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Acknowledgement

The Kyoto Protocol accepted by Japan in June 2002 targets the reduction of six greenhouse gases (GHGs): carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF_6). Quantified targets for reductions in emissions of greenhouse gases have been set for each of the developed nations. The target given to Japan for the first commitment period (the 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 one year before the begining of the commitment period (2007) must have in place a national system for the estimation of anthropogenic emissions by sources and removals by sinks of the aforementioned greenhouse gases. The GHGs inventories are therefore important data for Japan in reporting its achievement of the Kyoto Protocol's commitment.

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

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

In compiling GHGs inventories, the Greenhouse Gas Inventory Office of Japan (GIO) would like to acknowledge not just the work of the Committee members in seeking to develop the methodology, but those experts who made available the latest scientific knowledge, the industrial bodies and government departments and agencies that made available the data necessary to compile the inventories, and the UFJ Institute, the Suuri Keikaku Co. Ltd., and the Nomura Research Institute 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 researcher with the GIO, was responsible for writing this report and compiling the inventory files. Yukiko Yoshida, a GIO assistant fellow, created the GIO's web-site. Finally, our Secretary, Masako White conducted relevant administrative duties including the liaison with the Convention Secretariat.

September 2003

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Preface

On the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change, all Parties to the Convention are required to submit national inventories of greenhouse gas emissions and removals to the Secretariat of the Convention. Therefore, the inventories on emissions and removals of greenhouse gases and precursors from fiscal 1990 through 2001, are reported in the Common Reporting Format (CRF) and in this National Inventory Report, in accordance with UNFCCC Inventory Reporting Guidelines (FCCC/CP/1999/7).

This Report presents Japan's institutional arrangement for the inventory preparation, the estimation methods of greenhouse gas emissions and removals, the trends of 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)).

This report comprises of as follows:

The Executive Summary focusing on the most recent trends in emissions and removals of greenhouse gases in Japan.

Chapter 1 dealing with the institutional arrangement for the inventory preparation, a summary of the estimation methodology, key source category analysis, and results of uncertainty assessment.

Chapter 2 treating the latest information on trends in emissions and removals of greenhouse gases in Japan.

Chapters 3 to 8 providing detailed explanations category by categories given in the *Revised 1996 IPCC Guidelines*.

Appendices 1 to 7 offering additional information to assist in understanding Japan's inventory.

The background data submitted to the secretariat provide 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).

September 2003
Climate Change Policy Division
Global Environment Bureau
Ministry of the Environment

Executive Summary of National GHGs Inventory Report of Japan 2003

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

This National Inventory Report comprises the inventory of the emissions and removals of greenhouse gases and precursors in Japan for fiscal 1990 through to 2001, on the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change. The submission of Japan's inventories is based on the UNFCCC Reporting Guidelines on Annual Inventories (FCCC/CP/1999/7) adopted by the Conference of the Parties.

Estimation methodologies of greenhouse gas inventories have been defined by the IPCC (Intergovernmental Panel on Climate Change) in its Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereafter, Revised 1996 IPCC Guidelines). In 2000, the Good Practice and Uncertainty Management in National Greenhouse Gas Inventories (2000) (hereafter, Good Practice Guidance (2000)) was published. The Guidance presents methods for choosing methodologies appropriate to the circumstances of particular countries and quantitative methods for evaluating uncertainty. Parties are required to seek to apply the Good Practice Guidance in their inventory reporting in 2001.

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

Total greenhouse gas emission in fiscal 2001[1] (the sum of emissions of each type of greenhouse gas multiplied by its global warming potential [GWP][2]; not considering carbon dioxide removals) was 1,299 million tons (in CO_2 equivalents)[3]. Removals of carbon dioxide in FY1995 were 96.7 million tons[4], an increase of 15.3% since FY1990.

It should be noted that emissions of HFCs, PFCs, and SF_6 in the period from 1990 to 1994, and emissions and removals by land-use change and forestry sector from 1996 onward, have not been estimated (NE).

---

[1] "Fiscal" is indicated because CO_2 is the primary GHGs emissions and estimated in 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] Refer 1.8.2.1 Fuel Combustion (CO2) for detail.

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

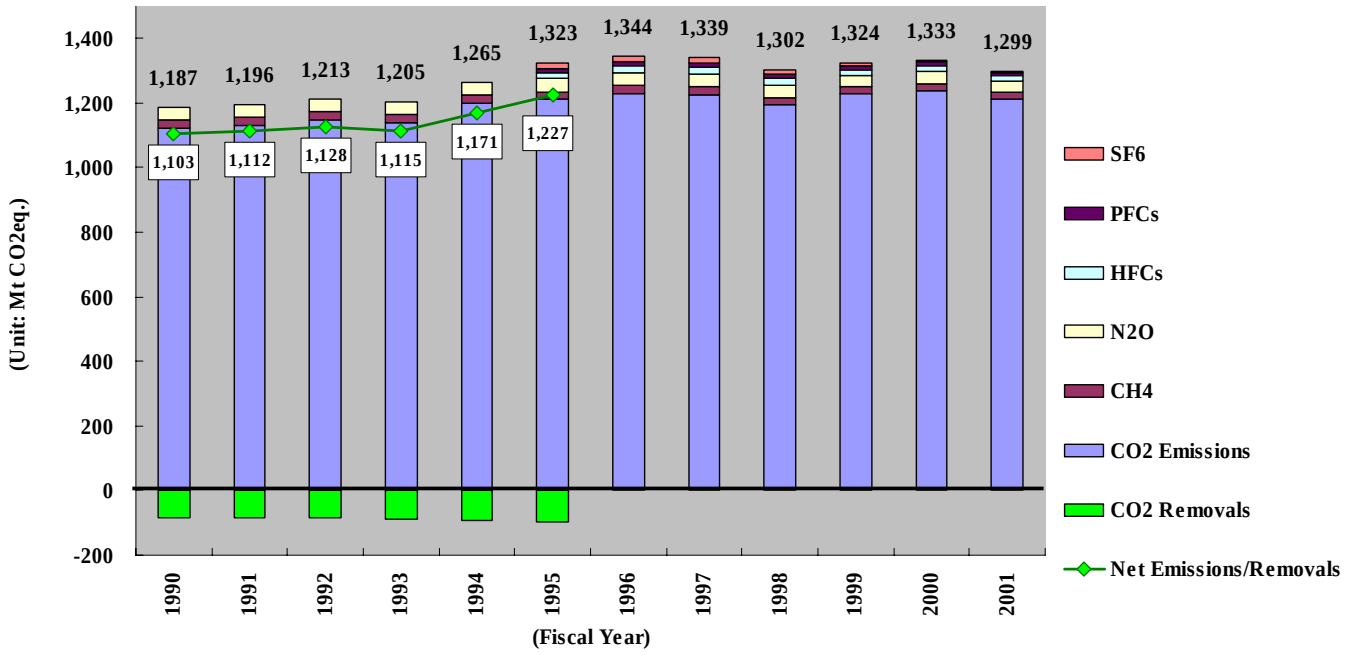


Figure 1 Trends in emission and removals of greenhouse gases in Japan[3]

* Figures in boxes represent net emissions or removals. No figures appear from 1996 onwards, however, as carbon dioxide removals have not been estimated.

Table 1 Trends in emissions and removals of greenhouse gas in Japan[3]

[Mt CO2 eq.]	GWP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO2 Emissions	1	1,122.1	1,131.2	1,148.7	1,140.4	1,200.2	1,210.9	1,231.2	1,226.8	1,195.0	1,228.2	1,238.7	1,213.7
Removals	1	▲ 83.9	▲ 83.9	▲ 85.6	▲ 90.1	▲ 93.5	▲ 96.7	NE	NE	NE	NE	NE	NE
CH4	21	24.8	24.7	24.5	24.5	24.1	23.4	22.9	22.1	21.5	21.3	20.9	20.3
N2O	310	40.2	39.7	40.0	39.7	40.6	40.8	41.7	42.2	40.8	35.1	37.8	35.4
HFCs	HFC-134a：1,300 etc.	NE	NE	NE	NE	NE	20.0	19.6	19.6	19.0	19.5	18.3	15.6
PFCs	PFC-14：6,500 etc.	NE	NE	NE	NE	NE	11.5	11.3	14.0	12.4	11.1	11.5	9.9
SF6	23,900	NE	NE	NE	NE	NE	16.7	17.2	14.4	12.8	8.4	5.7	4.5
Gross Total		1,187.1	1,195.6	1,213.2	1,204.6	1,264.9	1,323.4	1,343.9	1,339.1	1,301.6	1,323.6	1,332.9	1,299.4
Net Total		1,103.2	1,111.7	1,127.7	1,114.5	1,171.3	1,226.7	–	–	–	–	–	–

*NE: Not Estimated

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

The breakdown of emissions and removals of greenhouse gases in FY2001[1] by sector shows that the energy sector accounted for 88.5%, followed by industrial processes at 6.3%, solvents and other product use at 0.03%, agriculture at 2.6% and waste at 2.6%.

Removals by land-use change and forestry in FY1995 were 6.8% as a proportion of emissions.

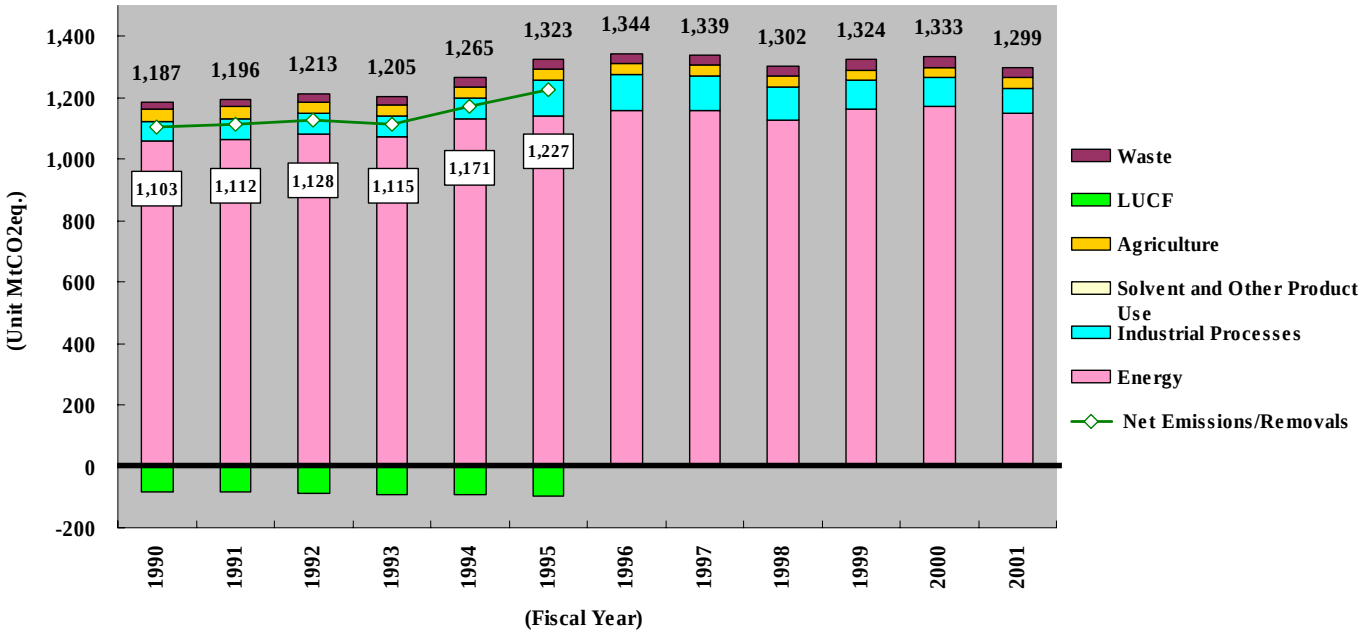


Figure 2 Trends in emissions and removals of greenhouse gases in each year[3]

* Figures in boxes represent net emissions or removals. No figures appear from 1996 onwards, however, as carbon dioxide removals have not been estimated.

Table 2 Trends in emissions and removals of greenhouse gases in each year[3]

[Mt CO2 eq.]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy	1,058.1	1,065.2	1,081.3	1,073.9	1,130.1	1,140.2	1,160.3	1,156.2	1,128.9	1,163.2	1,171.8	1,149.5
Industrial Processes	64.8	65.7	66.1	65.0	66.9	115.2	115.7	114.6	104.4	92.6	92.8	82.1
Solvent and Other Product Use	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3
Agriculture	39.0	38.8	38.7	38.6	38.0	37.1	36.2	35.4	34.9	34.4	34.1	33.8
Land Use Change and Forestry	▲ 83.8	▲ 83.8	▲ 85.5	▲ 90.0	▲ 93.5	▲ 96.6	NE	NE	NE	NE	NE	NE
Waste	24.9	25.5	26.7	26.6	29.4	30.4	31.3	32.6	33.0	33.0	33.9	33.6
Net Emissions/Removals	1,103.2	1,111.7	1,127.7	1,114.5	1,171.3	1,226.7	–	–	–	–	–	–

*NE: Not Estimated

Chapter 1. Introduction

1.1. Background Information on Greenhouse Gas Inventories and Climate Change

This National Inventory Report comprises the inventory of the emissions and removals of global greenhouse gases and precursors in Japan for fiscal 1990 through to 2001[1], on the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change. The submission of Japan's inventories is based on the *UNFCCC Reporting Guidelines on Annual Inventories* (FCCC/CP/1999/7) adopted by the Conference of the Parties.

Estimation methodologies of greenhouse gas inventories have been defined by the IPCC (Intergovernmental Panel on Climate Change) in its *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereafter, *Revised 1996 IPCC Guidelines*). 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 methods for choosing methodologies appropriate to the circumstances of particular countries and quantitative methods for evaluating uncertainty. Parties are required to seek to apply the *Good Practice Guidance* in their inventory reporting in 2001.

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

1.2. A Description of the Institutional Arrangement for Inventory Preparation

The following is an outline of the institutional arrangement for inventory preparation.

In response to international requirements and to reflect the latest scientific knowledge in Japan's inventories, the Ministry of the Environment (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, MOE compiles inventories that include identification of key source categories, uncertainty assessment, and estimates of GHGs emissions and removals.

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

The actual task of compiling the inventories, including the input of data, calculation of emissions and removals, input to the Common Reporting Format (CRF), and compilation of the National Inventory Report (NIR), is achieved with the assistance of consultants and the Greenhouse Gas Inventory Office (GIO), in the Center for Global Environmental Research of the National Institute for Environmental Studies.

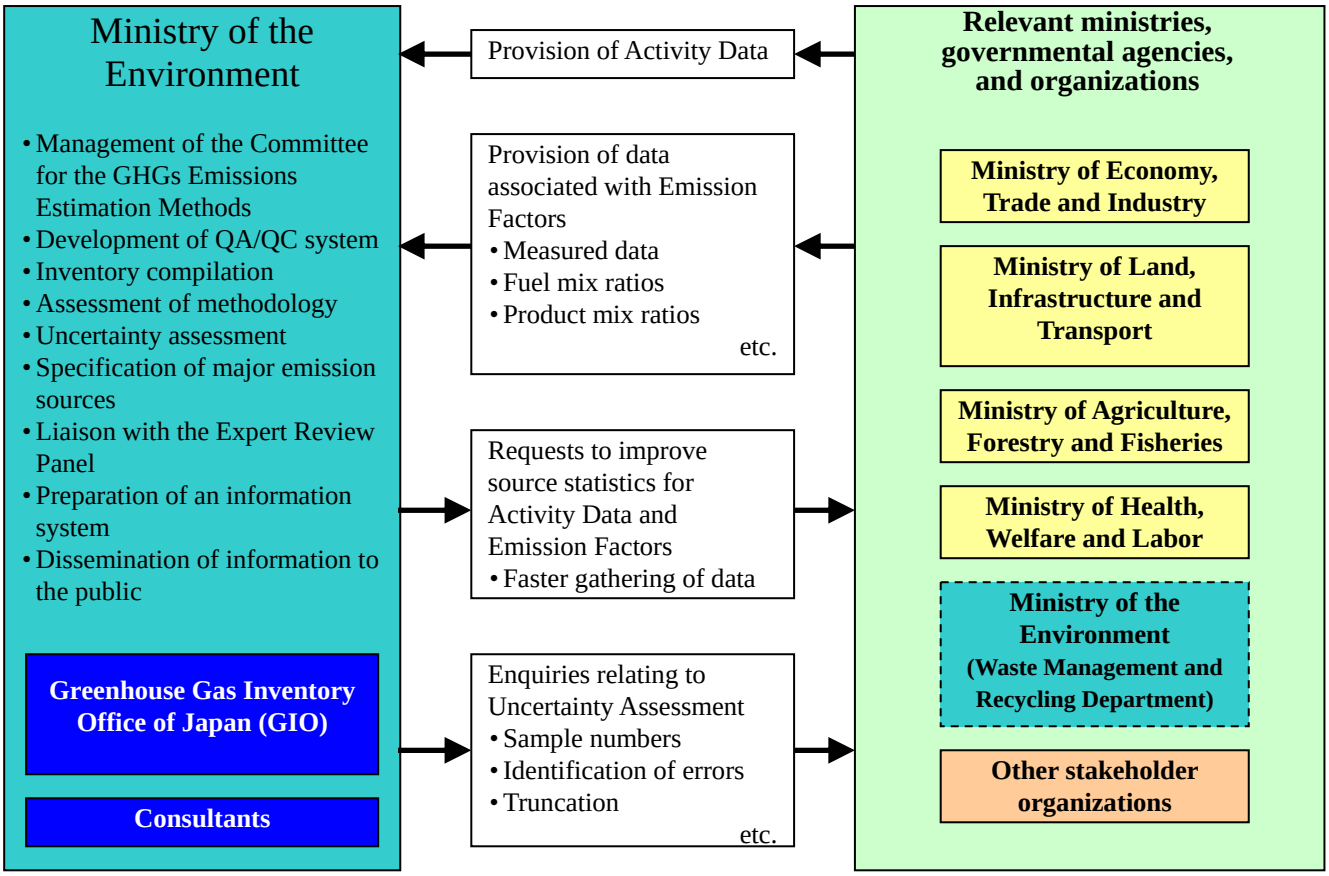
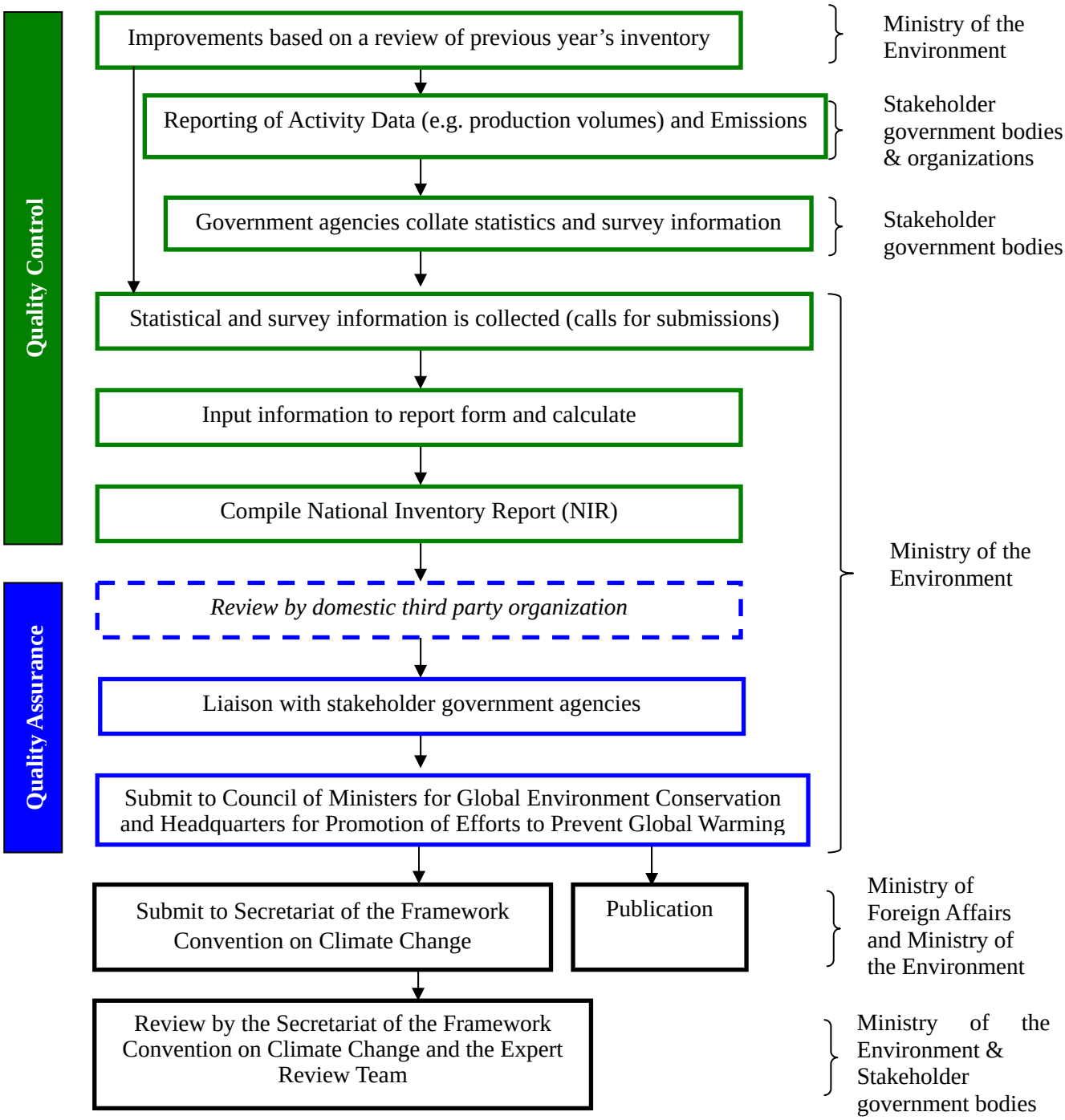


Figure 1-1 Institutional arrangement for the inventory preparation in Japan

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

The steps described bellow were followed in preparing the inventory, in order to ensure and maintain the quality control as it pertains to the completeness, accuracy and consistency of data.



N.B. Dotted lines indicate future initiatives

Figure 1-2 Process of the inventory preparation

In FY2000 and FY2002, the Ministry of the Environment (MOE) set up the first Committee for the Greenhouse Gas Emissions Estimation Methods and five breakout groups identified by field of expertise to carry out review and evaluation of methodologies. In FY2002, MOE established the inventory working group that would primarily investigate crosscutting issues. In FY2002, the Committee for the Greenhouse Gas Emissions Estimation Methods reviewed estimation methodology and uncertainty assessment from December 20, 2001, to July 10, 2003. Some 60 Japanese experts from universities, national research institutes, and industrial bodies participated in the working groups.

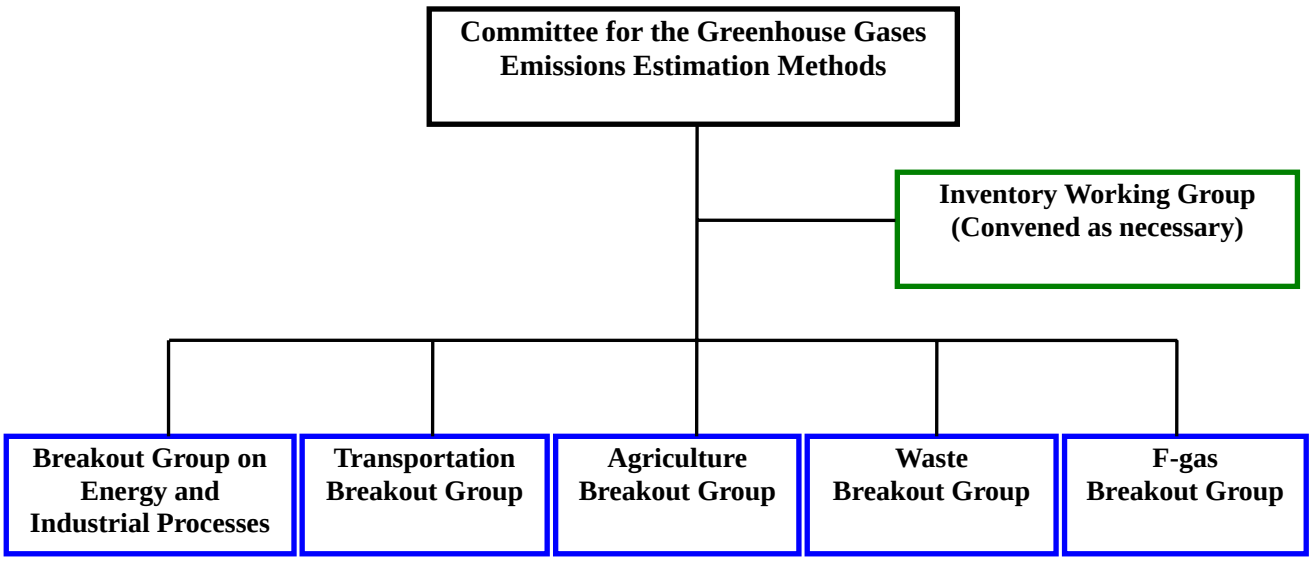


Figure 1-3 Committee for the Greenhouse Gas Emissions Estimation Methods

1.4. Brief General Description of Methodologies and Data Sources Used

The methodology used is basically same as the one given in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)*. Carbon dioxide emissions from cement production and lime production, methane emissions from rice cultivation and solid waste disposal on land etc., however, reflect the situations of emissions in Japan and the methodology used was therefore country-specific.

Basically, actual measurements or estimates from Japanese research were used for the Emission Factor. However, for categories of sources from which emissions were thought to be low (such as fugitive emissions from fuel (oil and natural gas (1B2))), and emission sources for which the reality of emissions is unsure (such as indirect emissions from soil in agricultural land (4D3)), the default values given in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)* were used.

1.5. Brief Description of Key Source Categories

Assessment was based on the analytical methods for key source categories given in the *Good Practice Guidance (2000)* (Tier 1 level assessment, or trend assessment).

Analytical results from both methods gave the following 40 source categories as Japan's key source category of emissions in fiscal 2001. Refer to Appendix 2 for more detailed results.

Table 1-1 Japan's key source categories in FY2001

	A IPCC Source Category		B Direct GHGs	Level	Trend
#1	1A Stationary Combustion	Steam Coal (imported)	CO2	#1	#1
#2	1A3 Mobile Combustion	b. Road Transportation: Gasoline	CO2	#2	#4
#3	1A Stationary Combustion	LNG	CO2	#3	#6
#4	1A3 Mobile Combustion	b. Road Transportation: Diesel Oil	CO2	#4	#9
#5	1A Stationary Combustion	Heating Oil A	CO2	#5	#23
#6	1A Stationary Combustion	Kerosene	CO2	#6	#30
#7	1A Stationary Combustion	Coke	CO2	#7	#5
#8	1A Stationary Combustion	Town Gas	CO2	#8	#8
#9	1A Stationary Combustion	Heating Oil C	CO2	#9	#10
#10	1A Stationary Combustion	Blast Furnace Gas	CO2	#10	#19
#11	1A Stationary Combustion	Refinery Gas	CO2	#11	#20
#12	1A Stationary Combustion	LPG	CO2	#12	#34
#13	2A Mineral Product	1. Cement Production	CO2	#13	#17
#14	1A Stationary Combustion	Coke Oven Gas	CO2	#14	#12
#15	1A Stationary Combustion	Heating Oil C for Power Generation	CO2	#15	#3
#16	6C Waste Incineration		CO2	#16	#16
#17	1A Stationary Combustion	PCI Coal	CO2	#17	#13
#18	1A Stationary Combustion	Diesel Oil or Gas Oil	CO2	#18	#24
#19	1A Stationary Combustion	Oil Coke	CO2	#19	#21
#20	1A Stationary Combustion	Crude Oil for Power Generation	CO2	#20	#2
#21	1A3 Mobile Combustion	a. Civil Aviation: Jet Fuel	CO2	#21	#27
#22	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#22	
#23	1A3 Mobile Combustion	d. Navigation: Heating Oil C	CO2	#23	#33
#24	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	#24	#14
#25	1A Stationary Combustion	Asphalt	CO2	#25	#31
#26	1A Stationary Combustion	Coking Coal	CO2	#26	#26
#27	1A Stationary Combustion	Converter Furnace Gas	CO2	#27	
#28	1A3 Mobile Combustion	b. Road Transportation	N2O	#28	
#29	4C Rice Cultivation		CH4	#29	
#30	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	#30	#28
#31	4D Agricultural Soils	3. Indirect Emissions	N2O	#31	
#32	1A Stationary Combustion	Indigenous Coal (underground)	CO2		#7
#33	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6		#11
#34	1A3 Mobile Combustion	e. Error: Gasoline: Diesel Oil	CO2		#15
#35	2B Chemical Industry	3. Adipic Acid Production	N2O		#18
#36	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#22
#37	1A Stationary Combustion	Indigenous Coal (open pit)	CO2		#25
#38	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#29
#39	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs		#32
#40	4C Rice Cultivation		CH4		#35

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

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

1.6.1. Uncertainty of Japan's Total Emissions in FY2001

Fiscal 2001 total emissions in Japan were approximately 1.29 billion tons (in CO_2 equivalents) [2], and uncertainty of total emissions has been assessed at 2%.

Table 1-2 Uncertainty of Japan's Total Emissions in FY2001

IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	[%]	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (CO2)	CO2	1,138,559.2	87.6%	2%	9	1.88%	1
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	2,954.8	0.2%	46%	2	0.10%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	6,876.5	0.5%	163%	1	0.86%	2
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	1,149.3	0.1%	16%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	52,068.9	4.0%	4%	8	0.14%	6
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	30,061.3	2.3%	34%	3	0.78%	4
3. Solvent & other Product Use	N2O	343.6	0.0%	5%	7	0.00%	9
4. Agriculture	CH4、N2O	33,848.2	2.6%	18%	5	0.48%	5
6. Waste	CO2、CH4、N2O	33,581.0	2.6%	32%	4	0.82%	3
Total Emissions	(D)	1,299,442.9	100.0%	(E) **2%**			

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

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

1.6.2. Sources with high degree of contribution to the uncertainty of total emissions

"The proportion of the uncertainty of each emission source to the total emission" (hereafter, "degree of contribution") is useful for looking at the degree to which the uncertainties of emissions from individual sources contribute to the uncertainty of total emissions. Table 2 ranks the top 20 sources with a high degree of contribution to uncertainty of total emissions.

[2] Refer 1.8.2.1 Fuel Combustion (CO2) for detail.

Table 1-3 Sources with a high degree of contribution to uncertainty of total emissions (top 20)

#	IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
#3	1A. Fuel Combustion - Solid Fuels - Steam Coal (imported)	CO2	205,469.4	0.5%	6.8%	7%	144	1.07%	**1**
#12	1A. Fuel Combustion - Liquid Fuels - Gasoline	CO2	138,644.4	0.6%	8.5%	9%	138	0.91%	**2**
#31	1A. Fuel Combustion (Transport) - a. Civil Aviation	N2O	106.9	10000.0%	5.0%	10000%	**1**	0.82%	**3**
#25	1A. Fuel Combustion - Gaseous Fuels - LNG	CO2	104,985.8	2.3%	9.3%	10%	134	0.77%	**4**
#70	2. Industrial Processes - E. Production of F-gas - 1. By-product Emissions (HCFC-22)	HFCs	9,336.6	100.0%	5.0%	100%	42	0.72%	**5**
#159	6. Waste - C. Waste Incineration - Industrial Solid Waste	CO2	11,680.8	—	—	71%	59	0.64%	6
#16	1A. Fuel Combustion - Liquid Fuels - Diesel Oil or Gas Oil	CO2	109,437.0	0.4%	5.8%	6%	146	0.49%	7
#5	1A. Fuel Combustion - Solid Fuels - Coke	CO2	63,537.0	5.0%	8.2%	10%	133	0.47%	8
#156	6. Waste - C. Waste Incineration - Municipal Solid Waste	CO2	12,825.0	11.2%	44.8%	46%	94	0.46%	9
#19	1A. Fuel Combustion - Liquid Fuels - Heating Oil C	CO2	87,974.3	0.5%	4.3%	4%	158	0.30%	10
#15	1A. Fuel Combustion - Liquid Fuels - Kerosene	CO2	70,443.9	0.2%	5.2%	5%	152	0.28%	11
#27	1A. Fuel Combustion - Gaseous Fuels - Town Gas*	CO2	54,695.8	5.0%	3.9%	6%	145	0.27%	12
#33	1A. Fuel Combustion (Transport) - b. Road Transportation	N2O	6,350.9	50.0%	5.0%	50%	85	0.25%	13
#127	4. Agriculture - D. Agricultural Soils - 3. Indirect Emissions - N Leaching & Run-off	N2O	3,764.4	—	—	84%	52	0.24%	14
#17	1A. Fuel Combustion - Liquid Fuels - Heating Oil A	CO2	80,651.9	0.6%	3.8%	4%	160	0.24%	15
#8	1A. Fuel Combustion - Solid Fuels - Blast Furnace Gas	CO2	40,054.7	5.0%	5.0%	7%	141	0.22%	16
#120	4. Agriculture - D. Agricultural Soils - 1. Direct Soil Emissions - Synthetic Fertilizers	N2O	2,156.9	—	—	130%	26	0.22%	17
#106	4. Agriculture - B. Manure Management - Non-Dairy Cattle	N2O	3,669.7	—	—	72%	58	0.20%	18
#23	1A. Fuel Combustion - Liquid Fuels - Refinery Gas	CO2	33,599.8	1.0%	7.6%	8%	140	0.20%	19
#89	2. Industrial Processes - F. Consumption of F-gas - 6. Semiconductor Manufacture	PFCs	3,860.7	50.0%	40.0%	64%	63	0.19%	20

1.7. Recalculation

The major points recalculated from the submission in the previous year are indicated below. Refer to the worksheet "*Table8(a)s1*", "*Table8(a)s2*" and "*Table8(b)*" of "*CRF-****-v01-JPN-2003.xls*" for details of the recalculation.

1.7.1. Energy (Category1)

- The methodology is improved because of the overall revision of General Energy Statistics (Agency for Natural Resources and Energy) used for the estimation of CO_2 emissions from fuel combustion.

1.7.2. Industrial Processes (Category2)

- Limestone consumption indicated in the *Yearbook of ceramics and building materials statistics* from FY1990 to FY 1992 does not include the cement used as raw material for solidification agent. Therefore, these data are recalculated with the production of cement including raw material cement for solidification agent.

1.7.3. Across the Sectors

- The latest activity data in the previous submission are recalculated because of the revision of statistics.

1.8. Further Inventory Development

For further inventory development, following issues need to be addressed.

1.8.1. Crosscutting Issues

- Japan has reported its emissions of greenhouse gases every fiscal year (April to March). However, the values are required to report by calendar year in accordance with the *Revised 1996 IPCC Guideline* in the course of calculation of greenhouse gas emissions and removals. Estimation of GHG emissions in fiscal year does not satisfy the requirement by the Revised 1996 IPCC Guidelines, in which the countries are required to estimate GHG emissions in calendar year basis. However, it is difficult to assure consistency and accuracy in recalculating the past statistics under calendar year basis. Efforts are being made to collect future data on a calendar year basis.

- With regard to the sources reported as "NE", review of emission status is needed considering the potential emissions theoretically.

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

1.8.2. Energy (Category1)

1.8.2.1. Fuel Combustion (CO_2)

- In the current inventories, emission factors of liquid fuels such as crude oil, oil products, refinery gas, etc. are fixed from 1990 to following years. Analysis of the oil refinery sector of the inventories in detail revealed that carbon content in crude oil input to refinery is not balanced with those in each oil product and refinery gas. Essentially, in the oil refinery sector, carbon input and output should be balanced. The current method therefore has issues to be addressed. Difference of national total emissions relating to this issue would be a few percent, therefore, to address those issues mention above immediate actions need to be taken.[3]

- Carbon included in solvents emitted to atmosphere as NMVOC is converted to CO_2 with atmospheric oxidation in short time. Reporting these CO_2 in the inventory is indicated in the new *UNFCCC Reporting Guidelines on Annual Inventories*[4] adopted in COP8. From 2004, inclusion of these emissions as part of inventory should be

[3] The discussion on the issue is currently under way. Newly established emissions based on the conclusions reached in the discussion might be presented to the reviewers during the in-country-review of inventory in 2003.

[4] FCCC/CP/2002/8

conducted and the framework of CO_2 emission estimate including the emissions such as NMVOC emissions from solvent use and cascade usage of by-product fuel should be reviewed.

- Discharged synthetic detergent and interfacial active agent within a watershed are decomposed in sewage works and generate greenhouse gases. In the current inventory, these emissions are not estimated. The review of these emission estimates may be conducted. The method adjusting the deduction ratio of fuel used as feedstock of chemical industry may be one option.

- In the current inventory, waste used as fuel in sectors other than the waste treatment may not be captured. The *Revised 1996 IPCC Guidelines* mentions "Incineration of waste for waste-to-energy facilities should be reported here (category1 energy sector) and not under Section 6C." [5] However, these emissions are reported under Section 6C.

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

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

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

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

- CH_4 and N_2O emissions from natural gas vehicles and motorcycles are not estimated. Methods for these emissions are needed.

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

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

1.8.3. Industrial Processes (Category2)

1.8.3.1. Non-F-gas

- Country-specific method is still applied to the sources below. Application of the *Good Practice Guidance (2000)* to these sources needs to be reviewed.
  - CO_2 emissions from lime production (category 2A2)
  - CO_2 emissions from iron and steel production (category 2C1)
- Carbon contained in the fuel for non-energy use as reduction agent in metal production may not be captured. Therefore estimation method needs to be reviewed.

1.8.3.2. F-gas

- A few type of PFCs that are additional GHGs for which 100-year GWP values are not yet adopted by the COP is used in Japan. Current status of consumption of these gases are needed and the knowledge of these PFCs' GWP should be reported.

- Reporting of F-gas is based on the Documentation from the Chemical and Bio Sub-Group, Industrial Structure Council, the Ministry of Economy, Trade and Industry. The Chemical and Bio Sub-Group is currently discussing on the improvement of estimation methods for F-gas in order to meet the requirement by the *Good Practice Guidance* (2000).

- Some substances of F-gas treated by few companies are reported with aggregated data because of the confidentiality. However, some sources mentioned above have large amount of emissions. When the treatment guidance of confidential data is decided by COP, handling of these data along the guidance would be needed.

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

1.8.4. Agriculture (Category4)

- Multiple statistics are used in Japan's inventories. In the case of calculating the total amount of estimation of many kinds of farm products, taking care of difference among statistics such as different definition is important. The estimation for total growing area of farmland has same issues.

1.8.5. Land-Use Change and Forestry (Category5)

- Emissions and removals from 1996 onward should be reported after an application of estimation methods to *LULUCF GPG* is thoroughly examined since the completion of GPG is scheduled in December 2003.

1.8.6. Waste (Category6)

- Discharged synthetic detergent and interfacial active agent within a watershed are decomposed in sewage works and generate greenhouse gases. In the current inventory, these emissions are not estimated. The review of these emission estimates may be conducted. The method adjusting the deduction ratio of fuel used as feedstock of chemical industry may be one option. (*Previously mentioned in 1.8.2.1. Fuel Combustion (CO_2)*)

- In the current inventory, waste used as fuel in sectors other than the waste treatment may not be captured. The *Revised 1996 IPCC Guidelines* mentions "Incineration of waste for waste-to-energy facilities should be reported here (category1 energy sector) and not under Section 6C." However, these emissions are reported under Section 6C. (*Previously mentioned in 1.8.2.1. Fuel Combustion (CO_2)*)

- Generally, usage of recycled waste encourages society with an environmentally-sound material cycle and is expected to decrease GHGs national total emissions. The method provided by the *Revised 1996 IPCC Guidelines*, in which emissions from waste-to-energy facilities should be reported under the energy sector, aims to account the accurate national total emissions. If these emissions which were part of waste sector are accounted in the energy sector according to the *IPCC Guidelines*, it might discourage the incentive for promoting thermal recycle or chemical recycle. Therefore, the evaluation method which does not discourage recycling should be considered as other methods than methods of inventories.

- In category 6C: "municipal solid waste incineration", CO_2 emissions are estimated only from plastics derived from fossil fuels. Synthetic fibers incinerated are not captured as activity data. Therefore, collection of the activity data should be improved.

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 2001[1] (the sum of emissions of each type of greenhouse gas multiplied by its global warming potential [GWP][2]; not considering carbon dioxide removals) was 1,299 million tons (in CO_2 equivalents)[3]. Removals of carbon dioxide in FY1995 were 96.7 million tons[4], an increase of 15.3% since FY1990.

It should be noted that emissions of HFCs, PFCs, and SF_6 in the period from 1990 to 1994, and emissions and removals by land-use change and forestry sector from 1996 onward, have not been estimated (NE).

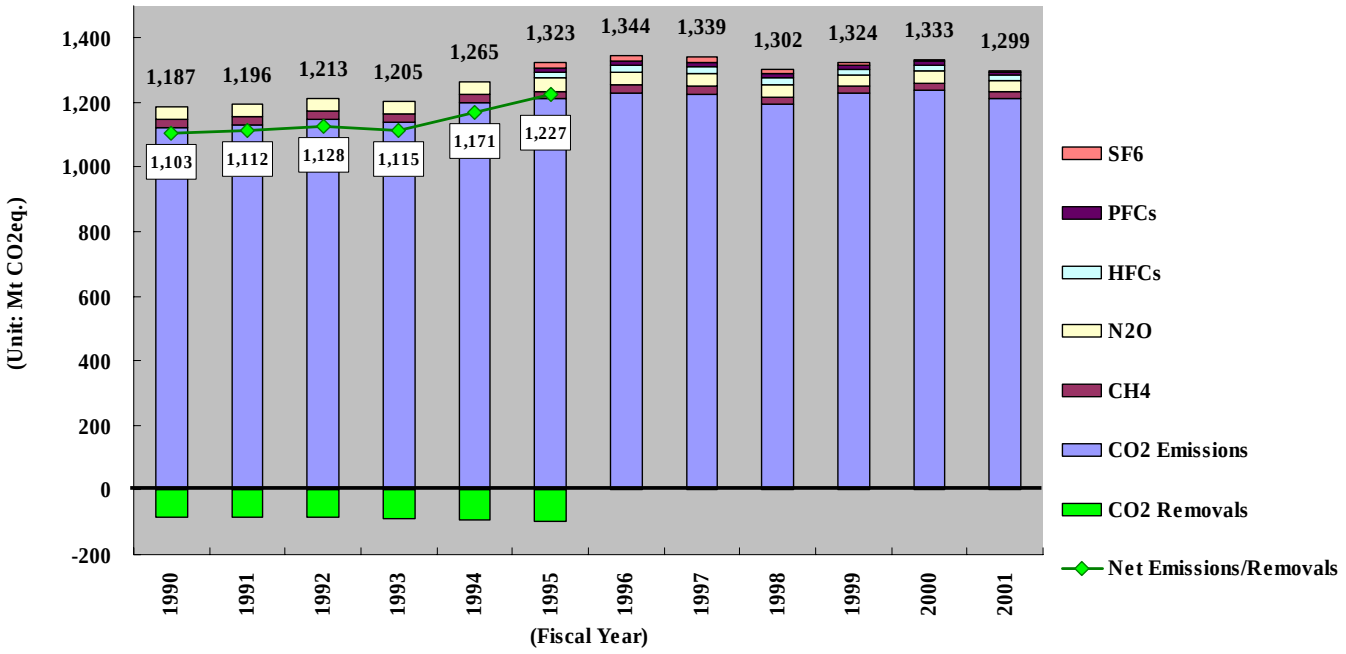


Figure 2-1 Trends in emission and removals of greenhouse gases in Japan[3]

* Figures in boxes represent net emissions or removals. No figures appear from 1996 onwards, however, as carbon dioxide removals have not been estimated.

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[1] "Fiscal" is indicated because CO_2 is the primary GHGs emissions and estimated in 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] Refer 1.8.2.1 Fuel Combustion (CO2) for detail.

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

2.1.2. Per Capita CO_2 Emissions

Total carbon dioxide emissions in fiscal 2001 were 1,214 million tons[3], giving a per capita emission of 9.53 tons. Compared to fiscal 1990, it represents an increase in total carbon dioxide emissions of 8.2%, or a per capita increase in carbon dioxide emissions of 5.0%. Total carbon dioxide emissions compared to the previous year were a decrease of 2.0%, a per capita decrease of 2.3%.

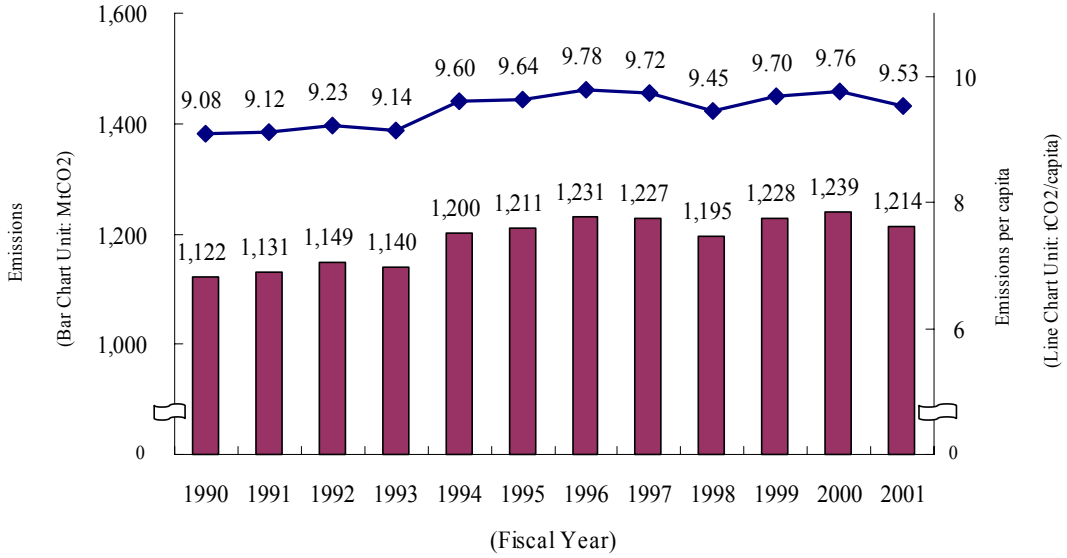

Figure 2-2 Trends in total CO_2 emissions and per capita CO_2 emissions[3]

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 2001 were 2,280 tons/billion yen. This is a decline of 4.5% on fiscal 1990, and a decline of 0.6% on the previous year.

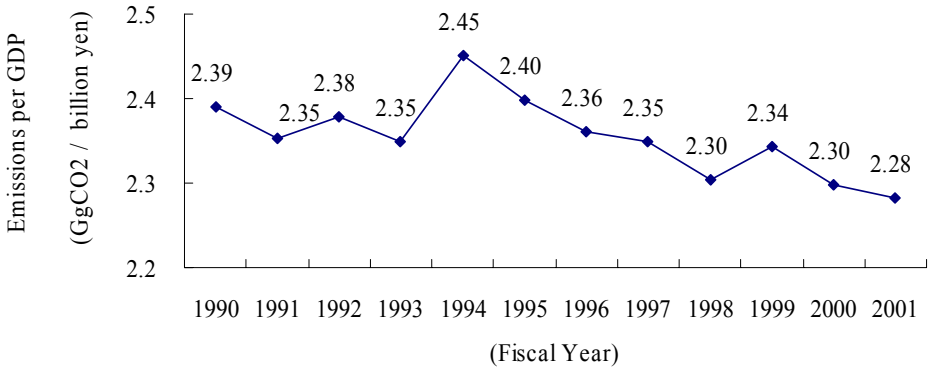

Figure 2-3 Trends in CO_2 emissions per unit of GDP[3]

Source of GDP: Economic and Social Research Institute, *Annual Report on National Accounts of 2001 CD-ROM*（SNA93 Category: GDP）

2.2. Description and Interpretation of Emissions and Removals by Gases[5]

A breakdown of emissions of greenhouse gases in fiscal 2001[3] shows that carbon dioxide accounts for the large portion.

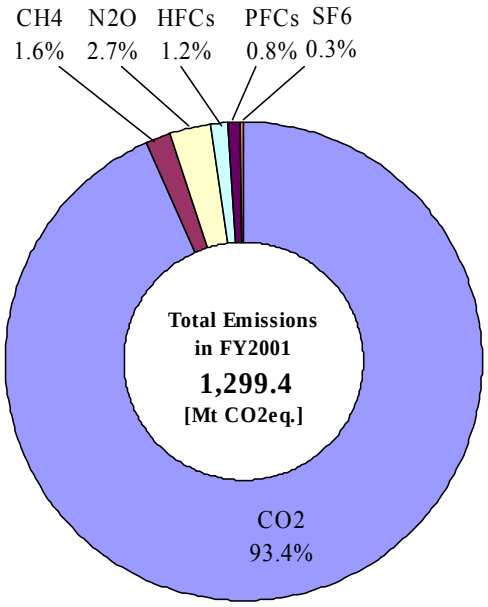

Figure 2-4 Breakdown of individual greenhouse gases in FY2001[3]

Emissions of carbon dioxide in FY2001[3] were 1,214 million tons, comprising 93.4% of the total. The table represents an increase of 8.2% on fiscal 1990[3], and a year-on-year decrease of 2.0%. Removals of CO_2 in FY1995[6] were 96.7 million tons, equivalent to 7.3% of total annual greenhouse gas emissions. The table represents an increase of 15.3% on FY1990, and a year-on-year increase of 3.4%.

Emissions in FY2001 of CH_4 were 20.3 million tons (in CO_2 eq.), comprising 1.6% of total emissions. The figure represents a reduction of 18.0% on FY1990, and 2.5% year-on-year. Emissions in FY2001 of N_2O were 35.4 million tons (in CO_2 eq.), comprising 2.7% of total emissions. The figure represents a reduction of 12.0% on FY1990, and a year-on-year decrease of 6.4%.

Emissions in CY2001 of HFCs were 15.6 million tons (in CO_2 eq.), comprising 1.2% of total emissions. The figure represents a reduction of 22.1% on CY1995, and 15.0% year-on-year. Emissions in CY2001 of PFCs were 9.9 million tons (in CO_2 eq.), comprising 0.8% of total emissions. The figure represents a reduction of 13.7% on CY1995, and 13.6% year-on-year. Emissions in CY2001 of SF_6 were 4.5 million tons (in CO_2 eq.), comprising 0.3% of total emissions. The figure represents a reduction of 72.9% on CY1995, and 21.0% year-on-year.

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[5] Refer 1.8.1 Crosscutting Issues for detail.

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

Table 2-1 Trends in emissions and removals of greenhouse gas in Japan[3]

[Mt CO2 eq.]	GWP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO2 Emissions	1	1,122.1	1,131.2	1,148.7	1,140.4	1,200.2	1,210.9	1,231.2	1,226.8	1,195.0	1,228.2	1,238.7	1,213.7
Removals	1	▲ 83.9	▲ 83.9	▲ 85.6	▲ 90.1	▲ 93.5	▲ 96.7	NE	NE	NE	NE	NE	NE
CH4	21	24.8	24.7	24.5	24.5	24.1	23.4	22.9	22.1	21.5	21.3	20.9	20.3
N2O	310	40.2	39.7	40.0	39.7	40.6	40.8	41.7	42.2	40.8	35.1	37.8	35.4
HFCs	HFC-134a：1,300 etc.	NE	NE	NE	NE	NE	20.0	19.6	19.6	19.0	19.5	18.3	15.6
PFCs	PFC-14：6,500 etc.	NE	NE	NE	NE	NE	11.5	11.3	14.0	12.4	11.1	11.5	9.9
SF6	23,900	NE	NE	NE	NE	NE	16.7	17.2	14.4	12.8	8.4	5.7	4.5
Gross Total		1,187.1	1,195.6	1,213.2	1,204.6	1,264.9	1,323.4	1,343.9	1,339.1	1,301.6	1,323.6	1,332.9	1,299.4
Net Total		1,103.2	1,111.7	1,127.7	1,114.5	1,171.3	1,226.7	–	–	–	–	–	–

*NE: Not Estimated

2.2.1. CO_2[7]

CO_2 emissions in FY2001 were 1,214 million tons, an increase of 8.2% on FY1990, and decline of 2.0% year-on-year.

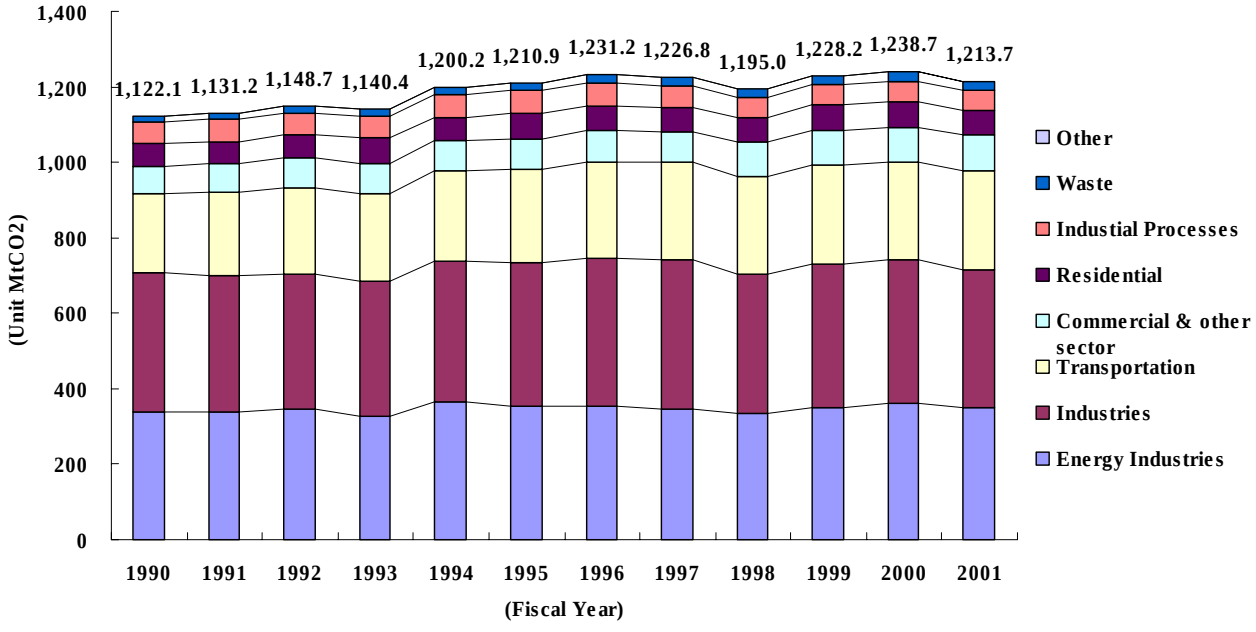

Figure 2-5 Trends in CO_2 emissions[3]

The breakdown of CO_2 emissions in FY2000 shows that carbon dioxide emitted in

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

association with the combustion of fuel accounted for 93.8% of the total, carbon dioxide from industrial processes accounted for 4.2%, and carbon dioxide from the waste sector accounted for 2.0%.

The industrial sector accounts for 30% of emissions of CO_2 from fuel combustion, making it the single largest source of emissions. It is followed by the energy conversion sector at 29% and the transport sector at 21%.

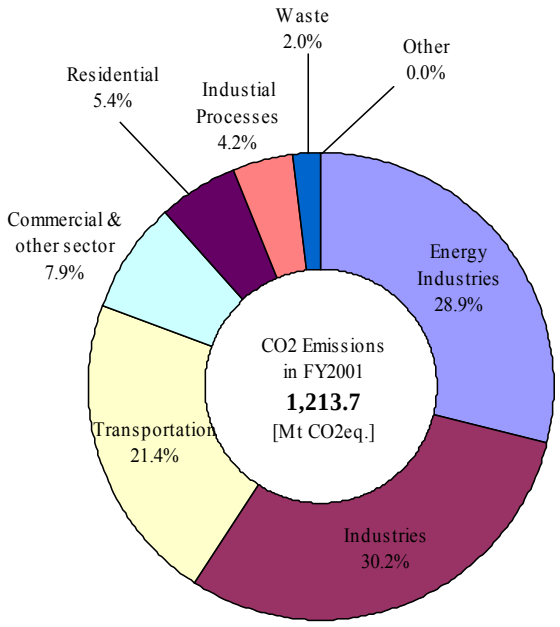

Figure 2-6 Breakdown of FY2001 CO_2 emissions[3]

Fluctuations in emissions by sector show that CO_2 emissions from fuel combustion in the industrial sector, which accounts for 30% of CO_2 emissions, decreased 0.7% compared toFY1990, and decreased 3.3% year-on-year.

CO_2 emissions from fuel combustion in the energy industries increased 3.6% compared to FY1990, and decreased 3.1% year-on-year.

CO_2 emissions from fuel combustion in the transportation increased 23.6% compared to FY1990, and 0.9% year-on-year.

