CGER-REPORT ISSN 1341-4356

National Greenhouse Gas Inventory Report of JAPAN

April, 2011

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

Center for Global Environmental Research

National Institute for Environmental Studies, Japan

National Greenhouse Gas Inventory Report of JAPAN (2011)

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Foreword

On the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and Article 7 of the Kyoto Protocol, all Parties to the Convention are required to submit national inventories of greenhouse gas emissions and removals to the Secretariat of the Convention. Therefore, the inventories on emissions and removals of greenhouse gases and precursors are reported in the Common Reporting Format (CRF) and in this National Inventory Report, in accordance with UNFCCC Inventory Reporting Guidelines (FCCC/SBTA/2006/9).

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

The structure of this report is fully in line with the recommended structure indicated in the Annex I of UNFCCC Inventory Reporting Guidelines (FCCC/SBSTA/2006/9).

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

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

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

April, 2011
Low-carbon Society Promotion Office
Global Environment Bureau
Ministry of the Environment

Preface

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

The GHGs inventory of Japan including this report represents the combined knowledge of over 70 experts in a range of fields from universities, industrial bodies, regional governments, relevant government departments and agencies, and relevant research institutes, who are members of the Committee for the Greenhouse Gas Emissions Estimation Methods established by Ministry of Environment in November 1999 and has been often held since then.

In compiling GHGs inventories, the Greenhouse Gas Inventory Office of Japan (GIO) would like to acknowledge not just the work of the Committee members in seeking to develop the methodology, but other experts who provided the latest scientific knowledge, the industrial bodies and government departments and agencies that provided the data necessary for compiling the inventories. We would like to express our gratitude to the Climate Change Policy Division, and Low-carbon Society Promotion Office of the Global Environment Bureau of the Ministry of the Environment, which has replaced the former in the responsibility from October 2010 for their support to GIO.

This is the second time to submit the inventory in the commitment period to the secretariat of the United Nations Convention on Climate Change (UNFCCC). Getting many feedbacks from internal and external reviewers, we have made further efforts to improve this report. We hope this report will be used accurately and universally as an index that Japan should accomplish emission reduction targets and an index evaluated states of implementing measures against global warming of Japan and relative sectors.

My appreciation also extends to Mr. Kiyoto TANABE, a GIO researcher, and Ms. Makiko YAMADA, our assistant, who supported us to smooth GIO operation.

April, 2011

野尻幸宏

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E.S.1. Background Information on GHGs Inventories and Climate Change

This National Inventory Report comprises the inventory of the emissions and removals of greenhouse gases (GHGs), indirect GHGs and SO_2 in Japan for FY 1990 through to FY 2009[1], on the basis of Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC).

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

For the submission of Japan's inventories, the trial use of the *UNFCCC Reporting Guidelines on Annual Inventories* (FCCC/SBSTA/2006/9) has been determined by the Conference of the Parties, and the inventory will be reported in accordance with this guideline. For the preparation of the LULUCF inventory[2], the *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereafter, *GPG-LULUCF*) was published in 2003, and the Parties are required to seek to apply the *GPG-LULUCF* to their inventory reporting from 2005 and afterward.

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

Total GHGs emissions in FY 2009[3] (excluding LULUCF) were 1,209 million tonnes (in CO_2 eq.). They increased by 0.4% compared to the emissions in FY 1990[4] (excluding LULUCF). Compared to the emissions in the base year under the Kyoto Protocol[5], they decreased by 4.1%.

It should be noted that actual emissions of HFCs, PFCs, and SF_6 in the period from CY 1990 to 1994 are not estimated (NE)[6].

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[1] "FY" (Fiscal Year), from April of the reporting year through March of the next year, is used because CO_2 is the primary GHGs emissions and estimated on a fiscal year basis. "CY" stands for "Calendar Year".

[2] Abbreviation of "Land Use, Land-Use Change and Forestry"

[3] The sum of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 emissions converted to CO_2 equivalents multiplied by their respective global warming potential (GWP). The GWP is a coefficient by means of which greenhouse gas effects of a given gas are made relative to those of an equivalent amount of CO_2. The coefficients are subjected to the *Second Assessment Report* (1995) issued by the Intergovernmental Panel on Climate Change (IPCC).

[4] The sum of CO_2, CH_4 and N_2O emissions converted to CO_2 equivalents multiplied by their respective GWP.

[5] Japan's base year under the Kyoto Protocol for CO_2, CH_4, N_2O emissions is FY 1990, while FY 1995 is the base year for HFCs, PFCs, and SF_6emissions.

[6] Potential emissions are reported in Common Reporting Format (CRF) for CY 1990 to 1994.

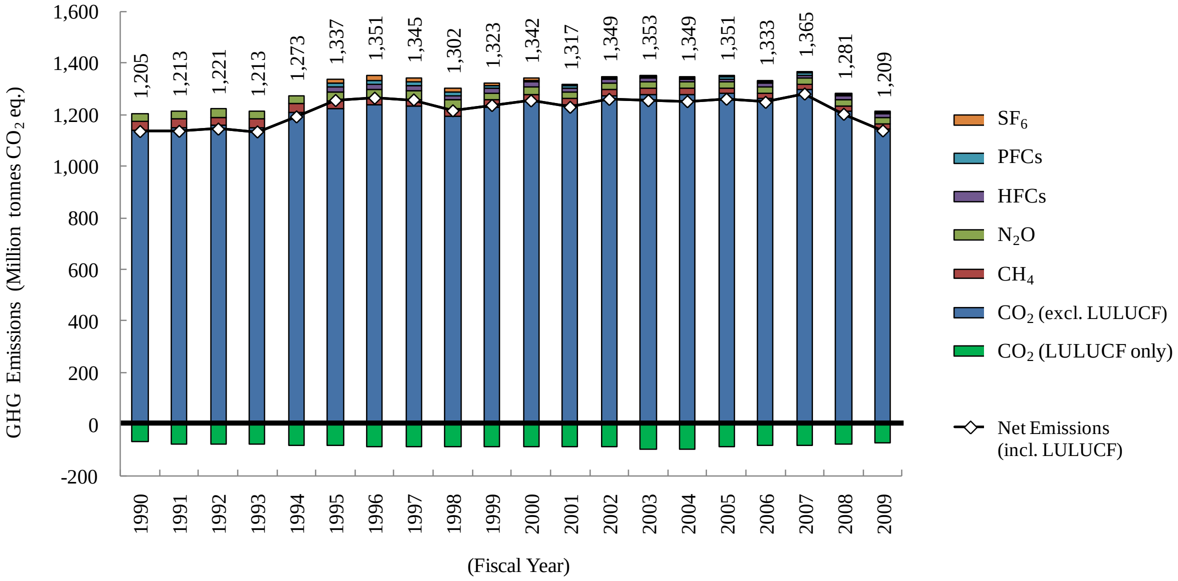

Figure 1 Trends in GHGs emission and removals in Japan

Table 1 Trends in GHGs emission and removals in Japan

[Million tonnes CO_2 eq.]	GWP	Base year of KP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (excl. LULUCF)	1	1,144.1	1,141.2	1,150.1	1,158.6	1,150.9	1,210.7	1,223.7	1,236.6	1,231.5	1,195.9	1,230.9	1,251.6
CO_2 (incl. LULUCF)	1	NA	1,071.5	1,073.2	1,082.0	1,071.4	1,129.5	1,142.1	1,150.3	1,144.9	1,109.5	1,144.2	1,164.2
CO_2 (LULUCF only)	1	NA	-69.7	-76.9	-76.6	-79.5	-81.2	-81.6	-86.3	-86.6	-86.4	-86.6	-87.3
CH_4 (excl. LULUCF)	21	33.4	31.9	31.7	31.4	31.1	30.5	29.6	28.9	27.8	27.0	26.4	25.8
CH_4 (incl. LULUCF)	21	NA	31.9	31.7	31.4	31.2	30.5	29.6	28.9	27.8	27.0	26.4	25.8
N_2O (excl. LULUCF)	310	32.6	31.6	31.1	31.3	31.0	32.2	32.7	33.7	34.3	32.8	26.4	28.9
N_2O (incl. LULUCF)	310	NA	31.7	31.2	31.3	31.1	32.3	32.7	33.7	34.4	32.8	26.4	29.0
HFCs	HFC-134a : 1,300 etc.	20.2	NE	NE	NE	NE	NE	20.3	19.9	19.9	19.4	19.9	18.8
PFCs	PFC-14 : 6,500 etc.	14.0	NE	NE	NE	NE	NE	14.2	14.8	16.2	13.4	10.4	9.5
SF_6	23,900	16.9	NE	NE	NE	NE	NE	17.0	17.5	15.0	13.6	9.3	7.2
Gross Total (excl. LULUCF)		1,261.3	1,204.7	1,212.9	1,221.2	1,213.1	1,273.3	1,337.4	1,351.3	1,344.7	1,302.2	1,323.3	1,341.8
Net Total (incl. LULUCF)		NA	1,135.1	1,136.1	1,144.7	1,133.7	1,192.2	1,255.9	1,265.1	1,258.2	1,215.8	1,236.7	1,254.5

