%*	*-0.04%*	*-0.07%*	*0.70%*	*1.48%*	*1.73%*	*1.43%*

1) JNGI2005: Japan National GHG Inventory submitted in 2005
2) JNGI2006.8: Japan National GHG Inventory submitted in August 2006
3) LULUCF: Land Use, Land-Use Change, and Forestry

Table 10-3 Comparison of the May 2006 and the August 2006 inventories

[Mt CO_2eq.]

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CO_2	JNGI2006.5[1]	1,066.7	1,086.0	1,084.8	1,071.4	1,122.8	1,131.4	1,236.6	1,230.5	1,194.2	1,231.1	1,252.9	1,237.7	1,270.6	1,280.4	1,280.0
with LULUCF[3]	JNGI2006.8[2]	1,069.3	1,071.4	1,079.7	1,071.3	1,130.9	1,144.9	1,154.0	1,149.5	1,113.7	1,148.8	1,169.6	1,154.4	1,191.4	1,189.4	1,190.9
	difference	*0.24%*	*-1.35%*	*-0.47%*	*0.00%*	*0.73%*	*1.19%*	*-6.68%*	*-6.59%*	*-6.74%*	*-6.68%*	*-6.65%*	*-6.73%*	*-6.23%*	*-7.11%*	*-6.96%*
CO_2	JNGI2006.5	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
without LULUCF	JNGI2006.8	1,144.1	1,153.0	1,160.6	1,153.0	1,212.8	1,226.4	1,239.3	1,234.8	1,198.6	1,233.7	1,254.6	1,239.3	1,276.8	1,284.4	1,285.8
	difference	*0.47%*	*0.43%*	*0.23%*	*0.28%*	*0.53%*	*0.57%*	*0.46%*	*0.56%*	*0.56%*	*0.37%*	*0.28%*	*0.25%*	*0.59%*	*0.39%*	*0.52%*
CH_4	JNGI2006.5	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	24.4
with LULUCF	JNGI2006.8	33.5	33.2	33.0	32.7	32.0	31.0	30.3	29.2	28.4	27.7	27.0	26.2	25.3	24.8	24.5
	difference	*0.35%*	*0.33%*	*0.39%*	*0.14%*	*-0.35%*	*-1.22%*	*-1.11%*	*-1.15%*	*-1.27%*	*-1.14%*	*-0.99%*	*-0.67%*	*-0.51%*	*-0.13%*	*0.14%*
CH_4	JNGI2006.5	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
without LULUCF	JNGI2006.8	33.4	33.1	32.9	32.6	31.9	31.0	30.2	29.2	28.3	27.7	27.0	26.2	25.2	24.7	24.4
	difference	*0.65%*	*0.68%*	*0.76%*	*0.45%*	*-0.10%*	*-0.98%*	*-1.39%*	*-1.43%*	*-1.49%*	*-1.33%*	*-1.16%*	*-0.86%*	*-0.69%*	*-0.23%*	*0.00%*
N_2O	JNGI2006.5	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	28.5
with LULUCF	JNGI2006.8	32.8	32.4	32.4	32.1	33.2	33.6	34.7	35.3	33.9	27.4	29.9	26.4	26.0	25.8	25.8
	difference	*-2.21%*	*-2.14%*	*-2.75%*	*-2.82%*	*-2.77%*	*-2.80%*	*-3.29%*	*-2.98%*	*-3.27%*	*-5.06%*	*-4.72%*	*-6.25%*	*-7.31%*	*-8.37%*	*-9.29%*
N_2O	JNGI2006.5	33.2	32.7	33.0	32.7	33.9	34.4	35.9	36.4	35.0	28.9	31.4	28.2	28.1	28.1	28.5
without LULUCF	JNGI2006.8	32.7	32.3	32.4	32.0	33.2	33.5	34.7	35.3	33.8	27.4	29.9	26.4	26.0	25.8	25.8
	difference	*-1.31%*	*-1.31%*	*-1.98%*	*-2.11%*	*-2.31%*	*-2.39%*	*-3.40%*	*-3.07%*	*-3.35%*	*-5.16%*	*-4.80%*	*-6.33%*	*-7.38%*	*-8.42%*	*-9.34%*
HFCs	JNGI2006.5	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3	8.5
	JNGI2006.8	NE	NE	NE	NE	NE	20.2	19.8	19.8	19.3	19.8	18.6	15.8	13.1	12.5	8.3
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*-0.10%*	*-0.11%*	*0.10%*	*0.12%*	*0.11%*	*0.21%*	*0.49%*	*1.95%*	*1.98%*	*-1.77%*
PFCs	JNGI2006.5	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0	9.9
	JNGI2006.8	NE	NE	NE	NE	NE	14.0	14.5	15.5	12.6	9.7	8.6	7.2	6.5	6.2	6.3
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*11.71%*	*-5.24%*	*-8.59%*	*-24.33%*	*-34.77%*	*-37.08%*	*-37.51%*	*-33.75%*	*-30.98%*	*-36.28%*
SF_6	JNGI2006.5	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.7	4.5
	JNGI2006.8	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.7	4.5
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.04%*	*-0.05%*	*0.00%*	*0.11%*	*-0.08%*	*0.07%*	*0.22%*	*0.45%*	*0.25%*	*0.24%*
Total	JNGI2006.5	1,133.7	1,152.2	1,151.0	1,137.1	1,189.0	1,247.1	1,355.8	1,348.0	1,307.2	1,331.9	1,350.6	1,325.2	1,352.1	1,359.3	1,355.8
with LULUCF	JNGI2006.8	1,135.6	1,137.0	1,145.1	1,136.1	1,196.1	1,260.7	1,270.8	1,264.1	1,221.2	1,242.6	1,260.6	1,235.8	1,267.7	1,263.3	1,260.3
	difference	*0.17%*	*-1.32%*	*-0.51%*	*-0.08%*	*0.60%*	*1.09%*	*-6.27%*	*-6.23%*	*-6.58%*	*-6.70%*	*-6.67%*	*-6.75%*	*-6.25%*	*-7.06%*	*-7.04%*
Total	JNGI2006.5	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	1,354.9
with LULUCF	JNGI2006.8	1,210.3	1,218.4	1,225.9	1,217.6	1,277.9	1,342.1	1,356.0	1,349.3	1,306.0	1,327.4	1,345.5	1,320.6	1,353.0	1,358.3	1,355.2
	difference	*0.38%*	*0.34%*	*0.14%*	*0.17%*	*0.41%*	*0.52%*	*0.23%*	*0.29%*	*0.08%*	*-0.19%*	*-0.25%*	*-0.24%*	*0.16%*	*0.00%*	*0.02%*

1) JNGI2006.5: Japan National GHG Inventory submitted in May 2006
2) JNGI2006.8: Japan National GHG Inventory submitted in August 2006
3) LULUCF: Land Use, Land-Use Change, and Forestry

10.3. Implication for Emission Trends, including Time Series Consistency

Table 10-4 and Table 10-5 show the changes made to the emission trends due to the recalculations indicated in "Section 10.1. Explanation and Justification for Recalculations" (i.e. changes in emissions over the 1990–2003 period were used for a comparison with the previous year, and the changes over the 1990–2004 period were used for the comparison with the May 2006 inventory.).

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 with respect to the values reported in the previous inventory, and a comparison of these emissions between 1995 and 2004 was performed with respect to the values reported in the May 2006 submission.

Total emissions excluding CO_2 in LULUCF sector decreased by approximately 5.3 million tons (in CO_2 equivalents) and by 0.6 points compared to the data reported in 2005 submission. Compared to the May 2006 inventory, the value decreased by about 6.4 million tons (CO_2 equivalent) and the rate of change decreased by 0.5 points.

Table 10-4 Comparison of emissions trends between the inventories submitted in 2005 and August 2006 excluding CO_2 in LULUCF sector

		Trend [Mt CO_2eq.]			Trend (%)		
		JNGI2005	JNGI2006	Difference	JNGI2005	JNGI2006	Difference
CO_2	1)	137.1	140.2	3.1	12.2%	12.3%	0.0%
CH_4	1)	-5.5	-8.6	-3.2	-22.1%	-25.9%	-3.8%
N_2O	1)	-5.6	-7.0	-1.4	-13.9%	-21.3%	-7.5%
HFCs	2)	-7.9	-7.7	0.2	-39.2%	-38.1%	1.1%
PFCs	2)	-3.5	-7.9	-4.3	-28.2%	-55.9%	-27.7%
SF_6	2)	-12.4	-12.2	0.3	-73.6%	-72.0%	1.6%
Total	3)	102.2	96.9	-5.3	8.3%	7.7%	-0.6%

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

Table 10-5 Comparison of changes in emissions in the May 2006 inventory and in the August 2006 inventory excluding CO_2 in LULUCF sector

		Trend [Mt CO_2eq.]			Trend (%)		
		JNGI2006.5	JNGI2006.8	Difference	JNGI2006.5	JNGI2006.8	Difference
CO_2	1)	140.4	141.7	1.3	12.3%	12.4%	0.1%
CH_4	1)	-8.7	-9.0	-0.2	-26.4%	-26.8%	-0.5%
N_2O	1)	-4.7	-6.9	-2.2	-14.3%	-21.2%	-7.0%
HFCs	2)	-11.7	-11.9	-0.1	-58.0%	-58.7%	-0.7%
PFCs	2)	-2.7	-7.7	-5.1	-21.1%	-55.0%	-33.9%
SF_6	2)	-12.5	-12.5	0.0	-73.6%	-73.6%	0.1%
Total	3)	100.1	93.7	-6.4	7.9%	7.4%	-0.5%

1) Emissions in FY1990 and FY2004 were compared.
2) Emissions in FY1995 and FY2004 were compared.
3) Emissions in the base year of the Kyoto Protocol (CO_2, CH_4 and N_2O: 1990; HFCs, PFCs and SF_6: 1995) and FY2004 were compared

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

10.4.1.1.a. Items Reflected in the May 2006 Inventory

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 SF_6 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 indicated in the IPCC Second Assessment Report.
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): CH_4 – 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.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.
33. 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.

34. Activity data used for estimating CO_2 emissions from LULUCF category (category 5), were revised.
35. 5.A.1. Forest land remaining forest land: activity data used for estimating CO_2 emissions from forest fires were revised.
36. 5.E.1. Settlements remaining settlements: activity data used for estimating CO_2 emissions from were revised.
37. 6.A.1. Managed Waste Disposal on Land (Sludge): CH_4 – Methane emissions associated with landfill disposal of sludge were recalculated.
38. 6.A.3. Illegal Disposal on Land: CH_4 – Estimations were recalculated.
39. 6.A.3. Composting of Organic Waste: CH_4 and N_2O – Estimations were recalculated.
40. 6.B.1. Industrial Waste Water: N_2O – Estimations were recalculated
41. 6.B.2. Decomposition of Domestic and Commercial Waste Water in Nature: CH_4 and N_2O – Estimations were recalculated.
42. 6.C. Municipal Waste Incineration (Synthetic Textile Scraps): CO_2 and 6.C Industrial Waste Incineration (Synthetic Textile Scraps): CO_2 – Estimations were recalculated.
43. 6.C. Waste Incineration (Special Management Waste): CO_2, CH_4 and N_2O – Estimations were recalculated.
44. 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).
45. 6.D. Emissions Associated with Decomposition of Petroleum-derived Surfactants: CO_2 – Estimations were recalculated.
46. 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.
47. 6.B.1. Industrial Waste Water Handling: CH_4 – Activity data was revised
48. 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.

10.4.1.1.b. Items Reflected in the August 2006 Inventory

1. 1.A. Fuel Combustion Activities (Stationary Combustion): CO_2 — Calculation of the emissions relating to manufacturing of coal products was added.
2. 1.A. Fuel Combustion Activities (Stationary Combustion): CH_4 and N_2O — The method for determining the shares by furnace type was revised.
3. 1.A. Fuel Combustion Activities (Mobile Combustion): CH_4 and N_2O — Emission factors relating to automobiles were revised.
4. 1.B.2.b.iv. Natural Gas Distribution: CH_4 — Methane emission sources in the Japanese town gas distribution sector were reorganized and the emissions were calculated for the first time.
5. 1.B.2.b.iii. Natural Gas Transmission: CH_4 — New Japan-specific emissions factors were applied to calculations.
6. 2.A.2. Lime Production: CO_2 — The method for calculation was changed to the Tier 1 default method, and the basis of activity data was changed from sales data to production data.
7. 2.B.4 Carbide Production: CH_4 — The category for reporting changed from Fuel Combustion (1.A. – Stationary Combustion) to Carbide Production.
8. 2.C.1. Use of Electric Arc Furnaces in Iron and Steel Production: CO_2 — The method for calculation was changed to include carbon dioxide emissions from electrical furnaces used for purposes other than steel production.
9. 2.C.1. Use of Electric Arc Furnaces in Iron and Steel Production: CH_4 — Activity data were revised, and the category for reporting changed from Fuel Combustion Activities (1.A. – Stationary Combustion) to Use of Electric Arc Furnaces in Iron and Steel Production.
10. 2.C.2. Ferroalloys Production: CH_4 — Activity data were revised, and the category for reporting activity data was changed from Fuel Combustion Activities (1.A. – Stationary Combustion) to Ferroalloys Production.
11. 2.F.3. Fire Extinguishers: HFCs — Notation key of emissions from manufacturing was changed.
12. 2.F.4. Aerosols/Medical Devises (Metered Dose Inhalers): HFCs — The method for calculation of emissions from “production” and “use” was changed.
13. 2.F.5. Solvents: HFCs — Emissions of HFCs were calculated for the first time.
14. 2.F.5. Solvents: PFCs— The PFC that the GWP is not in SAR was excluded from total emissions.
15. 2.F.6. Use of Alternative Fluorocarbons for Products Other Than Refrigerants and Foaming Agents: HFCs, PFCs and SF_6 , 2.F.9. Other HFCs, PFCs, SF_6—Notation keys were ascertained.
16. 4.C.1. Continuously Flooded Paddy Fields: CH_4 — The error in the equation to

calculate the emissions factors was corrected, and the emissions factors were revised to reflect the correction.

17. Emissions and removals for the LULUCF sector after 1995 were estimated and reported.
18. 5.A. Forest land (living biomass) :CO_2 - Estimation method was changed from “Default method” to “Stock change method” and parameters also were changed.
19. 5.B. Cropland (soils), 5.C. Grassland (soils) :CO_2 - Soil carbon stock data for rice field, crop field, orchard and grassland were changed.
20. 5.B.2. Land converted to Cropland :N_2O - C:N ratio was changed from IPCC default value to the country specific value.
21. 6.A.1. Managed Waste Disposal on Land: CH_4 — Calculation method was changed from the Japan-specific method, which used a decomposition curve based on the Sheldon-Arleta model, to the FOD method prescribed in the *2006 IPCC Guidelines*.
22. 6.A.1. Managed Waste Disposal on Land : CH_4 — Methods to establish carbon contents for kitchen garbage, paper scraps , wood scraps, and natural textile scraps were revised.
23. 6.A.1. Managed Waste Disposal on Land: CH_4 — The percentage of natural textile in textile scraps contained in industrial waste was reviewed. As a result, all textile scraps is now deemed to be natural textile.
24. 6.A.1. Managed Waste Disposal on Land: CH_4 — Percentages of solids in organic sludge discharged by food manufacturing and chemical industries were revised.
25. 6.B.2. Treatment of Domestic and Commercial Waste Water: CH_4 — Amounts of methane recovered from final treatment plants was calculated for the first time.
26. 6.B.2. Treatment of Domestic and Commercial Waste Water (Emissions from the Decomposition of Domestic Waste Water in Nature): CH_4, and N_2O — The method of establishing the concentrations of organic matter and nitrogen in human waste was modified.
27. 6.C. Municipal Waste Incineration: CO_2 — The method of establishing carbon contents of plastics contained in municipal waste was revised.
28. 6.C. Industrial Waste Incineration: CO_2 — The textile scrap contained in industrial waste was removed from the calculation of the total emissions as all textile scraps would now be regarded as natural textile.
29. 6.C. Emissions from Industrial Waste Incineration (RDF): CO_2, CH_4 and N_2O — The amount of RDF burnt in the 1990–1992 period was estimated for the first time.
30. International Marine Bunker: CO_2, CH_4, and N_2O — Diesel oil and kerosene were included.

* 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 in *Chapter 3-8* and A*nnex 2-3* 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. For key category analysis, Tier.2 level assessment, Tier.2 trend assessment and analysis for LULUCF sector were newly conducted. The description of the key category analysis in *Annex 1: Key Categories* was updated.
6. Detailed description of the difference between reference approach and sectoral approach was added in Annex 4: *CO_2 Reference Approach and Comparison with Sectoral Approach, and Relevant Information on the National Energy Balance*.
7. Table showing dissolving "NE" were added in *Annex 5: Assessment of Completeness and (Potential) Sources and Sinks of Greenhouse Gas Emissions and Removals Excluded Outline of Inventory*.
8. Detailed descriptions of the inventory preparation system and the QA/QC plan were updated in *Annex 6: Additional Information to be Considered as Part of the NIR Submission or Other Useful Reference Information.*
9. The content of *Annex 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)

Notation keys were revised as follows.

Table 10-6 Notation keys changed in the May 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 2(II)s1 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.7. Semiconductors: HFCs, PFCs, SF_6 emissions from manufacturing	NE	IE
	2.F.7. Semiconductors: HFCs, PFCs, SF_6 emissions from disposal	NE	NA
Table 3.A-D	3.D. Other, Aerosol Cans	NE	NA

Table 10-6 Notation keys changed in the May 2006 inventory (continued)

Sheet name	Emission classification	Pre-change	Post-change
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
Table 5(II)	5.A. N_2O emissions from drainage of soils (Organic Soil)	NE	NO

Table 10-7 Notation keys changed in the August 2006 Inventory Report

Sheet name	Emission classification	Pre-change	Post-change
Table 1.B.2	1.B.2.b.iv. Natural Gas Transmission: CO_2 emissions	NE	NA
	1.B.2.c.ii. Venting (Gas): CH_4 emissions	Calculated value	IE
Table 1.C	Marine Bunker Gas/Diesel Oil: CO_2, CH_4, N_2O	NE	Calculated value
	Marine Bunker Other, Kerosene: CO_2, CH_4, N_2O	NE	Calculated value or NO
Table 2(I).A-Gs1 Table 2(I).A-Gs2	2.B.5. Other (Coke): CO_2 emissions	Calculated value	IE
	2.C.1. Iron and Steel Production (Coke): CO_2 emissions	NE	IE
	2.C.1. Iron and Steel Production (Crude steel production by electric furnaces): CH_4 emissions	IE	Calculated value
Table 2(II)s1 Table 2(II).Fs2	2.C.2. Ferroalloys Production: CH_4 emissions	IE	Calculated value
	2.F.4. Aerosols MDI: HFC emissions (from manufacturing)	NE	Calculated value
	2.F.5. Solvents: Emissions (from manufacturing, use, and at disposal)	NE	IE
	2.F.6. Other Applications using ODS Substitutes: PFC and SF_6 emissions (from manufacturing, use, and at disposal)	NE	NA
	2.F.9. Other:HFCs (from manufacturing, use and at disposal)	NE	NA
Table 6.A,C	6.A.1. Managed Waste Disposal on Land: Recovery of CH_4	NE	Calculated value
Table 6.A,C	6.C. Waste Incineration, b. Other, 2. Waste: Use as alternative fuels, etc.; (d) RDF and RPF: Activity data, and CO_2, CH_4, and N_2O emissions (for the 1990–1992 period)	NO	Calculated value
Table 6.Bs1	6.B.2. Domestic and Commercial Wastewater, a. Waste Water: Recovery of CH_4	NE	Calculated value

Annex 1. Key Categories

1.1. Outline of Key Category Analysis

The *UNFCCC Inventory Reporting Guidelines*[1] require the application of the *Good Practice Guidance (2000)*, and the key category analysis[2] 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 key category for Land use, land use change and forestry (LULUCF) sector were assessed in accordance with *LULUCF-GPG*. The key categories were identified for the inventory excluding LULUCF first, and then the key category analysis was repeated for the full inventory including the LULUCF categories.

The results of an analysis using methods above (Tier 1 Level Assessment, Tier 1 Trend Assessment, Tier 2 Level assessment and Tier 2 Trend assessment) are summarized in the following table 1 of 40 sources and sinks, 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 and removals could be identified as the key categories in accordance with the existing qualitative analysis method since emissions and removals have been newly estimated or the estimation methods have been changed in many categories since the 2005 inventory submission, 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] Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (following incorporation of the provisions of decision 13/CP.9) (FCCC/SBSTA/2004/8)

[2] The *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (2003), which was welcomed in COP9, extends the key source analysis to LULUCF categories. In the latest UNFCCC reporting guidelines (FCCC/SBSTA/2004/8), the term “key source category” was revised to “key category”.

Table 1 Japan's Key Categories

	A IPCC Category		B Direct GHGs	L1	T1	L2	T2
#1	1A Stationary Combustion	Solid Fuels	CO_2	#1	#2	#3	#10
#2	1A Stationary Combustion	Liquid Fuels	CO_2	#2	#1	#7	#11
#3	1A3 Mobile Combustion	b. Road Transportation	CO_2	#3	#4	#6	#23
#4	1A Stationary Combustion	Gaseous Fuels	CO_2	#4	#3		
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO_2	#5	#5	#5	#13
#6	6C Waste Incineration		CO_2	#6	#7	#2	#5
#7	2A Mineral Product	1. Cement Production	CO_2	#7	#10	#8	#14
#8	1A3 Mobile Combustion	d. Navigation	CO_2	#8	#20		
#9	2A Mineral Product	3. Limestone and Dolomite Use	CO_2	#9		#15	
#10	1A3 Mobile Combustion	a. Civil Aviation	CO_2	#10	#18		
#11	4A Enteric Fermentation		CH_4	#11		#25	
#12	2A Mineral Product	2. Lime Production	CO_2	#12		#21	
#13	6A Solid Waste Disposal on Land		CH_4		#13	#16	#12
#14	4C Rice Cultivation		CH_4		#21	#19	
#15	4B Manure Management		N_2O			#11	#22
#16	4D Agricultural Soils	1. Direct Soil Emissions	N_2O			#4	#8
#17	1A Stationary Combustion		N_2O			#18	#24
#18	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	1. Refrigeration and Air Conditioning Equipment	HFCs		#16	#13	#9
#19	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	PFCs			#9	#27
#20	1A3 Mobile Combustion	b. Road Transportation	N_2O			#12	#17
#21	5A Forest Land	2. Land converted to Forest Land	CO_2		#14		#16
#22	4D Agricultural Soils	3. Indirect Emissions	N_2O			#14	#21
#23	6C Waste Incineration		N_2O			#10	#18
#24	4B Manure Management		CH_4			#17	#25
#25	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	SF_6			#20	
#26	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs		#9		#4
#27	5C Grassland	2. Land converted to Grassland	CO_2		#15		#19
#28	6B Wastewater Handling		N_2O			#22	
#29	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs		#6		#15
#30	2B Chemical Industry	other products except Anmonia	CO_2			#26	
#31	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF_6		#8		#2
#32	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs			#24	
#33	2B Chemical Industry	3. Adipic Acid	N_2O		#11		#20
#34	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF_6		#12	#27	#3
#35	5E Settlements	2. Land converted to Settlements	CO_2		#19		
#36	5B Cropland	2. Land converted to Cropland	CO_2				#26
#37	1A3 Mobile Combustion	d. Navigation	N_2O			#23	
#38	1A3 Mobile Combustion	a. Civil Aviation	N_2O			#1	#6
#39	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH_4		#17		#7
#40	5F Other Land	2. Land converted to Other Land	CO_2				#1

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 and removals in each category to the total emissions and removals. The calculated values of proportion are added from the category that accounts for the largest proportion, until the sum reaches 95% for Tier 1, 90% for Tier 2. Tier 1 level assessment uses emissions and removals from each category directly and Tier 2 level assessment analyzes the emissions and removals of each category, multiplied by the uncertainty of each category.

The key category analysis was conducted for the inventory excluding LULUCF and the key categories for source sectors were identified first. Then the key category analysis was repeated for the full inventory including the LULUCF categories and key categories for

LULUCF sector were identified.

Tier 1 level assessment of the latest emissions and removals (FY2004) gives the following 12 sub-categories as the key categories (Table 2). Tier 2 level assessment of the latest emissions and removals (FY2004) gives the following 27 sub-categories as the key categories (Table 3).

Table 2 Results of Tier 1 Level Assessment

	A IPCC Category		**B Direct GHGs**	**D Current Year Estimate [Gg CO2eq.]**	**F % Contribution to Level**	**Cumulative**
#1	1A Stationary Combustion	Solid Fuels	CO_2	431,058.41	29.7%	29.7%
#2	1A Stationary Combustion	Liquid Fuels	CO_2	343,946.42	23.7%	53.4%
#3	1A3 Mobile Combustion	b. Road Transportation	CO_2	230,273.39	15.9%	69.2%
#4	1A Stationary Combustion	Gaseous Fuels	CO_2	166,893.26	11.5%	80.7%
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO_2	90,838.44	6.3%	87.0%
#6	6C Waste Incineration		CO_2	35,697.77	2.5%	89.5%
#7	2A Mineral Product	1. Cement Production	CO_2	31,415.59	2.2%	91.6%
#8	1A3 Mobile Combustion	d. Navigation	CO_2	12,893.54	0.9%	92.5%
#9	2A Mineral Product	3. Limestone and Dolomite Use	CO_2	10,879.82	0.7%	93.3%
#10	1A3 Mobile Combustion	a. Civil Aviation	CO_2	10,663.39	0.7%	94.0%
#11	4A Enteric Fermentation		CH_4	7,136.37	0.5%	94.5%
#12	2A Mineral Product	2. Lime Production	CO_2	6,961.89	0.5%	95.0%

Table 3 Results of Tier 2 Level Assessment

	A IPCC Category		**B Direct GHGs**	**D Current Year Estimate [Gg CO2eq.]**	**I Source/Sink Uncertinty**	**K Contribution to Total L2**	**Cumulative**
#1	1A3 Mobile Combustion	a. Civil Aviation	N_2O	106.49	10000%	0.12	12.1%
#2	6C Waste Incineration		CO_2	35,697.77	29%	0.12	23.9%
#3	1A Stationary Combustion	Solid Fuels	CO_2	431,058.41	1%	0.07	31.2%
#4	4D Agricultural Soils	1. Direct Soil Emissions	N_2O	4,247.29	145%	0.07	38.2%
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO_2	90,838.44	6%	0.06	44.2%
#6	1A3 Mobile Combustion	b. Road Transportation	CO_2	230,273.39	2%	0.06	50.3%
#7	1A Stationary Combustion	Liquid Fuels	CO_2	343,946.42	1%	0.04	54.1%
#8	2A Mineral Product	1. Cement Production	CO_2	31,415.59	10%	0.04	57.8%
#9	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	3,905.09	64%	0.03	60.7%
#10	6C Waste Incineration		N_2O	2,896.67	84%	0.03	63.4%
#11	4B Manure Management		N_2O	4,726.30	51%	0.03	66.2%
#12	1A3 Mobile Combustion	b. Road Transportation	N_2O	3,224.81	71%	0.03	68.8%
#13	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	4,011.75	48%	0.02	71.0%
#14	4D Agricultural Soils	3. Indirect Emissions	N_2O	2,944.64	64%	0.02	73.1%
#15	2A Mineral Product	3. Limestone and Dolomite Use	CO_2	10,879.82	17%	0.02	75.2%
#16	6A Solid Waste Disposal on Land		CH_4	5,973.93	28%	0.02	77.1%
#17	4B Manure Management		CH_4	2,539.88	65%	0.02	78.9%
#18	1A Stationary Combustion		N_2O	4,220.02	33%	0.02	80.5%
#19	4C Rice Cultivation		CH_4	5,747.41	23%	0.01	82.0%
#20	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF_6	1,784.38	64%	0.01	83.3%
#21	2A Mineral Product	2. Lime Production	CO_2	6,961.89	16%	0.01	84.6%
#22	6B Wastewater Handling		N_2O	1,188.93	90%	0.01	85.8%
#23	1A3 Mobile Combustion	d. Navigation	N_2O	106.55	1000%	0.01	87.0%
#24	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	862.82	100%	0.01	88.0%
#25	4A Enteric Fermentation		CH_4	7,136.37	12%	0.01	88.9%
#26	2B Chemical Industry	other products except Anmonia	CO_2	1,001.11	77%	0.01	89.8%
#27	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF_6	764.80	100%	0.01	90.7%

1.2.3. Trend Assessment

The difference between the rate of change in emissions and removals in a category and the rate of change in total emissions and removals is calculated. The trend assessment is calculated by multiplying this value by the ratio of contribution of the relevant category to total emissions and removals. 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% for Tier 1, 90% for Tier 2. At this point, these categories are defined as the key categories. Tier 1 level assessment uses emissions and removals from each category directly and Tier 2 level assessment analyzes the emissions and removals of each category, multiplied by the uncertainty of each category.

The key category analysis was conducted for the inventory excluding LULUCF and the key categories for source sectors were identified first. Then the key category analysis was repeated for the full inventory including the LULUCF categories and key categories for LULUCF sector were identified.

Tier 1 trend assessment of the latest emissions and removals (FY2004) gives the following 21 sub-categories as the key categories (Table 4). Tier 2 trend assessment of the latest emissions and removals (FY2004) gives the following 27 sub-categories as the key categories (Table 5).