CO_2 emissions from fuel combustion in the commercial and other sector increased 30.8% compared to FY1990, and 2.8% year-on-year.

CO_2 emissions from fuel combustion in the residential sector increased 14.6% compared to FY1990, and 5.0% year-on-year.

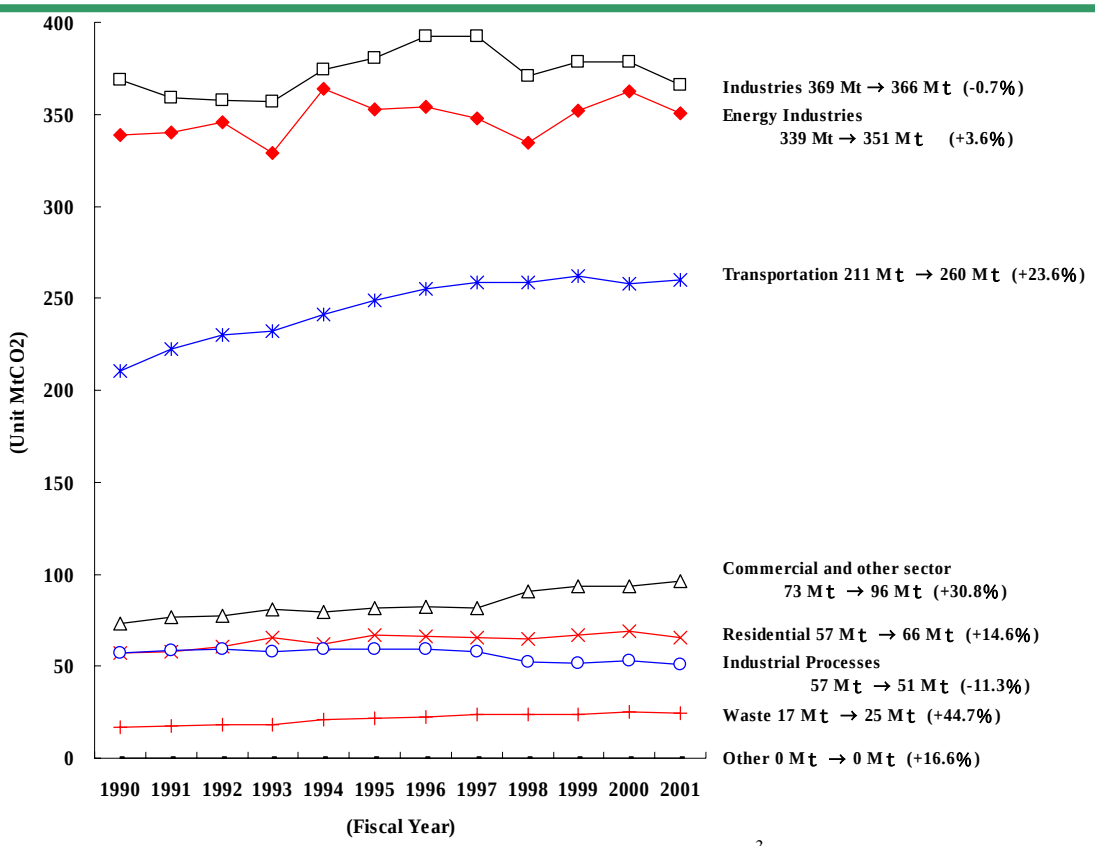

Figure 2-7 Trends in CO_2 emissions in each sector[3]

Table 2-2 Trends in CO_2 emissions in each sector[3]

Category	1990	1995	1999	2000	2001
1A. Fuel Combustion	1,048,171.96	1,130,066.80	1,152,427.43	1,160,959.48	1,138,559.17
Energy Industry	338,571.94	352,633.54	351,588.59	362,158.21	350,769.54
Public Electricity & Heat Production	296,840.62	311,936.88	314,031.87	324,818.69	316,823.30
Petroleum Refining	14,321.95	16,479.81	16,032.88	16,321.98	16,207.54
Manufacture of Solid Fuel and Other Energy Industry	27,409.37	24,216.85	21,523.85	21,017.53	17,738.70
Industries	368,502.10	380,313.13	378,158.38	378,568.09	366,055.18
Iron and Steel	147,527.92	142,067.05	164,584.07	143,361.91	139,314.05
Non-Ferrous Metals	5,380.87	4,183.02	3,006.59	2,868.61	2,717.34
Chemicals	151,387.14	151,749.54	67,577.90	67,175.92	64,400.94
Pulp & Paper	25,226.87	28,991.78	27,930.18	28,678.45	27,976.76
Food Processing, Beverage and Tobacco	8,202.70	7,927.85	9,551.02	9,170.10	9,170.10
Other Manufacturing	-2,675.71	11,495.52	76,519.82	97,522.39	92,685.27
Agriculture, Forestry and Fisheries	33,452.31	33,898.37	28,988.80	29,790.72	29,790.72
Transport	210,500.04	248,530.41	261,923.03	257,936.52	260,221.63
Civil Aviation	7,162.95	10,278.98	10,532.15	10,677.61	10,724.68
Road Transportation	192,655.38	232,794.19	249,361.95	249,250.45	252,579.23
Railways	941.98	828.30	734.54	707.44	677.16
Navigation	13,362.39	14,371.12	14,361.34	14,777.39	14,313.13
Other Transportation	-3,622.66	-9,742.19	-13,066.95	-17,476.36	-18,072.56
Commercial and Residential	130,597.89	148,589.72	160,757.42	162,296.66	161,512.82
Commercial & other sector	73,321.97	81,743.10	93,635.72	93,226.72	95,875.91
Residential	57,275.91	66,846.62	67,121.71	69,069.94	65,636.91
Other	0.00	0.00	0.00	0.00	0.00
1B. Fugitive Emissions from Fuel	0.51	0.60	0.58	0.61	0.60
2. Industrial Processes	57,008.97	59,213.29	51,885.07	52,797.32	50,592.04
Mineral Products	53,465.31	55,588.39	48,381.05	49,403.45	47,374.96
Chemical	3,543.66	3,624.90	3,504.02	3,393.87	3,217.08
6. Waste	16,935.48	21,627.24	23,928.57	24,941.66	24,505.85
Total	1,122,116.92	1,210,907.93	1,228,241.66	1,238,699.07	1,213,657.66

2.2.2. CH_4

Methane emissions in FY2001 were 20.3 million tons (in CO_2 equivalents), a decrease of 18.0% compared to FY1990, and 2.5% year-on-year.

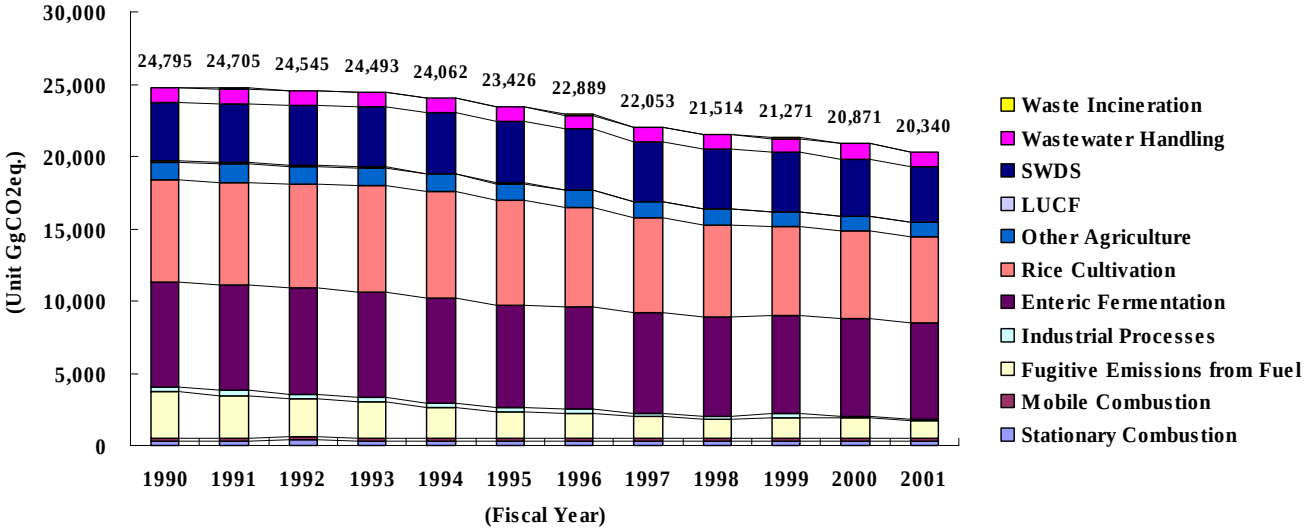

Figure 2-8 Trends in CH_4 emissions

The breakdown of methane emissions in FY2001 shows that methane emitted from enteric fermentation in livestock accounted for 33% of the total, making it the single largest source of emissions. It is followed by methane emissions from rice cultivation at 29%, and methane emissions from SWDS (Solid Waste Disposal Site) at 19%.

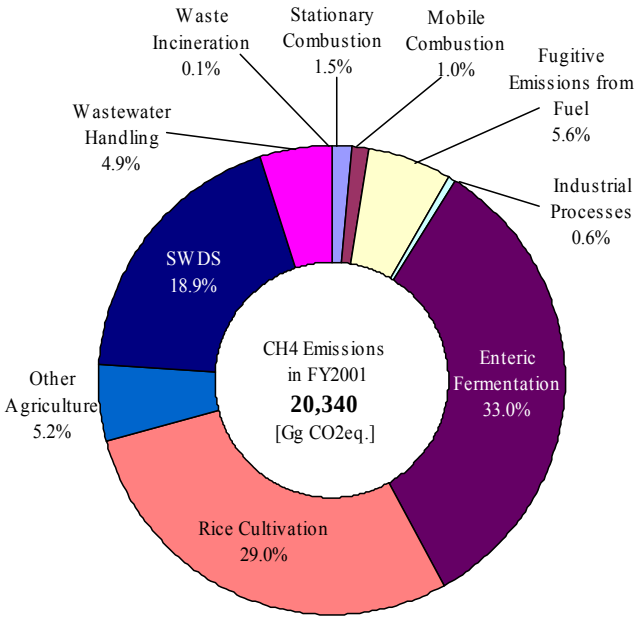

Figure 2-9 Breakdown of FY2001 CH_4 emissions

Table 2-3 Trends in CH_4 emissions

[Gg CO2eq.]

Category	1990	1995	1999	2000	2001
1A. Fuel Combustion	531.51	547.44	522.70	537.07	520.34
1A1. Energy Industries	-32.67	-35.60	-41.01	-41.89	-41.89
1A2. Industries	227.51	213.96	199.03	204.45	204.52
1A3. Transport	194.96	208.03	216.02	220.29	213.02
1A4. Residential / Institutional	141.70	161.05	148.67	154.22	144.69
1B. Fugitive Emissions from Fuels	3,176.12	1,761.47	1,439.81	1,338.53	1,148.74
1B1. Solid Fuels	2,806.43	1,344.68	1,004.76	887.20	701.72
1B2. Oil & Natural Gas	369.69	416.78	435.05	451.33	447.02
2. Industrial Processes	337.80	303.30	219.48	163.74	131.47
4. Agriculture	15,568.88	15,478.67	14,008.72	13,842.38	13,676.93
4A. Enteric Fermentation	7,249.10	7,118.91	6,809.37	6,759.68	6,712.35
4B. Manure Management	1,072.55	991.38	937.67	927.87	919.83
4C. Rice Cultivation	7,075.73	7,200.86	6,125.26	6,018.51	5,907.16
4D. Agricultural Soils	3.06	2.75	2.35	2.30	2.26
4F. Field Burning of Agricultural Residue	168.45	164.77	134.07	134.03	135.32
5. LUCF	53.07	86.37	NE	NE	NE
6. Waste	5,128.07	5,248.42	5,080.60	4,989.62	4,862.26
6A. SWDS	4,044.84	4,238.80	4,063.63	3,963.26	3,852.88
6B. Wastewater Handling	1,069.69	997.03	1,004.67	1,013.73	996.81
6C. Waste Incineration	13.54	12.59	12.30	12.64	12.57
Total	24,795.46	23,425.66	21,271.31	20,871.35	20,339.74

2.2.3. N_2O

N_2O emissions in FY2001 were 35.4 million tons (in CO_2 equivalents), a decrease of 12.0% compared to FY1990, and of 6.4% year-on-year. In FY1999, N_2O cracking facilities came on stream in the adipic acid production plant, causing a sharp decline in emissions from industrial processes during the period from FY1998 to FY1999. In FY2000, N_2O emissions increased because of the decrease in operational rate of the cracking facilities. In 2001, N_2O emissions decreased with normal operation of those facility.

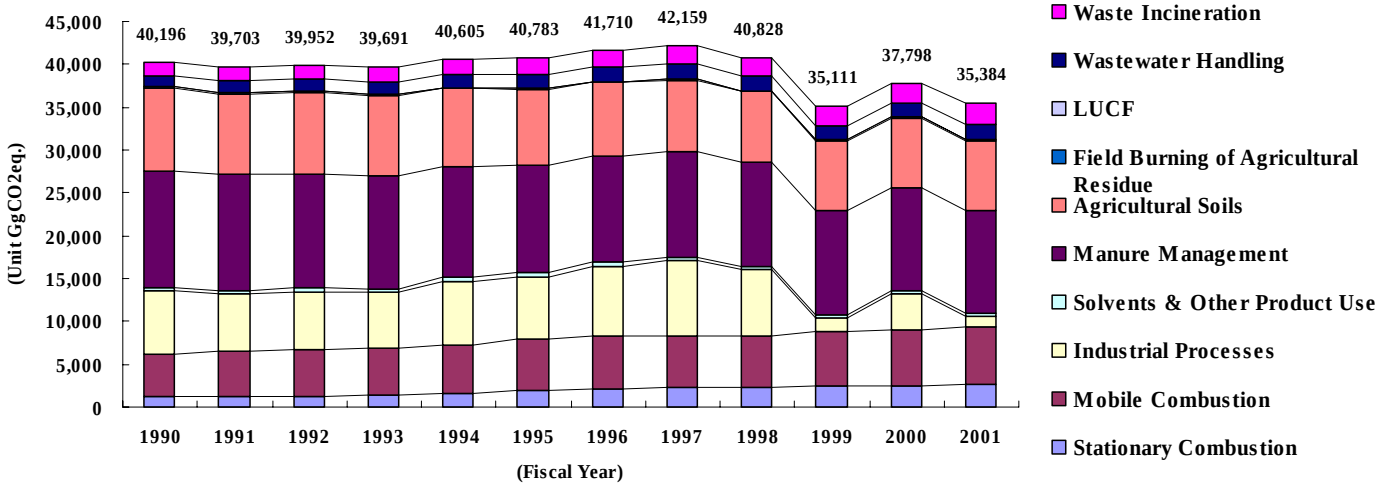

Figure 2-10 Trends in N_2O emissions

The breakdown of nitrous oxide emissions in FY2001 shows that emissions from manure management accounted for 34% of the total, making it the single largest source of emissions. It is followed by emissions from agricultural soils at 23%, and emissions from fuel combustion of motor vehicles and other mobile sources of 19%.

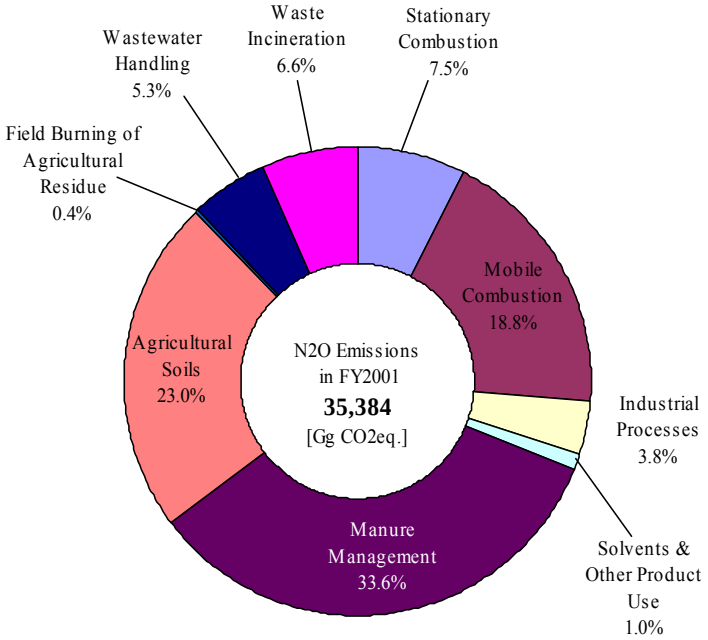

Figure 2-11 Breakdown of FY2001 N_2O emissions

Table 2-4 Trends in N_2O emissions

[Gg CO2eq.]

Category	1990	1995	1999	2000	2001
1A. Fuel Combustion	6,222.18	7,872.67	8,852.04	8,980.06	9,311.00
1A1. Energy Industries	300.30	722.52	827.33	839.59	854.56
1A2. Industries	847.81	1,218.84	1,562.86	1,567.71	1,733.91
1A3. Transport	5,022.68	5,863.32	6,397.19	6,503.41	6,663.51
1A4. Residential / Institutional	51.39	67.99	64.67	69.35	59.02
2. Industrial Processes	7,415.36	7,367.54	1,561.43	4,214.53	1,345.42
3. Solvent & Other Product Use	287.07	437.58	362.53	340.99	343.60
4. Agriculture	23,410.56	21,573.37	20,377.70	20,267.87	20,171.26
4B. Manure Management	13,534.20	12,635.26	12,093.12	11,989.93	11,897.20
4D. Agricultural Soils	9,746.46	8,797.91	8,151.76	8,144.45	8,136.00
4F. Field Burning of Agricultural Residue	129.90	140.19	132.82	133.48	138.06
5. LUCF	5.39	8.77	NE	NE	NE
6. Waste	2,855.12	3,523.22	3,956.90	3,994.39	4,212.91
6B. Wastewater Handling	1,269.61	1,539.67	1,711.34	1,724.37	1,872.18
6C. Waste Incineration	1,585.51	1,983.55	2,245.55	2,270.02	2,340.73
Total	40,195.67	40,783.15	35,110.60	37,797.84	35,384.19

2.2.4. HFCs

Emissions of HFCs in 2001[8] were 15.6 million tons (in CO_2 equivalents), a decrease of 22.1% compared to 1995, and 15.0% year-on-year.

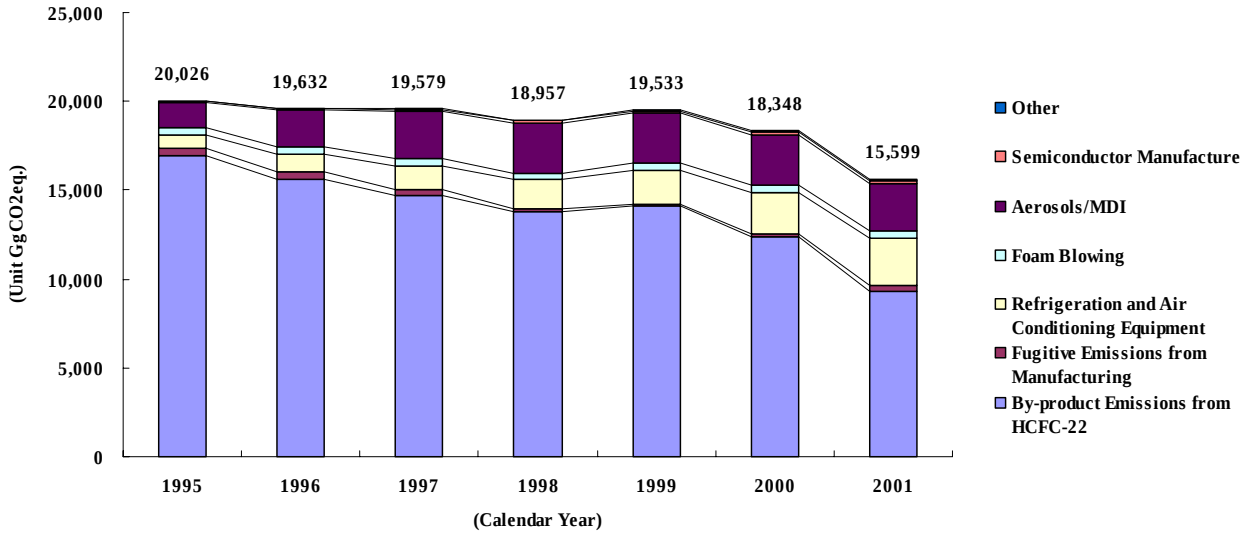

Figure 2-12 Trends in HFCs emission

The breakdown of HFCs emissions in 2001 shows that by-product HFC-23 emission during production of HCFC-22 accounted for 60% of the total, followed by emissions from aerosols / MDI at 17%, and emissions from refrigerants of refrigeration and air conditioning equipment at 17%.

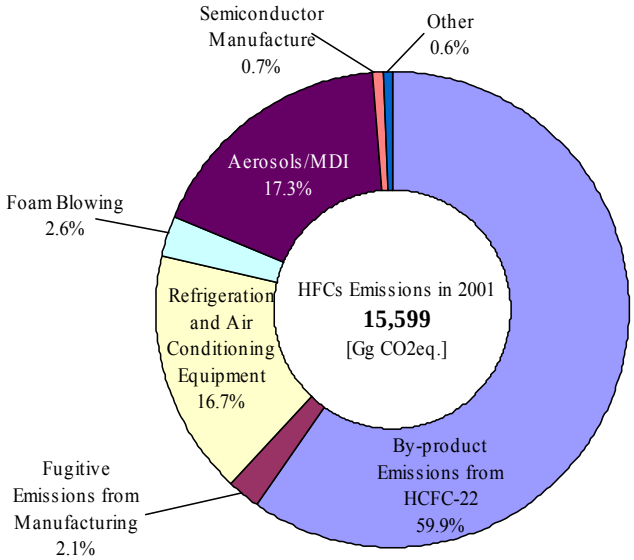

Figure 2-13 Breakdown of 2001 HFCs emissions

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

Table 2-5 Trends in HFCs emissions

[Gg CO2eq.]

Category	1995	1998	1999	2000	2001
2E. Productions of F-gas	17,398.00	13,994.60	14,199.50	12,582.00	9,664.60
2E1. By-product Emissions from Production of HCFC-22	16,965.00	13,782.60	14,098.50	12,402.00	9,336.60
2E2. Fugitive Emissions	433.00	212.00	101.00	180.00	328.00
2F. Consumption of F-gas	2,628.19	4,961.91	5,333.10	5,765.69	5,934.19
2F1. Refrigeration and Air Conditioning Equipment	690.40	1,583.77	1,891.32	2,248.04	2,609.42
2F2. Foam Blowing	452.40	405.60	403.00	442.00	412.35
2F4. Aerosols/MDI	1,365.00	2,799.03	2,828.93	2,847.22	2,697.13
2F6. Semiconductor Manufacture	119.54	139.00	144.00	145.00	115.30
2F8. Other	0.86	34.52	65.85	83.43	100.00
Total	20,026.19	18,956.51	19,532.60	18,347.69	15,598.79

2.2.5. PFCs

PFCs emissions in 2001[6] were 9.9 million tons (in CO_2 equivalents), a decrease of 13.7% compared to 1995, and an increase of 13.6% year-on-year.

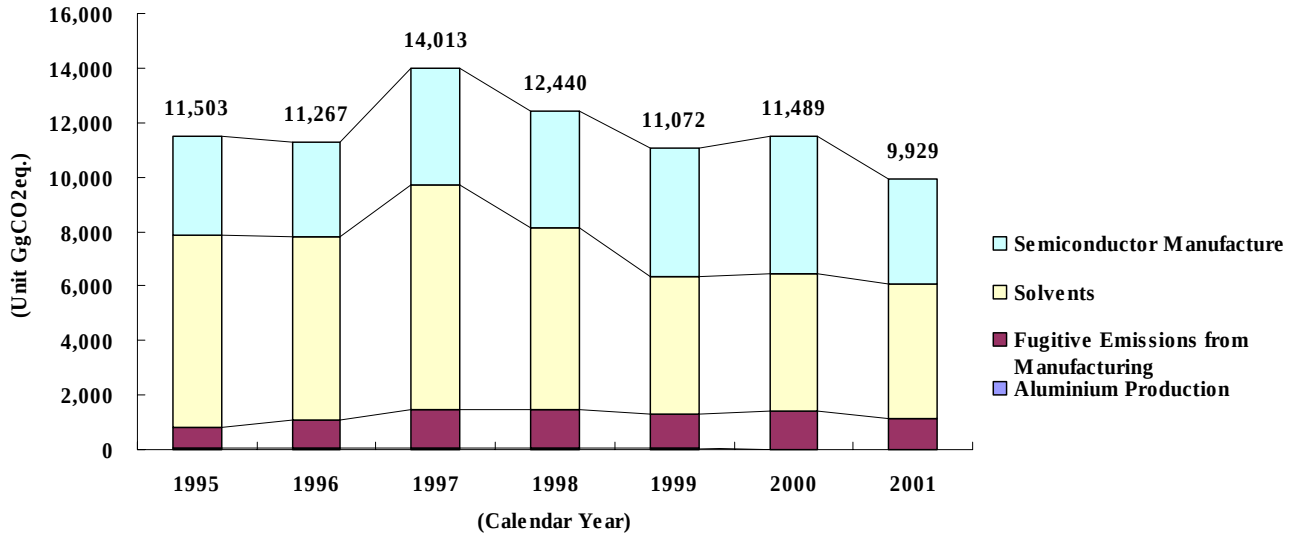

Figure 2-14 Trends in PFCs emission

The breakdown of PFCs emissions in 2001 shows that emission from solvents in washing metals etc. accounted for 50% of the total, followed by emissions from semiconductor manufacture at 39%, and fugitive emissions from manufacturing at 11%.

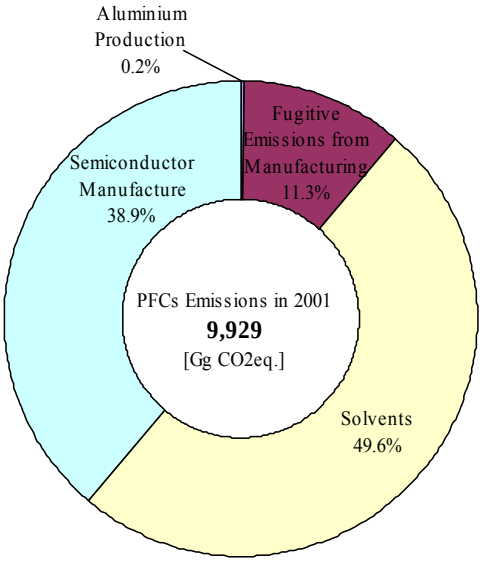

Figure 2-15 Breakdown of 2001 PFCs emissions

Table 2-6 Trends in PFCs emissions

[Gg CO2eq.]

Category	1995	1998	1999	2000	2001
2C3. Aluminium Production	69.73	49.43	29.14	17.80	15.71
2E2. Fugitive Emissions	762.00	1,390.00	1,273.00	1,382.00	1,124.00
2F. Consumption of F-gas	10,671.39	11,000.27	9,770.20	10,089.54	8,789.20
2F5. Solvents	7,013.55	6,671.27	5,068.20	5,041.54	4,928.50
2F6. Semiconductor Manufacture	3,657.84	4,329.00	4,702.00	5,048.00	3,860.70
Total	11,503.12	12,439.70	11,072.34	11,489.34	9,928.91

2.2.6. SF_6

Emissions of SF_6 in 2001 were 4.5 million tons (in CO_2 equivalents), a decrease of 72.9% compared to 1995, and 21.0% year-on-year.

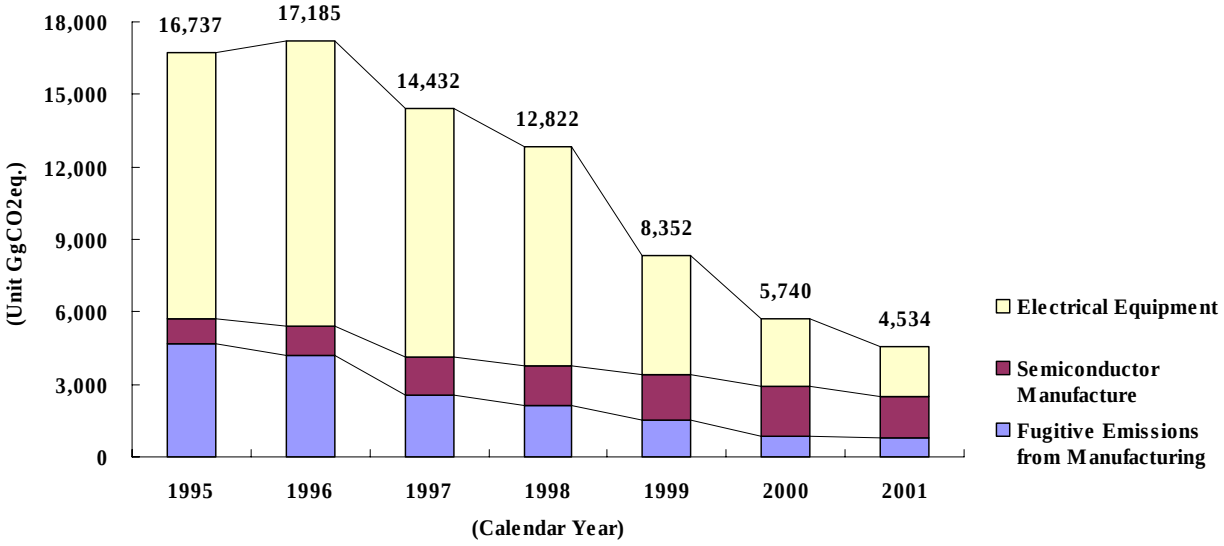

Figure 2-16 Trends in SF_6 emissions

The breakdown of SF_6 emissions in 2001 shows that emissions from electrical equipment accounted for 46%, followed by emissions from the semiconductor manufacture at approximately 37%, and emissions from fugitive emissions from manufacturing at 17%.

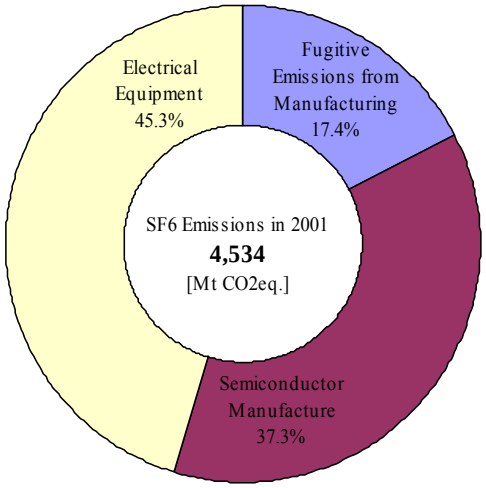

Figure 2-17 Breakdown of 2001 SF_6 emissions

Table 2-7 Trends in SF_6 emissions

[Gg CO2eq.]

Category	1995	1998	1999	2000	2001
2E2. Fugitive Emissions	4,710.71	2,103.20	1,529.60	860.40	788.70
2F. Consumption of F-gas	12,025.93	10,719.00	6,822.20	4,879.30	3,744.90
2F6. Semiconductor Manufacture	1,031.93	1,637.00	1,851.00	2,083.00	1,689.50
2F7. Electrical Equipment	10,994.00	9,082.00	4,971.20	2,796.30	2,055.40
Total	16,736.64	12,822.20	8,351.80	5,739.70	4,533.60

2.3. Description and Interpretation of Emissions and Removals by Category

The breakdown of emissions and removals of greenhouse gases in FY2001[1] by sector shows that the energy sector accounted for 88.5%, followed by industrial processes at 6.3%, solvents and other product use at 0.03%, agriculture at 2.6% and waste at 2.6%.

Removals by land-use change and forestry in FY1995 were 6.8% as a proportion of emissions.

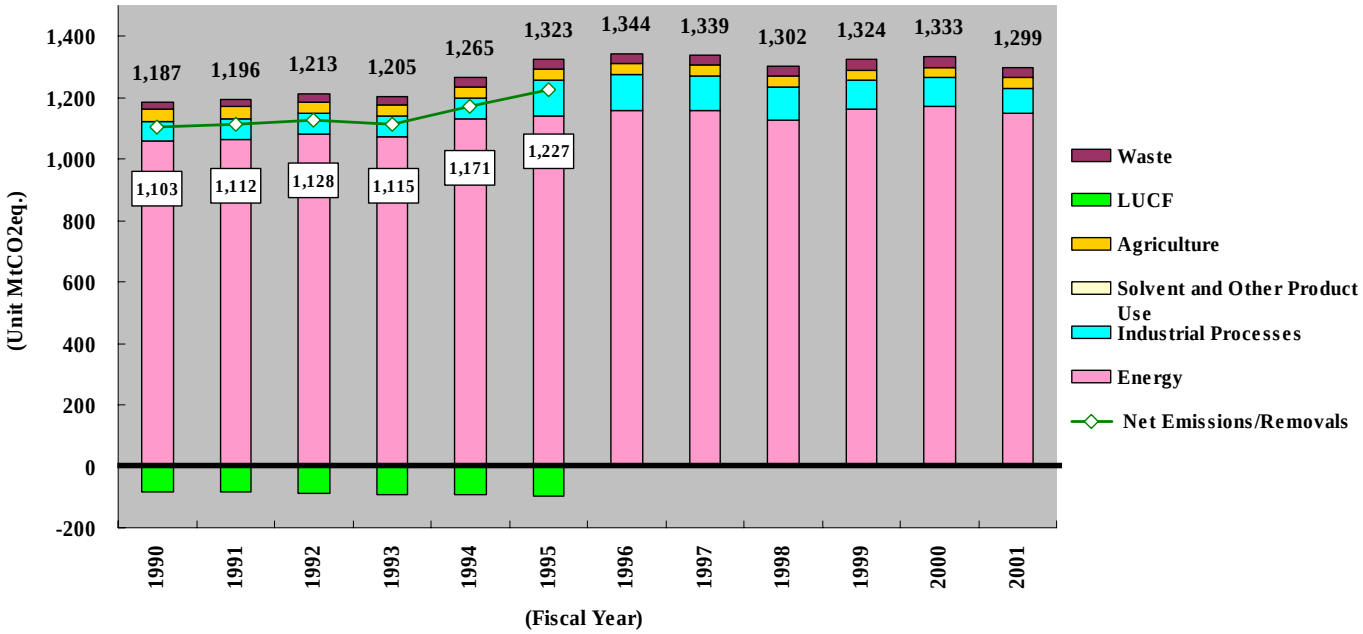

Figure 2-18 Trends in emissions and removals of greenhouse gases in each year[9]

* Figures in boxes represent net emissions or removals. No figures appear from 1996 onwards, however, as carbon dioxide removals have not been estimated.

Table 2-8 Trends in emissions and removals of greenhouse gases in each year[8]

[Mt CO2 eq.]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy	1,058.1	1,065.2	1,081.3	1,073.9	1,130.1	1,140.2	1,160.3	1,156.2	1,128.9	1,163.2	1,171.8	1,149.5
Industrial Processes	64.8	65.7	66.1	65.0	66.9	115.2	115.7	114.6	104.4	92.6	92.8	82.1
Solvent and Other Product Use	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3
Agriculture	39.0	38.8	38.7	38.6	38.0	37.1	36.2	35.4	34.9	34.4	34.1	33.8
Land Use Change and Forestry	▲ 83.8	▲ 83.8	▲ 85.5	▲ 90.0	▲ 93.5	▲ 96.6	NE	NE	NE	NE	NE	NE
Waste	24.9	25.5	26.7	26.6	29.4	30.4	31.3	32.6	33.0	33.0	33.9	33.6
Net Emissions/Removals	1,103.2	1,111.7	1,127.7	1,114.5	1,171.3	1,226.7	–	–	–	–	–	–

*NE: Not Estimated

[9] Refer 1.8.2.1 Fuel Combustion (CO2) for detail.

2.3.1. Energy

Emissions from the energy sector in FY2001 were 1,150 billion tons (in CO_2 equivalents), an increase of 8.6% compared to FY1990, and a decrease 1.9% year-on-year.

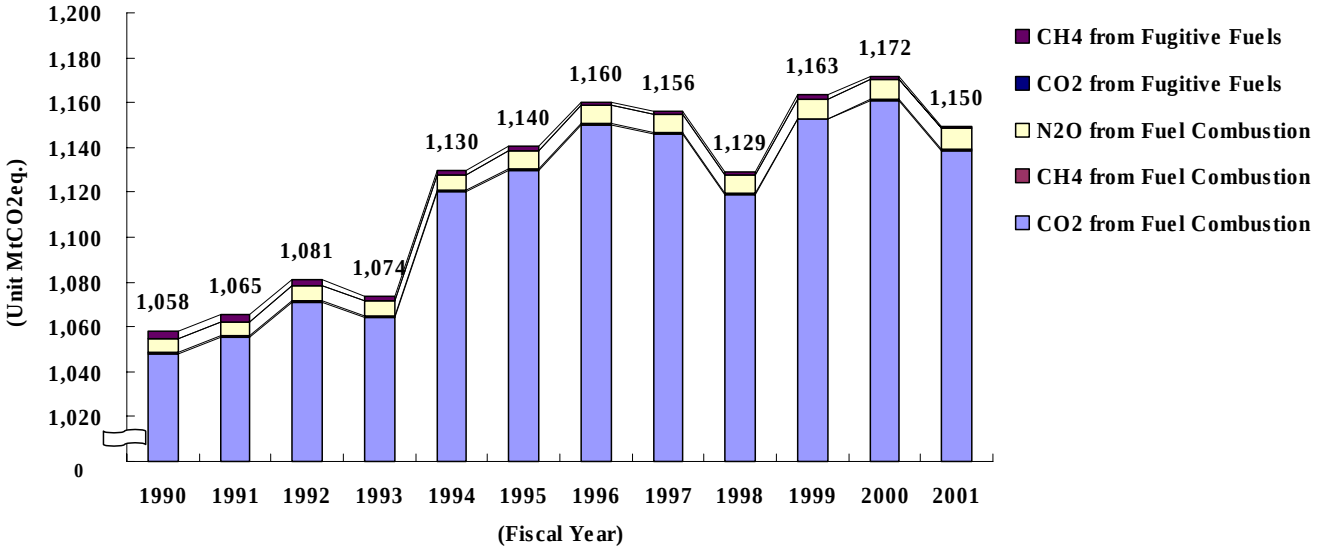

Figure 2-19 Trends in emissions of greenhouse gases from the energy sector[8]

The breakdown of emissions of greenhouse gases from the energy sector in FY2001 shows that emission of CO_2 accounted for 99%, making it the single largest source of emissions.

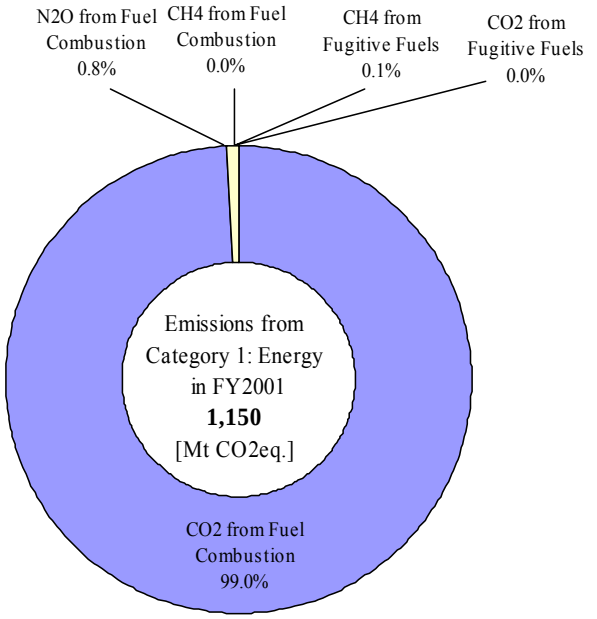

Figure 2-20 Breakdown of GHGs emissions from the energy sector in FY2001[8]

Table 2-9 Trends in GHGs emissions from the energy sector[8]

[Gg CO2eq.]

Source Category	1990	1995	1999	2000	2001
1A. Fuel Combustion	1,054,925.65	1,138,486.91	1,161,802.17	1,170,476.61	1,148,390.50
CO2	1,048,171.96	1,130,066.80	1,152,427.43	1,160,959.48	1,138,559.17
CH4	531.51	547.44	522.70	537.07	520.34
N2O	6,222.18	7,872.67	8,852.04	8,980.06	9,311.00
1B. Fugitive Emissions from Fuel	3,176.63	1,762.07	1,440.39	1,339.14	1,149.34
CO2	0.51	0.60	0.58	0.61	0.60
CH4	3,176.12	1,761.47	1,439.81	1,338.53	1,148.74
Total	1,058,102.28	1,140,248.97	1,163,242.56	1,171,815.75	1,149,539.84

2.3.2. Industrial Processes

Emissions from the industrial processes sector in FY2001 were 82.1 million tons (in CO_2 equivalents), an increase of 26.8% compared to FY1990, and 11.5% year-on-year.

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

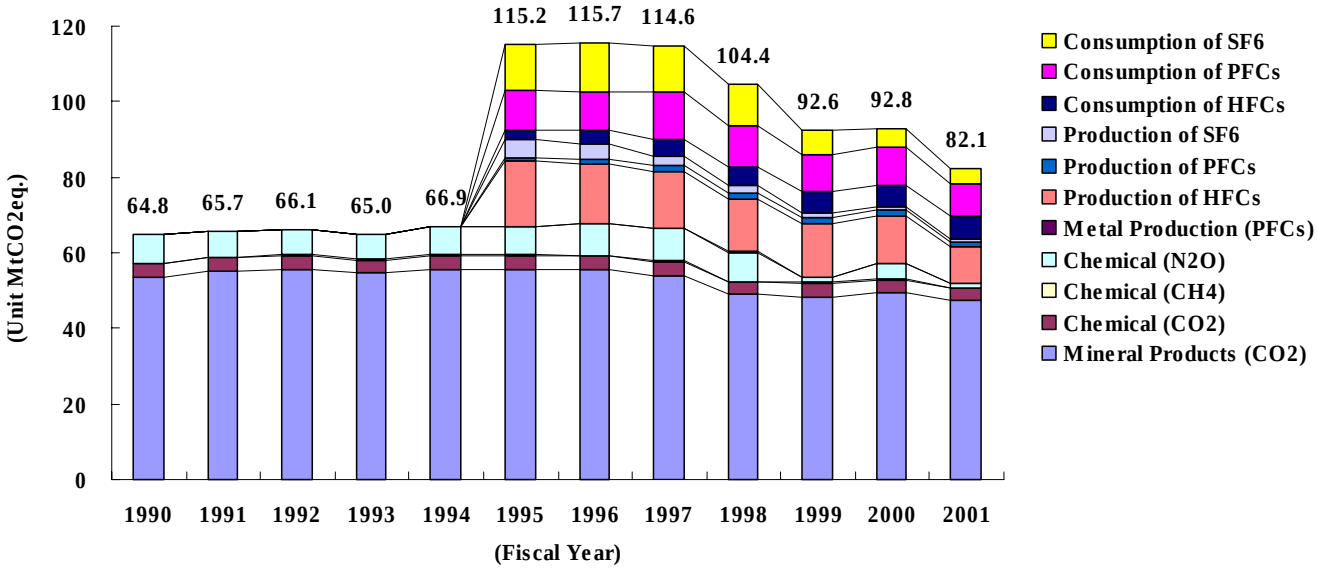

Figure 2-21 Trends in GHGs emissions from the industrial processes sector

The breakdown of emissions of greenhouse gases from the industrial processes sector in FY2000 shows that emissions from mineral products, such as CO_2 emissions from the limestone in cement production account for 58%, making it the single largest source of emissions. It is followed by emissions from the production of HFCs at 12%, and consumption of PFCs such as semiconductor manufacture at approximately 11%.

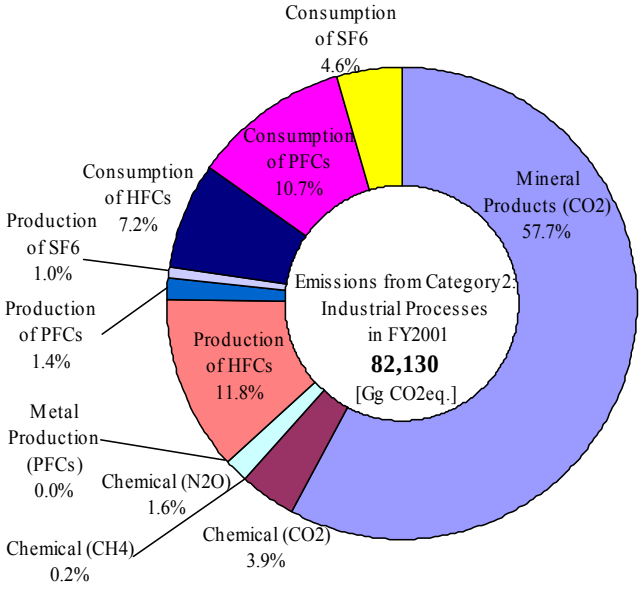

Figure 2-22 Breakdown of GHGs emissions in the industrial processes sector in FY2001

Table 2-10 Trends in GHGs emissions in the industrial processes

[Gg CO2eq.]

Category	1990	1995	1999	2000	2001
2A. Mineral Products (CO2)	53,465.31	55,588.39	48,381.05	49,403.45	47,374.96
2B. Chemical Industry	11,296.82	11,295.74	5,284.92	7,772.14	4,693.98
CO2	3,543.66	3,624.90	3,504.02	3,393.87	3,217.08
CH4	337.80	303.30	219.48	163.74	131.47
N2O	7,415.36	7,367.54	1,561.43	4,214.53	1,345.42
2C. Metal Production (PFCs)	NE	69.73	29.14	17.80	15.71
2E. Production of F-gas	0.00	22,870.71	17,002.10	14,824.40	11,577.30
HFCs	NE	17,398.00	14,199.50	12,582.00	9,664.60
PFCs	NE	762.00	1,273.00	1,382.00	1,124.00
SF6	NE	4,710.71	1,529.60	860.40	788.70
2F. Consumption of F-gas	0.00	25,325.51	21,925.50	20,734.53	18,468.29
HFCs	NE	2,628.19	5,333.10	5,765.69	5,934.19
PFCs	NE	10,671.39	9,770.20	10,089.54	8,789.20
SF6	NE	12,025.93	6,822.20	4,879.30	3,744.90
Total	64,762.12	115,150.08	92,622.71	92,752.32	82,130.24

2.3.3. Solvent and Other Product Use

Emissions from the solvents and other product use in FY2001 were 344 thousand tons (of CO_2 equivalents), an increase of 19.7% on FY1990, and 0.8% year-on-year.

The only substance included in calculations in this sector is laughing gas (nitrous oxide) used as a general anesthetic in hospitals.

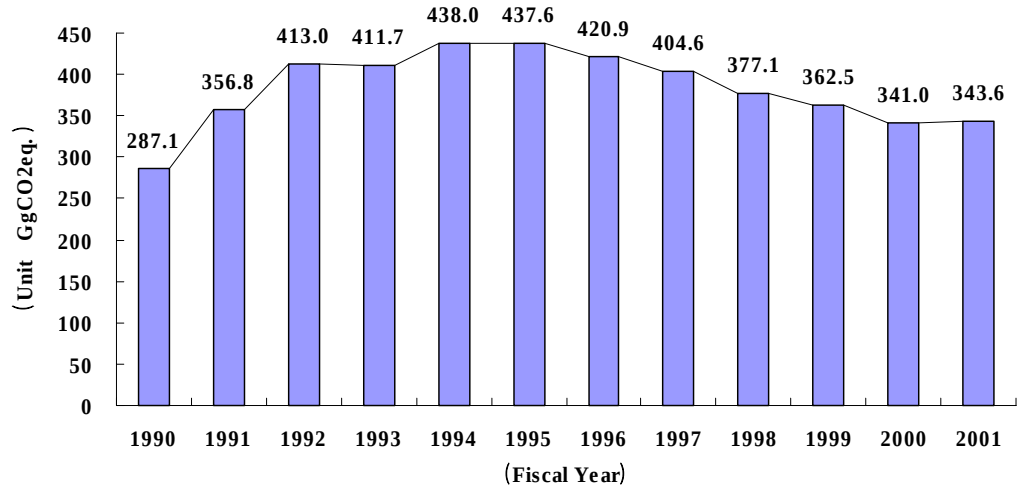

Figure 2-23 Trends in GHGs emissions from solvent and other product use

2.3.4. Agriculture

Emissions in the agriculture in FY2001 were 33.9 million tons (in CO_2 equivalents), a decrease of 13.2% compared to FY1990, and 0.8% year-on-year.

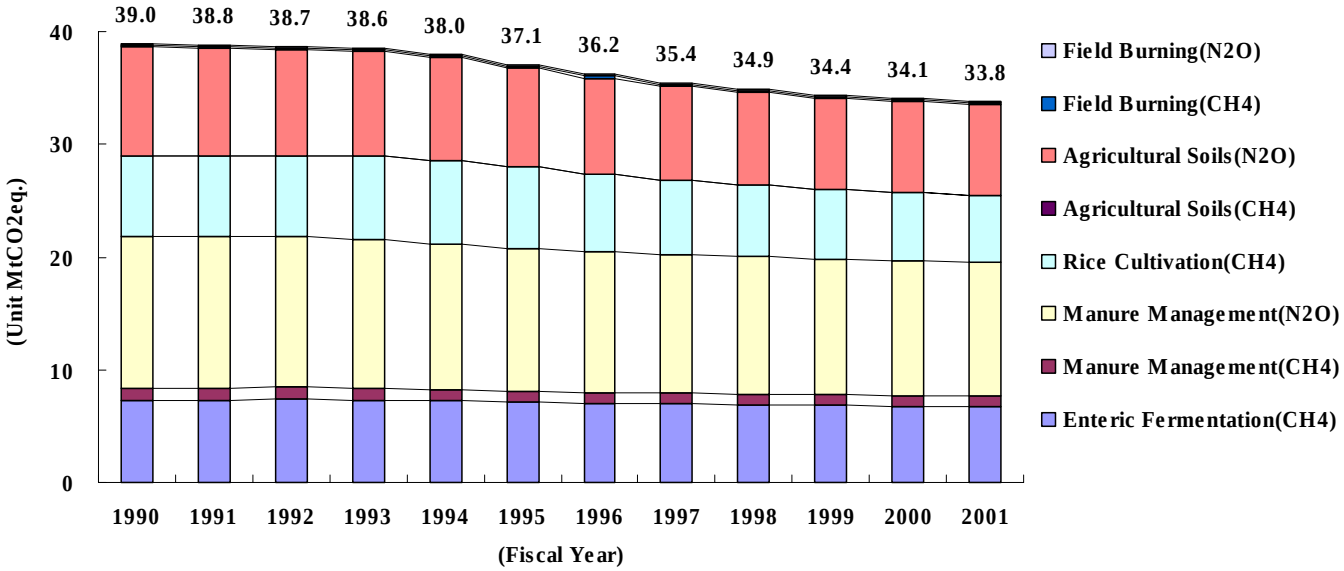

Figure 2-24 Trends in GHGs emissions from Agriculture

The breakdown of emissions of greenhouse gases from the agriculture in FY2001 shows that N_2O emissions from manure management account for 35%, making it the single largest source. It is followed by N_2O emissions from agricultural due to the nitrogen-based fertilizers, at 24%, and CH_4 emissions from enteric fermentation, at 20%.

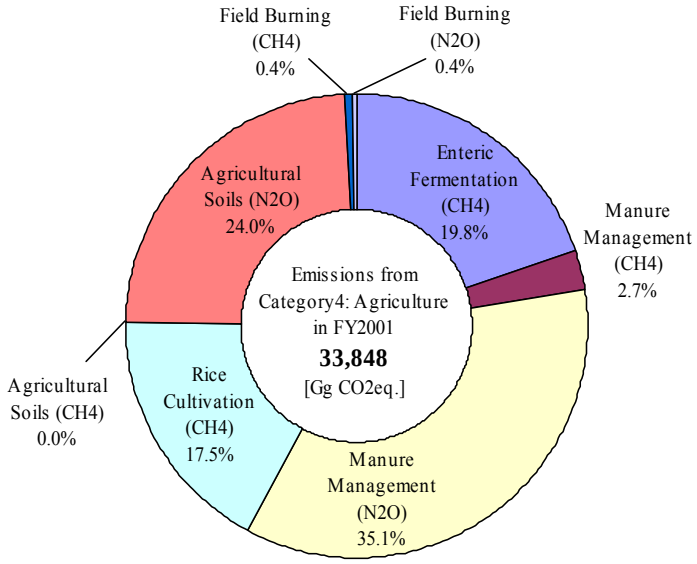

Figure 2-25 Breakdown of GHGs emissions from agriculture in FY2001

Table 2-11 Trends in GHGs emissions from agriculture

[Gg CO2eq.]

排出源	1990	1995	1999	2000	2001
4A. Enteric Fermentation(CH4)	7,249.10	7,118.91	6,809.37	6,759.68	6,712.35
4B. Manure Management	14,606.75	13,626.65	13,030.79	12,917.80	12,817.04
CH4	1,072.55	991.38	937.67	927.87	919.83
N2O	13,534.20	12,635.26	12,093.12	11,989.93	11,897.20
4C. Rice Cultivation(CH4)	7,075.73	7,200.86	6,125.26	6,018.51	5,907.16
4D. Agricultural Soils	9,749.52	8,800.66	8,154.11	8,146.75	8,138.27
CH4	3.06	2.75	2.35	2.30	2.26
N2O	9,746.46	8,797.91	8,151.76	8,144.45	8,136.00
4F. Field Burning of Agricultural Residues	298.35	304.97	266.89	267.51	273.38
CH4	168.45	164.77	134.07	134.03	135.32
N2O	129.90	140.19	132.82	133.48	138.06
Total	38,979.45	37,052.04	34,386.42	34,110.25	33,848.19

2.3.5. Land-Use Change and Forestry

Removals of carbon dioxide in the land-use change and forestry in fiscal 1995 was 96.6 million tons, an increase of 15.2% on FY1990, and 3.4% year-on-year. In the absence of usable data, emissions and removals since FY1996 have not been estimated (NE).

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

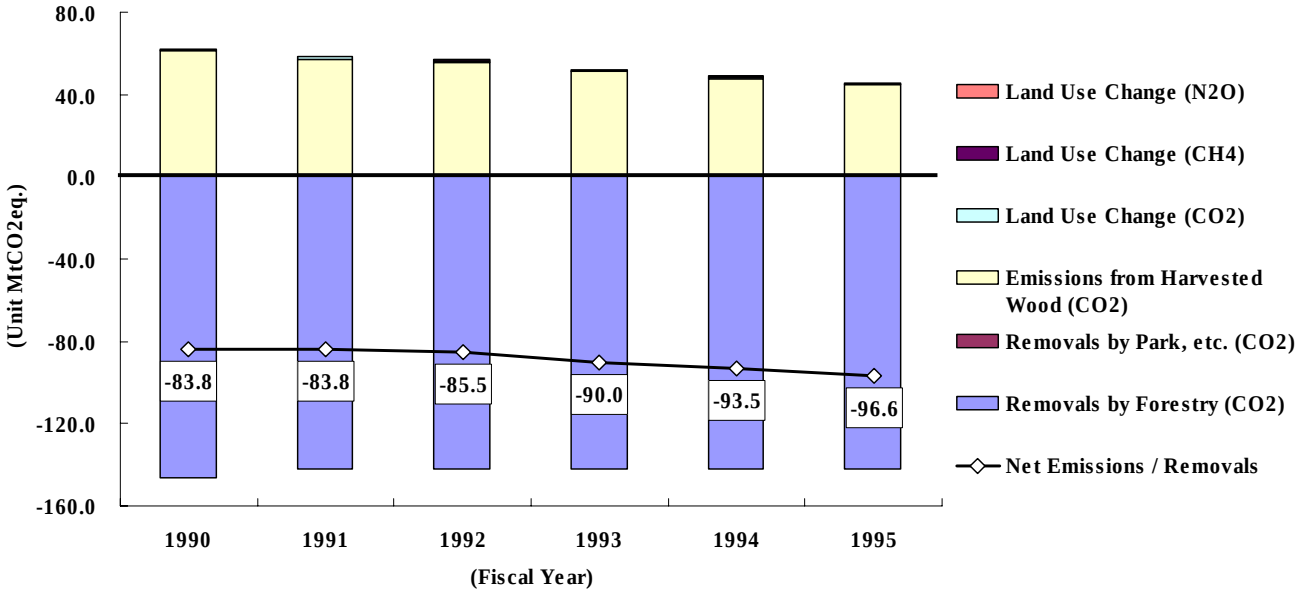

Figure 2-26 Trends in emissions and removals of GHGs from land-use change and forestry

Table 2-12 Trends in emissions and removals of GHGs from land-use change and forestry

[Gg CO2eq.]