[Million tonnes CO_2 eq.]	GWP	2001	2002	2003	2004	2005	2006	2007	2008	2009	Emission increase from the base year of KP	Emission increase from 1990 (2009)	Emission increase from 1995 (2009)	Emission increase from previous year (2009)
CO_2 (excl. LULUCF)	1	1,236.4	1,273.5	1,278.6	1,278.0	1,282.3	1,263.1	1,296.3	1,213.3	1,144.6	0.04%	0.3%	-	-5.7%
CO_2 (incl. LULUCF)	1	1,149.0	1,184.9	1,180.9	1,180.7	1,192.0	1,178.5	1,212.5	1,134.9	1,073.0	-	0.1%	-	-5.5%
CO_2 (LULUCF only)	1	-87.5	-88.6	-97.7	-97.3	-90.3	-84.6	-83.8	-78.4	-71.5	-	2.7%	-	-8.7%
CH_4 (excl. LULUCF)	21	25.0	24.0	23.5	23.1	22.7	22.3	21.8	21.2	20.7	-38.0%	-35.1%	-	-2.4%
CH_4 (incl. LULUCF)	21	25.0	24.1	23.5	23.1	22.7	22.3	21.8	21.2	20.7	-	-35.1%	-	-2.4%
N_2O (excl. LULUCF)	310	25.5	24.8	24.5	24.5	24.0	24.0	22.7	22.4	22.1	-32.2%	-30.0%	-	-1.4%
N_2O (incl. LULUCF)	310	25.5	24.8	24.5	24.5	24.0	24.0	22.7	22.5	22.1	-	-30.1%	-	-1.4%
HFCs	HFC-134a : 1,300 etc.	16.2	13.7	13.8	10.6	10.6	11.7	13.3	15.3	16.7	-17.5%	-	-17.7%	9.0%
PFCs	PFC-14 : 6,500 etc.	7.9	7.4	7.2	7.5	7.0	7.3	6.4	4.6	3.3	-76.7%	-	-77.0%	-29.1%
SF_6	23,900	6.0	5.6	5.3	5.1	4.8	4.9	4.4	3.8	1.9	-89.1%	-	-89.1%	-51.2%
Gross Total (excl. LULUCF)		1,317.0	1,349.0	1,352.8	1,348.7	1,351.3	1,333.3	1,364.9	1,280.6	1,209.2	-4.1%	0.4%	-9.6%	-5.6%
Net Total (incl. LULUCF)		1,229.5	1,260.4	1,255.1	1,251.5	1,261.1	1,248.8	1,281.1	1,202.3	1,137.7	-	0.2%	-	-5.4%

* NA : Not Applicable
* NE : Not Estimated
* LULUCF: Land Use, Land-Use Change and Forestry

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

The breakdown of GHGs emissions and removals in FY 2009 by sector[7] shows that the Energy accounts for 90.8% of total GHGs emissions. It is followed by the Industrial Processes (5.3%), the Agriculture (2.1%), the Waste (1.8%) and the Solvents and Other Product Use (0.01%).

Removals by the LULUCF in FY 2009 were equivalent to 5.9% of total GHGs emissions.

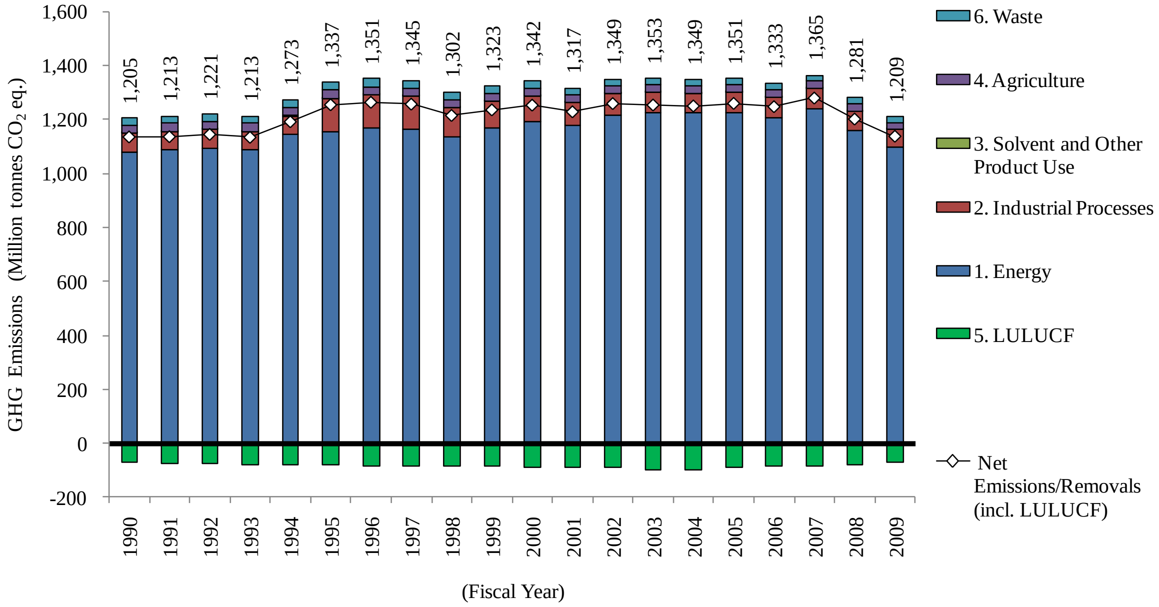

Figure 2 Trends in GHGs emissions and removals in each category

Table 2 Trends in GHGs emissions and removals in each category

[Million tonnes CO_2 eq.]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy	1,079.0	1,086.9	1,094.2	1,087.7	1,143.7	1,156.8	1,169.0	1,165.9	1,135.7	1,171.0	1,190.9
2. Industrial Processes	68.6	68.9	68.8	67.6	69.8	121.3	123.5	120.1	108.6	95.3	94.4
3. 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
4. Agriculture	31.3	31.2	31.2	31.1	30.7	30.1	29.4	28.8	28.3	27.9	27.7
5. LULUCF	-69.6	-76.8	-76.5	-79.4	-81.1	-81.5	-86.2	-86.5	-86.4	-86.6	-87.3
6. Waste	25.6	25.5	26.6	26.2	28.6	28.8	29.1	29.5	29.1	28.7	28.5
Net Emissions/Removals (incl. LULUCF)	1,135.1	1,136.1	1,144.7	1,133.7	1,192.2	1,255.9	1,265.1	1,258.2	1,215.8	1,236.7	1,254.5
Emissions (excl. LULUCF)	1,204.7	1,212.9	1,221.2	1,213.1	1,273.3	1,337.4	1,351.3	1,344.7	1,302.2	1,323.3	1,341.8

[Million tonnes CO_2 eq.]	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	1,178.0	1,217.8	1,223.5	1,223.3	1,227.0	1,208.4	1,241.9	1,161.2	1,098.1
2. Industrial Processes	84.4	78.0	76.7	73.9	73.8	75.8	74.4	70.8	63.8
3. Solvent and Other Product Use	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1
4. Agriculture	27.4	27.1	26.9	26.7	26.5	26.5	26.1	25.8	25.4
5. LULUCF	-87.4	-88.6	-97.7	-97.2	-90.3	-84.5	-83.7	-78.3	-71.5
6. Waste	26.8	25.7	25.4	24.5	23.7	22.4	22.2	22.7	21.8
Net Emissions/Removals (incl. LULUCF)	1,229.5	1,260.4	1,255.1	1,251.5	1,261.1	1,248.8	1,281.1	1,202.3	1,137.7
Emissions (excl. LULUCF)	1,317.0	1,349.0	1,352.8	1,348.7	1,351.3	1,333.3	1,364.9	1,280.6	1,209.2

* LULUCF: Land Use, Land-Use Change and Forestry

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

E.S.4. Other Information (Indirect GHGs and SO_2)

Under the UNFCCC, it is required to report emissions not only 6 types of GHGs (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) that are controlled by the Kyoto Protocol, but also emissions of indirect GHGs (NO_X, CO and NMVOC) as well as SO_2. Their emission trends are indicated below.