Table 4 Results of Tier.1 Trend Assessment

	A IPCC Category		**B Direct GHGs**	**C Base Year Estimate [Gg CO2eq.]**	**D Current Year Estimate [Gg CO2eq.]**	**H % Contribution to Trend**	**Cumulative**
#1	1A Stationary Combustion	Liquid Fuels	CO_2	435,103.20	343,946.42	28.7%	28.7%
#2	1A Stationary Combustion	Solid Fuels	CO_2	308,618.14	431,058.41	22.3%	51.0%
#3	1A Stationary Combustion	Gaseous Fuels	CO_2	104,300.83	166,893.26	12.4%	63.4%
#4	1A3 Mobile Combustion	b. Road Transportation	CO_2	189,227.88	230,273.39	5.9%	69.3%
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO_2	68,051.39	90,838.44	4.0%	73.3%
#6	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	17,023.50	1,050.66	4.0%	77.2%
#7	6C Waste Incineration		CO_2	21,995.80	35,697.77	2.7%	79.9%
#8	2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF_6	11,001.17	958.39	2.5%	82.4%
#9	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	10,356.00	1,535.46	2.2%	84.6%
#10	2A Mineral Product	1. Cement Production	CO_2	37,966.28	31,415.59	2.2%	86.8%
#11	2B Chemical Industry	3. Adipic Acid	N_2O	7,501.25	838.90	1.7%	88.5%
#12	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF_6	4,708.30	764.80	1.0%	89.4%
#13	6A Solid Waste Disposal on Land		CH_4	9,081.13	5,973.93	0.9%	90.3%
#14	5A Forest Land	2. Land converted to Forest Land	CO_2	6,285.93	3,049.89	0.9%	91.2%
#15	5C Grassland	2. Land converted to Grassland	CO_2	4,190.96	1,369.13	0.7%	91.9%
#16	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	807.13	4,011.75	0.7%	92.6%
#17	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH_4	2,785.23	57.18	0.7%	93.3%
#18	1A3 Mobile Combustion	a. Civil Aviation	CO_2	7,162.41	10,663.39	0.7%	93.9%
#19	5E Settlements	2. Land converted to Settlements	CO_2	2,538.25	611.47	0.5%	94.4%
#20	1A3 Mobile Combustion	d. Navigation	CO_2	13,730.95	12,893.54	0.4%	94.9%
#21	4C Rice Cultivation		CH_4	7,002.78	5,747.41	0.4%	95.3%

Table 5 Results of Tier.2 Trend Assessment

	Category Code	A IPCC Category		B Direct GHGs	C Base Year Estimate [Gg CO2eq.]	D Current Year Estimate [Gg CO2eq.]	I Source/Sink Uncertinty	M Contribution to Total T2	Cumulative
#1	E-22	5F Other Land	2. Land converted to Other Land	CO_2	122.88	1.04	14486%	0.30	30.3%
#2	B-28	2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF_6	11,001.17	958.39	40%	0.07	37.3%
#3	B-19	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF_6	4,708.30	764.80	100%	0.07	44.2%
#4	B-24	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	10,356.00	1,535.46	40%	0.06	50.3%
#5	F-04	6C Waste Incineration		CO_2	21,995.80	35,697.77	29%	0.06	55.8%
#6	A-14	1A3 Mobile Combustion	a. Civil Aviation	N_2O	69.75	106.49	10000%	0.05	60.8%
#7	A-18	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH_4	2,785.23	57.18	89%	0.04	65.0%
#8	D-05	4D Agricultural Soils	1. Direct Soil Emissions	N_2O	5,110.74	4,247.29	145%	0.03	67.9%
#9	B-20	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	807.13	4,011.75	48%	0.02	70.3%
#10	A-02	1A Stationary Combustion	Solid Fuels	CO_2	308,618.14	431,058.41	1%	0.02	72.6%
#11	A-01	1A Stationary Combustion	Liquid Fuels	CO_2	435,103.20	343,946.42	1%	0.02	74.6%
#12	F-01	6A Solid Waste Disposal on Land		CH_4	9,081.13	5,973.93	28%	0.02	76.3%
#13	E-01	5A Forest Land	1. Forest Land remaining Forest Land	CO_2	68,051.39	90,838.44	6%	0.02	77.9%
#14	B-01	2A Mineral Product	1. Cement Production	CO_2	37,966.28	31,415.59	10%	0.02	79.5%
#15	B-16	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	17,023.50	1,050.66	5%	0.01	81.0%
#16	E-02	5A Forest Land	2. Land converted to Forest Land	CO_2	6,285.93	3,049.89	22%	0.01	82.3%
#17	A-15	1A3 Mobile Combustion	b. Road Transportation	N_2O	3,901.71	3,224.81	71%	0.01	83.4%
#18	F-06	6C Waste Incineration		N_2O	1,910.66	2,896.67	84%	0.01	84.5%
#19	E-10	5C Grassland	2. Land converted to Grassland	CO_2	4,190.96	1,369.13	21%	0.01	85.6%
#20	B-08	2B Chemical Industry	3. Adipic Acid	N_2O	7,501.25	838.90	9%	0.01	86.6%
#21	D-06	4D Agricultural Soils	3. Indirect Emissions	N_2O	3,675.81	2,944.64	64%	0.01	87.7%
#22	D-03	4B Manure Management		N_2O	5,543.05	4,726.30	51%	0.01	88.7%
#23	A-07	1A3 Mobile Combustion	b. Road Transportation	CO_2	189,227.88	230,273.39	2%	0.01	89.6%
#24	A-05	1A Stationary Combustion		N_2O	2,331.61	4,220.02	33%	0.01	90.5%
#25	D-02	4B Manure Management		CH_4	3,120.57	2,539.88	65%	0.01	91.4%
#26	E-06	5B Cropland	2. Land converted to Cropland	CO_2	1,279.59	114.06	42%	0.01	92.2%
#27	B-26	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	2,857.35	3,905.09	64%	0.01	93.1%

Table 6 Data used in the key category analysis

A IPCC Category		B Direct GHGs	C Base Year Estimate [Gg CO2eq.]	D Current Year Estimate [Gg CO2eq.]	E Level Assessment	F % Contribution to Level	G Trend Assessment	H % Contribution to Trend	I Source/Sink Uncertinty	J Level Uncertainty (x 1000)	K Contribution to Total L2	L Trend Uncertainty (x 1000)	M Contribution to Total T2	Cumulative
1A Stationary Combustion	Liquid Fuels	CO_2	435,103.20	343,946.42	0.237	23.7%	0.0803	28.7%	1%	2.32	0.04	0.79	0.02	23.7%
1A Stationary Combustion	Solid Fuels	CO_2	308,618.14	431,058.41	0.297	29.7%	0.0624	22.3%	1%	4.40	0.07	0.92	0.02	53.4%
1A Stationary Combustion	Gaseous Fuels	CO_2	104,300.83	166,893.26	0.115	11.5%	0.0346	12.4%	0%	0.33	0.01	0.10	0.00	64.9%
1A Stationary Combustion		CH_4	533.07	574.13	0.000	0.0%	0.0000	0.0%	47%	0.19	0.00	0.00	0.00	64.9%
1A Stationary Combustion		N_2O	2,331.61	4,220.02	0.003	0.3%	0.0011	0.4%	33%	0.96	0.02	0.36	0.01	65.2%
1A3 Mobile Combustion	a. Civil Aviation	CO_2	7,162.41	10,663.39	0.007	0.7%	0.0019	0.7%	3%	0.18	0.00	0.05	0.00	65.9%
1A3 Mobile Combustion	b. Road Transportation	CO_2	189,227.88	230,273.39	0.159	15.9%	0.0166	5.9%	2%	3.65	0.06	0.38	0.01	81.8%
1A3 Mobile Combustion	c. Railways	CO_2	932.45	648.04	0.000	0.0%	0.0002	0.1%	2%	0.01	0.00	0.01	0.00	81.9%
1A3 Mobile Combustion	d. Navigation	CO_2	13,730.95	12,893.54	0.009	0.9%	0.0012	0.4%	2%	0.21	0.00	0.03	0.00	82.7%
1A3 Mobile Combustion	a. Civil Aviation	CH_4	2.94	4.83	0.000	0.0%	0.0000	0.0%	200%	0.01	0.00	0.00	0.00	82.7%
1A3 Mobile Combustion	b. Road Transportation	CH_4	265.72	224.81	0.000	0.0%	0.0000	0.0%	64%	0.10	0.00	0.03	0.00	82.8%
1A3 Mobile Combustion	c. Railways	CH_4	1.18	0.84	0.000	0.0%	0.0000	0.0%	11%	0.00	0.00	0.00	0.00	82.8%
1A3 Mobile Combustion	d. Navigation	CH_4	26.33	25.48	0.000	0.0%	0.0000	0.0%	200%	0.04	0.00	0.00	0.00	82.8%
1A3 Mobile Combustion	a. Civil Aviation	N_2O	69.75	106.49	0.000	0.0%	0.0000	0.0%	10000%	7.34	0.12	1.99	0.05	82.8%
1A3 Mobile Combustion	b. Road Transportation	N_2O	3,901.71	3,224.81	0.002	0.2%	0.0006	0.2%	71%	1.57	0.03	0.45	0.01	83.0%
1A3 Mobile Combustion	c. Railways	N_2O	121.38	84.48	0.000	0.0%	0.0000	0.0%	101%	0.06	0.00	0.03	0.00	83.0%
1A3 Mobile Combustion	d. Navigation	N_2O	111.31	106.55	0.000	0.0%	0.0000	0.0%	1000%	0.73	0.01	0.09	0.00	83.0%
1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH_4	2,785.23	57.18	0.000	0.0%	0.0019	0.7%	89%	0.04	0.00	1.68	0.04	83.0%
1B Fugitive Emission	1a ii. Coal Mining and Handling (surface)	CH_4	21.20	9.33	0.000	0.0%	0.0000	0.0%	185%	0.01	0.00	0.02	0.00	83.0%
1B Fugitive Emission	2a. Oil	CO_2	0.14	0.13	0.000	0.0%	0.0000	0.0%	19%	0.00	0.00	0.00	0.00	83.0%
1B Fugitive Emission	2a. Oil	CH_4	28.32	28.17	0.000	0.0%	0.0000	0.0%	17%	0.00	0.00	0.00	0.00	83.0%
1B Fugitive Emission	2a. Oil	N_2O	0.00	0.00	0.000	0.0%	0.0000	0.0%	27%	0.00	0.00	0.00	0.00	83.0%
1B Fugitive Emission	2b. Natural Gas	CO_2	0.25	0.36	0.000	0.0%	0.0000	0.0%	25%	0.00	0.00	0.00	0.00	83.0%
1B Fugitive Emission	2b. Natural Gas	CH_4	187.94	276.62	0.000	0.0%	0.0000	0.0%	21%	0.04	0.00	0.01	0.00	83.0%
1B Fugitive Emission	2c. Venting & Flaring	CO_2	36.23	34.50	0.000	0.0%	0.0000	0.0%	19%	0.00	0.00	0.00	0.00	83.0%
1B Fugitive Emission	2c. Venting & Flaring	CH_4	14.45	12.42	0.000	0.0%	0.0000	0.0%	21%	0.00	0.00	0.00	0.00	83.0%
1B Fugitive Emission	2c. Venting & Flaring	N_2O	0.11	0.11	0.000	0.0%	0.0000	0.0%	19%	0.00	0.00	0.00	0.00	83.0%
2A Mineral Product	1. Cement Production	CO_2	37,966.28	31,415.59	0.022	2.2%	0.0061	2.2%	10%	2.26	0.04	0.64	0.02	85.2%
2A Mineral Product	2. Lime Production	CO_2	7,371.02	6,961.89	0.005	0.5%	0.0006	0.2%	16%	0.76	0.01	0.10	0.00	85.7%
2A Mineral Product	3. Limestone and Dolomite Use	CO_2	11,527.41	10,879.82	0.007	0.7%	0.0010	0.4%	17%	1.25	0.02	0.17	0.00	86.4%
2A Mineral Product	4. Soda Ash Production and Use	CO_2	583.63	372.75	0.000	0.0%	0.0002	0.1%	16%	0.04	0.00	0.03	0.00	86.5%
2B Chemical Industry	1. Ammonia Production	CO_2	3,384.68	2,307.30	0.002	0.2%	0.0009	0.3%	23%	0.37	0.01	0.20	0.00	86.6%
2B Chemical Industry	other products except Anmonia	CO_2	1,129.29	1,001.11	0.001	0.1%	0.0001	0.0%	77%	0.53	0.01	0.11	0.00	86.7%
2B Chemical Industry	2. Nitric Acid	N_2O	765.70	818.71	0.001	0.1%	0.0000	0.0%	46%	0.26	0.00	0.00	0.00	86.7%
2B Chemical Industry	3. Adipic Acid	N_2O	7,501.25	838.90	0.001	0.1%	0.0046	1.7%	9%	0.05	0.00	0.43	0.01	86.8%
2B Chemical Industry	4. Carbide Production	CH_4	0.42	0.66	0.000	0.0%	0.0000	0.0%	100%	0.00	0.00	0.00	0.00	86.8%
2B Chemical Industry	5. Carbon Black, Ethylene, Ethylene Dichloride, Styrene, Methanol, Coke	CH_4	337.80	115.92	0.000	0.0%	0.0002	0.1%	89%	0.07	0.00	0.14	0.00	86.8%
2C Metal Production	1 Iron and Steel Production	CO_2	356.09	257.84	0.000	0.0%	0.0001	0.0%	5%	0.01	0.00	0.00	0.00	86.8%
2C Metal Production	1 Iron and Steel Production	CH_4	15.47	14.28	0.000	0.0%	0.0000	0.0%	163%	0.02	0.00	0.00	0.00	86.8%
2C Metal Production	2. Ferroalloys Production	CH_4	3.89	2.64	0.000	0.0%	0.0000	0.0%	163%	0.00	0.00	0.00	0.00	86.8%
2C Metal Production	3. Aluminium Production	PFCs	69.73	14.79	0.000	0.0%	0.0000	0.0%	33%	0.00	0.00	0.01	0.00	86.8%
2C Metal Production	4. SF6 Used in Aluminium and Magnesium oundries	SF_6	119.50	966.76	0.001	0.1%	0.0005	0.2%	5%	0.03	0.00	0.03	0.00	86.9%
2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	17,023.50	1,050.66	0.001	0.1%	0.0111	4.0%	5%	0.04	0.00	0.60	0.01	87.0%
2E Production of Halocarbons and SF6	2. Fugitive Emissions	HFCs	419.02	416.16	0.000	0.0%	0.0000	0.0%	100%	0.29	0.00	0.02	0.00	87.0%
2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	762.85	862.82	0.001	0.1%	0.0000	0.0%	100%	0.60	0.01	0.03	0.00	87.0%
2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF_6	4,708.30	764.80	0.001	0.1%	0.0028	1.0%	100%	0.53	0.01	2.77	0.07	87.1%
2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	807.13	4,011.75	0.003	0.3%	0.0020	0.7%	48%	1.32	0.02	0.96	0.02	87.4%
2F(a) Consumption of Halocarbons	2. Foam Blowing	HFCs	451.76	590.64	0.000	0.0%	0.0001	0.0%	63%	0.26	0.00	0.04	0.00	87.4%
2F(a) Consumption of Halocarbons	3. Fire Extinguishers	HFCs	0.00	0.00	0.000	0.0%	0.0000	0.0%	71%	0.00	0.00	0.00	0.00	87.4%
2F(a) Consumption of Halocarbons	4. Aerosols/ Metered Dose Inhalers	HFCs	1,365.00	2,150.98	0.001	0.1%	0.0004	0.2%	36%	0.53	0.01	0.15	0.00	87.6%
2F(a) Consumption of Halocarbons	5. Solvents	PFCs	10,356.00	1,535.46	0.001	0.1%	0.0062	2.2%	40%	0.42	0.01	2.46	0.06	87.7%
2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	HFCs	145.40	129.78	0.000	0.0%	0.0000	0.0%	64%	0.06	0.00	0.01	0.00	87.7%
2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	2,857.35	3,905.09	0.003	0.3%	0.0005	0.2%	64%	1.72	0.03	0.33	0.01	87.9%
2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF_6	1,099.82	1,784.38	0.001	0.1%	0.0004	0.1%	64%	0.79	0.01	0.24	0.01	88.1%
2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF_6	11,001.17	958.39	0.001	0.1%	0.0070	2.5%	40%	0.26	0.00	2.77	0.07	88.1%
3 Solvent & Other Product Use	Using Laughing Gas in Hospital	N_2O	287.07	297.54	0.000	0.0%	0.0000	0.0%	5%	0.01	0.00	0.00	0.00	88.2%
4A Enteric Fermentation		CH_4	7,641.73	7,136.37	0.005	0.5%	0.0007	0.3%	12%	0.58	0.01	0.08	0.00	88.7%
4B Manure Management		CH_4	3,120.57	2,539.88	0.002	0.2%	0.0005	0.2%	65%	1.14	0.02	0.34	0.01	88.8%
4B Manure Management		N_2O	5,543.05	4,726.30	0.003	0.3%	0.0008	0.3%	51%	1.67	0.03	0.41	0.01	89.2%
4C Rice Cultivation		CH_4	7,002.78	5,747.41	0.004	0.4%	0.0012	0.4%	23%	0.90	0.01	0.26	0.01	89.5%
4D Agricultural Soils	1. Direct Soil Emissions	N_2O	5,110.74	4,247.29	0.003	0.3%	0.0008	0.3%	145%	4.23	0.07	1.17	0.03	89.8%
4D Agricultural Soils	3. Indirect Emissions	N_2O	3,675.81	2,944.64	0.002	0.2%	0.0007	0.2%	64%	1.29	0.02	0.42	0.01	90.0%
4F Field Burning of Agricultural Residues		CH_4	129.77	101.33	0.000	0.0%	0.0000	0.0%	144%	0.10	0.00	0.04	0.00	90.0%
4F Field Burning of Agricultural Residues		N_2O	103.92	73.63	0.000	0.0%	0.0000	0.0%	182%	0.09	0.00	0.04	0.00	90.1%
5A Forest Land	1. Forest Land remaining Forest Land	CO_2	68,051.39	90,838.44	0.063	6.3%	0.0111	4.0%	6%	3.68	0.06	0.65	0.02	96.3%
5A Forest Land	2. Land converted to Forest Land	CO_2	6,285.93	3,049.89	0.002	0.2%	0.0024	0.9%	22%	0.45	0.01	0.51	0.01	96.5%
5A Forest Land		CH_4	8.31	11.54	0.000	0.0%	0.0000	0.0%	53%	0.00	0.00	0.00	0.00	96.5%
5A Forest Land		N_2O	0.84	1.17	0.000	0.0%	0.0000	0.0%	89%	0.00	0.00	0.00	0.00	96.5%
5B Cropland	1. Cropland remaining Cropland	CO_2	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00	96.5%
5B Cropland	2. Land converted to Cropland	CO_2	1,279.59	114.06	0.000	0.0%	0.0008	0.3%	42%	0.03	0.00	0.34	0.01	96.5%
5B Cropland		CH_4	21.72	1.45	0.000	0.0%	0.0000	0.0%	81%	0.00	0.00	0.01	0.00	96.5%
5B Cropland		N_2O	65.04	10.01	0.000	0.0%	0.0000	0.0%	108%	0.01	0.00	0.04	0.00	96.5%
5C Grassland	1. Grassland remaining Grassland	CO_2	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00	96.5%
5C Grassland	2. Land converted to Grassland	CO_2	4,190.96	1,369.13	0.001	0.1%	0.0020	0.7%	21%	0.20	0.00	0.43	0.01	96.6%
5C Grassland		CH_4	3.06	0.22	0.000	0.0%	0.0000	0.0%	81%	0.00	0.00	0.00	0.00	96.6%
5C Grassland		N_2O	0.31	0.02	0.000	0.0%	0.0000	0.0%	108%	0.00	0.00	0.00	0.00	96.6%
5D Wetlands	1. Wetlands remaining Wetlands	CO_2	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00	96.6%
5D Wetlands	2. Land converted to Wetlands	CO_2	56.49	48.50	0.000	0.0%	0.0000	0.0%	31%	0.01	0.00	0.00	0.00	96.6%
5D Wetlands		CH_4	1.32	1.05	0.000	0.0%	0.0000	0.0%	83%	0.00	0.00	0.00	0.00	96.6%
5D Wetlands		N_2O	0.13	0.11	0.000	0.0%	0.0000	0.0%	110%	0.00	0.00	0.00	0.00	96.6%
5E Settlements	1. Settlements remaining Settlements	CO_2	262.87	440.23	0.000	0.0%	0.0001	0.0%	0%	0.00	0.00	0.00	0.00	96.7%
5E Settlements	2. Land converted to Settlements	CO_2	2,538.25	611.47	0.000	0.0%	0.0014	0.5%	17%	0.07	0.00	0.23	0.01	96.7%
5E Settlements		CH_4	54.63	11.65	0.000	0.0%	0.0000	0.0%	78%	0.01	0.00	0.02	0.00	96.7%
5E Settlements		N_2O	5.54	1.18	0.000	0.0%	0.0000	0.0%	105%	0.00	0.00	0.00	0.00	96.7%
5F Other Land	1. Other Land remaining Other Land	CO_2	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00	96.7%
5F Other Land	2. Land converted to Other Land	CO_2	122.88	1.04	0.000	0.0%	0.0001	0.0%	14486%	0.10	0.00	12.17	0.30	96.7%
5F Other Land		CH_4	10.30	6.46	0.000	0.0%	0.0000	0.0%	84%	0.00	0.00	0.00	0.00	96.7%
5F Other Land		N_2O	1.05	0.66	0.000	0.0%	0.0000	0.0%	110%	0.00	0.00	0.00	0.00	96.7%
6A Solid Waste Disposal on Land		CH_4	9,081.13	5,973.93	0.004	0.4%	0.0024	0.9%	28%	1.14	0.02	0.68	0.02	97.1%
6B Wastewater Handling		CH_4	2,119.61	1,496.95	0.001	0.1%	0.0005	0.2%	44%	0.45	0.01	0.22	0.01	97.2%
6B Wastewater Handling		N_2O	1,289.37	1,188.93	0.001	0.1%	0.0001	0.0%	90%	0.73	0.01	0.12	0.00	97.3%
6C Waste Incineration		CO_2	21,995.80	35,697.77	0.025	2.5%	0.0076	2.7%	29%	7.14	0.12	2.21	0.06	99.8%
6C Waste Incineration		CH_4	62.80	80.95	0.000	0.0%	0.0000	0.0%	88%	0.05	0.00	0.01	0.00	99.8%
6C Waste Incineration		N_2O	1,910.66	2,896.67	0.002	0.2%	0.0005	0.2%	84%	1.67	0.03	0.44	0.01	100.0%
6C Other		CO_2	702.83	508.26	0.000	0.0%	0.0002	0.1%	25%	0.09	0.00	0.04	0.00	100.0%
6C Other		N_2O	20.12	19.54	0.000	0.0%	0.0000	0.0%	86%	0.01	0.00	0.00	0.00	100.0%
TOTAL			1,344,402.55	1,451,693.27	1.00	100.0%	0.28	100.0%		60.54	1.00	40.09	1.00	

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 and removals 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.c. CH_4 and N_2O emissions from Railways (Steam Locomotives)
    - 1.B.2.iv CH_4 emissions from distribution of Natural Gas
    - 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 (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 emissions and removals have been newly estimated (after 1996)

- 5.A Forest land (living biomass, soil) : CO_2
- 5.B.2 Land converted to Cropland (living biomass, soil) : CO_2
- 5.C.2 Land converted to Grassland (living biomass, soil) : CO_2
- 5.D.2 Land converted to Wetland (living biomass) : CO_2
- 5.E.2 Land converted to Settlements (living biomass, soil) : CO_2
- 5.F.2 Land converted to Other land (living biomass, soil) : CO_2

- 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
  - 1.B.2.b.iii CH_4 emissions from Transmission of Natural Gas
  - 2.A.1. CO_2 emissions from Cement Production
  - 2.A.2. CO_2 emissions from Lime Production
  - 2.A.3. CO_2 emissions from Limestone and Dolomite Use
  - 2.C.1. CO_2 emissions from Use of Electric Arc Furnaces in Steel Production
  - 2.F.2. HFCs 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.C.1. CH_4 emissions from Rice cultivation (continuously flooded)
  - 4.D.3. N_2O emissions from Agricultural Soils (Indirect Emissions)
  - 4.F. CH_4 and N_2O emissions from Field Burning of Agricultural Residue
  - 5.A Forest land (living biomass, soil) : CO_2 (previously mentioned above)
  - 5.B Cropland (Soil) : CO_2
  - 5.B.2. Land converted to Cropland: N_2O
  - 5.C. Grassland (Soil): CO_2
  - 5.E.1 Settlements remaining Settlements: CO_2
  - 6.A. CH_4 emissions from Managed Waste Disposal on Land (MSW)
  - 6.B. CH_4, N_2O 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 procuction 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〕

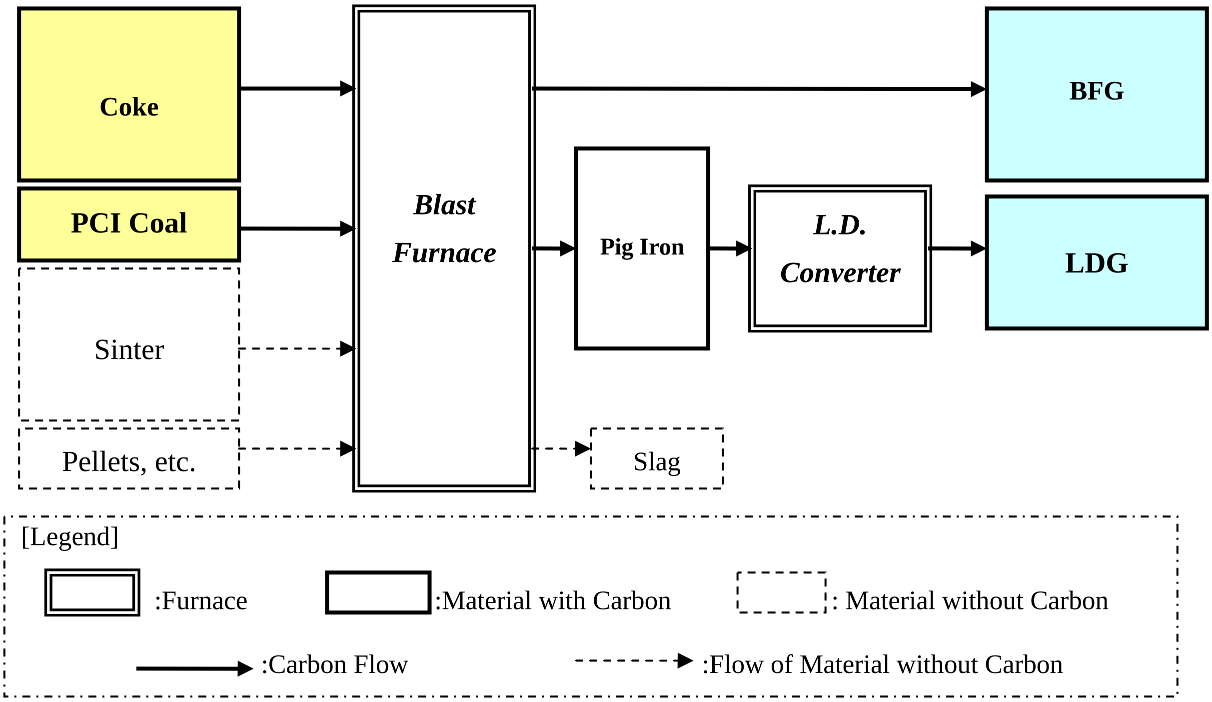

Figure 1 Overview of carbon flow for iron & steel

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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 [$171], Kerosene [$330], Refinery Gas [$380], LPG [$390], LNG [$410], Indigenous natural gas ［$420］

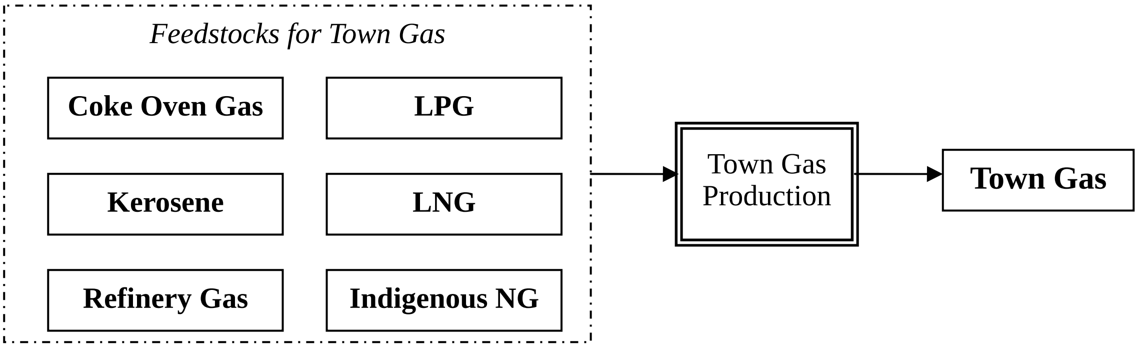

Figure 2 Manufacturing Flow for Town Gas

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

$$\text{Values of duplication adjustment} = E_p - E_t$$

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 steel materials, steel pipes (except cold working steel pipes), or cast iron tubes. Iron and steel.	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 materials, steel pipes (except cold working steel pipes), or cast iron tubes. Iron and 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	* Civil 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		

2.4. CO_2 emissions from Coal Products Section

Coal Products [#2500] is the section that expresses the energy conversion processes that produce coal products from coal. In the section, there is the difference between the amount of input carbon and output carbon on coke production process. The difference is reported as CO_2 emissions of coal products section because that carbon is assumed as the amount of coke oxidized by exposing to the atmosphere during in the quenching car from the coke furnace to CDQ (Coke Dry Quenching) among others, though it is necessary to examine this issue further.

Activity data is estimated by dividing CO_2 emissions by carbon emission factor of coke.

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-2006.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	Heavy oil A	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]
	Heavy oil B	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]
	Heavy oil C	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]
	Diesel oil	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]
	Kerosene	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 Mineral Resources and Petroleum Products Statistics* (former *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 heavy oil A, B, C, diesel oil and kerosene are used by vessels. Heavy oil A, B, and C are used for propulsion of international water-borne vessels. Diesel oil and kerosene are used only for fuels of private power generator (eg. heating).

$\underline{CO_2}$

The kiloliter-based consumption data given in the Ministry of Economy, Trade and Industry's *Yearbook of Mineral Resources and Petroleum Products Statistics* (former *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*.

$\underline{CH_4, N_2O}$

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 Mineral Resources and Petroleum Products Statistics* (former *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.

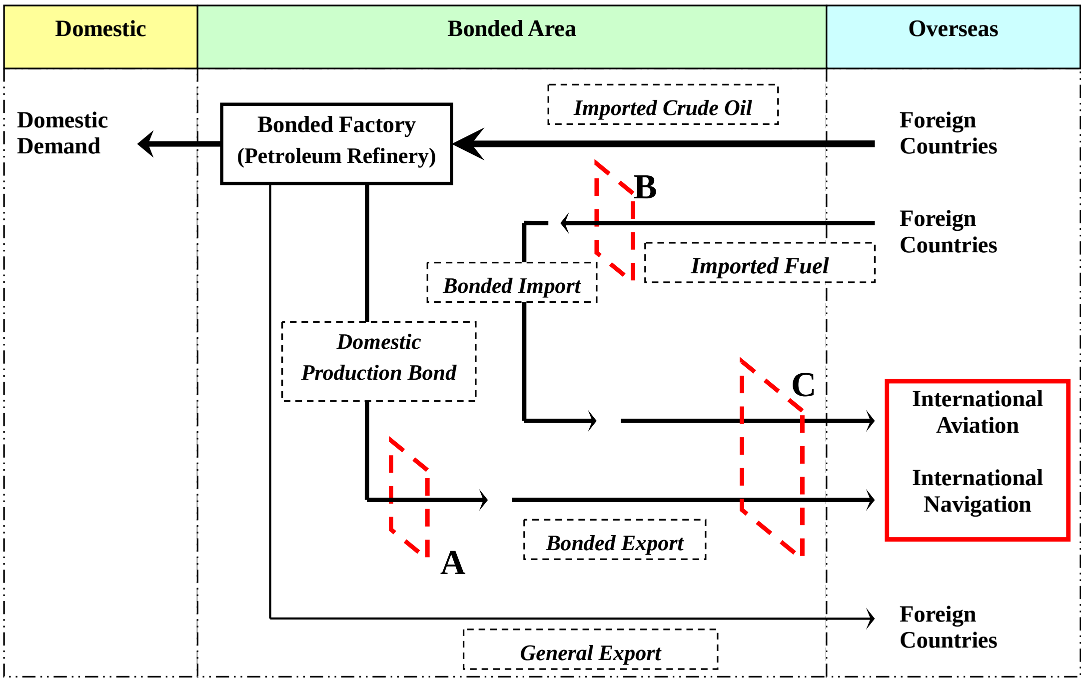

Figure 1 Activity data for international bunkers

• *Explanation of the difference between IEA energy balance and Japan's energy statistics for inventory preparation*

The desk review report in 2004 indicated that there was a significant difference between bunker AD reported in the CRF (table 1.C) and bunker consumption data reported to the International Energy Agency (IEA). The followings explain the causes for the difference.

➢ Error of data

The ERT in 2004 used the following IEA energy balances for analysis.

- Data for 2000-2001: " ENERGY BALANCES OF OECD COUNTRIES 2000-2001」 II 94-95"
- Data for 2002-2003: " ENERGY BALANCES OF OECD COUNTRIES 2002-2003」 II 94-95"

After the publication of the data, it was found out that there were some errors in data of 2000 and 2001 submitted to IEA, including omission of full counting of imported bunker fuel and errors in the values of exported diesel oil. In March 2006, Japan reported the revision of these errors and the errors have been corrected since then.

➢ Difference of fuel types reported as "bunker"

Up to Japan's national greenhouse gas inventories submitted in May 2004, Japan reported the bonded imports and exports of heavy oil A, B, and C as marine bunker. In IEA energy balance, marine bunker reported includes bonded diesel oil, kerosene and lubricant, other than bonded heavy oil A, B and C. This difference causes the variation between inventory data and IEA data.

Japan revised the estimation method in the inventory submitted in August 2004 and has reported bonded diesel oil and kerosene consumption as marine bunker since then[1].

➢ Errors of density and conversion factor

Data for the IEA energy balance need to be reported in the metric-ton unit. Japan calculates and reports to IEA values in metric-ton by multiplying the volume of fuel combustion given in the *Yearbook of Mineral Resources and Petroleum Products Statistics* by the density of each fuel type given in the *information of petroleum*, Sekiyu –Tsushin. IEA converts the values in metric ton into tons of oil equivalent (TOE) by using conversion factors. Given that the values are expressed in net calorific-based value equivalent, one can judge that the conversion factors used in IEA are net calorific value.

Conversion of a unit to TOE by using information given in the inventory can be conducted by multiplying the volume of fuel consumption by gross calorific-based values.

This difference in the conversion process causes the variation between IEA energy balance and Japans energy statistics for inventory preparation

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[1] Lubricant is not included because lubricant is not combusted by use.

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*

Ministry of Economy, Trade and Industry, *Yearbook of Mineral Resources and Petroleum Products Statistics*

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)

3.2.1.1.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.

3.2.1.1.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.

3.2.1.1.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	0.106
	Passenger Vehicle (including LPG)	gNOx/km	0.237	0.203	0.199	0.118	0.107
	Light Cargo Truck	gNOx/km	0.873	0.658	0.375	0.280	0.248
	Small Cargo Truck	gNOx/km	1.115	0.897	0.478	0.152	0.121
	Regular Cargo Truck	gNOx/km	1.833	1.093	0.560	0.183	0.107
	Bus	gNOx/km	4.449	3.652	2.438	0.181	0.116
	Special Vehicle	gNOx/km	1.471	0.873	0.429	0.173	0.136
Diesel	Passenger Vehicle	gNOx/km	0.636	0.526	0.437	0.491	0.468
	Small Cargo Truck	gNOx/km	1.326	1.104	1.005	1.016	0.982
	Regular Cargo Truck	gNOx/km	5.352	4.586	4.334	4.548	4.461
	Bus	gNOx/km	4.226	3.830	3.597	4.265	4.142
	Special Vehicle	gNOx/km	3.377	2.761	2.152	3.574	3.495

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	1.236
	Passenger Vehicle (including LPG)	gCO/km	2.325	2.062	2.034	1.310	1.235
	Light Cargo Truck	gCO/km	10.420	8.540	5.508	4.086	3.535
	Small Cargo Truck	gCO/km	9.656	10.079	8.309	3.452	2.772
	Regular Cargo Truck	gCO/km	12.624	10.601	8.950	4.346	3.033
	Bus	gCO/km	26.209	25.079	21.938	3.854	2.807
	Special Vehicle	gCO/km	12.466	10.666	8.924	2.737	2.249
Diesel	Passenger Vehicle	gCO/km	0.480	0.432	0.429	0.406	0.396
	Small Cargo Truck	gCO/km	0.975	0.896	0.808	0.674	0.633
	Regular Cargo Truck	gCO/km	3.221	2.988	2.440	2.446	2.209
	Bus	gCO/km	2.579	2.534	2.200	2.349	2.140
	Special Vehicle	gCO/km	2.109	1.893	1.297	1.828	1.641

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	0.041
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.077	0.030	0.029	0.029	0.025
	Passenger Vehicle (including LPG)	gHC/km	0.189	0.112	0.104	0.042	0.038
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.113	0.067	0.062	0.025	0.023
	Light Cargo Truck	gHC/km	1.058	0.610	0.274	0.209	0.184
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.635	0.366	0.165	0.125	0.110
	Small Cargo Truck	gHC/km	1.188	0.882	0.346	0.116	0.086
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.713	0.529	0.208	0.069	0.052
	Regular Cargo Truck	gHC/km	1.658	0.959	0.471	0.132	0.081
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.995	0.575	0.283	0.079	0.049
	Bus	gHC/km	3.604	3.164	2.193	0.152	0.092
		%	60%	60%	60%	60%	60%
		gNMVOC/km	2.162	1.899	1.316	0.091	0.055
	Special Vehicle	gHC/km	1.619	0.786	0.317	0.096	0.073
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.972	0.472	0.190	0.058	0.044
Diesel	Passenger Vehicle	gHC/km	0.109	0.098	0.097	0.094	0.092
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.065	0.059	0.058	0.056	0.055
	Small Cargo Truck	gHC/km	0.389	0.343	0.258	0.240	0.212
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.233	0.206	0.155	0.144	0.127
	Regular Cargo Truck	gHC/km	1.634	1.488	1.040	1.019	0.882
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.980	0.893	0.624	0.611	0.529
	Bus	gHC/km	1.273	1.255	0.995	1.020	0.900
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.764	0.753	0.597	0.612	0.540
	Special Vehicle	gHC/km	1.101	0.965	0.526	0.729	0.625
		%	60%	60%	60%	60%	60%
		gNMVOC/km	0.661	0.579	0.316	0.437	0.375

Top row: THC emission factors;

Middle row: Percentage of NMVOC in the THC emission;

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:

<u>Calculation of annual consumption of solvents in Year X</u>

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 CO_2 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	7.8	7.8	7.8	7.8	7.8
	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 “7-2006.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.