Category	1990	1992	1993	1994	1995
5A2. Removals by Forestry	-146,056.09	-142,061.31	-142,090.14	-142,118.97	-142,147.79
5A5. Removals by Park etc.	-90.65	-103.46	-106.82	-111.55	-114.49
5A5. Emissions from Havested Wood	61,664.52	55,680.02	51,193.14	47,758.15	44,614.75
5B. Forestry & Grassland Conversion	637.61	1,007.09	1,014.72	1,022.35	1,037.61
CO2	579.15	914.76	921.69	928.62	942.48
CH4	53.07	83.83	84.46	85.10	86.37
N2O	5.39	8.51	8.57	8.64	8.77
Total	-83,844.62	-85,477.66	-89,989.10	-93,450.01	-96,609.92

2.3.6. Waste

Emissions from waste in FY2001 were 33.6 million tons (in CO_2 equivalents), an increase of 34.8% compared to FY1990, and a decrease of 1.0% year-on-year.

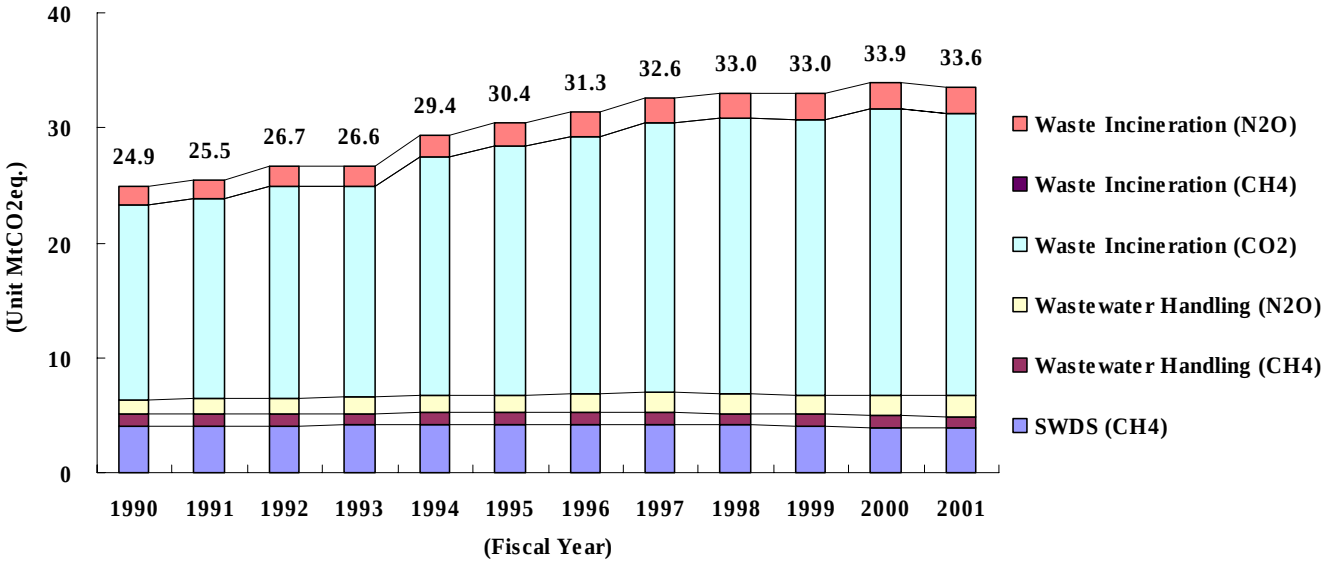

Figure 2-27 Trends in GHGs emissions from waste

The breakdown of GHGs emissions from waste in FY2001 shows that CO_2 emissions from the waste derived from petrochemicals such as waste plastics and waste oil incineration, account for 73%, making it the single largest source of emissions. It is followed by CH_4 emissions from solid waste disposal site, at 12%, and N_2O emissions from combustion of waste (including waste products derived from substances other than fossil fuels), at 7%.

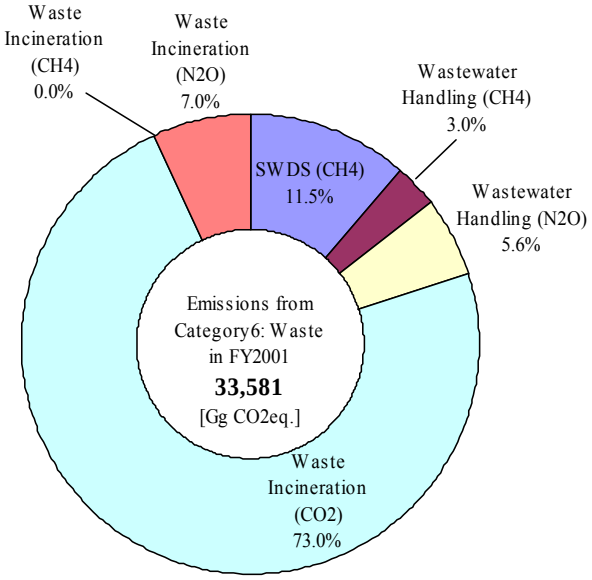

Figure 2-28 Breakdown of GHGs emissions from waste in FY2001

Table 2-13 Trends in GHGs emissions from waste

[Gg CO2eq.]

Category	1990	1995	1999	2000	2001
6A. SWDS (CH4)	4,044.84	4,238.80	4,063.63	3,963.26	3,852.88
6B. Wastewater Handling	2,339.30	2,536.71	2,716.01	2,738.10	2,868.99
CH4	1,069.69	997.03	1,004.67	1,013.73	996.81
N2O	1,269.61	1,539.67	1,711.34	1,724.37	1,872.18
6C. Waste Incineration	18,534.53	23,623.38	26,186.43	27,224.32	26,859.15
CO2	16,935.48	21,627.24	23,928.57	24,941.66	24,505.85
CH4	13.54	12.59	12.30	12.64	12.57
N2O	1,585.51	1,983.55	2,245.55	2,270.02	2,340.73
Total	24,918.67	30,398.88	32,966.07	33,925.67	33,581.02

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Chapter 3. Energy (CRF sector1)

3.1. Fuel Combustion (1A)

1) CO_2

• Methodology for Estimating Emissions of GHGs

The Tier 1 Sectoral Approach has been used in accordance with Decision Tree of the *Good Practice Guidance (2000)*(GPG 2000, p. 2.10 Fig. 2.1) to calculate emissions from FY 1990 to FY 2001[1]. For all types of fuel, the country-specific emission factors are used. Activity data is taken from the Energy Balance Table(Gross Calorific Value). (Refer to *1A-CO2-****-2003.xls¥SA(CRF)* for results of calculations. Refer to *1A-CO2-****-2003.xls* for calculation process.)

• Emission Factors

It is assumed that all carbon in fuel becomes carbon dioxide. The emission factors used have all been given in carbon content per unit of calorific value (Gross Calorific Value), and are country-specific values. Emission factors for 1990 and 2001 are shown in the following table.

In the sectoral approach, the emission factors for coke, coke oven gases, blast furnace gas, converter furnace gases, and coal briquettes were taken to be the average emission factors calculated by dividing the total non-calorific value of coke by an estimate of the amount of carbon incinerated in coke (the primary product of coking coal), coke oven gases, and other by-products. The emission factor for town gas has been calculated by taking the total carbon content of fossil fuels injected as raw material, and dividing by the total calorific value of the town gas manufactured.

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

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

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

tC/TJ(Gross)

			1990	1995	1999	2000	2001
Solid Fuels							
	Coal						
		Imported Steel Making Coal	23.65	23.65	23.65	23.65	23.65
		Coaking Coal	23.65	23.65	23.65	23.65	23.65
		PCI Coal	23.65	23.65	23.65	23.65	23.65
		Imported Coal	24.71	24.71	24.71	24.71	24.71
		Indigenous Coal	24.90	24.90	24.90	24.90	24.90
		Hard Coal or Anthracite & Lignite	24.71	24.71	24.71	24.71	24.71
	Coal Products						
		Coke	28.52	28.55	28.03	25.91	24.83
		Coke Oven Gas	28.52	28.55	28.03	25.91	24.83
		Blast Furnace Gas	28.52	28.55	28.03	25.91	24.83
		Converter Furnace Gas	28.52	28.55	28.03	25.91	24.83
Liquid Fuels							
	Oil						
		Crude Oil	18.66	18.66	18.66	18.66	18.66
		Natural Gas Liquid & Condensate	18.66	18.66	18.66	18.66	18.66
	Oil Products						
		Liquified Petroleum Gas	16.32	16.32	16.32	16.32	16.32
		Naphtha	18.17	18.17	18.17	18.17	18.17
		Gasoline	18.29	18.29	18.29	18.29	18.29
		Jet Fuel	18.31	18.31	18.31	18.31	18.31
		Kerosene	18.51	18.51	18.51	18.51	18.51
		Diesel Oil or Gas Oil	18.73	18.73	18.73	18.73	18.73
		Heating Oil A	18.90	18.90	18.90	18.90	18.90
		Heating Oil C	19.54	19.54	19.54	19.54	19.54
		Lublicating Oil	19.22	19.22	19.22	19.22	19.22
		Other Heavy Oil Products	20.77	20.77	20.77	20.77	20.77
		Oil Coke	25.35	25.35	25.35	25.35	25.35
		Refinary Gas	14.15	14.15	14.15	14.15	14.15
Gaseous Fuels							
	Natural Gas						
		Liquefied Natural Gas	13.47	13.47	13.47	13.47	13.47
		Indigenous Natural Gas	13.47	13.47	13.47	13.47	13.47
	Town Gas						
		Town Gas	14.53	14.21	13.98	13.91	13.84

N.B.: based on Gross Calorific Value

Source: Environmental Agency, *The Estimation of CO_2 in Japan*, 1992

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

tC/TJ(Gross)

			1990	1995	1999	2000	2001
Solid Fuels							
	Indigenous Coal		**24.90**	**24.90**	**24.90**	**24.90**	**24.90**
		Underground	**24.90**	**24.90**	**24.90**	**24.90**	**24.90**
		Open Pit	**24.90**	**24.90**	**24.90**	**24.90**	**24.90**
	Lignite		**24.71**	**24.71**	**24.71**	**24.71**	**24.71**
	Coal Briquette		**28.52**	**28.55**	**28.03**	**25.91**	**24.83**
	COM						
	CWM		**24.71**	**24.71**	**24.71**	**24.71**	**24.71**
	Coal Tar		**28.52**	**28.55**	**28.03**	**25.91**	**24.83**
Liquid Fuels							
	Crude Oil						
		Crude Oil for Power Generation	**18.66**	**18.66**	**18.66**	**18.66**	**18.66**
		Vitumous Mixture Fuel	**18.66**	**18.66**	**18.66**	**18.66**	**18.66**
	Liquified Petroleum Gas						
		Propane Gas	**16.32**	**16.32**	**16.32**	**16.32**	**16.32**
	Gasoline						
		Regular	**18.29**	**18.29**	**18.29**	**18.29**	**18.29**
		Premium	**18.29**	**18.29**	**18.29**	**18.29**	**18.29**
	Heating Oil B		**19.22**	**19.22**	**19.22**	**19.22**	**19.22**
	Heating Oil C						
		Heating Oil C for Power Generation	**19.54**	**19.54**	**19.54**	**19.54**	**19.54**
	Asphalt		**20.77**	**20.77**	**20.77**	**20.77**	**20.77**
Gaseous Fuels							
	Coal Mining Gas		**13.47**	**13.47**	**13.47**	**13.47**	**13.47**
	Town Gas						
		4A～7C	**13.94**	**13.94**	**13.94**	**13.94**	**13.94**
		12A･13A	**13.94**	**13.94**	**13.94**	**13.94**	**13.94**
		LPG	**13.94**	**13.94**	**13.94**	**13.94**	**13.94**

N.B.: based on Gross Calorific Value
Source: Environmental Agency, *The Estimation of CO_2 in Japan*, 1992

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

tC/TJ(Gross)

		1990	1995	1999	2000	2001
for RA	Coke Oven Gas	**10.99**	**10.99**	**10.99**	**10.99**	**10.99**
for RA	Coke etc	**29.38**	**29.38**	**29.38**	**29.38**	**29.38**

N.B.: based on Gross Calorific Value
Source: Environmental Agency, *The Estimation of CO_2 in Japan*, 1992

Table 3-4 Process of calculating average emission factors for coke etc.

TJ

	1990	1995	1999	2000	2001
Total Input of Raw Material for Cokes	2,367,737	2,180,028	1,924,672	1,878,142	1,786,824
Coking Coal	2,121,327	1,986,921	1,752,615	1,698,080	1,624,882
Imported Coal	213,005	167,911	139,037	147,076	141,209
Indigenous Coal	0	0	0	0	0
Hard Coal or Anthracite & Lignite	0	0	0	0	0
Oil Coke	33,405	25,196	33,021	32,986	20,732
Total Coal Product Converted (A)	1,874,900	1,723,045	1,549,832	1,636,551	1,623,591
Coke & Related Products	1,031,750	921,853	661,917	778,105	788,344
Coke Oven Gas	362,589	334,896	306,779	336,600	325,280
Blast Furnace Gas	414,450	404,922	515,649	450,921	439,870
Converter Furnace Gas	66,111	61,374	65,487	70,925	70,097

Gg-C

	EF [tC/TJ] (Gross)	1990	1995	1999	2000	2001
Total Input of Raw Material for Cokes (B)		56,280	51,779	45,722	44,630	42,443
Coking Coal	23.65	50,169	46,991	41,449	40,160	38,428
Imported Coal	24.71	5,263	4,149	3,436	3,634	3,489
Indigenous Coal	24.90	0	0	0	0	0
Hard Coal or Anthracite & Lignite	24.71	0	0	0	0	0
Oil Coke	25.35	847	639	837	836	526
Total Input of Raw Material for Cokes*0.95		53,466	49,190	43,436	42,399	40,321
Average EF (B)/(A)	[tC/TJ] (Gross)	**28.52**	**28.55**	**28.03**	**25.91**	**24.83**

Assumption: 5% of carbon in the raw material is not combusted.
(Refer to *1-EF-2003.xls¥Coke* for detail on the calculation process, and other years)

Table 3-5 Process of calculating average emission factor for town gas

TJ

	1990	1995	1999	2000	2001
Total Input of Raw Material for Town Gas	665,681	894,139	1,022,657	1,061,463	1,078,011
Coke	0	0	0	0	0
Coke Oven Gas	19,178	12,205	9,732	9,573	7,765
Naphtha	0	0	0	0	0
Kerosene	10,936	15,038	5,380	3,728	2,971
Refinary Gas	13,114	14,061	13,324	13,112	13,712
Liquified Petroleum Gas	118,299	128,909	113,387	109,735	99,097
Liquefied Natural Gas	464,233	676,078	823,443	864,278	892,479
Indigenous Natural Gas	39,920	47,849	57,390	61,036	61,986
Town Gas Converted (A)	664,661	892,307	1,021,607	1,061,122	1,077,550
Town Gas	664,661	892,307	1,021,607	1,061,122	1,077,550

Gg-C

	EF [tC/TJ] (Gross)	1990	1995	1999	2000	2001
Total Input of Raw Material for Town Gas (B)		9,657	12,682	14,277	14,759	14,917
Coke	Flactuated in every year	0	0	0	0	0
Coke Oven Gas	Flactuated in every year	547	348	273	248	193
Naphtha	18.17	0	0	0	0	0
Kerosene	18.51	202	278	100	69	55
Refinary Gas	14.15	186	199	189	186	194
Liquified Petroleum Gas	16.32	1,931	2,104	1,851	1,791	1,618
Liquefied Natural Gas	13.47	6,254	9,107	11,093	11,643	12,023
Indigenous Natural Gas	13.47	538	645	773	822	835

Average EF (B)/(A) [tC/TJ] (Gross)		**14.53**	**14.21**	**13.98**	**13.91**	**13.84**

N.B. The Common Reporting Format (CRF) does not include a Town Gas category of fuel. It is not therefore appropriate to include carbon dioxide emissions associated with town gas in gaseous fuel sources. Emissions of carbon dioxide from town gas have therefore been divided proportionately into liquid, solid and gaseous fuel, based on the consideration of the volumes of raw materials for town gas used, such as coke and coking coal derivatives, naphtha, oil refinery gases, LPG, natural gas and LNG (consumption of fossil fuels by town gas distributors as given in the Energy Balance Table).

(Refer to *1-EF-2003.xls¥Coke* for detail on the calculation process, and other years)

• ***Activity Data***

Final energy consumption figures for the energy conversion, industry, residential and commercial, and transport as depicted in Japan's Energy Balance Table (*General Energy Statistics*) were used for activity level (Refer to *1A-CO2-****-2003.xls¥****FY(EU)* for details).

Some energy relates to a portion of final energy consumption that is applied to purposes other than combustion. Therefore, energy consumption indicated in "Non-Energy" of Energy Balance Table is deducted.

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

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

• ***Issues to be addressed***

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

Essentially, in the oil refinery sector, carbon input and output should be balanced. The current method therefore has issues to be addressed.

It is thought that the composition of refinery gas is not as stabilized as gasoline and gas oil because the composition of refinery gas is not regulated.[3].

Therefore, in order to find a solution to this issue, discussion is currently under way to solve the difference in carbon content from the perspective of energy and carbon balance in the petroleum refinery. In addition, newly established emissions based on the conclusions reached in the discussion might be presented to reviewers during the in-country-visit of inventory in 2003.

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

[3] In fiscal year 1990 – 2001, yield (gasoline from crude oil supplied: volume base) increased from 20% to 25%. This fact is considered to be one of the reasons why the carbon content ration of the refinery gas has fluctuated.

3.1.2. Stationary Combustion (1A1, 1A2, 1A4)

1) CH_4 and N_2O

• Methodology for Estimating Emissions of GHGs

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

Exhaustive 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. In fiscal 1990, 1991, 1993, and 1994, sampling surveys were conducted in relation only to large-scale facilities and operating sites.

• Emission Factors

-Facilities emitting soots and smokes

Emissions were estimated by multiplying the calorific values from each facility in the *MAP Survey* by the emission factor (Refer to *1A-eftable-2003.xls* for details. Available only in Japanese.)

Emissions of nitrous oxide from fluidized bed boilers have been estimated separately. (Refer to *1A-n2o-fb-2003.xls* for details. Available only in Japanese.)

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

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

-Residential

The default Gross Calorific Values from the *Revised 1996 IPCC Guidelines* were converted and used as the emission factors for methane and nitrous oxide.

• Activity Data

-Facilities emitting soots and smokes

The results from the *MAP Survey* conducted in exhaustive survey years were used.

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

(a) Factories common to the most recent exhaustive survey
(b) Factories not common to the most recent exhaustive survey (i.e., new factories)
(c) Factories not sampled, to which growth rates in activity data by industry type were applied

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

In estimating growth rates, however, factories common to both the most recent exhaustive survey and sampling survey for which the growth rate per factory fell outside the range 0.5 to 2 were excluded from the point at which growth rates were formulated.

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

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

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

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

-Residential

General Energy Statistics residential sector — Activity data has been taken to be consumption by type of fuel for residential use. Subject fuels were town gas, LPG, kerosene, steaming coal, and coal briquettes

• Point to Note

The emission values from a number of sources of emissions have been given as negative values. The reason is that the combustion causes concentrations of methane and nitrous oxide in exhaust gases to fall below their concentrations in intake gases.

3.1.3. Mobile Combustion (1A3)

3.1.3.1. Road Transportation (CH_4 and N_2O) (1A3b)

• Methodology for Estimating Emissions of GHGs

Emissions from FY1990 to FY2001 have been calculated using the Tier 3 method, in accordance with Decision Tree of the *Good Practice Guidance (2000)*(GPG (2000) p. 2.45 Fig. 2.5). The emission factor used for each category of vehicle is country-specific emission factor. The activity data used is that given in the Ministry of Land, Infrastructure and Transport's *Statistical Yearbook of Motor Vehicle Transport*. (Refer to *1A3-car-2003.xls* for detail on the calculation process.)

• Emission Factors

Emission factors for methane and nitrous oxide have been established for each type of fuel in each category of vehicle, using actual Japanese data.

The method used to establish emission factors was to take a weighted average of the emission factors estimated for each category of running speed, using the proportion of mileage by each running speed for each category given in the Ministry of Land, Infrastructure and Transport's *Road Transport Census*. The emission factors reflect motor vehicle operation in Japan by using the proportion of mileage by each running speed during times of congestion.

Detail on the method of establishing emission factors is given in the Environmental Agency Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report Part 3*, (September 2000) and Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *GHGs Estimation Methods Committee Report* Part 3, (August 2002).

Table 3-6 Methane emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	1999	2000	2001
Gasoline	Light Vehicle	gCH4/km	0.011	0.011	0.011	0.011	0.010
	Passenger Vehicle (including LPG)	gCH4/km	0.011	0.011	0.011	0.011	0.010
	Light Cargo Truck	gCH4/km	0.011	0.011	0.011	0.011	0.011
	Small Cargo Truck	gCH4/km	0.035	0.035	0.035	0.035	0.035
	Regular Cargo Truck	gCH4/km	0.035	0.035	0.035	0.035	0.035
	Bus	gCH4/km	0.035	0.035	0.035	0.035	0.035
	Special Vehicle	gCH4/km	0.035	0.035	0.035	0.035	0.035
Diesel	Passenger Vehicle	gCH4/km	0.0020	0.0020	0.0020	0.0020	0.0020
	Small Cargo Truck	gCH4/km	0.0088	0.0091	0.0082	0.0079	0.0076
	Regular Cargo Truck	gCH4/km	0.017	0.016	0.015	0.015	0.015
	Bus	gCH4/km	0.019	0.018	0.017	0.017	0.017
	Special Vehicle	gCH4/km	0.017	0.015	0.013	0.013	0.013

(Refer to *1-EF-2003.xls¥car* for other years.)

Table 3-7 Nitrous oxide emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	1999	2000	2001
Gasoline	Light Vehicle	gN2O/km	0.019	0.021	0.022	0.022	0.023
	Passenger Vehicle (including LPG)	gN2O/km	0.027	0.029	0.030	0.030	0.030
	Light Cargo Truck	gN2O/km	0.021	0.022	0.023	0.023	0.023
	Small Cargo Truck	gN2O/km	0.027	0.029	0.027	0.027	0.027
	Regular Cargo Truck	gN2O/km	0.039	0.041	0.039	0.039	0.039
	Bus	gN2O/km	0.045	0.046	0.044	0.044	0.044
	Special Vehicle	gN2O/km	0.039	0.042	0.038	0.038	0.038
Diesel	Passenger Vehicle	gN2O/km	0.007	0.007	0.007	0.007	0.007
	Small Cargo Truck	gN2O/km	0.025	0.025	0.025	0.025	0.025
	Regular Cargo Truck	gN2O/km	0.025	0.025	0.025	0.025	0.025
	Bus	gN2O/km	0.025	0.025	0.025	0.025	0.025
	Special Vehicle	gN2O/km	0.025	0.025	0.025	0.025	0.025

(Refer to *1-EF-2003.xls¥car* for other years.)

• ***Activity Data***

Estimates of annual running mileage by each category of vehicle and each type of fuel have been used for 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 *Road Transport Statistics Annual Report*. (Refer to *1-AD-2003.xls¥car(****)* for the process of estimating activity data).

The following table gives the results of estimates of activity data.

Table 3-8 Running mileages by category of vehicle ($\times 10^6$ vehicle·km)

10^6 vehicles km	1990	1995	1999	2000	2001
light vehicle	15,281	39,386	62,982	70,055	77,577
gasoline	15,281	39,386	62,982	70,055	77,577
diesel oil					
LPG					
passenger vehicle	350,317	407,001	438,550	438,204	448,845
gasoline	289,828	322,862	360,560	364,150	377,404
diesel oil	42,434	66,792	62,789	58,816	56,550
LPG	18,055	17,347	15,201	15,238	14,891
bus	7,112	6,768	6,601	6,619	6,762
gasoline	60	20	14	13	14
diesel oil	7,052	6,748	6,587	6,606	6,748
LPG					
light cargo truck	85,336	84,534	75,789	74,914	73,425
gasoline	85,336	84,534	75,789	74,914	73,425
diesel oil					
LPG					
small cargo truck + cargo passenger truck	92,409	87,924	81,414	82,209	81,229
gasoline	37,053	25,892	24,611	24,988	24,991
diesel oil	55,356	62,032	56,803	57,221	56,238
LPG					
regular cargo truck	66,881	78,446	80,628	83,024	82,695
gasoline	448	361	316	331	350
diesel oil	66,433	78,086	80,312	82,693	82,345
LPG					
special vehicle	11,247	16,224	19,093	20,699	20,287
gasoline	825	851	1,427	1,584	1,507
diesel oil	10,422	15,373	17,665	19,115	18,780
LPG					

(Refer to *1-AD-2003.xls¥car* for other years.)

• ***Completeness***

-Natural gas

Currently, the majority of natural gas vehicles used around the world, including Japan, are driven by compressed natural gas (CNG). Work in Japan on development of a practical liquid natural gas (LNG) vehicle started from fiscal 1996.

At the end of September 2002, the number of natural gas vehicles (CNG vehicles and others) owned was approximately 14,000[4] (only 0.02% of all motor vehicles owned, which was 77.12 million[5] at the end of October 2002). On the assumption that emissions are almost negligible, and that an emission factor has not been established, it has been reported as "NE" ("not estimated").

-Biomass fuels

Ethanol vehicles driven by biomass fuels are not operating 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 222 at the end of March 2000 (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.

[4] From the website of the Japan Gas Association (http://www.gas.or.jp/ngvj/spread/jpn_spread.html)
[5] From the website of the Automobile Inspection and Registration Association (http://www.aira.or.jp/data/data_r.html)

3.1.3.2. Civil Aviation (CH_4 and N_2O) (1A3a)

• Methodology for Estimating Emissions of GHGs

Emissions from FY1990 to FY2001 have been calculated using the Tier 2a method, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 2.58 Fig. 2.7). (Refer to *1A3-2003.xls¥ Airplane Emissions* for detail on the calculation process.)

• Emission Factors

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 (0.78 t/kl). The following table gives the emission factors for methane and nitrous oxide at LTO and cruising.

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

	CH_4	N_2O
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]

* LTO=Landing/takeoff cycle

Source: Ministry of the Environment, *Results of Review of Greenhouse Gases Emissions Estimations Part 3 (August 2002*)

(Refer to *1-EF-2003.xls¥airplane* for detail on the calculation process.)

• Activity Data

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

• Completeness

Fuel used in aviation includes jet fuel and aviation gasoline used in light aircraft, helicopters, etc.

The emission factors for greenhouse gases associated with the use of aviation gasoline are given in the *Revised 1996 IPCC Guidelines*. Using that emission factor to calculate the emissions of methane and nitrous oxide associated with the use of

aviation gasoline showed that emissions were negligible (less than 1000 t of carbon dioxide on a carbon dioxide equivalent basis for the number of significant decimal places given in the Common Reporting Format (CRF)). The figure has therefore been reported as 0 (zero).

3.1.3.3. Navigation (CH_4 and N_2O) (1A3d)

• Methodology for Estimating Emissions of GHGs

Emissions from FY1990 to FY2001 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)*(GPG (2000) p. 2.52 Fig. 2.6). (Refer to *1A3-2003.xls¥ShipEmissions* for details of the calculation process.)

• Emission Factors

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

Table 3-10 Default emission factors for navigation

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

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

• Activity Data

Consumption of each type of combustible substance by internal navigation taken from the *Survey on Transport Energy* of the Ministry of Land, Infrastructure and Transport was used for activity data.

• Point to Note

The default emission factor given in the *Revised 1996 IPCC Guidelines, etc.*, is given as a net calorific value. Therefore, in order to use the IPCC default emission factor per unit of calorific value, calorific value, defined as “gross calorific value” in Japan, is converted into the liter-based value using the converted net calorific value.

• Completeness

The Common Reporting Format (CRF) gives 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 relevant category has therefore been reported under *Other Fuels* in the Common Reporting Format (CRF), and the *Residual Oil* column has been reported as "IE".

3.1.3.4. Railways (CH_4 and N_2O) (1A3c)

• Methodology for Estimating Emissions of GHGs

This source of emissions is not a key source category, and as such, emissions for the period FY1990 to FY2001 were calculated by multiplying the default emission factor given in the *Revised 1996 IPCC Guidelines* by fuel consumption on a calorific basis. (Refer to *1A3-2003.xls¥Train Emissions* for details of the calculation process).

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

• Emission Factors

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

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

Table 3-11 Default emission factors of railways

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

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

• Activity Data

The consumption of gas oil by railways given in the *Survey on Transport Energy* of the Ministry of Land, Infrastructure and Transport, has been used for activity data.

• ***Point to Note***

The default emission factor given in the *Revised 1996 IPCC Guidelines* and elsewhere is given as a net calorific value. Therefore, in order to use the IPCC default emission factor per unit of calorific value, calorific value, defined as "gross calorific value" in Japan, is converted into the liter-based value using the converted net value.

• ***Completeness***

The emission factors for greenhouse gases associated with the use of coal in steam engines are given in the *Revised 1996 IPCC Guidelines*. As a result of calculating emissions of methane and nitrous oxide arising from the use of coal in steam engines using that emission factor, activity data has been found to be low (steam engines (locomotives) are almost used for tourism purposes in Japan), and emissions are negligible (less than 1000 t of carbon dioxide on a carbon dioxide equivalent basis for the number of significant decimal places given in the Common Reporting Format (CRF)). The figure has therefore been reported as 0 (zero).

3.2. Fugitive Emissions from Fuels (1B)

3.2.1. Solid Fuels (1B1)

3.2.1.1. Coal Mining (1B1a)

3.2.1.1.a. Underground Mines (1B1a. i)

• ***Methodology for Estimating Emissions of GHGs***

-Mining Activities

Emissions from mining activities in the period from FY1990 to FY2001 were drawn from actual measurements taken at individual coal mines, in accordance with Decision Tree of the *Good Practice Guidance (2000)*(GPG (2000) p. 2.72 Fig. 2.10). (Refer to *1B1-2003.xls* for the calculation process.)

-Post-Mining Activities

Emissions from post-mining activities in the period FY1990 to FY2001 were calculated using the Tier 1 method, which uses default emission factors in accordance with Decision Tree of the *Good Practice Guidance (2000)*(GPG (2000) p. 2.73 Fig. 2.11). (Refer to *1B1-2003.xls* for the calculation process.)

• ***Emission Factors***

-Mining Activities

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

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

Item	Unit	1990	1995	1999	2000	2001	Reference
Coal Production of Underground Mines	kt	6,775	5,622	3,102	2,364	2,528	METI "Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke"
CH4 Total Emissions	1000m3	181,358	80,928	63,077	56,502	42,829	Surveyed by J-COAL
CH4 Total Emissions	Gg-CH4	121.51	54.22	42.26	37.86	28.70	=CH4 [1000m3] / 1000 × 0.67 [$Gg/10^6m^3$]
Emission Factor	kgCH4/t	17.9	9.6	13.6	16.0	11.3	CH4 Total Emissions / Coal Production of Underground Mines

-Post-Mining Activities

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

Calculation of Emission Factor

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

• *Activity Data*

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

3.2.1.1.b. Surface Mines (1B1a. ii)

• *Methodology for Estimating Emissions of GHGs*

-Mining Activities

Emissions from mining activities in the period FY1990 to FY2001 were calculated using the Tier 1 method and the default emission factor in accordance with Decision Tree of the *Good Practice Guidance (2000)*(GPG (2000) p. 2.71 Fig. 2.9). (Refer to *1B1-2003.xls* for the calculation process.)

-Post-Mining Activities

Emissions from post-mining activities in the period FY1990 to FY2001 were calculated using the Tier 1 method and the default emission factor in accordance with Decision Tree or the *Good Practice Guidance (2000)*(GPG (2000) p. 2.73 Fig. 2.11). (Refer to *1B1-2003.xls* for the calculation process.)

• *Emission Factors*

-Mining Activities

A value (0.77 [kg-CH_4/t-coal]) 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 density of methane at one atmosphere and 20 °C (0.67 [Gg/10^6m^3]), was used as the emission factor for mining activities.

Calculation of Emission Factor

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

-Post-Mining Activities

A value (0.07 [kg-CH_4/t-coal]) 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 density of methane at one atmosphere and 20 °C (0.67 [$Gg/10^6m^3$]) was used as the emission factor for post-mining activities.

Calculation of Emission Factor

0.1 [m^3/t] × 0.67 [$Gg/10^6m^3$] = 0.07 [kg-CH_4/t-coal]

• Activity Data

The figure for open-cut production given in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* prepared by the Ministry of Economy, Trade and Industry was used as the activity data for mining and post-mining activities

• Completeness

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

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

3.2.1.2. Solid Fuel Transformation (1B1b)

The activities that come under this particular category have been determined to be the production of coking coal and coal briquettes.

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

The process of coal briquette production involves introducing water to coal, and squeeze-drying it. Therefore the process is not thought to involve chemical reactions, but the emission of carbon dioxide, or of methane or nitrous oxide remains a possibility. As no actual measurements have been taken, however, it is not presently possible to calculate emissions. Also, there is no default value for the emission of carbon dioxide or methane associated with solid fuel transformation, and as it is also not possible to estimate an upper limit for an emission factor, the figure has been reported as “NE”.

3.2.2. Oil and Natural Gas (1B2)

3.2.2.1. Oil (1B2a)

3.2.2.1.a. Exploration (1B2a. i)

• ***Methodology for Estimating Emissions of GHGs***

This source is not a key source category, and for that reason, the emissions in the period FY1990 to FY2001 were calculated by multiplying the default emission factor for exploration given in the *Good Practice Guidance (2000)* by the number of wells drilled, and the number of successful wells by the default emission factor for testing. (Refer to *1B2-2003.xls¥1B2a i Exploration* for detail on the calculation process.)

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

• ***Emission Factors***

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

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

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

Source: *GPG (2000)* Table 2.16

• ***Activity Data***

-Drilling

The figures 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 those reasons, the median of exploratory and successful wells of the wells tested for oil and gas was used.

3.2.2.1.b. Production (1B2a. ii)

• Methodology for Estimating Emissions of GHGs

Emissions for the period from FY1990 to FY2001 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)*(GPG (2000) p. 2.81 Fig. 2.13). (Refer to *1B2-2003.xls¥1B2a ii Production* for details of the calculation process.)

• Emission Factors

-Production

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

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

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

Source: *GPG (2000)* Table 2.16

1) 1 m^3 = 1 kiloliter 2) The default value is $1.4\times10^{-3} – 1.5\times10^{-3}$

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

-Servicing

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

Table 3-15 EF for fugitive emissions from servicing of petroleum production wells

[Gg/No. 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 figures for production of oil in Japan given in the METI's *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* were used as the activity data for fugitive emissions from production.

-Servicing

The number of wells at the end of May in each year given in the METI's *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* were

used as the activity data of fugitive emissions from servicing of production wells. Production wells are typically shut down or re-tapped for oil in accordance with demand, and in a normal year the number of wells fluctuates, and is not consistent throughout any year. As the winter demand season from May to October is typically an average, the number of wells as at the end of May was used as the value representative of the relevant year.

3.2.2.1.c. Transport (1B2a. iii)

• Methodology for Estimating Emissions of GHGs

Emissions for the period from FY1990 to FY2001 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)*(GPG (2000) p. 2.81 Fig. 2.13). (Refer to *1B2-2003.xls¥1B2a iii Transport* for details of the calculation process.)

• Emission Factors

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

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

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

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

• Activity Data

The figures for production of oil in Japan given in the METI's *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* were used as the activity data for fugitive emissions from transport.

• Assumptions Relating to Estimation of Emissions

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

The proportion of sea transport is carried entirely by pipeline, and as such, is not expected to generate 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 in calculations that tanker trucks or rail cars transport all oil.

3.2.2.1.d. Refining / Storage (1B2a. iv)

• ***Methodology for Estimating Emissions of GHGs***

-Refining

Emissions for the period from FY1990 to FY2001 relating to fugitive emissions from refining were calculated using the Tier 1 method in accordance with Decision Tree the *Good Practice Guidance (2000)*(GPG (2000) p. 2.82 Fig. 2.14).

-Storage

Emissions for the period from FY1990 to FY2001 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)*(GPG (2000) p. 2.82 Fig. 2.14), but as a country-specific emission factor is available for use, it was applied to the inventories instead. (Refer to *1B2-2003.xls¥1B2a iii Refining_Storage* for details of the calculation process.)

• ***Emission Factors***

-Refining

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

Table 3-17 Emission factor during refining of crude oil

Emission Factor [kg-CH_4/PJ]	
Oil Refining	90[1)]

Source: *GPG (2000)* Table 2.16

1) The default value is 90–1,400

-Storage

Oil is stored in either corn-roof tanks or floating-roof tanks. All oil storage in Japan is done in floating-roof tanks, which means that fugitive methane emissions are considered to be very limited. If fugitive methane emissions were to occur, they could only occur from the small amount of oil left coating the wall of the tank that is exposed 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 evaporation of methane from tank walls by building a model floating-roof tank to calculate estimates of methane emissions.

The emission factor associated with storage of crude oil used is the value derived by converting the estimates of the Petroleum Association (7 t/year as at 1998) to a net calorific value and dividing it by the relevant activity data.

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

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

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

2) Net Calorific Value = Gross Calorific Value ×0.95

• Activity Data

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

• Point to Note

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

• Completeness

Oil and NGL are refined and stored in Japan, and where carbon dioxide is present 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 of crude oil, it is not currently possible to calculate emissions.

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

3.2.2.1.e. Distribution of Oil Products (1B2a. v)

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

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

3.2.2.2. Natural Gas (1B2b)

3.2.2.2.a. Exploration (1B2b. -)

There is test drilling of oil and gas fields in Japan, and it is conceivable that the activity could give rise to emissions of carbon dioxide, methane, or nitrous oxide. It is difficult, however, to distinguish between oilfields and gas fields prior to test drilling, and for that reason the figures are calculated in conjunction with the aforementioned section 3.1.B.2.a. Oil 1) Exploration, and reported as "IE".

3.2.2.2.b. Production / Processing (1B2b. i)

• ***Methodology for Estimating Emissions of GHGs***

Fugitive emissions of the production of natural gas and processing of natural gas, such as adjusting its constituent elements, and servicing natural gas production wells was calculated for the period FY1990 to FY2001 using the Tier 1 method, and in accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 2.80 Fig. 2.12) (Refer to *1B2-2003.xls¥1B2b i Production_Processing* for detail on the calculation process.).

• ***Emission Factors***

-Production

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

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

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

Source: *GPG (2000)* Table 2.16
1) The default value is 2.6×10^{-3} – 2.9×10^{-3}
2) Excluded from calculations, as the default value is 0 (zero)

-Processing

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

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

		CH_4 1)	CO_2	N_2O 2)
During Processing of Natural Gas	During 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 value is 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 3-21 Emission factors during servicing of natural gas production wells [Gg/No. 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* was used as the activity data during production and processing.

-Servicing

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

3.2.2.2.c. Transmission (1B2b. ii)

• Methodology for Estimating Emissions of GHGs

Fugitive emissions from the transmission of natural gas were calculated for the period 1990 to 2001 using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)*(GPG (2000) p. 2.80 Fig. 2.12) (Refer to *1B2-2003.xls¥1B2b ii Transmission* for detail on the calculation process.)

• Emission Factors

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

Table 3-22 EF for fugitive emissions from transmission of natural gas [Gg-gas/km-pipeline]

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

Source: *GPG (2000)* Table 2.16
1) The default value is $2.1\times10^{-3} – 2.9\times10^{-3}$
2) The default value is $0.8\times10^{-3} – 1.2\times10^{-3}$
3) Excluded from calculations, as the default value is 0 (zero)

• Activity Data

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

3.2.2.2.d. Distribution (1B2b. ii-)

• Methodology for Estimating Emissions of GHGs

Emissions for the period from FY1990 to FY2001 relating to fugitive emissions from distribution should be calculated using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)*(GPG (2000) p. 2.82 Fig. 2.14), but because a country-specific emission factor is available, it was applied to the inventories instead.

The object of the calculations is methane emitted during normal operation of LNG receival terminals, town gas production facilities, and satellite terminals in Japan, as well as methane emitted during regular maintenance or construction. The primary source of emissions is the gases sampled during analysis and residual gases emitted during regular maintenance of manufacturing facilities. (Refer to *1B2-2003.xls¥1B2b ii Distribution* for details of the calculation process.)

• Emission Factor

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

• Activity Data

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

• Point to Note

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

• Completeness

Town gas is produced in Japan, and the 93% of town gas are based on LNG and free of carbon dioxide. Domestic natural gas, however, contains minute amounts of carbon dioxide. Therefore when town gas is produced from domestic natural gas, a negligible quantity of fugitive carbon dioxide emissions is probably released.

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

As emissions of carbon dioxide from this source are less than 0.5 [Gg-CO_2], in accordance with the UNFCCC inventory reporting guidelines[6], they have been reported as 0 (zero).

3.2.2.2.e. At industrial plants and power station / in residential and commercial sectors (1B2b. -)

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, and as no actual measurements have ever been taken, it is not currently possible to calculate emissions.

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

[6] FCCC/CP/1999/7 p9 para21 (f): “0” for emissions by sources and removals by sinks of greenhouse gases which are estimated to be less than one half the unit being used to record the inventory table, and which therefore appear as zero after rounding. The amount should still be included in the national totals and any relevant subtotals.6, 7 In the sectoral background tables of the common reporting format Parties should provide data as detailed as methods allow.

3.2.2.3. Venting and Flaring (1B2c)

3.2.2.3.a. Venting (Oil) (1B2c-venting i)

• ***Methodology for Estimating Emissions of GHGs***

Emission from oilfield venting was calculated for the period FY1990 to FY2001 using the Tier 1 method, and in accordance with Decision Tree of the *Good Practice Guidance (2000)*(GPG (2000) p. 2.81 Fig. 2.13)

• ***Emission Factors***

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

Table 3-23 Emission factors of oilfield venting

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

Source: *GPG (2000)* Table 2.16
1) The default value is 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* was used as the activity data of fugitive emissions from oilfield venting.

3.2.2.3.b. Venting (Gas) (1B2c-venting ii)

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

3.2.2.3.c. Venting (Combined) (1B2c-venting iii)

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

3.2.2.3.d. Flaring (1B2c-flaring)

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

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Chapter 4. Industrial Processes (CRF sector2)

4.1. Mineral Products (2A)

4.1.1. Cement Production (2A1)

• Methodology for Estimating Emissions of GHGs

A country-specific method is used for this particular source of emissions. The volume of limestone used as the raw material in cement was multiplied by the emission factor to calculate the emissions between FY1990 and FY2001. (Refer to *2-CO2-2003.xls¥2A1 Cement* for detail on the calculation process.)

• Emission Factors

The emission factor in FY2000 was calculated by multiplying the weight-for-weight ratio of limestone to carbon dioxide in the chemical reaction, by the purity of the limestone used in FY2000 (from the Japan Cement Association) by all domestic cement manufacturers (20 companies).

Calculation of Emission Factor (FY 2000 example)

- Molecular weight of $CaCO_3$ (primary constituent of limestone): 100.0872
- Molecular weight of CO_2 : 44.0098
- Purity of limestone: 94.8%（from the Japan Cement Association）

Emission Factor ＝ (Molecular weight of CO_2 / Molecular weight of $CaCO_3$) × Purity
＝ (44.0098/100.0872)×0.948 ＝ 0.4168 [t-CO_2/t]
＝ **417 [kg-CO_2/t]**

（Refer to *2-CO2-2003.xls¥2A1 Cement* for other years）

• Activity Data

The activity data for carbon dioxide emissions from cement production was calculated by correcting the financial year measure of limestone consumption by wet weight, given in the Ministry of Economy, Trade and Industry *Yearbook of ceramics and building materials Statistics*, for the ratio of water content (from the Japan Cement Association), and converting it to a dry weight value.

In addition, limestone consumption indicated in the *Yearbook of ceramics and building materials statistics* from FY1990 to FY 1992 does not include the cement used as raw material for solidification agent. Therefore, these data are recalculated with the production of cement including raw material cement for solidification agent.

• ***Japanese Country Specific Method***

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

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

For the foregoing reasons, therefore, in Japan the methodology used incorporates both the amount of limestone used and the emission factor.

4.1.2. Lime Production (2A2)

• ***Methodology for Estimating Emissions of GHGs***

A country-specific method is used in this emission source. The volume of limestone and dolomite used as the raw material for lime is multiplied by the emission factor to calculate emissions between FY1990 and FY2001. (Refer to *2-CO2-2003.xls¥Lime and ¥2-CO2-2003.xls¥dolomite* for details of the calculation process.)

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

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

• ***Emission Factors***

-Limestone

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

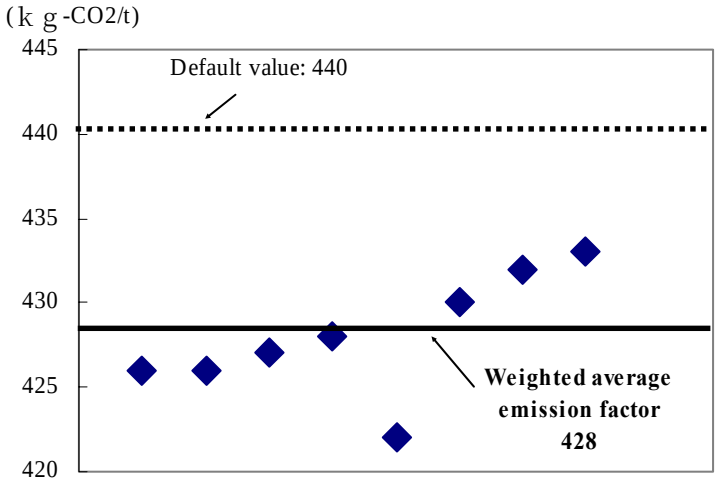

Figure 4-1 Emission factor for limestone used in lime production

N.B. Production volumes are confidential

Source: Data from the Japan Lime Association

-Dolomite

The purity of quarried dolomite from each of three regions found in a survey by Japan Lime Association, and the amount of residual carbon dioxide (carbon dioxide remaining in the raw material after the lime production), was used as the basis for which to establish an emission factor using weighted averages. The emission factor is 449 [kg-CO_2/t].

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

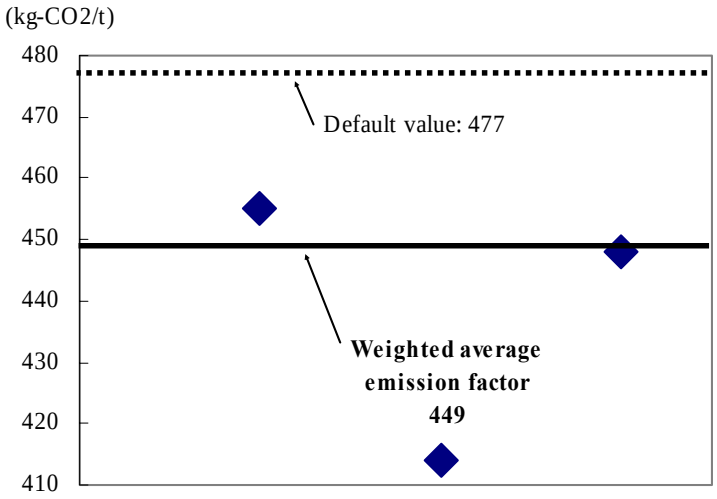

Figure 4-2 Emission factor for dolomite used in lime production
N.B. Production volumes are confidential
Source: Data from the Japan Lime Association

• ***Activity Data***

The volume of limestone and dolomite sold for lime given in the Ministry of Economy, Trade and Industry's *Yearbook of minerals and non-ferrous metals statistics*, was used for activity data for carbon dioxide emissions associated with the manufacture of quicklime.

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

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

4.1.3. Limestone and Dolomite Use (2A3)

• 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 between 1990 and 2001. (Refer to *2-CO2-2003.xls¥Lime* and *2-CO2-2003.xls¥dolomite* for details on the calculation process.)

• Emission Factors

-Limestone

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

Calculation of Emission Factor（Limestone）

$CaCO_3 \rightarrow CaO + CO_2$

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

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

Molecular weight of CO_2: 44.0095

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

Source
a. Median of 54.8%～56.0%: Japan Lime Association *The Story of Lime*
b. IUPAC *Atomic Weights of the Elements 1999*
(http://www.chem.qmul.ac.uk/iupac/AtWt/AtWt9.html)

-Dolomite

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

Calculation of Emission Factor (Dolomite)

$CaCO_3 \rightarrow CaO + CO_2$

$MgCO_3 \rightarrow MgO + CO_2$

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

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

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

Molecular weight of CO_2: 44.0095

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

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

• Activity Data

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

Volumes of limestone and dolomite sold for soda glass after 2000 were excluded from the statistical survey. Therefore provisional consumption was made using the 1999 figure.

• Completeness

Emissions of carbon dioxide from limestone and dolomite used in the sinter furnace that is part of the iron and steel production process were included in this emission source (Category 2A3 of the Common Reporting Format (hereafter, CRF)). (See 4.3.1.3. Sinter (2C1-))

4.1.4. Soda Ash Production Use (2A4)

Soda ash in Japan is produced using a parallel production method. In the parallel production method, carbon dioxide generated during the production of soda ash is used as a raw material for calcination of limestone and synthesis of ammonia. The carbon dioxide is almost entirely incorporated into the product, but it is likely that some carbon dioxide is released to the atmosphere in the manufacturing process. The carbon dioxide in question may already have been calculated in Limestone and Dolomite Use (2A3), and Ammonia Production (2B1), but as investigation to date is inadequate, it was reported as "NE".

4.1.5. Asphalt Roofing (2A5)

Asphalt roofing is manufactured in Japan, but information about the manufacturing process and activity data is inadequate, and it is not possible to definitively say that carbon dioxide emissions are not 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 they have been reported as "NE".

4.1.6. Road Paving with Asphalt (2A6)

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 they have been reported as "NE".

4.2. Chemical Industry (2B)

4.2.1. Ammonia Production (2B1)

1) CO_2

• Methodology for Estimating Emissions of GHGs

The volumes of the different types of fuel consumed as raw materials in the production of ammonia were multiplied by the emission factor to calculate the emissions between FY1990 and FY2001. (Refer to *2-CO2-2003.xls¥Ammonia* for detail on the calculation process).

• Emission Factors

The same emission factors as used in calculating carbon dioxide from the fuel combustion sector were used. (Refer to Chapter3.)

• Activity Data

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

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

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

a. Gross Calorific Value
b. Used the calorific value of imported steaming coal
c. Used the calorific value of oil refinery gas

• Point to Note

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

2) CH_4

Emission of methane from the ammonia production has been confirmed by actual measurements. As there are insufficient examples 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 (2B2)

• Methodology for Estimating Emissions of GHGs

Emissions reported from factories and the emission factors[4] were used in accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 3.31 Fig. 3.4) to report on emissions between FY1990 and FY2001.

• Emission Factors

Total emissions reported by factories to the Ministry of Economy, Trade and Industry have been reported, but emissions from individual factory are categorized as confidential data. For convenience, therefore, actual data from ten factories located throughout Japan was the basis for establishing emission factors using weighted averages of the production volumes of each factory, which were then recorded on the calculation sheet. (Refer to *2-N2O-2003.xls¥N2Oemissions* for detail.)

The emission factors for all factories from FY1990 to FY2001 fall within the range 0.8~8.6 [kg N_2O/t HNO_3 (98%)].

• Activity Data

Production volumes 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 manufacture of nitric acid.

[4] Data provided by METI

4.2.3. Adipic Acid Production (2B3)

• Methodology for Estimating Emissions of GHGs

Emissions reported from operating sites, and the emission factor and decomposition volumes were used in accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 3.31 Fig. 3.4) to report on emissions between FY1990 and FY2001.

Calculation of Emissions

Emissions = Emission Factor × Production of adipic acid

= {Rate of generation of N_2O

× (1 - Rate of decomposition of N_2O × Operating rate of decomposition unit)}

× Production of adipic acid

Source: *GPG (2000)* p 3.30 Equation 3.9

• Emission Factors

Values calculated using the above equation has been used as the emission factors. Parameters were established using the following methods.

-Rate of generation of nitrous oxide

The figure used is 250 [kg-N_2O/t], based on actual measurement[5] data 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, which is 99.9%. The concentration of nitrous oxide in exhaust gas from normal operation of the nitrous oxide decomposition unit was not detected (the concentration was below measurable limits). Therefore, the value considering the significant digits amounts to be 99.9%.

The nitrous oxide decomposition unit has been operating since March 1999.

-Operating rate of decomposition unit

The figure reported by the operating site has been used.

• Activity Data

The data used for activity data for nitrous oxide emissions associated with the manufacture of adipic acid was that submitted to the Ministry of Economy, Trade and Industry by the manufacturer.

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

4.2.4. Carbide Production (2B4)

4.2.4.1. Silicon Carbide (2B4-)

1) CO_2

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

2) CH_4

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

4.2.4.2. Calcium Carbide (2B4-)

1) CO_2

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

2) CH_4

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

4.2.5. Other (2B5)

4.2.5.1. Carbon Black (2B5-)

• Methodology for Estimating Emissions of GHGs

Production of carbon black was multiplied by a country-specific emission factor to report on methane emissions from carbon black production between FY1990 and FY2001.

• Emission Factors

The five major companies representing 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 boiler inspection carried out by the five major domestic producers, deriving from weighted averages and using production volumes of carbon black. The emission factor is 0.35 [kg-CH_4/t].

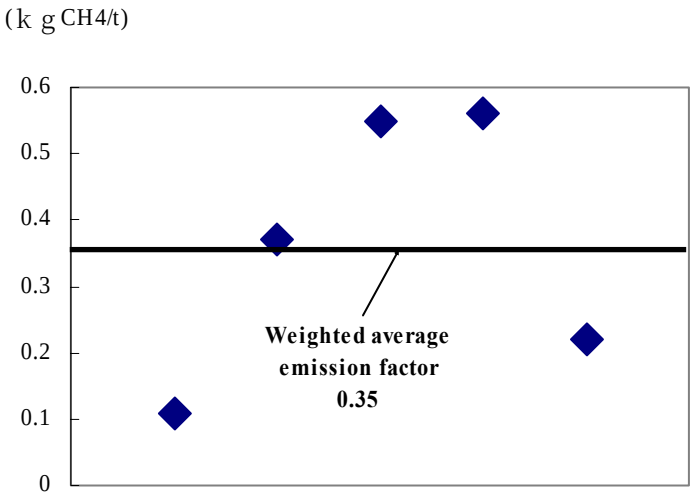

Figure 4-3 CH_4 Emission factor for carbon black production
Source: Data provided by the Carbon Black Association

Table 4-2 Methane emissions and carbon black production by the 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 given in the *Yearbook of Chemical Industries Statistics* compiled by the Ministry of Economy, Trade and Industry were used for activity data for methane emissions associated with the manufacture of carbon black.

4.2.5.2. Ethylene (2B5-)

1) CO_2, CH_4

• ***Methodology for Estimating Emissions of GHGs***

Emissions of methane and carbon dioxide associated with the manufacture of ethylene between FY1990 and FY2001 were reported by multiplying ethylene production by country specific emission factor.

• ***Emission Factors***

-CH_4

Estimates 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 production volume to calculate emission factors for each company. The weighted average of production from each company was then used to establish the emission factor. The emission factor is 0.015 [kg-CH_4/t].

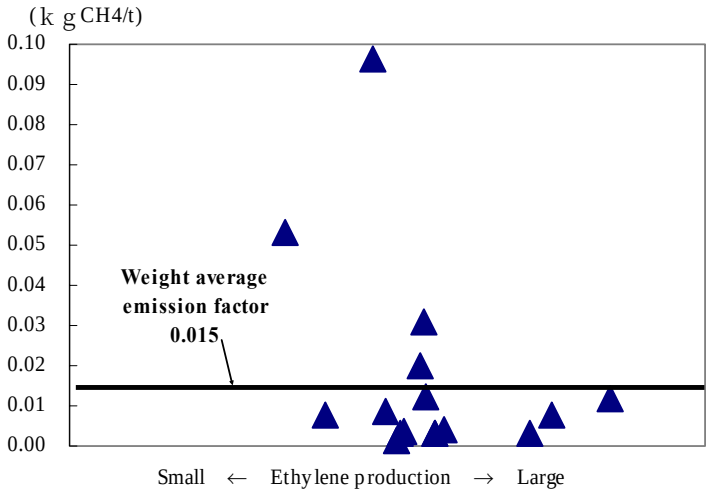

Figure 4-4 Emission factor for methane from ethylene manufacture

Source: Data provided by the Japan Petrochemical Industry Association

-CO_2

The emission factor for normal operation and abnormal operation at operating sites in Japan was established using actual measurement data recorded in FY2000. A pre-condition in establishing the emission factor was the assumption that all carbon dioxide refined in the naphtha-cracking sector is emitted. The emission factor is 0.028 [t-CO_2/t]

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

	[t-CO_2 / t]
Ethylene production	0.028

Source: Data provided by the Japan Petrochemical Industry Association

• ***Activity Data***

Ethylene production volumes from the *Yearbook of Chemical Industries Statistics* compiled by the Ministry of Economy, Trade and Industry were used as activity data for emissions of methane and carbon dioxide from ethylene production.