Nitrogen oxide (NO_X) emissions in FY 2009 were 1,782 thousand tonnes. They decreased by 12.6% since FY 1990 and decreased by 4.5% compared to the previous year.

Carbon monoxide (CO) emissions in FY 2009 were 2,535 thousand tonnes. They decreased by 43.5% since FY 1990 and decreased by 3.0% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY 2009 were 1,563 thousand tonnes. They decrease by 19.6% since FY 1990 and decreased by 1.9% compared to the previous year.

Sulfur dioxide (SO_2) emissions in FY 2009 were 769 thousand tonnes. They decreased by 24.0% since FY 1990 and decreased by 2.0% compared to the previous year.

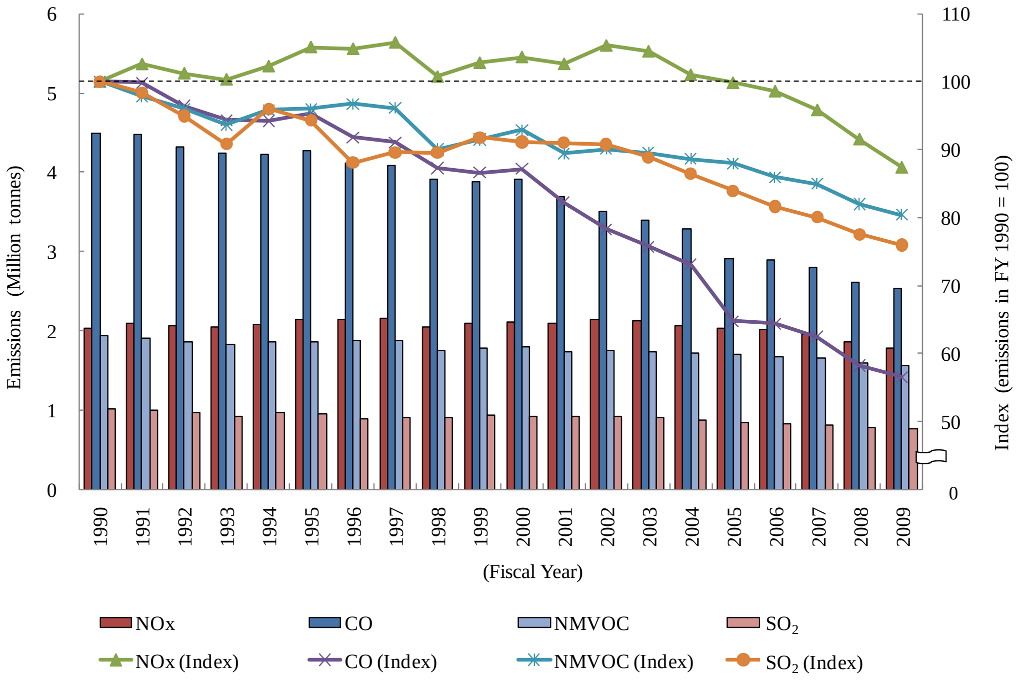

Figure 3 Trends in Emissions of Indirect GHGs and SO_2

Chapter 1. Introduction

1.1. Background Information on Japan's Greenhouse Gas Inventory

The National Inventory Report (NIR) is comprised of the inventories of the emissions and removals of greenhouse gases (GHGs), including indirect GHGs and SO_2 in Japan from FY 1990 to FY 2009[1], on the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC).

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

Japan's national inventory is reported in accordance with the *UNFCCC Reporting Guidelines on Annual Inventories* (FCCC/SBSTA/2006/9). With regard to the preparation of the LULUCF inventory, parties are required to attempt the application of the *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (*GPG-LULUCF*), published in 2003, to their inventory reporting from 2005 and afterwards.

1.2. A Description of Japan's Institutional Arrangement for the Inventory Preparation

The Ministry of the Environment (MOE), with the cooperation of relevant ministries, agencies and organizations, prepares Japan's national inventory, which is annually submitted to the UNFCCC Secretariat in accordance with the UNFCCC and the Kyoto Protocol. The MOE takes overall responsibilities for the national inventory and therefore also makes an effort on improving its quality. For instance, the MOE organizes "the Committee for the Greenhouse Gas Emission Estimation Methods (the Committee)" in order to integrate the latest scientific knowledge into the inventory and to modify it based on more recent international provisions. The estimation of GHG emissions and removals, the key category analysis and the uncertainty assessment are then carried out by taking the decisions of the Committee into consideration. Substantial activities, such as the estimation of emissions and removals and the preparation of Common Reporting Format (CRF) and NIR, are done by the Greenhouse Gas Inventory Office of Japan (GIO), which belongs to the Center for Global Environmental Research of the National Institute for Environmental Studies. The relevant ministries, agencies and organizations provide the GIO the appropriate data (e.g., activity data, emission factors, GHG emissions and removals) through compiling various statistics. The relevant ministries check and verify these inventories (i.e., CRF, NIR, KP-CRF and KP-NIR) including the spreadsheets that are actually utilized for the estimation, as a part of the Quality Control (QC) activities. The checked and verified inventory data are Japan's official values. They are then made public by the MOE and the national inventory is submitted to the UNFCCC Secretariat by the Ministry of Foreign Affairs.

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[1] "FY (fiscal year)" is used because the major part of CO_2 emission estimate is on the fiscal year basis (April to March).

Figure 1-1 shows the overall institutional arrangement for the inventory preparation within Japan. More detailed information on the role and responsibility of each relevant ministry, agency and organization in the inventory preparation process is described in Annex 6.