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

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

Agency of Natural Resources and Energy, *Study on the total system for prevention of HC-Vapor in petroleum industries*, 1975

Ministry of Agriculture, Forestry and Fisheries, *Crop Statistics*

Ministry of Economy, Trade and Industry, *Yearbook of Chemical Industries Statistics*

Ministry of Economy, Trade and Industry, *Yearbook of Mineral Resources and Petroleum Production Statistics*

Ministry of Economy, Trade and Industry, *Yearbook of Production, Supply and Demand of Petroleum, Coal, and Coke*

Ministry of Economy, Trade and Industry, *Statistics of rubber products*

Ministry of Land, Infrastructure and Transport, *Statistical Yearbook of Motor Vehicle Transport*

Ministry of Land and Transport, *Statistical Yearbook of Air Transport*

Ministry of Land and Transport, *The Survey on Transport Energy*

Ministry of the Environment, *Research of Air Pollutant Emissions from Stationary Sources*

Ministry of the Environment, Air Quality Management Bureau, *Manual to control HC emissions*, 1982

Ministry of the Environment, Waste Management and Recycling Department , *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)*

Ministry of the Environment, Waste Management and Recycling Department , *Waste Treatment in Japan*

Institute of Behavioral Science, *Basic Study on HC Sources*, 1987

Institute of Behavioral Science, *Report on the Survey of Measures for Stationary Sources of Hydrocarbons*, 1991

Institute of Behavioral Science, *Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions*, 1984

Japan Adhesive Industry Association, *Current survey report on adhesive*

Japan Environmental Sanitation Center, *Report on Screening Survey Regarding Measures to Counter Global Warming*, 1989

Japan Paint Manufacturers Association, *Present condition and prospect about VOCs in Paint Industry*

Japan Sociality Atmospheric Environment, *Reports on Greenhouse gas emissions estimation methodology*, 1996

Tobacco Institute of Japan website (http://www.tioj.or.jp/)

Bando, Sakamaki, Moritomi, and Suzuki, *"Study of analysis of emissions from biomass burning", 1991 Report on Studies on Comprehensive Promotion Cost of Environmental Studies*, National Institute of Environmental Studies, 1992

Yoshinori Miura and Tadanori Kanno, *"Emissions of trace gases (CO_2, CO, CH_4, and N_2O) resulting from rice straw burning"*, Soil Sci. Plant Nutr. 43(4), pp849–854, 1997

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 -1.22% and 0.55%. The revision of the Energy Balance Table (*General Energy Statistics*) made difference under 1.3%, 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. 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	9,648	10,091	9,998	9,403	9,134	9,139	9,044	8,768
Solid fuels	3,291	3,376	3,626	3,720	4,187	4,280	4,422	4,551	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**	**15,263**	**16,244**	**16,389**	**16,715**	**16,534**	**16,768**	**16,950**	**17,090**
Sectoral Approach									
Liquid fuels	9,549	9,590	10,029	9,975	9,425	9,112	9,254	9,074	8,906
Solid fuels	3,354	3,332	3,635	3,731	4,116	4,219	4,482	4,604	4,721
Gaseous fuels	2,106	2,257	2,548	2,679	3,136	3,137	3,238	3,371	3,358
Total	**15,009**	**15,180**	**16,213**	**16,384**	**16,677**	**16,467**	**16,974**	**17,049**	**16,985**
Difference (%)									
Liquid fuels	-0.22%	0.60%	0.62%	0.23%	-0.23%	0.24%	-1.25%	-0.33%	-1.55%
Solid fuels	-1.86%	1.33%	-0.24%	-0.27%	1.73%	1.45%	-1.34%	-1.15%	5.49%
Gaseous fuels	-0.88%	-0.84%	-0.87%	-0.31%	-0.38%	-0.49%	-0.97%	-0.48%	-0.46%
Total	**-0.68%**	**0.55%**	**0.19%**	**0.03%**	**0.22%**	**0.41%**	**-1.22%**	**-0.58%**	**0.62%**

4.2. Difference in CO_2 Emissions

As shown in Table 2, fluctuations of a difference of CO_2 emissions between -1.08% and 1.40%. The reference revision of the Energy Balance Table (*General Energy Statistics*) made difference under about 1.4%, 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.

Difference of solid fuels in 2004 was quite large value, because of coal (Imported Steam Coal [$130]) stock change increasing.

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[1] FCCC/SBSTA/2004/8, paragraph 31

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	656.3	685.3	679.4	639.8	621.5	621.5	615.3	596.8
Solid fuels	296.2	303.4	326.0	335.2	378.5	386.5	399.9	411.5	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**	**1,070**	**1,136**	**1,147**	**1,173**	**1,162**	**1,180**	**1,193**	**1,213**
Sectoral Approach									
Liquid fuels	646.2	648.4	675.7	671.7	633.2	611.5	621.3	609.9	598.4
Solid fuels	308.6	305.8	331.7	341.0	376.4	384.8	409.5	419.6	431.1
Gaseous fuels	104.3	111.8	126.2	132.7	155.3	155.3	160.4	167.0	166.9
Total	**1,059**	**1,066**	**1,134**	**1,145**	**1,165**	**1,152**	**1,191**	**1,196**	**1,196**
Difference (%)									
Liquid fuels	0.31%	1.22%	1.43%	1.15%	1.05%	1.63%	0.04%	0.89%	-0.26%
Solid fuels	-4.02%	-0.79%	-1.73%	-1.69%	0.57%	0.46%	-2.34%	-1.92%	4.62%
Gaseous fuels	-1.02%	-0.98%	-1.03%	-0.48%	-0.50%	-0.63%	-1.13%	-0.69%	-0.97%
Total	**-1.08%**	**0.41%**	**0.23%**	**0.11%**	**0.69%**	**0.93%**	**-0.94%**	**-0.32%**	**1.40%**

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.

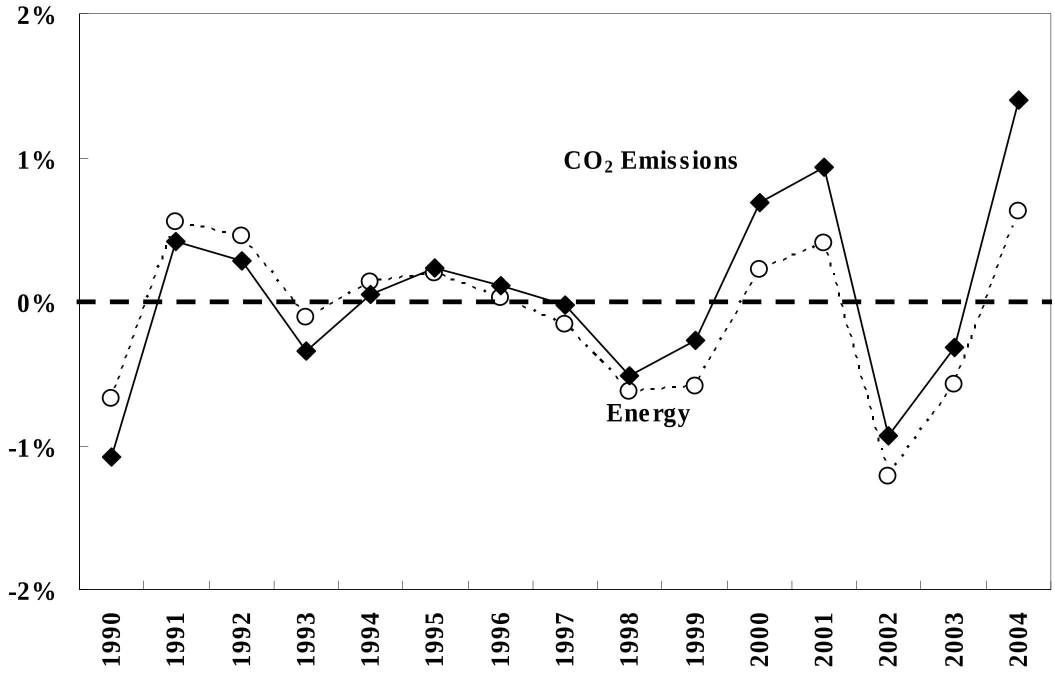

Figure 1 Trends in Difference of Energy Consumption and CO_2 Emissions

4.4. Causes of the difference between Reference Approach and Sectoral Approach

The difference in energy consumption and in CO_2 emissions can be explained by 'Other Conversions & Blending' [#2700], 'Other Input/Output' [#3000], 'Stock Change' [#3500], 'Statistical Discrepancy' [#4000] ,and "energy loss" and "carbon imbalance" of 'Oil Products' [#2600] of the Energy Balance Table (*General Energy Statistics*).

• *Matters not considered in the calculation process of Reference Approach*

In the current estimation of reference approach, it was assumed that the amount of energy subtracted the energy amount for non-energy use from the national energy amount supplied was completely combusted. However, in real situations, some of the energy amount combusted is left without being combusted. The increase or decrease of the remaining energy amount were not considered in the current estimation of reference approach.

➢ 'Other Input/Output' [#3000]

In oil refining and other parts of the energy conversion sector, energy source shipment/drawdown amounts do not necessarily match production/receipt amounts. Other than energy received through one's own imports or that produced by refining, factors involved include returns from consumption/sales sectors of products once shipped, transactions of small amounts of byproduct energy from other companies, stock buildups and drawdowns due to product storage tank installation or decommissioning at factories and business sites, and losses due to accidents or fires.

When energy source inconsistencies due to such causes in the energy conversion sector are determined, the other input/output sector accounts for the amount. However, this input/output are not reflected under reference approach emission calculation.

➢ 'Stock Change' [#3500]

The increase or decrease of stock were not reflected under reference approach emission calculation.

• *Matters which cannot be avoided for the characteristics of survey data*

➢ 'Statistical Discrepancy' [#4000]

Statistical discrepancy is originally the intrinsic error arising at the sampling stage in statistical studies (source error), and mutual discrepancies among the statistics for supply, conversion, and consumption. It is sometimes difficult to guess where discrepancies come from (relative error).

These errors induce the discrepancies among domestic supply, conversion, and final energy consumption, calculated as difference between both approaches.

• *Matters related to the difference of energy and carbon balance between energy input and output*

➢ 'Other Conversions & Blending' [#2700]

This sector represents energy conversion that does not belong to large-scale energy conversion such as power production, heat generation, and coal and oil product manufacturing. It also represents changes in coal and oil products through only very simple operations.

Carbon weight is considered to be consistent before and after blending or conversions. However, given that carbon content per calorific value is changed following such as blending, in statistics, carbon weight could be varied before and after blending or conversions. This difference can generate the variation between two approaches.

- ‘Oil Products’ [#2600]

Energy loss and carbon imbalance during the process of oil production produce the difference between input and output of energy or carbon.

The cumulative value of energy loss and carbon imbalance indicated in the above five categories perfectly coincides with the difference between the reference and sectoral approaches, although breakdown by fuel types may not be consistent. This inconsistency is considered due to the difference in fuel types reported in the reference and sectoral approaches for oil cock and town gas.

Table.3 Comparison of CO_2 emissions (detail)

[Gg-CO_2]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
RA	**1,047,597**	**1,070,359**	**1,075,547**	**1,062,341**	**1,121,807**	**1,136,203**	**1,146,589**	**1,141,063**	**1,105,433**	**1,142,698**	**1,172,803**	**1,162,299**	**1,180,002**	**1,192,693**	**1,213,097**
Liquid fuels	648,135	656,301	668,614	651,097	685,839	685,319	679,370	657,598	640,456	647,855	639,794	621,482	621,516	615,267	596,847
Solid fuels	296,226	303,369	295,000	296,467	315,085	325,990	335,188	345,892	324,474	346,364	378,530	386,512	399,944	411,532	450,983
Gaseous fuels	103,236	110,689	111,933	114,777	120,884	124,893	132,031	137,573	140,503	148,479	154,478	154,304	158,543	165,894	165,268
SA	**1,059,076**	**1,065,968**	**1,072,466**	**1,065,960**	**1,121,284**	**1,133,604**	**1,145,287**	**1,141,380**	**1,111,159**	**1,145,849**	**1,164,802**	**1,151,546**	**1,191,173**	**1,196,484**	**1,196,376**
Liquid fuels	646,157	648,406	658,639	643,414	678,244	675,688	671,666	652,596	633,873	643,789	633,156	611,506	621,279	609,857	598,425
Solid fuels	308,618	305,775	300,795	306,724	320,898	331,718	340,950	350,607	335,786	352,062	376,385	384,761	409,535	419,582	431,058
Gaseous fuels	104,301	111,787	113,031	115,822	122,142	126,198	132,671	138,176	141,501	149,999	155,261	155,279	160,359	167,045	166,893
RA-SA	**-11,478**	**4,391**	**3,081**	**-3,619**	**523**	**2,598**	**1,302**	**-317**	**-5,727**	**-3,152**	**8,001**	**10,752**	**-11,170**	**-3,791**	**16,721**
Liquid fuels	1,978	7,895	9,974	7,683	7,595	9,631	7,705	5,001	6,584	4,066	6,638	9,976	236	5,410	-1,578
Solid fuels	-12,392	-2,406	-5,795	-10,257	-5,814	-5,728	-5,762	-4,715	-11,312	-5,698	2,146	1,751	-9,591	-8,049	19,925
Gaseous fuels	-1,065	-1,098	-1,098	-1,045	-1,258	-1,304	-640	-603	-998	-1,520	-783	-975	-1,816	-1,152	-1,626
Statistical Discrepancy	**-11,299**	**7,412**	**3,521**	**3,915**	**-1,538**	**4,491**	**-3,928**	**-11,185**	**-7,648**	**-6,379**	**-1,687**	**-1,464**	**-11,827**	**-7,948**	**-9,912**
Liquid fuels	-3,708	3,756	491	494	2,250	3,839	-3,015	-5,828	-8,174	-9,279	-5,664	-5,292	-12,641	-10,667	-16,050
Solid fuels	-7,630	3,548	2,943	3,315	-4,006	417	-976	-5,536	255	2,563	3,486	3,382	363	2,373	5,654
Gaseous fuels	39	108	88	105	219	236	62	178	271	337	491	446	450	346	485
Other Conversions & Blending	**-2,828**	**-3,269**	**-3,104**	**-3,021**	**-3,153**	**-3,076**	**-2,965**	**-2,576**	**-2,506**	**-2,177**	**-1,189**	**-1,277**	**-782**	**-775**	**-606**
Liquid fuels	803	860	945	976	1,001	1,058	1,106	1,130	1,135	1,101	1,119	1,091	1,136	1,171	1,158
Solid fuels	-2,807	-3,245	-3,104	-3,008	-3,145	-3,078	-2,960	-2,579	-2,501	-2,115	-1,121	-1,168	-709	-709	-551
Gaseous fuels	-825	-884	-945	-990	-1,009	-1,056	-1,112	-1,127	-1,141	-1,163	-1,186	-1,201	-1,210	-1,237	-1,213
Stock Change	**2,286**	**-1,341**	**-1,892**	**-8,237**	**3,827**	**768**	**1,936**	**7,583**	**-3,973**	**-5,276**	**2,650**	**4,206**	**-9,464**	**-7,856**	**15,812**
Liquid fuels	788	-1,910	733	-926	-376	1,311	454	547	191	-2,677	-976	1,209	-3,753	-1,853	-2,364
Solid fuels	1,515	624	-2,655	-7,425	4,381	-353	834	6,412	-4,302	-2,191	3,359	2,850	-5,028	-6,126	18,691
Gaseous fuels	-18	-56	29	114	-177	-190	648	625	137	-408	268	148	-683	123	-515
Other Input/Output	**-895**	**-561**	**-587**	**-345**	**-813**	**-642**	**-765**	**-805**	**-795**	**2,146**	**2,106**	**623**	**1,878**	**2,010**	**2,054**
Liquid fuels	-895	-561	-587	-345	-813	-642	-765	-805	-795	2,146	2,106	623	1,878	2,010	2,054
Solid fuels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaseous fuels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil Products	**1,257**	**2,151**	**5,143**	**4,069**	**2,199**	**1,057**	**7,024**	**6,665**	**9,196**	**8,535**	**6,121**	**8,664**	**9,025**	**10,777**	**9,373**
Liquid fuels	1,518	2,416	5,413	4,344	2,490	1,351	7,263	6,944	9,462	8,820	6,476	9,032	9,399	11,162	9,755
Solid fuels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaseous fuels	-261	-266	-270	-275	-291	-294	-238	-279	-265	-285	-355	-368	-374	-385	-382
Total	**-11,478**	**4,391**	**3,081**	**-3,619**	**523**	**2,598**	**1,302**	**-317**	**-5,727**	**-3,152**	**8,001**	**10,752**	**-11,170**	**-3,791**	**16,721**
Liquid fuels	-1,493	4,562	6,994	4,544	4,551	6,917	5,044	1,989	1,819	111	3,060	6,663	-3,981	1,822	-5,447
Solid fuels	-8,921	927	-2,815	-7,118	-2,770	-3,014	-3,102	-1,703	-6,548	-1,743	5,724	5,064	-5,373	-4,461	23,794
Gaseous fuels	-1,064	-1,098	-1,098	-1,045	-1,258	-1,304	-640	-603	-998	-1,520	-783	-975	-1,816	-1,152	-1,626
(RA-SA)-(Total)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Liquid fuels	3,471	3,333	2,980	3,139	3,044	2,714	2,661	3,012	4,764	3,955	3,578	3,313	4,218	3,588	3,869
Solid fuels	-3,471	-3,333	-2,980	-3,139	-3,044	-2,714	-2,661	-3,012	-4,764	-3,955	-3,578	-3,313	-4,218	-3,588	-3,869
Gaseous fuels	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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 27 above; (para 27: 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/SBSTA/2004/8)

* 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.

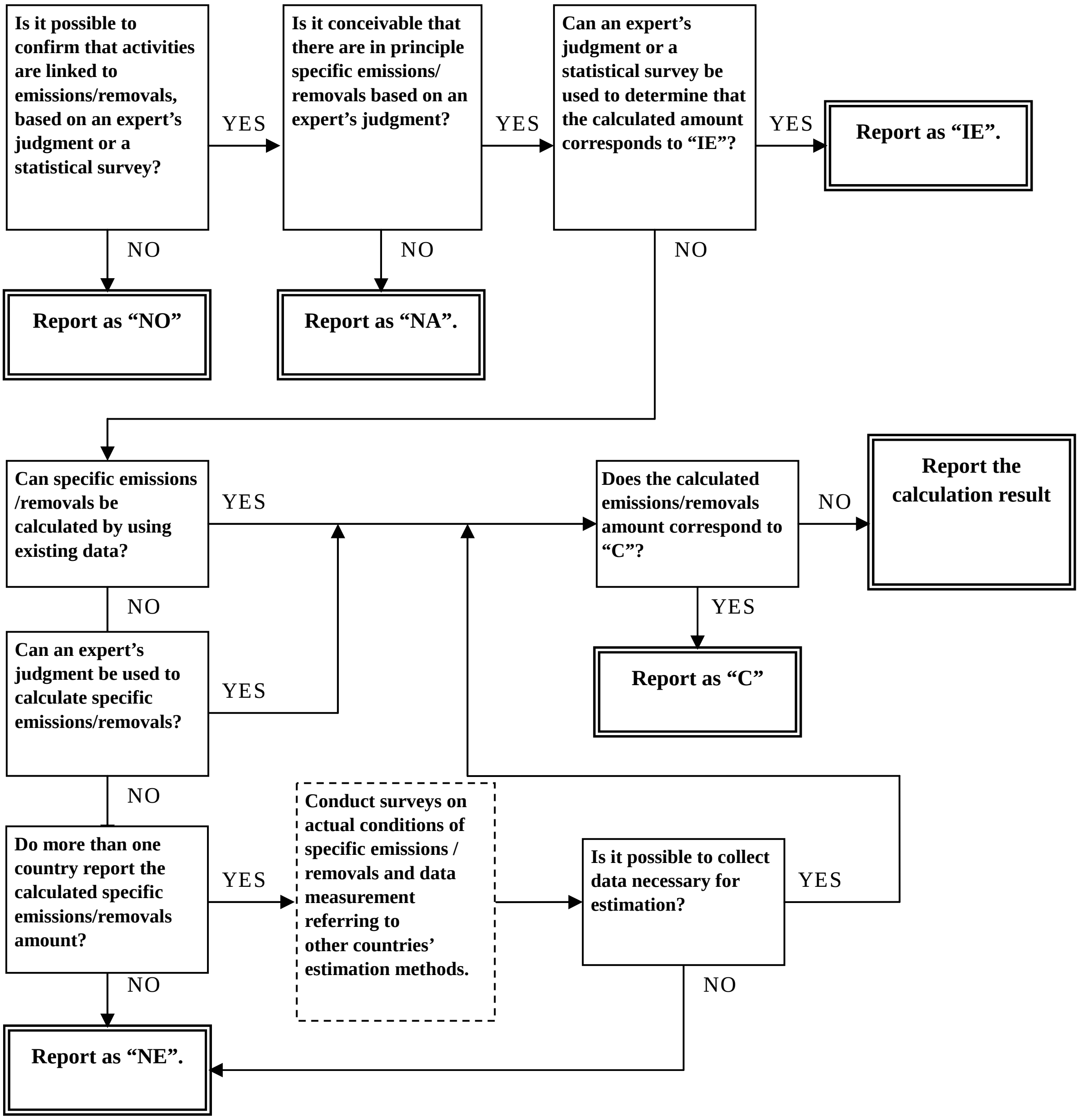

Figure 1 Decision tree for application of notation keys

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 actual emissions 1990-1994 of HFCs, PFCs and SF_6 are not estimated.

Table 3 Dissolution of “NE” categories for 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	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・Kerosene			CO_2
22	Energy	International Bunkers	Marine・Kerosene			CH_4
23	Energy	International Bunkers	Marine・Kerosene			N_2O
24	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Production		CO_2
25	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Use（Including desulfurization equipment）		CO_2
26	Industrial Processes	Chemical Industry	Carbide Production	Silicon Carbide		CO_2
27	Industrial Processes	Chemical Industry	Carbide Production	Calcium Carbide		CO_2
28	Industrial Processes	Chemical Industry	Carbide Production	Calcium Carbide		CH_4
29	Industrial Processes	Chemical Industry	Other	Ethylene		N_2O
30	Industrial Processes	Chemical Industry	Other	Coke		CO_2
31	Industrial Processes	Chemical Industry	Other	Coke		N_2O
32	Industrial Processes	Metal Production	Iron and Steel Production	Coke		CO_2
33	Industrial Processes	Metal Production	Aluminium Production			PFCs
34	Industrial Processes	Metal Production	SF_6 Used in Aluminium and Magnesium Foundries	Aluminium Foundries		SF_6
35	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Commercial Refrigeration	Manufacturing/Stocks/Disposal	PFCs
36	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Automatic Vender Machine	Manufacturing/Stocks/Disposal	PFCs
37	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing/Stocks/Disposal	HFCs
38	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing/Stocks/Disposal	PFCs
39	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Industrial Refrigeration	Manufacturing/Stocks/Disposal	PFCs
40	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Stationary Air-Conditioning	Manufacturing/Stocks/Disposal	PFCs
41	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Mobile Air-Conditioning	Manufacturing/Stocks/Disposal	PFCs
42	Industrial Processes	Consumption of Halocarbons and SF_6	Foam Blowing	Hard Form	Stocks and Disposal of Urethane Foam	HFCs
43	Industrial Processes	Consumption of Halocarbons and SF_6	Foam Blowing	Hard Form	Stocks and Disposal of Polystyrene Foam	HFCs
44	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	HFCs
45	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	PFCs
46	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	SF_6
47	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Aerosols	Manufacturing/Disposal	HFCs
48	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Metered Dose Inhalers	Manufacturing/Disposal	HFCs
49	Industrial Processes	Consumption of Halocarbons and SF_6	Solvents		Manufacturing/Stocks/Disposal	HFCs
50	Industrial Processes	Consumption of Halocarbons and SF_6	Solvents		Manufacturing/Disposal	PFCs
51	Industrial Processes	Consumption of Halocarbons and SF_6	Other applications using ODS substitutes		Manufacturing/Stocks/Disposal	PFCs
52	Industrial Processes	Consumption of Halocarbons and SF_6	Other applications using ODS substitutes		Manufacturing/Stocks/Disposal	SF_6
53	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	HFCs
54	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	PFCs
55	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	SF_6
56	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Disposal	HFCs
57	Agriculture	Enteric Fermentation	Buffalo			CH_4
58	Agriculture	Enteric Fermentation	Camels and Llamas			CH_4
59	Agriculture	Enteric Fermentation	Mules and Asses			CH_4
60	Agriculture	Enteric Fermentation	Poultry			CH_4
61	Agriculture	Manure Management	Buffalo			CH_4
62	Agriculture	Manure Management	Camels and Llamas			CH_4
63	Agriculture	Manure Management	Mules and Asses			CH_4
64	Agriculture	Manure Management	Sheep, Goats & Horses			N_2O
65	Agriculture	Agricultural Soils	Direct Soil Emissions	Crop Residue		N_2O
66	Agriculture	Agricultural Soils	Direct Soil Emissions	Cultivation of Histosols		N_2O
67	Waste	Solid Waste Disposal on Land	Managed Waste Disposal on Land			CO_2
68	Waste	Solid Waste Disposal on Land	Unmanaged Waste Disposal Sites			CO_2
69	Waste	Solid Waste Disposal on Land	Unmanaged Waste Disposal Sites			CH_4
70	Waste	Wastewater Handling	Industrial Wastewater			N_2O

Table 4 "NE" categories for 2004

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	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Use（Including desulfurization equipment）		CO_2
19	Industrial Processes	Mineral Products	Asphalt roofing			CO_2
20	Industrial Processes	Mineral Products	Road Paving with Asphalt			CO_2
21	Industrial Processes	Chemical Industry	Ammonia Production			CH_4
22	Industrial Processes	Metal Production	Aluminium Production			CH_4
23	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Commercial Refrigeration	Manufacturing/Stocks/Disposal	PFCs
24	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Automatic Vender Machine	Manufacturing/Stocks/Disposal	PFCs
25	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing/Stocks/Disposal	PFCs
26	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Industrial Refrigeration	Manufacturing/Stocks/Disposal	PFCs
27	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Mobile Air-Conditioning	Manufacturing/Stocks/Disposal	PFCs
28	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	HFCs
29	Industrial Processes	Consumption of Halocarbons and SF_6	Other applications using ODS substitutes		Manufacturing/Stocks/Disposal	HFCs
30	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	PFCs
31	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	SF_6
32	Solvent and Other Product Use	Degreasing and Dry-Cleaning				CO_2
33	Solvent and Other Product Use	Other	Fire Extinguishers			N_2O
34	Solvent and Other Product Use	Other	Other Use of N_2O			CO_2
35	Solvent and Other Product Use	Other	Other Use of N_2O			N_2O
36	Agriculture	Enteric Fermentation	Poultry			CH_4
37	Agriculture	Field Burning of Agricultural Residues	Other			CH_4
38	Agriculture	Field Burning of Agricultural Residues	Other			N_2O
39	Land - use Change and Forestry	Forest Land	Drainage of Soils	Mineral Soils		N_2O
40	Land - use Change and Forestry	Cropland	Agricultural lime apprication	Limestone		CO_2
41	Land - use Change and Forestry	Cropland	Agricultural lime apprication	Dolomite		CO_2
42	Land - use Change and Forestry	Cropland	Cropland remaining Cropland	Dead Organic Matter		CO_2
43	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Dead Organic Matter		CO_2
44	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Biomass Burning	Wildfires	CO_2
45	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Biomass Burning	Wildfires	CH_4
46	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Biomass Burning	Wildfires	N_2O
47	Land - use Change and Forestry	Grassland	Agricultural lime apprication	Limestone		CO_2
48	Land - use Change and Forestry	Grassland	Agricultural lime apprication	Dolomite		CO_2
49	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Dead Organic Matter		CO_2
50	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	CO_2
51	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	CH_4
52	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	N_2O
53	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	CO_2
54	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	CH_4
55	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	N_2O
56	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Dead Organic Matter		CO_2
57	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	CO_2
58	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	CH_4
59	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	N_2O
60	Land - use Change and Forestry	Wetlands	Drainage of Soils	Mineral Soils		N_2O
61	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Living Biomass		CO_2
62	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Dead Organic Matter		CO_2
63	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Soils		CO_2
64	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	CO_2
65	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	CH_4
66	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	N_2O
67	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	CO_2
68	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	CH_4
69	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	N_2O
70	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Dead Organic Matter		CO_2
71	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Soils		CO_2
72	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	CO_2
73	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	CH_4
74	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	N_2O
75	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Living Biomass Decrease		CO_2
76	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Dead Organic Matter		CO_2
77	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Soils		CO_2
78	Land - use Change and Forestry	Settlements	Land Converted to Settlements	Dead Organic Matter		CO_2
79	Land - use Change and Forestry	Settlements	Land Converted to Settlements	Soils		CO_2
80	Land - use Change and Forestry	Other Land	Land Converted to Other Land	Dead Organic Matter		CO_2
81	Land - use Change and Forestry	Harvested Wood Product				CO_2
82	Land - use Change and Forestry	Harvested Wood Product				CH_4
83	Land - use Change and Forestry	Harvested Wood Product				N_2O
84	Waste	Wastewater Handling	Domestic and Commercial Wastewater			CH_4
85	Waste	Wastewater Handling	Domestic and Commercial Wastewater			N_2O
86	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.	GIO1)
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.	MOE2), 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)

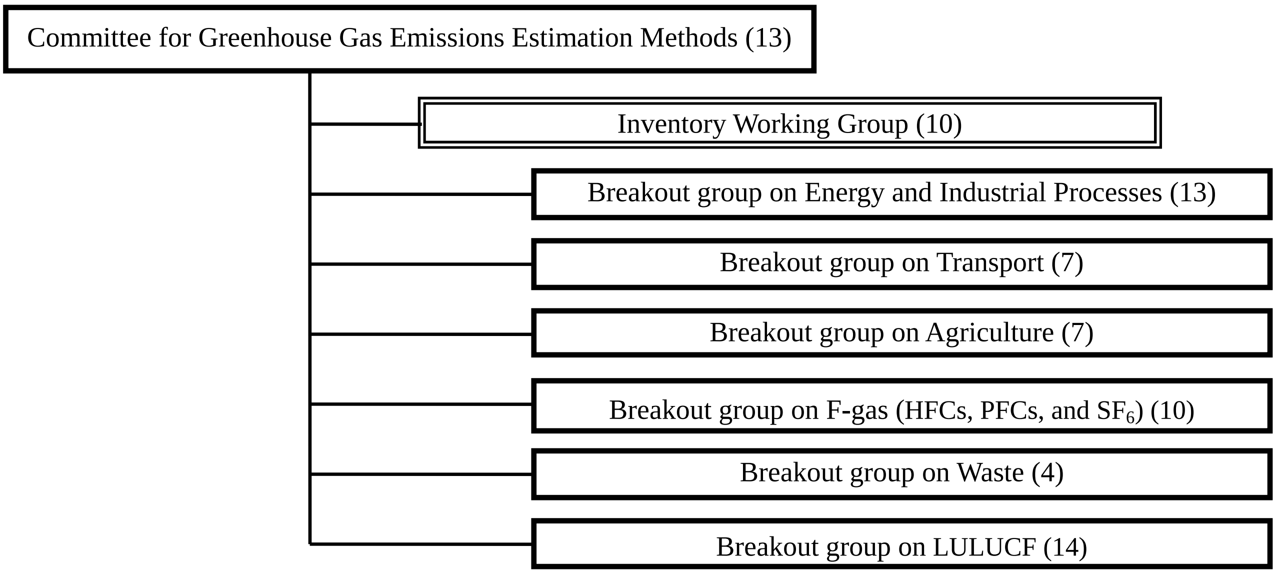


Figure 1 Organization of Committee for the Greenhouse Gases Emissions Estimation Methods (Parentheses show numbers of experts in FY2005)

- ***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

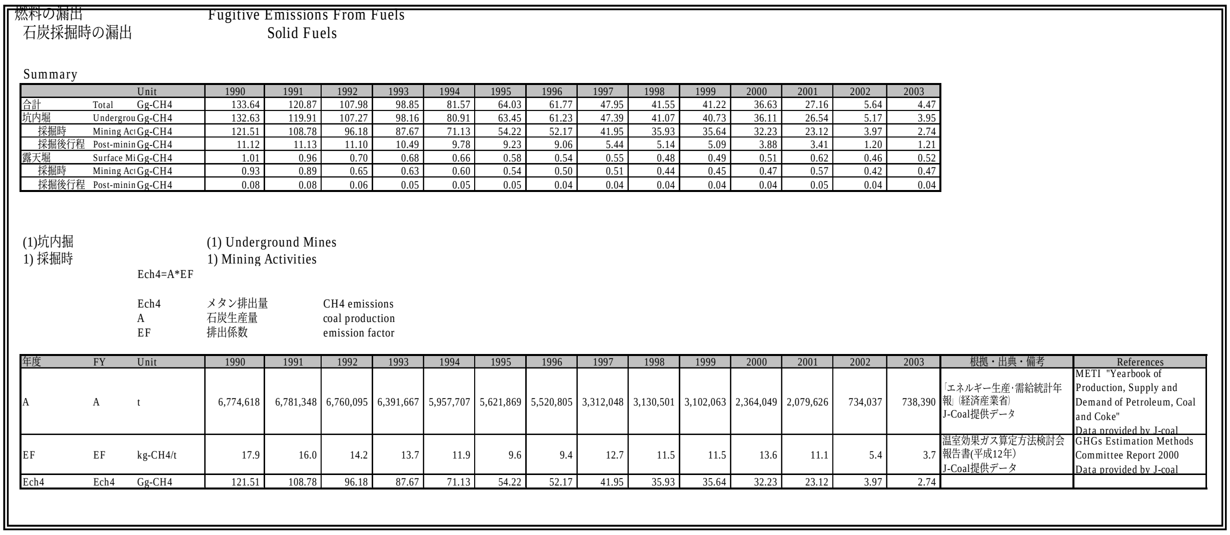
• *Individual Tasks*

-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 Act	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 Act	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 2　An estimation file (emission/removal estimation sheet) (“Coal” in 1B1-2005.xls)