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. If there is any generation of nitrous oxide from the process at all, it can be considered to be negligible. There are no measurement results, and the *Revised 1996 IPCC Guidelines* do not provide a default value, making it impossible to calculate nitrous oxide emissions. Therefore they have been reported as “NE”.

4.2.5.3. 1,2-Dichloroethane (2B5-)

• Methodology for Estimating Emissions of GHGs

Methane emissions from 1,2-dichloroethane production were reported for the period between FY1990 and FY2001 by multiplying production volumes by country specific emission factor.

• Emission Factors

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

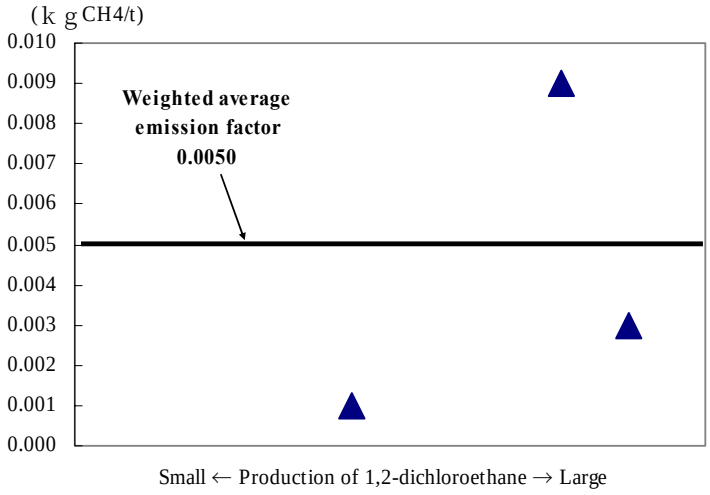

Figure 4-5 Methane emission factors for 1,2-dichloroethane production
Source: Data provided by the Vinyl Environmental Council

• Activity Data

Dichloroethylene production volumes from the *Yearbook of Chemical Industries Statistics* compiled by the Ministry of Economy, Trade and Industry were used as activity data for methane emissions from 1,2-dichloroethane production

4.2.5.4. Styrene (2B5-)

• ***Methodology for Estimating Emissions of GHGs***

Methane emissions from styrene production were reported for the period between FY1990 and FY2001 by multiplying styrene production volumes by country specific emission factor.

• ***Emission Factors***

Estimates 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 production volume to calculate emission factors for each company. The weighted average of production from each company was then used to establish the emission factor. The emission factor is 0.031 [kg-CO_2/t].

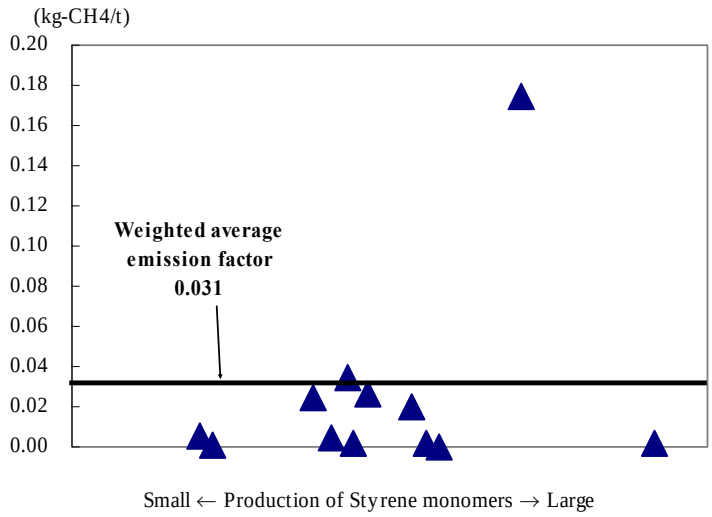

Figure 4-6 Methane emission factors for styrene production

Source: Data provided by the Japan Petrochemical Industry Association

• ***Activity Data***

Styrene monomer production volumes from the *Yearbook of Chemical Industries Statistics* compiled by the Ministry of Economy, Trade and Industry were used as activity data for methane emissions from styrene production.

4.2.5.5. Methanol (2B5-)

• Methodology for Estimating Emissions of GHGs

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

• Emission Factors

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

Table 4-4 Methane emission factor from methanol production

	[kg-CH_4 / t]
Methanol Production	2

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

• Activity Data

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

• Point to Note

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

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

4.2.5.6. Coke (2B5-)

1) CH_4

• Methodology for Estimating Emissions of GHGs

Methane emissions from coke production were reported for the period between FY1990 and FY2001 by multiplying the production volume of coke by country specific emission factor.

• Emission Factors

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

-Combustion exhaust gas

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

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

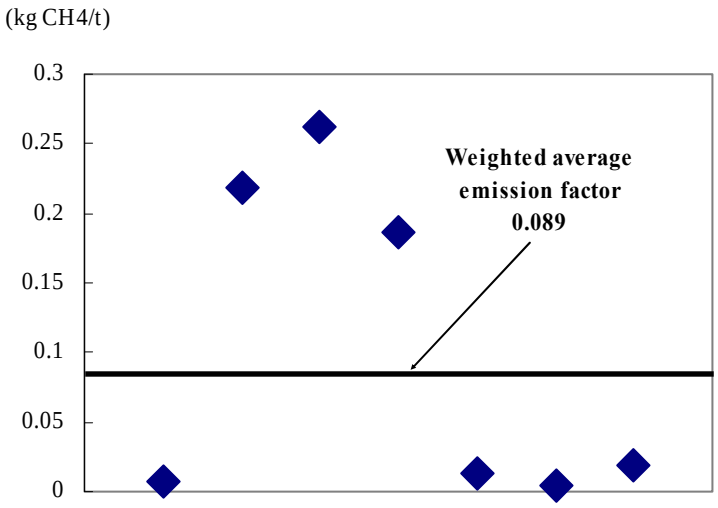

Figure 4-7 Emission factors for methane in combustion exhaust gas from coking furnaces

Source: Data provided by the Japan Iron and Steel Federation

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

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

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

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

Source: Data provided by the Japan Iron and Steel Federation

-Methane emission factor for coke production

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

• Activity Data

Production volume given in the *Yearbook of production, supply and demand of petroleum, coal and coke* compiled by the Ministry of Economy, Industry and Trade has been used as the activity data for methane emitted from coke production.

• Completeness

The SBDT[6] (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 2C1 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.

[6] SBDT: Sectoral Background Data Table

2) CO_2, N_2O

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

4.3. Metal Production (2C)

4.3.1. Iron and Steel Production (2C1)

4.3.1.1. Steel (2C1-)

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 (1A), and as the carbon dioxide generated through the oxidization of coke used as a reducing agent has already been calculated under Fuel Combustion Sector (1A), it has been reported as "IE".

4.3.1.2. Pig Iron (2C1-)

1) CO_2

Carbon dioxide generated from pig iron production is emitted when coke used as a reduction agent oxidizes. The amount of coke used has been included under consumption of fuel in Fuel Combustion Sector (1A), and as the carbon dioxide generated through the oxidization of coke used as a reducing agent has already been calculated under Fuel Combustion Sector (1A), 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 from actual measurements that methane is not emitted. Emissions have therefore been reported as "NA".

4.3.1.3. Sinter (2C1-)

1) CO_2

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

Limestone and dolomite sources of carbon dioxide emissions used in the sinter production have been counted under *4.1.3. Limestone and Dolomite Use (2A3).*

2) CH_4

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

4.3.1.4. Coke (2C1-)

1) CO_2

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

2) CH_4

Emissions of methane were calculated at *4.2.5.6. Coke (2B5-)*, and have therefore been reported as "IE".

4.3.2. Ferroalloys Production (2C2)

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 (1A), 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 (1A). 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. It has therefore been reported as "IE".

2) CH_4

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

4.3.3. Aluminium Production (2C3)

1) PFCs

• Methodology for Estimating Emissions of GHGs

Emissions for the period from 1995 to 2001 were calculated by multiplying production volumes from primary refining of aluminum. by emission factors calculated at domestic facilities based on the methods specified in the IPCC Guidelines.

• Emission Factors

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

Table 4-6 PFCs emission factor of aluminum production

	Unit	1995	1999	2000	2001
PFC-14 (CF4)	kg PFC-14/t	0.542	0.406	0.369	0.317
PFC-116 (C2F6)	kg PFC-116/t	0.054	0.041	0.037	0.032

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

• ***Activity Data***

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

2) CO_2

Carbon dioxide generated in association with aluminum smelting is emitted in conjunction with the oxidization of the anode paste used as a reducing agent. Consumption of coke, the main ingredient in the anode paste has been included in fuel consumption under Fuel Combustion Sector (1A), 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 (1A), and has therefore been reported as "IE".

3) CH_4

There is a small amount of hydrogen in the pitch that act as 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 (2C4)

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

The Japan Magnesium Association has indicated that, in relation to emissions associated with the use of SF_6 when casting magnesium, the use of SF_6 in Japan under this category began in the 1970s and is today very widespread. Also, the Association has indicated it is about to start the survey on its use in Japan, including its use in the past. The Association is working towards an implementation plan for promulgation in 2002, in relation to reducing greenhouse gases. It would seem appropriate that reporting be awaited until the outcomes of the Association's survey. Statistics relating to magnesium production volumes, however, ceased to be available after January 2001, and have therefore been reported as "NE".

4.4. Other Production (2D)

4.4.1. Pulp and Paper (2D1)

(The CRF requires reporting 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 (2D2)

Food and drink are manufactured in Japan, and because carbon dioxide is used in the manufacturing process, 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 food and drink, however, is a by-product gas of petrochemical products, and as such emissions have been incorporated into Fuel Combustion Sector (1A), they have been reported as “IE”.

4.5. Production of Halocarbons and SF_6 (2E)

4.5.1. By-product Emissions: Production of HCFC-22 (2E1-)

The figure that has been reported is that given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council, for emissions of by-product HFC-23 associated with the production of HCFC-22. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2E* for detail on the calculation process and related indices.)

Table 4-7 Indices related to By-product Emissions of HFC-23: Production of HCFC-22

Item	Unit	1995	1999	2000	2001
HCFC-22 production	t	81,000	94,525	95,271	88,157
Generation Factor	%	2.13%	1.75%	1.70%	1.39%
Emission Factor	%	1.79%	1.27%	1.11%	0.91%

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

4.5.2. Fugitive Emissions (2E2)

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for fugitive emissions from manufacture of HFCs, PFCs, and SF_6. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2E* for detail on the calculation process and related indices.)

Table 4-8 Indices related to fugitive emissions from HFCs, PFCs, and SF_6 production

GHGs	Item	Unit	1995	1999	2000	2001
HFCs	HFCs production	t	28,205	26,620	29,423	38,300
	Emission Factor	%	1.16%	0.29%	0.50%	0.60%
PFCs	PFCs production	t	1,207	1,855	2,337	2,141
	Emission Factor	%	8.78%	8.95%	7.87%	6.91%
SF6	SF6 production	t	2,392	1,838	1,556	1,666
	Emission Factor	%	8.24%	3.48%	2.31%	1.98%

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

4.6. Consumption of Halocarbons and SF_6 (2F)

4.6.1. Refrigeration and Air Conditioning Equipment (2F1)

4.6.1.1. Domestic Refrigeration (2F1-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for HFCs emissions from domestic refrigeration. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-9 Indices related to emissions of HFCs from domestic refrigeration

Item	Unit	1995	1999	2000	2001
Total HFC Charged in the year	t	520	632	590	563
Fugitive Ratio from Manucfacturing	%	1.0%	1.0%	1.0%	0.49%
Device Stock	1000 devices	4,489	23,309	28,194	31,568
Refrigirant contained	g / device	150	140	125	128
Refrigirant filled while servicing	%	0.3%	0.3%	0.3%	0.3%
Discarded Devices	1000 devices	1	93	180	552
Collect Rate	%	-	-	-	86.1%

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

2) PFCs

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

4.6.1.2. Commercial Refrigeration (2F1-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for HFC emissions from commercial refrigeration. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F1* for detail on the calculation process and related indices.)

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

Item	Unit	1995	1999	2000	2001
Device contained HFCs Production (Distribution)	1000 devices	231	1,127	1,114	1,059
Refrigirant contained	kg / device	0.4～480	0.4～480	0.4～480	0.4～480
Fugitive Ratio from Manucfacturing	%	0.1%～0.2%	0%～0.2%	0%～0.2%	0%～0.2%
Fugitive Ratio from Instaration	%	0.1%～0.5%	0%～1%	0%～1%	0%～1%
Assembly Fugitive Emissions	t	-	-	-	1.2
Device contained HFCs Stocks	1000 devices	379	3,186	4,280	5,291
Annual Fugitive Ratio	%	0%～3%	0%～3%	0%～3%	0%～3%
Refrigirant Stock	t	402	1,968	2,477	3,594
Fugitive Ratio form Servicing	%	100%	100%	100%	100%
Annual Repairing Ratio	%	0.1～2%	0.1%～2%	0.1%～2%	0.1%～2%
Discarded Devices	1000 devices	-	-	14	-
Residual Refrigirant per device	kg / device	-	-	0.3	0.3
Collect Rate of HFCs	%	-	-	32%	-

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

2) PFCs

It is thought that there is no incidence of use in Japan, but as that has not been confirmed, emissions have been reported as “NE”.

4.6.1.3. Automatic Vender Machine (2F1-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFCs emissions from automatic vender machines. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls ¥2F1* for detail on the calculation process and related indices.)

Table 4-11 Indices related to emissions of HFCs from automatic vender machines

Item	Unit	1995	1999	2000	2001
Device contained HFCs Production (Distribution)	1000 devices	0	12	272	344
Fugitive Ratio from Manucfacturing	%	-	0.4%	0.4%	0.5%
Working Devices	1000 devices	0	12	284	628
Annual breakdown Ratio	%	-	0.35%	0.35%	0.35%
Refrigirant contained	g / device	-	300	300	300
Average Fugitive Ratio from breakdown	%	-	0.21%	0.21%	0.21%
Annual Repairing Ratio	%	-	0.35%	0.35%	0.35%
Refrigirant filled while servicing	g / device	-	300	300	300
Fugitive Ratio form Servicing	%	-	0.4%	0.4%	0.4%
Discarded Devices	1000 devices	0	0	0	0

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

2) PFCs

It is thought that there is no incidence of use within Japan, but as that has not been confirmed, emissions have been reported as “NE”.

4.6.1.4. Transport Refrigeration (2F1-)

1) HFCs

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

2) PFCs

It is thought that there is no incidence of use within Japan, but as that has not been confirmed, emissions have been reported as “NE”.

4.6.1.5. Industrial Refrigeration (2F1-)

1) HFCs

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

2) PFCs

It is thought that there is no incidence of use within Japan, but as that has not been confirmed, emissions have been reported as “NE”.

4.6.1.6. Stationary Air-Conditioning (Household) (2F1-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFCs emissions associated with stationary air-conditioning (household). The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-12 Indices related to emissions of HFCs from stationary air-conditioning (household)

Item	Unit	1995	1999	2000	2001
Production(distribution) of devices containing HFCs	1000 devices	0	518	1,053	2,610
Refrigirant contained	g / device	—	765	765	765
Fugitive Ratio from Manucfacturing	%	—	0.1%	0.1%	0.1%
Fugitive Ratio from Instaration	%	—	4.0%	4.0%	4.0%
Device contained HFCs Stocks	1000 devices	0	649	1,702	4,312
Incidence Rate of accedent or breakdown	%	—	1.0%	1.0%	1.0%
Fugitive Ratio from accident	%	—	100.0%	100.0%	100.0%

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

2) PFCs

It is thought that there is no incidence of use within Japan, but as that has not been confirmed, emissions have been reported as “NE”.

4.6.1.7. Mobile Air-Conditioning (Car Air Conditioners) (2F1-)

1) HFCs

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFC-134a emissions from car air conditioners. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F1* for detail on the calculation process and related indices.)

Table 4-13 Indices related to emissions of HFC-134a from car air conditioners

Item	Unit	1995	1999	2000	2001
Vehicle Production	1000 vehicle	6,572	8,236	8,539	8,517
Assembly Emission Factor	g / vehicle	3.5	3.5	3.5	3.5
Vehicle Stock	1000 vehicle	15,970	38,862	43,811	48,944
Average Refrigerant Weight per Vehicle	g / vehicle	700	650	615	603
Annual Operation Emission Factor	g / vehicle / year	15	15	15	15
Ratio of Repairing	%	4%	4%	4%	4%
Ratio of Vehicle leaking	%	50%	50%	50%	50%
Vehicle Collapsed Completely	1000 vehicle	50	173	215	233
Refrigerant Filled in collapsed completely	g / vehicle	650	567	539	511
Vehicle Disassembled	1000 vehicle	8	268	413	541
Refrigerant Filled in disassembled	g / vehicle	650	567	539	511
Refrigerant Recovered	t	-	-	-	8

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

2) PFCs

It is thought that there is no incidence of use within Japan, but as that has not been confirmed, emissions have been reported as “NE”.

4.6.2. Foam Blowing (2F2)

4.6.2.1. Hard Form (2F2-)

4.6.2.1.a. Urethane Foam (2F2--)

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFC-134a emissions from urethane foam production. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F2* for detail on the calculation process and related indices.)

Table 4-14 Indices related to emissions of HFC-134a from urethane foam

Item	Unit	1995	1999	2000	2001
Total HFC used in the year	t	0	0	167	177
Assembly Emission Rate	%	10.0%	10.0%	10.0%	10.0%
Operational Emission Rate	%	4.5%	4.5%	4.5%	4.5%
Average Product Lifetime	years	30	30	30	30

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

4.6.2.1.b. Polyethylene Foam (2F2--)

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council for HFC-134a emissions associated with polyethylene foam production. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F1* for detail on the calculation process and related indices.)

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

Item	Unit	1995	1999	2000	2001
Total HFC used in the year	t	348	310	320	290

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

4.6.2.1.c. Polystyrene Foam (2F2--)

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for HFC-134a emissions associated with polystyrene foam production. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F2* for detail on the calculation process and related indices.)

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

Item	Unit	1995	1999	2000	2001
Total HFC used in the year	t	0	0	0	10
Foam Yield Rate	%	75.0%	75.0%	75.0%	75.0%
Operational Emission Rate	%	-	-	-	2.5%
Average Product Lifetime	years	30	30	30	30

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

4.6.2.2. Soft Form (2F2-)

All foam that uses HFCs is hard foam. Emissions have therefore been reported as "NO".

4.6.3. Fire Extinguishers (2F3)

It is thought that there is incidence of use within Japan, but as that has not been confirmed, emissions have been reported as "NE".

4.6.4. Aerosols/Metered Dose Inhalers (2F4)

4.6.4.1. Aerosols (2F4-)

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for HFC-134a and HFC-152a emissions associated with aerosols. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F4* for detail on the calculation process and related indices.)

Table 4-17 Indices related to emissions of HFCs from aerosols

Item	Unit	1995	1999	2000	2001
Potential Emissions of HFC-134a	t	1,300	2,163	2,124	1,884
Potential Emissions of HFC-152a	t	0	0	35	121
Ratio of products containing single chemical	%	70.0%	88.0%	88.0%	86.0%
Mixing Rate of products containing single chemical(HFC-134a)	%	0.0%	0.0%	14.6%	12.7%
Assembly Fugitive Ratio	%	5.0%	4.6%	3.8%	3.1%

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

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

4.6.4.2. Metered Dose Inhalers (2F4-)

The figures that have been reported are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for HFC-134a and HFC-227ea emissions associated with MDI. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F4* for detail on the calculation process and related indices.)

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

Item	Unit	1995	1999	2000	2001
Domestic HFC-134a consumption for MDI	t HFC-134a	0.0	1.3	1.4	1.0
Imported HFC-134a consumption for MDI	t HFC-134a	0.0	29.9	42.0	45.0
Ammount of Disposal HFC-134a for MDI	t HFC-134a	0.0	0.1	0.2	0.1
Domestic HFC-227ea consumption for MDI	t HFC-227ea	0.0	0.0	0.0	5.6
Imported HFC-227ea consumption for MDI	t HFC-227ea	0.0	0.0	3.6	6.7
Ammount of Disposal HFC-227ea for MDI	t HFC-227ea	0.0	0.0	0.0	0.0

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

4.6.5. Solvents (2F5)

The figures that have been reported for this source are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for PFC emissions associated with the use of solvents during washing of consumer electronics parts, manufacture of semiconductors, and manufacture of liquid crystals. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F5* for detail on the calculation process and related indices.)

In electronic component production process, some years' implied GWP are smaller than 6,500 because of PFC which is not indicated in the CRF[7].

Table 4-19 Indices related to emissions of PFCs from solvents

Item	Unit	1995	1999	2000	2001
Ammount of Shipping PFCs for Solvent	t	1,300	1,000	1,000	1,000
Open System	t	900	700	700	700
Closed System	t	400	300	300	300
Assembly Fugitive Rate	%	1%	1%	1%	1%
Operational Fugitive Rate	%	0.1%	0.1%	0.1%	0.1%
Disposal Collect Rate	%	90%	90%	90%	90%
Average Product Lifetime	years	20	20	20	20

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

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

4.6.6. Semiconductors (2F6)

The figures that have been reported for this source are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for PFCs emissions associated with the use of solvents during manufacture of semiconductors, and manufacture of liquid crystals. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F6* for detail on the calculation process and related indices.)

Table 4-20 Indices related to emissions of F-gas from manufacturing of semiconductors

Item	Unit	1995	1999	2000	2001
PFCs purchased	t	-	810	909	708
HFC-23 purchased	t	-	46	46	38
SF_6 purchased	t	-	105	126	92
Supply Rate for Process	%	90.0%	90.0%	90.0%	90.0%
Chemical Reaction Consumption Rate of PFCs etc.	—	0.2～0.8	0.2～0.8	0.2～0.8	0.2～0.8
Reselection Efficiency of PFCs etc.	—	0.9	0.9	0.9	0.9
Generation Rate of by-product					
C_2F_6	—	0.1	0.1	0.1	0.1
C_3F_8	—	0.2	0.2	0.2	0.2
Desellection Efficiency of CF_4	—	0.9	0.9	0.9	0.9

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

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

Item	Unit	1995	1999	2000	2001
HFC-23 purchased	t	0.1	1.4	0.7	1.0
PFC-14 purchased	t	20.7	48.1	47.3	30.9
PFC-116 purchased	t	0.4	1.8	2.7	3.9
SF_6 purchased	t	11.5	80.4	85.3	83.3
Supply Rate for Process	%	90.0%	90.0%	90.0%	90.0%
Chemical Reaction Consumption Rate of PFCs etc.	—	0.2～0.8	0.2～0.8	0.2～0.8	0.2～0.8
Desellection Efficiency of PFCs etc.	—	0.9	0.9	0.9	0.9
Generation Rate of by-product					
C_2F_6	—	0.1	0.1	0.1	0.1
C_3F_8	—	0.2	0.2	0.2	0.2
Desellection Efficiency of CF_4	—	0.9	0.9	0.9	0.9

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

4.6.7. Electrical Equipment (2F7)

The figures that have been reported for this source are given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry's Industrial Structure Council for SF_6 emissions from electrical equipment. The associated indices are given in the table below. (Refer to *2-Fgas-A-2003.xls¥2F7* for detail on the calculation process and related indices.)

Table 4-22 Indices related to emissions of SF_6 from electrical equipment

Item	Unit	1995	1999	2000	2001
Stocks of SF_6	t	6,260.00	7,690.00	8,040.00	8,300.00
Operational Fugitive Rate	%	0.1%	0.1%	0.1%	0.1%
Device Production	Devices	4,900	4,750	-	-
SF_6 Re-use Rate	%	0%	0%	-	-
Refrigerant contained	Mt CO2eq.	35	24	-	10
Assembly Fugitive Rate	%	30%	18%	-	-
Device Stock (estimated)	(about) Devices	1,400	1,400	1,200	-
Electricity Companies' SF_6 Stock	(about) t	6,300	7,700	8,000	8,300
Average Device Lifetime (Device assembled before 1975)	(about) years	30	30	30	30
Average Device Lifetime (Device assembled after 1975)	(about) years	40	40	40	40
Service Cycle	(about) years	12	12	12	-
Servicing Collect Rate	%	60%	87%	93%	96%
Dismantlement Collect Rate	%	0%	88%	94%	97%

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

4.6.8. Other (Research Purposes, Medical Purposes, Fire Extinguishers) (2F8)

The figures relating to HFCs emissions from activities that are for research purposes, medical purposes, or fire extinguishers have been incorporated in the data under 2F8 Other. The figures are as given in Documentation from the Chemical and Bio Sub-Group, Industrial Structure Council, the Ministry of Economy, Trade and Industry

References

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Ministry of Economy, Trade and Industry, *Yearbook of ceramics and building materials Statistics*

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Japan Lime Association, *The Story of Lime*

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

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

Data provided by the Ministry of Economy, Trade and Industry (Emissions of nitrous oxide and emission factor associated with manufacture of nitric acid)

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

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Data provided by the Carbon Black Association

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

Data provided by the Japan Petrochemical Industry Association

Data provided by the Environmental Vinyl Council

Methanol and Formalin Association, *Methanol Supply and Demand*

Data provided by the Japan Iron and Steel Federation

Documentation from the Chemical and Bio Sub-Group, Industrial Structure Council, the Ministry of Economy, Trade and Industry

Chapter 5. Solvent and Other Product Use (CRF sector3)

5.1. Paint Application (3A)

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

5.2. Degreasing and Dry-Cleaning (3B)

1) CO_2

Degreasing and dry-cleaning are activities that occur in Japan.

Degreasing is defined under the heading "washing processes that do not involve chemical reactions", and it is therefore assumed that it does not generate carbon dioxide. Carbon dioxide emissions may be assumed to occur in association with washing methods involving dry ice or carbonic gas, but it is thought that such methods are generally not used in Japan.

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

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

2) N_2O

Degreasing and dry-cleaning are activities that occur 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 occur. It is therefore assumed that nitrous oxide is not generated. There are also no methods for degreasing or dry-cleaning used in Japan that have the potential to emit nitrous oxide. They have therefore been reported as "NA".

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

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

5.4. Other (3D)

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

1) N_2O

• Methodology for Estimating Emissions of GHGs

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

• Emission Factors

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

• Activity Data

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

2) CO_2

Only nitrous oxide is used as a general anesthetic in Japan, and carbon dioxide is not so used. They have therefore been reported as "NO".

5.4.2. Fire Extinguishers (3D-)

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. The carbon dioxide with which the fire extinguishers are filled, however, is all 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 have therefore 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 the possibility that the nitrogen gas emitted engages in a chemical reaction generating nitrous oxide. There is still insufficient data on the reality of nitrous oxide emissions associated with the use of fire extinguishers filled with nitrogen gas, and it is not currently possible to calculate emissions. There is also no default emission factor, and as it is not

possible to estimate an upper limit for an emission factor, it is reported as “NE”.

5.4.3. Aerosol Cans (3D-)

1) CO_2

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

2) N_2O

Aerosol products manufactured in Japan do not use nitrous oxide. Because in principle no nitrous oxide is emitted, 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 sector4)

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 previous to and the year after the relevant year to report a three-year average for emissions.

6.1. Enteric Fermentation (4A)

6.1.1. Cattle (4A1)

• ***Methodology for Estimating Emissions of GHGs***

Methane emissions associated with enteric fermentation in cattle have been calculated for the period FY1990 to FY2001, using a methodology similar to the Tier 2 method, but country-specific to Japan.

The categories reflect Japanese situation, in that calculation of emissions is based on categorization of cattle as shown below, by type and age. (Refer to *4A-CH4-2003.xls* for details of the calculation process.)

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

Type of livestock		Assumptions underlying calculation of emissions
Dairy cattle	Lactating	―
	Dry	―
	Heifer (Under Two Years)	Calves less than 6 months in age are assumed to account for 25% of the herd, and have been excluded from estimates.
Non-Dairy cattle	Dairy breeding	Calves less than 6 months in age are assumed to account for 25% of the herd, and have been excluded from estimates.
	Fattening (One Year and Over)	―
	Fattening (Under One Year)	Calves less than 6 months in age are assumed to account for 50% of the herd, and have been excluded from estimates.
	Breeding Cows (One Year and Over)	―
	Breeding Cows (Under One Year)	Calves less than 6 months in age are assumed to account for 50% of the herd, and have been excluded from estimates.

• ***Emission Factors***

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

Results of measurements have made it clear that it is possible to estimate methane generated in association with 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 entered into the above equation to establish the following table of emission factors.

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

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

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

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

• *Activity Data*

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

• *Japanese Country-Specific Method*

In accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 4.24 Fig. 4.2), calculations for dairy and non-dairy cattle should be done 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. Therefore the emission factor has been established using the volume of dry matter intake.

6.1.2. Sheep, Goats, Horses & Swine (4A3, 4A4, 4A6, 4A8)

• *Methodology for Estimating Emissions of GHGs*

Methane emissions associated with enteric fermentation in sheep, goats, horses and swine have been calculated for the period FY1990 to FY2001, using the Tier 1 method, in accordance with Decision Tree of the *Good Practice Guidance (2000)*. (Refer to *4A-CH4-2003.xls* for details of the calculation process.)

• *Emission Factors*

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

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

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

a: Volume of methane generated (l/day/head) is divided by 22.4 [l/mol] and multiplied by the molecular weight of methane (16).
b: Volume of methane generated (g/day/head) has been multiplied either by 365 (days) or 366 (days).
c: Mamoru Saito, *Methane emissions from fattening swine and expectant swine*, Japan Society of Animal Science, *Animal Science Journal*, 59: pp 773–778 (1988)
d: *Revised 1996 IPCC Guidelines*（Crutzen, P.J., et al. "Methane production by domestic animals, wild ruminants, other herbivorous fauna, and humans." Tellus, 33B: pp 271‐284 (1986))

• ***Activity Data***

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

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

6.1.3. Poultry (4A9)

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".

6.1.4. Buffalo, Camels and Llamas, Mules and Asses (4A2, 4A5, 4A7)

The animals that would come under this category in Japan are to be found in zoos and tourist farms. The herd sizes can be expected to be extremely small, and therefore the category has been reported as "0".

6.1.5. Other (4A10)

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

6.2. Manure Management (4B)

6.2.1. Dairy Cattle, Non-Dairy Cattle, Swine, Hens & Broiler (CH_4, N_2O: 4B1, 4B8, 4B9)

• ***Methodology for Estimating Emissions of GHGs***

Methane emissions associated with management of livestock excretion have been calculated for the period FY1990 to FY2001 by multiplying the emission factor for each method of treating livestock manure by the amount of organic matter contained in the manure for each type of livestock (dairy cattle, non-dairy cattle, swine, hens, and broilers). (Refer to 4B-CH4-2003.xls for details of the calculation process.)

Nitrous oxide emissions associated with management of livestock excretion have been calculated for the period FY1990 to FY2001 by multiplying the emission factor for each method of treating livestock manure by the amount of nitrogen contained in the manure for each type of livestock (dairy cattle, non-dairy cattle, swine, hens, and broilers). (Refer to 4B-N2O-2003.xls for details of the calculation process.)

• ***Emission Factors***

Emission factors for methane and nitrous oxide associated with management of livestock excretion from dairy cattle, non-dairy cattle, swine, hens, and broilers have been established for each method of treatment for each type of livestock, on the basis of the results of research carried out in Japan. Specific values are given in the following tables.

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

Separation or otherwise of manure		Treatment method	CH_4 EF [g CH_4/g-organic matter]		N_2O EF [g N_2O/g TN]	
Separate	Feces	Sunlight drying	0.0125	%	0.4	%
		Thermal drying	0	%	0.4	%
		Composting	0.025	%	0.75	%
		Deposition	0.33	%	4.65	%
		Incineration	0.4	%	0.1	%
	Urine	Composting	0.025	%	11	%
		Wastewater management	0	%	12	%
		Pit storage	0.92	%	0.75	%
Mixed		Sunlight drying	0.125	%	0.4	%
		Thermal drying	0	%	0.4	%
		Composting	0.025	%	11	%
		Deposition	0.33	%	4.65	%
		Wastewater management	0	%	12	%
		Pit storage	0.92	%	0.75	%

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*, March 2002
Japan Livestock Technology Association, *GHGs emissions control in livestock Part4*, March 1999
Y. Fukumoto, *et al. Measurement of NH_3, N_2O and CH_4 emissions from swine manure composting using a new dynamic chamber system*, Proceedings of 1st IWA International Conference on Odor and VOCs; Measurement, Regulation and Control techniques. Australia pp 613-620. March 2001

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

Separation or otherwise of manure		Treatment method	CH_4 EF [g CH_4/g-organic matter]		N_2O EF [g N_2O/g TN]	
Separate	Feces	Sunlight drying	0.0125	%	0.4	%
		Thermal drying	0	%	0.4	%
		Composting	0.025	%	0.75	%
		Deposition	1.3 *	%	4.65	%
		Incineration	0.4	%	0.1	%
	Urine	Composting	0.025	%	6.7 *	%
		Wastewater management	0	%	12	%
		Pit storage	0.92	%	0.75	%
Mixed		Sunlight drying	0.125	%	0.4	%
		Thermal drying	0	%	0.4	%
		Composting	0.025	%	6.7 *	%
		Deposition	1.3 *	%	4.65	%
		Wastewater management	0	%	12	%
		Pit storage	2.6 *	%	0.75	%

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

• ***Activity Data***

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

The method of estimating volumes of organic matter and nitrogen excreted annually by various types of livestock were calculated by multiplying individual herd or flock sizes by the volume of manure excreted, to arrive at the volume of manure generated. An estimate was then made of the volumes of organic matter and nitrogen contained in manure, which was then allocated to each method of treatment. The method for calculating activity data is given below.

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

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

Source:
Nitrogen content in feces or urine: Japan Livestock Technology Association Chikusan ni okeru Onshitu Kouka Gasu no Hassei Seigyo Soushuuhen
Other elements of the equation are as per methane.

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

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

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

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

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

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

Table 6-8 Proportion of separate and mixed treatment of manure, by type of livestock

Type of livestock	Separate	Mixed
Dairy Cattle	60%	40%
Non-Dairy Cattle	7%	93%
Swine	70%	30%
Hen	100%	—
Broiler	100%	—

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

Table 6-9 Share of each treatment method by type of livestock

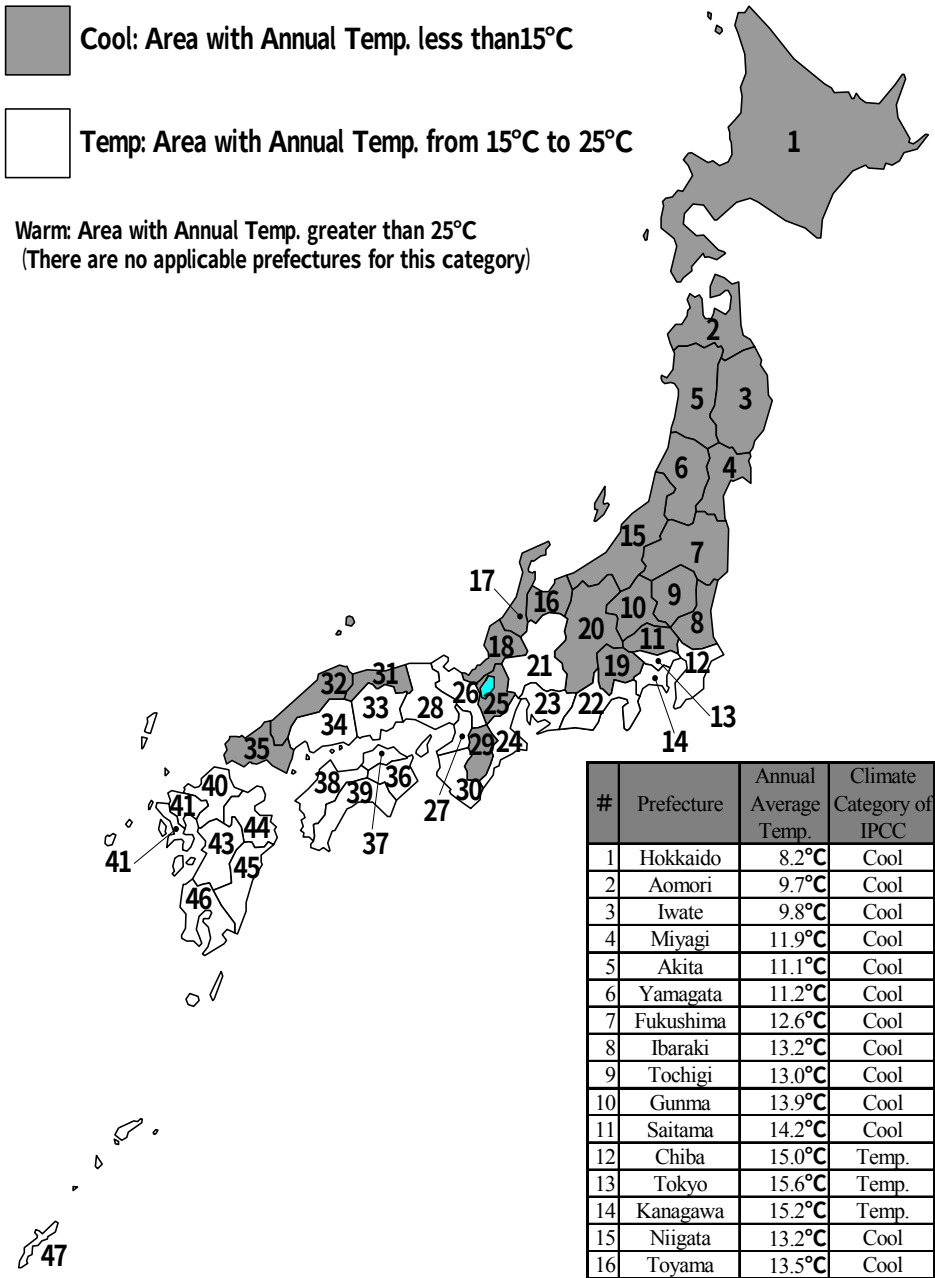
Separation or otherwise of manure		Treatment method	Dairy Cattle	Non-Dairy Cattle	Swine	Hen	Broiler
Separate	Feces	Sunlight drying	2.8%	1.5%	7.0%	30.0%	15.0%
		Thermal drying	0.0%	0.0%	0.7%	3.0%	0.0%
		Composting	9.0%	11.0%	62.0%	42.0%	5.1%
		Deposition	88.0%	87.0%	29.6%	23.0%	66.9%
		Incineration	0.2%	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

• *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 in the order of 15 ºC. This figure is almost the same as the cut-off point 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 the need to categorize climate into temperate and cool.



#	Prefecture	Annual Average Temp.	Climate Category of IPCC	#	Prefecture	Annual Average Temp.	Climate Category of IPCC
1	Hokkaido	8.2℃	Cool	25	Shiga	14.1℃	Cool
2	Aomori	9.7℃	Cool	26	Kyoto	15.3℃	Temp.
3	Iwate	9.8℃	Cool	27	Osaka	16.3℃	Temp.
4	Miyagi	11.9℃	Cool	28	Hyogo	15.6℃	Temp.
5	Akita	11.1℃	Cool	29	Nara	14.4℃	Cool
6	Yamagata	11.2℃	Cool	30	Wakayama	16.1℃	Temp.
7	Fukushima	12.6℃	Cool	31	Tottori	14.5℃	Cool
8	Ibaraki	13.2℃	Cool	32	Shimane	14.3℃	Cool
9	Tochigi	13.0℃	Cool	33	Okayama	15.8℃	Temp.
10	Gunma	13.9℃	Cool	34	Hiroshima	15.0℃	Temp.
11	Saitama	14.2℃	Cool	35	Yamaguchi	14.7℃	Cool
12	Chiba	15.0℃	Temp.	36	Tokushima	15.9℃	Temp.
13	Tokyo	15.6℃	Temp.	37	Kagawa	15.3℃	Temp.
14	Kanagawa	15.2℃	Temp.	38	Ehime	15.8℃	Temp.
15	Niigata	13.2℃	Cool	39	Kochi	16.4℃	Temp.
16	Toyama	13.5℃	Cool	40	Fukuoka	16.2℃	Temp.
17	Ishikawa	14.1℃	Cool	41	Saga	16.1℃	Temp.
18	Fukui	14.1℃	Cool	42	Nagasaki	16.7℃	Temp.
19	Yamanashi	13.9℃	Cool	43	Kumamoto	16.2℃	Temp.
20	Nagano	11.5℃	Cool	44	Oita	15.7℃	Temp.
21	Gifu	15.1℃	Temp.	45	Miyazaki	17.0℃	Temp.
22	Shizuoka	16.1℃	Temp.	46	Kagoshima	17.6℃	Temp.
23	Aichi	15.1℃	Temp.	47	Okinawa	22.4℃	Temp.
24	Mie	15.1℃	Temp.				

(Source) Japan Meteorological Agency "Climate Charts of Japan"

Figure 6-1 Categorization of climate in prefectures in Japan, as indicated in the Revised 1996 IPCC Guidelines

6.2.2. Sheep, Goats & Horses (4B3, 4B4, 4B6)

1) CH_4

• Methodology for Estimating Emissions of GHGs

Methane emissions associated with management of the manure of sheep, goats and horses have been calculated for the period FY1990 to FY2001, using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (*GPG (2000)* p. 4.33 Fig. 4.3) (Refer to *4B-CH4-2003.xls* for details of the calculation process.)

• Emission Factors

The emission factors for methane associated with management of manure from sheep, goats and horses are the default values for temperate zones in industrialized nations, given in the *Revised 1996 IPCC Guidelines*.

Table 6-10 Emission factors for sheep, goats and horses

Type of livestock	Emission Factors [kg CH_4/head/year]
Sheep	0.28
Goats	0.18
Horses	2.08

Source: Revised 1996 IPCC Guidelines Vol. 2 p. 4.6 Table 4-4

• Activity Data

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

2) N_2O

It is conceivable that nitrous oxide is emitted in association with the management of manure from sheep, goats and horses, 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. This category has therefore been reported as "NE".

6.3. Rice Cultivation (4C)

6.3.1. Intermittently Flooded (Single Aeration) (4C1-)

• Methodology for Estimating Emissions of GHGs

Methane emissions from intermittently flooded paddy fields (Single Aeration) have been calculated for the period FY1990 to FY2001, using emission factors appropriate to the type of organic matter spread and type of soil, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (*GPG (2000)* p. 4.79 Fig. 4.9). (Refer to *4C-CH4-2003.xls* for details of the calculation process.)

• Emission Factors

The following table summarizes the emission factors established for each category of this source.

The emission factors established 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 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 6-11 Methane emission factor for intermittently flooded paddy fields (single aeration)

Soil Type	Straw amendment [gCH_4/m^2/year]	Various compost amendment [gCH_4/m^2/year]	No-amendment [gCH_4/m^2/year]
Andosol	8.50	7.59	6.07
Yellow soil	21.4	14.6	11.7
Lowland soil	19.1	15.3	12.2
Gley soil	17.8	13.8	11.0
Peat soil	26.8	20.5	16.4

Source: Haruo Tsuruta, *Emission Rates of Methane from Rice Paddy Fields and Nitrous Oxide from Fertilized Upland Fields Estimated from Intensive Field Measurement for Three Years (1992-1994) All Over Japan*

• Activity Data

It is assumed that intermittently flooded paddy fields (single aeration) comprise some 98% of planted paddy area and that the remaining 2% are constantly flooded paddies.

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 represented by specific soil types, and then to multiply that by the proportion subject to organic mulch

management.

Table 6-12 Proportion of Japan's surface area represented by specific soil types

Type of soil		Proportion of Japan's surface area
Andosol	Andosol, moist andosol, andosol gley soil	11.9%
Yellow soil	Brown forest soil, gray ground soil, gley ground soil, yellow soil, dark red soil	9.4%
Lowland soil	Brown lowland soil, grey lowland soil	41.5%
Gley soil	Gley soil, strong gley soil	30.8%
Peat soil	Black peat, peat soil	6.4%
Total		100.0%

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

Table 6-13 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

- ***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 an outline.

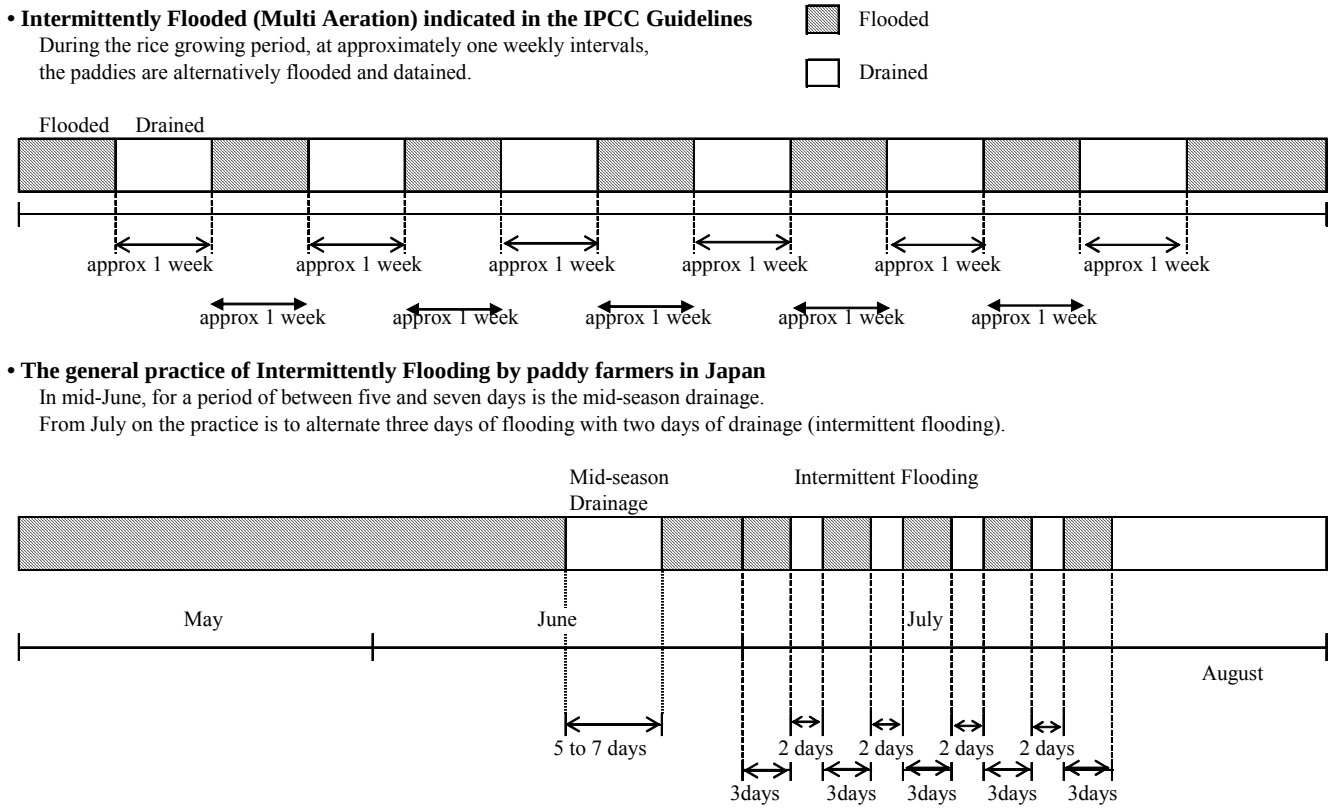


Figure 6-2 Comparison of water management regime in Japan and indicated in the IPCC Guidelines

6.3.2. Continuously Flooded (4C1-)

• *Methodology for Estimating Emissions of GHGs*

Methane emissions from continuously flooded paddies for the period from FY1990 to FY2001 have been calculated 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)* (*GPG (2000)* p. 4.79 Fig. 4.9). (Refer to *4C-CH4-2003.xls¥ Continuously Flooded* for details of the calculation process.)

• *Emission Factors*

Research results [2] 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

[2] Kazuyuki Yagi, *Establishment of GHGs reduction model*, Incorporated foundation, Society for the Study of Agricultural Technology: "A Report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000F.Y. " p.27

fields: divide the nominal emission factor for intermittently flooded paddy fields by 0.435.

Table 6-14 Emission factor for methane from constantly flooded paddy fields

	Emission Factors [gCH_4/m^2/year]
Intermittently flooded paddy fields (mid-season drainage)	15.98*
Constantly flooded paddy fields	36.74

*3.4.C.1 Implied emission factor for intermittently flooded paddy fields (single aeration)

• ***Activity Data***

It is assumed that intermittently flooded paddy fields (single aeration) comprise some 98% of planted paddy area and that the remaining 2% are constantly flooded paddies.

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 (4C2, 4C3)

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. This category has therefore been reported as "NO".

6.3.4. Other (4C4)

Just as the IRRI (International Rice Research Institute) *World Rice Statistics 1993-94* indicates, a possible source of emissions in this category is upland crop paddies, but as 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 methane generated. As generation of methane is therefore not feasible, this category was reported as "NA".

6.4. Agricultural Soils (4D)

6.4.1. Direct Soil Emissions (N_2O) (4D1)

6.4.1.1. Synthetic Fertilizers (4D1-)

6.4.1.1.a. Fields (4D1--)

• ***Methodology for Estimating Emissions / Removals of GHGs***

Nitrous oxide emissions associated with the application of synthetic fertilizer to farmland soil (field lands) were calculated for the period from FY1990 to FY2001, using country-specific emission factors, and in accordance with Decision Tree of the *Good Practice Guidance (2000)* (*GPG (2000)* p. 4.55 Fig. 4.7) (Refer to *4D-N2O-2003.xls¥S-Fertilizer(dry)* for detail on the calculation process).

• ***Emission Factors***

Emission factors for nitrous oxide associated with the application of synthetic fertilizers to farmland soil (field lands) were established using the following steps (i) to (iii), based on actual data measurement conducted in Japan.

(i) Volume of nitrogen input was calculated by multiplying planted area for each type of crop by the amount of fertilizer applied
(ii) The volume of nitrogen input for each type of crop was multiplied by the emission factor based on actual measurements of each to derive the amount of nitrous oxide generated
(iii) The total nitrous oxide generated from all crops was divided by the total volume of nitrogen input to each crop to derive the emission factor.

Table 6-15 The process of calculating emission factor for nitrous oxide associated with applying synthetic fertilizer to dry fields

Farm Products	Area [ha]	Application Rate [kgN/10a]	N total input [kgN]	EF [N2O-N/N]	N2O generated [kgN2O-N]
Vegetable	539,750	21.27	114,804,825	0.00773	887,441
Fruit	295,300	14.70	43,409,100	0.00690	299,523
Tea	51,200	48.50	24,832,000	0.04740	1,177,037
Potatoes	99,950	12.70	12,693,650	0.02010	255,142
Pulse	183,200	3.10	5,679,200	0.00730	41,458
Feed crops	1,038,000	10.00	103,800,000	0.00600	622,800
Sweet potatoes	45,600	6.20	2,827,200	0.00727	20,554
Wheat	275,600	10.00	27,560,000	0.00486	133,942
Buckwheat	35,500	4.12	1,462,600	0.00730	10,677
Mulberries	10,300	16.20	1,668,600	0.00730	12,181
Industrial Crops	146,000	22.90	33,434,000	0.00730	244,068
Tobacco	25,300	15.40	3,896,200	0.00730	28,442
Total	2,745,700		376,067,375		3,733,265
Emission Factor （Total Emissions [kgN2O-N]／N total input [kgN]）					**0.993%**

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

• ***Activity Data***

Activity data for nitrous oxide emissions associated with the application of synthetic fertilizers to dry fields was derived by subtracting the volume of nitrogen-based fertilizer applied to paddies from the demand for nitrogen-based fertilizers given in the Ministry of Agriculture, Forestry and Fisheries *Yearbook of Fertilizer Statistics (Pocket Edition)*. The method of calculating activity data is given below.

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

Volume of nitrogen-based fertilizer applied to fields [t]
= Demand for nitrogen-based fertilizers [t]
− Area of wet rice cropping [ha] × Volume of fertilizer per 10 a of rice [kg/10 a]

Source:
Demand for nitrogen-based fertilizers, volume of fertilizer per 10a of rice: MAFF, *Yearbook of Fertilizer Statistics (Pocket Edition)*
Area of wet rice cropping: MAFF, *Statistics of Arable and Planted Land Area*

6.4.1.1.b. Paddy Fields (4D1--)

• ***Methodology for Estimating Emissions of GHGs***

Emissions of nitrous oxide associated with the application of synthetic fertilizer to farmland soil (paddies) have been calculated for the period from FY1990 to FY2001 using country-specific emission factors, in accordance with Decision Tree of the *Good Practice Guidance (2000)*(*GPG (2000)* p.4.55 Fig. 4.7). (Refer to *4D-N2O-2003.xls¥S-Fertilizer(rice)* for detail on the calculation process.)

• ***Emission Factors***

Emission factors have been established on the basis of actual measurements taken in Japan.

Table 6-16 Emission factor for N_2O from the application of synthetic fertilizer to paddies

	Emission Factors [kgN_2O-N/kgN]
N_2O emissions from applying synthetic fertilizer to paddies	0.00673

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

• ***Activity Data***

Activity data for nitrous oxide emissions associated with the application of synthetic fertilizer to paddies was derived by multiplying the area of wet rice cropping given in the Ministry of Agriculture, Forestry and Fisheries *Statistics of Arable and Planted Land Area*, by the volume of fertilizer applied per 10 are of rice given in the Ministry of Agriculture, Forestry and Fisheries *Yearbook of Fertilizer Statistics (Pocket Edition)*.

6.4.1.2. Organic Fertilizer (Animal Wastes Applied to Soils) (4D1-)

• ***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 for the period from FY1990 to FY2001 using country-specific emission factors, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (*GPG (2000)* p. 4.55 Fig. 4.7). (Refer to *4D-N2O-2003.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）

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

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/10 a）×10

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

• ***Emission Factors***

There is little direct data available in Japan on emission factors for nitrous oxide from compost and barnyard manure and organic fertilizers. Therefore it was assumed that the nitrous oxide associated with the application of compost and barnyard manure and organic fertilizers is the same as that for synthetic fertilizers, and actual data on emission factors for nitrous oxide from the application of synthetic fertilizers measured for each type of crop, have been used. The emission factors are shown below.

Table 6-17 Nitrous oxide emission factors, by type of crop

Type of crop	Emission Factors [kgN_2O-N/kgN]
Vegetables	0.00773
Rice	0.00673
Fruit	0.0069
Tea	0.0474
Potatoes	0.0201
Pulse	0.0073
Feed crops	0.006
Sweet potato	0.00727
Wheat	0.00486
Buckwheat	0.0073
Mulberries	0.0073
Industrial crops	0.0073
Tobacco	0.0073

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

• ***Activity Data***

Activity data for nitrous oxide emission associated with the application of organic fertilizers to agricultural soils was derived by multiplying the area under cultivation for each type of crop, by the volume of nitrogen applied per unit area for each type of crop.

The source of the data on volume of nitrogen applied per unit area for each type of crop was the same as that for emission factor. The sources of the data on the area under cultivation for each type of crop were as shown below.

Table 6-18 Sources of data on area under cultivation for each type of crop

Source	Type of crop
MAFF, *Statistics of Arable and Planted Land Area*	Vegetables, Rice, Fruit, Tea, Pulse, Sweet potato, wheat, Buckwheat, Mulberries, Industrial crops
MAFF, *Vegetable Production and Shipment Statistics*	Potatoes
The data of "Japan Tobacco Inc."	Tobacco

6.4.1.3. N-fixing Crops (4D1-)

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 have been reported as "IE".

6.4.1.4. Crop Residue (4D1-)

The default value given in the *Good Practice Guidance (2000)* for nitrous oxide emissions associated with the application of crop residue to agricultural soil is not considered applicable to the circumstances of emissions in Japan and has been reported as "NE".

6.4.1.5. Cultivation of Histosols (4D1-)

The default value given in the *Good Practice Guidance (2000)* for nitrous oxide emissions associated with the application of cultivation of histosols, is not considered applicable to the circumstances of emissions in Japan and has been reported as "NE".

6.4.1.6. Direct Soil Emissions（CH_4） (4D1)

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 it becomes anaerobic, resulting in the generation of methane by methane-generating bacteria. Conversely, the soil in fields is normally acidic, and does not become anaerobic. Therefore it is not theoretically possible for methane generation to take place in field soil. For that reason, direct emission of methane from soil has been reported as "NA".