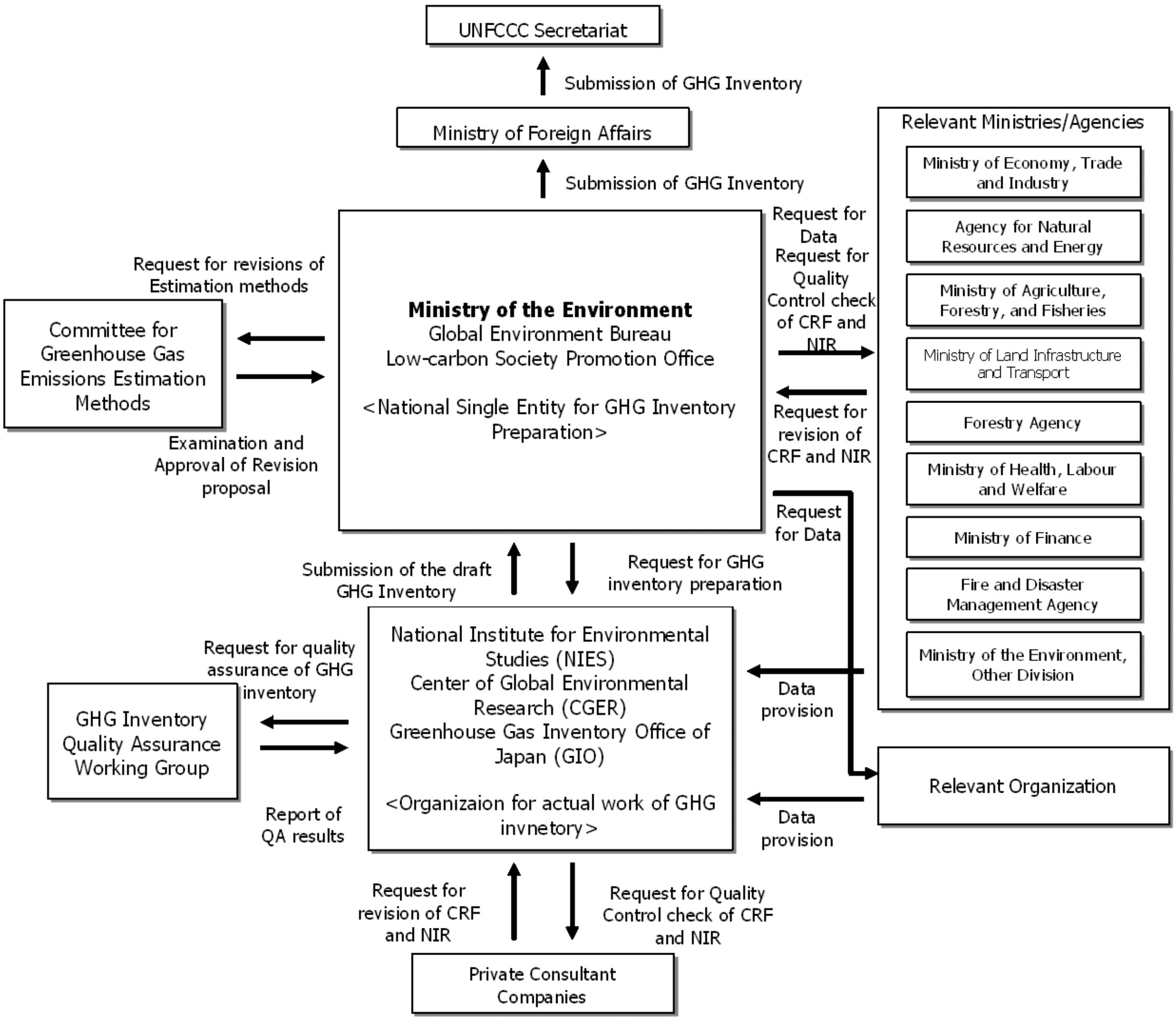

Figure 1-1 Japan’s institutional arrangement for the national inventory preparation

1.3. Brief Description of the Inventory Preparation Process

1.3.1. Annual cycle of the inventory preparation

Table 1-1 shows the annual cycle of the inventory preparation. In Japan, in advance of the estimation of national inventory submitted to the UNFCCC (submission deadline: 15th April), preliminary figures are estimated and published as a document for an official announcement. (In preliminary figures, only GHG emissions excluding removals are estimated.)

Table 1-1 Annual cycle of the inventory preparation

*Inventory preparation in fiscal yaer "n"

	Process	Relevant Entities	Calender Year n+1								CY n+2			
			Fiscal Year n+1											FY n+2
			May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1	Discussion on the inventory improvement	MOE, GIO		→	→	→	→							
2	Holding the meeting of the Committee	MOE, (GIO, Private consultant)		→	→	→	→	→	→	→	→			
3	Collection of data for the national inventory	MOE, GIO, Relevant Ministries/Agencies, Relevant organization, Private consultant								→	→	→	→	
4	Preparation of a draft of CRF	GIO, Private consultant									→	→	→	
5	Preparation of a draft of NIR	GIO, Private consultant									→	→	→	
6	Implementation of the exterior QC and the coordination with the relevant ministries and agencies	MOE, GIO, Relevant Ministries/Agencies, Private consultant										→	→	→
7	Correction of the drafts of CRF and NIR	MOE, GIO, Private consultant											→	→
8	Submission and official announcement of the national inventory	MOE, Ministry of Foreign Affairs, GIO												★
9	Holding the meeting of the QA-WG	MOE, GIO	→	→	→	→								

★: Inventory submission and official announcement must be implemented within 6 weeks after April 15.
MOE: Ministry of the Environment
GIO: Greenhouse Gas Inventory Office of Japan
The Committee: The Committee for the Greenhouse Gas Emission Estimation Methods
The QA-WG: The Inventory Quality Assurance Working Group

1.3.2. Process of the inventory preparation

1） *Discussion on the inventory improvement (Step 1)*

The MOE and the GIO identify the items, which need to be addressed by the Committee, based on the results of the previous inventory review of the UNFCCC, the recommendations of “the Inventory Quality Assurance Working Group (the QA-WG)”, the items needing improvement as identified at former Committee’s meetings, as well as any other items, requiring revision, as determined during previous inventory preparations. The schedule for the expert evaluation (step 2) is developed by taking the above mentioned information into account.

2） *Holding the meeting of the Committee for the Greenhouse Gas Emission Estimation Methods [evaluation and examination of estimation methods by experts] (Step 2)*

The MOE holds the meeting of the Committee, in which estimation methodologies for an annual inventory and the issues that require technical reviews are discussed by experts with different scientific backgrounds (refer to Annex 6).

3） *Collection of data for the national inventory (Step 3)*

The data required for preparing the national inventory is collected.

4） *Preparation of a draft of CRF [including the implementation of the key category analysis and the uncertainty assessment] (Step 4)*

The data input and estimation of emissions and removals are carried out simultaneously by utilizing files containing spreadsheets (JNGI: Japan National GHG Inventory files), which have inter-connecting links among themselves based on the calculation formulas for emissions and removals. Subsequently, the key category analysis and the uncertainty assessment are also carried out.

5） *Preparation of a draft of NIR (Step 5)*

The drafts of NIR and KP-NIR are prepared by following the general guidelines made by the MOE and the GIO. These entities identify the points, which need to be revised or which require an additional description by taking the discussion at step 1 into account. The GIO and the selected private consulting companies prepare new NIR and KP-NIR by updating data, and by adding and revising descriptions in the previous NIR and KP-NIR.

6） Implementation of the exterior QC and the coordination with the relevant ministries and agencies (Step 6)

As a QC activity, the selected private consulting companies check the JNGI files and the initial draft of CRF (the 0th draft) prepared by the GIO (exterior QC). These companies not only check the input data and the calculation formulas in the files, but also verify the estimations by re-calculating the total amounts of GHG emissions determined by utilizing the same files. Because of this cross-check, any possible data input and emission estimation mistakes are avoided. They also check the content and descriptions of the initial draft of NIR (the 0th draft) prepared by the GIO.

Subsequently, the GIO sends out the primary drafts of the inventories as well as of official announcements as electronic computer files to the MOE and the relevant ministries and agencies, and possible revisions are carried out by them. These primary drafts include not only the drafts, to which the exterior QC was applied, but also the drafts of KP-CRF and KP-NIR that are prepared by the selected private consulting companies. The data, which are estimated based on confidential data, are only sent out for confirmation to the ministry and/or the agency which provided them.

7） Correction of the drafts of CRF and NIR (Step 7)

When revisions are requested at step 6, the possible corrections are discussed among the MOE, the GIO and the relevant ministries and/or agencies. The corrected drafts are then the secondary drafts. These secondary drafts are sent out again to the relevant ministries and/or the agencies for conclusive confirmation. If there is no additional request for revision, they are considered to be the final versions.

8） Submission and official announcement of the national inventory (Step 8)

The completed inventory is submitted by the MOE via the Ministry of Foreign Affairs to the UNFCCC Secretariat. Information on the estimated GHG emissions and removals is officially made public and is published on the MOE’s homepage (http://www.env.go.jp/) complete with any additional relevant information. The inventory is also published on the GIO’s homepage (http://www-gio.nies.go.jp/index-j.html).

9） Holding the meeting of the Greenhouse Gas Inventory Quality Assurance Working Group (Step 9)

The QA-WG, which is composed of experts who are not directly involved in or related to the inventory preparation process, is organized in order to guarantee the inventory’s quality and to find out possible improvements. This QA-WG verifies the validation of the following information: estimation methodologies, activity data, emission factors, and the contents of CRF and NIR.
GIO integrates the items, which were suggested for improvement by the QA-WG, into the inventory improvement program, and utilizes them in discussions on the inventory estimation methods and in subsequent inventory preparation.

1.4. Brief General Description of Methodologies and Data Sources Used

The methodology used in estimation of GHG emissions or removals is basically in accordance with the *Revised 1996 IPCC Guidelines*, the *GPG (2000)* and the *GPG-LULUCF*. The country-specific methodologies are also used for some categories (e.g., “4.C. methane emissions from rice cultivation") in order to reflect the actual situation of emissions in Japan.

Results of the actual measurements or estimates based on research conducted in Japan are used to determine the emissions factors (country-specific emissions factors). The default values given in the *Revised 1996 IPCC Guidelines*, the *GPG (2000)* and the *GPG-LULUCF* are used for: emissions, which are assumed to be quite low (e.g., "1.B.2.a.ii fugitive emissions from fuel (oil and natural gas")), and where the possibility of emission from a given source is uncertain (e.g., "4.D.3. Indirect emissions from soil in agricultural land").