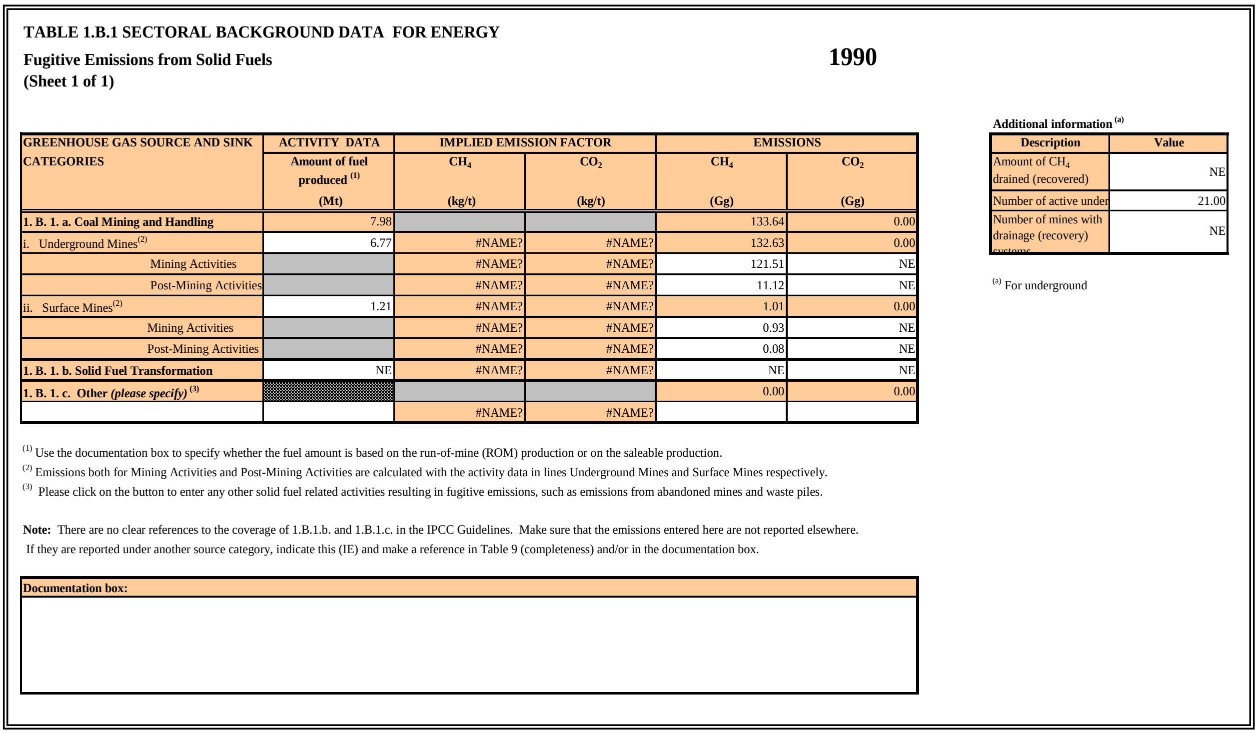


TABLE 1.B.1 SECTORAL BACKGROUND DATA FOR ENERGY

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:

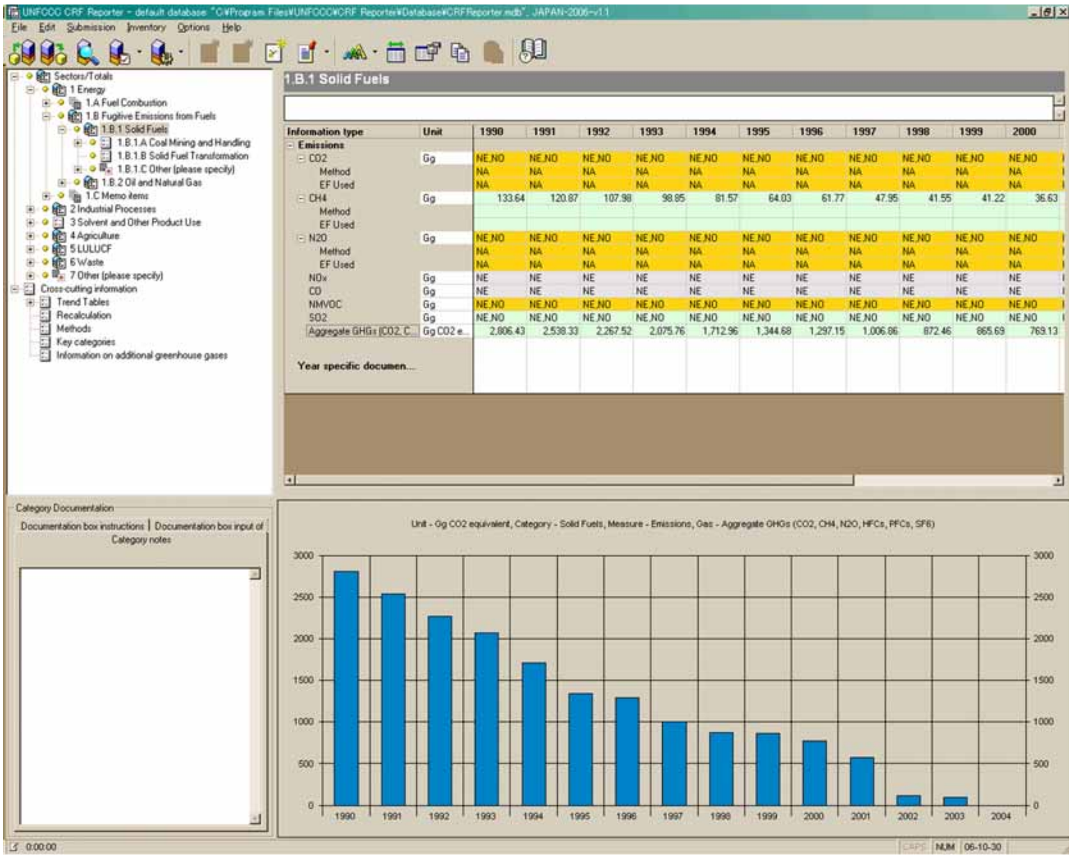
Figure 3　An estimation file (CRF link sheet) (“CRF1990” in 1B1-2005.xls)

- 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.



1.B.1 Solid Fuels

Information type	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Emissions												
CO2	Gg	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Method		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EF Used		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CH4	Gg	133.64	120.87	107.98	98.85	81.57	64.03	61.77	47.95	41.55	41.22	36.63
Method												
EF Used												
N2O	Gg	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Method		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EF Used		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NOx	Gg	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO	Gg	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
NMVOC	Gg	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
SO2	Gg	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Aggregate GHGs (CO2, C...	Gg CO2 e...	2,806.43	2,538.33	2,267.52	2,075.76	1,712.96	1,344.68	1,297.15	1,006.86	872.46	865.69	769.13
Year specific documen...												

Figure 4 CRF Reporter screen shot (1B1 Solid Fuels)

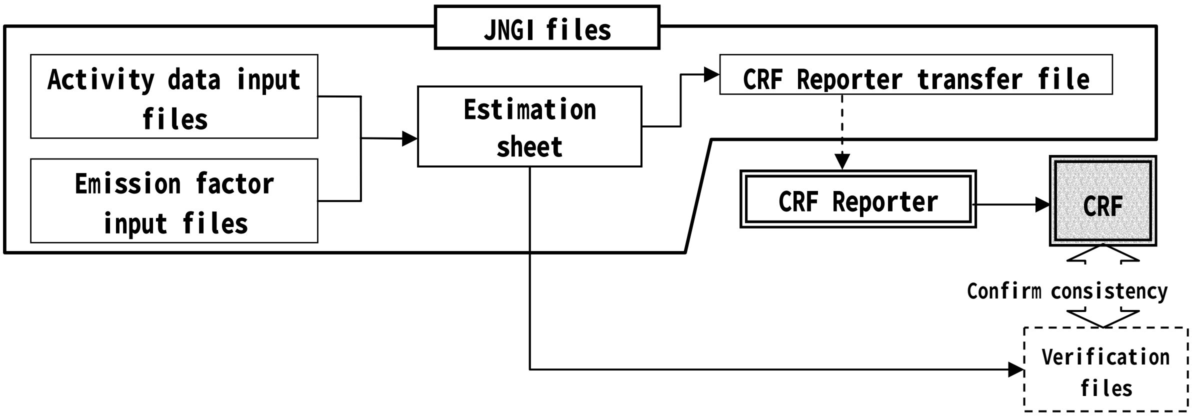


Figure 5 Link structure of estimation files, CRF Reporter, CRF, and verification files

- 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, Ministry of Foreign affairs, 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 CO2 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 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.

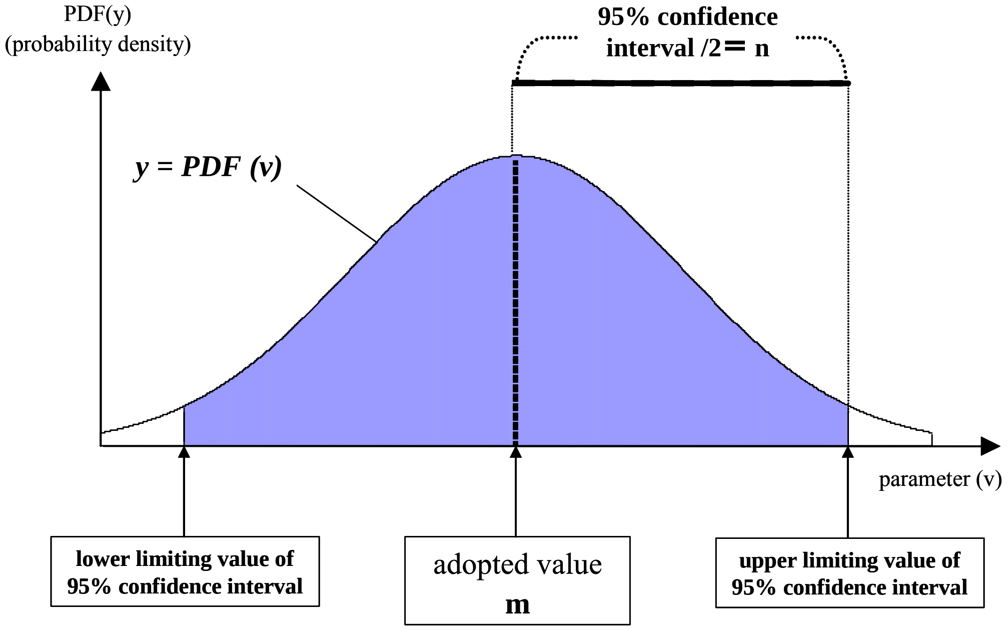
$$U = \sqrt{U_{EF}^2 + U_A^2}$$

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.

$$\text{Uncertainty of EF or A} = \frac{\text{95\% confidential interval / 2 (n)}}{|\ \text{Adopted Value of EF or E (m)}\ |}$$



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.

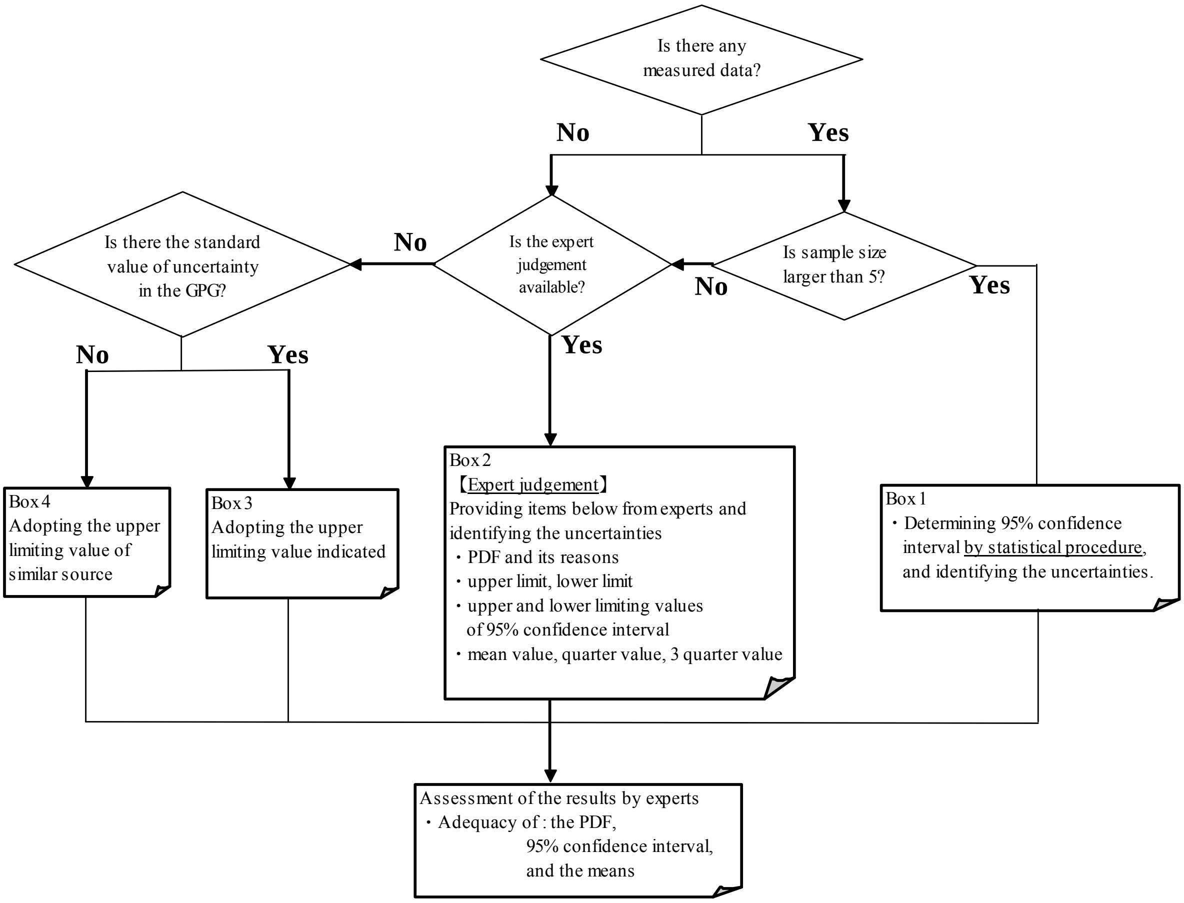


Figure 1 Decision tree for assessing uncertainty associated with emission factors established by the *Committee for the GHGs Emissions Estimation Methods*

- 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 $' / \sqrt{n}$ 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.

$$Uncertainty\ of\ Emission\ Factor\ (\%) = \frac{1.96 \times \sigma_{EF}}{|\ EF\ |} \quad \ldots \text{ Equation 1.1.}$$

σ_{EF} : Standard Deviation of Average

EF : Emission Factor

2) Emission factor has been calculated using a weighted average of the sample data

Where the emission factor has been derived using a weighted average of the sample data, it is assumed that the data used in calculating the emission factor follows a normal distribution. Therefore, the standard deviation σ_{EF} of the sample is derived using the equation below. Uncertainty is calculated by finding the 95 percent confidence interval of the averages in accordance with Equation 1.1. Note that the equation does not account for the uncertainty of weights *wi*.

The weight applied in the weighted average, wi ($\sum wi = 1$)

Sample averages : $EF = \sum (wi \times EFi)$

Unbiased variance of sample averages :

$$\sigma_{EF}^2 = \sum \left\{ w_i \times \left(EF_i - \overline{EF} \right)^2 \right\} / \left(1 - \sum w_i^2 \right) \times \sum w_i^2$$

b) When the distribution of data used in calculating emission factor is derived using statistical methods

When it is possible to derive the distribution of data used in calculating the emission factor by using statistical methods, it is assumed that the data follows a normal distribution, and the uncertainty of each piece of data is estimated on the basis of section "*a) When it is not possible to use statistical methods to derive the distribution of data used in calculating emission factors*". The uncertainty of each piece of data is then determined using Equation 1.2, and the standard deviation of the emission factor σ_{EF} is calculated, to obtain the uncertainty.

If experts at *Working Group on Inventory of Committee for the GHGs Emissions Estimation Methods* indicate that statistical analysis is inappropriate, even using five or more samples, then uncertainty should be assessed by expert judgment. Conversely, if an expert determines that it is possible to carry out statistical analysis, even with less than five samples, uncertainty shall be assessed statistically.

When weight averaging is done to obtain at emission factors, the emission factor *EF* is expressed as follows, where the emission factor of each sub-category is EF_i, the weight variable is A_i, and the total of weight variables is *A*.

$$EF = \frac{\sum_i EF_i \times A_i}{\sum_i A_i} = \frac{\sum_i EF_i \times A_i}{A}$$

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.

$$\sigma_{EF}^2 = \sum_i \left\{ \left(\frac{\partial EF}{\partial EF_i}\right)^2 \sigma_{EFi}^2 + \left(\frac{\partial EF}{\partial A_i}\right)^2 \sigma_{Ai}^2 \right\} = \sum_i \left\{ \frac{A_i^2}{A^2}\sigma_{EFi}^2 + \frac{(EF_i - EF)^2}{A^2}\sigma_{Ai}^2 \right\} \quad \text{… Equation 1.2}$$

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

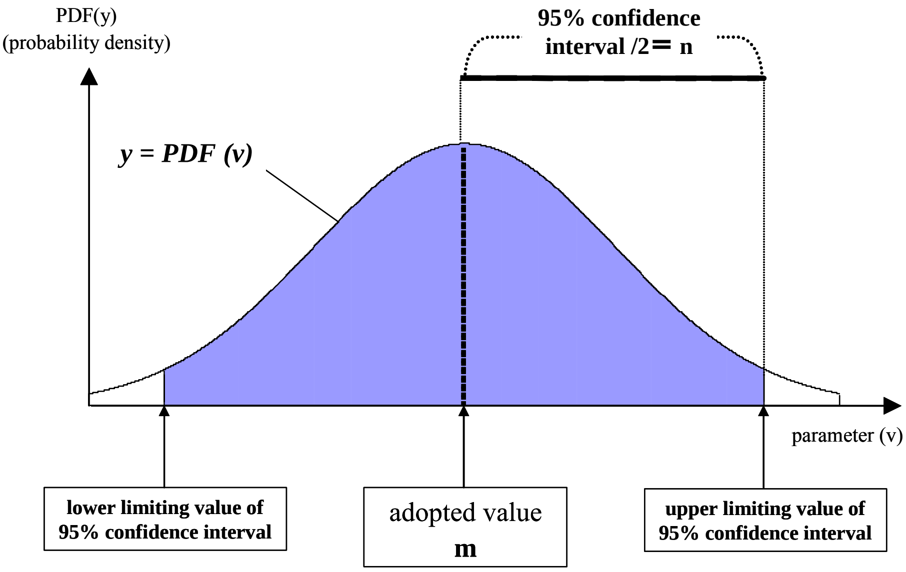
When there is no actual measurement data, or there are less than five samples, uncertainty shall be assessed by expert judgment.

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



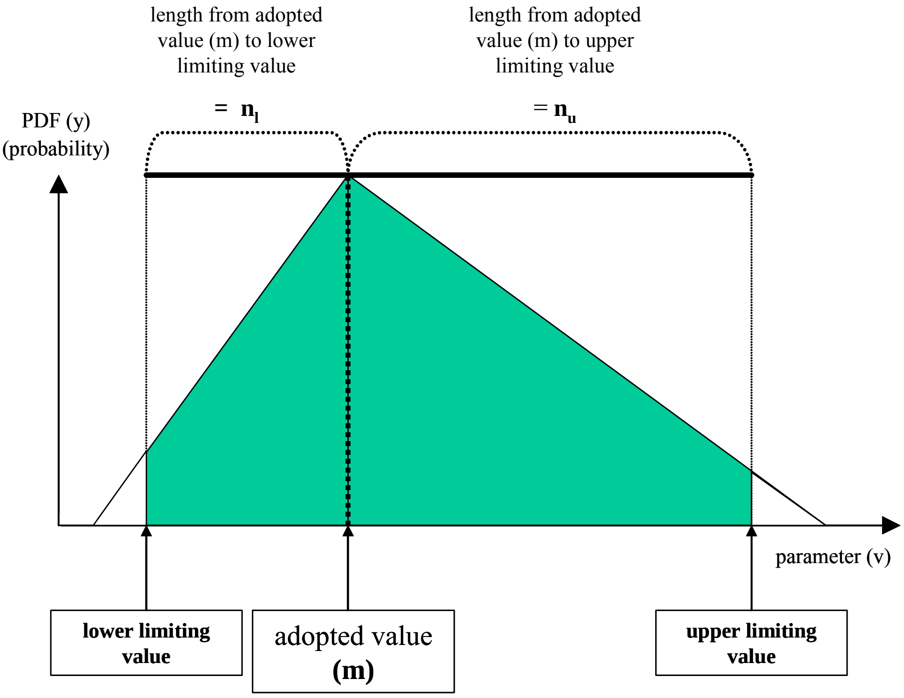
$$\text{Uncertainty of EF or A} = \frac{\text{95\% confidential interval / 2 (n)}}{|\,\text{Adopted Value of EF or E (m)}\,|}$$

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.

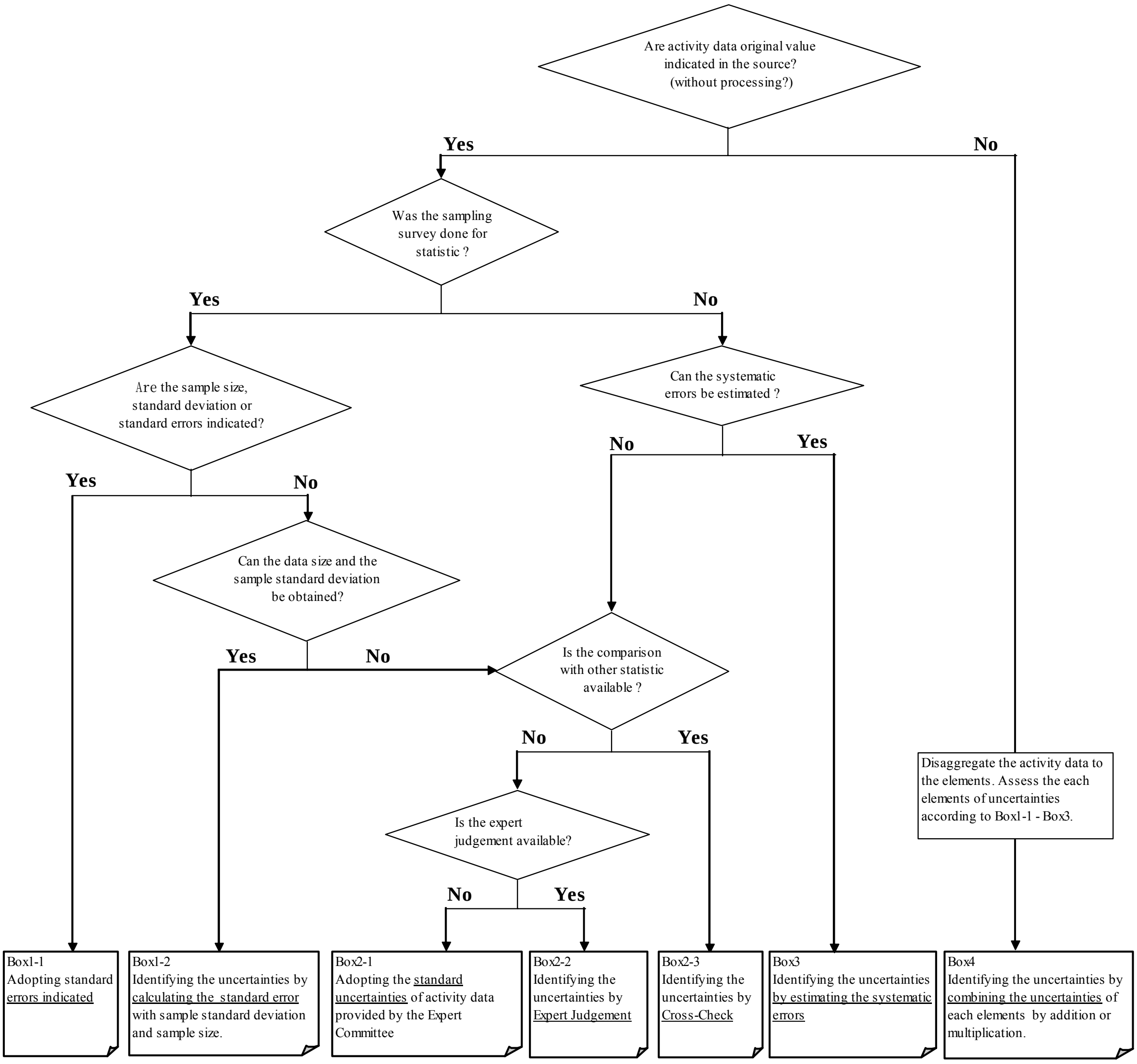


Figure 2 Decision tree for assessing uncertainty associated with activity data established by the *Committee for the GHGs Emissions Estimation Methods*

- 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 $\boldsymbol{A_1} \times \boldsymbol{A_2}$

$$U_A = \sqrt{U_{A1}^2 \times U_{A2}^2}$$

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 and FY2006.

7.2.2. Uncertainty of Japan's Total Emissions

Fiscal 2004 total net emissions in Japan were approximately 1.260 billion tons (carbon dioxide equivalents). Uncertainty of total emissions has been assessed at 2% and uncertainty introduced into the trend in total national net emissions has been assessed at 2%.

Table 3 Uncertainty of Japan's Total Net Emissions

IPCC Category	GHGs	Emissions / Removals [Gg CO2eq.] A	[%]	Combined Uncertainty [%] 1) B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (CO2)	CO2	1,196,376.5	94.9%	1%	10	0.69%	3
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	4,794.1	0.4%	30%	2	0.11%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	3,778.3	0.3%	290%	1	0.87%	1
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	418.8	0.0%	19%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	54,987.4	4.4%	7%	7	0.32%	5
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	19,142.5	1.5%	20%	5	0.30%	6
3. Solvent & other Product Use	N2O	297.5	0.0%	5%	9	0.00%	9
4. Agriculture	CH4、N2O	27,516.8	2.2%	26%	3	0.57%	4
5. LULUCF	CO2、CH4、N2O	▲ 94,879.2	-7.5%	6%	8	-0.43%	10
6. Waste	CO2、CH4、N2O	47,863.0	3.8%	23%	4	0.86%	2
Total Emissions	(D)	1,260,295.8	100.0%	(E) 2) **2%**			

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 Table 4 and the following tables.

7.2.3. Energy Sector

7.2.3.1. Fuel Combustion (CO_2)

Carbon-Hydrogen ratio of hydrocarbons is strongly correlating with calorific value in theory, then, standard deviation of sample data of each fuel's calorific value are used for uncertainty assessment based on assumption that deviation of carbon content and that of calorific value is equal. 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 Category			GHGs	Emissions / Removals [Gg CO2eq.]	EF/RF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
				A	a	b	B 3)		C	
1A. Fuel Combustion	Solid Fuels	Steel Making Coal	CO2	14,068.0	3.5%	1.2%	4%	10	0.04%	12
		Steam Coal (imported)	CO2	244,697.3	2.0%	1.2%	2%	22	0.45%	1
		Steam Coal (indigenous)	CO2	0.0	2.0%	1.2%	2%	22	0.00%	31
		Hard Coal	CO2	0.0	4.5%	1.2%	5%	7	0.00%	31
		Coke	CO2	97,351.0	1.7%	1.2%	2%	30	0.16%	6
		Coal Tar	CO2	2,149.2	5.0%	1.2%	5%	5	0.01%	20
		Coal Briquette	CO2	0.0	5.0%	1.2%	5%	5	0.00%	31
		Coke Oven Gas	CO2	14,892.5	2.0%	1.2%	2%	22	0.03%	15
		Blast Furnace Gas	CO2	47,028.3	3.8%	1.2%	4%	8	0.15%	8
		Converter Furnace Gas	CO2	10,759.7	2.9%	1.2%	3%	11	0.03%	16
	Liquid Fuels	Crude Oil for Refinery	CO2	224.3	0.8%	2.3%	2%	17	0.00%	25
		Crude Oil for Power Generation	CO2	16,420.8	0.9%	2.3%	2%	16	0.03%	13
		Vitumous Mixture Fuel	CO2	117.2	0.4%	2.3%	2%	21	0.00%	28
		NGL & Condensate	CO2	50.3	1.6%	2.3%	3%	12	0.00%	29
		Naphtha	CO2	699.5	0.1%	2.3%	2%	25	0.00%	21
		Reformed Material Oil	CO2	0.0	0.1%	2.3%	2%	25	0.00%	31
		Gasoline	CO2	142,340.1	0.03%	2.3%	2%	29	0.26%	2
		Jet Fuel	CO2	12,088.9	1.0%	2.3%	3%	15	0.02%	18
		Kerosene	CO2	67,584.0	0.05%	2.3%	2%	28	0.12%	9
		Gas Oil or Diesel Oil	CO2	99,079.4	1.2%	2.3%	3%	14	0.20%	3
		Heating Oil A	CO2	80,156.5	1.5%	2.3%	3%	13	0.17%	4
		Heating Oil B	CO2	168.1	5.0%	2.3%	6%	1	0.00%	24
		Heating Oil C	CO2	86,901.6	0.6%	2.3%	2%	18	0.16%	5
		Lubricating Oil	CO2	202.8	5.0%	2.3%	6%	1	0.00%	23
		Asphalt	CO2	8,995.7	0.6%	2.3%	2%	18	0.02%	19
		Non Asphalt Heavy Oil Products	CO2	0.1	0.6%	2.3%	2%	18	0.00%	30
		Oil Coke	CO2	11,317.6	5.0%	2.3%	6%	1	0.05%	11
		Galvanic Furnace Gas	CO2	79.7	2.9%	2.3%	4%	9	0.00%	27
		Refinary Gas	CO2	35,374.4	5.0%	2.3%	6%	1	0.15%	7
		LPG	CO2	31,367.2	0.1%	2.3%	2%	25	0.06%	10
	Gaseous Fuels	LNG	CO2	104,245.1	0.1%	0.3%	0%	33	0.03%	17
		Indigenous Natural Gas	CO2	2,113.0	0.6%	0.3%	1%	31	0.00%	22
		Town Gas*	CO2	64,583.7	0.5%	0.3%	1%	32	0.03%	14
		Small Scale Town Gas*	CO2	1,320.2	0.1%	0.3%	0%	33	0.00%	26
	Sub Total			1,196,376.5			0.7%		0.69%	
Total Emissions			(D)	1,260,295.8			2%			

* Reported in Gaseous Fuels according to the main material; LNG

3) $B = \sqrt{a^2 + b^2}$ (Hereafter, the same method has been used in each sector appearing in Table5 and following)

7.2.3.2. Stationary Combustion (CH_4 and N_2O)

Table 5 Results of uncertainty assessment of fuel combustion (CO_2)

IPCC Category		GHGs	Emissions / Removals [Gg CO2eq.]	EF/RF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
			A	a	b	B		C	
1A. Fuel Combustion (Stationary)		CH4	574.1	— 4)	— 4)	47%	1	0.02%	2
		N2O	4,220.0	— 4)	— 4)	33%	2	0.11%	1
	Sub Total		4,794.1			30%		0.11%	
Total Emissions		(D)	1,260,295.8			2%			

4) Because "—" means aggregation of detailed sub-categories, uncertainties of EF/RF and AD can not be calculated for this level of disaggregation of categories.

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 Category		GHGs	Emissions / Removals [Gg CO2eq.]	EF/RF 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	200.0%	10.0%	200%	**4**	0.00%	7
		N2O	106.5	10000.0%	10.0%	10000%	1	0.84%	**1**
	b. Road Transportation	CH4	224.8	40.0%	50.0%	64%	7	0.01%	**4**
		N2O	3,224.8	50.0%	50.0%	71%	6	0.18%	**2**
	c. Railways	CH4	0.8	5.0%	10.0%	11%	8	0.00%	8
		N2O	84.5	5.0%	100.5%	101%	**5**	0.01%	**5**
	d. Navigation	CH4	25.5	200.0%	13.0%	200%	**3**	0.00%	6
		N2O	106.6	1000.0%	13.0%	1000%	**2**	0.08%	**3**
	Sub Total		3,778.3			290%		0.87%	
Total Emissions		(D)	1,260,295.8			2%			

(Note) CO_2 emissions from 1A Fuel Combustion (Transport) have been reported under the table 4.