6.4.2. Animal Production (4D2)

• Methodology for Estimating Emissions of GHGs

Emissions of methane and nitrous oxide associated with animal production (methane or nitrous oxide from manure directly excreted onto grazing land or into water troughs by grazing livestock) have been calculated for the period from FY1990 to FY2001 using country-specific emission factors, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (*GPG (2000)* p.4.55 Fig. 4.7). (Refer to *4D-N2O-2003.xls¥AnimalProduction* for detail on the calculation process.)

• Emission Factors

Emission factors have been established on the basis of the results of calculations of methane and nitrous oxide emissions from the manure of grazing cattle in Japan.

Table 6-19 Emission factors for animal production

GHGs	Emission Factors	Unit
CH_4	3.67	[g CH_4/head/day]
N_2O	0.32	[g N_2O-N/head/day]

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

• Activity Data

Activity data for methane and nitrous oxide emissions associated with animal production was derived by multiplying grazing herd size by grazing time.

The figures for grazing herd size are the figures for herds on public farms, given in the Ministry of Agriculture, Forestry and Fisheries *Data relating to Public Enterprise of Stockbreeding*. The figure used for grazing time (191 days from late April to October) is established by Shibuya et al. [3]

• Grazing in Japan

In Japan, free-ranging of dairy or non-dairy cattle is not typically practiced, and the statistics do not identify grazing herd size. Therefore the size of grazing herds on public sector farms has been used as activity data.

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

6.4.3. Indirect Emissions (4D3)

6.4.3.1. Atmospheric Deposition (4D3-)

• ***Methodology for Estimating Emissions of GHGs***

Nitrous oxide emissions associated with atmospheric deposition have been calculated for the period from FY1990 to FY2001 using country specific emission factors, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (*GPG (2000)* p.4.69 Fig. 4.8). (Refer to *4D-N2O-2003.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_4-N+NO_X-N]
× Volume of nitrogen volatilized from ammonia and nitrogen oxides from livestock manure and synthetic fertilizers [kg NH_4-N+NO_X-N]

Volume of nitrogen volatilized as ammonia or nitrogen oxides from synthetic fertilizers [kg NH_3-N+NO_X-N]
= {Synthetic nitrogen-based fertilizers applied to soil [kg N]
× Proportion that volatilizes from synthetic fertilizer as ammonia or nitrogen oxides
+ $\Sigma_{\text{Type of Livestock}}$ (Herd size by type of livestock [head]
× Volume of nitrogen emitted by type of livestock [kg/head])
× Proportion that volatilizes from amount of nitrogen from livestock manure as ammonia or nitrogen oxides}

• ***Emission Factors***

The default value given in the *Revised 1996 IPCC Guidelines* has been used as the emission factor for this source.

Table 6-20 Emission factor for nitrous oxide emissions associated with atmospheric deposition

	Emission Factors [kgN_2O-N/kg NH_4-N & NO_X-N deposited]
Nitrous oxide emissions associated with atmospheric deposition	0.01

Source: The Revised 1996 IPCC Guidelines Vol.2 Table 4-18
(Good Practice Guidance (2000) Table4.18)

• ***Activity Data***

-Synthetic Fertilizers

Activity data for nitrous oxide emissions associated with atmospheric deposition and the application of synthetic fertilizers was derived by multiplying the demand for nitrogen-based fertilizers given in the Ministry of Agriculture, Forestry and Fisheries Yearbook of *Fertilizer Statistics (Pocket Edition)* by the default value, $Frac_{GASF}$, the proportion of nitrogen volatilized as ammonia or nitrogen oxides from synthetic fertilizers, given in the *Revised 1996 IPCC Guidelines*.

Table 6-21 $Frac_{GASF}$: 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: The Revised 1996 IPCC Guidelines Vol.2 Table 4-17

-Manure

Activity data for nitrous oxide emissions associated with atmospheric deposition and the application of livestock manure was derived by multiplying the volume of nitrogen excreted by each type of livestock, as given in the *Revised 1996 IPCC Guidelines,* by the livestock herd size given in *FAO statistics* and in *Livestock Statistics* prepared by the Ministry of Agriculture, Forestry and Fisheries, and then multiplying the product by the default value, $Frac_{GASM}$, the proportion of nitrogen volatilized as ammonia or nitrogen oxides from livestock manure, given in the *Revised 1996 IPCC Guidelines*.

Table 6-22 Volume of nitrogen excreted by type of livestock

Type of livestock	Annual volume of nitrogen excreted [kg N/head/year]
Non-dairy cattle	40
Dairy cattle	60
Poultry	0.6
Sheep	12
Swine	16
Other	40

Source: The Revised 1996 IPCC Guidelines Vol.2 Table 4-6 (Asia & Far East)

Table 6-23 $Frac_{GASM}$: Proportion of nitrogen volatilized from livestock manure as ammonia or nitrogen oxides

Value	Units
0.2	[kg NH_3-N + NO_X-N/kg of nitrogen excreted by livestock]

Source: *Revised 1996 Guidelines* Vol. 2, Table 4-17

6.4.3.2. Nitrogen Leaching and Run-off (4D3-)

• ***Methodology for Estimating Emissions of GHGs***

Nitrous oxide emissions associated with nitrogen leaching and run-off have been calculated for the period from FY1990 to FY2001 using default values, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (*GPG (2000)* p.4.69 Fig. 4.8). (Refer to *4D-N2O-2003.xls¥ N-Leaching and Run-off* for detail on the calculation process.)

Calculation of nitrous oxide emitted in association with nitrogen leaching and run-off

Volume of nitrous oxide emitted in association with nitrogen leaching and run-off [kg N_2O-N]
= Default emission factor [kg N_2O-N/kg N]
× Volume of leached nitrogen or nitrogen run-off [kg N]

Volume of leached nitrogen or nitrogen run-off [kg N]
= {Volume of synthetic nitrogen fertilizer applied to soil [kg N]
+ $\Sigma_{\text{Type of livestock}}$ (Herd size by type of livestock [head]
× Volume of nitrogen emitted by type of livestock [kg/head])}
× Proportion of nitrogen applied subject to leaching or run-off

• ***Emission Factors***

The default value given in the *Revised 1996 IPCC Guidelines* has been used as the emission factor for this source.

Table 6-24 Emission factor for N_2O emissions associated with nitrogen leaching or run-off

	Emission Factors [kgN_2O-N/kg N]
Nitrous oxide emitted in association with nitrogen leaching or run-off	0.025

Source: *Revised 1996 Guidelines* Vol. 2, Table 4-18 (Good Practice Guidance (2000) Table 4.18)

• ***Activity Data***

Activity data was derived by multiplying the proportion of nitrogen applied subject to leaching or run-off, as given in the *Revised 1996 IPCC Guidelines*, by the amount of nitrogen in livestock manure or synthetic fertilizer derived from atmospheric deposition.

Table 6-25 $Frac_{LEACH}$: Proportion of nitrogen applied subject to leaching and run-off

Value	Units
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) (4D3)

Direct emission of methane from soil is not possible, and it is not theoretically possible for methane to be emitted indirectly from field soil either. These sources have therefore been reported as "NA".

Other than direct emissions from soil, animal husbandry, and indirect emissions as a source of methane emissions from cultivated farmland soil, there are no other conceivable sources related to atmospheric deposition or nitrogen leaching or run-off. They have therefore been reported as "NO".

6.5. Prescribed Burning of Savannas (4E)

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 therefore been reported as "NO".

6.6. Field Burning of Agricultural Residues (4F)

6.6.1. Rice Straw, Rice Chaff & Straw of Wheat, Barley, Oats and Rye (4F1)

• ***Methodology for Estimating Emissions of GHGs***

The country specific method has been used to calculate emissions of methane and nitrous oxide in association with incineration of rice straw, rice chaff & straw of wheat, barley, oats and rye. (Refer to *4F-CH4-2003.xls¥Rice* and *¥4F-N2O-2003.xls¥Rice* for detail of the calculation process.)

Calculation of CH_4 emissions from burning of rice straw, rice chaff & straw of wheat etc.

Volume of CH_4 emitted from burning of rice straw, rice chaff & straw of wheat etc. [Gg CH_4]
= Volume of straw, chaff, or barley straw incinerated [t]× Carbon content
× Proportion of carbon emitted as carbon dioxide
× Molar ratio of methane and carbon dioxide in waste gas

Calculation of N_2O emissions from burning of rice straw, rice chaff & straw of wheat etc.

Volume of N_2O emitted from burning of rice straw, rice chaff & straw of wheat etc. [Gg N_2O]
= Volume of straw, chaff, or barley straw incinerated [t]× Carbon content
× Proportion of carbon emitted as carbon dioxide
× Molar ratio of nitrous oxide and carbon dioxide in waste gas

• ***Emission Factors***

Carbon content and other parameters have been established on the basis of actual measurements taken in Japan.

Table 6-26 Carbon content of rice straw, rice chaff, & straw of wheat, barley, oats and rye

	Carbon content	Note
rice chaff	0.356	Median adopted between 0.369[a] and 0.342[b]
Rice Straw	0.344	Actual measurements from Bando et al.[a]
Straw of wheat etc.	0.356	Same assumption as for rice straw

Source:

a: Bando, Sakamaki, Moritomi and Suzuki, *Study on methane & nitrous oxide emission from biomass burning*, National Institute for Environmental Studies "*Final Reports of The Global Environment Research Fund in 1992*"

b: Yoshinori Miura and Tadanori Kannno, *Emissions of Trace Gases (CO_2, CO, CH_4 and N_2O) Resulting from Rice Straw Burning*, Soil Sci.Plant Nutr.,43(4), 849-854,1997

Table 6-27 Carbon content of rice straw, rice chaff & straw of wheat, barley, oats and rye

	Proportion of carbon emitted as carbon dioxide	Note
Rice straw	0.684	Median adopted between 0.8[a] and 0.567[b]
Rice chaff	0.8	Actual measurements from Bando et al.[a]
Straw of wheat etc.	0.684	Same assumption as for rice straw

Source: As for carbon content

Table 6-28 Molar ratio of CH_4 and CO_2 in gas from combustion of rice straw, rice chaff & straw of wheat, barley, oats and rye

	Molar ratio of CH_4 and CO_2 in gas	Note
Rice straw	0.0134	Median adopted between 0.0159[a] and 0.109[b]
Rice chaff	0.0157	Actual measurements from Bando et al.[a]
Straw of wheat etc.	0.0134	Same assumption as for rice straw

Source: As for carbon content

Table 6-29 Molar ratio of N_2O and CO_2 in gas from combustion of rice straw, rice chaff & straw of wheat, barley, oats and rye

	Molar ratio of N_2O and CO_2 in gas	Note
Rice straw	0.00070	Median adopted between 0.00015[a] and 0.00124[b]
Rice chaff	0.000059	Actual measurements from Bando et al.[a]
Straw of wheat etc.	0.00070	Same assumption as for rice straw

Source: As for carbon content

• ***Activity Data***

-Straw of Wetland Rice & Chaff of Wetland Rice

Ministry of Agriculture, Forestry and Fisheries survey results have been adopted for rice straw and rice chaff incineration volumes.

-Straw of Wheat, Barley, Oats and Rye

Volume of straw of wheat, barley, oats and rye incinerated has been derived by multiplying the proportion of rice straw incinerated to paddy rice harvest volumes, by the barley harvest volumes given in the Ministry of Agriculture, Forestry and Fisheries *Crop Statistics*.

6.6.2. Maize, Peas, Soybeans, Adzuki beans, Kidney beans, Peanuts, Potatoes, Sugarbeet & Sugar cane (4F1, 4F2, 4F3, 4F4)

• ***Methodology for Estimating Emissions of GHGs***

Emissions of methane and nitrous oxide associated with the incineration of maize, peas, soybeans, adzuki beans, kidney beans, peanuts, potatoes, sugarbeet and sugar cane have been calculated for the period from FY1990 to FY2001 using default values, in accordance with Decision Tree or the *Good Practice Guidance (2000)* (*GPG (2000)* p.4.52 Fig. 4.6). (Refer to *4F-CH4-2003.xls* and *4F-N2O-2003.xls* for details of the calculation process.)

Calculation of methane emissions associated with combustion of maize, peas, soybeans, adzuki beans, kidney beans, peanuts, potatoes, sugarbeet and sugar cane

Volume of methane emitted in association with combustion of maize etc. [Gg CH_4]
$= \Sigma_{\text{Type of crop}}$ {Total amount of carbon released, by type of crop [Gg C]
× Default value for rate of emission of methane ×16/12}

Total amount of carbon released, by type of crop [Gg C]
$= \Sigma_{\text{Type of crop}}$ {Annual crop production [Gg]× Ratio of stubble to crop production
× Average fraction of dry matter in stubble × Proportion burnt in fields
× degree of oxidation × percentage of Carbon content}

Calculation of nitrous oxide emissions associated with incineration of maize, peas, soybeans, adzuki beans, kidney beans, peanuts, potatoes, sugarbeet and sugar cane

Nitrous oxide emissions associated with incineration of maize etc. [Gg N_2O]
$= \Sigma_{\text{Type of crop}}$ {Total volume of nitrogen released per crop [Gg N]}
× Default nitrous oxide emission rate ×44/28}

Total volume of nitrogen released by type of crop [Gg N]
$= \Sigma_{\text{Type of crop}}$ {Annual crop production [Gg]} × Ratio of stubble to crop production
× Average fraction of dry matter in stubble × Proportion burnt in fields
× degree of oxidation × Nitrogen formation rate※}

※ For sugarbeet, carbon formation rate and N/C ratio have been used in place of nitrogen formation rate.

• *Emission Factors*

The default value given in the *Revised 1996 IPCC Guidelines* for this source was used as the emission factor.

Table 6-30 Emission factors for CH_4 and N_2O emissions from the incineration of maize, peas, soybeans, adzuki beans, kidney beans, peanuts, potatoes, sugarbeet and sugar cane

	Value	Unit
CH_4	0.005	[kg CH_4/kg C]
N_2O	0.007	[kg N_2O/kg N]

Source: *Revised 1996 IPCC Guidelines* Vol. 2, Table 4-16

• *Activity Data*

Activity data has been derived by multiplying the parameters given in the equation by the production volume of each type of crop given in the Ministry of Agriculture, Forestry and Fisheries *Crop Statistics*, and *Vegetable Production and Shipment Statistics*.

Table 6-31 Residue/Crop Product Ratio, Dry Matter Fraction, Carbon Fraction, and Nitrogen Fraction

Crop	Residue/Crop Product Ratio	Dry Matter Fraction	Carbon Fraction	Nitrogen Fraction
Corn	1.0	0.86	0.4709	0.0081
Peas	1.5	0.87	0.45[a]	0.0142
Soy	2.1	0.89	0.45[a]	0.0230[b]
Adzuki, beans[b]	2.1	0.89	0.45[a]	0.0230
Peanuts	1.0	0.86	0.45[a]	0.0106
Potatoes	0.4	0.6[c]	0.4226	0.0110
Beets	0.2	0.2	0.4072	0.0150[d]
Sugar cane	1.62	0.83[c]	0.4235	0.0040

Source: *Good Practice Guidance (2000)* Table 4.16

a: In the absence of a default value, values for dicotyledonous and monocotyledonous plants have been used. Noboru Murayama, et al. *Alimentation of Crops and Fertilizer*, Buneido, p.26

b: The value given at 'beans' in Table 4.16 of GPG (2000) has been applied.

c: *Revised 1996 IPCC Guidelines* Vol. 2, Table 4-15

d: No default values are given. The median values given in the *Revised 1996 IPCC Guidelines* Vol. 2, p. 4.30（0.01–0.02）have been adopted.

Table 6-32 Default values for oxidation, and proportion burnt in fields

	Value	Unit
Proportion burnt in fields	0.10	—
Rate of oxidation	0.90	—

Source: *Revised 1996 IPCC Guidelines* Vol. 3, p. 4.83

6.6.3. Dry bean (4F2-)

Dry beans are a type of kidney bean, 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 4F2, under 'Other crops' and, therefore, the dry beans have been reported as "IE".

6.6.4. Other (4F5)

It is possible that agricultural waste other than that for cereals, pulse, root vegetables and sugar cane is burnt in the field. However data on actual activity are not available and it is not possible to establish an emission factor. Therefore these sources have been reported as "NE".

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Chapter 7. Land-Use Change and Forestry (CRF sector5)

7.1. Changes in Forest and Other Woody Biomass Stocks (5A)

7.1.1. Temperate Forests (5A2)

• ***Methodology***

To estimate carbon stock changes as a result of tree growth in temperate forests, carbon dioxide emissions and removals for FY1990 to FY1995 were calculated separately for intensively managed forest (single storied forest: sugi cedar etc.), semi-natural forest (beech, oak etc.) and others (forestland where no tree grows, bamboo) using the methodology given in the *Revised 1996 IPCC Guidelines*. (Refer to *5-2003.xls¥5A2* for details of the calculation process)

• ***Parameters***

-Average annual biomass growth rate

The average annual biomass growth rate is calculated by multiplying the values established for wood density by the biomass expansion factor and by the annual increment in volume per unit area (hectare) for each forest type.

Table 7-1 Average annual biomass growth rate by forest type (dm = dry matter)

Item	Unit	1990	1991	1992	1993	1994	1995
Intesively Managed Forest (Single Storied Forest: Sugi Ceder etc.)	[t dm/ha]	5.03	4.96	4.96	4.96	4.96	4.96
Semi-Natural Forest (Beech, Oak etc.)	[t dm/ha]	2.05	1.94	1.94	1.94	1.94	1.94
Other	[t dm/ha]	0.00	0.00	0.00	0.00	0.00	0.00

Table 7-2 Wood density by forest type (dm = dry matter)

Forest type	Wood density [t dm/m^3]
Intensively Managed Forest (single storied forest: sugi cedar etc.)	0.4
Semi-Natural Forest (beech, oak etc.)	0.6
Others (forestland where no tree grows, bamboo)	0.6
Multi Storied Forest *	0.6

Source: Forestry Agency
* Reference values

Table 7-3 Biomass expansion factors by forest type

Forest type	Biomass expansion factor
Intensively Managed Forest (single storied forest: sugi cedar etc.)	1.7
Semi-Natural Forest (beech, oak etc.)	1.9
Others (forestland where no tree grows, bamboo)	1.9

Source: Forestry Agency

Table 7-4 Annual increment in volume per unit area (hectare)

Forest type	Annual increment in volume per unit area [m^3/ha]	
	1990	1991 onwards
Intensively Managed Forest (single storied forest: sugi cedar etc.)	7.4	7.3
Semi-Natural Forest (beech, oak etc.)	1.8	1.7
Others (forestland where no tree grows, bamboo)	0.0	0.0

Source: Based on the Forestry Agency's *Forest Status Survey*

-Carbon content of dry matter

The default value given in the Revised 1996 IPCC Guidelines has been adopted as the carbon content of dry matter.

Carbon content of dry matter
0.5

Source: *Revised 1996 IPCC Guidelines* Vol. 2, p 5.5

• Activity Data

Values given in the Forestry Agency's *Handbook of Forestry Statistics* have been used to determine the activity data for changes in forest and other woody biomass stocks in temperate forests. Refer to the following table for details.

Table 7-5 Classifications of *Handbook of Forestry Statistics*

Forest type	*Handbook of Forestry Statistics* classifications	Notes
Intensively Managed Forest (single storied forest: sugi cedar etc.)	Forest land: Planted Forest	—
Semi-Natural Forest (beech, oak etc.)	Forest land: Semi-Natural forest	—
Others (forestland where no tree grows, bamboo)	forestland where no tree grows, bamboo	Add an adjustment (54 [ha]) to the values at the left column to ensure consistency with the National Land-Use Plan

• ***Point to Note***

It should be noted that, while the natural forest assumed in EU and US is too old to expect its function as a carbon stock there has been an assumption of negligible expectation of increase in old-growth stock for natural forest in Europe and the US, Japan has also included post-harvest regeneration forest under Semi-Natural Forest.

7.1.2. Other (5A5)

7.1.2.1. Harvested Wood (5A5-)

• ***Methodology***

To determine carbon stock decrease by harvested wood, carbon dioxide emissions for FY1990 to FY1995 were calculated separately for industrial round wood, bed-log for mushroom culture, and fuel wood, using the methodology given in the *Revised 1996 IPCC Guidelines*. (Refer to *5-2003.xls¥5A2* for details of the calculation process)

• ***Parameters***

-Biomass conversion / Expansion ratio

Factors for conversion to biomass have been calculated by multiplying the wood density by biomass expansion factor established for each timber type. For round wood, because a weighting is applied according to production volumes of timber from coniferous and broadleaf trees, the value changes according to the age of tree.

Table 7-6 Average annual biomass growth rate by forest type (dm = dry matter)

Item	Unit	1990	1991	1992	1993	1994	1995
Industrial Roundwood	[t dm/m3]	0.83	0.81	0.81	0.79	0.77	0.77
Bed-log for mushroom culture	[t dm/m3]	1.14	1.14	1.14	1.14	1.14	1.14
Fuelwood	[t dm/m3]	1.14	1.14	1.14	1.14	1.14	1.14

N.B.: Data of *Industrial Roundwood* in 1995 is tentative value

Table 7-7 Wood density by timber type

Timber type		Wood density [t dm/m^3]	Notes
Industrial Roundwood	Needle-leafed forest	0.4	Apply Planted Forest values
	Broad-leafed forest	0.6	Apply Semi-Natural Forest values
Bed-log for mushroom culture		0.6	Apply Multi Storied Forest
Fuelwood		0.6	Apply Semi-Natural Forest values

Source: Forestry Agency

Table 7-8 Biomass expansion factor by timber type

Timber type		Biomass expansion factor	Notes
Industrial Roundwood	Needle-leafed forest	1.7	Apply Planted Forest values
	Broad-leafed forest	1.9	Apply Semi-Natural Forest values
Bed-log for mushroom culture		1.9	Apply Multi Storied Forest
Fuelwood		1.9	Apply Semi-Natural Forest values

Source: Forestry Agency

Table 7-9 Trends in production volumes of Needle-leafed forest and Broad-leafed forest

Item	Unit	1990	1991	1992	1993	1994	1995
Roundwood of needle-leafed fore	[1000m3]	19,549	19,037	18,900	18,772	19,090	18,067
Roundwood of broad-leafed fores	[1000m3]	9,751	8,901	8,214	6,798	5,366	4,830
Total	[1000m3]	29,300	27,938	27,114	25,570	24,456	22,897
Share of roundwood of needle-leafed forest	[%]	66.7%	68.1%	69.7%	73.4%	78.1%	78.9%
Share of roundwood of broad-leafed forest	[%]	33.3%	31.9%	30.3%	26.6%	21.9%	21.1%

Source: Forestry Agency, *Handbook of Forestry Statistics*

-Carbon content of dry matter

The default value given in the Revised 1996 IPCC Guidelines has been adopted as the carbon fraction of dry matter.

Carbon content of dry matter
0.5

Source: *Revised 1996 IPCC Guidelines* Vol. 2, p 5.5

• ***Activity Data***

The activity data for reduction of carbon stock due to timber harvesting has been calculated by dividing timber supply volumes, given in the Forestry Agency's *Handbook of Forestry Statistics*, by the yield. Yield is assumed on the basis of 79% of stands becoming commercial timber.

7.1.2.2. Other (Park and Green space conservation zones) (5A5-)

• Methodology

To determine changes in tree stocks in park and green space conservation zones, carbon dioxide emissions and removals for FY1990 to FY1995 have been calculated using the methodology given in the *Revised 1996 IPCC Guidelines*. (Refer to *5-2003.xls¥5A5* for details of the calculation process)

• Parameters

-Annual biomass increment

The default value for temperate forest deciduous trees given in the *Revised 1996 IPCC Guidelines* has been adopted as the average annual growth rate for trees in municipal parks and green conservation areas.

Table 7-10 Annual average aboveground biomass uptake by natural regeneration for trees in park and green space conservation zones

	Average annual growth rate [t dm/ha]
Temperate forest: deciduous trees	2.0

Source: *Revised 1996 IPCC Guidelines* Vol. 3, p 5.20

-Carbon content of dry matter

The default value given in the Revised 1996 IPCC Guidelines has been adopted as the carbon fraction of dry matter.

Carbon content of dry matter
0.5

Source: *Revised 1996 IPCC Guidelines* Vol. 2, p 5.5

• Activity Data

The activity data for changes in tree stocks in park and green space conservation zones has been calculated by multiplying the ratio of tree-covered land area calculated from the number of trees and the park area, by the area of park and green space conservation zones in Ministry of Land, Infrastructure and Transport studies. Tree coverage of green conservation areas is assumed to be 100%.

Table 7-11 Tree coverage of parks

types of parks	number of planted trees (A)	number of existing trees (B)	area (ha) coresponding to (B) (C)	area (ha) of planted trees (D)=(A)*(C)/(B)	surveyed park's area (ha) (E)	percentage of planted trees' area (F)=(D)/(E)	propotion of area planted (planned value) (G)	percentage of planted trees' area (F) [In case that (F) exceeds (G), =(G)]
Square parks	2,544,874	144,358	119	2,106	11,178	0.19	0.30	0.19
Neighborhood parks	1,805,246	317,664	391	2,223	7,468	0.30	0.44	0.30
Community parks	1,464,939	375,771	523	2,040	6,178	0.33	0.46	0.33
Comprehensive parks	8,340,919	3,874,627	3,102	6,677	17,064	0.39	0.59	0.39
Sport parks	1,788,274	465,148	712	2,736	9,313	0.29	0.43	0.29
Large scaled parks	3,574,512	1,925,988	2,032	3,771	8,739	0.43	0.66	0.43
Specific parks	4,834,290	2,621,727	2,131	3,929	10,637	0.37	0.62	0.37
National government parks	775,279	161,329	132	633	1,609	0.39	0.70	0.39
Buffer greenbelts	1,069,787	362,660	157	463	1,393	0.33	0.71	0.33
Ornamental green spaces	2,409,496	1,025,383	1,100	2,585	7,831	0.33	0.64	0.33
Greenways	296,697	28,291	89	931	704	1.32	0.60	0.60
Specified community parks	215,179	61,338	79	277	855	0.32	0.49	0.32

Source: Ministry of Land, Infrastructure and Transport, *Survey for preparation of 5 years Greenery Promotion Plan* (1995)

7.2. Forest and Grassland Conversion (5B)

• *Methodology*

Carbon dioxide, methane and nitrous oxide emissions from forest and grassland conversion have been calculated for FY1990 to FY1995 using the methodology given in the *Revised 1996 IPCC Guidelines*. (Refer to 5-2003.xls¥5A5 for details of the calculation process).

• *Parameters*

-Biomass before and after conversion

Tree stocks per hectare have been calculated by dividing stocks of the semi-natural forest and forestland where no tree grows given in the Forestry Agency's *Handbook of Forestry Statistics* by the area of semi-natural forest. Biomass before conversion has been estimated by multiplying stocks per hectare by wood density by the biomass expansion factor. Biomass after conversion is assumed to be 0.

Table 7-12 Process of estimating biomass before conversion

Item	Unit	1990	1991	1992	1993	1994	1995
Trunk volume	[1000m3]	1,597,844	1,656,674	1,715,504	1,774,333	1,833,163	1,891,993
Area of forest	[kha]	10,327	10,341	10,355	10,370	10,384	10,398
trunk volume per unit area	[m3/ha]	154.70	160.20	165.70	171.10	176.50	182.00
Density	[t dm / m3]	0.4	0.4	0.4	0.4	0.4	0.4
Conversion Facotor	[t dm total / tdm trunk]	1.7	1.7	1.7	1.7	1.7	1.7
Biomass before conversion	[t dm/ha]	105.0	109.0	113.0	116.0	120.0	124.0

N.B.: Imputation of values from 1991-1994 are based on linear interpolation.

-Fraction of biomass burned on site

Fraction of biomass burned on site was determined by assuming that 30% of harvested timber is burned on-site and the remaining 70% is used for sawn timber.

Table 7-13 Fraction of biomass burned on site etc.

	Fraction
On-site burning	0.3
Off-site burning	0.0
Portion left to decay on site.	0.0

-Fraction of biomass oxidized

The default value given in the *Revised 1996 IPCC Guidelines* has been used to determine biomass oxidization.

Carbon fraction of dry matter
0.9

Source: *Revised 1996 IPCC Guidelines* Vol. 2, p. 5.15

-Carbon content of dry matter

The default value given in the Revised 1996 IPCC Guidelines has been adopted as the carbon fraction of dry matter.

Carbon content of dry matter
0.5

Source: *Revised 1996 IPCC Guidelines* Vol. 2, p 5.5

-Nitrogen-Carbon Ratio

The default value given in the Revised 1996 IPCC Guidelines has been used to determine the Nitrogen-Carbon ratio.

N-C ratio
0.01

Source: *Revised 1996 IPCC Guidelines* Vol. 2, p 5.18

-Methane and Nitrous Oxide emission ratios

The default values given in the *Revised 1996 IPCC Guidelines* have been used to determine the CH_4 and N_2O emission ratios.

Table 7-14 CH_4 and N_2O emission ratios

GHG	Emission ratio	Unit
CH_4	0.012	[CH_4-C / carbon from combustion source]
N_2O	0.007	[N_2O-N / nitrogen in fuel]

Source: *Revised 1996 IPCC Guidelines* Vol. 2, Table 5-7

• Activity Data

The difference between planted forest and semi-natural forest area from the previous year and the relevant year given in the *Handbook of Forestry Statistics*, has been used for the activity data for carbon dioxide, methane and nitrous oxide emissions associated with forest and grassland conversion. Where the increase in planted forest is greater than the reduction in area of semi-natural forest, it is assumed that semi-natural forest has been converted to planted forest, and the activity data (conversion of use from forest to other applications) has been reported as '0'.

7.3. Abandonment of Managed Lands (5C)

Although it is deemed that activities do exist in this classification in Japan, the lack of data for estimation purposes has resulted in this being reported as "NE".

7.4. CO_2 Emissions and Removals from Soil (5D)

Although it is deemed that activities do exist in this classification in Japan, the lack of data for estimation purposes has resulted in this being reported as "NE".

References

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, 1997

Forestry Agency data (density, Conversion factor: ("branches & roots" + "trunk") / "trunk")

Forestry Agency, *Forest Status Survey*

Forestry Agency, *Handbook of Forestry Statistics*

Ministry of Land, Infrastructure and Transport, *Survey for preparation of 5 years Greenery Promotion Plan*, 1995

Chapter 8. Waste (CRF sector6)

8.1. Solid Waste Disposal on Land (6A)

• Methodology for Estimating Emissions of GHGs

Methane and carbon dioxide emitted from this source have been calculated using a country-specific method. Emissions for the period from FY1990 to FY2001 have been calculated by multiplying the emission factor by the volume of carbon biologically broken down in the relevant year from the carbon included in waste in landfill in the past. (Refer to *6A-2003.xls* for detail on the calculation process.)

• Emission Factors

-Outline

Waste has been categorized into kitchen garbage, waste paper or waste textiles, and waste wood, and emission factors have been established for each type of waste respectively.

Emission factors by the carbon content of each type of waste were estimated by multiplying the rate of conversion to gas from waste in landfill and the proportions of methane and carbon dioxide in the generated gas.

The data used in calculating emission factors is based on the results of measurement of municipal solid waste. It has been assumed that the carbon content of industrial waste is same as for municipal solid waste, and therefore the same value has been used.

-Carbon Content

Carbon content for each type of waste has been estimated as an average for the relevant year, by using actual results from the cities of Tokyo, Yokohama, Kawasaki, Kobe and Fukuoka; calculating 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 converting it to a weighted average using the individual populations of each municipality. (For detail on the assumptions underlying the calculations, refer to *6-EF-2003.xls¥6A-CH4*.)

Table 8-1 Carbon content of kitchen garbage (%)

City	1990	1995	1999	2000	2001
Tokyo	42.49	40.66	41.31	42.47	—
Yokohama	42.32	43.64	44.34	46.54	—
Kawasaki	—	42.82	36.89	41.67	44.98
Kobe	—	43.73	46.42	47.19	—
Fukuoka	42.69	41.51	43.63	43.14	—

Source: Data provided by the cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka

Table 8-2 Carbon content of waste paper or waste textiles (%)

City	1990	1995	1999	2000	2001
Tokyo	43.79	40.63	43.11	41.93	—
Yokohama	43.66	43.30	42.64	42.19	—
Kawasaki	—	35.84	37.23	38.99	41.50
Kobe	—	42.27	42.56	40.88	—
Fukuoka	42.23	41.66	39.90	41.83	—

Source: Data provided by the cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka

Table 8-3 Carbon content of waste wood (%)

City	1990	1995	1999	2000	2001
Tokyo	43.90	46.77	25.57	35.32	—
Yokohama	50.03	48.66	49.54	47.94	—
Kawasaki	—	41.23	41.00	42.71	46.56
Kobe	—	46.65	47.89	46.33	—
Fukuoka	47.92	46.65	46.43	46.65	—

Source: Data provided by the cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka

-Rate of conversion of waste to gas

The rate of conversion to gas of carbon in kitchen garbage in landfill was set at 50%, on the basis of *Estimates of Volume of Methane Released from Sewage Treatment Plants by Matsuzawa et al.*, from a 1993 collection of research papers presented to the 4th Academic Conference on Waste.

-Proportions of methane and carbon dioxide in generated gas

The proportion of methane was established at 55% on the basis of *Primary Screening of Greenhouse Gases Generated in Association With the Biological Breakdown of Organic Wastes by Watanabe et al.*, from a 1992 collection of papers presented to the 13th Japan City Cleaning Research Conference, but carbon dioxide generated together with methane exists in solution in the water content of landfill sites. Therefore the proportion of methane is thought to be less than 55%. For that reason, the default value given in the *Revised 1996 IPCC Guidelines* was used and the proportion of methane was set at 50%. It was then assumed any gas other than methane was carbon dioxide, and the proportion of carbon dioxide was also set at 50%.

• Activity Data

Activity data has been calculated for each of municipal solid and industrial waste. The proportion of carbon broken down in the relevant year has been derived by multiplying the volume of landfill that can be broken down biologically (volume of landfill by type of waste [dry basis], provided by the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment) by the rate of breakdown with passage of time in number of years; the total proportion of carbon in the buried waste and broken down in the

relevant year, has been used as activity data. (Refer to ¥6A-AD-2003.xls for detail on the calculation process.)

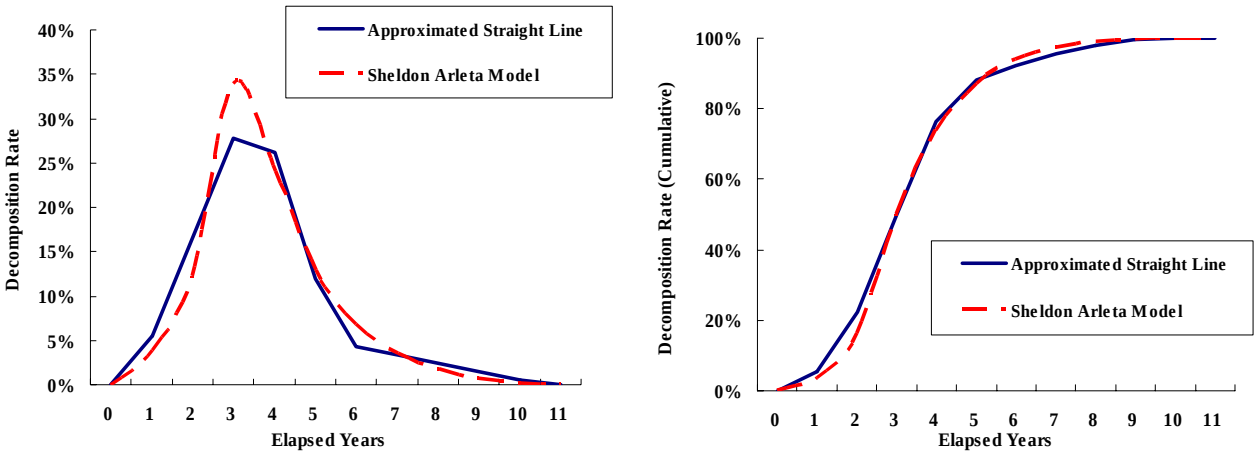

Figure 8-1 Rate of breakdown of kitchen garbage

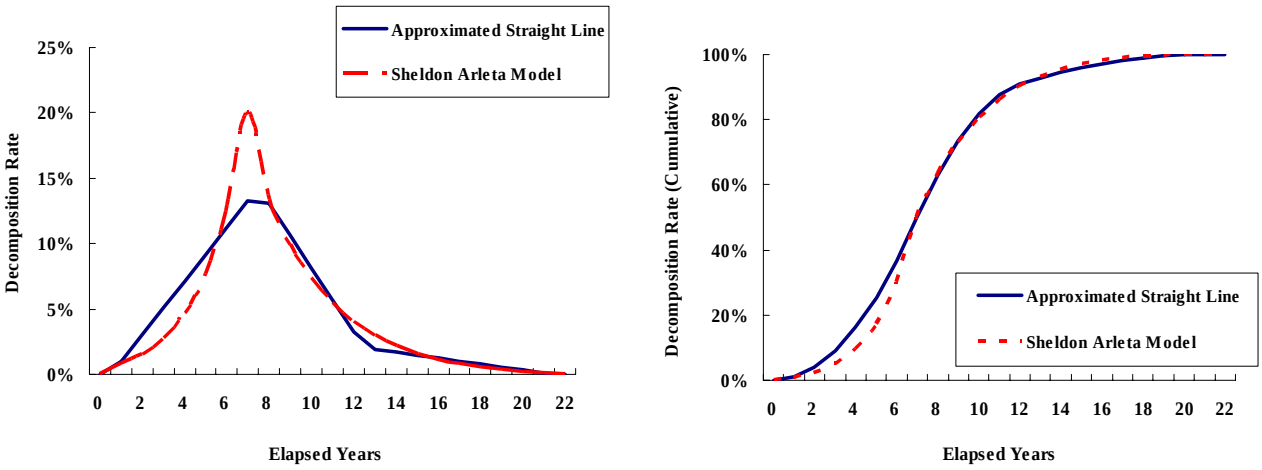

Figure 8-2 Rate of breakdown of waste paper or waste textiles

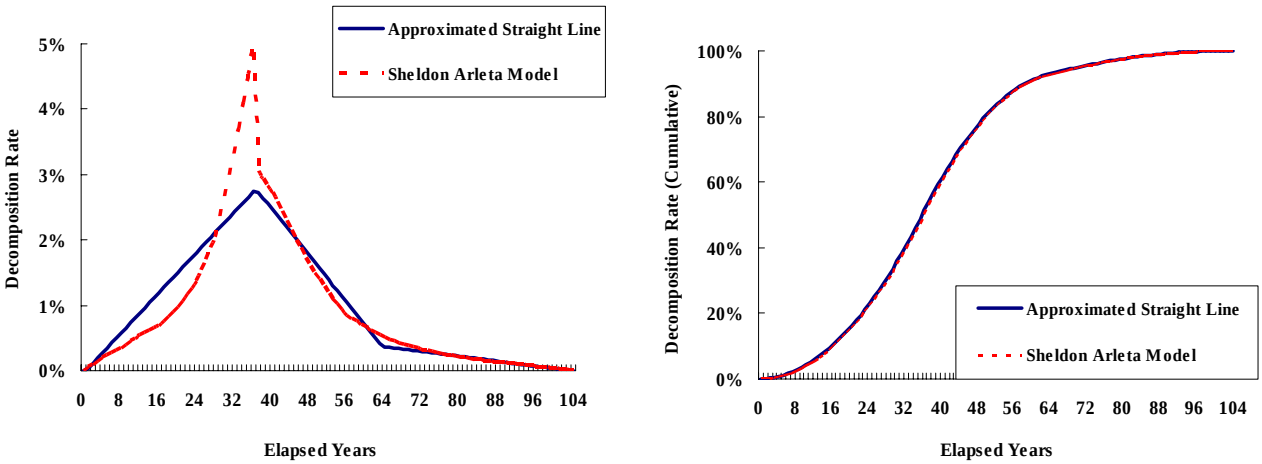

Figure 8-3 Rate of breakdown of waste paper or waste wood

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

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

Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 5.6 Fig. 5.1) requires that the Tier 2 first order decay (FOD) method is used in calculation.

Research has been conducted to understand the actual emissions of methane at waste landfill sites in Japan. The results of that research have been used to derive emissions, using a more advanced model, a simple approximation of the Sheldon Arleta model that depicts the breakdown of waste in a landfill site over time.

• ***Carbon Dioxide Emissions***

The carbon dioxide emitted from this source is biological in origin, and has therefore not been added to Japan's total emissions. As a reference, these carbon dioxide emissions have been given under Additional Information in the Common Reporting Format.

8.2. Wastewater Handling (6B)

8.2.1. Industrial Wastewater (6B1)

1) CH_4

• ***Methodology for Estimating Emissions of GHGs***

Emissions for the period from 1990 to 2001 have been derived by multiplying the emission factor for BOD by the annual BOD burden from the industry that generates the largest BOD burden. (Refer to *6B-2003.xls¥6B1-Ind* for detail on the calculation process.)

• ***Emission Factors***

The Water Environment Department of the Environmental Management Bureau in the Ministry of the Environment in its Comprehensive Survey of Emissions of Water Quality Contaminants, reports that the most typical means of treating industrial wastewater is the activated sludge method. Although there are differences in how the method is applied to industrial and domestic wastewater, when compared on a BOD basis, there is thought to be no great difference between them. The data on methane emissions given at *8.2.2.1. Sewage Treatment Plant (6B2-)* has therefore been used to calculate the volume of methane emitted per BOD to establish the emission factor.

Calculation of emission factor

- Methane emissions per volume treated by the activated sludge method: Methane emission factor for sewage treatment plant
- Planned run-off water quality: Planned run-off water quality of municipal solid domestic wastewater

Emission factor = Methane emissions per volume treated by the activated sludge method / Planned run-off water quality
= 0.00088 [kg CH_4/m^3] / 180 [mg BOD/ L]
= 0.004888 [kg CH_4/kg BOD]
= 0.0049 [kg CH_4/kg BOD]

Table 8-4 Number of operating sites by method of wastewater treatment (FY2000)

	Treatment Method	Total Operating Site Numbers	Proportion
1	Activated Sludge	15,972	45.9%
2	Other Biological Handling	6,209	17.9%
3	Coagulator, Floatation	3,877	11.2%
4	Sand Filtration	245	0.7%
5	Ozonation	68	0.2%
6	Activated Carbon	365	1.0%
7	Oily Water Separator	382	1.1%
8	Other High-Intensity Handling	633	1.8%
9	Other	2,873	8.3%
	No Answer	4,147	11.9%
	Total	34,771	100.0%

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

• ***Activity Data***

-Outline

With reference to the industry types given in the *Revised 1996 IPCC Guidelines*, activity data was obtained by deriving the total BOD burden for the types of industries for which both methane emissions associated with wastewater and BOD concentrations in wastewater are high.

BOD concentration for each industrial sub-category was multiplied by the volume of wastewater, and the total of the products was taken as the activity data (BOD burden). For industrial sub-categories for which BOD raw water quality by industry wastewater was not given, activity data was derived by substituting average BOD raw water quality by industry medium category.

-BOD concentration

BOD raw water quality for industrial sub-categories given in the Japan Sewage Works Association *Guidelines and Analysis of Comprehensive Planning Surveys for the Provision of Water Mains, by Catchment Area 1999 Edition* were used for BOD concentration by industry sub-category.

-Volume of wastewater

The volume of water used for treatment of products, by industrial sub-category, and the volume of water used for washing given in the Ministry of Economy, Trade and Industry's *Table of Industrial Statistics - Land and Water* were used for volume of wastewater.

Table 8-5 Industries for which activity data was calculated, and BOD burden

Code	Category of Manufacturing	Unit	1990	1995	1999	2000	2001
12	Food Manufacturing	Gg BOD / year (Calendar year)	497.8	529.1	534.7	549.0	547.5
13	Beverage, Tobacco and Feeding Stuff Manufacturing	Gg BOD / year (Calendar year)	137.9	142.7	141.4	139.0	138.6
14	Textile Manufacturing (excluding: Clothing Material, Other Textile)	Gg BOD / year (Calendar year)	159.9	135.7	107.4	101.3	101.0
15	Clothing Material and Other Textile Manufacturing	Gg BOD / year (Calendar year)	2.2	4.0	2.6	2.5	2.5
18	Pulp, Paper and Other Paper Manufacturing	Gg BOD / year (Calendar year)	1,640.1	1,524.0	1,524.3	1,527.7	1,523.5
20	Chemical Industries	Gg BOD / year (Calendar year)	693.6	645.0	665.5	667.2	665.4
21	Petroleum Products and Coal Product Manufacturing	Gg BOD / year (Calendar year)	3.0	2.2	2.5	2.6	2.6
22	Plastic Products Manufacturing	Gg BOD / year (Calendar year)	12.3	11.8	11.4	12.4	12.4
23	Rubber Products Manufacturing	Gg BOD / year (Calendar year)	0.9	0.9	0.7	0.6	0.6
24	Chamois, Chamois Products and Fur Skin Manufacturing	Gg BOD / year (Calendar year)	5.9	5.0	3.6	3.7	3.7
Total			3,153.6	3,000.3	2,994.1	3,005.9	2,997.7

N.B. Drainage volumes of 2001 are replaced by that of 2000.

Source: Calculated from BOD concentration (Japan Sewage Works Association （Guidelines and Analysis of Comprehensive Planning Surveys for the Provision of Water Mains, by Catchment Area 1999 Edition）and volume of wastewater (Ministry of Economy, Trade and Industry Table of Industrial Statistics – Land and Water

8.2.2. Domestic and Commercial Wastewater (6B2)

8.2.2.1. Sewage Treatment Plant (6B2-)

• Methodology for Estimating Emissions of GHGs

Emissions of methane and nitrous oxide from this source have been calculated using a country-specific method, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 5.14 Fig. 5.2). Emissions for the period FY1990 to FY2001 were derived by multiplying the volume of sewage treated at sewage treatment plants by the emission factor. (Refer to *6B-2003.xls¥6B2-D&C* for detail of the calculation process.)

• Emission Factors

Emission factors were established by adding the simple averages for each treatment process, having taken the actual volume of methane and nitrous oxide released from sludge treatment and water treatment processes measured at sewage treatment plants from research studies conducted in Japan.

Table 8-6 Actual volume of methane released from each treatment process [mg CH_4/m^3]

Water treatment process					Sludge treatment process			Source
Detritus pond	Initial settling pond	Biological reaction tank	Final settling pond	Total	Concentration tank	De-watering chamber	Total	
---	59.0	---	590.0	649.0	510.0	---	510.0	a
---			260.0	260.0	420.0	---	420.0	a
---	37.0	240.0	3.0	280.0	320.0	---	320.0	b
---	16.0	145.0	0.6	161.6	48.0	54.0	102.0	b
38.0	250.0	89.0	---	377.0	51.0	190.0	241.0	b
---	8.0	253.0	0.0	261.0	194.0	81.0	275.0	b
---	51.0	328.0	0.7	379.7	441.0	80.0	521.0	b
---	2.0	815.0	0.0	817.0	272.0	123.0	395.0	c
5.0	21.7	430.0	2.0	458.7	---	---	---	d
22.5	4.8	1,002.6	0.0	1,029.9	---	---	---	d
0.3	127.0	252.5	1.4	381.2	---	---	---	d
2.6	1.8	298.8	0.2	303.4	---	---	---	d
1.5	68.1	1,877.3	3.2	1,950.1	---	---	---	d
0.3	2.4	89.9	0.5	93.1	---	---	---	d
Simple average				**528.7**	**Simple average**		**348.0**	

N.B. --- Indicates that no measurements have been taken, or that data is not available.

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

b: Kyosai and Mizuochi *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1992 Global Environment Research Fund Outcome Report

c: Takeishi, Suzuki, and Matsubara *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment* Plants FY1993 Global Environment Research Fund Outcome Report

d: Nakamura, Suzuki, Sonemura, Ochi, and Harada *B-16(8) Sewage Treatment System Technology for Limiting Greenhouse Gases* FY1997 Global Environment Research Fund Outcome Report

Calculation of methane emission factor

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]

Table 8-7 Measurements of nitrous oxide released from each treatment process [mg N_2O/m^3]

Water treatment process				Sludge treatment process			Source
Initial Settling Pond	Biological reaction tank	Final settling pond	Total	Concentration tank	De-watering chamber	Total	
0.0	17.9	0.0	17.9	0.6	---	0.6	a
0.0	20.3	0.0	20.3	1.2	---	1.2	a
0.0	1.3	0.1	1.4	0.0	---	0.0	a
---	28.3	0.0	28.3	---	---	---	b
---	994.7	0.0	994.7	---	---	---	b
---	60.7	0.0	60.7	---	---	---	b
---	---	---	91.8	---	---	---	c
---	---	---	67.6	---	---	---	c
Simple average			**160.3**	**Simple average**		**0.6**	

N.B. Sources 2 and 3 are given in (mg-N/m^3) units and have been converted to (mg-N_2O/m^3)
--- Indicates that no measurements have been taken, or that data is not available.
a: Takeishi, Suzuki, and Matsubara *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1993 Global Environment Research Fund Outcome Report
b: Nakamura, Suzuki, Sonemura, Ochi, and Harada *B-16(8) Sewage Treatment System Technology for Limiting Greenhouse Gases* FY1997 Global Environment Research Fund Outcome Report
c: Inamori and Mizuochi *B-16(8) On-Site Surveys of Balance of Methane and Nitrous Oxide from Sewage and Waste* FY1998 Global Environment Research Fund Outcome Report

Calculation of nitrous oxide emission factor

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.).*

The reason for subtracting volumes subject to primary processing is twofold:

(i) methane and nitrous oxide emitted from this source are primarily emitted from biological reaction tanks, and

(ii) the annual volume of water treated as given in the *Sewage Statistics (Admin. Ed)* includes primary treatment volumes that are only subject to settling. Therefore, if annual volume of treated water were used as activity data, the estimates would be too large.

8.2.2.2. Domestic Sewage Treatment Plant (Private Sewerage Tank) (6B2-)

• Methodology for Estimating Emissions of GHGs

Methane and nitrous oxide emitted from this source were calculated using a country specific-method, in accordance with Decision Tree the *Good Practice Guidance (2000)* (GPG (2000) p. 5.14 Fig. 5.2). Emissions for the period from FY1990 to FY2001 were derived by multiplying the annual population using each type of domestic sewage treatment plant by the emission factor. (Refer to *6B-2003.xls¥6B2-D&C* for detail of the calculation process.)

• Emission Factors

Emission factors for methane and nitrous oxide have been established for each type of domestic sewage treatment plants, including community plants, on-site treatment facilities of domestic wastewater, septic tanks, and vault toilets.

Table 8-8 Methane emission factor for domestic sewage treatment plant

Domestic waste water treatment facilities	Methane emission factor [kg CH_4/person-year]
Community plants[a]	0.195
On-site treatment facilities of domestic wastewater[a]	1.106
Septic tanks[b]	0.196
Vault toilets[c]	0.196

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

b: Uses averages of actual measurements given in Takeishi, Suzuki, and Matsubara *B-2(7) Research to Reveal Emission Volumes from Sewage Treatment Plants* FY1993 and FY1994 Global Environment Research Fund Outcome Report

c: Assumed to be the same as for isolation type septic tanks

Table 8-9 Nitrous oxide emission factor for domestic sewage treatment plant

Domestic waste water treatment facilities	Nitrous oxide emission factor [kg N_2O/person-year]
Community plants[a]	0.0394
On-site treatment facilities of domestic wastewater[a]	0.0264
Septic tanks[bc]	0.0200
Vault toilets[d]	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 the same as for isolation type septic tanks

• Activity Data

Annual treatment population by type of domestic sewage treatment plant for community plants, on-site treatment facilities of domestic wastewater, septic tanks, and vault toilets given in the Ministry of the Environment's *Waste Treatment in Japan*, was used as the activity data for methane and nitrous oxide emitted in association with domestic waste water treatment facilities.

• Domestic Wastewater Treatment Facilities in Japan

The approach in Japan has been to give adequate consideration to the characteristics, efficacy, and economy of each type of system for treating wastewater, to choose the system most suited to a region, thereby avoiding excessive investment and efficiently providing the necessary infrastructure.

At the end of March 2003, more than 75% 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 mean low population density, and a low proportion of flat land. The municipalities responsible for commissioning the work have limited funds, and they require more economical infrastructure solutions.

Therefore the circumstances would suggest that on-site treatment facilities of domestic wastewater will be suited to the domestic wastewater treatment requirements of the small and medium-sized municipalities as well as sewage infrastructure, and their installation will be pursued systematically, as the focal point of domestic wastewater measures.

8.2.2.3. Human-Waste Treatment Plant (6B-)

• Methodology for Estimating Emissions of GHGs

Methane and nitrous oxide emitted from this source have been calculated using a country specific methodology, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 5.14 Fig. 5.2). Emissions for the period from FY1990 to FY2001 were calculated by multiplying the volume of domestic wastewater treated at human waste treatment plant, by the emission factor. (Refer to *6B-2003.xls¥6B2-D&C* for detail of the calculation process.)

• Emission Factors

A weighted average of emission factors for methane and nitrous oxide emissions for each treatment format, including anaerobic treatment, aerobic treatment, standard de-nitrification treatment, high load de-nitrification treatment, and membrane separation, was derived using the treatment capacity of each form of treatment. (Refer to *6-EF-2003.xls¥ 6B2c* for detail of the calculation process.)

Table 8-10 Methane emission factors for each treatment format

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 therefore been used.

c: Tanaka, Inoue, Matsuzawa, Osako, and Watanabe *B-2(1) Research into Volumes Released from Waste Treatment Plants* FY1994 Global Environment Research Fund Outcome Report

d: Actual data on emissions is not available. The emission factor for Aerobic treatment has been substituted.

Table 8-11 Nitrous oxide emission factor, by treatment format

Treatment method	Nitrous oxide emission factor [kg N_2O/m^3]
Anaerobic treatment[a]	0.00001
Aerobic treatment[a]	0.00001
Standard de-nitrification treatment[a]	0.00001
High load de-nitrification treatment[b]	0.45
Membrane separation[b]	0.45
Other[a]	0.00001

a: Upper limit for standard de-nitrification treatment given in Tanaka, Inoue, Matsuzawa, Osako, and Watanabe *B-2(1) Research into Volumes Released from Waste Treatment Plants* FY1994 Global Environment Research Fund Outcome Report

b: Simple average of measurements taken at 15 sites, from Tanaka, Inoue, Ohasama, 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

Table 8-12 Trends in treatment capacity by treatment format

	Unit	1990	1995	1999	2000	2001
Anaerobic Treatment	kl/day	34,580	19,869	12,277	10,996	7,773
Aerobic Treatment	kl/day	26,654	19,716	12,730	12,166	9,012
Standard Denitrogen	kl/day	25,196	30,157	31,815	31,908	33,692
High-Intensity Denitrogen	kl/day	8,158	13,817	16,331	16,498	18,770
Membrane Separation	kl/day	0	1,616	2,314	2,375	2,822
Other	kl/day	13,777	20,028	25,159	25,917	25,308
Total	kl/day	108,365	105,203	100,626	99,860	97,377

N.B. Data of 2001 are extrapolated by trend of 1992-2000. The division of the statistics is different before 1992.

Calculation of methane emission factor (FY2000)

Emission factor
= (Methane emission factor for anaerobic treatment × Treatment capacity of anaerobic treatment
+ Methane emission factor for aerobic treatment × Treatment capacity of aerobic treatment
+ Methane emission factor for standard de-nitrification
× Treatment capacity of standard de-nitrification
+ Methane emission factor for high load de-nitrification
× Treatment capacity of high load de-nitrification
+ Methane emission factor for membrane treatment × Treatment capacity of membrane treatment
+ Methane emission factor for other treatments × Treatment capacity of other treatments)
/ Total treatment capacity of all treatment formats

= (0.543 [kg CH_4/m^3] × 10,996 [kL/day] ＋ 0.00545 [kg CH_4/m^3] × 12,166 [kL/day]
+ 0.0059 [kg CH_4/m^3] ×31,908 [kL/day] + 0.005 [kg CH_4/m^3] ×16,498 [kL/day]
+ 0.00545 [kg CH_4/m^3] ×2,375 [kL/day] + 0.00545 [kg CH_4/m^3] ×25,917 [kL/day]
/（10,996＋12,166＋31,908＋16,498＋2,375＋25,917）[kL/day]
= 0.065 [kg CH_4/m^3]

Calculation of nitrous oxide emission factor (FY2000)

Emission factor
= (Nitrous oxide emission factor for anaerobic treatment × Treatment capacity of anaerobic treatment
+ Nitrous oxide emission factor for aerobic treatment × Treatment capacity of aerobic treatment
+ Nitrous oxide emission factor for standard de-nitrification
× Treatment capacity of standard de-nitrification
+ Nitrous oxide emission factor for high load de-nitrification
× Treatment capacity of high load de-nitrification
+ Nitrous oxide emission factor for membrane separation
× Treatment capacity of membrane separation
+ Nitrous oxide emission factor for other treatments × Treatment capacity of other treatments)
/ Total treatment capacity of all treatment formats

= (0.00001 [kg N_2O/m^3] ×10,996 [kL/day] + 0.00001 [kg N_2O/m^3] ×12,166 [kL/day]
+ 0.00001 [kg N_2O/m^3] ×31,908 [kL/day] + 0.45 [kg N_2O/m^3] ×16,498 [kL/day]
+ 0.45 [kg N_2O/m^3] ×2,375 [kL/day] + 0.00001 [kg N_2O/m^3] ×25,917 [kL/day]
/ (10,996＋12,166＋31,908＋16,498＋2,375＋25,917) [kl/day]
= 0.085 [kg N_2O/m^3]

• ***Activity Data***

Activity data for methane and nitrous oxide emissions associated with water treatment in human waste treatment facilities was derived from the volume of human waste treated at such facilities, given in the Ministry of the Environment's *Waste Treatment in Japan.*

8.3. Waste Incineration (6C)

8.3.1. Municipal Solid Waste Incineration (6C-)

1) CO_2

• ***Methodology for Estimating Emissions of GHGs***

Emissions of carbon dioxide from this source for the period from FY1990 to FY2001 were derived by using the volume of waste plastic incinerated and Japan's country specific emission factor, in accordance with Decision Tree of the *Good Practice Guidance* (2000) (GPG (2000) p. 5.24 Fig. 5.5). (Refer to *6C-CO2-2003.xls¥MSW* for details of the calculation process.)