1.5. Brief Description of Key Categories

Key category analysis is carried out in accordance with the *GPG (2000)* and the *GPG-LULUCF* (Tier 1, Tier 2 level assessment and trend assessment, and qualitative analysis).

This analysis identified 35 sources and sinks as Japan's key categories in FY 2009 (Table 1-2). The same analysis was also conducted for the base year of the UNFCCC (FY 1990) in response to previous recommendations from reviewers. A total of 32 sources and sinks were identified as key categories in the base year (Table 1-3). More detailed information is described in Annex 1.

Table 1-2 Japan’s key source categories in FY 2009

	A **IPCC Category**		**B Direct GHGs**	**L1**	**T1**	**L2**	**T2**
#1	1A Stationary Combustion	Solid Fuels	CO2	#1	#2	#3	#8
#2	1A Stationary Combustion	Liquid Fuels	CO2	#2	#1	#9	#7
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	#3	#4	#4	#17
#4	1A Stationary Combustion	Gaseous Fuels	CO2	#4	#3		
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO2	#5		#5	
#6	2A Mineral Product	1. Cement Production	CO2	#6	#7	#8	#10
#7	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	1. Refrigeration and Air Conditioning Equipment	HFCs	#7	#6	#2	#1
#8	1A Stationary Combustion	Other Fuels	CO2	#8	#11	#6	#9
#9	6C Waste Incineration		CO2	#9			
#10	1A3 Mobile Combustion	d. Navigation	CO2	#10			
#11	1A3 Mobile Combustion	a. Civil Aviation	CO2	#11	#15		
#12	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#12	#17	#17	#21
#13	4A Enteric Fermentation		CH4			#21	
#14	4C Rice Cultivation		CH4			#15	
#15	2A Mineral Product	2. Lime Production	CO2			#19	
#16	4B Manure Management		N2O			#10	
#17	1A Stationary Combustion		N2O			#14	#15
#18	6A Solid Waste Disposal on Land		CH4		#13		
#19	4D Agricultural Soils	1. Direct Soil Emissions	N2O			#7	#12
#20	4D Agricultural Soils	3. Indirect Emissions	N2O			#11	#18
#21	1A3 Mobile Combustion	b. Road Transportation	N2O			#12	#11
#22	4B Manure Management		CH4			#13	#20
#23	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	PFCs			#16	#14
#24	5E Settlements	2. Land converted to Settlements	CO2		#14		
#25	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs		#9		#4
#26	2B Chemical Industry	3. Adipic Acid	N2O		#10		#16
#27	5E Settlements	1. Settlements remaining Settlements	CO2			#22	
#28	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF6		#8		#2
#29	6D Other		CO2			#20	
#30	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#12		#3
#31	5B Cropland	2. Land converted to Cropland	CO2				#19
#32	1A3 Mobile Combustion	a. Civil Aviation	N2O			#1	#5
#33	1A3 Mobile Combustion	d. Navigation	N2O			#18	
#34	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs		#5		#13
#35	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#16		#6

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

Table 1-3 Japan's key source categories in FY 1990

	A **IPCC Category**		**B** **Direct GHGs**	**L1**	**L2**
#1	1A Stationary Combustion	Liquid Fuels	CO2	#1	#5
#2	1A Stationary Combustion	Solid Fuels	CO2	#2	#4
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	#3	#6
#4	1A Stationary Combustion	Gaseous Fuels	CO2	#4	
#5	5A Forest Land	1. Forest Land remaining Forest	CO2	#5	#9
#6	2A Mineral Product	1. Cement Production	CO2	#6	#8
#7	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	#7	#23
#8	1A3 Mobile Combustion	d. Navigation	CO2	#8	
#9	6C Waste Incineration		CO2	#9	
#10	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#10	#19
#11	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF6	#11	#2
#12	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs	#12	#7
#13	1A Stationary Combustion	Other Fuels	CO2	#13	#15
#14	4A Enteric Fermentation		CH4	#14	#24
#15	6A Solid Waste Disposal on Land		CH4	#15	
#16	2B Chemical Industry	3. Adipic Acid	N2O	#16	
#17	2A Mineral Product	2. Lime Production	CO2	#17	#22
#18	1A3 Mobile Combustion	a. Civil Aviation	CO2	#18	
#19	4C Rice Cultivation		CH4		#18
#20	4B Manure Management		N2O		#13
#21	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#3
#22	4D Agricultural Soils	1. Direct Soil Emissions	N2O		#10
#23	1A3 Mobile Combustion	b. Road Transportation	N2O		#12
#24	4D Agricultural Soils	3. Indirect Emissions	N2O		#14
#25	2B Chemical Industry	1. Ammonia Production	CO2		#25
#26	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	PFCs		#16
#27	4B Manure Management		CH4		#17
#28	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#11
#29	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs		#26
#30	6D Other		CO2		#21
#31	1A3 Mobile Combustion	d. Navigation	N2O		#20
#32	1A3 Mobile Combustion	a. Civil Aviation	N2O		#1

N.B. Figures recorded in the column L (Level) indicate the ranking of level assessments.

The data of HFCs, PFCs and SF_6 utilized for this analysis are the 1995 values.

1.6. Information on the QA/QC Plan including Verification and Treatment of Confidentiality Issues

The role and the responsibility for each entity in the inventory preparation process are clarified in Japan's national system. The relevant entities are: MOE, GIO, relevant ministries, relevant agencies, relevant organizations, the Committee, selected private consulting companies and the QA-WG. The QC activities (e.g., checking estimation accuracy, archiving documents) are carried out in each step of the inventory preparation process in accordance with the GPG (2000) in order to control the inventory's quality.

As a QA activity, the QA-WG is established in order to implement a detailed review of each source or sink. The QA-WG is composed of experts who are not directly involved in or related to the inventory preparation process. The QA-WG review several sectors/categories annually with the aim of reviewing the entire inventory within the next few years. The QA-WG review was implemented in the Industrial processes, and the Solvent and other product use sectors in FY 2010.

For further information on the national system and process for inventory preparation, see sections 1.2 and 1.3 of this chapter. Detailed information on the QA/QC plan is described in Annex 6.1.

1.7. General Uncertainty Assessment, including Data on the Overall Uncertainty for the Inventory Totals

Total net GHG emissions in Japan for FY 2009 were approximately 1,138 million tonnes (carbon dioxide equivalents). The total net emissions uncertainty was 2% and the uncertainty introduced into the trend in the total emissions was 1%. More detailed information on the uncertainty assessment is described in Annex 7.

Table 1-4 Uncertainty of Japan's Total Net Emissions

IPCC Category	GHGs	Emissions / Removals [Gg-CO_2 eq.]		Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions[1)]	rank
		A	[%]	B		C	
1A. Fuel Combustion (CO_2)	CO_2	1,089,728.4	90.1%	1%	10	0.74%	2
1A. Fuel Combustion (Stationary:CH_4,N_2O)	CH_4、 N_2O	5,077.1	0.4%	27%	4	0.12%	8
1A. Fuel Combustion (Transport:CH_4,N_2O)	CH_4、 N_2O	2,852.9	0.2%	351%	1	0.88%	1
1B. Fugitive Emissions from Fuels	CO_2、 CH_4、 N_2O	429.5	0.0%	19%	5	0.01%	9
2. Industrial Processes (CO_2,CH_4,N_2O)	CO_2、 CH_4、 N_2O	41,977.7	3.5%	7%	7	0.26%	7
2. Industrial Processes (HFCs,PFCs,SF_6)	HFCs、 PFCs、 SF_6	21,794.5	1.8%	31%	3	0.60%	4
3. Solvent & other Product Use	N_2O	120.5	0.0%	5%	9	0.00%	10
4. Agriculture	CH_4、 N_2O	25,402.1	2.1%	18%	6	0.40%	5
5. LULUCF	CO_2、 CH_4、 N_2O	-71,523.5	-5.9%	5%	8	0.32%	6
6. Waste	CO_2、 CH_4、 N_2O	21,830.5	1.8%	34%	2	0.65%	3
Total Net Emissions	(D)	1,137,689.7		(E) [2)] **2%**			

1) C = A × B / D

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

1.8. General Assessment of the Completeness

In this inventory report, emissions from some categories are not estimated and reported as "NE". In FY 2006, GHG emissions and removals from categories that were previously reported as NE were newly estimated by analyzing categories such as those, which possibly result in the emission of considerable amount of GHGs, as well as those, which require substantial improvement in their estimation methodology.