7.2.3.4. Fugitive Emissions from Fuel

Table 7 Results of uncertainty assessment of fugitive emissions from fuel

IPCC Category					GHGs	Emissions / Removals [Gg CO2eq.]	EF/RF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
						A	a	b	B		C	
1B. Fugitive Emissions from Fuels	1. Solid Fuels	a. Coal Mining	i. Underground Mines	Mining Activities	CH4	31.6	—	—	5%	24	0.00%	11
				Post-Mining Activities	CH4	25.5	200.0%	10.0%	200%	**1**	0.00%	**2**
			ii. Surface Mines	Mining Activities	CH4	8.6	200.0%	10.0%	200%	**1**	0.00%	**3**
				Post-Mining Activities	CH4	0.7	200.0%	10.0%	200%	**1**	0.00%	12
	2. Oil and Natural Gas	a. Oil		i. Exploration	CO2	0.03	25.0%	10.0%	27%	7	0.00%	20
					CH4	0.03	25.0%	10.0%	27%	6	0.00%	21
					N2O	0.00013	25.0%	10.0%	27%	**4**	0.00%	24
				ii. Production	CO2	0.09	25.0%	5.0%	25%	9	0.00%	17
					CH4	10.4	25.0%	5.0%	25%	9	0.00%	9
				iii. Transport	CO2	0.0045	25.0%	5.0%	25%	9	0.00%	22
					CH4	1.4	25.0%	5.0%	25%	9	0.00%	14
				iv. Refining / Storage	CH4	16.3	25.0%	0.9%	25%	23	0.00%	7
		b. Natural Gas		ii. Production / Processing	CO2	0.4	25.0%	5.0%	25%	9	0.00%	16
					CH4	226.9	25.0%	5.0%	25%	9	0.00%	**1**
				iii. Transmission	CH4	20.7	25.0%	10.0%	27%	**4**	0.00%	6
				iv. Distribution	CH4	29.0	25.0%	8.7%	26%	8	0.00%	**4**
		c. Venting and Flaring	Venting	i. oil	CO2	0.0	25.0%	5.0%	25%	9	0.00%	23
					CH4	9.9	25.0%	5.0%	25%	9	0.00%	10
			Flaring	i. oil	CO2	23.0	25.0%	5.0%	25%	9	0.00%	**5**
					CH4	0.99	25.0%	5.0%	25%	9	0.00%	15
					N2O	0.068	25.0%	5.0%	25%	9	0.00%	18
				ii. Gas	CO2	11.5	25.0%	5.0%	25%	9	0.00%	8
					CH4	1.5	25.0%	5.0%	25%	9	0.00%	13
					N2O	0.042	25.0%	5.0%	25%	9	0.00%	19
	Sub Total					418.8			19%		0.01%	
Total Emissions					(D)	1,260,295.8			2%			

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 Category				GHGs	Emissions / Removals [Gg CO2eq.] A	EF/RF 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	3.0%	10.0%	10%	15	0.26%	**1**
		2. Lime Production		CO2	6,961.9	15.0%	5.0%	16%	14	0.09%	**3**
		3. Limestone & Dolomite Use	Limestone	CO2	10,587.6	16.4%	4.8%	17%	12	0.14%	**2**
			Dolomite	CO2	292.2	3.5%	3.9%	5%	17	0.00%	11
		4. Soda Ash Production and Use		CO2	372.7	15.0%	6.5%	16%	13	0.00%	9
	B. Chemical Industries	1. Ammonia Production		CO2	2,307.3	22.5%	5.0%	23%	11	0.04%	**5**
		Chemical Industries other than		CO2	1,001.1	77.2%	5.0%	77%	8	0.06%	**4**
		2. Nitric Acid,		N2O	818.7	46.0%	5.0%	46%	10	0.03%	6
		3. Adipic Acid		N2O	838.9	9.0%	2.0%	9%	16	0.01%	8
		4. Carbide		CH4	0.66	100.0%	10.0%	100%	**5**	0.00%	17
		5. Other	Carbon Black	CH4	5.9	54.8%	5.0%	55%	9	0.00%	14
			Ethylene	CH4	2.4	77.2%	5.0%	77%	7	0.00%	16
			Dichloroethylene	CH4	0.38	100.7%	5.0%	101%	**4**	0.00%	18
			Styrene	CH4	2.2	113.2%	5.0%	113%	**3**	0.00%	15
			Methanol	CH4	0.0	NA	NA	NA	NA	NA	NA
			Coke	CH4	105.0	98.5%	5.0%	99%	6	0.01%	7
	C. Metal Production	1. Iron and steel		CO2	257.8	–	–	5%	18	0.00%	12
				CH4	14.3	163.0%	5.0%	163%	**1**	0.00%	10
		2. Ferroalloy		CH4	2.6	163.0%	5.0%	163%	**1**	0.00%	13
	Sub Total				54,987.4			7%		0.32%	
Total Emissions				(D)	1,260,295.8			2%			

7.2.4.2. F-gas

Table 9 Results of uncertainty assessment of industrial processes (F-gas)

IPCC Category					GHGs	Emissions / Removals [Gg CO2eq.] A	EF/RF 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%	29	0.00%	21
		4. SF6 Used in Aluminium and Magnesium Foundries			SF6	966.8	–	5.0%	5%	31	0.00%	18
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	1,050.7	2.0%	5.0%	5%	29	0.00%	17
		2. Fugitive Emissions			HFCs	416.2	100.0%	10.0%	100%	**1**	0.03%	8
					PFCs	862.8	100.0%	10.0%	100%	**1**	0.07%	**4**
					SF6	764.8	100.0%	10.0%	100%	**1**	0.06%	**5**
	F. Consumption of F-gas	1. Refrigeration and Air Conditioning Equipment	Domestic Refrigerator	manufacturing	HFCs	195.0	50.0%	40.0%	64%	7	0.01%	14
				stock	HFCs	IE	50.0%	40.0%	64%	7	0.00%	23
				disposal	HFCs	IE	–	40.0%	40%	20	0.00%	23
			Commercial Refrigerator	manufacturing	HFCs	588.0	50.0%	40.0%	64%	7	0.03%	9
				stock	HFCs	IE	50.0%	40.0%	64%	7	0.00%	23
				disposal	HFCs	IE	–	40.0%	40%	20	0.00%	23
			Stationary Air-Conditioning	manufacturing	HFCs	317.1	50.0%	40.0%	64%	7	0.02%	12
				stock	HFCs	IE	50.0%	40.0%	64%	7	0.00%	23
				disposal	HFCs	IE	–	40.0%	40%	20	0.00%	23
			Mobile Air-Conditioning	manufacturing	HFCs	2,911.6	50.0%	40.0%	64%	7	0.15%	**2**
				stock	HFCs	IE	50.0%	40.0%	64%	7	0.00%	23
				disposal	HFCs	IE	–	40.0%	40%	20	0.00%	23
		2. Foam Blowing		manufacturing	HFCs	522.9	50.0%	50.0%	71%	**4**	0.03%	10
				stock	HFCs	67.7	50.0%	50.0%	71%	**4**	0.00%	19
		3. Fire Extinguisher		manufacturing	HFCs	NO	50.0%	50.0%	71%	**4**	0.00%	23
		4. Aerosols / MDI	Aerosols	manufacturing	HFCs	54.7	–	40.0%	40%	20	0.00%	20
				stock	HFCs	1,908.1	–	40.0%	40%	20	0.06%	6
			MDI	manufacturing	HFCs	11.7	–	40.0%	40%	20	0.00%	22
				stock	HFCs	176.4	–	40.0%	40%	20	0.01%	16
		5. Solvents			PFCs	1,535.5	–	40.0%	40%	20	0.05%	7
		7. Semiconductor Manufacture			HFCs	129.8	50.0%	40.0%	64%	7	0.01%	15
					PFCs	3,905.1	50.0%	40.0%	64%	7	0.20%	**1**
					SF6	1,784.4	50.0%	40.0%	64%	7	0.09%	**3**
		8. Electrical Equipment		manufacturing	SF6	662.0	30.0%	40.0%	50%	19	0.03%	11
				stock	SF6	296.4	50.0%	40.0%	64%	7	0.02%	13
	Sub Total					19,142.5			20%		0.30%	
Total Emissions					(D)	1,260,295.8			2%			

(Note) Uncertainty of SF_6 emissions from 2.C.4 Magnesium Foundries are applied same value as that of 2.C.3 Aluminium

7.2.5. Solvents and Other Product Use

Table 10 Results of uncertainty assessment of solvent and other product use

IPCC Category			GHGs	Emissions / Removals [Gg CO2eq.] A	EF/RF 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)	1,260,295.8			2%			

7.2.6. Agriculture

Table 11 Results of uncertainty assessment of Agriculture

IPCC Category				GHGs	Emissions / Removals [Gg CO2eq.] A	EF/RF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
4. Agriculture	A. Enteric Fermentation	Dairy Cattle		CH4	3,502.1	—	0.7%	15%	61	0.04%	14
		Non-Dairy Cattle		CH4	3,397.8	—	0.7%	19%	60	0.05%	13
		Buffalo		CH4	0.10	50.0%	0.7%	50%	54	0.00%	57
		Sheep		CH4	0.96	50.0%	0.7%	50%	52	0.00%	51
		Goat		CH4	2.96	50.0%	0.7%	50%	52	0.00%	41
		Swine		CH4	223.0	50.0%	0.4%	50%	56	0.01%	19
		Horse		CH4	9.5	50.0%	0.7%	50%	54	0.00%	33
	B. Manure Management	Dairy Cattle		CH4	2,093.3	—	—	77%	45	0.13%	**4**
				N2O	753.3	—	—	97%	43	0.06%	12
		Non-Dairy Cattle		CH4	92.5	—	—	73%	48	0.01%	24
				N2O	801.3	—	—	125%	31	0.08%	8
		Buffalo		CH4	0.0036	100.0%	0.7%	100%	35	0.00%	61
				N2O	0.015	100.0%	0.7%	100%	35	0.00%	60
		Swine		CH4	285.0	—	0.4%	106%	33	0.02%	17
				N2O	1,410.0	—	0.4%	75%	46	0.08%	7
		Poultry (Hen, Broiler)		CH4	67.7	—	0.7%	73%	48	0.00%	25
				N2O	1,738.4	—	0.7%	103%	34	0.14%	**2**
		Sheep		CH4	0.065	100.0%	0.7%	100%	35	0.00%	56
				N2O	1.1	100.0%	0.7%	100%	35	0.00%	44
		Goat		CH4	0.13	100.0%	0.7%	100%	35	0.00%	55
				N2O	12.8	100.0%	0.7%	100%	35	0.00%	30
		Horse		CH4	1.1	100.0%	0.7%	100%	35	0.00%	45
				N2O	9.4	100.0%	0.7%	100%	35	0.00%	32
	C. Rice Cultivation	Continuously Flooded		CH4	200.4	116.3%	0.3%	116%	32	0.02%	18
		Intermittently Flooded	Straw amendment	CH4	3,778.8	—	0.3%	32%	59	0.10%	6
			Various compost	CH4	982.4	—	0.3%	32%	58	0.02%	16
			No-amendment	CH4	785.9	—	0.3%	46%	57	0.03%	15
	D. Agricultural Soils	1. Direct Soil Emissions	Synthetic Fertilizers	N2O	1,493.4	—	—	60%	51	0.07%	10
			Animal Waste Applied to Soils	N2O	1,094.6	—	—	70%	50	0.06%	11
			Crop residues	N2O	930.6	—	—	167%	27	0.12%	**5**
			Organic soil	N2O	728.7	—	—	800%	**1**	0.46%	**1**
		3. Indirect Emissions	Atmospheric Deposition	N2O	1,268.1	—	—	74%	47	0.07%	9
			N Leaching & Run-off	N2O	1,676.5	—	—	97%	43	0.13%	**3**
	F. Field Burning of Agricultural Residue	1. Cereals	Wheat	CH4	5.9	—	—	186%	19	0.00%	31
				N2O	1.3	—	—	185%	22	0.00%	37
			Barley	CH4	1.1	—	—	186%	19	0.00%	38
				N2O	1.0	—	—	187%	17	0.00%	39
			Maize	CH4	23.6	418.0%	50.0%	421%	7	0.01%	20
				N2O	20.0	423.0%	50.0%	426%	**3**	0.01%	23
			Oats	CH4	0.6	—	—	154%	29	0.00%	47
				N2O	0.5	—	—	168%	26	0.00%	48
			Rye	CH4	0.036	—	—	133%	30	0.00%	58
				N2O	0.019	—	—	157%	28	0.00%	59
			Rice	CH4	52.9	178.0%	50.0%	185%	23	0.01%	21
				N2O	21.2	175.0%	50.0%	182%	25	0.00%	26
		2. Pulse	Peas	CH4	0.21	481.0%	20.0%	481%	**2**	0.00%	46
				N2O	0.18	423.0%	20.0%	423%	**5**	0.00%	49
			Soybeans	CH4	2.19	176.0%	50.0%	183%	24	0.00%	35
				N2O	0.77	182.0%	50.0%	189%	16	0.00%	42
			Other (Adzuki beans)	CH4	0.81	179.0%	50.0%	186%	21	0.00%	40
				N2O	0.37	180.0%	50.0%	187%	18	0.00%	50
			Other (kidney beans)	CH4	0.27	418.0%	50.0%	421%	7	0.00%	43
				N2O	0.11	418.0%	50.0%	421%	7	0.00%	52
			Other (peanuts)	CH4	0.11	418.0%	50.0%	421%	7	0.00%	53
				N2O	0.04	418.0%	50.0%	421%	7	0.00%	54
		3. Tuber & Roots	Potatoes	CH4	3.7	418.0%	20.0%	418%	15	0.00%	29
				N2O	5.1	419.0%	20.0%	419%	14	0.00%	28
			Other: Sugarbeet	CH4	0.9	417.0%	50.0%	420%	13	0.00%	36
				N2O	1.0	419.0%	50.0%	422%	6	0.00%	34
		4. Sugar Cane		CH4	9.1	418.0%	50.0%	421%	7	0.00%	27
				N2O	22.1	423.0%	50.0%	426%	**3**	0.01%	22
	Sub Total				27,516.8			26%		0.57%	
Total Emissions				(D)	1,260,295.8			2%			

7.2.7. LULUCF

Table 12 Results of uncertainty assessment of LULUCF

IPCC Category			GHGs	Emissions / Removals [Gg CO2eq.]	EF/RF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank 5)
				A	a	b	B		C	
5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land	CO2	▲ 90,838.4	—	—	6%	20	-0.42%	**1**
		2. Land converted to Forest Land	CO2	▲ 3,049.9	—	—	22%	17	-0.05%	**2**
			CH4	11.5	25%	46%	53%	14	0.00%	11
			N2O	1.2	76%	46%	89%	**7**	0.00%	15
	B. Cropland	1. Cropland remaining Cropland	CO2	NA,NE	—	—	—	—	—	—
		2. Land converted to Cropland	CO2	114.1	—	—	42%	15	0.00%	7
			CH4	1.4	25%	77%	81%	10	0.00%	14
			N2O	10.0	76%	77%	108%	**4**	0.00%	9
	C. Grassland	1. Grassland remaining Grassland	CO2	NA,NE	—	—	—	—	—	—
		2. Land converted to Grassland	CO2	▲ 1,369.1	—	—	21%	18	-0.02%	**3**
			CH4	0.2	25%	77%	81%	10	0.00%	18
			N2O	0.0	76%	77%	108%	**4**	0.00%	20
	D. Wetlands	1. Wetlands remaining Wetlands	CO2	NE,NO	—	—	—	—	—	—
		2. Land converted to Wetlands	CO2	48.5	—	—	31%	16	0.00%	8
			CH4	1.1	25%	80%	83%	9	0.00%	16
			N2O	0.1	76%	80%	110%	**3**	0.00%	19
	E. Settlements	1. Settlements remaining Settlements	CO2	▲ 440.2	—	—	55%	13	-0.02%	**4**
		2. Land converted to Settlements	CO2	611.5	—	—	17%	19	0.01%	6
			CH4	11.6	25%	73%	78%	12	0.00%	10
			N2O	1.2	76%	73%	105%	6	0.00%	13
	F. Other Land	1. Other Land remaining Other Land	CO2	0.0	—	—	0%	21	0.00%	21
		2. Land converted to Other Land	CO2	▲ 1.0	—	—	14486%	**1**	-0.01%	**5**
			CH4	6.5	25%	80%	84%	8	0.00%	12
			N2O	0.7	76%	80%	110%	**2**	0.00%	17
	Sub Total			▲ 94,879.2			6%		0.43%	
Total Emissions			(D)	1,260,295.8			2%			

5) Numbers of the rank have been assessed based on the absolute values of "Combined uncertainty as % of total national emissions".

7.2.8. Waste

Table 13 Results of uncertainty assessment of Waste

IPCC Category				GHGs	Emissions / Removals [Gg CO2eq.] A	EF/RF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
6. Waste	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	Kitchen Garbage	CH4	898.4	42.4%	32.4%	53%	37	0.04%	11
			Waste Paper	CH4	2,081.6	42.4%	42.7%	60%	34	0.10%	6
			Waste Textile	CH4	131.9	43.8%	42.9%	61%	33	0.01%	26
			Waste Wood	CH4	1,106.7	42.5%	56.6%	71%	29	0.06%	9
			Sewage Sludge	CH4	443.0	44.2%	32.0%	55%	36	0.02%	20
			Human Waste Sludge	CH4	108.9	44.2%	32.6%	55%	35	0.00%	30
			Water Purification Sludge	CH4	68.4	108.6%	31.7%	113%	10	0.01%	27
			Organic Sludge from Manufacture	CH4	419.9	54.0%	33.4%	63%	32	0.02%	19
			Livestock Waste	CH4	649.5	46.9%	49.4%	68%	31	0.04%	12
		3. Other	Illegal Disposal	CH4	46.7	42.5%	66.8%	79%	23	0.00%	32
			Composting of Organic Waste	CH4	19.0	—	—	74%	26	0.00%	37
	B. Wastewater Handling	1. Industrial Wastewater		CH4	102.5	60.0%	37.4%	71%	30	0.01%	28
				N2O	110.2	300.0%	51.1%	304%	**1**	0.03%	15
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant	CH4	248.3	30.9%	10.4%	33%	42	0.01%	25
				N2O	672.8	145.7%	10.4%	146%	6	0.08%	8
			Private Sewerage Tank	CH4	441.9	86.8%	10.0%	87%	21	0.03%	14
				N2O	330.7	71.0%	10.0%	72%	28	0.02%	21
			Human-Waste Treatment Plant	CH4	26.8	100.0%	12.3%	101%	16	0.00%	33
				N2O	7.8	100.0%	33.9%	106%	13	0.00%	39
			Degradation of domestic wastewater in nature	CH4	677.6	—	—	76%	24	0.04%	10
				N2O	67.4	—	—	76%	24	0.00%	31
	C. Waste Incineration	Municipal Solid Waste	Plastics	CO2	13,404.4	4.3%	16.0%	17%	48	0.18%	**5**
			Waste textile	CO2	1,194.3	4.3%	22.4%	23%	47	0.02%	18
				CH4	17.9	—	—	101%	17	0.00%	35
				N2O	782.7	—	—	42%	40	0.03%	16
		Industrial Solid Waste	Waste Oil	CO2	7,498.1	4.8%	104.4%	105%	14	0.62%	**1**
			Plastics	CO2	5,015.7	4.8%	100.0%	100%	18	0.40%	**2**
				CH4	5.0	111.5%	100.0%	150%	**5**	0.00%	40
				N2O	2,069.9	58.8%	100.0%	116%	9	0.19%	**4**
		Specially Contorolled Industrial Solid Waste		CO2	2,249.1	—	—	167%	**3**	0.30%	**3**
				CH4	0.3	—	—	142%	7	0.00%	48
				N2O	13.1	—	—	159%	**4**	0.00%	34
		Raw material and fuel use of MSW		CO2	497.3	4.3%	16.0%	17%	48	0.01%	24
				CH4	0.0010	179.4%	10.0%	180%	**2**	0.00%	51
				N2O	0.011	111.2%	10.0%	112%	11	0.00%	50
		Raw material and fuel use of ISW	Waste Oil	CO2	1,118.2	4.8%	104.4%	105%	14	0.09%	7
				CH4	2.3	—	—	74%	27	0.00%	42
				N2O	3.0	—	—	41%	41	0.00%	43
			Waste Plastics	CO2	3,277.7	4.8%	12.3%	13%	51	0.03%	13
				CH4	0.5	91.7%	10.0%	92%	19	0.00%	47
				N2O	12.7	29.7%	10.0%	31%	44	0.00%	41
			Waste Wood	CH4	53.7	80.2%	100.0%	128%	8	0.01%	29
				N2O	9.0	45.3%	100.0%	110%	12	0.00%	38
		Raw material and fuel use of Waste tire		CO2	779.3	4.8%	14.5%	15%	50	0.01%	23
				CH4	1.2	—	—	91%	20	0.00%	45
				N2O	2.6	—	—	26%	45	0.00%	46
		Fuel use of RDF and RPF		CO2	663.7	42.6%	10.6%	44%	39	0.02%	17
				CH4	0.07	—	—	49%	38	0.00%	49
				N2O	3.7	—	—	33%	43	0.00%	44
	D. Oher	Decomposition of petroleum-derived surface-active agent		CO2	508.3	—	—	25%	46	0.01%	22
		Composting of Organic Waste		N2O	19.5	—	—	86%	22	0.00%	36
	Sub Total				47,863.0			23%		0.86%	
Total Emissions				(D)	1,260,295.8			2%			

6) Regarding 6A1, uncertainty of "Anaerobic landfill", which is the largest source under this sub-category, has been used.

7) Regarding 6A2, uncertainty of "Gappei-shori johkasou", which is the largest source under this sub-category, has been used.

8) Regarding CH_4 of 6C MSW, uncertainty of "Semi-Continuous Incinerator" has been used.

9) Regarding CH_4 of 6C ISW, uncertainty of "Waste Paper and Waste Wood" has been used.

10) Regarding N_2O of 6C ISW, uncertainty of "Waste Plastics" has been used.

11) Regarding 6C Fuel use of RDF and RPF, uncertainty of "RDF" has been used.

7.2.9. 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 14 Sensitivity Analysis on N_2O emissions from "4.D. Agricultural Soils 1 Direct Emissions"

	N_2O Emissions [Gg CO_2eq.]	Uncertainty of EF	Uncertainty of Total Emissions	Note
Original	3,597.58	129.9%	2.4%	2001's Emissions contained in the GHG inventory submitted in 2003
Case 1	3,597.58	500%	2.6%	EF uncertainty was changed to UK's case
Case 2	71,951.53	129.9%	4.8%	Emissions were changed to be approximately 5% of national total emissions in 2001

7.2.10. Issues in Uncertainty Assessment

- According to the method indicated in the *Revised 1996 IPCC Guidelines*, only emission sources of which emissions had already been calculated were the subject of uncertainty assessment. No assessment has been made for emission sources not estimated (NE), or of those portions unconfirmed in emission sources for which only partial calculation has been done (PART). Therefore, it should be remembered that the uncertainty of total emissions prepared by compiling the uncertainty of emissions from each source, does not depict the uncertainty of inventory in the context of the realities of emissions.
- In the sources recalculated, consideration is needed whether to re-assess the uncertainties or not.
- Where it was not possible to carry out a statistical assessment of the uncertainty of activity data, the values were derived from those established by the Committee for the GHGs Emissions Estimations Methods, which have established the uncertainty values in relation to whether the data were derived from specified statistics, or whether they were obtained from total population surveys. But further consideration needs to be given to improve the appropriateness of this approach.
- In carrying out a statistical assessment of uncertainty, it was assumed that the averages of all samples followed a normal distribution. In some cases, however, it means that the emission factor or activity data could, in fact, be negative. Emissions can only be positive under the

present IPCC guidelines, so further consideration would need to be given for the possibility to assume that the emission factor or activity data follows some other distribution.

- Where uncertainty of emissions was calculated from emission factor and activity data, in all cases the combining equation indicated by the Committee was used (the Tier 1 method given in the *Good Practice Guidance (2000)*), but when the coefficient of variation (Standard deviation/mean, and depicts sample dispersion) is 30% or greater, the *Good Practice Guidance (2000)* requires the combination to be achieved using the Monte Carlo method (*Good Practice Guidance (2000)* Tier 2 method). Further consideration needs to be given to assess feasibility to apply the Monte Carlo method to emission sources that have large coefficients of variation.
- The number of decimal places to be used when depicting uncertainty was set as follows for the uncertainty assessments conducted, but as the precision of uncertainty assessment varies between emission sources, further consideration needs to be given to the number of decimal places that are effective in uncertainty assessment.
  1) Uncertainty of emission factor is given to one decimal place.
  2) Uncertainty of activity data is also given to one decimal place.
  3) Uncertainty of emissions is given as an integer.（Proportion of total emissions attributable to the uncertainty of a particular source = two decimal places.）

7.2.11. Reference Material

Results of uncertainty assessment in this year using Table 6.1 in *GPG (2000)* are indicated below.