• ***Emission Factors***

-Outline

In accordance with the *Revised 1996 IPCC Guidelines*, the carbon content of plastics has been multiplied by the rate of incineration of plastics at incineration plants.

-Carbon content of plastics

The carbon content of plastics has been estimated as an average for the relevant year by using actual results from the cities of Tokyo, Yokohama, Kawasaki, Kobe and Fukuoka; calculating 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 converting it to a weighted average using the individual populations of each municipality.

Table 8-13 Carbon content of plastics (municipal solid waste) (%)

City	1990	1995	1999	2000	2001
Tokyo	71.08	67.86	75.01	68.58	—
Yokohama	71.81	72.60	66.58	70.15	—
Kawasaki	—	74.68	68.91	71.18	78.38
Kobe	—	79.86	78.74	78.39	—
Fukuoka	70.61	75.66	76.35	75.92	—

Source: Data provided by the cities of Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka

-Incineration rate of plastics

Given Japan's circumstances, the maximum default value given in the *Good Practice Guidance (2000)* has been used for incineration rate of plastics.

Calculation of emission factor (FY1998)

Emission Factor = 1,000 [kg] × Carbon content of plastics (dry basis)
× Incineration rate of plastics × 44/12
= 1,000 [kg] × 73.85% × 99% × 44/12
= 2,680.1 [kg CO_2 / t]
= 2,680 [kg CO_2 / t]

• Activity Data

Activity data for emission of carbon dioxide in association with the incineration of municipal solid waste was derived from the volume of plastics incinerated in municipal solid waste, given by the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment in the *Report on Review of Measures to Move Waste over a Wide Area (Estimation of Recycled Waste)*.

• Biomass Sources of Carbon Dioxide Emissions

Carbon dioxide from biomass sources have been calculated in the calculation file for carbon dioxide emissions associated with the incineration of municipal solid waste (*6C-CO2-2003.xls¥MSW*). Emissions of carbon dioxide from biomass sources have been reported as a reference, and have not been included in Japan's total emissions, in accordance with the *Revised 1996 IPCC Guidelines*.

2) CH_4

• Methodology for Estimating Emissions of GHGs

Emissions of methane from this source for the period from FY1990 to FY2001, were derived by multiplying the volume of municipal solid waste incinerated by type of waste incineration facility, by the individually defined emission factors. (Refer to *6C-2003.xls¥MSW* for details of the calculation process.)

• Emission Factors

The *Revised 1996 IPCC Guidelines* do not give a methodology for calculating emission factor. Therefore emission factors have been derived by obtaining from each incineration facility an 'air intake adjusted emission factor', adjusted for the concentration of atmospheric methane drawn in, based on the methane

concentration shown in actual—including existing—surveys, for each type of incineration facility in Japan. A weighted average of the volume of incineration from each facility, by both types of furnace and type of facility, was then used to find a weighted average of the volume of incineration from stoker and fluid bed furnaces, by types of incineration facility.

Table 8-14 Methane emission factor, by type of incineration facility, for municipal solid waste

Furnace Type	Unit	1990	1995	1999	2000	2001
Continuous Incinerator	gCH4/t	0.094	0.094	0.079	0.073	0.073
Semi-Continuous Incinerator	gCH4/t	55	55	58	61	61
Batch type Incinerator	gCH4/t	60	60	63	63	63

*2 Significant Digits

N.B. 2001 data has been substituted for 2000 data.

Source: Measurement surveys (Environmental Agency *Results of Review of Calculation of Emissions of Greenhouse Gas Part 2* (2000))

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

Japan Society of Atmospheric Environment *Method of Estimating Greenhouse Gas Emissions – Survey Report* (1996)

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

Ishikawa Prefecture, City of Osaka, Kanagawa Prefecture, City of Kyoto, City of Kobe, Niigata Prefecture, Hiroshima Prefecture, Hyogo Prefecture, Fukuoka Prefecture, Hokkaido *Survey of Compilation of Emission Units of Greenhouse Gas from Stationary Sources* (1991-1997)

• *Activity Data*

Volume of material incinerated by type of incineration facility has been used as the activity data for methane emissions associated with the incineration of municipal solid waste.

The method for calculating the relevant activity data was to multiply the volume of municipal solid waste incinerated, given in the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment *Report on Review of Measures to Move Waste over a Wide Area (Estimation of Recycled Waste)*, by the proportion of incineration for each type of facility for incinerating municipal solid waste, from the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment *Waste Treatment in Japan*.

3) N_2O

• Methodology for Estimating Emissions of GHGs

Nitrous oxide emitted from this source has been calculated for the period from FY1990 to FY2001 using Japan's country specific emission factor, in accordance with Decision Tree of the Good Practice Guidance (2000) (GPG (2000) p. 5.25 Fig. 5.6). (Refer to *6C-N2O-2003.xls¥MSW* for detail of the calculation process.)

• Emission Factors

Emission factors have been derived by obtaining from each incineration facility an 'air intake adjusted emission factor', adjusted for the concentration of atmospheric methane drawn in, based on the methane concentration shown in actual—including existing—surveys, for each type of incineration facility in Japan. A weighted average of the volume of incineration from each facility, by both type of furnace and facility, was then used to find a weighted average of the volume of incineration from stoker and fluid bed furnaces, by type of incineration facility.

Table 8-15 N_2O emission factor by type of facility for incinerating municipal solid wastes

Furnace Type	Unit	1990	1995	1999	2000	2001
Continuous Incinerator	gN2O/t	49.0	49.0	49.3	49.4	49.4
Semi-Continuous Incinerator	gN2O/t	48.5	48.5	48.9	49.3	49.3
Batch type Incinerator	gN2O/t	57.0	57.0	59.2	59.9	59.9

N.B. 2001 data has been substituted for 2000 data.

Source: Measurement surveys (Environmental Agency *Results of Review of Calculation of Emissions of Greenhouse Gas Part 2* (2000))

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

Japan Society of Atmospheric Environment *Method of Estimating Greenhouse Gas Emissions – Survey Report* (1996)

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 wastes, as for methane emissions.

8.3.2. Industrial Wastes Incineration (6C-)

1) CO_2

• Methodology for Estimating Emissions of GHGs

Emissions of carbon dioxide from this source have been calculated for the period from FY1990 to FY2001 using the volume of waste oil and plastics incinerated, and Japan's country-specific emission factor, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (GPG (2000) p. 5.24 Fig. 5.5)

• Emission Factors

-Outline

In accordance with the *Revised 1996 IPCC Guidelines*, the carbon content of waste oil from fossil fuels and waste plastic was multiplied by the rate of combustion of waste oil from fossil fuels and waste plastic.

-Carbon content of waste oil and plastics

The carbon content of waste oil from fossil fuels 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 of 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 realities of Japan, the rate of combustion in facilities for the incineration of waste oil from fossil fuels and waste plastic was deemed to be 99.5% on the basis of the maximum default value for dangerous wastes given in the *Good Practice Guidance*.

Calculation of emission factor for waste oil from fossil fuels (industrial waste)

Emission factor

= 1,000 [kg] × Carbon content of waste oil from fossil fuel × Rate of combustion × 44/12

= 1,000 [kg] × 80% × 99.5% × 44/12

= 2,919 [kg CO_2 / t]

= 2,900 [kg CO_2 / t]

Calculation of emission factor for waste plastic (industrial waste)

Emission factor
= 1,000 [kg] × Carbon content of waste plastic from fossil fuel × Rate of combustion× 44/12
= 1,000 [kg] × 70% × 99.5% × 44/12
= 2,554 [kg CO_2 / t]
= 2,600 [kg CO_2 / t]

• Activity Data

The volume of incinerated industrial waste (in the form of waste oil and plastic) given by the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment, in its *Report on Review of Measures to Move Waste over a Wide Area (Estimation of Recycled Waste)*, has been used as the activity data for carbon dioxide emitted in association with industrial waste.

• Carbon Dioxide Emissions from Biomass Sources

The calculation file (*6C-CO2-2003.xls¥ISW*) for carbon dioxide emissions associated with the combustion of industrial wastes calculates carbon dioxide from biomass sources. Emissions of carbon dioxide from biomass sources have been reported as a reference, without being included in Japan's total emissions, in accordance with the *Revised 1996 IPCC Guidelines*.

2) CH_4

• Methodology for Estimating Emissions of GHGs

Emissions of methane from this source have been calculated for the period from FY1990 to FY2001, by multiplying the volume of industrial waste incinerated by country specific emission factor. (Refer to *6C-2003.xls¥ISW* for detail of the calculation process.)

• Emission Factors

The method for calculating emission factors is not given in the *Revised 1996 IPCC Guidelines*, but an 'air intake adjusted emission factor', adjusted for the concentration of atmospheric methane drawn in, based on the methane concentration shown in actual—including existing—surveys was obtained, and a weighted average of the volume of incineration from each type of facility for the incineration of industrial wastes was derived, to calculate the emission factor.

Table 8-16 Methane emission factor for type of industrial waste

Type of waste	Emission factor [g CH_4 / t]	Remarks
Paper or wood scraps	-0.87	Weighted average of data from 5 facilities
Waste oil	0.56	Weighted average of data from 5 facilities
Waste plastics	-8.3	Weighted average of data from 4 facilities
Sludge	9.7	Weighted average of data from 19 facilities

Sources: Measurement surveys (Environmental Agency *Results of Review of Calculation of Emissions of Greenhouse Gas Part 2* (2000))
Japan Society of Atmospheric Environment *Method of Estimating Greenhouse Gas Emissions – Survey Report* (1996)
Ishikawa Prefecture, City of Osaka, Kanagawa Prefecture, City of Kyoto, Hiroshima Prefecture, Hyogo Prefecture, *Survey of Compilation of Emission Units of Greenhouse Gas from Stationary Sources* (1991-1999)

• Activity Data

The volume of material incinerated by type of waste has been used as the activity data for methane emitted in association with industrial wastes.

-Other than sludge

For waste paper and waste wood, waste oil, and waste plastics, volumes of the matter incinerated were taken from the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment *Report on Review of Measures to Move Waste over a Wide Area (Estimates of Recycled Waste)*.

-Sludge

The figure used for sludge is the sum of the volume of other organic sludge incinerated, from the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment *Waste Treatment in Japan*, and the total given in the Ministry of Land, Infrastructure and Transport's *Sewage Sludge Incineration Volumes, by Flocculant*.

• Points to Note

The emission factors for waste paper and waste wood, and waste plastics are negative, because in the process of combustion, the concentrations of methane and nitrous oxide in waste gas fall below their concentrations in the air intake.

3) N_2O

• Methodology for Estimating Emissions of GHGs

Nitrous oxide emitted from this source for the period from FY1990 to FY2001, has been derived by multiplying the volume of industrial waste incinerated, by

Japan's country specific emission factor. (Refer to *6C-2003.xls¥ISW* for detail of the calculation process.)

• *Emission Factors*

Emission factors have been derived by obtaining an 'air intake adjusted emission factor', adjusted for the concentration of atmospheric methane drawn in, based on the methane concentration shown in actual—including existing—surveys in Japan. A weighted average of the volume of incineration from each facility, by type of industrial waste, was then derived.

The emission factor for nitrous oxide from the incineration of sewage sludge can vary with the type of sludge flocculant used. Therefore emission factor was established by taking a weighted average of the volume of the matter incinerated, according to type of flocculant (high-molecular-weight flocculant, lime-based flocculants, and others; for high-molecular-weight flocculants, type of incineration facility was also considered.)

Table 8-17 Emission factor for nitrous oxide, by type of industrial waste

Item	Unit	1990	1995	1999	2000	2001
Waste Paper, Waste Wood	gN2O/t	10	10	10	10	10
Waste Oil	gN2O/t	9.8	9.8	9.8	9.8	9.8
Waste Plastics	gN2O/t	170	170	170	170	170
Sludge (without Sewage Sludge)	gN2O/t	450	450	450	450	450
Sewage Sludge	gN2O/t	714	815	902	903	903

*2 Significant Digits
*3 Significant Digits of Sewage Sludge

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）
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• ***Activity Data***

-Other than sewage sludge

The volume of matter incinerated for each type of paper and wood scraps, waste oil, waste plastics, and sludge (excluding sewage sludge) given in the Waste Management and Recycling Department of the Minister's Secretariat, Ministry of the Environment *Report on Review of Measures to Move Waste over a Wide Area (Estimation of Recycled Waste)* have been used. For sludge (other than sewage sludge), the value given in the same document under Volume of Other Organic Sludges Incinerated, has been used.

-Sewage sludge

The total of the figures for volume of sewage sludge incinerated by type of flocculant, given in the Ministry of Land, Infrastructure and Transport's *Sewage Sludge Incineration Volumes, by Flocculant*, have been used

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Appendix 1. Summary of Common Reporting Format

1.1. Emissions and Removals in 1990

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS Japan
(Sheet 1 of 1) 1990
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,038,213.84**	**24,795.46**	**40,195.67**	**NE**	**NE**	**NE**	**1,103,204.98**
1. Energy	**1,048,172.48**	**3,707.63**	**6,222.18**				**1,058,102.28**
A. Fuel Combustion (Sectoral Approach)	1,048,171.96	531.51	6,222.18				1,054,925.65
1. Energy Industries	338,571.94	-32.67	300.30				338,839.57
2. Manufacturing Industries and Construction	335,049.79	227.51	847.81				336,125.11
3. Transport	210,500.04	194.96	5,022.68				215,717.68
4. Other Sectors	164,050.19	141.70	51.39				164,243.28
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.51	3,176.12	0.00				3,176.63
1. Solid Fuels	NE,NO	2,806.43	NE,NO				2,806.43
2. Oil and Natural Gas	0.51	369.69	0.00				370.20
2. Industrial Processes	**57,008.97**	**337.80**	**7,415.36**	**NE**	**NE**	**NE**	**64,762.12**
A. Mineral Products	53,465.31	NO	NO				53,465.31
B. Chemical Industry	3,543.66	337.80	7,415.36	NE	NE	NE	11,296.82
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO.NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**287.07**				**287.07**
4. Agriculture	**NE**	**15,568.88**	**23,410.56**				**38,979.45**
A. Enteric Fermentation		7,249.10					7,249.10
B. Manure Management		1,072.55	13,534.20				14,606.75
C. Rice Cultivation		7,075.73					7,075.73
D. Agricultural Soils[2]	NE	3.06	9,746.46				9,749.52
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		168.45	129.90				298.35
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**-83,903.07**	**53.07**	**5.39**				**-83,844.62**
6. Waste	**16,935.48**	**5,128.07**	**2,855.12**				24,918.67
A. Solid Waste Disposal on Land	NE	4,044.84					4,044.84
B. Wastewater Handling		1,069.69	1,269.61				2,339.30
C. Waste Incineration	16,935.48	13.54	1,585.51				18,534.53
D. Other	NO	NE	NE				NE.NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**30,701.13**	**42.05**	**274.75**				**31,017.93**
Aviation	13,183.16	7.83	130.44				13,321.43
Marine	17,517.97	34.22	144.31				17,696.50
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**1,420.86**						**1,420.86**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	61,664.52	-146,146.74	-84,482.22			-84,482.22
B. Forest and Grassland Conversion	579.15		579.15	53.07	5.39	637.61
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE,NO
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	62,243.67	-146,146.74	-83,903.07	53.07	5.39	-83,844.62

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,187,049.59
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,103,204.98

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.2 . Emissions and Removals in 1991

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS Japan
(Sheet 1 of 1) 1991
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,047,338.25**	**24,705.04**	**39,702.56**	**NE**	**NE**	**NE**	**1,111,745.85**
1. Energy	**1,055,247.83**	**3,467.05**	**6,506.92**				**1,065,221.80**
A. Fuel Combustion (Sectoral Approach)	1,055,247.21	531.70	6,506.92				1,062,285.84
1. Energy Industries	340,059.29	-33.08	307.78				340,333.99
2. Manufacturing Industries and Construction	325,012.51	223.86	914.63				326,151.00
3. Transport	222,126.26	200.46	5,235.48				227,562.20
4. Other Sectors	168,049.15	140.46	49.03				168,238.64
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.62	2,935.34	0.00				2,935.96
1. Solid Fuels	NE,NO	2,538.33	NE,NO				2,538.33
2. Oil and Natural Gas	0.62	397.01	0.00				397.63
2. Industrial Processes	**58,601.01**	**328.47**	**6,771.10**	**NE**	**NE**	**NE**	**65,700.57**
A. Mineral Products	55,101.92	NO	NO				55,101.92
B. Chemical Industry	3,499.09	328.47	6,771.10	NE	NE	NE	10,598.65
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO,NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**356.85**				**356.85**
4. Agriculture	**NE**	**15,670.67**	**23,116.54**				**38,787.20**
A. Enteric Fermentation		7,339.31					7,339.31
B. Manure Management		1,066.84	13,477.74				14,544.57
C. Rice Cultivation		7,094.10					7,094.10
D. Agricultural Soils[(2)]	NE	3.19	9,503.23				9,506.42
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		167.23	135.57				302.79
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**-83,866.25**	**83.19**	**8.44**				**-83,774.62**
6. Waste	**17,355.67**	**5,155.67**	**2,942.72**				25,454.05
A. Solid Waste Disposal on Land	NE	4,100.78					4,100.78
B. Wastewater Handling		1,041.38	1,331.28				2,372.67
C. Waste Incineration	17,355.67	13.51	1,611.43				18,980.61
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**32,399.63**	**44.37**	**289.94**				**32,733.94**
Aviation	13,912.62	8.27	137.65				14,058.54
Marine	18,487.01	36.11	152.29				18,675.40
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**1,482.39**						**1,482.39**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	57,352.68	-142,126.76	-84,774.08			-84,774.08
B. Forest and Grassland Conversion	907.83		907.83	83.19	8.44	999.46
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE,NO
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	58,260.51	-142,126.76	-83,866.25	83.19	8.44	-83,774.62

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,195,520.47
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,111,745.85

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.3. Emissions and Removals in 1992

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1992
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,063,177.05**	**24,544.52**	**39,951.84**	**NE**	**NE**	**NE**	**1,127,673.41**
1. Energy	**1,071,229.87**	**3,258.51**	**6,765.52**				**1,081,253.90**
A. Fuel Combustion (Sectoral Approach)	1,071,229.24	591.38	6,765.52				1,078,586.14
1. Energy Industries	345,832.51	-34.84	272.53				346,070.19
2. Manufacturing Industries and Construction	324,198.78	270.60	939.25				325,408.63
3. Transport	229,720.86	201.18	5,495.80				235,417.83
4. Other Sectors	171,477.10	154.44	57.95				171,689.49
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.63	2,667.12	0.00				2,667.75
1. Solid Fuels	NE,NO	2,267.52	NE,NO				2,267.52
2. Oil and Natural Gas	0.63	399.60	0.00				400.23
2. Industrial Processes	**59,127.04**	**303.51**	**6,693.75**	**NE**	**NE**	**NE**	**66,124.30**
A. Mineral Products	55,602.80	NO	NO				55,602.80
B. Chemical Industry	3,524.24	303.51	6,693.75	NE	NE	NE	10,521.50
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO,NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**413.01**				**413.01**
4. Agriculture	**NE**	**15,760.21**	**22,949.45**				**38,709.66**
A. Enteric Fermentation		7,364.53					7,364.53
B. Manure Management		1,057.01	13,387.18				14,444.19
C. Rice Cultivation		7,176.75					7,176.75
D. Agricultural Soils[2]	NE	3.17	9,426.61				9,429.78
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		158.74	135.66				294.40
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**-85,570.00**	**83.83**	**8.51**				**-85,477.66**
6. Waste	**18,390.14**	**5,138.47**	**3,121.60**				26,650.21
A. Solid Waste Disposal on Land	NE	4,094.20					4,094.20
B. Wastewater Handling		1,030.99	1,397.86				2,428.85
C. Waste Incineration	18,390.14	13.28	1,723.74				20,127.15
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**32,852.43**	**44.86**	**294.20**				**33,191.49**
Aviation	14,210.12	8.44	140.60				14,359.16
Marine	18,642.30	36.42	153.60				18,832.33
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**1,424.28**						**1,424.28**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	55,680.02	-142,164.78	-86,484.76			-86,484.76
B. Forest and Grassland Conversion	914.76		914.76	83.83	8.51	1,007.09
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	56,594.78	-142,164.78	-85,570.00	83.83	8.51	-85,477.66

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,213,151.07
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,127,673.41

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.4 . Emissions and Removals in 1993

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS Japan
(Sheet 1 of 1) 1993
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,050,348.92**	**24,492.71**	**39,690.62**	**NE**	**NE**	**NE**	**1,114,532.25**
1. Energy	**1,064,004.69**	**3,029.13**	**6,855.65**				**1,073,889.47**
A. Fuel Combustion (Sectoral Approach)	1,064,004.07	546.80	6,855.65				1,071,406.52
1. Energy Industries	328,613.20	-32.79	287.50				328,867.91
2. Manufacturing Industries and Construction	326,066.35	217.71	1,025.63				327,309.70
3. Transport	232,105.67	199.70	5,477.81				237,783.17
4. Other Sectors	177,218.85	162.18	64.71				177,445.75
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.62	2,482.32	0.00				2,482.94
1. Solid Fuels	NE,NO	2,075.76	NE,NO				2,075.76
2. Oil and Natural Gas	0.62	406.56	0.00				407.18
2. Industrial Processes	**58,155.65**	**302.84**	**6,560.07**	**NE**	**NE**	**NE**	**65,018.55**
A. Mineral Products	54,812.94	NO	NO				54,812.94
B. Chemical Industry	3,342.71	302.84	6,560.07	NE	NE	NE	10,205.61
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO,NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**411.66**				**411.66**
4. Agriculture	**NE**	**15,885.14**	**22,692.92**				**38,578.06**
A. Enteric Fermentation		7,309.78					7,309.78
B. Manure Management		1,037.52	13,186.07				14,223.60
C. Rice Cultivation		7,368.45					7,368.45
D. Agricultural Soils[(2)]	NE	3.00	9,362.41				9,365.41
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		166.38	144.44				310.82
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**-90,082.13**	**84.46**	**8.57**				**-89,989.10**
6. Waste	**18,270.72**	**5,191.15**	**3,161.74**				26,623.60
A. Solid Waste Disposal on Land	NE	4,149.71					4,149.71
B. Wastewater Handling		1,028.44	1,432.21				2,460.65
C. Waste Incineration	18,270.72	13.00	1,729.53				20,013.24
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**34,839.77**	**49.22**	**309.90**				**35,198.88**
Aviation	13,849.72	8.23	137.03				13,994.98
Marine	20,990.06	40.99	172.86				21,203.91
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**1,318.35**						**1,318.35**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	51,193.14	-142,196.96	-91,003.82			-91,003.82
B. Forest and Grassland Conversion	921.69		921.69	84.46	8.57	1,014.72
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	52,114.83	-142,196.96	-90,082.13	84.46	8.57	-89,989.10

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,204,521.34
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,114,532.25

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.5. Emissions and Removals in 1994

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1994
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,106,641.11**	**24,062.28**	**40,605.21**	**NE**	**NE**	**NE**	**1,171,308.60**
1. Energy	**1,120,163.99**	**2,662.73**	**7,235.13**				**1,130,061.85**
A. Fuel Combustion (Sectoral Approach)	1,120,163.38	536.06	7,235.13				1,127,934.58
1. Energy Industries	363,803.90	-36.60	309.83				364,077.13
2. Manufacturing Industries and Construction	341,855.28	219.46	1,179.86				343,254.60
3. Transport	240,991.95	202.11	5,684.13				246,878.19
4. Other Sectors	173,512.25	151.09	61.31				173,724.65
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.60	2,126.67	0.00				2,127.27
1. Solid Fuels	NE,NO	1,712.96	NE,NO				1,712.96
2. Oil and Natural Gas	0.60	413.70	0.00				414.31
2. Industrial Processes	**59,170.82**	**302.31**	**7,444.26**	**NE**	**NE**	**NE**	**66,917.40**
A. Mineral Products	55,599.11	NO	NO				55,599.11
B. Chemical Industry	3,571.71	302.31	7,444.26	NE	NE	NE	11,318.28
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		NE	NE	IE,NA,NO,NE
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NE	NE,NO
3. Solvent and Other Product Use	**IE,NE,NO**		**438.02**				**438.02**
4. Agriculture	**NE**	**15,783.91**	**22,182.95**				**37,966.86**
A. Enteric Fermentation		7,220.20					7,220.20
B. Manure Management		1,013.06	12,900.72				13,913.77
C. Rice Cultivation		7,384.52					7,384.52
D. Agricultural Soils[2]	NE	2.88	9,142.09				9,144.96
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		163.24	140.15				303.39
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**-93,543.74**	**85.10**	**8.64**				**-93,450.01**
6. Waste	**20,850.05**	**5,228.23**	**3,296.21**				29,374.49
A. Solid Waste Disposal on Land	NE	4,211.56					4,211.56
B. Wastewater Handling		1,003.88	1,454.84				2,458.72
C. Waste Incineration	20,850.05	12.79	1,841.37				22,704.21
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**35,909.90**	**49.65**	**320.67**				**36,280.23**
Aviation	15,059.45	8.95	149.00				15,217.40
Marine	20,850.45	40.70	171.67				21,062.83
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**1,190.43**						**1,190.43**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	47,758.15	-142,230.51	-94,472.36			-94,472.36
B. Forest and Grassland Conversion	928.62		928.62	85.10	8.64	1,022.35
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	48,686.77	-142,230.51	-93,543.74	85.10	8.64	-93,450.01

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,264,758.61
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,171,308.60

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.6 • Emissions and Removals in 1995

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS Japan
(Sheet 1 of 1) 1995
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,114,202.88**	**23,425.66**	**40,783.15**	**20,026.19**	**11,503.12**	**16,736.64**	**1,226,677.63**
1. Energy	**1,130,067.40**	**2,308.90**	**7,872.67**				**1,140,248.97**
A. Fuel Combustion (Sectoral Approach)	1,130,066.80	547.44	7,872.67				1,138,486.91
1. Energy Industries	352,633.54	-35.60	722.52				353,320.46
2. Manufacturing Industries and Construction	346,414.75	213.96	1,218.84				347,847.55
3. Transport	248,530.41	208.03	5,863.32				254,601.75
4. Other Sectors	182,488.10	161.05	67.99				182,717.14
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.60	1,761.47	0.00				1,762.07
1. Solid Fuels	NE,NO	1,344.68	NE,NO				1,344.68
2. Oil and Natural Gas	0.60	416.78	0.00				417.38
2. Industrial Processes	**59,213.29**	**303.30**	**7,367.54**	**20,026.19**	**11,503.12**	**16,736.64**	**115,150.08**
A. Mineral Products	55,588.39	NO	NO				55,588.39
B. Chemical Industry	3,624.90	303.30	7,367.54	NE	NE	NE	11,295.74
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		69.73	NE	69.73
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				17,398.00	762.00	4,710.71	22,870.71
F. Consumption of Halocarbons and SF_6				2,628.19	10,671.39	12,025.93	25,325.51
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**437.58**				**437.58**
4. Agriculture	**NE**	**15,478.67**	**21,573.37**				**37,052.04**
A. Enteric Fermentation		7,118.91					7,118.91
B. Manure Management		991.38	12,635.26				13,626.65
C. Rice Cultivation		7,200.86					7,200.86
D. Agricultural Soils [(2)]	NE	2.75	8,797.91				8,800.66
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		164.77	140.19				304.97
G. Other		NO	NO				NO
5. Land-Use Change and Forestry [(1)]	**-96,705.05**	**86.37**	**8.77**				**-96,609.92**
6. Waste	**21,627.24**	**5,248.42**	**3,523.22**				30,398.88
A. Solid Waste Disposal on Land	NE	4,238.80					4,238.80
B. Wastewater Handling		997.03	1,539.67				2,536.71
C. Waste Incineration	21,627.24	12.59	1,983.55				23,623.38
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**38,075.84**	**51.35**	**341.56**				**38,468.75**
Aviation	16,915.09	10.05	167.36				17,092.50
Marine	21,160.75	41.30	174.20				21,376.24
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**1,108.51**						**1,108.51**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	44,614.75	-142,262.29	-97,647.53			-97,647.53
B. Forest and Grassland Conversion	942.48		942.48	86.37	8.77	1,037.61
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	45,557.23	-142,262.29	-96,705.05	86.37	8.77	-96,609.92

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,323,287.55
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,226,677.63

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.7. Emissions and Removals in 1996

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1996
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,231,207.47**	**22,888.63**	**41,710.39**	**19,631.83**	**11,267.41**	**17,185.41**	**1,343,891.15**
1. Energy	**1,149,820.61**	**2,257.76**	**8,225.68**				**1,160,304.04**
A. Fuel Combustion (Sectoral Approach)	1,149,820.02	542.31	8,225.68				1,158,588.01
1. Energy Industries	353,734.46	-36.99	731.31				354,428.78
2. Manufacturing Industries and Construction	359,494.17	201.54	1,310.56				361,006.27
3. Transport	255,031.96	212.60	6,117.21				261,361.77
4. Other Sectors	181,559.43	165.16	66.59				181,791.18
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.59	1,715.44	0.00				1,716.03
1. Solid Fuels	NE,NO	1,297.15	NE,NO				1,297.15
2. Oil and Natural Gas	0.59	418.29	0.00				418.88
2. Industrial Processes	**59,020.47**	**292.73**	**8,258.17**	**19,631.83**	**11,267.41**	**17,185.41**	**115,656.02**
A. Mineral Products	55,364.86	NO	NO				55,364.86
B. Chemical Industry	3,655.61	292.73	8,258.17	NE	NE	NE	12,206.51
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		65.92	NE	65.92
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				16,007.10	1,008.00	4,182.50	21,197.60
F. Consumption of Halocarbons and SF_6				3,624.73	10,193.50	13,002.91	26,821.14
G. Other	NO	NO	NO	NE	NE	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**420.94**				**420.94**
4. Agriculture	**NE**	**15,079.09**	**21,083.29**				**36,162.38**
A. Enteric Fermentation		7,036.44					7,036.44
B. Manure Management		976.80	12,461.02				13,437.82
C. Rice Cultivation		6,906.99					6,906.99
D. Agricultural Soils[2]	NE	2.71	8,488.19				8,490.90
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		156.15	134.08				290.23
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**NE**	**NE**	**NE**				**NE**
6. Waste	**22,366.39**	**5,259.06**	**3,722.33**				31,347.77
A. Solid Waste Disposal on Land	NE	4,239.29					4,239.29
B. Wastewater Handling		1,007.35	1,644.79				2,652.14
C. Waste Incineration	22,366.39	12.42	2,077.53				24,456.34
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**30,889.60**	**35.27**	**284.92**				**31,209.79**
Aviation	18,433.29	10.95	182.38				18,626.63
Marine	12,456.31	24.31	102.54				12,583.16
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**1,068.85**						**1,068.85**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	-119.30	-119.30			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	-119.30	-119.30	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,343,891.15
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,343,891.15

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.8 . Emissions and Removals in 1997

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1997
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,226,819.39**	**22,053.46**	**42,159.14**	**19,579.09**	**14,012.59**	**14,432.00**	**1,339,055.67**
1. Energy	**1,145,805.48**	**1,979.20**	**8,370.89**				**1,156,155.58**
A. Fuel Combustion (Sectoral Approach)	1,145,804.86	541.32	8,370.89				1,154,717.08
1. Energy Industries	348,041.83	-36.23	727.69				348,733.29
2. Manufacturing Industries and Construction	359,562.85	201.09	1,453.08				361,217.02
3. Transport	258,830.01	216.16	6,124.84				265,171.01
4. Other Sectors	179,370.17	160.30	65.29				179,595.76
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.62	1,437.88	0.00				1,438.50
1. Solid Fuels	NE,NO	1,006.86	NE,NO				1,006.86
2. Oil and Natural Gas	0.62	431.02	0.00				431.64
2. Industrial Processes	**57,574.40**	**241.64**	**8,718.91**	**19,579.09**	**14,012.59**	**14,432.00**	**114,558.63**
A. Mineral Products	54,003.43	NO	NO				54,003.43
B. Chemical Industry	3,570.97	241.64	8,718.91	NE	NE	NE	12,531.52
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		59.48	NE	59.48
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				15,032.20	1,417.00	2,581.20	19,030.40
F. Consumption of Halocarbons and SF_6				4,546.89	12,536.12	11,850.80	28,933.80
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**404.60**				**404.60**
4. Agriculture	**NE**	**14,617.45**	**20,769.20**				**35,386.65**
A. Enteric Fermentation		6,957.83					6,957.83
B. Manure Management		963.29	12,329.62				13,292.91
C. Rice Cultivation		6,547.69					6,547.69
D. Agricultural Soils [(2)]	NE	2.58	8,310.17				8,312.75
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		146.06	129.40				275.46
G. Other		NO	NO				NO
5. Land-Use Change and Forestry [(1)]	**NE**	**NE**	**NE**				**NE**
6. Waste	**23,439.50**	**5,215.16**	**3,895.54**				32,550.21
A. Solid Waste Disposal on Land	NE	4,190.06					4,190.06
B. Wastewater Handling		1,012.85	1,753.97				2,766.83
C. Waste Incineration	23,439.50	12.24	2,141.57				25,593.32
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**35,363.73**	**43.04**	**322.83**				**35,729.61**
Aviation	19,125.43	11.37	189.23				19,326.02
Marine	16,238.31	31.68	133.60				16,403.58
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**812.25**						**812.25**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	-122.80	-122.80			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	-122.80	-122.80	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,339,055.67
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,339,055.67

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.9. Emissions and Removals in 1998

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1998
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,195,039.04**	**21,514.06**	**40,827.85**	**18,956.51**	**12,439.70**	**12,822.20**	**1,301,599.37**
1. Energy	**1,118,763.46**	**1,821.11**	**8,350.14**				**1,128,934.71**
A. Fuel Combustion (Sectoral Approach)	1,118,762.88	519.47	8,350.14				1,127,632.49
1. Energy Industries	334,364.29	-35.24	726.18				335,055.23
2. Manufacturing Industries and Construction	339,634.07	186.65	1,437.38				341,258.10
3. Transport	258,327.76	213.83	6,125.73				264,667.32
4. Other Sectors	186,436.76	154.23	60.85				186,651.84
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.58	1,301.63	0.00				1,302.22
1. Solid Fuels	NE,NO	872.46	NE,NO				872.46
2. Oil and Natural Gas	0.58	429.18	0.00				429.76
2. Industrial Processes	**52,273.28**	**226.58**	**7,693.43**	**18,956.51**	**12,439.70**	**12,822.20**	**104,411.70**
A. Mineral Products	49,082.09	NO	NO				49,082.09
B. Chemical Industry	3,191.19	226.58	7,693.43	NE	NE	NE	11,111.19
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		49.43	NE	49.43
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				13,994.60	1,390.00	2,103.20	17,487.80
F. Consumption of Halocarbons and SF_6				4,961.91	11,000.27	10,719.00	26,681.18
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**377.05**				**377.05**
4. Agriculture	**NE**	**14,315.96**	**20,535.76**				**34,851.71**
A. Enteric Fermentation		6,891.58					6,891.58
B. Manure Management		950.81	12,218.34				13,169.15
C. Rice Cultivation		6,333.03					6,333.03
D. Agricultural Soils[2]	NE	2.47	8,191.16				8,193.64
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		138.06	126.25				264.31
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**NE**	**NE**	**NE**				**NE**
6. Waste	**24,002.30**	**5,150.42**	**3,871.48**				33,024.20
A. Solid Waste Disposal on Land	NE	4,136.21					4,136.21
B. Wastewater Handling		1,001.73	1,713.49				2,715.22
C. Waste Incineration	24,002.30	12.48	2,157.99				26,172.77
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**37,123.93**	**45.30**	**338.77**				**37,508.01**
Aviation	19,992.21	11.88	197.80				20,201.89
Marine	17,131.72	33.42	140.97				17,306.12
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**767.65**						**767.65**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	-129.69	-129.69			-129.69
B. Forest and Grassland Conversion	NE		NE	NE	NE	0.00
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	-129.69	-129.69	0.00	0.00	-129.69

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,301,729.06
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,301,599.37

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.10. Emissions and Removals in 1999

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
1999
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,228,241.66**	**21,271.31**	**35,110.60**	**19,532.60**	**11,072.34**	**8,351.80**	**1,323,580.30**
1. Energy	**1,152,428.01**	**1,962.51**	**8,852.04**				**1,163,242.56**
A. Fuel Combustion (Sectoral Approach)	1,152,427.43	522.70	8,852.04				1,161,802.17
1. Energy Industries	351,588.59	-41.01	827.33				352,374.91
2. Manufacturing Industries and Construction	349,169.58	199.03	1,562.86				350,931.46
3. Transport	261,923.03	216.02	6,397.19				268,536.23
4. Other Sectors	189,746.23	148.67	64.67				189,959.57
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.58	1,439.81	0.00				1,440.39
1. Solid Fuels	NE,NO	1,004.76	NE,NO				1,004.76
2. Oil and Natural Gas	0.58	435.05	0.00				435.63
2. Industrial Processes	**51,885.07**	**219.48**	**1,561.43**	**19,532.60**	**11,072.34**	**8,351.80**	**92,622.71**
A. Mineral Products	48,381.05	NO	NO				48,381.05
B. Chemical Industry	3,504.02	219.48	1,561.43	NE	NE	0.00	5,284.92
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		29.14	0.00	29.14
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				14,199.50	1,273.00	1,529.60	17,002.10
F. Consumption of Halocarbons and SF_6				5,333.10	9,770.20	6,822.20	21,925.50
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**362.53**				**362.53**
4. Agriculture	**NE**	**14,008.72**	**20,377.70**				**34,386.42**
A. Enteric Fermentation		6,809.37					6,809.37
B. Manure Management		937.67	12,093.12				13,030.79
C. Rice Cultivation		6,125.26					6,125.26
D. Agricultural Soils [(2)]	NE	2.35	8,151.76				8,154.11
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		134.07	132.82				266.89
G. Other		NO	NO				NO
5. Land-Use Change and Forestry [(1)]	**NE**	**NE**	**NE**				**NE**
6. Waste	**23,928.57**	**5,080.60**	**3,956.90**				32,966.07
A. Solid Waste Disposal on Land	NE	4,063.63					4,063.63
B. Wastewater Handling		1,004.67	1,711.34				2,716.01
C. Waste Incineration	23,928.57	12.30	2,245.55				26,186.43
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**34,178.57**	**41.76**	**311.88**				**34,532.21**
Aviation	18,377.00	10.92	181.82				18,569.75
Marine	15,801.57	30.84	130.06				15,962.46
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**679.19**						**679.19**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	-133.32	-133.32			-133.32
B. Forest and Grassland Conversion	NE		NE	NE	NE	0.00
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			0.00
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			0.00
E. Other	NO	NO	NO	NO	NO	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	-133.32	-133.32	0.00	0.00	-133.32

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	1,323,713.62
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	1,323,580.30

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.11 . Emissions and Removals in 2000

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Japan
2000
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,238,699.07**	**20,871.35**	**37,797.84**	**18,347.69**	**11,489.34**	**5,739.70**	**1,332,944.99**
1. Energy	**1,160,960.09**	**1,875.60**	**8,980.06**				**1,171,815.75**
A. Fuel Combustion (Sectoral Approach)	1,160,959.48	537.07	8,980.06				1,170,476.61
1. Energy Industries	362,158.21	-41.89	839.59				362,955.90
2. Manufacturing Industries and Construction	348,777.37	204.45	1,567.71				350,549.54
3. Transport	257,936.52	220.29	6,503.41				264,660.22
4. Other Sectors	192,087.37	154.22	69.35				192,310.95
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.61	1,338.53	0.00				1,339.14
1. Solid Fuels	NE,NO	887.20	NE,NO				887.20
2. Oil and Natural Gas	0.61	451.33	0.00				451.94
2. Industrial Processes	**52,797.32**	**163.74**	**4,214.53**	**18,347.69**	**11,489.34**	**5,739.70**	**92,752.32**
A. Mineral Products	49,403.45	NO	NO				49,403.45
B. Chemical Industry	3,393.87	163.74	4,214.53	NE	NE	NE	7,772.14
C. Metal Production	IE,NA,NO	NE,NA,NO	NO		17.80	NE	17.80
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				12,582.00	1,382.00	860.40	14,824.40
F. Consumption of Halocarbons and SF_6				5,765.69	10,089.54	4,879.30	20,734.53
G. Other	NO	NO	NO	NO	NO	0.00	0.00
3. Solvent and Other Product Use	**IE,NE,NO**		**340.99**				**340.99**
4. Agriculture	**NE**	**13,842.38**	**20,267.87**				**34,110.25**
A. Enteric Fermentation		6,759.68					6,759.68
B. Manure Management		927.87	11,989.93				12,917.80
C. Rice Cultivation		6,018.51					6,018.51
D. Agricultural Soils[2]	NE	2.30	8,144.45				8,146.75
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		134.03	133.48				267.51
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**NE**	**NE**	**NE**				**NE**
6. Waste	**24,941.66**	**4,989.62**	**3,994.39**				33,925.67
A. Solid Waste Disposal on Land	NE	3,963.26					3,963.26
B. Wastewater Handling		1,013.73	1,724.37				2,738.10
C. Waste Incineration	24,941.66	12.64	2,270.02				27,224.32
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**33,502.10**	**65.33**	**275.54**				**33,842.97**
Aviation	16,503.78	32.17	135.67				16,671.61
Marine	16,998.32	33.16	139.87				17,171.35
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**687.19**						**687.19**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	-136.96	-136.96			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	-136.96	-136.96	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,332,944.99
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,332,944.99

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

1.12. Emissions and Removals in 2001

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS Japan
(Sheet 1 of 1) 2001
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,213,657.66**	**20,339.74**	**35,384.19**	**15,598.79**	**9,928.91**	**4,533.60**	**1,299,442.89**
1. Energy	**1,138,559.77**	**1,669.08**	**9,311.00**				**1,149,539.84**
A. Fuel Combustion (Sectoral Approach)	1,138,559.17	520.34	9,311.00				1,148,390.50
1. Energy Industries	350,769.54	-41.89	854.56				351,582.21
2. Manufacturing Industries and Construction	336,264.46	204.52	1,733.91				338,202.89
3. Transport	260,221.63	213.02	6,663.51				267,098.15
4. Other Sectors	191,303.54	144.69	59.02				191,507.25
5. Other	0.00	NO	NO				0.00
B. Fugitive Emissions from Fuels	0.60	1,148.74	0.00				1,149.34
1. Solid Fuels	NE,NO	701.72	NE,NO				701.72
2. Oil and Natural Gas	0.60	447.02	0.00				447.62
2. Industrial Processes	**50,592.04**	**131.47**	**1,345.42**	**15,598.79**	**9,928.91**	**4,533.60**	**82,130.24**
A. Mineral Products	47,374.96	NO	NO				47,374.96
B. Chemical Industry	3,217.08	131.47	1,345.42	NE	NE	NE	4,693.98
C. Metal Production	IE,NA,NO	IE,NA,NO	NO		15.71	NE	15.71
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				9,664.60	1,124.00	788.70	11,577.30
F. Consumption of Halocarbons and SF_6				5,934.19	8,789.20	3,744.90	18,468.29
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**IE,NE,NO**		**343.60**				**343.60**
4. Agriculture	**NE**	**13,676.93**	**20,171.26**				**33,848.19**
A. Enteric Fermentation		6,712.35					6,712.35
B. Manure Management		919.83	11,897.20				12,817.04
C. Rice Cultivation		5,907.16					5,907.16
D. Agricultural Soils[2]	NE	2.26	8,136.00				8,138.27
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		135.32	138.06				273.38
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[1]	**NE**	**NE**	**NE**				**NE**
6. Waste	**24,505.85**	**4,862.26**	**4,212.91**				33,581.02
A. Solid Waste Disposal on Land	NE	3,852.88					3,852.88
B. Wastewater Handling		996.81	1,872.18				2,868.99
C. Waste Incineration	24,505.85	12.57	2,340.73				26,859.15
D. Other	NO	NE	NE				NE,NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0.00
Memo Items:							
International Bunkers	**33,342.65**	**39.74**	**303.85**				**33,686.24**
Aviation	18,643.11	11.08	182.95				18,837.14
Marine	14,699.54	28.66	120.90				14,849.10
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**716.70**						**716.70**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	NO	-141.30	-141.30			NE,NO
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE,NO
C. Abandonment of Managed Lands	NE,NO	NE,NO	NE,NO			NE,NO
D. CO_2 Emissions and Removals from Soil	NE	NE	NE			NE
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	0.00	-141.30	-141.30	0.00	0.00	0.00

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	1,299,442.89
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	1,299,442.89

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO2 emissions from LUCF.

Appendix 2. Key Source Category Analysis

2.1. Outline of Key Source Category Analysis

The *UNFCCC Inventory Reporting Guidelines* require the application of the *Good Practice Guidance*, and the key source category analysis given in the Guidance.

The guidelines for national system under Article 5 of the Kyoto Protocol also requires countries, in compiling their inventories, to follow the method given in Chapter 7 of the *Good Practice Guidance*, and to identify key source categories.

2.2. Results of Key Source Category Analysis

2.2.1. Key Source Categories

Key source categories were assessed in accordance with the *Good Practice Guidance* assessment methods (Tier 1 level assessment or trend assessment).

The results of analysis using both methods (Tier1 Level Assessment and Tier1 Trend Assessment) give the following table of 40 sources, which were Japan's key source categories in fiscal 2001.

Table 1 Japan's Key Source Categories in FY 2001

	A IPCC Source Category		B Direct GHGs	Level	Trend
#1	1A Stationary Combustion	Steam Coal (imported)	CO2	#1	#1
#2	1A3 Mobile Combustion	b. Road Transportation: Gasoline	CO2	#2	#4
#3	1A Stationary Combustion	LNG	CO2	#3	#6
#4	1A3 Mobile Combustion	b. Road Transportation: Diesel Oil	CO2	#4	#9
#5	1A Stationary Combustion	Heating Oil A	CO2	#5	#23
#6	1A Stationary Combustion	Kerosene	CO2	#6	#30
#7	1A Stationary Combustion	Coke	CO2	#7	#5
#8	1A Stationary Combustion	Town Gas	CO2	#8	#8
#9	1A Stationary Combustion	Heating Oil C	CO2	#9	#10
#10	1A Stationary Combustion	Blast Furnace Gas	CO2	#10	#19
#11	1A Stationary Combustion	Refinery Gas	CO2	#11	#20
#12	1A Stationary Combustion	LPG	CO2	#12	#34
#13	2A Mineral Product	1. Cement Production	CO2	#13	#17
#14	1A Stationary Combustion	Coke Oven Gas	CO2	#14	#12
#15	1A Stationary Combustion	Heating Oil C for Power Generation	CO2	#15	#3
#16	6C Waste Incineration		CO2	#16	#16
#17	1A Stationary Combustion	PCI Coal	CO2	#17	#13
#18	1A Stationary Combustion	Diesel Oil or Gas Oil	CO2	#18	#24
#19	1A Stationary Combustion	Oil Coke	CO2	#19	#21
#20	1A Stationary Combustion	Crude Oil for Power Generation	CO2	#20	#2
#21	1A3 Mobile Combustion	a. Civil Aviation: Jet Fuel	CO2	#21	#27
#22	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#22	
#23	1A3 Mobile Combustion	d. Navigation: Heating Oil C	CO2	#23	#33
#24	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	#24	#14
#25	1A Stationary Combustion	Asphalt	CO2	#25	#31
#26	1A Stationary Combustion	Coking Coal	CO2	#26	#26
#27	1A Stationary Combustion	Converter Furnace Gas	CO2	#27	
#28	1A3 Mobile Combustion	b. Road Transportation	N2O	#28	
#29	4C Rice Cultivation		CH4	#29	
#30	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	#30	#28
#31	4D Agricultural Soils	3. Indirect Emissions	N2O	#31	
#32	1A Stationary Combustion	Indigenous Coal (underground)	CO2		#7
#33	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6		#11
#34	1A3 Mobile Combustion	e. Error: Gasoline: Diesel Oil	CO2		#15
#35	2B Chemical Industry	3. Adipic Acid Production	N2O		#18
#36	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#22
#37	1A Stationary Combustion	Indigenous Coal (open pit)	CO2		#25
#38	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#29
#39	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs		#32
#40	4C Rice Cultivation		CH4		#35

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

2.2.2. Level Assessment

Level assessment involves defining categories as key source categories by calculating the proportion of total emissions accounted for by emissions in each category, and adding them, starting with the category that accounts for the largest proportion, until the total reaches 95%.

Tier 1 level assessment of the latest emissions (FY2001) gives the following 31 sub-categories as the key source categories.

Table 2 Results of Level Assessment in FY2001

	A IPCC Source Category		B Direct GHGs	D Current Year Estimate	F % Contribution to Level	Cumulative
#1	1A Stationary Combustion	Steam Coal (imported)	CO2	205,469.41	15.81%	15.81%
#2	1A3 Mobile Combustion	b. Road Transportation: Gasoline	CO2	145,700.58	11.21%	27.02%
#3	1A Stationary Combustion	LNG	CO2	104,985.81	8.08%	35.10%
#4	1A3 Mobile Combustion	b. Road Transportation: Diesel Oil	CO2	102,485.03	7.89%	42.99%
#5	1A Stationary Combustion	Heating Oil A	CO2	76,603.29	5.90%	48.89%
#6	1A Stationary Combustion	Kerosene	CO2	70,443.94	5.42%	54.31%
#7	1A Stationary Combustion	Coke	CO2	63,537.00	4.89%	59.20%
#8	1A Stationary Combustion	Town Gas	CO2	54,695.77	4.21%	63.41%
#9	1A Stationary Combustion	Heating Oil C	CO2	53,215.65	4.10%	67.50%
#10	1A Stationary Combustion	Blast Furnace Gas	CO2	40,054.65	3.08%	70.58%
#11	1A Stationary Combustion	Refinery Gas	CO2	33,599.75	2.59%	73.17%
#12	1A Stationary Combustion	LPG	CO2	33,328.84	2.56%	75.73%
#13	2A Mineral Product	1. Cement Production	CO2	32,520.39	2.50%	78.24%
#14	1A Stationary Combustion	Coke Oven Gas	CO2	28,886.07	2.22%	80.46%
#15	1A Stationary Combustion	Heating Oil C for Power Generation	CO2	25,328.48	1.95%	82.41%
#16	6C Waste Incineration		CO2	24,505.85	1.89%	84.29%
#17	1A Stationary Combustion	PCI Coal	CO2	18,584.44	1.43%	85.72%
#18	1A Stationary Combustion	Diesel Oil or Gas Oil	CO2	16,614.78	1.28%	87.00%
#19	1A Stationary Combustion	Oil Coke	CO2	13,057.48	1.00%	88.01%
#20	1A Stationary Combustion	Crude Oil for Power Generation	CO2	12,304.92	0.95%	88.96%
#21	1A3 Mobile Combustion	a. Civil Aviation: Jet Fuel	CO2	10,707.71	0.82%	89.78%
#22	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,616.37	0.82%	90.60%
#23	1A3 Mobile Combustion	d. Navigation: Heating Oil C	CO2	9,430.16	0.73%	91.32%
#24	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	9,336.60	0.72%	92.04%
#25	1A Stationary Combustion	Asphalt	CO2	7,689.70	0.59%	92.63%
#26	1A Stationary Combustion	Coking Coal	CO2	6,583.12	0.51%	93.14%
#27	1A Stationary Combustion	Converter Furnace Gas	CO2	6,383.05	0.49%	93.63%
#28	1A3 Mobile Combustion	b. Road Transportation	N2O	6,350.91	0.49%	94.12%
#29	4C Rice Cultivation		CH4	5,907.16	0.45%	94.57%
#30	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	4,928.50	0.38%	94.95%
#31	4D Agricultural Soils	3. Indirect Emissions	N2O	4,533.85	0.35%	95.30%

2.2.3. Trend Assessment

The difference between the rate of change in emissions in a category and the rate of change in total emissions is calculated. Trend assessment is calculated by multiplying that figure by the ratio of contribution to emissions of the relevant category. The results are summed, starting with the category of which the proportion to the sum of trend assessment values is the largest, until the total reaches 95%. At which point, those categories are defined as the key source categories.

Tier 1 level assessment of the latest emissions (FY2001) gives the following 35 sub-categories as the key source categories.