Source categories reported as NE in this year's report include those whose emissions are thought to be very small, those whose emissions are unknown, and those for which emission estimation methods have not been developed. For these categories, further investigation on their emission possibility and the development of estimation methodologies will be carried out in accordance with Japan's QA/QC plan. See Annex 5 for a list of not-estimated emission source categories.

For some categories, dealing with the emission sources of HFCs, PFCs and SF_6, activity data are not available from CY 1990 to 1994.Those categories are therefore reported as "NE" during that period.

Chapter 2. Trends in GHGs Emissions and Removals

2.1. Description and Interpretation of Emission and Removal Trends for Aggregate GHGs

2.1.1. GHGs Emissions and Removals

Total GHGs emissions in FY 2009[1,2] (excluding LULUCF[3]) were 1,209 million tonnes (in CO_2 eq.). They increased by 0.4% compared to the emissions in FY 1990[4] (excluding LULUCF). Compared to the emissions in the base year under the Kyoto Protocol[5], they decreased by 4.1%.

It should be noted that actual emissions of HFCs, PFCs, and SF_6 in the period from CY 1990 to 1994 are not estimated (NE)[6].

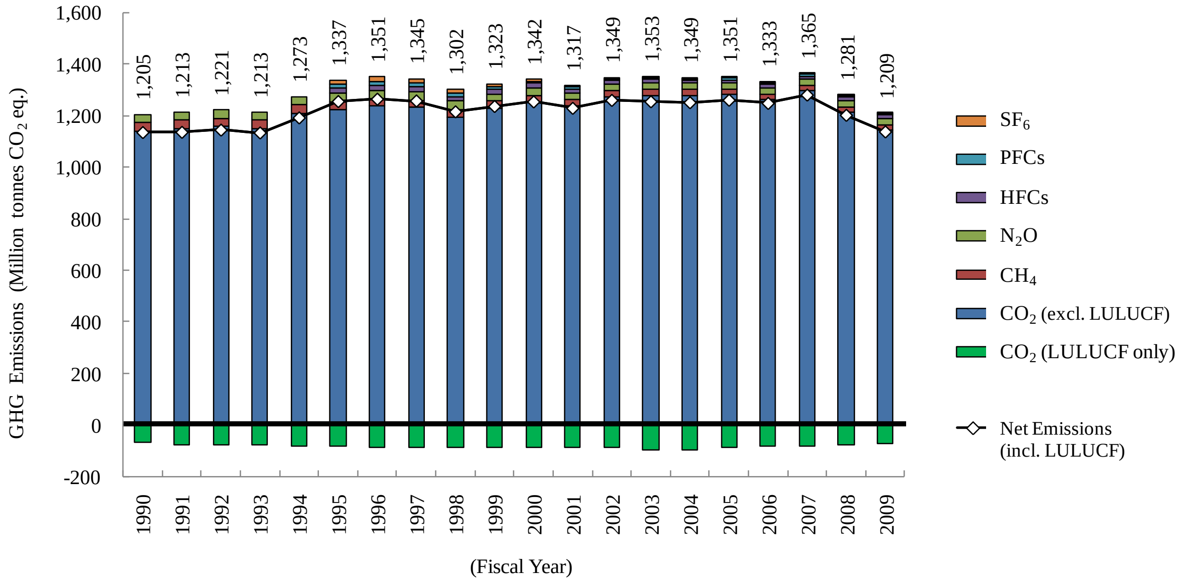

Figure 2-1 Trends in greenhouse gas emissions and removals in Japan

Carbon dioxide emissions in FY 2009 were 1,145 million tonnes (excluding LULUCF), accounting for 94.7% of total GHGs emissions. They increased by 0.3% since FY 1990 and decreased by 5.7% compared to the previous year. Carbon dioxide removals[7] in FY 2009 were 71.5 million tonnes and were equivalent to 5.9% of total GHGs emissions. They increased by 2.7% since FY 1990 and

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[1] "FY" (Fiscal Year), from April of the reporting year through March of the next year, is used because CO_2 is the primary GHGs emissions and estimated on a fiscal year basis. "CY" stands for "Calendar Year".

[2] The sum of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 emissions converted to CO_2 equivalents, multiplied by their respective global warming potential (GWP). The GWP is a coefficient by means of which greenhouse gas effects of a given gas are made relative to those of an equivalent amount of CO_2. The coefficients are subjected to the *Second Assessment Report* (1995) issued by the Intergovernmental Panel on Climate Change (IPCC).

[3] Abbreviation of "Land Use, Land-Use Change and Forestry"

[4] The sum of CO_2, CH_4 and N_2O emissions converted to CO_2 equivalents multiplied by their respective GWP.

[5] Japan's base year under the Kyoto Protocol for CO_2, CH_4, N_2O emissions is FY 1990, while FY 1995 is the base year for HFCs, PFCs, and SF_6 emissions.

[6] Potential emissions are reported in Common Reporting Format (CRF) for CY 1990 to 1994.

[7] Since the inventory to be submitted under the UNFCCC reports all GHG emissions and removals from the LULUCF Sector, these values do not correspond to emissions and removals which can be accounted for compliance under the Kyoto Protocol (for 'forest management', 13 million carbon tonnes as the upper limit for Japan is given in the Appendix to the Annex to Decision 16/CMP.1.)

decreased by 8.7% compared to the previous year. Methane emissions in FY 2009 (excluding LULUCF) were 20.7 million tonnes (in CO_2 eq.), accounting for 1.7% of total GHGs emissions. They decreased by 35.1% since FY 1990 and decreased by 2.4% compared to the previous year. Nitrous oxide emissions in FY 2009 (excluding LULUCF) were 22.1 million tonnes (in CO_2 eq.), accounting for 1.8% of total GHGs emissions. They decreased by 30.0% since FY 1990 and decreased by 1.4% compared to the previous year.

Hydrofluorocarbons emissions in CY 2009 were 16.7 million tonnes (in CO_2 eq.), accounting for 1.4% of total GHGs emissions. They decreased by 17.7% since CY 1995 and increased by 9.0% compared to the previous year. Perfluorocarbons emissions in CY 2009 were 3.3 million tonnes (in CO_2 eq.), accounting for 0.3% of total GHGs emissions. They decreased by 77.0% since CY 1995 and decreased by 29.1% compared to the previous year. Sulphur hexafluoride emissions in CY 2009 were 1.9 million tonnes (in CO_2 eq.), accounting for 0.2% of total GHGs emissions. They decreased by 89.1% since CY 1995 and decreased by 51.2% compared to the previous year.

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

[Million tonnes CO_2 eq.]	GWP	Base year of KP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO_2 (excl. LULUCF)	1	1,144.1	1,141.2	1,150.1	1,158.6	1,150.9	1,210.7	1,223.7	1,236.6	1,231.5	1,195.9	1,230.9	1,251.6
CO_2 (incl. LULUCF)	1	NA	1,071.5	1,073.2	1,082.0	1,071.4	1,129.5	1,142.1	1,150.3	1,144.9	1,109.5	1,144.2	1,164.2
CO_2 (LULUCF only)	1	NA	-69.7	-76.9	-76.6	-79.5	-81.2	-81.6	-86.3	-86.6	-86.4	-86.6	-87.3
CH_4 (excl. LULUCF)	21	33.4	31.9	31.7	31.4	31.1	30.5	29.6	28.9	27.8	27.0	26.4	25.8
CH_4 (incl. LULUCF)	21	NA	31.9	31.7	31.4	31.2	30.5	29.6	28.9	27.8	27.0	26.4	25.8
N_2O (excl. LULUCF)	310	32.6	31.6	31.1	31.3	31.0	32.2	32.7	33.7	34.3	32.8	26.4	28.9
N_2O (incl. LULUCF)	310	NA	31.7	31.2	31.3	31.1	32.3	32.7	33.7	34.4	32.8	26.4	29.0
HFCs	HFC-134a : 1,300 etc.	20.2	NE	NE	NE	NE	NE	20.3	19.9	19.9	19.4	19.9	18.8
PFCs	PFC-14 : 6,500 etc.	14.0	NE	NE	NE	NE	NE	14.2	14.8	16.2	13.4	10.4	9.5
SF_6	23,900	16.9	NE	NE	NE	NE	NE	17.0	17.5	15.0	13.6	9.3	7.2
Gross Total (excl. LULUCF)		1,261.3	1,204.7	1,212.9	1,221.2	1,213.1	1,273.3	1,337.4	1,351.3	1,344.7	1,302.2	1,323.3	1,341.8
Net Total (incl. LULUCF)		NA	1,135.1	1,136.1	1,144.7	1,133.7	1,192.2	1,255.9	1,265.1	1,258.2	1,215.8	1,236.7	1,254.5