Table 6.1
Tier1 Uncertainty Calculation & Reporting

A					B	C	D	E	F	G	H		I	J	K	L	M
IPCC Category					Gas	Base year emissions / removals	2004 emissions / removals	Activity Data Uncertainty	EForRF Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2004		Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by EForRF	Uncertainty in trend in National Emissions introduced by Activity	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	H^2	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						1,186,820.25	1,260,295.81				2%	0.0%					2%
1A. Fuel Combustion	Solid Fuels	Steel Making Coal			CO2	9,244.05	14,067.99	1.2%	3.5%	4%	0.0%	0.0%	0.4%	1.2%	0.0%	0.0%	0.0%
		Steam Coal (imported)			CO2	88,401.29	244,697.34	1.2%	2.0%	2%	0.5%	0.0%	12.7%	20.6%	0.3%	0.3%	0.4%
		Steam Coal (indigenous)			CO2	20,125.86	0.00	1.2%	2.0%	2%	0.0%	0.0%	-1.8%	0.0%	0.0%	0.0%	0.0%
		Hard Coal			CO2	0.00	0.00	1.2%	4.5%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Coke			CO2	117,790.21	97,350.97	1.2%	1.7%	2%	0.2%	0.0%	-2.3%	8.2%	0.0%	0.1%	0.1%
		Coal Tar			CO2	3,171.30	2,149.23	1.2%	5.0%	5%	0.0%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.0%
		Coal Briquette			CO2	310.20	0.00	1.2%	5.0%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Coke Oven Gas			CO2	15,976.84	14,892.48	1.2%	2.0%	2%	0.0%	0.0%	-0.2%	1.3%	0.0%	0.0%	0.0%
		Blast Furnace Gas			CO2	43,496.15	47,028.33	1.2%	3.8%	4%	0.1%	0.0%	0.1%	4.0%	0.0%	0.1%	0.1%
		Converter Furnace Gas			CO2	9,303.92	10,759.73	1.2%	2.9%	3%	0.0%	0.0%	0.1%	0.9%	0.0%	0.0%	0.0%
	Liquid Fuels	Crude Oil for Refinery			CO2	1.91	224.31	2.3%	0.8%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Crude Oil for Power Generation			CO2	58,483.38	16,420.84	2.3%	0.9%	2%	0.0%	0.0%	-3.8%	1.4%	0.0%	0.0%	0.1%
		Vitumous Mixture Fuel			CO2	0.00	117.22	2.3%	0.4%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		NGL & Condensate			CO2	1,380.12	50.30	2.3%	1.6%	3%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		Naphtha			CO2	1,297.82	699.46	2.3%	0.1%	2%	0.0%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
		Reformed Material Oil			CO2	0.00	0.00	2.3%	0.1%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Gasoline			CO2	103,913.39	142,340.12	2.3%	0.0%	2%	0.3%	0.0%	2.7%	12.0%	0.0%	0.4%	0.4%
		Jet Fuel			CO2	9,140.23	12,088.93	2.3%	1.0%	3%	0.0%	0.0%	0.2%	1.0%	0.0%	0.0%	0.0%
		Kerosene			CO2	64,049.60	67,583.98	2.3%	0.1%	2%	0.1%	0.0%	0.0%	5.7%	0.0%	0.2%	0.2%
		Gas Oil or Diesel Oil			CO2	98,847.94	99,079.36	2.3%	1.2%	3%	0.2%	0.0%	-0.5%	8.3%	0.0%	0.3%	0.3%
		Heating Oil A			CO2	74,790.57	80,156.53	2.3%	1.5%	3%	0.2%	0.0%	0.1%	6.8%	0.0%	0.2%	0.2%
		Heating Oil B			CO2	1,865.42	168.13	2.3%	5.0%	6%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%
		Heating Oil C			CO2	143,715.21	86,901.65	2.3%	0.6%	2%	0.2%	0.0%	-5.5%	7.3%	0.0%	0.2%	0.2%
		Lubricating Oil			CO2	67.74	202.80	2.3%	5.0%	6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Asphalt			CO2	5,444.29	8,995.73	2.3%	0.6%	2%	0.0%	0.0%	0.3%	0.8%	0.0%	0.0%	0.0%
		Non Asphalt Heavy Oil Products			CO2	7.76	0.15	2.3%	0.6%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Oil Coke			CO2	9,505.00	11,317.58	2.3%	5.0%	6%	0.0%	0.0%	0.1%	1.0%	0.0%	0.0%	0.0%
		Galvanic Furnace Gas			CO2	146.60	79.66	2.3%	2.9%	4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Refinary Gas			CO2	27,354.02	35,374.39	2.3%	5.0%	6%	0.2%	0.0%	0.5%	3.0%	0.0%	0.1%	0.1%
		LPG			CO2	37,373.48	31,367.20	2.3%	0.1%	2%	0.1%	0.0%	-0.7%	2.6%	0.0%	0.1%	0.1%
	Gaseous Fuels	LNG			CO2	76,303.80	104,245.11	0.3%	0.1%	0%	0.0%	0.0%	2.0%	8.8%	0.0%	0.0%	0.0%
		Indigenous Natural Gas			CO2	2,225.86	2,112.99	0.3%	0.6%	1%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
		Town Gas*			CO2	34,211.10	64,583.72	0.3%	0.5%	1%	0.0%	0.0%	2.4%	5.4%	0.0%	0.0%	0.0%
		Small Scale Town Gas*			CO2	1,130.79	1,320.23	0.3%	0.1%	0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
1A. Fuel Combustion (Stationary)					CH4	533.07	574.13	10.0%	45.9%	47.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	2,331.61	4,220.02	10.0%	31.4%	33.0%	0.1%	0.0%	0.1%	0.4%	0.0%	0.1%	0.1%
1A.Fuel Combu (Transport)	a. Civil Aviation				CH4	2.94	4.83	10.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	69.75	106.49	10.0%	10000.0%	10000%	0.8%	0.0%	0.0%	0.0%	0.3%	0.0%	0.3%
	b. Road Transportation				CH4	265.72	224.81	50.0%	40.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	3,901.71	3,224.81	50.0%	50.0%	71%	0.2%	0.0%	-0.1%	0.3%	0.0%	0.2%	0.2%
	c. Railways				CH4	1.18	0.84	10.0%	5.0%	11%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	121.38	84.48	100.5%	5.0%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	d. Navigation				CH4	26.33	25.48	13.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	111.31	106.55	13.0%	1000.0%	1000%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1B. Fugitive Emissions from Fuels	1. Solid Fuels	a. Coal Mining	i. Underground Mines	Mining Activities	CH4	2,551.70	31.64	5.4%	0.0%	5%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%
				Post-Mining Activities	CH4	233.53	25.54	10.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ii. Surface Mines	Mining Activities	CH4	19.50	8.59	10.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				Post-Mining Activities	CH4	1.70	0.75	10.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2. Oil and Natural Gas	a. Oil		i. Exploration	CO2	0.03	0.03	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH4	0.03	0.03	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.00	0.00	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				ii. Production	CO2	0.11	0.09	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH4	12.80	10.44	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				iii. Transport	CO2	0.00	0.00	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH4	0.76	1.38	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				iv. Refining / Storage	CH4	14.73	16.32	0.9%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		b. Natural Gas		ii. Production / Processing	CO2	0.25	0.36	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH4	159.12	226.93	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				iii. Transmission	CH4	15.12	20.74	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				iv. Distribution	CH4	13.69	28.96	8.7%	25.0%	26%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		c. Venting and Flaring	Venting	i. oil	CO2	0.01	0.00	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH4	12.19	9.94	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Flaring	i. oil	CO2	28.17	22.96	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH4	1.22	0.99	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.08	0.07	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				ii. Gas	CO2	8.06	11.53	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH4	1.04	1.49	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.03	0.04	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2. Industrial Processes	A. Mineral Products	1. Cement Production			CO2	37,966.28	31,415.59	10.0%	3.0%	10%	0.3%	0.0%	-0.7%	2.6%	0.0%	0.4%	0.4%
		2. Lime Production			CO2	7,371.02	6,961.89	5.0%	15.0%	16%	0.1%	0.0%	-0.1%	0.6%	0.0%	0.0%	0.0%
		3. Limestone & Dolomite Use	Limestone		CO2	10,657.49	10,587.64	4.8%	16.4%	17%	0.1%	0.0%	-0.1%	0.9%	0.0%	0.1%	0.1%
			Dolomite		CO2	869.92	292.19	3.9%	3.5%	5%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		4. Soda Ash Production and Use			CO2	583.63	372.75	6.5%	15.0%	16%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Chemical Industries	1. Ammonia Production			CO2	3,384.68	2,307.30	5.0%	22.5%	23%	0.0%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.0%
		Chemical Industries other			CO2	1,129.29	1,001.11	5.0%	77.2%	77%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		2. Nitric Acid,			N2O	765.70	818.71	5.0%	46.0%	46%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		3. Adipic Acid			N2O	7,501.25	838.90	2.0%	9.0%	9%	0.0%	0.0%	-0.6%	0.1%	-0.1%	0.0%	0.1%
		4. Carbide			CH4	0.42	0.66	10.0%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		5. Other	Carbon Black		CH4	5.83	5.95	5.0%	54.8%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Ethylene		CH4	1.88	2.38	5.0%	77.2%	77%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Dichloroethylene		CH4	0.28	0.38	5.0%	100.7%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Styrene		CH4	1.45	2.16	5.0%	113.2%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Methanol		CH4	3.52	0.00	5.0%	113.2%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Coke		CH4	324.84	105.05	5.0%	98.5%	99%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Metal Production	1. Iron and steel			CO2	356.09	257.84	4.5%	0.0%	4.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH4	15.47	14.28	5.0%	163.0%	163%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Ferroalloy			CH4	3.89	2.64	5.0%	163.0%	163%	0.0%	0.0%	0.0%	0.0%	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 Category					Gas	Base year emissions / removals	2004 emissions / removals	Activity Data Uncertainty	EForRF Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2004		Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by EForRF	Uncertainty in trend in National Emissions introduced by Activity	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	H^2	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						1,186,820.25	1,260,295.81				2%	0.0%					2%
2. Industrial Processes (F-gas)	C. Metal Production	3. Aluminium			PFCs	69.73	14.79	5.0%	33.0%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. SF6 Used in Aluminium and Magnesium Foundries			SF6	119.50	966.76	5.0%	0.0%	5.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	17,023.50	1,050.66	5.0%	2.0%	5%	0.0%	0.0%	-1.4%	0.1%	0.0%	0.0%	0.0%
		2. Fugitive Emissions			HFCs	419.02	416.16	10.0%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					PFCs	762.85	862.82	10.0%	100.0%	100%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
					SF6	4,708.30	764.80	10.0%	100.0%	100%	0.1%	0.0%	-0.4%	0.1%	-0.4%	0.0%	0.4%
	F. Consumption of F-gas	1. Refrigeration and Air Conditioning Equipment	Domestic Refrigerator	manufacturing	HFCs	11.34	195.04	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	0.00	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.00	0.00	40.0%	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Commercial Refrigerator	manufacturing	HFCs	9.20	588.02	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	0.00	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.00	0.00	40.0%	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Stationary Air-Conditionin	manufacturing	HFCs	0.00	317.07	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	0.00	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.00	0.00	40.0%	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Mobile Air-Conditionin	manufacturing	HFCs	786.58	2,911.61	40.0%	50.0%	64%	0.1%	0.0%	0.2%	0.2%	0.1%	0.1%	0.2%
				stock	HFCs	0.00	0.00	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.00	0.00	40.0%	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Foam Blowing		manufacturing	HFCs	451.76	522.93	50.0%	50.0%	71%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	67.71	50.0%	50.0%	71%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Fire Extinguisher		manufacturing	HFCs	0.00	NO	50.0%	50.0%	71%	0.0%	0.0%	NA	NA	NA	NA	NA
		4. Aerosols / MI	Aerosols	manufacturing	HFCs	1,365.00	54.74	40.0%	0.0%	40.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	1,908.07	40.0%	0.0%	40.0%	0.1%	0.0%	0.2%	0.2%	0.0%	0.1%	0.1%
			MDI	manufacturing	HFCs	0.00	11.73	40.0%	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	176.45	40.0%	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		5. Solvents			PFCs	10,356.00	1,535.46	40.0%	0.0%	40.0%	0.0%	0.0%	-0.8%	0.1%	0.0%	0.1%	0.1%
		7. Semiconductor Manufacture			HFCs	145.40	129.78	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					PFCs	2,857.35	3,905.09	40.0%	50.0%	64%	0.2%	0.0%	0.1%	0.3%	0.0%	0.2%	0.2%
					SF6	1,099.82	1,784.38	40.0%	50.0%	64%	0.1%	0.0%	0.1%	0.2%	0.0%	0.1%	0.1%
		8. Electrical Equipment		manufacturing	SF6	9,560.00	662.03	40.0%	30.0%	50%	0.0%	0.0%	-0.8%	0.1%	-0.2%	0.0%	0.2%
				stock	SF6	1,441.17	296.36	40.0%	50.0%	64%	0.0%	0.0%	-0.1%	0.0%	-0.1%	0.0%	0.1%
3. SOPU	D. Other	Anaesthesia			N2O	287.07	297.54	5.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4. Agriculture	A. Enteric Fermentatio	Dairy Cattle			CH4	4,042.62	3,502.14	0.7%	15.0%	15%	0.0%	0.0%	-0.1%	0.3%	0.0%	0.0%	0.0%
		Non-Dairy Cattle			CH4	3,322.59	3,397.75	0.7%	19.0%	19%	0.1%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%
		Buffalo			CH4	0.25	0.10	0.7%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Sheep			CH4	2.64	0.96	0.7%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Goat			CH4	3.12	2.96	0.7%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Swine			CH4	261.74	223.01	0.4%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Horse			CH4	8.77	9.45	0.7%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Manure Management	Dairy Cattle			CH4	2,609.46	2,093.30	10.0%	76.8%	77%	0.1%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.1%
					N2O	939.09	753.34	10.0%	96.5%	97%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Non-Dairy Cattle			CH4	93.78	92.50	10.0%	72.3%	73%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	812.38	801.31	10.0%	124.6%	125%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Buffalo			CH4	0.01	0.00	0.7%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.04	0.01	0.7%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Swine			CH4	334.57	285.05	0.4%	106.0%	106%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	1,654.93	1,409.97	0.4%	75.0%	75%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Poultry (Hen, Broiler)			CH4	81.43	67.74	0.7%	73.0%	73%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	2,111.38	1,738.41	0.7%	103.0%	103%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Sheep			CH4	0.18	0.06	0.7%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	3.09	1.12	0.7%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Goat			CH4	0.14	0.13	0.7%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	13.44	12.75	0.7%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Horse			CH4	1.01	1.09	0.7%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	8.70	9.38	0.7%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Rice Cultivation	Continuously Flooded			CH4	244.13	200.36	0.3%	116.3%	116%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Intermittently Flooded	Straw amendment		CH4	4,604.13	3,778.76	0.3%	31.7%	32%	0.1%	0.0%	-0.1%	0.3%	0.0%	0.0%	0.0%
			Various compost amendment		CH4	1,196.96	982.38	0.3%	32.0%	32%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			No-amendment		CH4	957.56	785.90	0.3%	46.0%	46%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
	D. Agricultura Soils	1. Direct Soil Emissions	Synthetic Fertilizers		N2O	1,918.10	1,493.36	10.0%	59.2%	60%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			Animal Waste Applied to Soils		N2O	1,317.10	1,094.59	10.0%	69.3%	70%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			Crop residues		N2O	1,071.25	930.63	10.0%	166.7%	167%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			Organic soil		N2O	804.28	728.72	10.0%	799.9%	800%	0.5%	0.0%	0.0%	0.1%	-0.1%	0.0%	0.1%
		3. Indirect Emissions	Atmospheric Deposition		N2O	1,536.83	1,268.10	10.0%	73.3%	74%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			N Leaching & Run-off		N2O	2,138.99	1,676.54	10.0%	96.5%	97%	0.1%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.1%
	F. Field Burning of Agricultural Residue	1. Cereals	Wheat		CH4	6.08	5.85	10.0%	185.7%	186%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	1.38	1.33	10.0%	184.7%	185%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Barley		CH4	1.96	1.14	10.0%	185.7%	186%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	1.79	0.98	10.0%	186.7%	187%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Maize		CH4	33.03	23.58	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	28.02	20.00	50.0%	423.0%	426%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Oats		CH4	0.26	0.58	10.0%	153.7%	154%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.18	0.49	10.0%	167.7%	168%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Rye		CH4	0.03	0.04	10.0%	132.6%	133%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.01	0.02	10.0%	156.7%	157%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Rice		CH4	62.81	52.94	50.0%	178.0%	185%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	25.10	21.16	50.0%	175.0%	182%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Pulse	Peas		CH4	0.42	0.21	20.0%	481.0%	481%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.36	0.18	20.0%	423.0%	423%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Soybeans		CH4	2.44	2.19	50.0%	176.0%	183%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.86	0.77	50.0%	182.0%	189%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (Adzuki beans)		CH4	1.11	0.81	50.0%	179.0%	186%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.50	0.37	50.0%	180.0%	187%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (kidney beans)		CH4	0.40	0.27	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.16	0.11	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (peanuts)		CH4	0.17	0.11	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.07	0.04	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Tuber & Root	Potatoes		CH4	4.58	3.65	20.0%	418.0%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	6.39	5.10	20.0%	419.0%	419%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other: Sugarbeet		CH4	0.81	0.89	50.0%	417.0%	420%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	0.92	1.02	50.0%	419.0%	422%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. Sugar Cane			CH4	15.69	9.06	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N2O	38.18	22.05	50.0%	423.0%	426%	0.0%	0.0%	0.0%	0.0%	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 Category				Gas	Base year emissions / removals	2004 emissions / removals	Activity Data Uncertainty	EForRF Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2004		Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by EForRF	Uncertainty in trend in National Emissions introduced by Activity	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	H^2	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					1,186,820.25	1,260,295.81				2%	0.0%					2%
5. LULUCF	A. Forest Lan	1. Forest Land remaining Forest Land		CO2	▲ 68,051.39	▲ 90,838.44	5.0%	3.1%	5.9%	-0.4%	0.0%	-1.6%	-7.7%	0.0%	-0.5%	0.5%
		2. Land converted to Forest Land		CO2	▲ 6,285.93	▲ 3,049.89	10.0%	19.1%	21.6%	-0.1%	0.0%	0.3%	-0.3%	0.1%	0.0%	0.1%
				CH4	8.31	11.54	46.5%	25.0%	53%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	0.84	1.17	46.5%	75.6%	89%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Cropland	1. Cropland remaining Cropland		CO2	NA,NE	NA,NE	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
		2. Land converted to Cropland		CO2	1,279.59	114.06	10.0%	40.5%	41.8%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
				CH4	21.72	1.45	76.6%	25.0%	81%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	65.04	10.01	76.6%	75.6%	108%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Grassland	1. Grassland remaining Grassland		CO2	NA,NE	NA,NE	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
		2. Land converted to Grassland		CO2	▲ 4,190.96	▲ 1,369.13	10.0%	19.0%	21.5%	0.0%	0.0%	0.3%	-0.1%	0.0%	0.0%	0.1%
				CH4	3.06	0.22	76.6%	25.0%	81%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	0.31	0.02	76.6%	75.6%	108%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	D. Wetlands	1. Wetlands remaining Wetlands		CO2	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
		2. Land converted to Wetlands		CO2	56.49	48.50	10.0%	29.6%	31.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				CH4	1.32	1.05	79.7%	25.0%	83%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	0.13	0.11	79.7%	75.6%	110%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	E. Settlement	1. Settlements remaining Settlements		CO2	▲ 262.87	▲ 440.23	10.0%	53.9%	54.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Land converted to Settlements		CO2	2,538.25	611.47	10.0%	13.5%	16.8%	0.0%	0.0%	-0.2%	0.1%	0.0%	0.0%	0.0%
				CH4	54.63	11.65	73.5%	25.0%	78%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	5.54	1.18	73.5%	75.6%	105%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	F. Other Land	1. Other Land remaining Other Land		CO2	0.00	0.00	—	—	0.0%	0.0%	0.0%	NA	NA	NA	NA	NA
		2. Land converted to Other Land		CO2	122.88	▲ 1.04	10.0%	14486.4%	14486.4%	0.0%	0.0%	0.0%	0.0%	-1.6%	0.0%	1.6%
				CH4	10.30	6.46	80.5%	25.0%	84%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	1.05	0.66	80.5%	75.6%	110%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6. Waste	A. Solid Wast Disposal on Land	1. Managed Wa Disposal on Land	Kitchen Garbage	CH4	1,467.35	898.35	32.4%	42.4%	53%	0.0%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
			Waste Paper	CH4	3,384.70	2,081.61	42.7%	42.4%	60%	0.1%	0.0%	-0.1%	0.2%	-0.1%	0.1%	0.1%
			Waste Textile	CH4	220.86	131.89	42.9%	43.8%	61%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Waste Wood	CH4	1,073.41	1,106.66	56.6%	42.5%	71%	0.1%	0.0%	0.0%	0.1%	0.0%	0.1%	0.1%
			Sewage Sludge	CH4	830.48	442.98	32.0%	44.2%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Human Waste Sludge	CH4	132.20	108.91	32.6%	44.2%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Water Purification Sludge	CH4	100.92	68.40	31.7%	108.6%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Organic Sludge from Manufacture	CH4	1,143.03	419.89	33.4%	54.0%	63%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
			Livestock Waste	CH4	704.03	649.53	49.4%	46.9%	68%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		3. Other	Illegal Disposal	CH4	4.34	46.71	66.8%	42.5%	79%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Composting of Organic Waste	CH4	19.82	18.98	10.0%	73.3%	74.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Wastewate Handling	1. Industrial Wastewater		CH4	112.52	102.50	37.4%	60.0%	71%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	122.21	110.21	51.1%	300.0%	304%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant	CH4	181.48	248.27	10.4%	30.9%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	491.78	672.79	10.4%	145.7%	146%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			Private Sewerage Tank	CH4	451.84	441.85	10.0%	86.8%	87%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	468.72	330.71	10.0%	71.0%	72%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Human-Waste Treatment Plant	CH4	110.14	26.76	12.3%	100.0%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	69.56	7.80	33.9%	100.0%	106%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Degradation of domestic wastewater in nature	CH4	1,263.64	677.57	10.0%	75.4%	76.1%	0.0%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
				N2O	137.10	67.42	10.0%	75.4%	76.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Waste Incineratio	Municipal Solid Waste	Plastics	CO2	10,451.61	13,404.41	16.0%	4.3%	17%	0.2%	0.0%	0.2%	1.1%	0.0%	0.3%	0.3%
			Waste textile	CO2	1,087.80	1,194.32	22.4%	4.3%	23%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
				CH4	21.09	17.88	10.0%	100.2%	100.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	687.07	782.70	10.0%	40.6%	41.8%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Industrial Solid Waste	Waste Oil	CO2	4,538.53	7,498.05	104.4%	4.8%	105%	0.6%	0.0%	0.2%	0.6%	0.0%	0.9%	0.9%
			Plastics	CO2	2,349.53	5,015.73	100.0%	4.8%	100%	0.4%	0.0%	0.2%	0.4%	0.0%	0.6%	0.6%
				CH4	3.74	4.97	100.0%	111.5%	150%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	1,204.85	2,069.90	100.0%	58.8%	116%	0.2%	0.0%	0.1%	0.2%	0.0%	0.2%	0.2%
		Specially Contorolled Industrial Solid Waste		CO2	946.78	2,249.14	100.0%	133.1%	166.5%	0.3%	0.0%	0.1%	0.2%	0.1%	0.3%	0.3%
				CH4	0.12	0.27	100.0%	100.3%	141.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	5.95	13.13	100.0%	123.2%	158.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of MSW		CO2	0.00	497.28	16.0%	4.3%	17%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				CH4	0.00	0.00	10.0%	179.4%	180%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	0.00	0.01	10.0%	111.2%	112%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material a fuel use of ISW	Waste Oil	CO2	0.00	1,118.22	104.4%	4.8%	105%	0.1%	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%
				CH4	0.00	2.27	10.0%	72.8%	74%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	0.00	2.95	10.0%	39.6%	41%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Waste Plastics	CO2	2,072.74	3,277.66	12.3%	4.8%	13%	0.0%	0.0%	0.1%	0.3%	0.0%	0.0%	0.0%
				CH4	0.25	0.52	10.0%	91.7%	92.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	4.90	12.69	10.0%	29.7%	31.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Waste Wood	CH4	36.94	53.72	100.0%	80.2%	128%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	6.18	8.98	100.0%	45.3%	110%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of Waste tire		CO2	524.23	779.27	14.5%	4.8%	15%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
				CH4	0.65	1.23	10.0%	90.8%	91.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	1.55	2.65	10.0%	23.7%	25.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Fuel use of RDF and RPF		CO2	24.58	663.69	10.6%	42.6%	44%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
				CH4	0.00	0.07	10.0%	48.1%	49.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N2O	0.16	3.66	10.0%	30.9%	32.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	D. Oher	Decomposition of petroleum-derived surface-active agent		CO2	702.83	508.26	10.0%	22.4%	24.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Composting of Organic Waste		N2O	20.12	19.54	10.0%	85.7%	86.3%	0.0%	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)

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 7.4% compared to the total emissions (1,261million 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.

Net emissions and removals from the Land Use, Land Use Change and Forestry sector in FY 2004 amounted to the removal of 95.0 million tons of CO_2 equivalent.

The base year emissions are increased by about 6 million-ton CO_2 compared to the value reported in May 2006 because close investigations on emissions and removals have been conducted since then. Because the base year emissions were increased due to the series of revisions[2], the percentage of the amount of removals to the total base year emissions which can be accounted under the Kyoto Protocol (13 Mt-C = approximately 48 million ton-CO_2) was resulted in 3.8% from 3.9%.

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	1,261	1,358 +7.7%	→ -0.2% →	**1,355** **+7.4%**
Carbon Dioxcide（CO_2）	1,144	1,284 +12.3%	→ +0.1% →	**1,286** **+12.4%**
Carbon Dioxide from energy use	1,059	1,196 +13.0%	→ 0.0% →	**1,196** **+13.0%**
Carbon Dioxide from other than energy use	85.1	87.9 +3.3%	→ +1.8% →	**89.4** **+5.2%**
Methane（CH_4）	33.4	24.7 -25.9%	→ -1.3% →	**24.4** **-26.8%**
Nitrous Oxide（N_2O）	32.7	25.8 -21.3%	→ +0.2% →	**25.8** **-21.2%**
F-gas	51.2	23.5 -54.2%	→ -18.4% →	**19.1** **-62.6%**
Hydrofluorocarbons（HFCs）	20.2	12.5 -38.1%	→ -33.3% →	**8.3** **-58.7%**
Perfluorocarbons (PFCs)	14.0	6.2 -55.9%	→ +2.0% →	**6.3** **-55.0%**
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).

[2] The values will be finally determined after the review to be conducted by the expert review team appointed by the UNFCCC secretariat in 2007.

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	1,144	1,144	1,153	1,161	1,153	1,213	1,226	1,239	1,235	1,199	1,234
CH_4	21	33	33.4	33.1	32.9	32.6	31.9	31.0	30.2	29.2	28.3	27.7
N_2O	310	33	32.7	32.3	32.4	32.0	33.2	33.5	34.7	35.3	33.8	27.4
HFCs	HFC-134a： 1,300 etc.	20						20.2	19.8	19.8	19.3	19.8
PFCs	PFC-14： 6,500 etc.	14						14.0	14.5	15.5	12.6	9.7
SF_6	23,900	17						16.9	17.5	14.8	13.4	9.1
計		1,261	1,210	1,218	1,226	1,218	1,278	1,342	1,356	1,349	1,306	1,327

	GWP	Base year of KP	2000	2001	2002	2003	2004
CO_2 Emissions	1	1,144	1,255	1,239	1,277	1,284	1,286
CH_4	21	33.4	27.0	26.2	25.2	24.7	24.4
N_2O	310	32.7	29.9	26.4	26.0	25.8	25.8
HFCs	HFC-134a： 1,300 etc.	20.2	18.6	15.8	13.1	12.5	8.3
PFCs	PFC-14： 6,500 etc.	14.0	8.6	7.2	6.5	6.2	6.3
SF_6	23,900	16.9	6.8	5.7	5.3	4.7	4.5
計		1,261	1,346	1,321	1,353	1,358	1,355

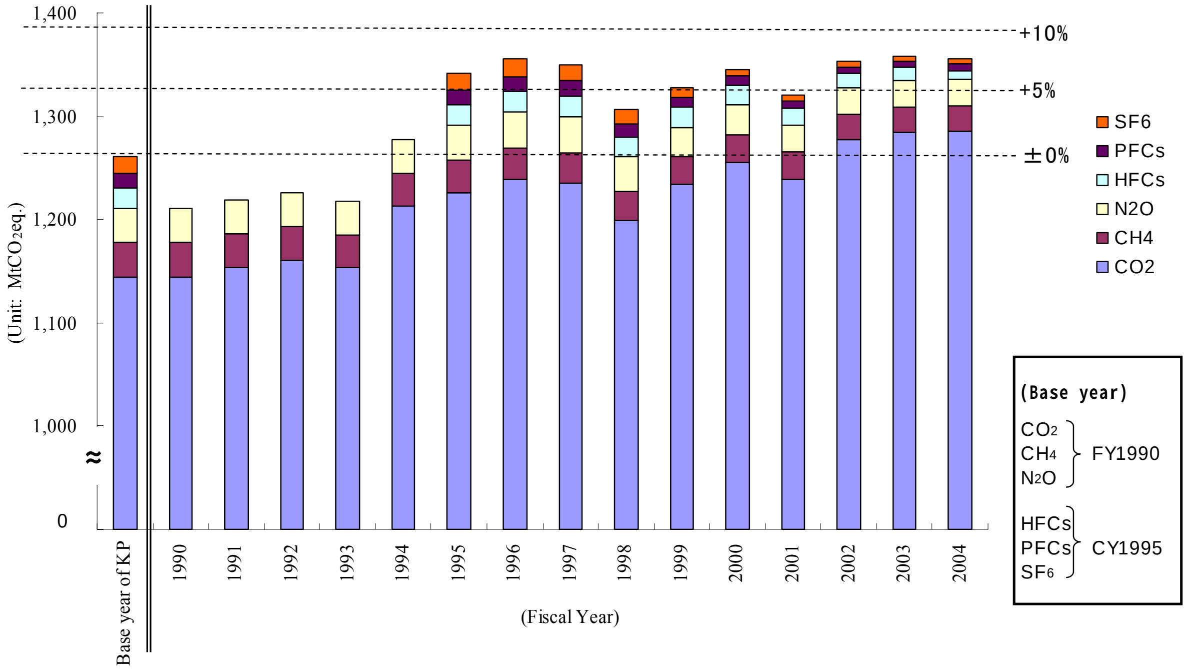

Figure 1 Trends of Total Greenhouse Gas Emissions

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 1,286 million tons. Total CO_2 emissions have increased by 12.4% compared to the total CO_2 emissions in the base year and increased 0.1% compared to 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		**1,144**	**1,284 (+12.3%)**	→ **+0.1%** →	**1,286 (+12.4%)**
Energy use	Sub Total	1,059	1,196 (+13.0%)	→ **-0.0%** →	**1,196 (+13.0%)**
	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 (+38.7%)	→ **-0.6%** →	**227 (+37.9%)**
	Residential	127	167 (+31.3%)	→ **+0.1%** →	**168 (+31.5%)**
	Energy Industries (Electric Power Plants, etc.)	68.3	79.5 (+16.5%)	→ **+1.2%** →	**81 (+18.0%)**
Other than energy use	Sub Total	85.1	87.9 (+3.3%)	→ **+1.8%** →	**89.4 (+5.2%)**
	Industrial Process	62.3	52.3 (-16.2%)	→ **+1.8%** →	**53.2 (-14.6%)**
	Waste (Incineration, etc.)	22.7	35.6 (+56.9%)	→ **+1.7%** →	**36.2 (+59.5%)**
	Fugitive Emissions	0.04	0.03 (-5.9%)	→ **+1.6%** →	**0.03 (-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 +2.9% in FY2003 to +4.6% in FY2004; therefore, total emissions compared to the base year have increased by 1.7% 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	+7.7%	59.7%	60Mt-CO_2	-4.8%	+2.9%
FY2004	+7.4%	68.9%	35Mt-CO_2	-2.8%	+4.6%

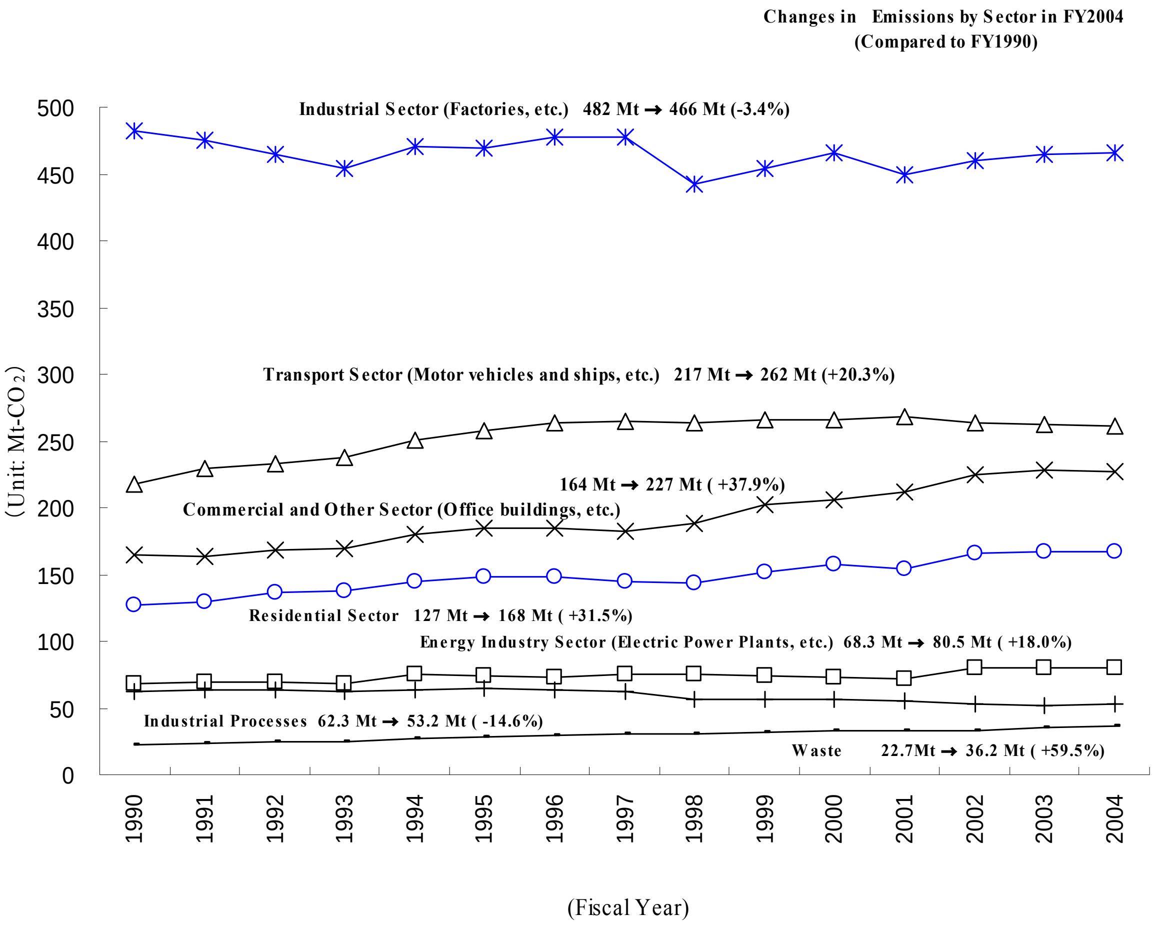

Figure 2 Trends in Carbon Dioxide Emissions by Sector

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 80.5 million tons of CO_2 equivalents and resulted in an increase of 18.0% compared to the base year emissions and an increase of 1.2% compared to the previous 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

8.2.1.3. 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 8.8% 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)	1,144	1,284 (+12.3%)	→ +0.1% →	**1,286** **(+12.4%)**
Population (1000 person)	123,611	127,619 (+3.2%)	→ +0.1% →	**127,687** **(+3.3%)**
CO_2 Emissions per capita (tCO_2/person)	9.26	10.06 (+8.7%)	→ 0.1% →	**10.07** **(+8.8%)**

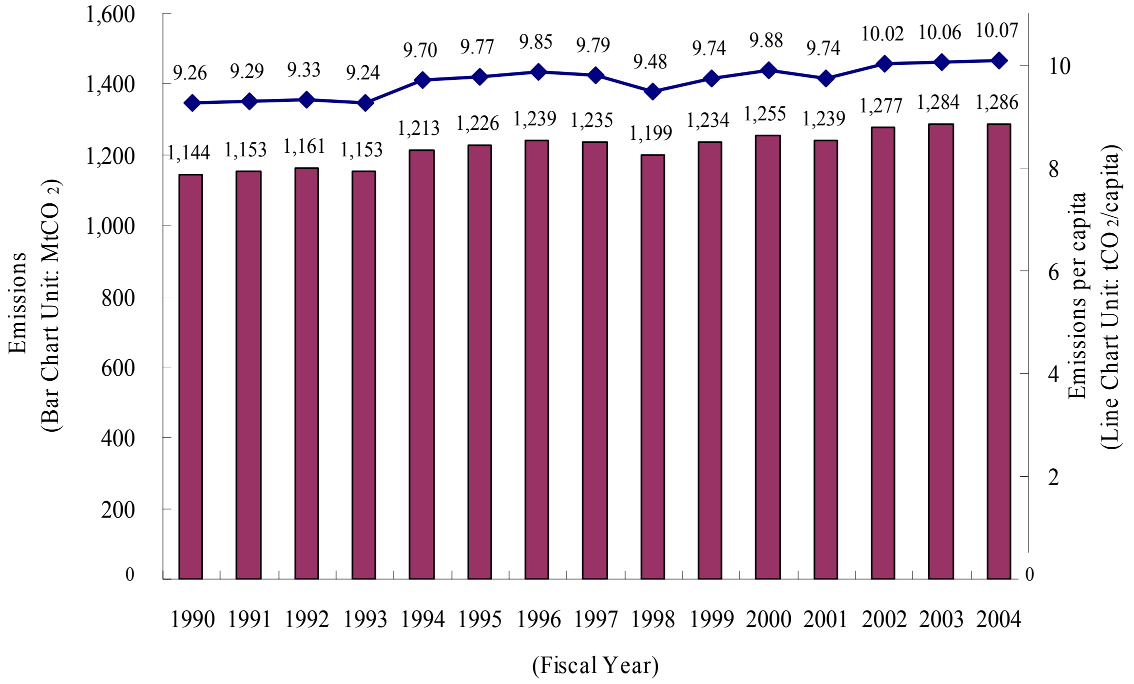


Figure 3 Trends in Carbon Dioxide Emissions Per Capita

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 26.8% compared to the base year emissions and a decrease of 1.3% 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	33.4	24.7 (-25.9%)	→ -1.3% →	**24.4 (-26.8%)**
Agriculture （Enteric Fermentation, Rice Cultivation, etc.）	17.9	15.6 (-12.9%)	→ -0.4% →	**15.5 (-13.2%)**
Waste （SWDS,Wastewater Handling, etc.）	11.3	7.8 (-30.9%)	→ -3.0% →	**7.6 (-33.0%)**
Fuel Combustion	0.8	0.8 (+1.3%)	→ -1.2% →	**0.8 (+0.1%)**
Fugitive Emissions from Fuels (Production of Natural Gas, Coal Mining, etc.)	3.0	0.4 (-86.9%)	→ -3.5% →	**0.4 (-87.4%)**
Industrial Process	0.4	0.1 (-62.6%)	→ -0.3% →	**0.1 (-62.7%)**

(Unit: Mt-CO_2)

8.2.3. Nitrous Oxide (N_2O)

Total N_2O emissions in FY2004 were 25.8 million tons of CO_2 equivalents and resulted in a decrease of 21.2% compared to the base year and an increase of 0.2% compared to the previous year. Primary factor to this decrease compared to the base year is a decrease of emissions from adipic acid production. Emissions in 2004 were decreased by 2.6 million ton CO_2 equivalent compared to the value reported in May, 2006 because emission estimation accuracy improved after revising N_2O emission factors for road transportation based on the latest scientific knowledge.

Table 7 N_2O Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Changes from FY2003	FY2004 (compared to base year)
Total	32.7	25.8 (-21.3%)	→ +0.2% →	**25.8 (-21.2%)**
Agriculture (Manure Management, Agricultural Soils, etc.)	14.4	12.1 (-16.4%)	→ -0.6% →	**12.0 (-16.9%)**
Fuel Combustion	6.5	8.0 (+22.6%)	→ -3.4% →	**7.7 (+18.5%)**
Waste （Wastewater Handling, Incineration）	3.2	4.1 (+27.1%)	→ +0.3% →	**4.1 (+27.5%)**
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%)	→ +1.8% →	**0.0001 (-2.4%)**

(Unit: Mt-CO_2)

8.2.4. Hydrofluorocarbons (HFCs),

Total HFCs emissions in FY2004 were 8.3 million tons of CO_2 equivalents and resulted in a decrease of 58.7% compared to the base year (FY1995) and a decrease of 33.3% compared to the previous year. Primary factor to these decreases is a considerable decrease of emissions from by-product from HCFC-22 production. In contrast, emissions from refrigeration and air conditioning equipment have increased due to the result of shifting from HCFC to HFC.

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	12.5 (-38.1%)	→ -33.3% →	**8.3** **(-58.7%)**
By-product Emissions from Production of HCFC-22	17.0	5.1 (-70.3%)	→ -79.2% →	**1.1** **(-93.8%)**
Aerosols/MDI	1.4	2.6 (+89.7%)	→ -16.9% →	**2.2** **(+57.6%)**
Refrigeration and Air Conditioning Equipment	0.8	3.7 (+359.7%)	→ +8.1% →	**4.0** **(+397.0%)**
Foam Blowing	0.5	0.7 (+44.6%)	→ -9.6% →	**0.6** **(+30.7%)**
Productions of HFCs	0.4	0.4 (-4.6%)	→ +4.1% →	**0.4** **(-0.7%)**
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 6.3 million tons of CO_2 equivalents and resulted in a decrease of 55.5% compared to the base year (FY1995) and an increase of 2.0% from the previous year. Emissions from semiconductor manufacturing increased from the previous year. Emissions in 2004 were decreased by 3.6 million ton CO_2 equivalent compared to the value reported in May, 2006 because emission estimation accuracy improved due to the detailed check of the substance required to report under the Kyoto Protocol.

Table 9 PFCs Emissions

	Base Year of Kyoto Protocol	FY2003 (compared to base year)	Changes from FY2003	FY2004 (compared to base year)
Total	14.0	6.2 (-55.9%)	→ +2.0% →	**6.3** **(-55.0%)**
Solvent	10.4	1.5 (-85.4%)	→ +1.7% →	**1.5** **(-85.2%)**
Semiconductor Manufacture	2.9	3.7 (+29.4%)	→ +5.6% →	**3.9** **(+36.7%)**
Productions of PFCs	0.8	1.0 (+27.3%)	→ -11.2% →	**0.9** **(+13.1%)**
Metal Production	0.1	0.02 (-78.3%)	→ -2.1% →	**0.01** **(-78.8%)**

(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%)	→ -20.4% →	**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 (+747.8%)	→ -4.6% →	**1.0** **(+709.0%)**

(Unit: Mt-CO_2)

8.2.7. Emissions and Removals from Land Use, Land Use Change and Forestry

Net emissions and removals from the Land Use, Land Use Change and Forestry sector in FY 2004 amounted to the removal of 94.9 million tons of CO_2 equivalent.