Table 3 Results of Trend Assessment in FY2001

	A IPCC Source Category		B Direct GHGs	C Base Year Estimate	D Current Year Estimate	H % Contribution to Trend	Cumulative
#1	1A Stationary Combustion	Steam Coal (imported)	CO2	81,997.55	205,469.41	23.40%	23.40%
#2	1A Stationary Combustion	Crude Oil for Power Generation	CO2	58,999.26	12,304.92	9.77%	33.17%
#3	1A Stationary Combustion	Heating Oil C for Power Generation	CO2	70,792.51	25,328.48	9.65%	42.82%
#4	1A3 Mobile Combustion	b. Road Transportation: Gasoline	CO2	104,967.79	145,700.58	6.93%	49.74%
#5	1A Stationary Combustion	Coke	CO2	86,359.29	63,537.00	5.36%	55.10%
#6	1A Stationary Combustion	LNG	CO2	76,264.17	104,985.81	4.86%	59.96%
#7	1A Stationary Combustion	Indigenous Coal (underground)	CO2	18,690.06	83.05	3.84%	63.81%
#8	1A Stationary Combustion	Town Gas	CO2	35,408.27	54,695.77	3.43%	67.23%
#9	1A3 Mobile Combustion	b. Road Transportation: Diesel Oil	CO2	83,001.52	102,485.03	2.98%	70.21%
#10	1A Stationary Combustion	Heating Oil C	CO2	62,843.14	53,215.65	2.53%	72.74%
#11	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6	10,994.00	2,055.40	1.87%	74.61%
#12	1A Stationary Combustion	Coke Oven Gas	CO2	35,773.46	28,886.07	1.72%	76.32%
#13	1A Stationary Combustion	PCI Coal	CO2	9,559.88	18,584.44	1.67%	78.00%
#14	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	9,336.60	1.67%	79.67%
#15	1A3 Mobile Combustion	e. Error: Gasoline: Diesel Oil	CO2	-3,622.66	-10,806.16	1.37%	81.04%
#16	6C Waste Incineration		CO2	16,935.48	24,505.85	1.31%	82.35%
#17	2A Mineral Product	1. Cement Production	CO2	37,006.41	32,520.39	1.26%	83.61%
#18	2B Chemical Industry	3. Adipic Acid Production	N2O	6,649.66	622.55	1.25%	84.86%
#19	1A Stationary Combustion	Blast Furnace Gas	CO2	43,334.90	40,054.65	1.09%	85.95%
#20	1A Stationary Combustion	Refinery Gas	CO2	27,357.20	33,599.75	0.95%	86.89%
#21	1A Stationary Combustion	Oil Coke	CO2	8,028.87	13,057.48	0.91%	87.80%
#22	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4,710.71	788.70	0.82%	88.62%
#23	1A Stationary Combustion	Heating Oil A	CO2	68,937.87	76,603.29	0.80%	89.42%
#24	1A Stationary Combustion	Diesel Oil or Gas Oil	CO2	19,184.35	16,614.78	0.70%	90.12%
#25	1A Stationary Combustion	Indigenous Coal (open pit)	CO2	3,327.96	18.01	0.68%	90.80%
#26	1A Stationary Combustion	Coking Coal	CO2	9,561.32	6,583.12	0.68%	91.49%
#27	1A3 Mobile Combustion	a. Civil Aviation: Jet Fuel	CO2	7,150.34	10,707.71	0.63%	92.11%
#28	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	7,013.55	4,928.50	0.48%	92.59%
#29	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2,785.23	689.76	0.44%	93.03%
#30	1A Stationary Combustion	Kerosene	CO2	64,872.00	70,443.94	0.43%	93.46%
#31	1A Stationary Combustion	Asphalt	CO2	5,456.40	7,689.70	0.38%	93.85%
#32	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	690.40	2,609.42	0.37%	94.22%
#33	1A3 Mobile Combustion	d. Navigation: Heating Oil C	CO2	7,190.93	9,430.16	0.37%	94.58%
#34	1A Stationary Combustion	LPG	CO2	33,175.75	33,328.84	0.31%	94.89%
#35	4C Rice Cultivation		CH4	7,075.73	5,907.16	0.30%	95.19%

Table 4 Data used in the key source category analysis

	A IPCC Source Category		B Direct GHGs	C Base Year Estimate	D Current Year Estimate	E Level Assessment	F % Contribution to Level	G Trend Assessment	H % Contribution to Trend
#1	1A Stationary Combustion	Coking Cole	CO2	9,561.32	6,583.12	0.005	0.51%	0.0025	0.68%
#2	1A Stationary Combustion	PCI Coal	CO2	9,559.88	18,584.44	0.014	1.43%	0.0062	1.67%
#3	1A Stationary Combustion	Steam Coal (imported)	CO2	81,997.55	205,469.41	0.158	15.81%	0.0872	23.40%
#4	1A Stationary Combustion	Indigenous Coal (underground)	CO2	18,690.06	83.05	0.000	0.01%	0.0143	3.84%
#5	1A Stationary Combustion	Indigenous Coal (open pit)	CO2	3,327.96	18.01	0.000	0.00%	0.0025	0.68%
#6	1A Stationary Combustion	Hard Coal or Anthracite & Lignite	CO2	78.20	0.00	0.000	0.00%	0.0000	0.00%
#7	1A Stationary Combustion	Coke	CO2	86,359.29	63,537.00	0.049	4.89%	0.0200	5.36%
#8	1A Stationary Combustion	Coal Tar	CO2	3,339.61	2,243.83	0.002	0.17%	0.0009	0.25%
#9	1A Stationary Combustion	Coal Briquette	CO2	301.08	0.00	0.000	0.00%	0.0000	0.00%
#10	1A Stationary Combustion	Coke Oven Gas	CO2	35,773.46	28,886.07	0.022	2.22%	0.0064	1.72%
#11	1A Stationary Combustion	Blast Furnace Gas	CO2	43,334.90	40,054.65	0.031	3.08%	0.0040	1.09%
#12	1A Stationary Combustion	Converter Furnace Gas	CO2	6,902.08	6,383.05	0.005	0.49%	0.0006	0.17%
#13	1A Stationary Combustion	Crude Oil for Refinery	CO2	0.00	0.00	0.000	0.00%	0.0000	0.00%
#14	1A Stationary Combustion	Crude Oil for Power Generation	CO2	58,999.26	12,304.92	0.009	0.95%	0.0364	9.77%
#15	1A Stationary Combustion	Vitumous Mixture Fuel	CO2	0.00	300.02	0.000	0.02%	0.0000	0.00%
#16	1A Stationary Combustion	NGL & Condensate	CO2	1,327.96	48.52	0.000	0.00%	0.0010	0.26%
#17	1A Stationary Combustion	Raw Material Oil & Return Naphtha	CO2	0.00	0.00	0.000	0.00%	0.0000	0.00%
#18	1A Stationary Combustion	Reformed Material Oil	CO2	0.00	0.00	0.000	0.00%	0.0000	0.00%
#19	1A Stationary Combustion	Naphtha	CO2	679.44	173.98	0.000	0.01%	0.0004	0.11%
#20	1A Stationary Combustion	Gasoline	CO2	281.06	193.25	0.000	0.01%	0.0001	0.02%
#21	1A Stationary Combustion	Jet Fuel	CO2	1,990.29	1,609.47	0.001	0.12%	0.0004	0.10%
#22	1A Stationary Combustion	Kerosene	CO2	64,872.00	70,443.94	0.054	5.42%	0.0016	0.43%
#23	1A Stationary Combustion	Diesel Oil or Gas Oil	CO2	19,184.35	16,614.78	0.013	1.28%	0.0026	0.70%
#24	1A Stationary Combustion	Heating Oil A	CO2	68,937.87	76,603.29	0.059	5.90%	0.0030	0.80%
#25	1A Stationary Combustion	Heating Oil B	CO2	603.96	106.20	0.000	0.01%	0.0004	0.10%
#26	1A Stationary Combustion	Heating Oil C	CO2	62,843.14	53,215.65	0.041	4.10%	0.0094	2.53%
#27	1A Stationary Combustion	Heating Oil C for Power Generation	CO2	70,792.51	25,328.48	0.019	1.95%	0.0359	9.65%
#28	1A Stationary Combustion	Lubricating Oil	CO2	67.75	156.61	0.000	0.01%	0.0001	0.02%
#29	1A Stationary Combustion	Asphalt	CO2	5,456.40	7,689.70	0.006	0.59%	0.0014	0.38%
#30	1A Stationary Combustion	Non Asphalt Heavy Oil Product	CO2	7.88	0.03	0.000	0.00%	0.0000	0.00%
#31	1A Stationary Combustion	Oil Coke	CO2	8,028.87	13,057.48	0.010	1.00%	0.0034	0.91%
#32	1A Stationary Combustion	Galvanic Furnace Gas	CO2	109.25	48.05	0.000	0.00%	0.0000	0.01%
#33	1A Stationary Combustion	Refinery Gas	CO2	27,357.20	33,599.75	0.026	2.59%	0.0035	0.95%
#34	1A Stationary Combustion	LPG	CO2	33,175.75	33,328.84	0.026	2.56%	0.0011	0.31%
#35	1A Stationary Combustion	LNG	CO2	76,264.17	104,985.81	0.081	8.08%	0.0181	4.86%
#36	1A Stationary Combustion	Indigenous Natural Gas	CO2	1,735.66	1,650.56	0.001	0.13%	0.0001	0.03%
#37	1A Stationary Combustion	Coal Mining Gas	CO2	77.02	0.00	0.000	0.00%	0.0000	0.00%
#38	1A Stationary Combustion	Off-gas from Crude Oil	CO2	246.49	339.79	0.000	0.03%	0.0001	0.02%
#39	1A Stationary Combustion	Town Gas	CO2	35,408.27	54,695.77	0.042	4.21%	0.0128	3.43%
#40	1A Stationary Combustion		CH4	336.54	307.32	0.000	0.02%	0.0000	0.01%
#41	1A Stationary Combustion		N2O	1,199.50	2,647.49	0.002	0.20%	0.0010	0.27%
#42	1A3 Mobile Combustion	b. Road Transportation: Gasoline	CO2	104,967.79	145,700.58	0.112	11.21%	0.0258	6.93%
#43	1A3 Mobile Combustion	b. Road Transportation: Diesel Oil	CO2	83,001.52	102,485.03	0.079	7.89%	0.0111	2.98%
#44	1A3 Mobile Combustion	b. Road Transportation: LPG	CO2	4,686.07	4,393.62	0.003	0.34%	0.0004	0.11%
#45	1A3 Mobile Combustion	d. Navigation: Diesel Oil	CO2	352.96	466.21	0.000	0.04%	0.0001	0.02%
#46	1A3 Mobile Combustion	d. Navigation: Heating Oil A	CO2	4,320.83	4,048.65	0.003	0.31%	0.0004	0.10%
#47	1A3 Mobile Combustion	d. Navigation: Heating Oil B	CO2	1,497.67	368.10	0.000	0.03%	0.0009	0.24%
#48	1A3 Mobile Combustion	d. Navigation: Heating Oil C	CO2	7,190.93	9,430.16	0.007	0.73%	0.0014	0.37%
#49	1A3 Mobile Combustion	a. Civil Aviation: Gasoline	CO2	12.61	16.97	0.000	0.00%	0.0000	0.00%
#50	1A3 Mobile Combustion	a. Civil Aviation: Jet Fuel	CO2	7,150.34	10,707.71	0.008	0.82%	0.0023	0.63%
#51	1A3 Mobile Combustion	c. Railways: Diesel Oil	CO2	941.98	677.16	0.001	0.05%	0.0002	0.06%
#52	1A3 Mobile Combustion	e. Error: Gasoline	CO2	0.00	-7,266.40	-0.006	-0.56%	0.0000	0.00%
#53	1A3 Mobile Combustion	e. Error: Gasoline: Diesel Oil	CO2	-3,622.66	-10,806.16	-0.008	-0.83%	0.0051	1.37%
#54	1A3 Mobile Combustion	e. Error: Gasoline: Jet Fuel	CO2	0.00	0.00	0.000	0.00%	0.0000	0.00%
#55	1A3 Mobile Combustion	e. Error: Gasoline: Heating Oil A	CO2	0.00	0.00	0.000	0.00%	0.0000	0.00%
#56	1A3 Mobile Combustion	e. Error: Gasoline: Heating Oil B	CO2	0.00	0.00	0.000	0.00%	0.0000	0.00%
#57	1A3 Mobile Combustion	e. Error: Gasoline: Heating Oil C	CO2	0.00	0.00	0.000	0.00%	0.0000	0.00%
#58	1A3 Mobile Combustion	e. Error: Gasoline: LPG	CO2	0.00	0.00	0.000	0.00%	0.0000	0.00%
#59	1A3 Mobile Combustion	b. Road Transportation	CH4	164.80	180.20	0.000	0.01%	0.0000	0.00%
#60	1A3 Mobile Combustion	d. Navigation	CH4	26.33	27.76	0.000	0.00%	0.0000	0.00%
#61	1A3 Mobile Combustion	a. Civil Aviation	CH4	2.71	4.24	0.000	0.00%	0.0000	0.00%
#62	1A3 Mobile Combustion	c. Railways	CH4	1.12	0.81	0.000	0.00%	0.0000	0.00%
#63	1A3 Mobile Combustion	b. Road Transportation	N2O	4,720.20	6,350.91	0.005	0.49%	0.0010	0.27%
#64	1A3 Mobile Combustion	d. Navigation	N2O	111.31	117.66	0.000	0.01%	0.0000	0.00%
#65	1A3 Mobile Combustion	a. Civil Aviation	N2O	69.70	106.89	0.000	0.01%	0.0000	0.01%
#66	1A3 Mobile Combustion	c. Railways	N2O	121.47	88.03	0.000	0.01%	0.0000	0.01%
#67	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2,785.23	689.76	0.001	0.05%	0.0016	0.44%
#68	1B Fugitive Emission	1a ii. Coal Mining and Handling (surface)	CH4	21.20	11.96	0.000	0.00%	0.0000	0.00%
#69	1B Fugitive Emission	2a. Oil	CO2	0.20	0.23	0.000	0.00%	0.0000	0.00%
#70	1B Fugitive Emission	2a. Oil	CH4	36.26	39.21	0.000	0.00%	0.0000	0.00%
#71	1B Fugitive Emission	2a. Oil	N2O	0.00	0.00	0.000	0.00%	0.0000	0.00%
#72	1B Fugitive Emission	2b. Natural Gas	CO2	0.30	0.36	0.000	0.00%	0.0000	0.00%
#73	1B Fugitive Emission	2b. Natural Gas	CH4	314.44	386.54	0.000	0.03%	0.0000	0.01%
#74	1B Fugitive Emission	2c. Venting & Flaring	CO2	0.01	0.01	0.000	0.00%	0.0000	0.00%
#75	1B Fugitive Emission	2c. Venting & Flaring	CH4	18.98	21.28	0.000	0.00%	0.0000	0.00%

Table 5 Data used in the key source category analysis (continued.)

	A IPCC Source Category		B Direct GHGs	C Base Year Estimate	D Current Year Estimate	E Level Assessment	F % Contribution to Level	G Trend Assessment	H % Contribution to Trend
#76	2A Mineral Product	1. Cement Production	CO2	37,006.41	32,520.39	0.025	2.50%	0.0047	1.26%
#77	2A Mineral Product	2. Lime Production	CO2	5,052.59	4,238.20	0.003	0.33%	0.0008	0.21%
#78	2A Mineral Product	3. Limestone and Dolomite Use	CO2	11,406.30	10,616.37	0.008	0.82%	0.0010	0.27%
#79	2B Chemical Industry	1. Ammonia Production	CO2	3,376.61	3,010.98	0.002	0.23%	0.0004	0.11%
#80	2B Chemical Industry	2. Nitric Acid Production	N2O	765.70	722.86	0.001	0.06%	0.0001	0.02%
#81	2B Chemical Industry	3. Adipic Acid Production	N2O	6,649.66	622.55	0.000	0.05%	0.0047	1.25%
#82	2B Chemical Industry	5. Ethylene	CO2	167.05	206.10	0.000	0.02%	0.0000	0.01%
#83	2B Chemical Industry	5. Carbon Black, Ethylene, Ethylene Dichloride, Styrene, Methanol, Coke	CH4	337.80	131.47	0.000	0.01%	0.0002	0.04%
#84	2C Metal Production	3. Aluminium Production	PFCs	69.73	15.71	0.000	0.00%	0.0000	0.01%
#85	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	9,336.60	0.007	0.72%	0.0062	1.67%
#86	2E Production of Halocarbons and SF6	2. Fugitive Emissions	HFCs	433.00	328.00	0.000	0.03%	0.0001	0.03%
#87	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs	690.40	2,609.42	0.002	0.20%	0.0014	0.37%
#88	2F(a) Consumption of Halocarbons	2. Foam Blowing	HFCs	452.40	412.35	0.000	0.03%	0.0000	0.01%
#89	2F(a) Consumption of Halocarbons	4. Aerosols/ Metered Dose Inhalers	HFCs	1,365.00	2,697.13	0.002	0.21%	0.0009	0.25%
#90	2F(a) Consumption of Halocarbons	6. Semiconductor Manufacture	HFCs	119.54	115.30	0.000	0.01%	0.0000	0.00%
#91	2F(a) Consumption of Halocarbons	7. Other (for studies, medical use, etc.)	HFCs	0.86	100.00	0.000	0.01%	0.0001	0.02%
#92	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	762.00	1,124.00	0.001	0.09%	0.0002	0.06%
#93	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	7,013.55	4,928.50	0.004	0.38%	0.0018	0.48%
#94	2F(a) Consumption of Halocarbons	6. Semiconductor Manufacture	PFCs	3,657.84	3,860.70	0.003	0.30%	0.0000	0.00%
#95	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4,710.71	788.70	0.001	0.06%	0.0030	0.82%
#96	2F(a) Consumption of Halocarbons	6. Semiconductor Manufacture	SF6	1,031.93	1,689.50	0.001	0.13%	0.0004	0.12%
#97	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6	10,994.00	2,055.40	0.002	0.16%	0.0070	1.87%
#98	3 Solvent & Other Product Use	Using Laughing Gas in Hospital	N2O	287.07	343.60	0.000	0.03%	0.0000	0.01%
#99	4A Enteric Fermentation	1b. Non-dairy Cattle	CH4	3,141.12	3,206.84	0.002	0.25%	0.0001	0.02%
#100	4A Enteric Fermentation	1a. Dairy Cattle	CH4	3,831.70	3,269.33	0.003	0.25%	0.0006	0.15%
#101	4A Enteric Fermentation	3. Sheep	CH4	2.64	0.96	0.000	0.00%	0.0000	0.00%
#102	4A Enteric Fermentation	4. Goats	CH4	3.12	3.05	0.000	0.00%	0.0000	0.00%
#103	4A Enteric Fermentation	6. Horses	CH4	8.77	9.45	0.000	0.00%	0.0000	0.00%
#104	4A Enteric Fermentation	8. Swine	CH4	261.74	222.73	0.000	0.02%	0.0000	0.01%
#105	4B Manure Management	1b. Non-dairy Cattle	CH4	189.91	190.90	0.000	0.01%	0.0000	0.00%
#106	4B Manure Management	1a. Dairy Cattle	CH4	377.59	314.46	0.000	0.02%	0.0001	0.02%
#107	4B Manure Management	3. Sheep	CH4	0.18	0.06	0.000	0.00%	0.0000	0.00%
#108	4B Manure Management	4. Goats	CH4	0.14	0.13	0.000	0.00%	0.0000	0.00%
#109	4B Manure Management	6. Horses	CH4	1.01	1.09	0.000	0.00%	0.0000	0.00%
#110	4B Manure Management	8. Swine	CH4	220.13	187.48	0.000	0.01%	0.0000	0.01%
#111	4B Manure Management	9. Poultry	CH4	283.58	225.70	0.000	0.02%	0.0001	0.01%
#112	4B Manure Management	1b. Non-dairy Cattle	N2O	3,650.66	3,669.68	0.003	0.28%	0.0001	0.03%
#113	4B Manure Management	1a. Dairy Cattle	N2O	2,573.72	2,143.42	0.002	0.16%	0.0004	0.11%
#114	4B Manure Management	8. Swine	N2O	3,925.85	3,343.61	0.003	0.26%	0.0006	0.15%
#115	4B Manure Management	9. Poultry: Hen	N2O	1,248.11	1,173.11	0.001	0.09%	0.0001	0.03%
#116	4B Manure Management	9. Poultry: Broiler	N2O	2,135.87	1,567.38	0.001	0.12%	0.0005	0.13%
#117	4C Rice Cultivation		CH4	7,075.73	5,907.16	0.005	0.45%	0.0011	0.30%
#118	4D Agricultural Soils	2. Animal Production	CH4	3.06	2.26	0.000	0.00%	0.0000	0.00%
#119	4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,340.62	3,597.58	0.003	0.28%	0.0007	0.19%
#120	4D Agricultural Soils	2. Animal Production	N2O	6.18	4.58	0.000	0.00%	0.0000	0.00%
#121	4D Agricultural Soils	3. Indirect Emissions	N2O	5,399.66	4,533.85	0.003	0.35%	0.0008	0.22%
#122	4F Field Burning of Agricultural Residues		CH4	168.45	135.32	0.000	0.01%	0.0000	0.01%
#123	4F Field Burning of Agricultural Residues		N2O	129.90	138.06	0.000	0.01%	0.0000	0.00%
#124	6A Solid Waste Disposal on Land		CH4	4,044.84	3,852.88	0.003	0.30%	0.0003	0.08%
#125	6B Wastewater Handling		CH4	1,069.69	996.81	0.001	0.08%	0.0001	0.03%
#126	6B Wastewater Handling		N2O	1,269.61	1,872.18	0.001	0.14%	0.0004	0.11%
#127	6C Waste Incineration		CO2	16,935.48	24,505.85	0.019	1.89%	0.0049	1.31%
#128	6C Waste Incineration		CH4	13.54	12.57	0.000	0.00%	0.0000	0.00%
#129	6C Waste Incineration		N2O	1,585.51	2,340.73	0.002	0.18%	0.0005	0.13%

Appendix 3. Methodology of Uncertainty Assessment

3.1. Background and Purpose

Under the terms of the United Nations Framework Convention on Climate Change, Japan is required to communicate its inventory of emissions and removals of greenhouse gases (hereafter, 'the Inventory') to the Convention Secretariat. The *Good Practice Guidance* promulgated in May 2000 further requires Japan to quantitatively assess and report any uncertainty associated with its inventory. The 2001(F.Y.) Committee for the GHGs Emissions Estimation Methods was charged with the responsibility of quantifying the uncertainty associated with Japan's inventory.

A high or low assessment of uncertainty will not negate the legitimacy of inventory, nor enable international comparisons of accuracy. It is intended to contribute to continuous development in the accuracy of a nation's inventory.

This document will be used as a guideline for uncertainty assessment for Japanese Inventories, but will be subjected to improvement as necessary.

3.2. Uncertainty Assessment Indicated in the Good Practice Guidance

3.2.1. About Uncertainty Assessment

3.2.1.1. What is uncertainty?

- Uncertainty is a concept that is much broader than that of accuracy as it relates to discrepancies in measurements. The term refers to the degree of deviation from a true value, or from the representational reliability of a measurement.
- The uncertainty of emissions from a particular source is calculated by finding and applying the uncertainty associated with the source's emission factor, and the uncertainty of activity data.
- The *Good Practice Guidance* 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 (%)

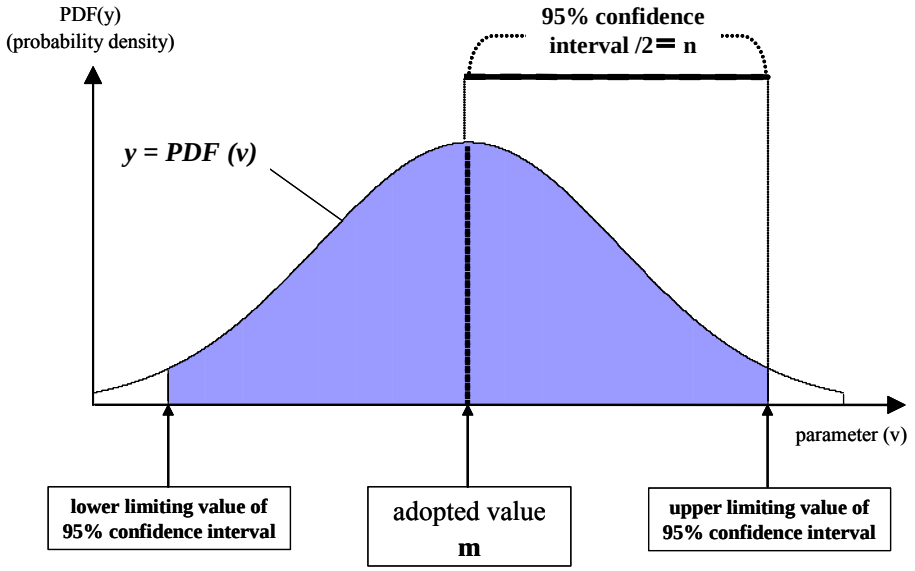
U_{EF} :Uncertainty of the emission factor (%)

U_A :Uncertainty of the activity data (%)

3.2.1.2. 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.

$$\text{Uncertainty of EF or A} = \frac{\text{95\% confidential interval / 2 (n)}}{\text{| Adopted Value of EF or A (m) |}}$$



3.2.1.3. 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* suggests two rules of expedience that relate to a method by which uncertainties may be combined (addition and multiplication). This report adopts Rule A, given in Table 6.1 of the *Good Practice Guidance*, on 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 " (%)

3.2.2. Targets of the Uncertainty Assessment

The *Good Practice Guidance* suggests that all uncertainties be taken into account when estimating emissions. It indicates that the following may be sources of uncertainty in emission factors or activity data.

Examples of common sources of uncertainty in emission factors
➢ Uncertainties associated with continuous monitoring of emissions - Uncertainties arising from differences in conditions at the time of measurement, such as measurements that are taken annually. ➢ Uncertainties associated with direct determination of emission factors - Startup and shutdown 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 can depend on load. In these cases, the estimation of total emissions and uncertainty analysis may need to be stratified to take account of load expressed, for example, as percentage of full capacity. This could be done by regression analysis and scatter plots of the emission rate against seemingly influential variables (e.g., emissions versus load) with load becoming part of the required activity data. - 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 direct determination of emission factors - The distribution of emission factors is often other than normal. When distribution is already known, it is appropriate that it be established according to expert judgment, by appending a document that provides the theoretical background.

Examples of common sources of uncertainty in activity data
➢ Interpretation of statistical differences. Statistical differences in energy balances usually represent a difference between amounts of reported primary fuels and amounts of fuels identified in the categories ‘final consumption’ and ‘in transformation’. They can give an indication of the 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 use should be commensurate with the sum by vehicle type of vehicle-km times fuel consumption efficiency. ➢ 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. This can be significant and may introduce bias into the activity data. Apparent consumption and the sum of the sectoral fuel use 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.

3.2.3. Methodology of Uncertainty Assessment

The *Good Practice Guidance* suggests that uncertainty be assessed through expert judgment and actual data in the form of emission factors, with consideration to the sources of uncertainty indicated in section above.

3.3. Methodology of Uncertainty Assessment in Japanese Inventory

3.3.1. Principle of Uncertainty Assessment

The following method of uncertainty assessment is used, with regard for both convenience and suggestions made in the *Good Practice Guidance*, in a manner that as far as possible ensures there is no deviation from assessment standards between categories or experts.

3.3.2. Separation between Emission Factors and Activity Data

The equation for estimating the level of emissions from individual sources is generally represented as follows.

$$E\ (Emissions) = EF\ (Emissions\ Factor) \times A\ (Activity\ Data)$$

There are sources of emissions, however, where emission levels 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 instances, 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:

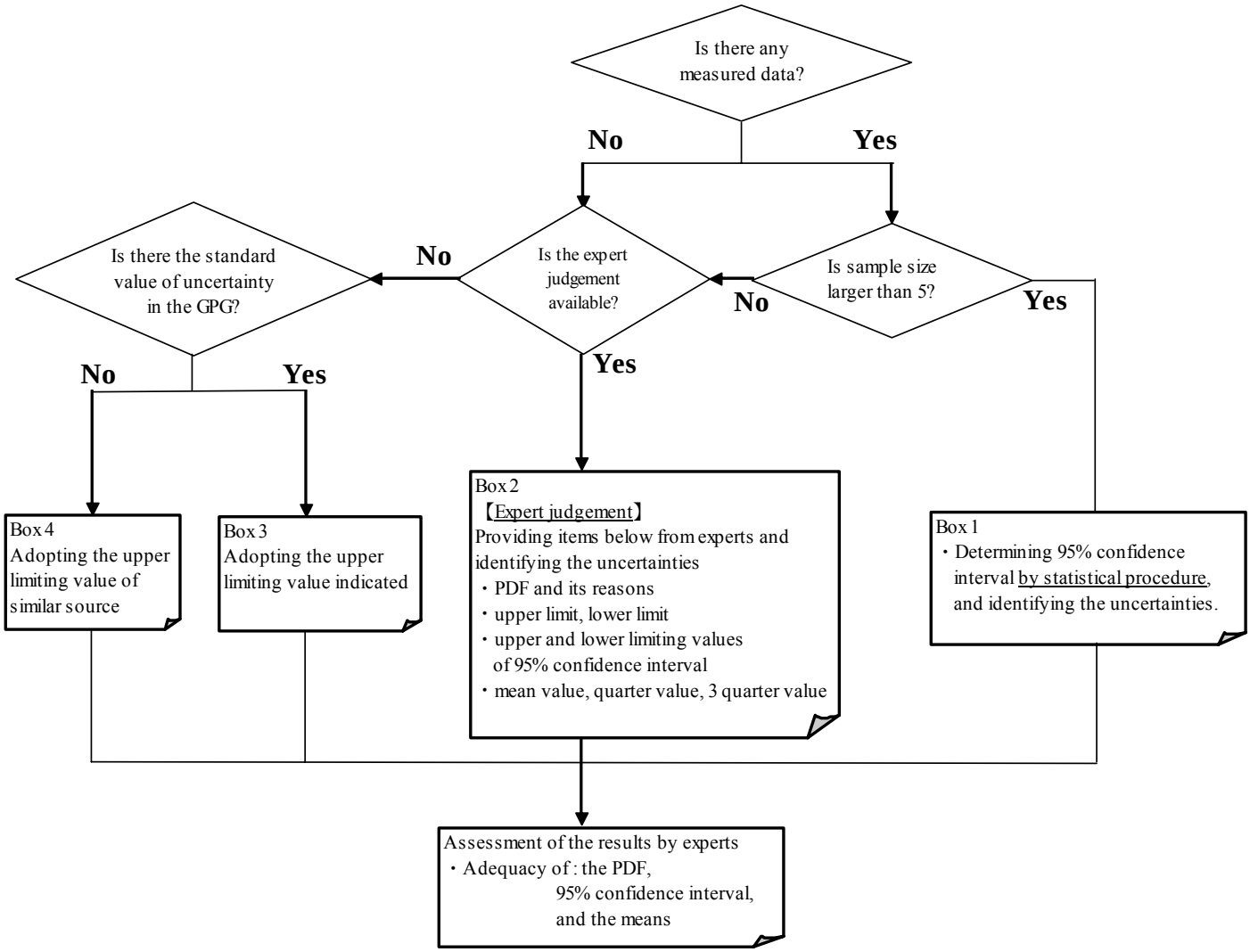
Volume of emissions from the source

= Carbon content of 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)

3.3.3. Uncertainty Assessment of Emission Factors

The uncertainty of emission factors (parameters) is assessed using the following decision tree.



* GPG: *Good Practice Guidance*
PDF: probability density function

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.

3.3.3.1. Case where there is measurement data and 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, in a manner that, as far as possible, ensures there is no deviation from assessment standards between categories, and with regard for both convenience and suggestions made in the Good Practice Guidance.

Guidelines for assessment of uncertainty associated with emission factors
Guideline 1 Where data from actual measurements is available and there are five or more samples, the central limit theorem says that the distribution of averages will follow a normal distribution curve. Assuming that all averages $\bar{x}$ and standard deviations $\sigma / \sqrt{n}$ follow a normal distribution curve, uncertainty need only be assessed on the basis of the data used to establish the emission factor. 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 future investigation. If, through expert judgment, it is possible to estimate their uncertainty, the uncertainty shall be estimated in accordance with expert judgment.

3.3.3.1.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 calculated by finding a simple average of the sample data

Where the emission factor has been calculated using a simple average, it is assumed that the data used in calculating the emission factor follows a normal distribution curve. Therefore, the standard deviation of the sample is divided by the square root of the number of samples to estimate the standard deviation of the emission factor σ_{EF}, and uncertainty is calculated by finding the 95 percent confidence interval in accordance with Equation 1.1.

[1] The *Good Practice Guidance* cites "adequate samples", but for convenience, the Secretariat of *Committee for the GHGs Estimation Methods* suggests the use of five or more.

$$\text{Uncertainty of Emission Factor (\%)} = \frac{1.96 \times \sigma_{EF}}{|\ EF\ |} \qquad (\textit{Equation 1.1})$$

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, and, 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, w_i ($\sum w_i = 1$)
Sample averages: $\overline{EF} = \sum(w_i \times EF_i)$
Unbiased variance of sample averages:
$\sigma_{EF}^2 = \sum\{ w_i \times (EF_i - \overline{EF})^2\} / (1 - \sum w_i^2) \times \sum w_i^2$

3.3.3.1.b. When the distribution of data used in calculating emission factor is to be 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 3.3.3.1.a.* 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 arrive at 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 arrive 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.

$$U = \frac{1.96 \times \sigma_{EF}}{|EF|}$$

3.3.3.2. Case where there is no actual measurement data, or there are less than five samples

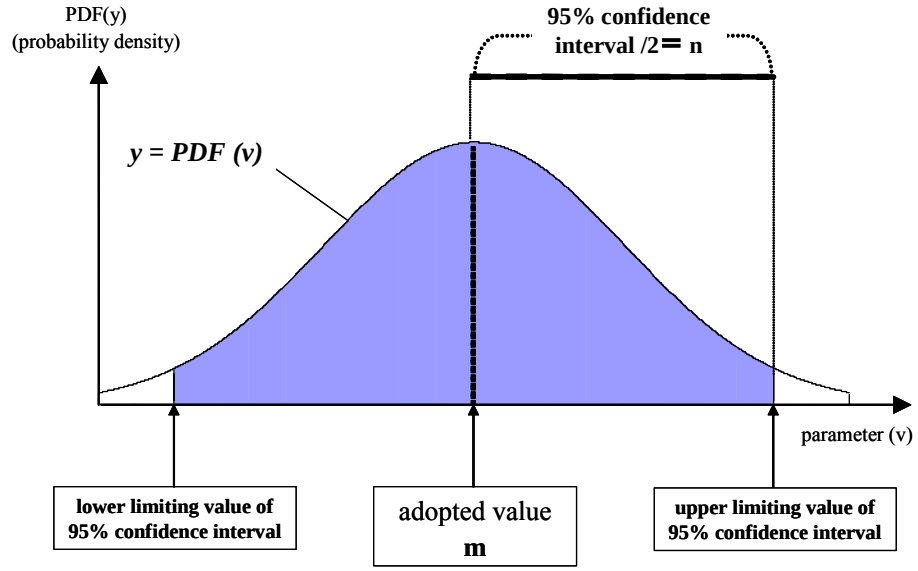
When there is no actual measurement data, or there are less than five samples, uncertainty shall be assessed by expert judgment.

3.3.3.2.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 person 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



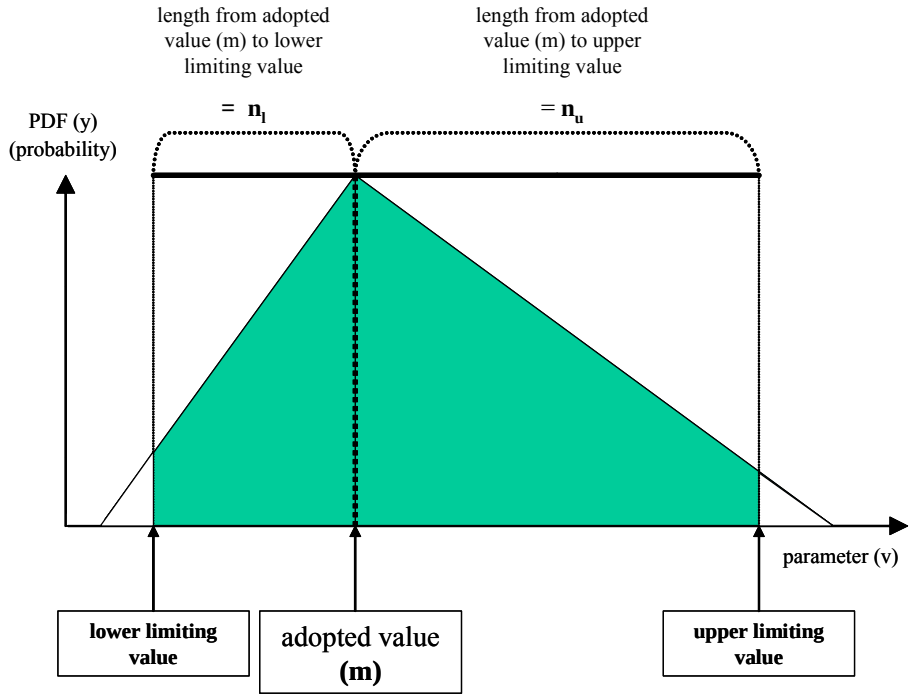
$$\text{Uncertainty of EF or A} = \frac{\text{95\% confidence interval / 2 (n)}}{\left|\text{Adopted Value of EF orA (m)}\right|}$$

2) When the distribution of the probability density function of emission factors cannot be obtained using expert judgment

Ask an expert for the upper and lower limiting values appropriate to emission factors in Japan (parameters), and draw a triangular distribution for the emission factors (parameters) with the Japanese emission factor as the vertex, and such that the upper and lower limiting values of a 95 percent confidence interval correspond to the upper and lower limiting values appropriate to the Japanese emission factor (see diagram below).

If the emission factor (parameter) used is larger than the upper limiting value, the emission factor should be used as the upper limiting value. If the emission factor (parameter) used is smaller than the lower limiting value, the emission factor (parameter) should be used as the lower limiting value.

The person 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 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.

3.3.3.2.b. When expert judgment is not possible

1) A standard value for uncertainty is provided in the *Good Practice Guidance* (Box 3)

When the *Good Practice Guidance* provides a standard value for uncertainty for a particular emission source, an estimate of uncertainty should err on the side of caution, and the upper limiting value of the standard uncertainty value given in the Good Practice Guidance should be used.

2) No standard value for uncertainty is provided in the *Good Practice Guidance* (Box 4)

When the Good Practice Guidance does not provide a standard uncertainty for a particular emission source, the standard uncertainty given in the Good Practice Guidance for a similar emission source should be used for the upper limiting value.

Category	Uncertainty of EF
1. Energy	
1A CO_2	5%
1A CH_4, N_2O	3% – 10%
1A3 Transport (CH_4, N_2O)	5%
2. Industrial Processes	
Excluding HFCs, PFCs, SF6	1% – 100%
HFCs, PFCs, SF6	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 Good Practice Guidance.

** Category 5: Changes in land use and forestry are not dealt with in the Good Practice Guidance.

3.3.3.3. Methods for Combining Uncertainties of Emission Factors

The basic method for combining uncertainties is Tier 1 in the *Good Practice Guidance*. When correlation between elements is high, uncertainties may be combined using the Monte Carlo method (Tier 2 in the *Good Practice Guidance*).

3.3.3.3.a. Emission factor uncertainty derived from a combination of multiple parameters

The uncertainty of an emission factor may be arrived at from the uncertainty of multiple parameters using the equation given below, in situations of the type described in the example on page 3.3.

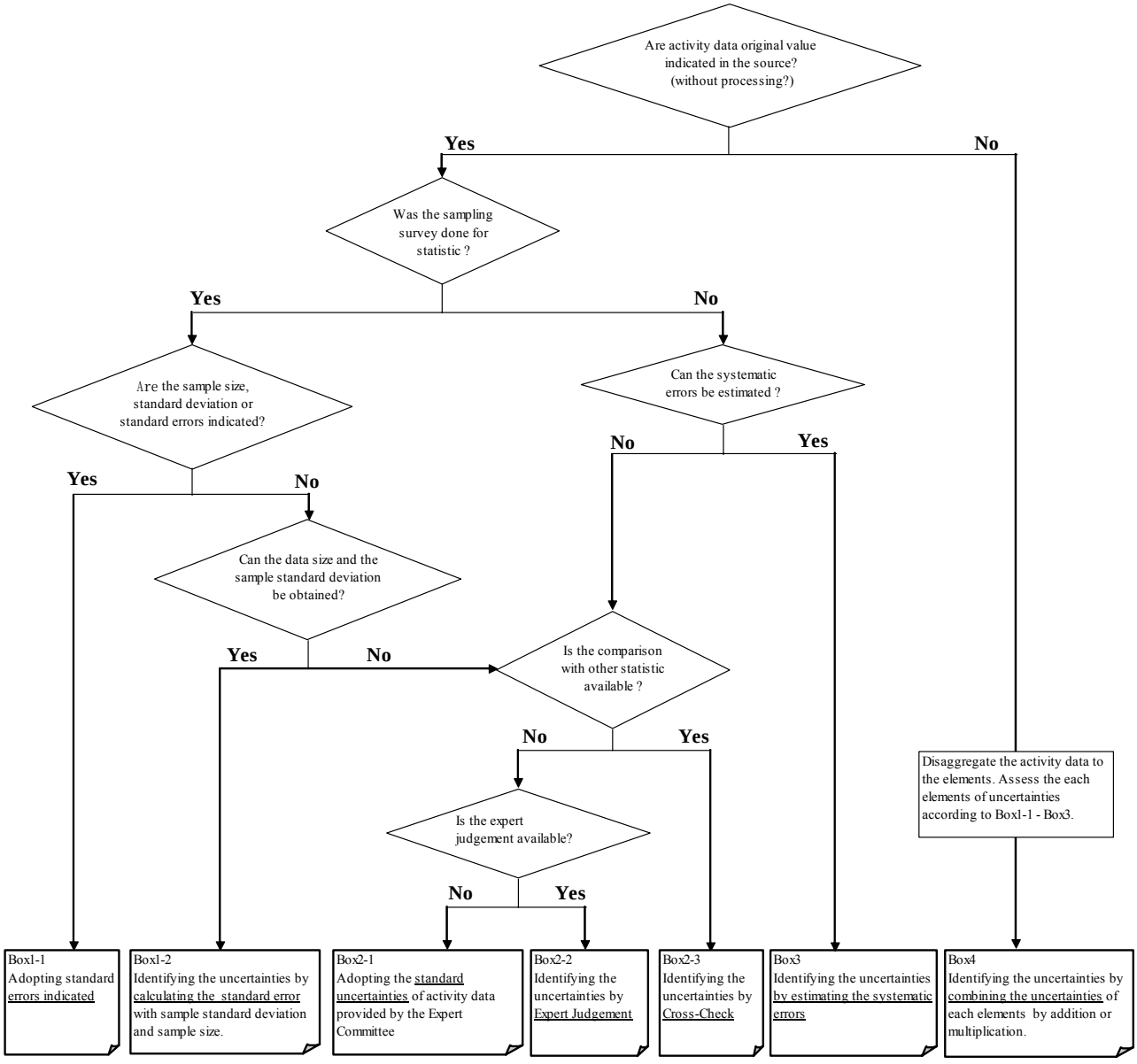
$$U_{EF} = \sqrt{U_1^2 + U_2^2 + \cdots + U_n^2}$$

U_{EF} : Uncertainties of Emission Factors (%)

Ui : Uncertainties of Parameter “i” (%)

3.3.4. Uncertainty Assessment of Activity Data

The uncertainty of activity data is assessed in accordance with the decision tree depicted below.



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. 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.

3.3.4.1. Using statistical values for activity data

When using statistical values for activity data, uncertainty should be quantitatively assessed in accordance with the following guidelines, in a manner that as far as possible ensures there is no deviation from assessment standards between categories, and with due regard for both convenience and the suggestions given in the Good Practice Guidance.

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 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 systemic error, uncertainty should be assessed through crosschecks, or by expert judgment. Guideline 4 Where quantitative assessment is difficult, matters that would contribute to uncertainty should be recorded for future investigation.

3.3.4.1.a. Statistical values based on a sample survey

1) The publisher has made public the errors (Box 1-1)

When the publisher of a statistical document has made public the sampling errors in the sample survey, it should be used as the uncertainty of the activity data.

2) The publisher has not made the error public (Box 1-2)

Enquire the publisher of the statistical document of 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.

$$\text{Uncertainty } U = (1.96 \times s / \sqrt{n}) / X_{ad}$$

X_{ad}: Sample average s: Standard deviation of sample n: Number of items of data

If, however, distribution is asymmetrical, the uncertainty U 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}.

Confirmation of the method used to estimate figures for Japan from values drawn from the sample survey and, as far as possible, estimation of the uncertainty associated with the estimate should be done also (e.g., multiply the sample average of stock 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 are 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*.

Uncertainty $U = (1.96 \times \boldsymbol{s}) / X_{ap}$

X_{ap}: Value used for activity data
s: Standard deviation (data to be cross-checked)

If, however, 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 only one other statistical value, assessment should be done using the same method described at 2) in *Section 3.3.3.2*.

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 *Appendix 3.11*) 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 person 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* and other material. Statistics other than designated statistics have been deemed to be twice the designated statistics.

3.3.4.1.b. Statistical values not based on a sample survey

1) Systemic error can be estimated (Box 3)

Where systemic error can be estimated, it should be estimated and used. The method by which 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.

3) Systemic error cannot be estimated, crosschecking is not possible, and expert judgment is available (Box 2-2)

Same as for 4) on the previous page, where amount of data and sample standard deviation are not available, and expert judgment is available (Box 2-2).

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 (no 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.

3.3.4.2. Using statistical values dressed up as activity data (Box 3)

3.3.4.2.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 *3.3.4.1. Using statistical values for activity data*.

In the example above, for elements based on survey research, such as the figure 20%, uncertainty should be assessed on the basis of the method shown at section *3.3.3. Uncertainty Assessment of Emission Factors*.

[2] Environmental Agency, *The Estimation of CO2 Emission in Japan*, 1992

3.3.4.2.b. Combining elements

Combine each table using the sum and product methods of combination, and assess uncertainty.

- ***Sum method (Rule A): Where uncertainty quantities are to be combined by addition.***

  Activity data is expressed as A1＋A2

$$U_{A\text{-}total} = \frac{\sqrt{(U_{A1}\times A_1)^2 + (U_{A2}\times A_2)^2}}{A_1 + A_2}$$

U_{An} : Uncertainty of element An (%)

- ***Product method (Rule B): Where uncertainty quantities are to be combined by multiplication.***

  Activity data is expressed as A 1×A2

$$U_A = \sqrt{U_{A1}^2 + U_{A2}^2}$$

U_{An} : Uncertainty of element An (%)

3.3.5. Uncertainty Assessment of Emissions

3.3.5.1. 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 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_{Ei} : Uncertainty of element An (%)

U_{Ei} : Uncertainty of element An (%)

2) Actual measurements taken of emissions

When emissions are actually being measured, uncertainty of emissions should be assessed directly, in accordance with *3.3.3. Uncertainty Assessment of Emission Factors*.

3.3.5.2. 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*.

$$U_{total} = \frac{\sqrt{(U_1 \times E_1)^2 + (U_2 \times E_2)^2 + \cdots + (U_n \times E_n)^2}}{E_1 + E_2 + \cdots + E_n}$$

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. Do not combine the uncertainties of both emission factor and activity data.

Appendix 4. Results of Uncertainty Assessment

4.1. Assumption of Uncertainty Assessment

Uncertainty Assessment is conducted with the assumption which uncertainties of each source's emissions in FY2001 are equal to the results of uncertainty assessment in Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods in 2002.

4.2. Uncertainty of Japan's Total Emissions in FY2001

Fiscal 2001 total emissions in Japan were approximately 1.29 billion tons (carbon dioxide equivalents), and uncertainty of total emissions has been assessed at 2%.

Table 1 Uncertainty of Japan's Total Emissions in FY2001

IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	[%]	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (CO2)	CO2	1,138,559.2	87.6%	2%	9	1.88%	1
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	2,954.8	0.2%	46%	2	0.10%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	6,876.5	0.5%	163%	1	0.86%	2
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	1,149.3	0.1%	16%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	52,068.9	4.0%	4%	8	0.14%	6
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	30,061.3	2.3%	34%	3	0.78%	4
3. Solvent & other Product Use	N2O	343.6	0.0%	5%	7	0.00%	9
4. Agriculture	CH4、N2O	33,848.2	2.6%	18%	5	0.48%	5
6. Waste	CO2、CH4、N2O	33,581.0	2.6%	32%	4	0.82%	3
Total Emissions	(D)	1,299,442.9	100.0%	(E) **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 Tables 3 and follows.

4.3. Sources have high contributing to the uncertainty of total emissions

"The proportion of total emissions accounted for by the uncertainty of each emission source" (hereafter, "degree of contribution") is useful for looking at the degree to which the uncertainties of emissions from individual sources contribute to the uncertainty of total emissions. Table 2 ranks the top 20 sources with a high degree of contribution to uncertainty of total emissions.

The result of uncertainty assessment, by sector, is as follows.

Table 2 Sources with a high degree of contribution to uncertainty of total emissions (top 20)

#	IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
#3	1A. Fuel Combustion - Solid Fuels - Steam Coal (imported)	CO2	205,469.4	0.5%	6.8%	7%	144	1.07%	**1**
#12	1A. Fuel Combustion - Liquid Fuels - Gasoline	CO2	138,644.4	0.6%	8.5%	9%	138	0.91%	**2**
#31	1A. Fuel Combustion (Transport) - a. Civil Aviation	N2O	106.9	10000.0%	5.0%	10000%	**1**	0.82%	**3**
#25	1A. Fuel Combustion - Gaseous Fuels - LNG	CO2	104,985.8	2.3%	9.3%	10%	134	0.77%	**4**
#70	2. Industrial Processes - E. Production of F-gas - 1. By-product Emissions (HCFC-22)	HFCs	9,336.6	100.0%	5.0%	100%	42	0.72%	**5**
#159	6. Waste - C. Waste Incineration - Industrial Solid Waste	CO2	11,680.8	—	—	71%	59	0.64%	6
#16	1A. Fuel Combustion - Liquid Fuels - Diesel Oil or Gas Oil	CO2	109,437.0	0.4%	5.8%	6%	146	0.49%	7
#5	1A. Fuel Combustion - Solid Fuels - Coke	CO2	63,537.0	5.0%	8.2%	10%	133	0.47%	8
#156	6. Waste - C. Waste Incineration - Municipal Solid Waste	CO2	12,825.0	11.2%	44.8%	46%	94	0.46%	9
#19	1A. Fuel Combustion - Liquid Fuels - Heating Oil C	CO2	87,974.3	0.5%	4.3%	4%	158	0.30%	10
#15	1A. Fuel Combustion - Liquid Fuels - Kerosene	CO2	70,443.9	0.2%	5.2%	5%	152	0.28%	11
#27	1A. Fuel Combustion - Gaseous Fuels - Town Gas*	CO2	54,695.8	5.0%	3.9%	6%	145	0.27%	12
#33	1A. Fuel Combustion (Transport) - b. Road Transportation	N2O	6,350.9	50.0%	5.0%	50%	85	0.25%	13
#127	4. Agriculture - D. Agricultural Soils - 3. Indirect Emissions - N Leaching & Run-off	N2O	3,764.4	—	—	84%	52	0.24%	14
#17	1A. Fuel Combustion - Liquid Fuels - Heating Oil A	CO2	80,651.9	0.6%	3.8%	4%	160	0.24%	15
#8	1A. Fuel Combustion - Solid Fuels - Blast Furnace Gas	CO2	40,054.7	5.0%	5.0%	7%	141	0.22%	16
#120	4. Agriculture - D. Agricultural Soils - 1. Direct Soil Emissions - Synthetic Fertilizers	N2O	2,156.9	—	—	130%	26	0.22%	17
#106	4. Agriculture - B. Manure Management - Non-Dairy Cattle	N2O	3,669.7	—	—	72%	58	0.20%	18
#23	1A. Fuel Combustion - Liquid Fuels - Refinery Gas	CO2	33,599.8	1.0%	7.6%	8%	140	0.20%	19
#89	2. Industrial Processes - F. Consumption of F-gas - 6. Semiconductor Manufacture	PFCs	3,860.7	50.0%	40.0%	64%	63	0.19%	20

4.4. Energy Sector

4.4.1. Fuel Combustion (CO_2)

In assessing uncertainty in the fuel sector, difficulties were encountered using statistical methods (summing of systemic error) to calculate the uncertainty of energy consumption given in the *General Energy Statistics* and used as activity data. Therefore, the uncertainty for consumption of each type of energy has been established by adjusting the overall uncertainty of energy consumption used in calculating activity data (energy consumption before deducting naphtha, LNG, and other non-fuel components), to make it equal to the proportion of statistical error given in the *General Energy Statistics*.

Therefore it should be noted that the figures that are the results of uncertainty assessment are predicated on the foregoing.

Table 3 Results of uncertainty assessment of fuel combustion (CO_2)

IPCC Source Category			GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion	Solid Fuels	Coking Coal	CO2	25,167.6	0.9%	9.3%	9%	9	0.18%	12
		Steam Coal (imported)	CO2	101.1	1.3%	6.8%	7%	16	0.00%	26
		Steam Coal (indigenous)	CO2	205,469.4	0.5%	6.8%	7%	17	1.07%	**1**
		Hard Coal	CO2	0.0	5.0%	7.9%	9%	10	0.00%	27
		Coke	CO2	63,537.0	5.0%	8.2%	10%	6	0.47%	**5**
		Coal Tar and Coal Briquette	CO2	2,243.8	5.0%	50.9%	51%	**1**	0.09%	17
		Coke Oven Gas	CO2	28,886.1	2.2%	5.2%	6%	20	0.13%	14
		Blast Furnace Gas	CO2	40,054.7	5.0%	5.0%	7%	14	0.22%	10
		Converter Furnace Gas	CO2	6,383.1	5.0%	5.0%	7%	14	0.03%	20
	Liquid Fuels	Crude Oil	CO2	12,604.9	0.9%	9.3%	9%	8	0.09%	16
		NGL	CO2	48.5	1.7%	26.7%	27%	**2**	0.00%	25
		Gasoline	CO2	138,644.4	0.6%	8.5%	9%	11	0.91%	**2**
		Naphtha & Material Oil	CO2	174.0	0.5%	21.1%	21%	**4**	0.00%	23
		Jet Fuel	CO2	12,317.2	0.6%	8.1%	8%	12	0.08%	18
		Kerosene	CO2	70,443.9	0.2%	5.2%	5%	23	0.28%	7
		Diesel Oil or Gas Oil	CO2	109,437.0	0.4%	5.8%	6%	19	0.49%	**4**
		Heating Oil A	CO2	80,651.9	0.6%	3.8%	4%	27	0.24%	9
		Heating Oil B	CO2	474.3	5.0%	0.0%	5%	24	0.00%	24
		Heating Oil C	CO2	87,974.3	0.5%	4.3%	4%	25	0.30%	6
		Lubricating Oil	CO2	156.6	5.0%	24.2%	25%	**3**	0.00%	22
		Oil Coke & Galvanic Furnace Gas	CO2	13,105.5	0.3%	4.1%	4%	26	0.04%	19
		LPG	CO2	37,722.5	3.7%	4.1%	6%	21	0.16%	13
		Refinery Gas	CO2	33,599.8	1.0%	7.6%	8%	13	0.20%	11
		Other Oil Products	CO2	7,689.7	5.0%	19.5%	20%	**5**	0.12%	15
	Gaseous Fuels	LNG	CO2	104,985.8	2.3%	9.3%	10%	7	0.77%	**3**
		NG	CO2	1,990.3	0.7%	5.4%	5%	22	0.01%	21
		Town Gas*	CO2	54,695.8	5.0%	3.9%	6%	18	0.27%	8
	Sub Total			1,138,559.2			2%		1.88%	
Total Emissions			(D)	1,299,442.9			2%			

* Reported in Gaseous Fuels according to the main material; LNG

1) $B = \sqrt{a^2 + b^2}$ Hereafter, the same method for calculating uncertainty assessment has been used in each sector appearing in Tables 4 and follows.

4.4.2. Stationary Combustion (CH_4 and N_2O)

Table 4 Results of uncertainty assessment of stationary combustion (CH_4 and N_2O)

IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (Stationary)	CH4	307.3	—	—	21%	2	0.01%	2
	N2O	2,647.5	—	—	51%	1	0.10%	1
Sub Total		2,954.8			46%		0.10%	
Total Emissions	(D)	1,299,442.9			2%			

2) ― indicates that it is not possible to calculate the uncertainty of an emission factor or activity data for this category, because it is a total of emissions of greenhouse gases from smaller, multiple sources.

4.4.3. Mobile Combustion (CH_4 and N_2O)

Table 5 Results of uncertainty assessment of mobile combustion (CH_4 and N_2O)

IPCC Source Category		GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A.Fuel Combustion (Transport)	a. Civil Aviation	CH4	4.2	200.0%	5.0%	200%	**4**	0.00%	7
		N2O	106.9	10000.0%	5.0%	10000%	**1**	0.82%	**1**
	b. Road Transportation	CH4	180.2	40.0%	5.0%	40%	6	0.01%	**4**
		N2O	6,350.9	50.0%	5.0%	50%	**5**	0.25%	**2**
	c. Railways	CH4	0.8	5.0%	10.0%	11%	7	0.00%	8
		N2O	88.0	5.0%	10.0%	11%	7	0.00%	6
	d. Navigation	CH4	27.8	200.0%	16.1%	201%	**3**	0.00%	**5**
		N2O	117.7	1000.0%	16.1%	1000%	**2**	0.09%	**3**
	Sub Total		6,876.5			163%		0.86%	
Total Emissions		(D)	1,299,442.9			2%			

N.B. Carbon dioxide emissions from the transport sector have been included in Table 3.

4.4.4. Fugitive Emissions from Fuel

The uncertainty calculated for the fuel sector has been used as the uncertainty of activity data for refining and storage of crude oil and natural gas liquids (NGL), and supply of natural gas (town gas production). That uncertainty has been calculated on the basis of the results of allocating equally to each fuel type the overall uncertainty in the Energy Balance Table.

Table 6 Results of uncertainty assessment of fugitive emissions from fuel

IPCC Source Category					GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1B. Fugitive Emissions from Fuels	1. Solid Fuels	a. Coal Mining	i. Underground Mines	Mining Activities	CH4	602.6	–	–	5%	19	0.00%	**4**
				Post-Mining Activities	CH4	87.2	200.0%	5.0%	200%	**1**	0.01%	**1**
			ii. Surface Mines	Mining Activities	CH4	11.0	200.0%	5.0%	200%	**1**	0.00%	**5**
				Post-Mining Activities	CH4	1.0	200.0%	5.0%	200%	**1**	0.00%	10
	2. Oil and Natural Gas	a. Oil		i. Exploration	CO2	0.0	–	–	27%	6	0.00%	16
					CH4	0.0	–	–	27%	**5**	0.00%	15
					N2O	0.0	–	–	27%	**4**	0.00%	19
				ii. Production	CO2	0.2	–	–	25%	13	0.00%	13
					CH4	22.7	–	–	25%	14	0.00%	6
				iii. Transport	CO2	0.0	25.0%	5.0%	25%	9	0.00%	18
					CH4	0.4	25.0%	5.0%	25%	9	0.00%	11
				iv. Refining / Storage	CH4	16.1	–	–	26%	8	0.00%	9
		b. Natural Gas		i. Production / Processing	CO2	0.3	–	–	21%	15	0.00%	12
					CH4	189.5	–	–	20%	16	0.00%	**2**
				ii. Transmission	CO2	0.1	–	–	19%	18	0.00%	14
					CH4	178.9	–	–	20%	17	0.00%	**3**
				Distribution	CH4	18.1	25.0%	8.7%	26%	7	0.00%	8
		c. Venting and Flaring		Venting i. oil	CO2	0.0	25.0%	5.0%	25%	9	0.00%	17
					CH4	21.3	25.0%	5.0%	25%	9	0.00%	7
	Sub Total					1,149.3			16%		0.01%	
Total Emissions					(D)	1,299,442.9			2%			

4.5. Industrial Processes

4.5.1. Non-F-gas

For emissions sources for which there is actual data available for emission factors, the emission factor dataset is deemed to be a sample of the total dataset, and uncertainty assessment is achieved statistically. It is not a synthesis of the uncertainties of measured error of emissions from each operating site.