[Million tonnes CO_2 eq.]	GWP	2001	2002	2003	2004	2005	2006	2007	2008	2009	Emission increase from the base year of KP	Emission increase from 1990 (2009)	Emission increase from 1995 (2009)	Emission increase from previous year (2009)
CO_2 (excl. LULUCF)	1	1,236.4	1,273.5	1,278.6	1,278.0	1,282.3	1,263.1	1,296.3	1,213.3	1,144.6	0.04%	0.3%	-	-5.7%
CO_2 (incl. LULUCF)	1	1,149.0	1,184.9	1,180.9	1,180.7	1,192.0	1,178.5	1,212.5	1,134.9	1,073.0	-	0.1%	-	-5.5%
CO_2 (LULUCF only)	1	-87.5	-88.6	-97.7	-97.3	-90.3	-84.6	-83.8	-78.4	-71.5	-	2.7%	-	-8.7%
CH_4 (excl. LULUCF)	21	25.0	24.0	23.5	23.1	22.7	22.3	21.8	21.2	20.7	-38.0%	-35.1%	-	-2.4%
CH_4 (incl. LULUCF)	21	25.0	24.1	23.5	23.1	22.7	22.3	21.8	21.2	20.7	-	-35.1%	-	-2.4%
N_2O (excl. LULUCF)	310	25.5	24.8	24.5	24.5	24.0	24.0	22.7	22.4	22.1	-32.2%	-30.0%	-	-1.4%
N_2O (incl. LULUCF)	310	25.5	24.8	24.5	24.5	24.0	24.0	22.7	22.5	22.1	-	-30.1%	-	-1.4%
HFCs	HFC-134a : 1,300 etc.	16.2	13.7	13.8	10.6	10.6	11.7	13.3	15.3	16.7	-17.5%	-	-17.7%	9.0%
PFCs	PFC-14 : 6,500 etc.	7.9	7.4	7.2	7.5	7.0	7.3	6.4	4.6	3.3	-76.7%	-	-77.0%	-29.1%
SF_6	23,900	6.0	5.6	5.3	5.1	4.8	4.9	4.4	3.8	1.9	-89.1%	-	-89.1%	-51.2%
Gross Total (excl. LULUCF)		1,317.0	1,349.0	1,352.8	1,348.7	1,351.3	1,333.3	1,364.9	1,280.6	1,209.2	-4.1%	0.4%	-9.6%	-5.6%
Net Total (incl. LULUCF)		1,229.5	1,260.4	1,255.1	1,251.5	1,261.1	1,248.8	1,281.1	1,202.3	1,137.7	-	0.2%	-	-5.4%

* NA : Not Applicable
* NE : Not Estimated
* LULUCF: Land Use, Land-Use Change and Forestry

2.1.2. CO_2 Emissions per Capita

Total CO_2 emissions in FY 2009 (excluding LULUCF) were 1,145 million tonnes, and on a per capita basis, they were 8.98 tonnes. Compared to FY 1990, they increased by 0.3% in total emissions, and decreased by 2.8% in per capita emissions. Compared to the previous year, they decreased by 5.7% in total emissions, and decreased by 5.5% in per capita emissions.

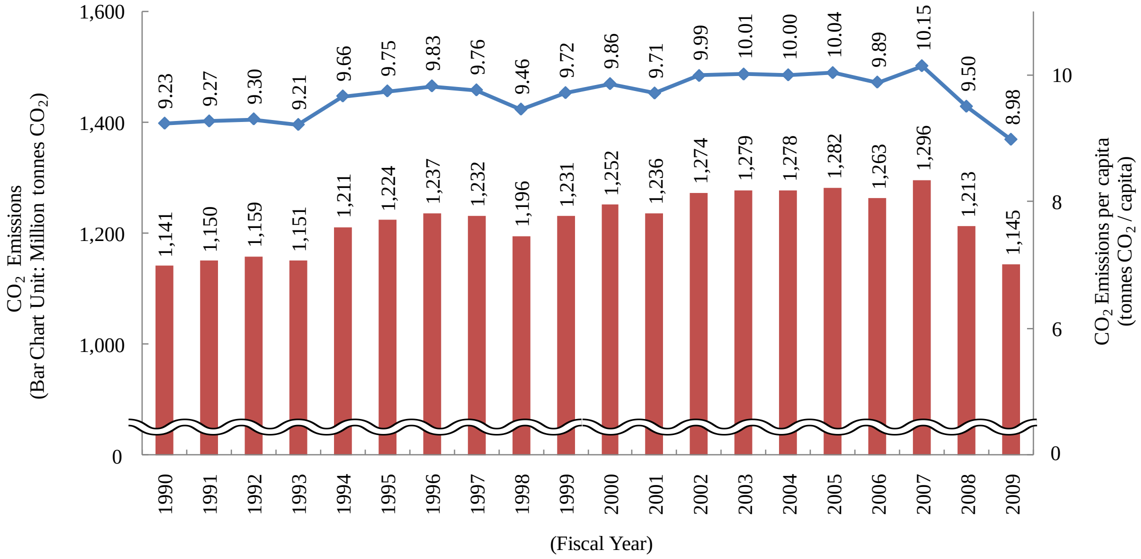

Figure 2-2 Trends in total CO_2 emissions and CO_2 emissions per capita

Source of population data: Ministry of Public Management, Home Affairs, Posts and Telecommunications Japan, *Population Census* and *Annual Report on Current Population Estimates*

2.1.3. CO_2 Emissions per Unit of GDP

Carbon dioxide emissions per unit of GDP (million yen) in FY 2009 were 2.17 tonnes. They decreased by 13.6% since FY 1990 and decreased by 3.4% compared to the previous year.

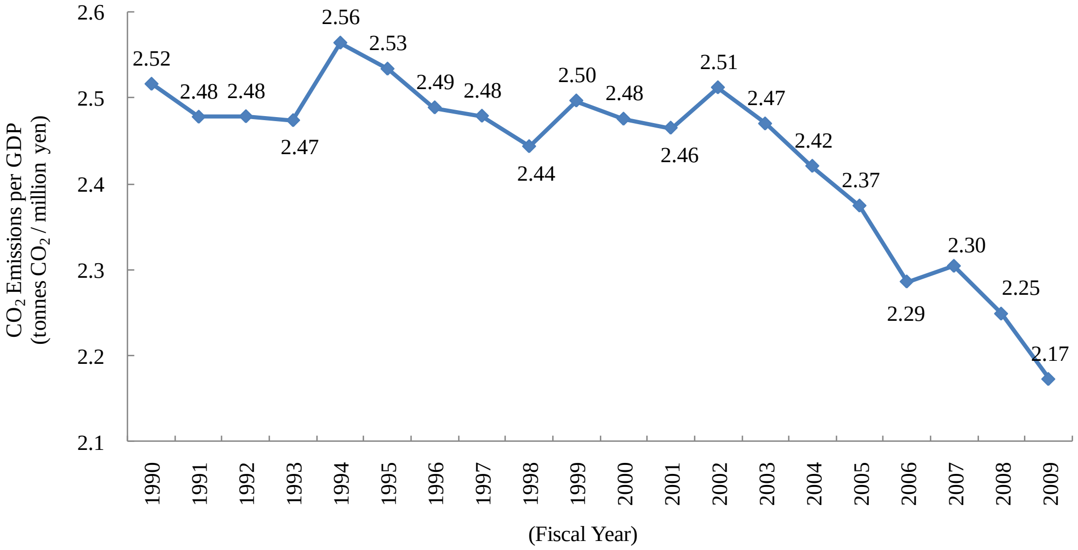

Figure 2-3 Trends in CO_2 emissions per unit of GDP

Source of GDP data: Cabinet Office, Government of Japan, *Annual Report on National Accounts*

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

2.2.1. CO_2

Carbon dioxide emissions in FY 2009 were 1,145 million tonnes (excluding LULUCF), accounting for 94.7% of total GHGs emissions. They increased by 0.3% since FY 1990 and decreased by 5.7% compared to the previous year.