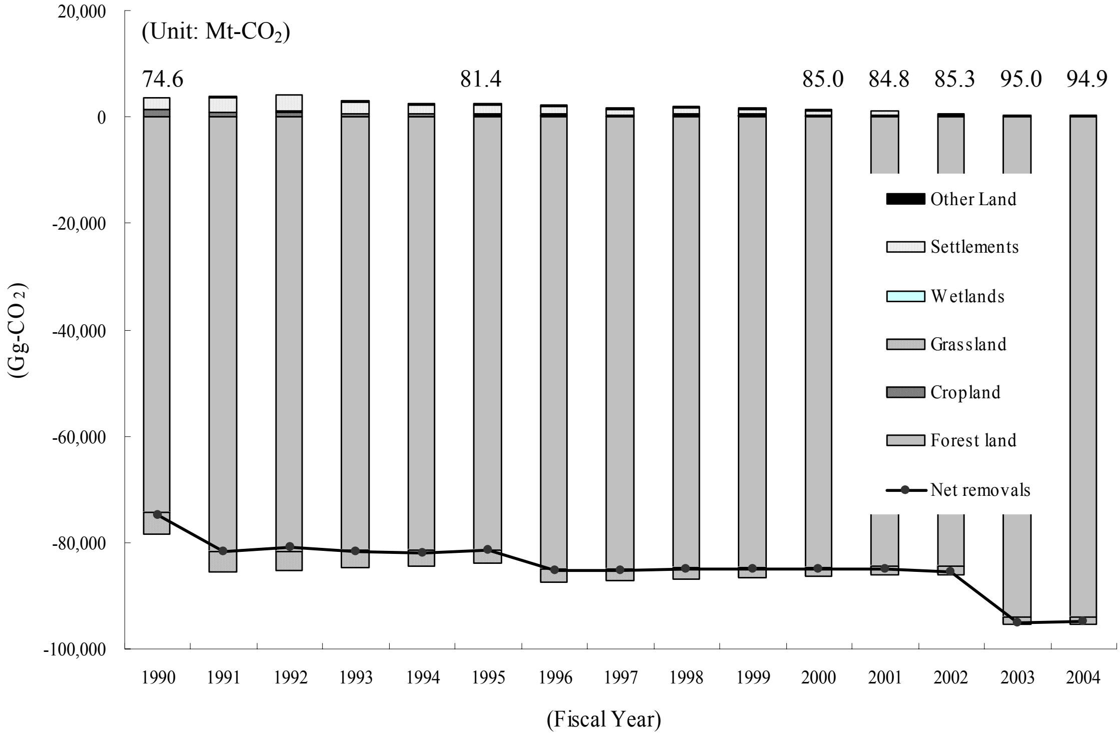


Figure 4 Trends in emissions and removals from the Land Use, Land Use Change and Forestry sector

Note: Emissions and removals from the Land Use, Land Use Change and Forestry sector includes emissions and removals from grassland and etc. as well as forest land. The reported amount of removals by forest land represents the removals for the whole managed forest land Therefore, the value is different to the amount of removals listed in the appendix table in the annex of decision 16/CMP.1 which will be able to added to the assigned amount for the first commitment period under the Kyoto protocol. The amount of emissions and removals under the Kyoto Protocol will be estimated as a trial and reported in the 2005 inventory to be submitted in April or May, 2007 as supplementary information according to the Kyoto protocol.

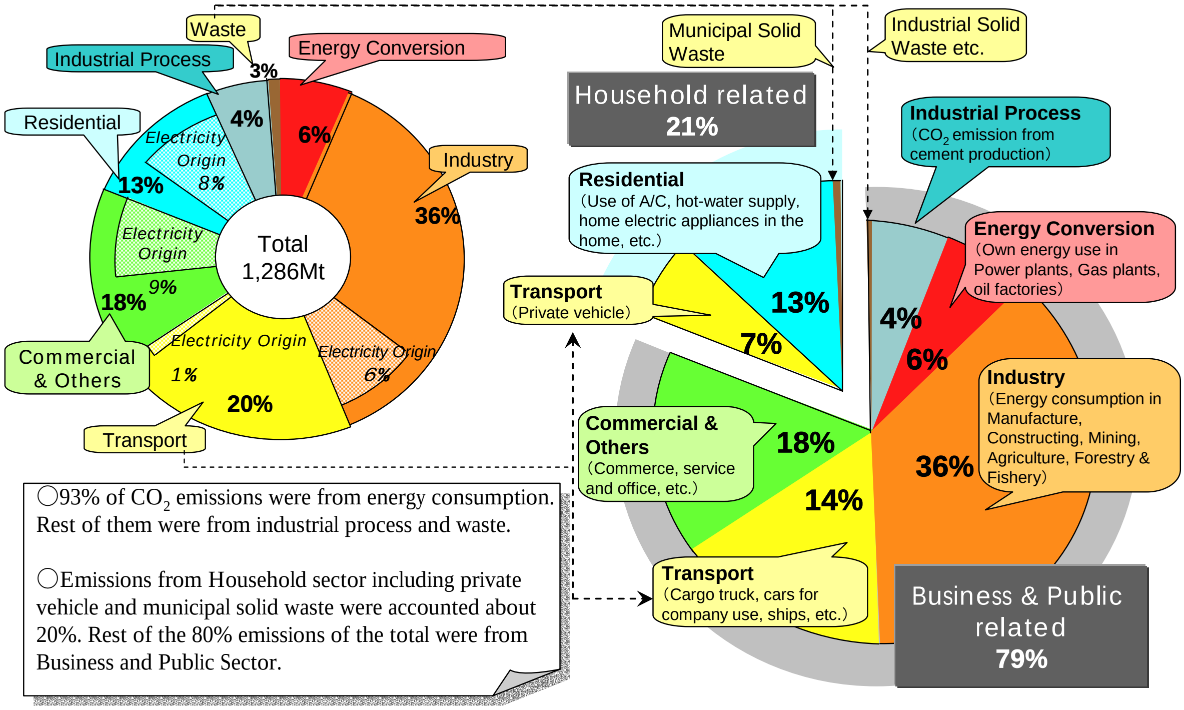
8.3. Reference Data

8.3.1. 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

8.3.2. Carbon Dioxide Emissions by Emission Origin Type and Emissions Management Type in FY2004

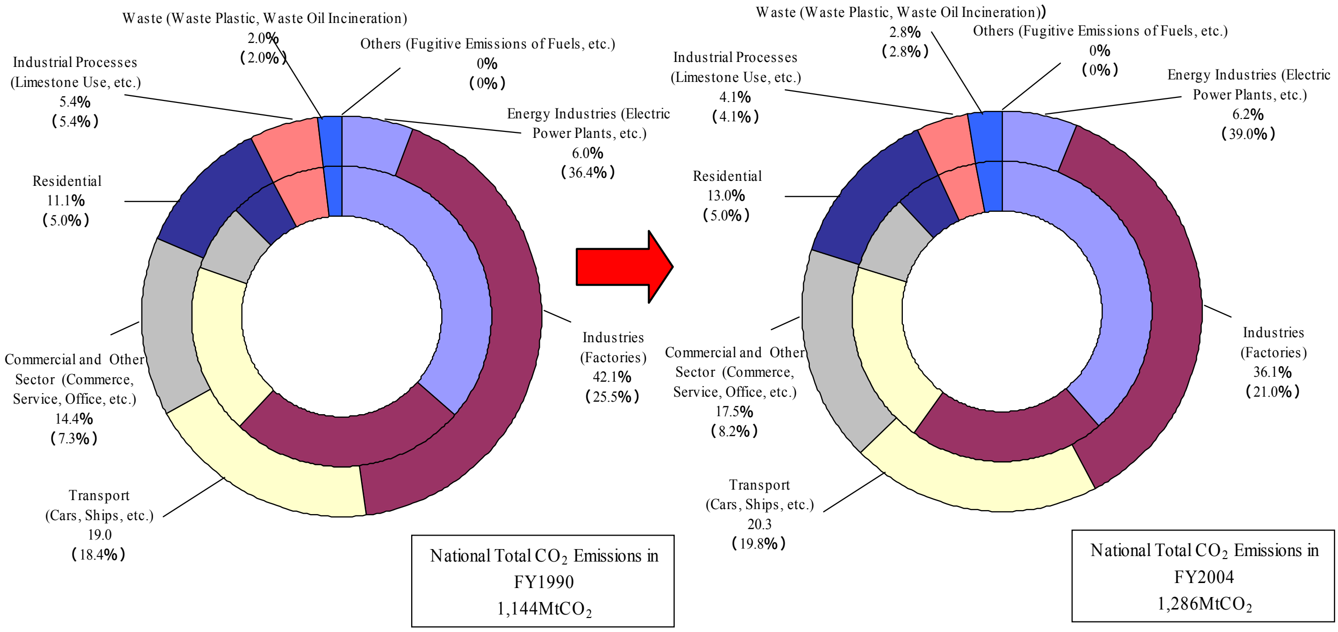


○93% of CO$_2$ emissions were from energy consumption. Rest of them were from industrial process and waste.

○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.

8.3.3. Sectoral Breakdown of Greenhouse Gas Emissions in FY2004

- **Carbon Dioxide (CO$_2$)**

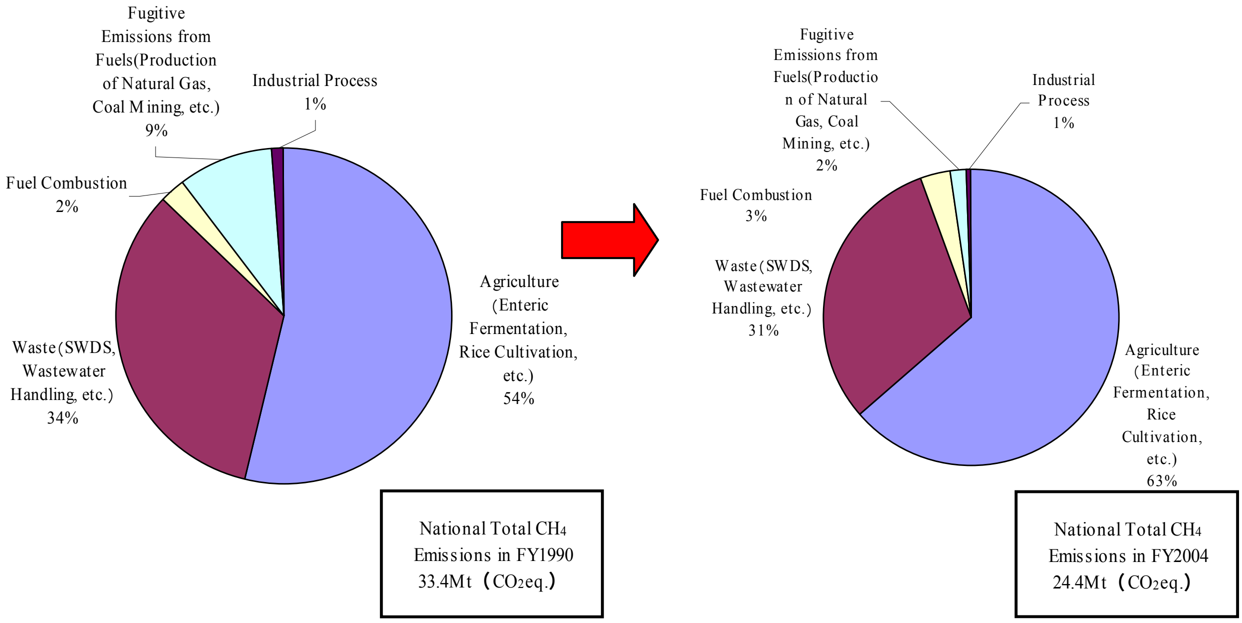


Note 1: The inner circle shows the proportion of the direct emissions by each sector (values in parentheses), and the outer circle shows the proportion of the emissions including the direct emissions and indirect emissions from power generation by electric utilities and steam generation (industrial steam generation and district heat supply) allocated to final

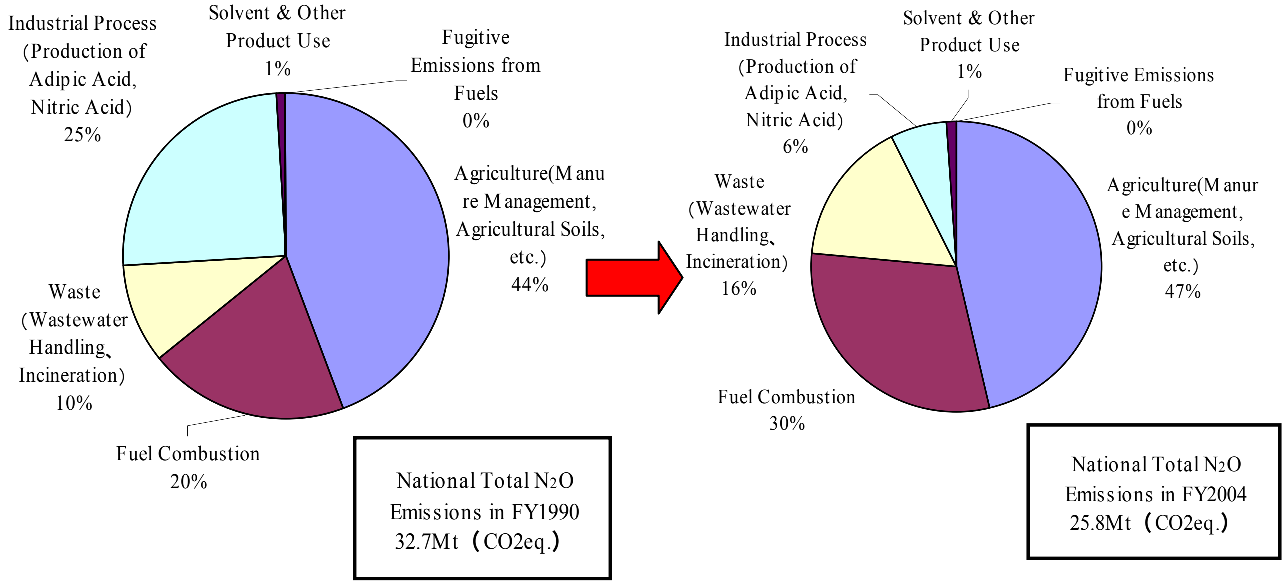
demand sector in accordance with the electric and heat consumption (values without parenthesis).

Note 2: Total for sectoral breakdown may not sum to 100% due to statistical error and rounding off.

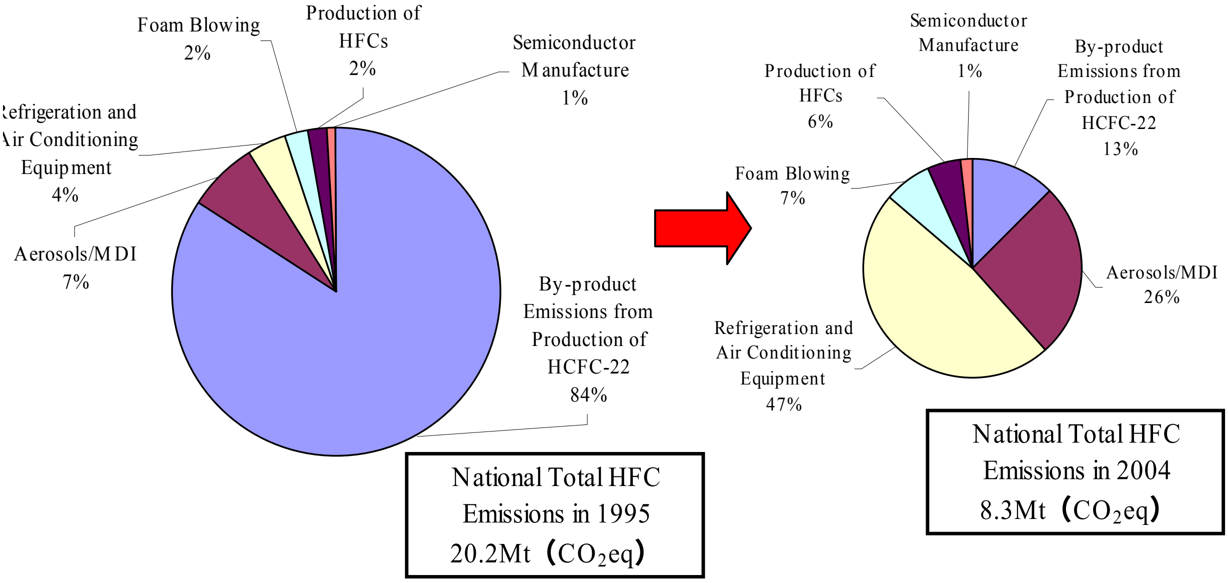
- **Methane (CH_4)**



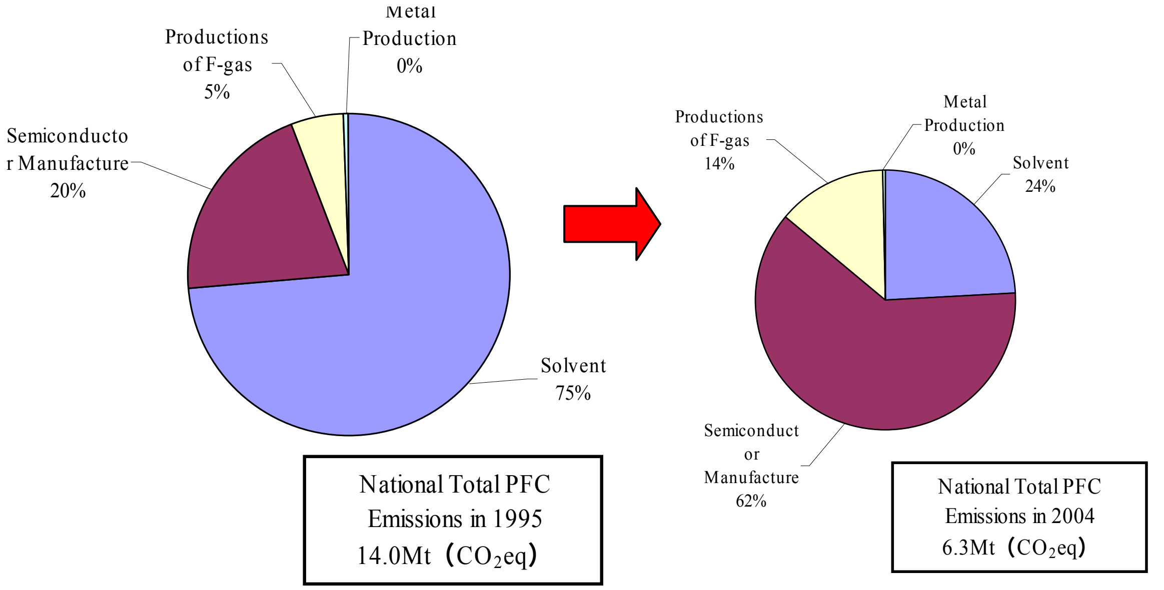
- **Nitrous Oxide (N_2O)**



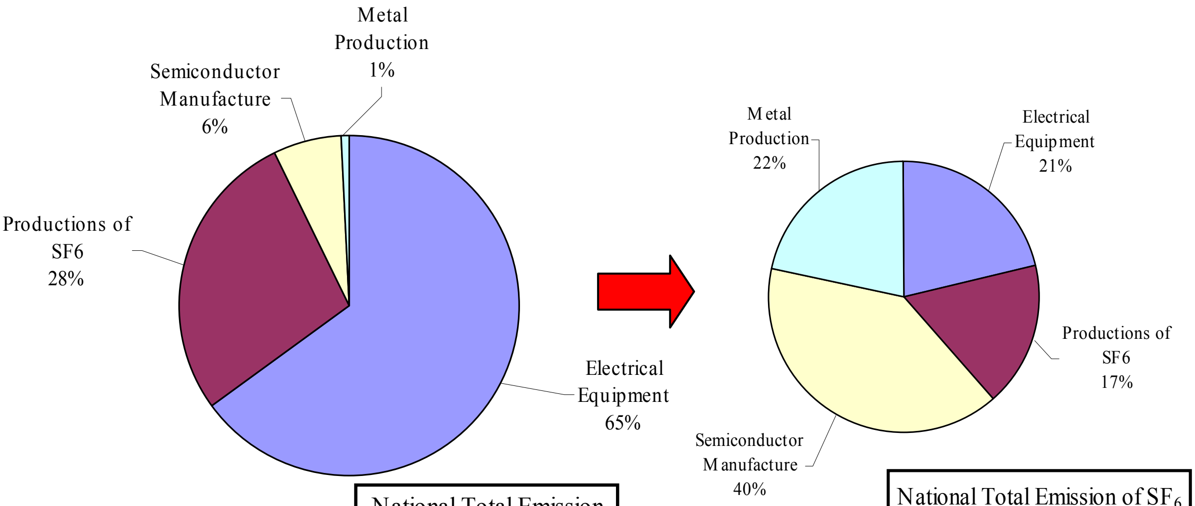
- **Hydrofluorocarbons (HFCs)**



- **Perfluorocarbons (PFCs)**



- **Sulfur Hexafluoride (SF_6)**



National Total Emission of SF_6 in 1995
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

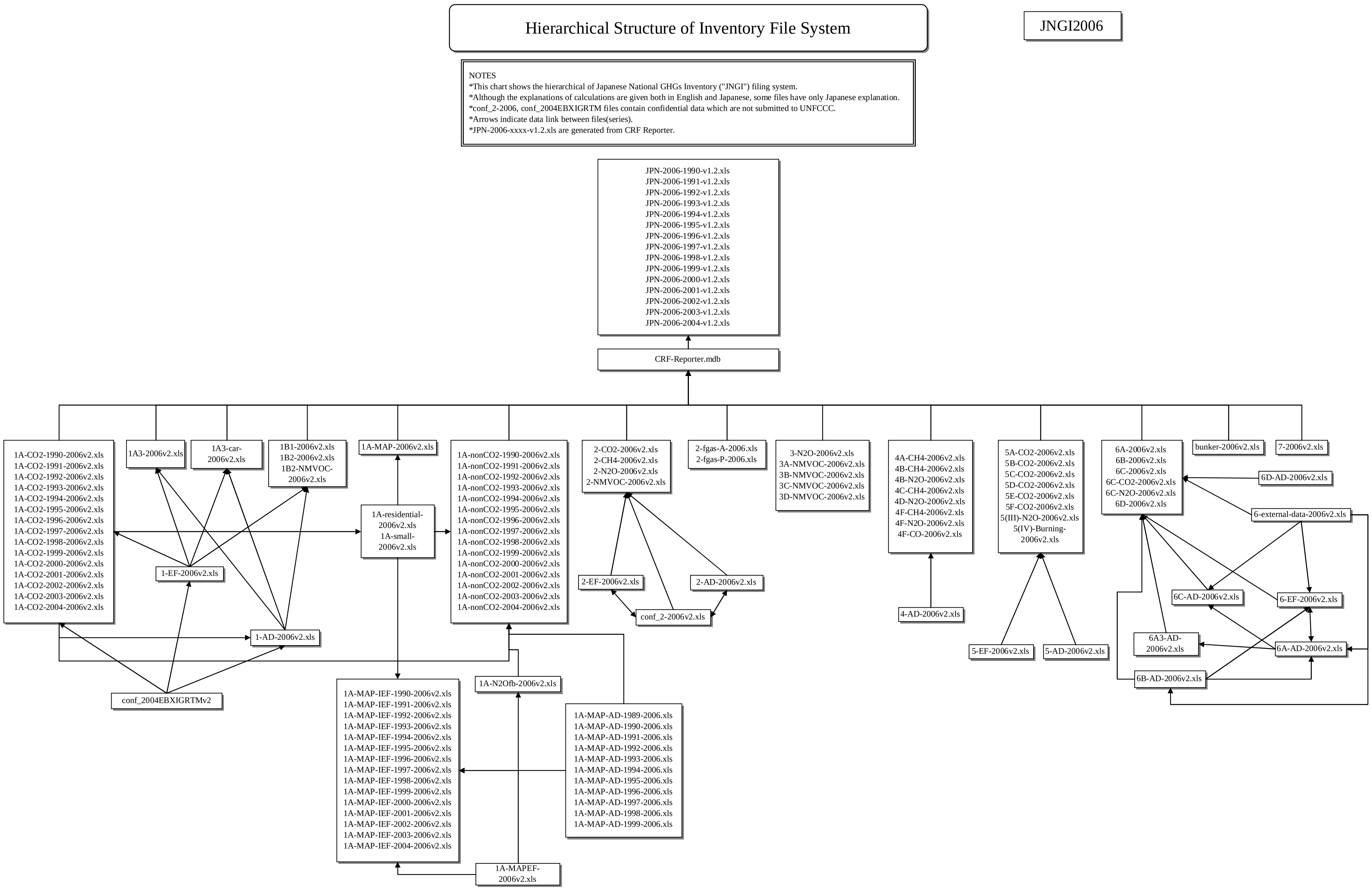
Multiple MS Excel files have been used when estimating Japanese inventory. The explanation of each MS Excel file and the hierarchical structure of Japanese National GHGs Inventory (JNGI) file system are shown below.

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-MAP-AD-1989-2006.xls ～ 1A-MAP-AD-1999-2006.xls	Share by furnace type for calculation of emissions of Non-CO2 from stationary combustion
	1A-MAP-IEF-1989-2006.xls ～ 1A-MAP-IEF-1999-2006.xls	Implied Emission Factors of Non-CO2 from stationary combustion
	1A-N2Ofb-2006.xls	N$_2$O 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
2. 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$_2$O 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$_2$O 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
	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-2006.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



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-v1.2.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

“Summary.2 Table” of the CRF indicated below shows emissions and removals for every year.

During 1990-1994, Japan had reported only potential emissions of HFCs, PFCs, and SF_6. In Table.10 of the CRF showing the trend each year, between 1990 and 1994, the potential emissions of HFCs, PFCs, and SF_6 are shown, and from 1995 onward, actual emissions of HFCs, PFCs, SF_6 are shown.

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 v1.2
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)	**1,069,335.57**	**33,481.67**	**32,816.48**	**17,930.00**	**5,670.00**	**38,240.00**	**1,197,473.73**
1. Energy	**1,059,112.49**	**3,866.37**	**6,535.87**				**1,069,514.73**
A. Fuel Combustion (Sectoral Approach)	1,059,075.87	829.23	6,535.76				1,066,440.85
1. Energy Industries	317,760.48	18.37	545.63				318,324.48
2. Manufacturing Industries and Construction	367,576.51	307.03	1,495.44				369,378.98
3. Transport	211,053.69	296.16	4,204.15				215,554.00
4. Other Sectors	161,675.49	207.13	272.34				162,154.95
5. Other	1,009.70	0.54	18.19				1,028.43
B. Fugitive Emissions from Fuels	36.62	3,037.14	0.11				3,073.88
1. Solid Fuels	NE,NO	2,806.43	NE,NO				2,806.43
2. Oil and Natural Gas	36.62	230.71	0.11				267.45
2. Industrial Processes	**62,318.39**	**357.58**	**8,266.95**	**17,930.00**	**5,670.00**	**38,240.00**	**132,782.92**
A. Mineral Products	57,448.33	NA,NO	NA,NO				57,448.33
B. Chemical Industry	4,513.97	338.22	8,266.95	IE,NE,NO	IE,NE,NO	IE,NE,NO	13,119.14
C. Metal Production	356.09	19.36	NO	IE,NE	IE,NA,NE	IE,NA,NE	375.45
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		**17,894.84**	**14,433.52**				**32,328.36**
A. Enteric Fermentation		7,641.73					7,641.73
B. Manure Management		3,120.57	5,543.05				8,663.62
C. Rice Cultivation		7,002.78					7,002.78
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)	**-74,793.94**	**99.33**	**72.92**				**-74,621.68**
A. Forest Land	-74,337.32	8.31	0.84				-74,328.17
B. Cropland	1,279.59	21.72	65.04				1,366.35
C. Grassland	-4,190.96	3.06	0.31				-4,187.59
D. Wetlands	56.49	1.32	0.13				57.95
E. Settlements	2,275.37	54.63	5.54				2,335.55
F. Other Land	122.88	10.30	1.05				134.23
G. Other		NE	NE				NE
6. Waste	**22,698.63**	**11,263.54**	**3,220.16**				**37,182.33**
A. Solid Waste Disposal on Land	NA,NE,NO	9,081.13					9,081.13
B. Waste-water Handling		2,119.61	1,289.37				3,408.98
C. Waste Incineration	21,995.80	62.80	1,910.66				23,969.26
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	30,812.23	42.28	275.71				31,130.22
Aviation	13,182.57	7.83	130.44				13,320.84
Marine	17,629.65	34.45	145.28				17,809.38
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)	1,272,095.41
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,197,473.73

(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 v1.2
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)	**1,071,376.49**	**33,242.77**	**32,372.50**	**18,070.00**	**6,370.00**	**43,498.00**	**1,204,929.75**
1. Energy	**1,066,021.41**	**3,628.62**	**6,811.81**				**1,076,461.84**
A. Fuel Combustion (Sectoral Approach)	1,065,967.74	833.86	6,811.65				1,073,613.25
1. Energy Industries	320,303.88	19.59	568.32				320,891.79
2. Manufacturing Industries and Construction	361,844.32	306.31	1,579.24				363,729.87
3. Transport	222,466.79	298.57	4,367.17				227,132.54
4. Other Sectors	160,348.66	208.79	278.78				160,836.23
5. Other	1,004.09	0.61	18.12				1,022.82
B. Fugitive Emissions from Fuels	53.67	2,794.76	0.16				2,848.59
1. Solid Fuels	NE,NO	2,538.33	NE,NO				2,538.33
2. Oil and Natural Gas	53.67	256.43	0.16				310.26
2. Industrial Processes	**63,875.92**	**347.49**	**7,539.75**	**18,070.00**	**6,370.00**	**43,498.00**	**139,701.17**
A. Mineral Products	59,052.72	NA,NO	NA,NO				59,052.72
B. Chemical Industry	4,500.16	329.15	7,539.75	IE,NE,NO	IE,NE,NO	IE,NE,NO	12,369.06
C. Metal Production	323.04	18.34	NO	IE,NE	IE,NA,NE	IE,NA,NE	341.38
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		**18,016.38**	**14,299.41**				**32,315.79**
A. Enteric Fermentation		7,751.70					7,751.70
B. Manure Management		3,116.81	5,499.54				8,616.35
C. Rice Cultivation		7,020.95					7,020.95
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)	**-81,593.90**	**98.26**	**70.24**				**-81,425.39**
A. Forest Land	-81,729.94	6.22	0.63				-81,723.09
B. Cropland	885.89	12.28	61.52				959.68
C. Grassland	-3,686.93	1.75	0.18				-3,685.00
D. Wetlands	54.71	1.20	0.12				56.03
E. Settlements	2,692.23	64.99	6.60				2,763.81
F. Other Land	190.14	11.82	1.20				203.17
G. Other		NE	NE				NE
6. Waste	**23,073.05**	**11,152.01**	**3,294.44**				**37,519.50**
A. Solid Waste Disposal on Land	NA,NE,NO	9,011.92					9,011.92
B. Waste-water Handling		2,077.23	1,311.17				3,388.40
C. Waste Incineration	22,386.61	62.86	1,966.95				24,416.42
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	32,514.09	44.61	290.93				32,849.64
Aviation	13,912.00	8.27	137.65				14,057.92
Marine	18,602.09	36.34	153.28				18,791.72
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)	1,286,355.14
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,204,929.75

(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 v1.2
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)	**1,079,664.82**	**32,990.25**	**32,441.23**	**19,750.00**	**6,370.00**	**47,800.00**	**1,219,016.30**
1. Energy	**1,072,522.76**	**3,375.67**	**6,970.24**				**1,082,868.67**
A. Fuel Combustion (Sectoral Approach)	1,072,465.80	848.33	6,970.07				1,080,284.20
1. Energy Industries	327,020.00	20.45	541.47				327,581.92
2. Manufacturing Industries and Construction	353,077.55	301.90	1,661.51				355,040.97
3. Transport	226,859.69	301.50	4,459.21				231,620.40
4. Other Sectors	164,522.45	223.78	289.88				165,036.11
5. Other	986.11	0.70	18.00				1,004.80
B. Fugitive Emissions from Fuels	56.95	2,527.34	0.17				2,584.46
1. Solid Fuels	NE,NO	2,267.52	NE,NO				2,267.52
2. Oil and Natural Gas	56.95	259.82	0.17				316.94
2. Industrial Processes	**63,524.19**	**322.22**	**7,452.41**	**19,750.00**	**6,370.00**	**47,800.00**	**145,218.82**
A. Mineral Products	58,818.65	NA,NO	NA,NO				58,818.65
B. Chemical Industry	4,380.50	304.45	7,452.41	IE,NE,NO	IE,NE,NO	IE,NE,NO	12,137.36
C. Metal Production	325.05	17.76	NO	IE,NE	IE,NA,NE	IE,NA,NE	342.81
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		**18,101.56**	**14,115.96**				**32,217.52**
A. Enteric Fermentation		7,793.32					7,793.32
B. Manure Management		3,089.85	5,447.38				8,537.23
C. Rice Cultivation		7,102.75					7,102.75
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)	**-80,955.64**	**105.52**	**68.13**				**-80,781.99**
A. Forest Land	-81,638.13	4.34	0.44				-81,633.35
B. Cropland	940.16	14.07	58.85				1,013.08
C. Grassland	-3,471.28	2.05	0.21				-3,469.02
D. Wetlands	162.25	3.85	0.39				166.49
E. Settlements	2,945.30	71.58	7.26				3,024.14
F. Other Land	106.06	9.63	0.98				116.67
G. Other		NE	NE				NE
6. Waste	**24,573.52**	**11,085.29**	**3,421.47**				**39,080.27**
A. Solid Waste Disposal on Land	NA,NE,NO	8,983.86					8,983.86
B. Waste-water Handling		2,038.24	1,296.16				3,334.39
C. Waste Incineration	23,874.62	63.19	2,108.55				26,046.36
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	32,919.13	45.00	294.78				33,258.91
Aviation	14,209.49	8.44	140.60				14,358.53
Marine	18,709.64	36.56	154.19				18,900.38
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)	1,299,798.29
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,219,016.30

(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 v1.2
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)	**1,071,340.85**	**32,707.54**	**32,084.50**	**21,310.00**	**8,860.00**	**45,410.00**	**1,211,712.89**
1. Energy	**1,066,013.69**	**3,207.32**	**7,001.99**				**1,076,223.00**
A. Fuel Combustion (Sectoral Approach)	1,065,960.47	868.09	7,001.83				1,073,830.39
1. Energy Industries	308,959.26	20.39	551.21				309,530.85
2. Manufacturing Industries and Construction	352,033.63	303.38	1,677.75				354,014.75
3. Transport	231,727.93	294.22	4,432.03				236,454.18
4. Other Sectors	172,320.58	249.40	322.74				172,892.72
5. Other	919.08	0.71	18.11				937.89
B. Fugitive Emissions from Fuels	53.21	2,339.23	0.16				2,392.61
1. Solid Fuels	NE,NO	2,075.76	NE,NO				2,075.76
2. Oil and Natural Gas	53.21	263.46	0.16				316.84
2. Industrial Processes	**62,767.28**	**320.55**	**7,302.85**	**21,310.00**	**8,860.00**	**45,410.00**	**145,970.68**
A. Mineral Products	58,279.87	NA,NO	NA,NO				58,279.87
B. Chemical Industry	4,156.65	303.85	7,302.85	IE,NE,NO	IE,NE,NO	IE,NE,NO	11,763.35
C. Metal Production	330.76	16.70	NO	IE,NE	IE,NA,NE	IE,NA,NE	347.46
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		**18,185.94**	**13,871.11**				**32,057.04**
A. Enteric Fermentation		7,748.30					7,748.30
B. Manure Management		3,026.51	5,347.77				8,374.27
C. Rice Cultivation		7,292.48					7,292.48
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)	**-81,619.19**	**97.48**	**64.58**				**-81,457.12**
A. Forest Land	-81,536.46	23.91	2.43				-81,510.12
B. Cropland	550.83	4.99	55.20				611.02
C. Grassland	-3,149.35	0.74	0.07				-3,148.54
D. Wetlands	69.88	1.68	0.17				71.73
E. Settlements	2,190.71	54.09	5.49				2,250.29
F. Other Land	255.20	12.06	1.22				268.49
G. Other		NE	NE				NE
6. Waste	**24,179.07**	**10,896.25**	**3,432.30**				**38,507.63**
A. Solid Waste Disposal on Land	NA,NE,NO	8,846.41					8,846.41
B. Waste-water Handling		1,986.60	1,299.83				3,286.43
C. Waste Incineration	23,498.33	63.24	2,114.98				25,676.55
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	34,915.92	49.37	310.56				35,275.86
Aviation	13,849.10	8.23	137.03				13,994.36
Marine	21,066.82	41.14	173.53				21,281.50
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)	1,293,170.01
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,211,712.89

(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.