Table 7 Results of uncertainty assessment of industrial processes (Non-F-gas)

IPCC Source Category				GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
2. Industrial Processes	A. Mineral Products	1. Cement Production		CO2	32,520.4	1.6%	5.2%	5%	8	0.14%	**1**
		2. Lime Production		CO2	4,238.2	—	—	5%	9	0.02%	**4**
		3. Limestone & Dolomite Use		CO2	10,616.4	—	—	5%	11	0.04%	**2**
	B. Chemical Industries	1. Ammonia Production		CO2	3,011.0	—	—	4%	12	0.01%	6
		2. Nitric Acid Production		N2O	722.9	46.0%	5.0%	46%	7	0.03%	**3**
		3. Adipic Acid Production		N2O	622.6	—	—	5%	10	0.00%	8
		5. Other	Carbon Black	CH4	5.5	54.8%	5.0%	55%	6	0.00%	9
			Ethylene	CH4	2.3	77.2%	5.0%	77%	**3**	0.00%	11
				CO2	206.1	77.2%	5.0%	77%	**3**	0.01%	**5**
			Dichloroethylene	CH4	0.3	100.7%	5.0%	101%	**2**	0.00%	12
			Styrene	CH4	2.0	113.2%	5.0%	113%	**1**	0.00%	10
			Coke	CH4	121.4	—	—	57%	**5**	0.01%	7
	Sub Total				52,068.9			4%		0.14%	
Total Emissions				(D)	1,299,442.9			2%			

4.5.2. F-gas

Table 8 Results of uncertainty assessment of industrial processes (F-gas)

IPCC Source Category					GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
2. Industrial Processes (F-gas)	C. Metal Production	3. Aluminium			PFCs	15.7	33.0%	5.0%	33%	27	0.00%	21
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	9,336.6	100.0%	5.0%	100%	**4**	0.72%	**1**
		2. Fugitive Emissions			HFCs	328.0	100.0%	10.0%	100%	**1**	0.03%	10
					PFCs	1,124.0	100.0%	10.0%	100%	**1**	0.09%	**4**
					SF6	788.7	100.0%	10.0%	100%	**1**	0.06%	8
	F. Consumption of F-gas	1. Refrigeration and Air Conditioning Equipment	Domestic Refrigerator	manufacturing	HFCs	71.7	50.0%	40.0%	64%	6	0.00%	18
				stock	HFCs	IE	50.0%	40.0%	64%	6	0.00%	22
				disposal	HFCs	IE	—	40.0%	40%	20	0.00%	22
			Commercial Refrigerator	manufacturing	HFCs	81.3	50.0%	40.0%	64%	6	0.00%	17
				stock	HFCs	IE	50.0%	40.0%	64%	6	0.00%	22
				disposal	HFCs	0.0	—	40.0%	40%	20	0.00%	22
			Stationary Air-Conditioning	manufacturing	HFCs	141.5	50.0%	40.0%	64%	6	0.01%	14
				stock	HFCs	56.9	50.0%	40.0%	64%	6	0.00%	19
			Mobile Air-Conditioning	manufacturing	HFCs	51.7	50.0%	40.0%	64%	6	0.00%	20
				stock	HFCs	1,702.7	50.0%	40.0%	64%	6	0.08%	**5**
				disposal	HFCs	503.8	—	40.0%	40%	20	0.02%	13
		2. Foam Blowing		manufacturing	HFCs	412.3	50.0%	50.0%	71%	**5**	0.02%	12
		4. Aerosols / MDI		stock/disposal	HFCs	2,697.1	—	40.0%	40%	20	0.08%	7
		5. Solvents			PFCs	4,928.5	—	40.0%	40%	20	0.15%	**3**
		6. Semiconductor Manufacture			HFCs	115.3	50.0%	40.0%	64%	6	0.01%	15
					PFCs	3,860.7	50.0%	40.0%	64%	6	0.19%	**2**
					SF6	1,689.5	50.0%	40.0%	64%	6	0.08%	6
		7. Electrical Equipment		manufacturing	SF6	1,577.4	30.0%	40.0%	50%	19	0.06%	9
				stock	SF6	478.0	50.0%	40.0%	64%	6	0.02%	11
				Maintenance	SF6	IE	—	40.0%	40%	20	0.00%	22
				disposal	SF6	IE	—	40.0%	40%	20	0.00%	22
		8. Other (for Studies etc.)			HFCs	100.0	50.0%	40.0%	64%	6	0.00%	16
	Sub Total					30,061.3			34%		0.78%	
Total Emissions					(D)	1,299,442.9			2%			

4.6. Solvents and Other Product Use

Table 9 Results of uncertainty assessment of solvent and other product use

IPCC Source Category			GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
3. Solvent and Other Product Use	D. Other	Anaesthesia	N2O	343.6	—	5.0%	5%	1	0.00%	1
	Sub Total			343.6			5%		0.00%	
Total Emissions			(D)	1,299,442.9			2%			

4.7. Agriculture

Table 10 Results of uncertainty assessment of Agriculture

IPCC Source Category				GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
4. Agriculture	A. Enteric Fermentation	Dairy Cattle		CH4	3,269.3	—	—	19%	49	0.05%	11
		Non-Dairy Cattle		CH4	3,206.8	—	—	22%	48	0.05%	10
		Sheep		CH4	1.0	50.0%	4.9%	50%	41	0.00%	43
		Goat		CH4	3.0	50.0%	4.9%	50%	41	0.00%	38
		Swine		CH4	222.7	50.0%	4.9%	50%	41	0.01%	22
		Horse		CH4	9.5	50.0%	4.9%	50%	41	0.00%	33
	B. Manure Management	Dairy Cattle		CH4	314.5	—	—	164%	15	0.04%	12
				N2O	2,143.4	—	—	60%	38	0.10%	6
		Non-Dairy Cattle		CH4	190.9	—	—	215%	**5**	0.03%	14
				N2O	3,669.7	—	—	72%	34	0.20%	**3**
		Swine		CH4	187.5	—	—	147%	16	0.02%	18
				N2O	3,343.6	—	—	65%	36	0.17%	**4**
		Hen		CH4	80.2	—	—	230%	**4**	0.01%	21
				N2O	1,173.1	—	—	80%	33	0.07%	8
		Broiler		CH4	145.5	—	—	233%	**3**	0.03%	16
				N2O	1,567.4	—	—	101%	22	0.12%	**5**
		Sheep		CH4	0.1	100.0%	4.9%	100%	23	0.00%	47
		Goat		CH4	0.1	100.0%	4.9%	100%	23	0.00%	46
		Horse		CH4	1.1	100.0%	4.9%	100%	23	0.00%	39
	C. Rice Cultivation	Continuously Flooded		CH4	264.7	115.3%	7.6%	116%	19	0.02%	17
		Intermittently Flooded	Straw amendment	CH4	3,843.7	—	—	32%	47	0.09%	7
			Various compost amendment	CH4	999.3	—	—	46%	45	0.04%	13
			No-amendment	CH4	799.4	—	—	32%	46	0.02%	19
	D. Agricultural Soils	1. Direct Soil Emissions	Synthetic Fertilizers	N2O	2,156.9	—	—	130%	17	0.22%	**2**
			Animal Waste Applied to Soils	N2O	1,440.6	—	—	55%	39	0.06%	9
			Crop Residue	N2O	NE	—	—	396%	**2**	0.00%	48
			Cultivation Histosols	N2O	NE	—	—	769%	**1**	0.00%	48
		2. Animal Production		CH4	2.3	114.4%	10.0%	115%	20	0.00%	35
				N2O	4.6	116.0%	10.0%	116%	18	0.00%	29
		3. Indirect Emissions	Atmospheric Deposition	N2O	769.4	—	—	52%	40	0.03%	15
			N Leaching & Run-off	N2O	3,764.4	—	—	84%	30	0.24%	**1**
	F. Field Burning of Agricultural Residue	1. Cereals	Rice	CH4	86.1	—	—	62%	37	0.00%	23
				N2O	107.9	—	—	202%	13	0.02%	20
			Wheat etc.	CH4	4.7	100.9%	50.0%	113%	21	0.00%	30
				N2O	10.0	198.7%	50.0%	205%	12	0.00%	26
			Maize	CH4	26.0	78.0%	50.0%	93%	26	0.00%	24
				N2O	10.9	204.7%	50.0%	211%	6	0.00%	25
		2. Pulse	Peas	CH4	0.3	78.0%	20.0%	81%	31	0.00%	45
				N2O	0.2	204.7%	20.0%	206%	10	0.00%	44
			Soybeans	CH4	2.2	78.0%	50.0%	93%	26	0.00%	37
				N2O	2.7	204.7%	50.0%	211%	6	0.00%	28
			Other	CH4	1.2	—	—	70%	35	0.00%	40
				N2O	1.4	—	—	168%	14	0.00%	36
		3. Tuber & Roots	Potatoes	CH4	3.7	78.0%	20.0%	81%	31	0.00%	34
				N2O	2.4	204.7%	20.0%	206%	10	0.00%	32
			Other: Sugarbeet	CH4	0.8	78.0%	50.0%	93%	26	0.00%	41
				N2O	0.3	204.7%	50.0%	211%	6	0.00%	42
		4. Sugar Cane		CH4	10.4	78.0%	50.0%	93%	26	0.00%	27
				N2O	2.4	204.7%	50.0%	211%	6	0.00%	31
	Sub Total				33,848.2			18%		0.48%	
Total Emissions				(D)	1,299,442.9			2%			

4.8. Waste

Table 11 Results of uncertainty assessment of Waste

IPCC Source Category				GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
6. Waste	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	Kitchen Garbage	CH4	940.5	101.3%	23.5%	104%	6	0.08%	**5**
			Paper & Textiles	CH4	1,739.1	102.6%	17.5%	104%	**5**	0.14%	**3**
			Waste Wood	CH4	1,173.3	104.3%	15.4%	105%	**4**	0.10%	**4**
	B. Wastewater Handling	1. Industrial Wastewater		CH4	308.5	100.0%	16.9%	101%	7	0.02%	9
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant	CH4	232.5	30.9%	10.0%	33%	15	0.01%	13
				N2O	624.2	145.7%	10.0%	146%	**2**	0.07%	7
			Private Sewerage Tank	CH4	426.8	—	—	60%	11	0.02%	10
				N2O	356.5	—	—	49%	12	0.01%	12
			Human-Waste Treatment Plant	CH4	29.0	91.6%	10.0%	92%	8	0.00%	14
				N2O	891.5	108.0%	10.0%	108%	**3**	0.07%	6
	C. Waste Incineration	Municipal Solid Waste		CO2	12,825.0	11.2%	44.8%	46%	13	0.46%	**2**
				CH4	11.6	—	—	89%	9	0.00%	15
				N2O	666.6	—	—	26%	16	0.01%	11
		Industrial Solid Waste		CO2	11,680.8	—	—	71%	10	0.64%	**1**
				CH4	1.0	—	—	264%	**1**	0.00%	16
				N2O	1,674.1	—	—	33%	14	0.04%	8
	Sub Total				33,581.0			32%		0.82%	
Total Emissions				(D)	1,299,442.9			2%			

4.9. Issues in Uncertainty Assessment

- Accordance with the method indicated in the *Revised 1996 IPCC Guidelines*, only emission sources for emissions which had already been calculated were the subject of uncertainty assessment. No assessment has been made of 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 composing 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 figures were derived from those established by the Committee for the GHGs Emissions Estimations Methods, which have considered whether the statistics were specified, or a total population survey, but further consideration needs to be given to 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 emission factor or activity data could, in fact, be negative. For example, carbon dioxide emissions from fuel combustion can only be positive, so further consideration would need to be given to the question of whether it is appropriate 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 Review Committee was used (the Tier 1 method given in the *Good Practice Guidance*), but when the coefficient of variation* is 30% or greater, the *Good Practice Guidance* requires the combination to be achieved using the Monte Carlo method (*Good Practice Guidance* Tier 2 method). Further consideration needs to be given to whether it is feasible to apply the Monte Carlo method to emission sources that have large coefficients of variation.
  * N.B. Coefficient of variation = Standard deviation/mean, and depicts sample dispersion.

- 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.)

Appendix 5. GHGs Emissions from International Bunkers

• ***Methodology for Estimating Emissions of GHGs***

Emissions of carbon dioxide, methane, and nitrous oxide from this source for the period from FY1990 to FY2001, are derived by multiplying the consumption of each type of fuel handled by bonds by the emission factor. (Refer to *bunker-2003.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. (Refer to Chapter 3)

-CH_4, N_2O

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

Table 1 Emission factors for methane and nitrous oxide from international bunkers

Transport mode	Type of fuel	CH_4 emission factor	N_2O emission factor
Aircraft	Jet fuel	0.002 [g CH_4/MJ] [a]	0.1 [kg N_2O/t] [b]
Shipping	Heating oil A	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]
	Heating oil B	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]
	Heating oil C	0.007 [g CH_4/MJ] [c]	0.002 [g N_2O/MJ] [c]

a. *Revised 1996 IPCC Guidelines* Vol. 3, Table 1-47
b. 〃 Table 1-52
c. 〃 Table 1-48

• ***Activity Data***

Totals for bonded imports and bonded exports given in the Ministry of Economy, Trade and Industry's *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* are used for emissions of carbon dioxide, methane, and nitrous oxide from the relevant source.

It is assumed that jet fuel is used by aircraft, while Heating oil A, B and C are used by vessels.

-CO_2

The kiloliter-based figure given in the Ministry of Economy, Trade and Industry's *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* is converted to a Joule-based figure using the standard calorific values given in the Agency for Natural Resources and Energy's *General Energy Statistics*.

-CH_4, N_2O

The *Revised 1996 IPCC Guidelines* provide a default emission factor that is based on net calorific value. Activity data in gross calorific values are converted to net calorific values by multiplying them by 0.95.

Regarding activity data of N_2O from international aviation, the *Revised 1996 IPCC Guidelines* provide a default emission factor in weight units. In order to adapt the activity data to that unit, kiloliter-based value is multiplied by the density identified by the Petroleum Association of Japan for nitrous oxide from aircraft (0.78 [g/cm^3]).

• ***Categorization of Activity Data***

A and B in the diagram below correspond to the items under bonded exports and bonded imports respectively in the Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke. C, the sum of A and B, is used as the activity data for this source of emissions. This is considered to be approximately the amount of the fuels sold in Japan for the international aviation and marine transport.

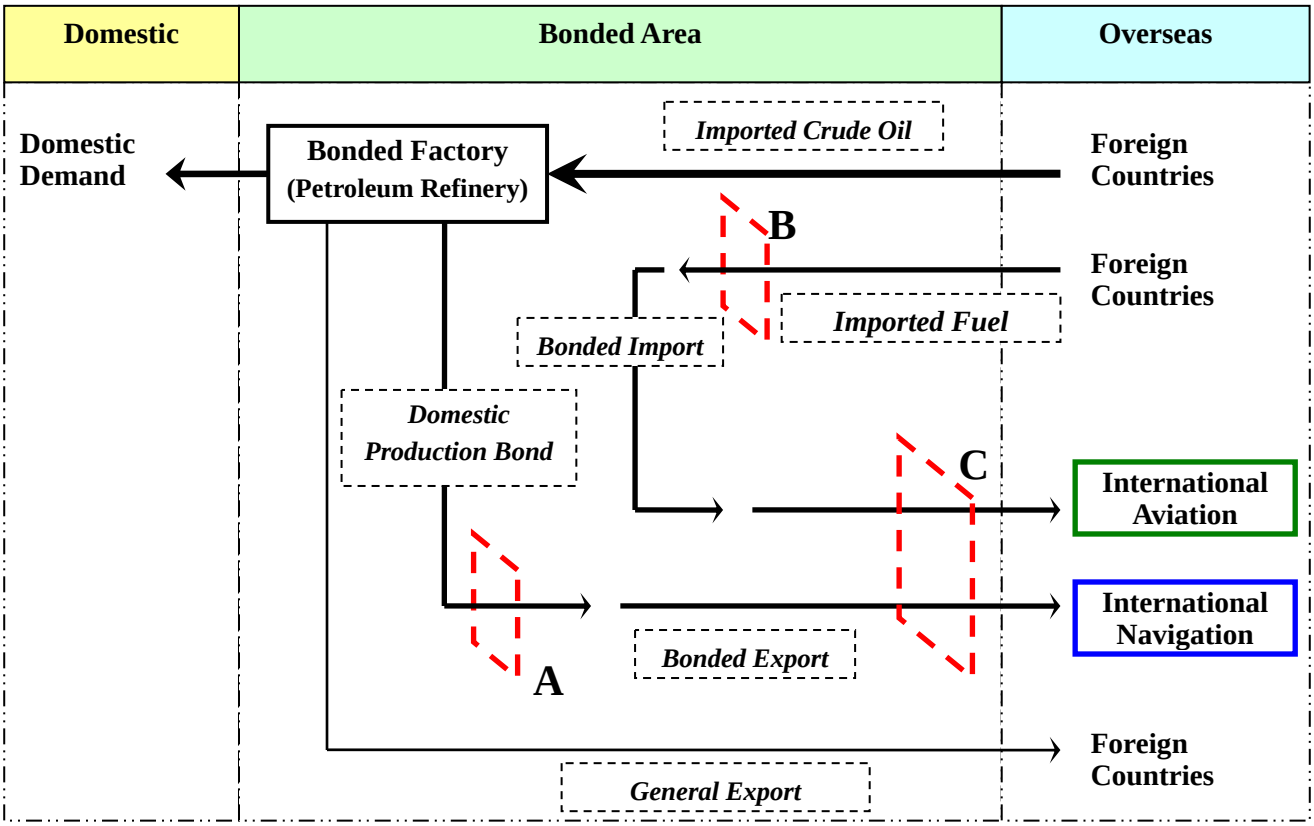


Figure 1 Activity data for international bunkers

Glossary

-Bonded Jet Fuel

Under the Tariff Law, aircraft (Japanese and non-Japanese) flying international routes are deemed to be overseas return aircraft, and the fuel they consume is tariff-free, subject to completion of the required procedures. The application of this legislation means that if fuel is refined from crude oil imported to a 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 importation tariff is waived. The foregoing is termed “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 “bonded fuel oil”.

-Bonded Export

The demand for fuel supplied to aircraft (Japanese and non-Japanese) flying international routes and ships (Japanese and non-Japanese) that ply foreign ocean routes is termed bonded demand, and aircraft are supplied with jet fuel, while ships are filled with fuel oil. Of the bonded demand, that supplied by product that has been produced from crude oil is counted by the Ministry of Economy, Trade and Industry as bonded exports.

- Bonded imports (Bond to Bond)

Product that is imported from foreign countries, landed in a bonded area, and supplied from the bonded area without going through domestic customs, is counted by the Ministry of Economy, Trade and Industry as bonded imports.

References

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, 1997

Documentation prepared by the 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*

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

Petroleum Association of Japan（http://www.paj.gr.jp/html/statis/kansan.html）

Appendix 6. Hierarchical Structure of Japanese National GHGs Inventory File System

Multiple excel files have been used when estimating Japanese inventory. The hierarchical structure of Japanese National GHGs Inventory (JNGI) files system is shown below.

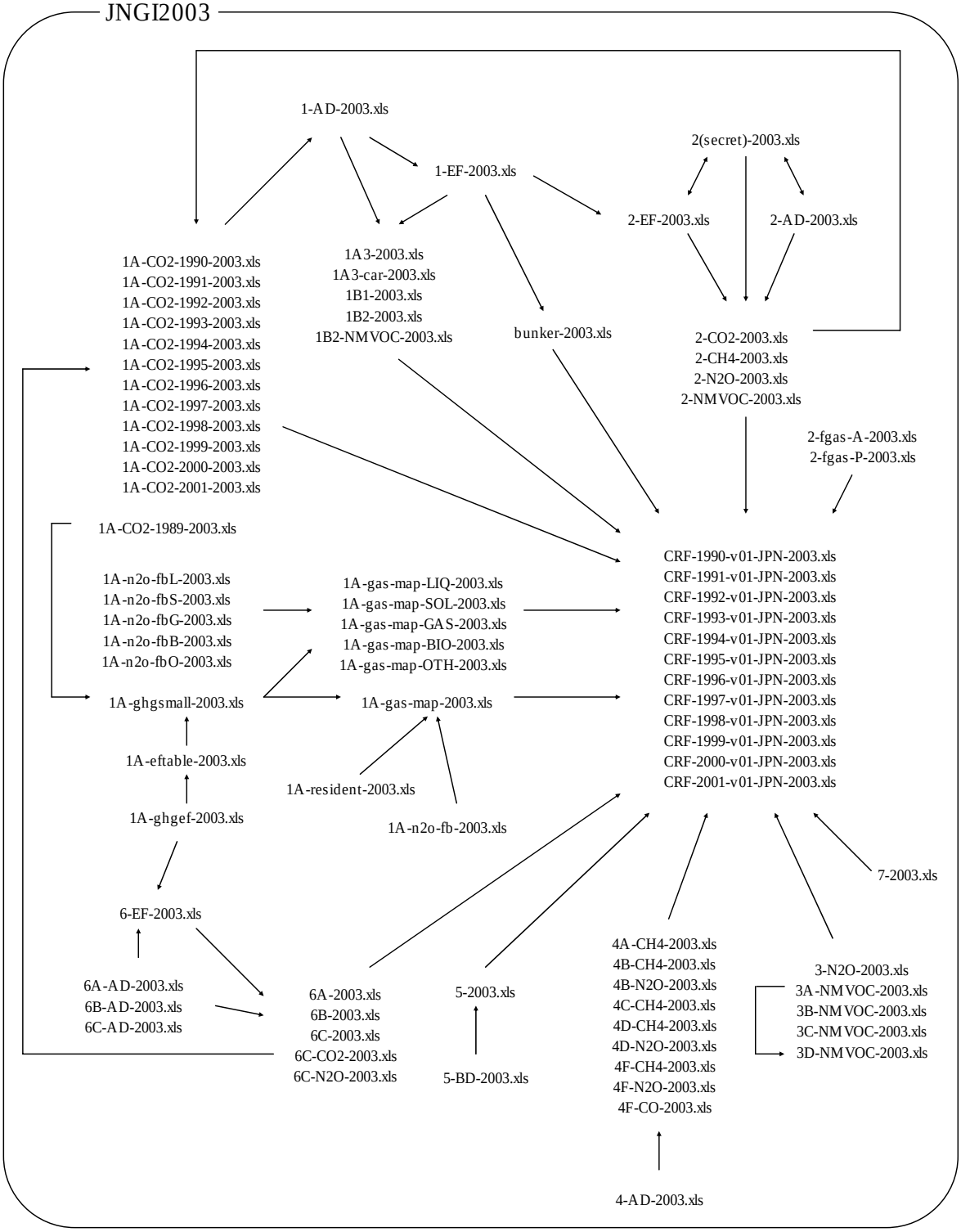


Figure 1 Hierarchical Structure of JNGI file system

Table 1 Contents of each file (part 1)

category	file name	contents
	CRF-1990-v01-JPN-2003.xls ～	Common reporting format provided by UNFCCC secretariat
1. Energy	1A3-2003.xls	GHGs emissions from transport sector (except non-CO2 from Car)
	1A3-car-2003.xls	non-CO2 emissions from car
	1A-CO2-1990-2003.xls ～ 1A-CO2-2001-2003.xls	CO2 emissions from fuel combustions at stationary facilities
	1-AD-2003.xls	Activity Data of Caotegory1 (except Energy Balance Sheet)
	1A-eftable-2003.xls	Emission Factors of Non-CO2 from stationary combustion (original data)
	1A-gas-map-2003.xls	Emissions of Non-CO2 from stationary combustion
	1A-gas-map-BIO-2003.xls	Emissions of Non-CO2 from stationary combustion (Biomass)
	1A-gas-map-GAS-2003.xls	Emissions of Non-CO2 from stationary combustion (Gaseous Fuel)
	1A-gas-map-LIQ-2003.xls	Emissions of Non-CO2 from stationary combustion (Liquid Fuel)
	1A-gas-map-OTH-2003.xls	Emissions of Non-CO2 from stationary combustion (other Fuel)
	1A-gas-map-SOL-2003.xls	Emissions of Non-CO2 from stationary combustion (Solid Fuel)
	1A-ghgef-2003.xls	Emission Factors of Non-CO2 from stationary combustion
	1A-ghgsmall-2003.xls	Emissions of Non-CO2 from Commercial and other sector
	1A-n2o-fb-2003.xls	N2O Emissions from fluidized-bed boilers
	1A-n2ofbB-2003.xls	N2O Emissions from fluidized-bed boilers (Biomass)
	1A-n2ofbG-2003.xls	N2O Emissions from fluidized-bed boilers (Gaseous Fuel)
	1A-n2ofbL-2003.xls	N2O Emissions from fluidized-bed boilers (Liquid Fuel)
	1A-n2ofbO-2003.xls	N2O Emissions from fluidized-bed boilers (other Fuel)
	1A-n2ofbS-2003.xls	N2O Emissions from fluidized-bed boilers (Solid Fuel)
	1A-resident-2003.xls	Emissions of Non-CO2 from Resident
	1B1-2003.xls	GHGs fugitive emissions from coal production
	1B2-2003.xls	GHGs fugitive emissions from oil & gas production
	1B2-NMVOC-2003.xls	NMVOC fugitive emissions from oil facilities
	1-EF-2003.xls	Emission Factors of Category1
2. Industrial Processes	2(secret)-2003.xls	Confidential Data of Category2 (Industrial Processes)
	2-AD-2003.xls	Activity Data of Caotegory2 (except F-gas)
	2-CH4-2003.xls	CH4 emissions from Category2 (Industrial Processes)
	2-CO2-2003.xls	CO2 emissions from Category2 (Industrial Processes)
	2-EF-2003.xls	Emission Factors of Category2
	2-Fgas-A-2003.xls	F-gas (HFCs, PFCs, SF6) actual emissions
	2-Fgas-P-2003.xls	F-gas (HFCs, PFCs, SF6) potential emissions
	2-N2O-2003.xls	N2O emissions from Category2 (Industrial Processes)
	2-NMVOC-2003.xls	NMVOC emissions from Category2 (Industrial Processes)
3. Solvent and Other Product Use	3A-NMVOC-2003.xls	NMVOC emissions from paint application use
	3B-NMVOC-2003.xls	NMVOC emissions from dry cleaning & Degreasing
	3C-NMVOC-2003.xls	NMVOC emissions from paint production, ink production & use, polyethylene laminate, solvent-type adhesive use and gum solvent use
	3D-NMVOC-2003.xls	NMVOC emissions from other solvent
	3-N2O-2003.xls	N2O emissions from anesthesia

Table 2 Contents of each file (part 2)

カテゴリ	ファイル名	
4. Agriculture	4A-CH4-2003.xls	CH4 emissions from enteric fermentation
	4-AD-2003.xls	Activity Data of Caotegory4
	4B-CH4-2003.xls	CH4 emissions from manure management
	4B-N2O-2003.xls	N2O emissions from manure management
	4C-CH4-2003.xls	CH4 emissions from rice cultivation
	4D-CH4-2003.xls	CH4 emissions from agricultural soils
	4D-N2O-2003.xls	N2O emissions from agricultural soils
	4F-CH4-2003.xls	CH4 emissions from field burning of agricultural residues
	4F-CO-2003.xls	CO emissions from field burning of agricultural residues
	4F-N2O-2003.xls	N2O emissions from field burning of agricultural residues
5. LUCF	5-2003.xls	GHGs emissions/removals from/by Category5
	5-BD-2003.xls	Backdata (activity data, parameters etc.) of Category5
6. Waste	6A-2003.xls	GHGs emissions from solid waste disposal on land
	6A-AD-2003.xls	Activity data of solid waste disposal on land
	6B-2003.xls	GHGs emissions from wastewater handling
	6B-AD-2003.xls	Activity data of wastewater handling
	6C-2003.xls	GHGs emissions from waste incineration (exclude CO2, N2O)
	6C-AD-2003.xls	Activity data of waste incineration
	6C-CO2-2003.xls	CO2 emissions from waste incineration
	6C-N2O-2003.xls	N2O emissions from waste incineration
	6-EF-2003.xls	Emission Factors of Category6
7. Other	7-2003.xls	CO Emissions from tobaccos
	bunker-2003.xls	GHGs emissions from bunker fuels

Appendix 7. National Greenhouse Gas Emissions in Fiscal Year 2001 (for the Kyoto Protocol)

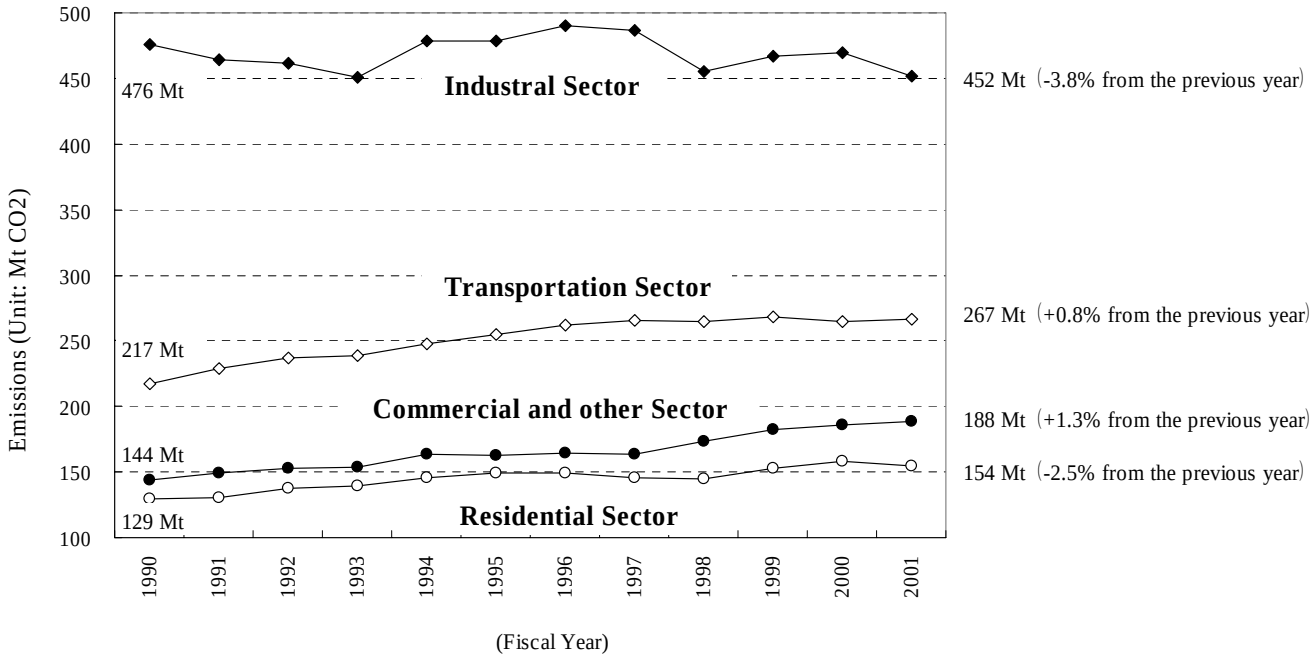
In this appendix, to review the achievement of Japan's commitment of the Kyoto Protocol (6% reduction on the base year[1] [1990 for CO_2, CH_4 and N_2O, while 1995 for HFCs, PFCs and SF_6]), national total greenhouse gas emissions without LUCF sector is expressed. CO_2 emissions from power generation and heat generation (industrial steam generation and district heat supply) are allocated to the sector consuming the electricity and heat in order to review the progress of countermeasures against global warming issues.

Summary

- Total greenhouse gas emission in fiscal 2001 was 1,299 million tons (in CO_2 equivalents)[2] .
- The figure shows a 2.5% decrease over the previous year's level.
- As compared to that of the base year under the Kyoto Protocol (in principle: 1990), it increased by 5.2%

Sectoral breakdown of Carbon Dioxide (CO_2) emissions which accounts for more than 90% of the total greenhouse gas emissions is as follows.

<Industrial Sector>	decrease of 5.1% over fiscal 1990
<Transportation Sector>	increase of 22.8% over fiscal 1990
<Commercial and other Sector>	increase of 30.9% over fiscal 1990
<Residential Sector>	increase of 19.4% over fiscal 1990



[1] The base year of emissions of HFCs, PFCs and SF_6 could be available to set up the year for 1995 in accordance with Article 3, paragraph 8 of the Kyoto Protocol.

[2] This values are provisional and subject to change in accordance with the future revision of calculation methods.

7.1. National Total Greenhouse Gas Emissions

The total emissions of greenhouse gases (calculated by multiplying each greenhouse gas emissions by Global Warming Potential (GWP)[*1], and adding them up) in fiscal year 2001 is 1,299 million tons of carbon dioxide equivalents. It has increased by 5.2% compared with the total emissions (1,235 million tons) of the base year under the Kyoto Protocol (1990 for CO_2, CH_4 and N_2O, while 1995 for HFCs, PFCs and SF_6)[*2] and decreased by 2.5% from the previous year.

Table 1 Trends in Emissions of Greenhouse Gases

[Mt CO2 eq.]

	GWP	Base year of KP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO2	1	1,122.1	1,122.1	1,131.2	1,148.7	1,140.4	1,200.2	1,210.9	1,231.2	1,226.8	1,195.0	1,228.2	1,238.7	1,213.7
CH4	21	24.7	24.7	24.6	24.5	24.4	24.0	23.3	22.9	22.1	21.5	21.3	20.9	20.3
N2O	310	40.2	40.2	39.7	39.9	39.7	40.6	40.8	41.7	42.2	40.8	35.1	37.8	35.4
HFCs	HFC-134a：1,300 etc.	20.0						20.0	19.6	19.6	19.0	19.5	18.3	15.6
PFCs	PFC-14：6,500 etc.	11.5						11.5	11.3	14.0	12.4	11.1	11.5	9.9
SF6	23,900	16.7						16.7	17.2	14.4	12.8	8.4	5.7	4.5
Gross Total		1,235.3	1,187.0	1,195.5	1,213.2	1,204.5	1,264.8	1,323.3	1,343.9	1,339.1	1,301.6	1,323.6	1,332.9	1,299.4

N.B. Does not include the LUCF sector.

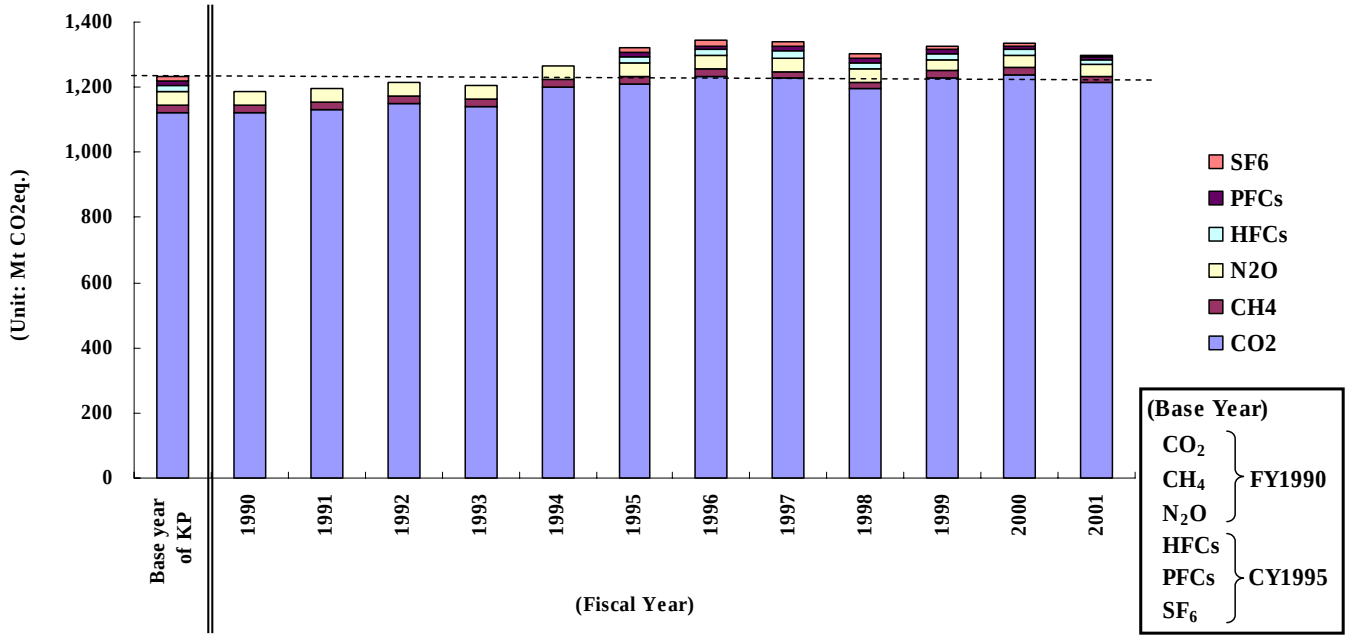


Figure 1 Total Emissions Trend of Greenhouse Gases

The emissions for the base year have to be submitted by January 1, 2007, after the enforcement of the Kyoto Protocol. Estimation for emissions in this report is provisional value and subject to change in accordance with the future revision of calculation methods.

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

*2 The base year of emissions of HFCs, PFCs and SF_6 could be available to set up the year for 1995 in accordance with Article 3, paragraph 8 of the Kyoto Protocol.

*3 The method used for the above estimation of GHGs needs further improvement, since it dose not fully ensure the carbon balance. (For instance, an estimation method that ensures the carbon balance results in the followings for energy-related CO_2 emission: 1,066 million ton-CO_2 in the base year and 1,127 million ton-CO_2 in 2001). Government of Japan intends to continue to discuss more appropriate method technically and draw a conclusion by this fall. Depending on the conclusion, the volume of CO_2 emission could change drastically.

*4 Japan has reported its emissions of greenhouse gases every fiscal year (April to March). However, the values are required to report by calendar year in accordance with the *Revised 1996 IPCC Guidelines (for National Greenhouse Gas Inventories)* in the course of calculation of greenhouse gas emissions and removals. Further study is required to change the basis of estimation method from fiscal year to calendar year.

7.2. Status of Greenhouse Gas Emissions

7.2.1. Carbon Dioxide (CO_2)

Carbon dioxide emissions in fiscal year 2001 estimate 1,214 million tons and 9.53 ton per capita.

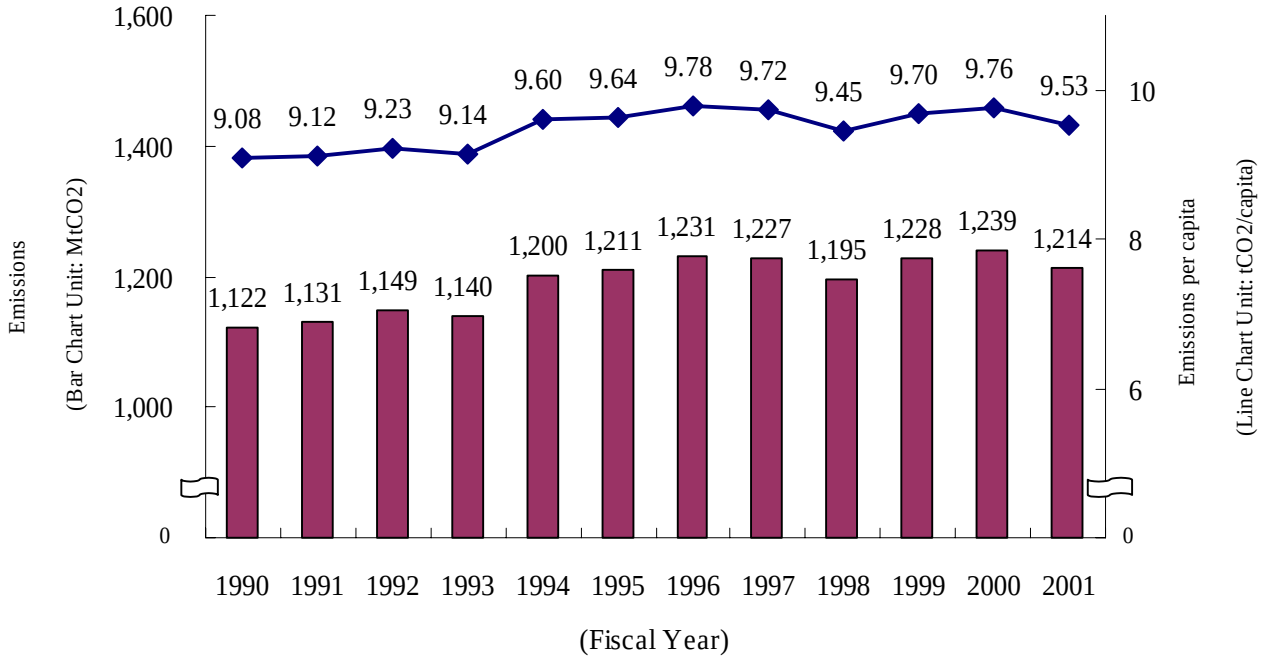


Figure 2 CO_2 Emission Trend

The values increased by 8.2% and 5.0 % from 1990's level and decreased by 2.0% and 2.3% from the previous year, respectively.

The emissions from the industrial sector (except for industrial processes) which hold 40% of the total carbon dioxide emissions decreased by 5.1% in fiscal year 2001 when compared with fiscal 1990, and decreased by 3.8% from the previous year.

The emissions from the transport sector increased by 22.8% in fiscal year 2001 when compared with fiscal 1990, and by 0.8% from the previous year.

The emissions from the residential sector increased by 19.4% in fiscal year 2001 when compared with fiscal 1990, and decreased by 2.5% from the previous year. The emissions from the commercial and other sector increased by 30.9% when compared with fiscal 1990, and increased by 1.3% from the previous year.

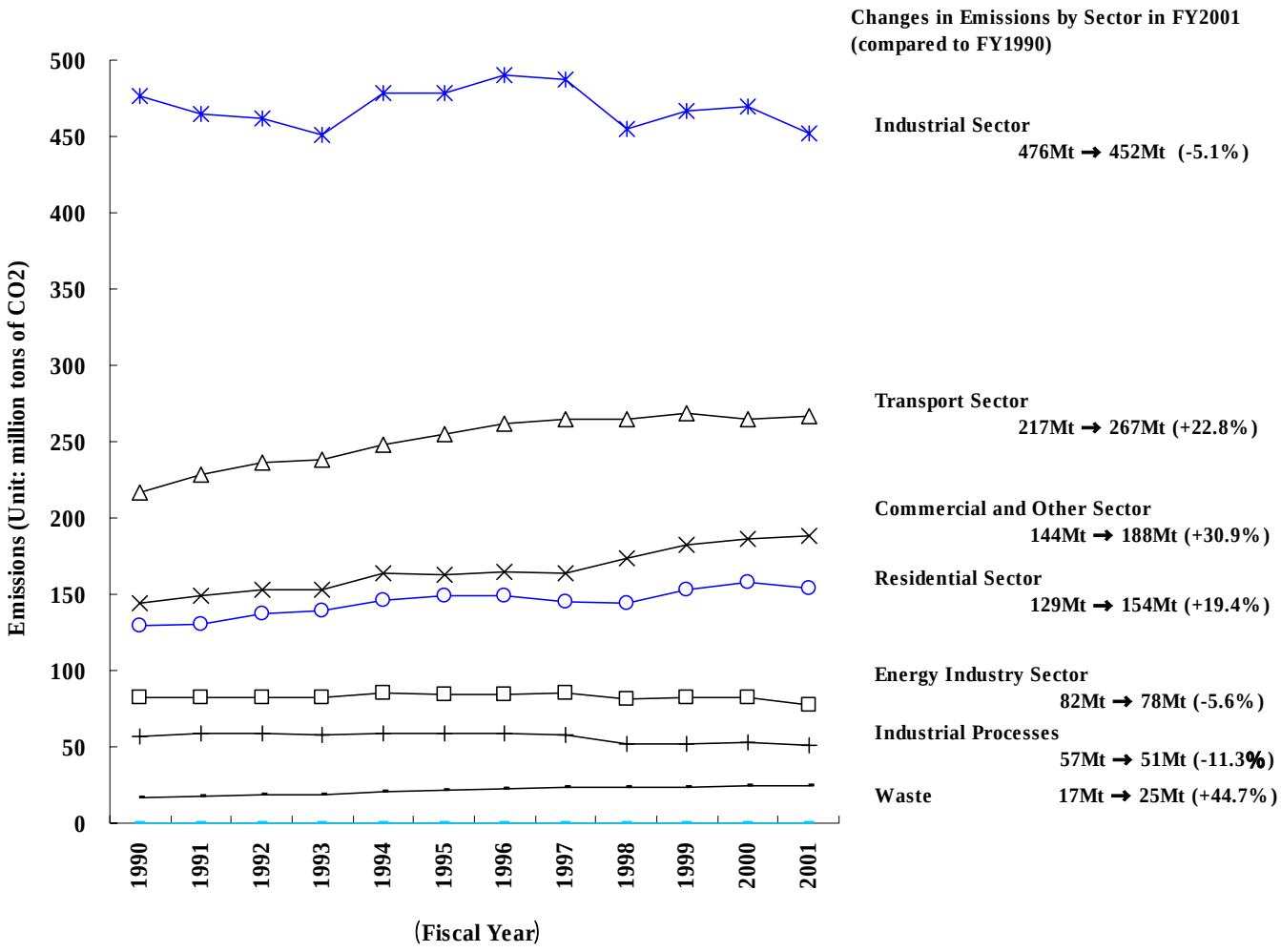


Figure 3 Changes in Carbon Dioxide Emissions

N.B. Figure 3 is created by allocating CO_2 emissions from power generation and steam generation into each of the final demand sector.

7.2.2. Methane (CH_4)

The emissions of methane in fiscal year 2001 is 20.3 million tons of carbon dioxide equivalent, decreasing by 17.8% compared to fiscal 1990, while decreasing by 2.5% compared to the previous year. The emissions from Coal Mining have remarkably decreased.

7.2.3. Nitrous Oxide (N_2O)

The emissions of nitrous oxide in fiscal year 2001 is 35.4 million tons of carbon dioxide equivalent, decreasing by 12.0% compared to fiscal 1990, while decreasing by 6.4% compared to the previous year. The emissions from Adipic Acid Production have remarkably decreased.

7.2.4. Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride (SF_6)

The emissions of HFCs in fiscal year 2001 is 15.6 million tons of carbon dioxide equivalent, decreasing by 22.1% compared to the base year (fiscal 1995), while decreasing by 15.0% compared to the previous year. The emissions from By-product HFC-23 from Manufacture of HCFC-22 are continuing to decrease largely.

The emissions of PFCs is 9.9 million tons of carbon dioxide equivalent, decreasing by 13.7% compared to the base year (fiscal 1995), while decreasing by 13.6% compared to the previous year. The emissions from Semiconductor Manufacture have decreased compared to the previous year.

The emissions of SF_6 is 4.5 million tons of carbon dioxide equivalent, decreasing by 72.9% compared to the base year (fiscal 1995), while decreasing by 21.0% compared to the previous year. The emissions from Electrical Equipment have decreased the most.

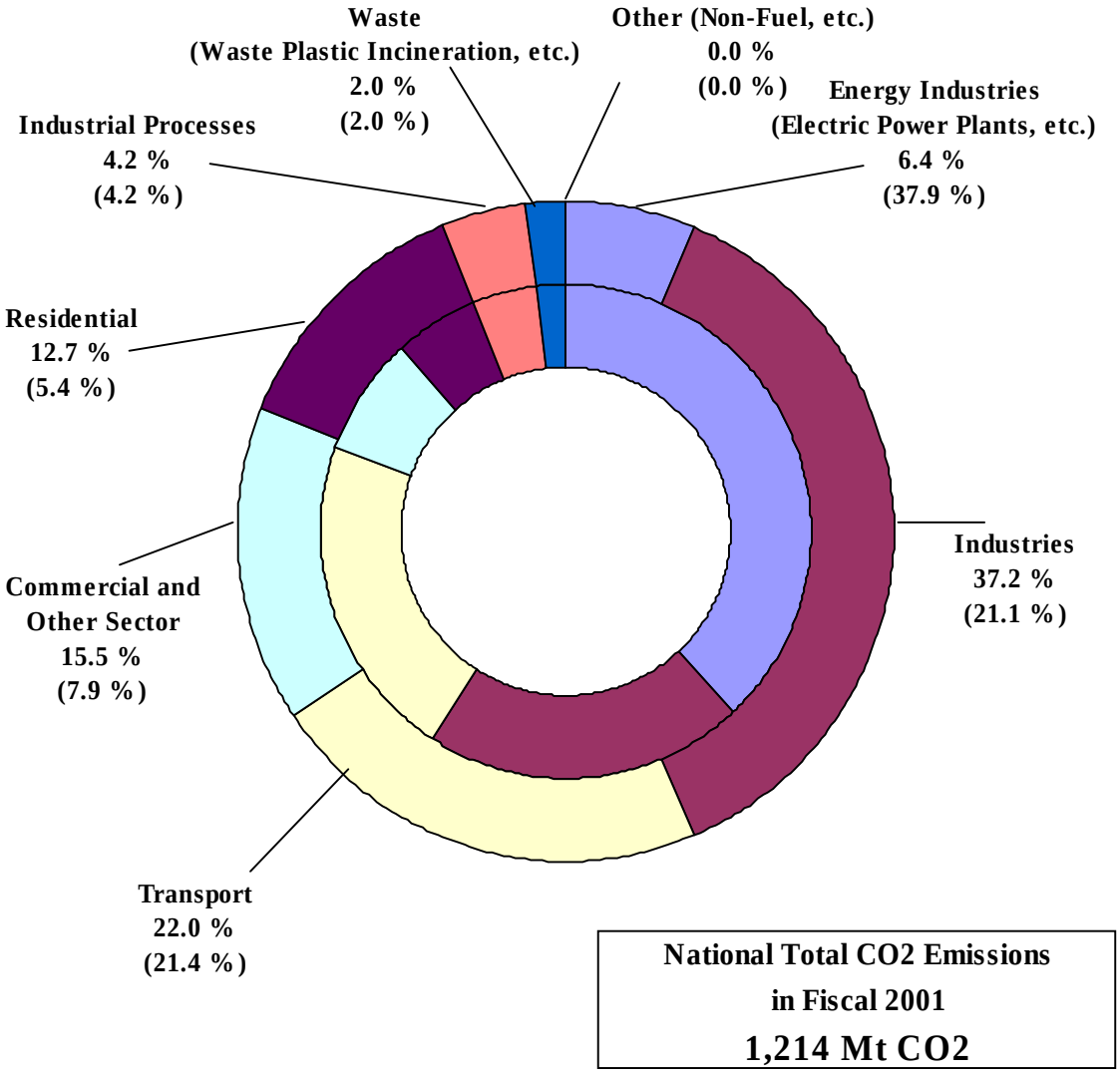
7.3. Remarks

(1) Each greenhouse gas emissions are recalculated retroactive to fiscal 1990, with the revision of calculation methods and emission factors based on the latest scientific knowledge. The calculation methods of the emissions need to be improved in accordance with the movement of the international examination or expanding of the scientific information.

(2) The most influential change is improving the methodology because of the overall revision of *General Energy Statistics* (Agency for Natural Resources and Energy) used for the estimation of carbon dioxide emissions from fuel combustion.

Reference: Sectoral Breakdown of the emissions of Greenhouse Gases in Fiscal Year 2001

• Carbon Dioxide (CO_2)



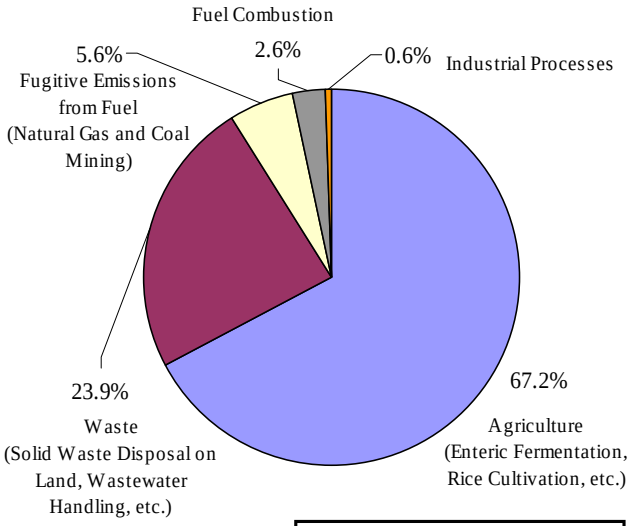
Note 1: The inner circle shows the proportion of the direct emissions by each sector (values in parentheses), and the outer circle shows the proportion of the emissions including the direct emissions and indirect emissions from power generation by electric utilities and steam generation (industrial steam generation and district heat supply) allocated to final demand sector in accordance with the electric and heat consumption (values without parenthesis).

Note 2: The added proportion among sectors is not always 100% because of the statistical error and half adjust.

Note 3: Other includes the fugitive emissions from fuels and errors of electric power distribution, etc.

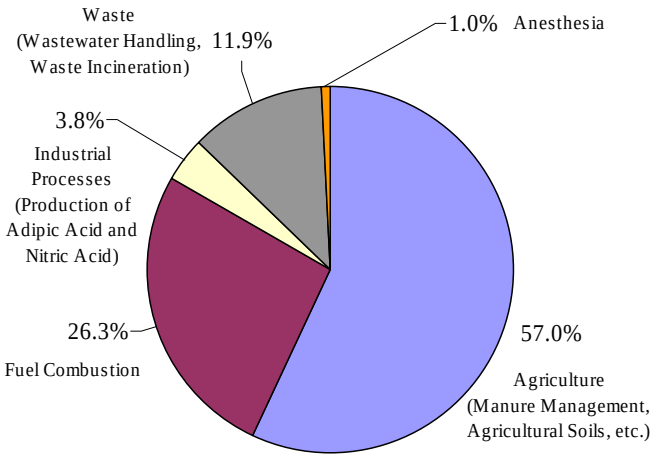
Note 4: The method used for the above estimation of GHGs in this CRF needs further improvement, since it dose not fully ensure the carbon balance. (For instance, an estimation method that ensures the carbon balance results in the followings for energy-related CO_2 emission: 1,066 million ton-CO_2 in the base year and 1,127 million ton-CO_2 in 2001). Government of Japan intends to continue to discuss more appropriate method technically and draw a conclusion by this fall. Depending on the conclusion, the volume of CO_2 emission could change drastically.（Refer 1.8.2.1 Fuel Combustion (CO_2) for detail.）

• Methane (CH_4)



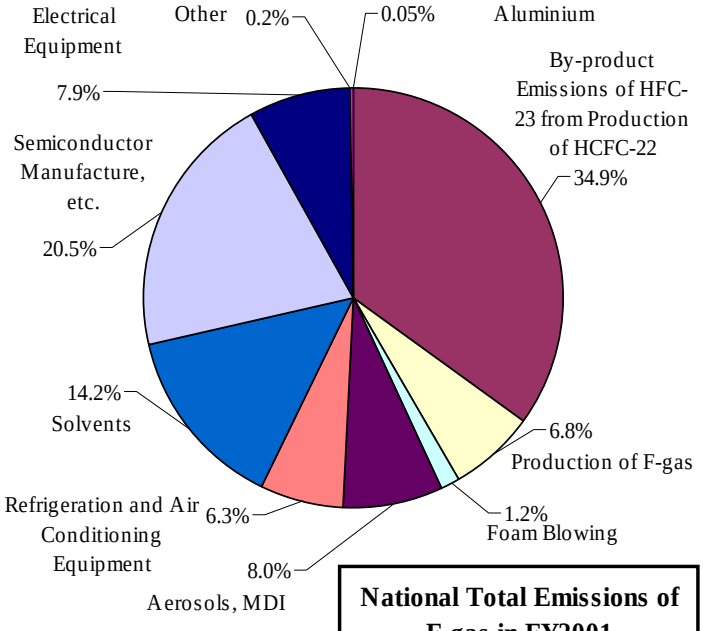
National Total CH4 Emissions in FY2001 2,030 Mt（CO2 eq.）

• Nitrous Oxide (CO_2)



National Total N2O Emissions in FY2001 3,540 Mt (CO2 eq.)

• Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride (SF_6)



National Total Emissions of F-gas in FY2001 3,010 Mt (CO2 eq.)