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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 v1.2
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)	**1,130,948.27**	**31,995.17**	**33,205.90**	**28,840.00**	**12,274.00**	**45,410.00**	**1,282,673.34**
1. Energy	**1,121,335.40**	**2,846.13**	**7,320.73**				**1,131,502.27**
A. Fuel Combustion (Sectoral Approach)	1,121,284.25	866.60	7,320.58				1,129,471.43
1. Energy Industries	349,637.32	22.63	622.06				350,282.02
2. Manufacturing Industries and Construction	359,827.47	312.43	1,840.88				361,980.78
3. Transport	243,681.03	295.61	4,513.22				248,489.85
4. Other Sectors	167,275.64	235.19	326.05				167,836.87
5. Other	862.80	0.74	18.37				881.90
B. Fugitive Emissions from Fuels	51.15	1,979.53	0.16				2,030.84
1. Solid Fuels	NE,NO	1,712.96	NE,NO				1,712.96
2. Oil and Natural Gas	51.15	266.57	0.16				317.88
2. Industrial Processes	**64,049.23**	**320.85**	**8,298.10**	**28,840.00**	**12,274.00**	**45,410.00**	**159,192.18**
A. Mineral Products	59,270.16	NA,NO	NA,NO				59,270.16
B. Chemical Industry	4,433.31	303.40	8,298.10	IE,NE,NO	IE,NE,NO	IE,NE,NO	13,034.81
C. Metal Production	345.76	17.45	NO	IE,NE	IE,NA,NE	IE,NA,NE	363.21
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		**18,041.41**	**13,530.91**				**31,572.31**
A. Enteric Fermentation		7,660.50					7,660.50
B. Manure Management		2,956.18	5,220.30				8,176.48
C. Rice Cultivation		7,308.38					7,308.38
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)	**-81,880.67**	**78.70**	**53.42**				**-81,748.54**
A. Forest Land	-81,423.76	17.75	1.80				-81,404.20
B. Cropland	462.60	4.90	45.93				513.43
C. Grassland	-2,916.67	0.73	0.07				-2,915.86
D. Wetlands	77.57	1.84	0.19				79.59
E. Settlements	1,699.46	42.50	4.31				1,746.27
F. Other Land	220.12	10.99	1.12				232.23
G. Other		NE	NE				NE
6. Waste	**27,444.31**	**10,708.08**	**3,564.72**				**41,717.11**
A. Solid Waste Disposal on Land	NA,NE,NO	8,723.32					8,723.32
B. Waste-water Handling		1,920.29	1,264.39				3,184.68
C. Waste Incineration	26,742.39	64.48	2,284.55				29,091.43
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	36,329.79	50.58	324.09				36,704.46
Aviation	14,993.78	8.91	148.36				15,151.05
Marine	21,336.01	41.67	175.74				21,553.41
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)	1,364,421.89
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,282,673.34

(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 v1.2
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)	**1,144,901.10**	**31,030.75**	**33,594.20**	**20,211.80**	**14,045.93**	**16,928.79**	**1,260,712.57**
1. Energy	**1,133,655.22**	**2,509.46**	**7,935.63**				**1,144,100.31**
A. Fuel Combustion (Sectoral Approach)	1,133,604.30	899.59	7,935.48				1,142,439.37
1. Energy Industries	337,867.69	23.02	1,033.30				338,924.01
2. Manufacturing Industries and Construction	364,516.67	314.41	1,896.92				366,728.00
3. Transport	251,175.26	306.24	4,649.77				256,131.27
4. Other Sectors	179,175.77	255.04	336.19				179,767.00
5. Other	868.90	0.89	19.30				889.09
B. Fugitive Emissions from Fuels	50.92	1,609.87	0.16				1,660.95
1. Solid Fuels	NE,NO	1,344.68	NE,NO				1,344.68
2. Oil and Natural Gas	50.92	265.19	0.16				316.26
2. Industrial Processes	**64,264.52**	**322.37**	**8,212.71**	**20,211.80**	**14,045.93**	**16,928.79**	**123,986.12**
A. Mineral Products	59,381.83	NA,NO	NA,NO				59,381.83
B. Chemical Industry	4,525.47	304.45	8,212.71	IE,NE,NO	IE,NE,NO	IE,NE,NO	13,042.62
C. Metal Production	357.22	17.92	NO	IE,NE	69.73	119.50	564.37
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				17,442.52	762.85	4,708.30	22,913.67
F. Consumption of Halocarbons and SF_6 (2)				2,769.29	13,213.35	12,100.99	28,083.63
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**437.58**				**437.58**
4. Agriculture		**17,718.38**	**13,247.54**				**30,965.92**
A. Enteric Fermentation		7,575.17					7,575.17
B. Manure Management		2,895.37	5,111.81				8,007.18
C. Rice Cultivation		7,126.61					7,126.61
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)	**-81,488.86**	**70.56**	**47.00**				**-81,371.29**
A. Forest Land	-81,300.64	8.66	0.88				-81,291.10
B. Cropland	451.49	5.10	40.36				496.95
C. Grassland	-2,663.85	0.77	0.08				-2,663.00
D. Wetlands	183.96	4.43	0.45				188.84
E. Settlements	1,652.29	41.84	4.25				1,698.38
F. Other Land	187.89	9.77	0.99				198.64
G. Other		NE	NE				NE
6. Waste	**28,470.23**	**10,409.98**	**3,713.74**				**42,593.94**
A. Solid Waste Disposal on Land	NA,NE,NO	8,485.01					8,485.01
B. Waste-water Handling		1,859.63	1,246.87				3,106.50
C. Waste Incineration	27,802.40	65.34	2,450.63				30,318.37
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	35,689.59	47.75	320.69				36,058.04
Aviation	16,145.10	9.60	159.75				16,314.44
Marine	19,544.49	38.16	160.94				19,743.60
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)	1,342,083.87
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,260,712.57

(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 v1.2
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)	**1,153,956.77**	**30,333.62**	**34,714.50**	**19,844.37**	**14,461.86**	**17,494.78**	**1,270,805.90**
1. Energy	**1,145,336.42**	**2,459.02**	**8,140.89**				**1,155,936.33**
A. Fuel Combustion (Sectoral Approach)	1,145,287.05	898.53	8,140.74				1,154,326.31
1. Energy Industries	337,751.05	24.77	1,052.48				338,828.29
2. Manufacturing Industries and Construction	372,505.35	331.10	2,030.39				374,866.84
3. Transport	256,806.58	311.60	4,736.76				261,854.94
4. Other Sectors	177,312.16	230.15	301.43				177,843.75
5. Other	911.91	0.90	19.68				932.49
B. Fugitive Emissions from Fuels	49.37	1,560.49	0.15				1,610.01
1. Solid Fuels	NE,NO	1,297.15	NE,NO				1,297.15
2. Oil and Natural Gas	49.37	263.34	0.15				312.86
2. Industrial Processes	**64,029.45**	**312.02**	**9,220.07**	**19,844.37**	**14,461.86**	**17,494.78**	**125,362.55**
A. Mineral Products	59,153.87	NA,NO	NA,NO				59,153.87
B. Chemical Industry	4,495.60	293.80	9,220.07	IE,NE,NO	IE,NE,NO	IE,NE,NO	14,009.47
C. Metal Production	379.99	18.22	NO	IE,NE	65.97	143.40	607.58
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				16,050.22	1,008.00	4,182.50	21,240.72
F. Consumption of Halocarbons and SF_6 (2)				3,794.16	13,387.89	13,168.88	30,350.92
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		**17,321.41**	**13,003.66**				**30,325.07**
A. Enteric Fermentation		7,518.23					7,518.23
B. Manure Management		2,851.35	5,044.17				7,895.52
C. Rice Cultivation		6,835.77					6,835.77
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)	**-85,353.52**	**84.33**	**40.91**				**-85,228.28**
A. Forest Land	-85,041.90	28.37	2.88				-85,010.66
B. Cropland	377.73	4.10	32.77				414.60
C. Grassland	-2,458.78	0.62	0.06				-2,458.10
D. Wetlands	332.24	8.01	0.81				341.06
E. Settlements	1,287.80	33.37	3.39				1,324.56
F. Other Land	149.39	9.87	1.00				160.26
G. Other		NE	NE				NE
6. Waste	**29,944.41**	**10,156.84**	**3,888.04**				**43,989.29**
A. Solid Waste Disposal on Land	NA,NE,NO	8,265.98					8,265.98
B. Waste-water Handling		1,824.66	1,268.42				3,093.08
C. Waste Incineration	29,303.94	66.20	2,602.93				31,973.08
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	30,941.62	35.37	285.38				31,262.37
Aviation	18,432.47	10.95	182.38				18,625.81
Marine	12,509.15	24.42	103.00				12,636.56
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)	1,356,034.18
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,270,805.90

(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 v1.2
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)	**1,149,452.63**	**29,237.43**	**35,338.46**	**19,808.45**	**15,489.63**	**14,778.35**	**1,264,104.96**
1. Energy	**1,141,427.58**	**2,164.97**	**8,379.13**				**1,151,971.68**
A. Fuel Combustion (Sectoral Approach)	1,141,379.60	887.73	8,378.98				1,150,646.31
1. Energy Industries	334,252.92	26.47	1,083.59				335,362.98
2. Manufacturing Industries and Construction	374,453.24	312.87	2,189.45				376,955.57
3. Transport	258,799.14	312.37	4,781.86				263,893.37
4. Other Sectors	172,975.50	235.23	304.71				173,515.45
5. Other	898.80	0.78	19.36				918.95
B. Fugitive Emissions from Fuels	47.97	1,277.25	0.15				1,325.37
1. Solid Fuels	NE,NO	1,006.86	NE,NO				1,006.86
2. Oil and Natural Gas	47.97	270.39	0.15				318.51
2. Industrial Processes	**62,306.04**	**260.90**	**9,742.87**	**19,808.45**	**15,489.63**	**14,778.35**	**122,386.25**
A. Mineral Products	57,478.48	NA,NO	NA,NO				57,478.48
B. Chemical Industry	4,443.09	242.58	9,742.87	IE,NE,NO	IE,NE,NO	IE,NE,NO	14,428.53
C. Metal Production	384.48	18.33	NO	IE,NE	59.51	191.20	653.52
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				15,075.19	1,417.00	2,581.20	19,073.39
F. Consumption of Halocarbons and SF_6 (2)				4,733.26	14,013.12	12,005.95	30,752.34
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**404.60**				**404.60**
4. Agriculture		**16,867.21**	**12,808.88**				**29,676.09**
A. Enteric Fermentation		7,472.96					7,472.96
B. Manure Management		2,802.40	4,989.17				7,791.57
C. Rice Cultivation		6,480.18					6,480.18
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)	**-85,328.51**	**82.68**	**32.81**				**-85,213.02**
A. Forest Land	-84,925.60	34.31	3.48				-84,887.81
B. Cropland	283.08	3.06	24.73				310.87
C. Grassland	-2,219.57	0.47	0.05				-2,219.06
D. Wetlands	82.94	2.00	0.20				85.15
E. Settlements	1,161.37	30.68	3.11				1,195.17
F. Other Land	289.26	12.16	1.23				302.66
G. Other		NE	NE				NE
6. Waste	**31,047.52**	**9,861.67**	**3,970.17**				**44,879.35**
A. Solid Waste Disposal on Land	NA,NE,NO	8,017.67					8,017.67
B. Waste-water Handling		1,778.44	1,278.76				3,057.20
C. Waste Incineration	30,392.29	65.56	2,674.00				33,131.84
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	35,413.17	43.15	323.27				35,779.59
Aviation	19,124.57	11.37	189.23				19,325.17
Marine	16,288.60	31.78	134.04				16,454.42
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)	1,349,317.97
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,264,104.96

(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 v1.2
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)	**1,113,689.99**	**28,376.51**	**33,871.23**	**19,293.12**	**12,581.06**	**13,406.89**	**1,221,218.80**
1. Energy	**1,111,201.97**	**2,001.27**	**8,258.21**				**1,121,461.45**
A. Fuel Combustion (Sectoral Approach)	1,111,159.24	863.29	8,258.08				1,120,280.62
1. Energy Industries	324,060.52	27.84	1,097.31				325,185.66
2. Manufacturing Industries and Construction	351,555.81	280.46	2,142.74				353,979.01
3. Transport	257,779.33	301.84	4,675.54				262,756.71
4. Other Sectors	176,917.54	252.56	323.64				177,493.74
5. Other	846.04	0.60	18.85				865.49
B. Fugitive Emissions from Fuels	42.73	1,137.98	0.13				1,180.84
1. Solid Fuels	NE,NO	872.46	NE,NO				872.46
2. Oil and Natural Gas	42.73	265.52	0.13				308.38
2. Industrial Processes	**56,237.38**	**243.52**	**8,577.87**	**19,293.12**	**12,581.06**	**13,406.89**	**110,339.85**
A. Mineral Products	52,038.56	NA,NO	NA,NO				52,038.56
B. Chemical Industry	3,905.71	227.37	8,577.87	IE,NE,NO	IE,NE,NO	IE,NE,NO	12,710.95
C. Metal Production	293.11	16.15	NO	IE,NE	49.45	406.30	765.01
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				14,049.73	1,390.00	2,103.20	17,542.93
F. Consumption of Halocarbons and SF_6 (2)				5,243.39	11,141.61	10,897.39	27,282.39
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**377.05**				**377.05**
4. Agriculture		**16,559.74**	**12,654.78**				**29,214.52**
A. Enteric Fermentation		7,438.25					7,438.25
B. Manure Management		2,744.51	4,940.43				7,684.94
C. Rice Cultivation		6,267.74					6,267.74
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)	**-84,888.29**	**62.39**	**28.59**				**-84,797.30**
A. Forest Land	-84,819.67	10.68	1.08				-84,807.91
B. Cropland	299.28	3.79	22.64				325.71
C. Grassland	-1,972.59	0.58	0.06				-1,971.95
D. Wetlands	314.69	7.61	0.77				323.07
E. Settlements	1,085.31	29.77	3.02				1,118.10
F. Other Land	204.70	9.97	1.01				215.68
G. Other		NE	NE				NE
6. Waste	**31,138.92**	**9,509.59**	**3,974.72**				**44,623.23**
A. Solid Waste Disposal on Land	NA,NE,NO	7,714.01					7,714.01
B. Waste-water Handling		1,732.98	1,261.85				2,994.83
C. Waste Incineration	30,529.80	62.59	2,695.40				33,287.79
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	37,340.95	45.75	340.65				37,727.35
Aviation	19,991.32	11.88	197.80				20,201.00
Marine	17,349.63	33.87	142.85				17,526.35
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)	1,306,016.11
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,221,218.80

(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 v1.2
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)]	**1,148,833.91**	**27,713.39**	**27,440.40**	**19,786.00**	**9,736.47**	**9,105.78**	**1,242,615.95**
1. Energy	**1,145,887.45**	**2,017.75**	**8,515.34**				**1,156,420.53**
A. Fuel Combustion (Sectoral Approach)	1,145,849.39	888.01	8,515.23				1,155,252.62
1. Energy Industries	341,336.25	30.75	1,217.82				342,584.81
2. Manufacturing Industries and Construction	358,649.35	280.03	2,257.81				361,187.19
3. Transport	260,013.80	300.95	4,662.58				264,977.32
4. Other Sectors	185,032.12	275.76	358.57				185,666.45
5. Other	817.87	0.52	18.45				836.84
B. Fugitive Emissions from Fuels	38.06	1,129.74	0.12				1,167.92
1. Solid Fuels	NE,NO	865.69	NE,NO				865.69
2. Oil and Natural Gas	38.06	264.05	0.12				302.23
2. Industrial Processes	**56,232.58**	**236.22**	**2,000.86**	**19,786.00**	**9,736.47**	**9,105.78**	**97,097.90**
A. Mineral Products	51,736.11	NA,NO	NA,NO				51,736.11
B. Chemical Industry	4,241.98	220.14	2,000.86	IE,NE,NO	IE,NE,NO	IE,NE,NO	6,462.98
C. Metal Production	254.49	16.08	NO	IE,NE	29.15	645.30	945.02
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				14,256.65	1,273.73	1,529.60	17,059.98
F. Consumption of Halocarbons and SF_6 [(2)]				5,529.34	8,433.59	6,930.88	20,893.81
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**362.53**				**362.53**
4. Agriculture		**16,234.79**	**12,512.47**				**28,747.26**
A. Enteric Fermentation		7,379.06					7,379.06
B. Manure Management		2,685.52	4,888.02				7,573.54
C. Rice Cultivation		6,062.11					6,062.11
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)]	**-84,882.15**	**53.12**	**26.85**				**-84,802.19**
A. Forest Land	-84,715.35	5.20	0.53				-84,709.62
B. Cropland	259.51	3.60	21.82				284.93
C. Grassland	-1,843.01	0.55	0.06				-1,842.40
D. Wetlands	249.94	6.04	0.61				256.60
E. Settlements	913.91	26.58	2.70				943.19
F. Other Land	252.85	11.14	1.13				265.12
G. Other		NE	NE				NE
6. Waste	**31,596.04**	**9,171.51**	**4,022.35**				**44,789.90**
A. Solid Waste Disposal on Land	NA,NE,NO	7,420.88					7,420.88
B. Waste-water Handling		1,685.18	1,225.62				2,910.80
C. Waste Incineration	30,943.46	65.46	2,779.17				33,788.09
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	34,398.21	42.21	313.78				34,754.20
Aviation	18,376.18	10.92	181.82				18,568.93
Marine	16,022.03	31.29	131.96				16,185.27
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)]	1,327,418.13
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry [(5)]	1,242,615.95

[(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 v1.2
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]	**1,169,582.95**	**27,023.79**	**29,940.13**	**18,585.39**	**8,610.59**	**6,823.27**	**1,260,566.12**
1. Energy	**1,164,837.60**	**1,937.99**	**8,484.13**				**1,175,259.72**
A. Fuel Combustion (Sectoral Approach)	1,164,801.57	892.08	8,484.02				1,174,177.67
1. Energy Industries	348,484.03	31.01	1,262.55				349,777.58
2. Manufacturing Industries and Construction	369,907.25	292.43	2,276.91				372,476.59
3. Transport	259,230.32	298.75	4,564.25				264,093.32
4. Other Sectors	186,312.04	269.34	361.54				186,942.92
5. Other	867.93	0.56	18.77				887.26
B. Fugitive Emissions from Fuels	36.03	1,045.91	0.11				1,082.05
1. Solid Fuels	NE,NO	769.13	NE,NO				769.13
2. Oil and Natural Gas	36.03	276.79	0.11				312.93
2. Industrial Processes	**56,877.08**	**181.23**	**4,690.09**	**18,585.39**	**8,610.59**	**6,823.27**	**95,767.65**
A. Mineral Products	52,450.67	NA,NO	NA,NO				52,450.67
B. Chemical Industry	4,177.99	164.40	4,690.09	IE,NE,NO	IE,NE,NO	IE,NE,NO	9,032.47
C. Metal Production	248.42	16.84	NO	IE,NE	17.78	1,027.70	1,310.74
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]				5,930.85	7,210.20	4,935.17	18,076.22
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**340.99**				**340.99**
4. Agriculture		**16,053.79**	**12,384.35**				**28,438.15**
A. Enteric Fermentation		7,344.65					7,344.65
B. Manure Management		2,644.16	4,844.14				7,488.29
C. Rice Cultivation		5,956.45					5,956.45
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				189.71
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[1]	**-85,036.06**	**46.90**	**24.46**				**-84,964.70**
A. Forest Land	-84,602.80	7.75	0.79				-84,594.26
B. Cropland	188.56	1.91	19.89				210.36
C. Grassland	-1,723.23	0.29	0.03				-1,722.91
D. Wetlands	237.33	5.74	0.58				243.66
E. Settlements	739.12	22.95	2.33				764.40
F. Other Land	124.96	8.25	0.84				134.05
G. Other		NE	NE				NE
6. Waste	**32,904.33**	**8,803.87**	**4,016.11**				**45,724.31**
A. Solid Waste Disposal on Land	NA,NE,NO	7,091.00					7,091.00
B. Waste-water Handling		1,636.74	1,213.58				2,850.32
C. Waste Incineration	32,248.42	76.13	2,783.87				35,108.42
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	36,731.88	45.17	333.30				37,110.35
Aviation	19,542.61	11.61	191.78				19,746.00
Marine	17,189.28	33.55	141.52				17,364.35
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]	1,345,530.83
Total CO$_2$ Equivalent Emissions with Land Use, Land-Use Change and Forestry [5]	1,260,566.12

[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 v1.2
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)	**1,154,393.81**	**26,230.97**	**26,448.16**	**15,837.00**	**7,191.30**	**5,678.65**	**1,235,779.90**
1. Energy	**1,151,578.64**	**1,719.62**	**8,469.27**				**1,161,767.52**
A. Fuel Combustion (Sectoral Approach)	1,151,546.20	877.15	8,469.17				1,160,892.52
1. Energy Industries	340,210.70	30.69	1,289.16				341,530.55
2. Manufacturing Industries and Construction	360,116.49	282.87	2,416.44				362,815.80
3. Transport	261,885.74	293.46	4,381.65				266,560.86
4. Other Sectors	188,428.41	269.55	362.92				189,060.88
5. Other	904.86	0.58	18.99				924.43
B. Fugitive Emissions from Fuels	32.44	842.47	0.10				875.00
1. Solid Fuels	NE,NO	570.30	NE,NO				570.30
2. Oil and Natural Gas	32.44	272.17	0.10				304.71
2. Industrial Processes	**54,745.15**	**147.48**	**1,414.89**	**15,837.00**	**7,191.30**	**5,678.65**	**85,014.47**
A. Mineral Products	50,677.44	NA,NO	NA,NO				50,677.44
B. Chemical Industry	3,857.00	131.64	1,414.89	IE,NE,NO	IE,NE,NO	IE,NE,NO	5,403.52
C. Metal Production	210.71	15.84	NO	IE,NE	15.70	1,147.20	1,389.46
D. Other Production	IE						IE
E. Production of Halocarbons and SF$_6$				9,709.27	1,078.70	788.70	11,576.67
F. Consumption of Halocarbons and SF$_6$ (2)				6,127.74	6,096.90	3,742.75	15,967.38
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**343.60**				**343.60**
4. Agriculture		**15,882.76**	**12,250.23**				**28,132.98**
A. Enteric Fermentation		7,305.16					7,305.16
B. Manure Management		2,622.92	4,807.13				7,430.05
C. Rice Cultivation		5,846.25					5,846.25
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	79.92				188.35
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-84,880.75**	**50.07**	**22.82**				**-84,807.87**
A. Forest Land	-84,496.48	12.34	1.25				-84,482.88
B. Cropland	175.71	1.38	17.88				194.97
C. Grassland	-1,620.96	0.21	0.02				-1,620.73
D. Wetlands	249.97	6.05	0.61				256.63
E. Settlements	629.86	21.10	2.14				653.10
F. Other Land	181.16	8.98	0.91				191.05
G. Other		NE	NE				NE
6. Waste	**32,950.78**	**8,431.05**	**3,947.35**				**45,329.18**
A. Solid Waste Disposal on Land	NA,NE,NO	6,785.58					6,785.58
B. Waste-water Handling		1,583.37	1,191.43				2,774.80
C. Waste Incineration	32,320.25	62.10	2,735.57				35,117.92
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	33,492.36	40.05	305.15				33,837.56
Aviation	18,642.28	11.08	182.95				18,836.31
Marine	14,850.08	28.97	122.20				15,001.25
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)	1,320,587.76
Total CO$_2$ Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,235,779.90

(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 v1.2
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)	**1,191,376.49**	**25,262.27**	**26,047.60**	**13,147.94**	**6,521.39**	**5,306.86**	**1,267,662.55**
1. Energy	**1,191,203.79**	**1,296.53**	**8,286.91**				**1,200,787.23**
A. Fuel Combustion (Sectoral Approach)	1,191,172.85	883.81	8,286.82				1,200,343.47
1. Energy Industries	371,369.42	32.31	1,346.47				372,748.20
2. Manufacturing Industries and Construction	366,908.21	285.93	2,428.03				369,622.16
3. Transport	256,758.85	284.01	4,117.81				261,160.66
4. Other Sectors	195,241.67	280.96	375.62				195,898.25
5. Other	894.70	0.60	18.89				914.20
B. Fugitive Emissions from Fuels	30.94	412.72	0.10				443.75
1. Solid Fuels	NE,NO	118.34	NE,NO				118.34
2. Oil and Natural Gas	30.94	294.38	0.10				325.42
2. Industrial Processes	**52,613.11**	**141.64**	**1,238.77**	**13,147.94**	**6,521.39**	**5,306.86**	**78,969.72**
A. Mineral Products	48,735.04	NA,NO	NA,NO				48,735.04
B. Chemical Industry	3,657.13	125.00	1,238.77	IE,NE,NO	IE,NE,NO	IE,NE,NO	5,020.90
C. Metal Production	220.95	16.64	NO	IE,NE	14.82	1,123.30	1,375.71
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				6,452.46	1,006.10	860.40	8,318.96
F. Consumption of Halocarbons and SF_6 (2)				6,695.48	5,500.47	3,323.16	15,519.12
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**334.05**				**334.05**
4. Agriculture		**15,709.68**	**12,152.47**				**27,862.15**
A. Enteric Fermentation		7,271.70					7,271.70
B. Manure Management		2,604.77	4,779.78				7,384.54
C. Rice Cultivation		5,729.23					5,729.23
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	77.47				181.45
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-85,395.67**	**43.23**	**19.26**				**-85,333.18**
A. Forest Land	-84,373.41	20.53	2.08				-84,350.79
B. Cropland	150.70	1.28	15.00				166.99
C. Grassland	-1,566.03	0.20	0.02				-1,565.81
D. Wetlands	72.76	1.71	0.17				74.65
E. Settlements	223.34	11.69	1.19				236.21
F. Other Land	96.96	7.82	0.79				105.57
G. Other		NE	NE				NE
6. Waste	**32,955.27**	**8,071.18**	**4,016.13**				**45,042.58**
A. Solid Waste Disposal on Land	NA,NE,NO	6,474.15					6,474.15
B. Waste-water Handling		1,534.00	1,173.85				2,707.85
C. Waste Incineration	32,378.22	63.03	2,822.93				35,264.18
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	36,728.93	42.96	335.74				37,107.63
Aviation	21,149.32	12.57	207.55				21,369.44
Marine	15,579.61	30.39	128.19				15,738.19
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)	1,352,995.73
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,267,662.55

(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 v1.2
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]	**1,189,357.55**	**24,759.14**	**25,769.80**	**12,519.09**	**6,194.39**	**4,745.95**	**1,263,345.93**
1. Energy	**1,196,518.08**	**1,237.63**	**8,011.76**				**1,205,767.46**
A. Fuel Combustion (Sectoral Approach)	1,196,483.62	839.94	8,011.65				1,205,335.21
1. Energy Industries	385,208.36	32.97	1,383.48				386,624.81
2. Manufacturing Industries and Construction	367,366.25	286.77	2,426.98				370,080.00
3. Transport	254,621.01	273.83	3,823.99				258,718.82
4. Other Sectors	188,352.32	245.74	358.05				188,956.11
5. Other	935.67	0.62	19.16				955.45
B. Fugitive Emissions from Fuels	34.46	397.69	0.11				432.26
1. Solid Fuels	NE,NO	93.86	NE,NO				93.86
2. Oil and Natural Gas	34.46	303.83	0.11				338.39
2. Industrial Processes	**52,253.05**	**133.88**	**1,259.55**	**12,519.09**	**6,194.39**	**4,745.95**	**77,105.91**
A. Mineral Products	48,603.05	NA,NO	NA,NO				48,603.05
B. Chemical Industry	3,408.43	117.38	1,259.55	IE,NE,NO	IE,NE,NO	IE,NE,NO	4,785.36
C. Metal Production	241.57	16.50	NO	IE,NE	15.11	1,013.07	1,286.26
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				5,453.01	971.40	812.60	7,237.01
F. Consumption of Halocarbons and SF_6 [2]				7,066.08	5,207.88	2,920.28	15,194.23
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**320.83**				**320.83**
4. Agriculture		**15,580.65**	**12,068.31**				**27,648.95**
A. Enteric Fermentation		7,176.22					7,176.22
B. Manure Management		2,576.76	4,753.43				7,330.19
C. Rice Cultivation		5,725.83					5,725.83
D. Agricultural Soils[3]		NA	7,240.16				7,240.16
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]	**-95,018.52**	**24.46**	**15.92**				**-94,978.14**
A. Forest Land	-93,931.51	3.90	0.40				-93,927.22
B. Cropland	152.08	1.56	13.60				167.23
C. Grassland	-1,471.54	0.24	0.02				-1,471.28
D. Wetlands	48.81	1.15	0.12				50.08
E. Settlements	177.12	11.35	1.15				189.62
F. Other Land	6.52	6.27	0.64				13.42
G. Other		NE	NE				NE
6. Waste	**35,604.95**	**7,782.53**	**4,093.43**				**47,480.91**
A. Solid Waste Disposal on Land	NA,NE,NO	6,211.80					6,211.80
B. Waste-water Handling		1,489.85	1,172.14				2,661.99
C. Waste Incineration	35,088.43	80.87	2,901.98				38,071.28
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	37,506.71	45.52	340.95				37,893.18
Aviation	20,387.64	12.12	200.08				20,599.83
Marine	17,119.07	33.40	140.87				17,293.34
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]	1,358,324.07
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry [5]	1,263,345.93

(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 v1.2
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)	**1,190,889.09**	**24,456.50**	**25,807.77**	**8,349.96**	**6,318.17**	**4,474.32**	**1,260,295.81**
1. Energy	**1,196,411.46**	**1,213.82**	**7,742.47**				**1,205,367.74**
A. Fuel Combustion (Sectoral Approach)	1,196,376.46	830.08	7,742.36				1,204,948.91
1. Energy Industries	381,821.90	32.09	1,395.52				383,249.51
2. Manufacturing Industries and Construction	372,595.10	289.68	2,447.94				375,332.72
3. Transport	254,478.37	255.96	3,522.34				258,256.66
4. Other Sectors	186,507.02	251.67	357.19				187,115.88
5. Other	974.08	0.69	19.37				994.14
B. Fugitive Emissions from Fuels	34.99	383.73	0.11				418.84
1. Solid Fuels	NE,NO	66.51	NE,NO				66.51
2. Oil and Natural Gas	34.99	317.22	0.11				352.32
2. Industrial Processes	**53,196.31**	**133.49**	**1,657.60**	**8,349.96**	**6,318.17**	**4,474.32**	**74,129.86**
A. Mineral Products	49,630.05	NA,NO	NA,NO				49,630.05
B. Chemical Industry	3,308.42	116.58	1,657.60	IE,NE,NO	IE,NE,NO	IE,NE,NO	5,082.60
C. Metal Production	257.84	16.91	NO	IE,NE	14.79	966.76	1,256.30
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				1,466.82	862.82	764.80	3,094.44
F. Consumption of Halocarbons and SF_6 (2)				6,883.15	5,440.55	2,742.77	15,066.46
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**297.54**				**297.54**
4. Agriculture		**15,524.99**	**11,991.86**				**27,516.84**
A. Enteric Fermentation		7,136.37					7,136.37
B. Manure Management		2,539.88	4,726.30				7,266.17
C. Rice Cultivation		5,747.41					5,747.41
D. Agricultural Soils(3)		NA	7,191.93				7,191.93
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		101.33	73.63				174.95
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-94,924.71**	**32.37**	**13.15**				**-94,879.19**
A. Forest Land	-93,888.33	11.54	1.17				-93,875.63
B. Cropland	114.06	1.45	10.01				125.51
C. Grassland	-1,369.13	0.22	0.02				-1,368.88
D. Wetlands	48.50	1.05	0.11				49.65
E. Settlements	171.24	11.65	1.18				184.08
F. Other Land	-1.04	6.46	0.66				6.07
G. Other		NE	NE				NE
6. Waste	**36,206.04**	**7,551.83**	**4,105.14**				**47,863.01**
A. Solid Waste Disposal on Land	NA,NE,NO	5,973.93					5,973.93
B. Waste-water Handling		1,496.95	1,188.93				2,685.88
C. Waste Incineration	35,697.77	80.95	2,896.67				38,675.39
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	39,113.12	47.56	355.43				39,516.11
Aviation	21,190.20	12.59	207.95				21,410.75
Marine	17,922.92	34.97	147.47				18,105.36
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)	1,355,175.00
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry (5)	1,260,295.81

(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.