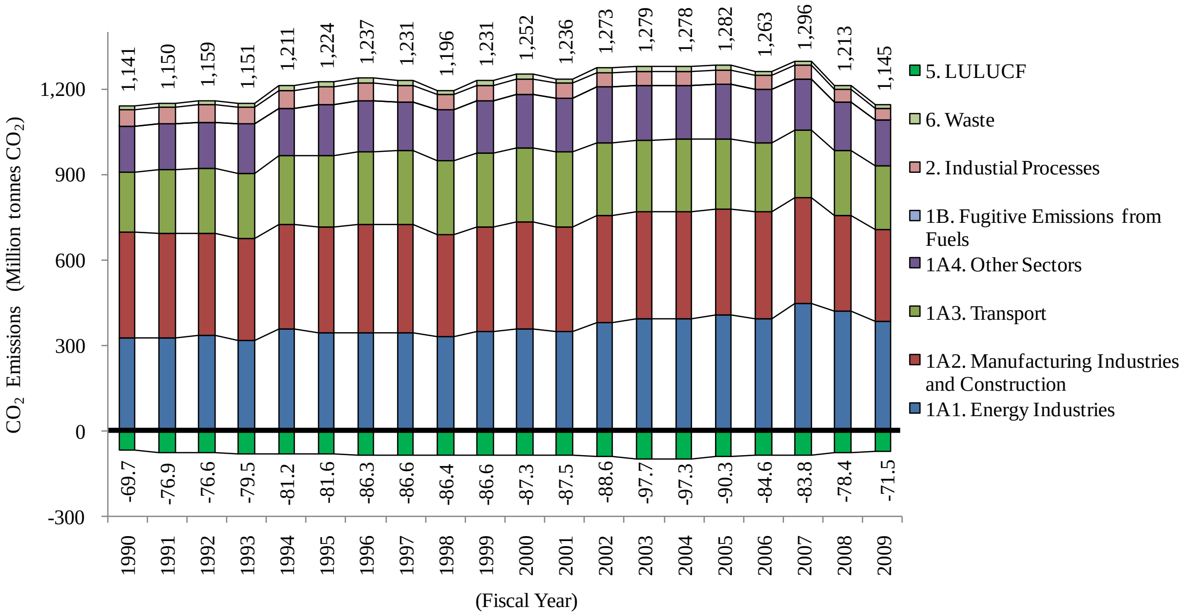

Figure 2-4 Trends in CO_2 emissions

The breakdown of CO_2 emissions in FY 2009 shows that the largest source is the Fuel Combustion, accounting for 95.2%. It is followed by the Industrial Processes (3.5%) and the Waste sectors (1.3%). As for the breakdown of CO_2 emissions within the Fuel Combustion, the Energy Industries accounts for 35.5% and is followed by the Industries at 29.2%, the Transport at 20.5%, and the Other Sectors[8] at 14.8%.

By looking at the changes in emissions by sector, emissions from the Fuel Combustion in the Energy Industries, which accounts for about 30% of total CO_2 emissions, increased by 19.2% since FY 1990 and decreased by 8.0% compared to the previous year. Emissions from the Industries decreased by 14.2% since FY 1990 and decreased by 5.2% compared to the previous year. Emissions from the Transport increased by 5.6% compared to FY 1990 and decreased by 2.3% compared to the previous year. Emissions from the Other Sectors increased by 0.1% since FY 1990 and decreased by 3.9% compared to the previous year.

The main driving factor for the decrease in CO_2 emissions compared to the previous year is the drop in energy demand of all the sub-sectors including the Industries sector as the result of the severe economic recession.

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[8] It covers emissions from Commercial/Institutional, Residential and Agriculture/Forestry/Fisheries.

Carbon dioxide removals in FY 2009 were 71.5 million tonnes, and they were equivalent to 5.9% of total GHGs emissions. They increased by 2.7% since FY 1990 and decreased by 8.7% compared to the previous year.

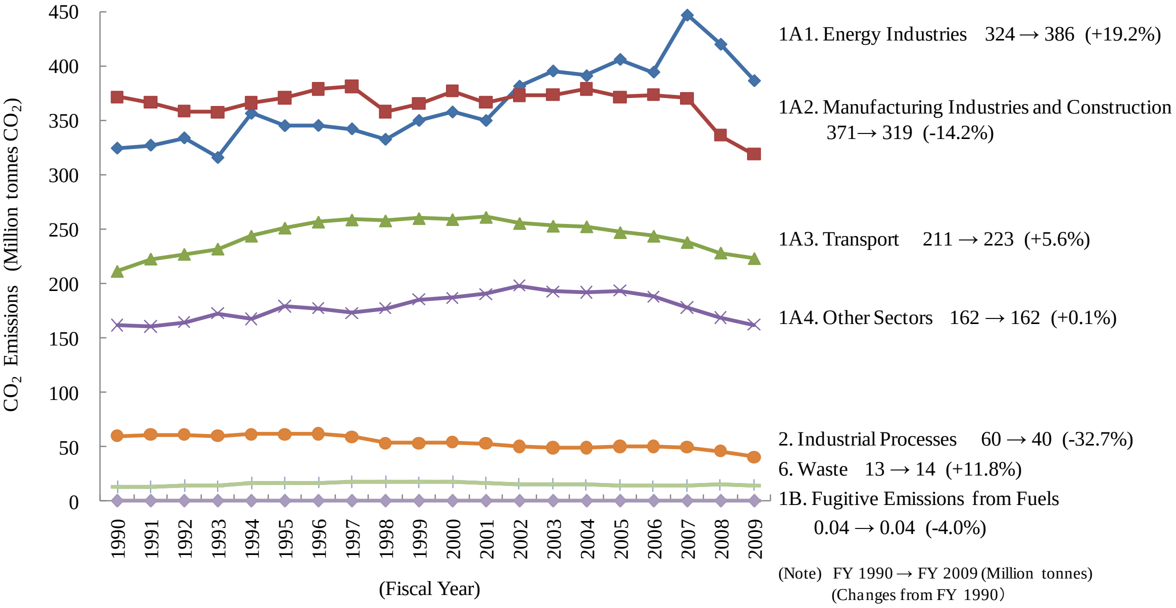

Figure 2-5 Trends in CO_2 emissions in each sector

(Figures in brackets indicate relative increase or decrease to the FY 1990 values)

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

[Thousand tonnes CO_2]

Category	1990	1995	2000	2005	2007	2008	2009
1A. Fuel Combustion	1,068,260	1,145,769	1,180,044	1,217,696	1,232,916	1,152,590	1,089,728
1A1. Energy Industries	324,253	344,948	357,574	406,038	446,855	419,991	386,429
Public Electricity and Heat Production	297,074	315,399	330,863	378,920	423,153	394,442	357,595
Petroleum Refining	15,893	16,956	17,285	16,441	16,018	14,324	14,564
Manufacture of Solid Fuels and Other Energy Industries	11,286	12,592	9,426	10,677	7,684	11,225	14,270
1A2. Manufacturing Industries and Construction	371,311	370,539	376,778	371,229	370,255	336,064	318,571
Iron and Steel	149,600	141,862	150,776	152,741	159,979	143,269	134,525
Non-Ferrous Metals	6,092	4,770	3,042	2,634	2,659	2,333	2,120
Chemicals	64,736	74,806	67,216	58,650	59,320	53,325	52,532
Pulp, Paper and Print	25,825	29,449	29,035	26,552	24,920	22,843	21,240
Food Processing, Beverages and Tobacco	13,129	14,407	13,161	11,326	9,776	8,862	8,728
Other Manufacturing	111,929	105,245	113,547	119,326	113,601	105,432	99,427
1A3. Transport	211,054	251,167	259,076	247,010	237,831	228,099	222,915
Civil Aviation	7,162	10,278	10,677	10,799	10,876	10,277	9,781
Road Transportation	189,228	225,381	232,827	222,652	214,161	205,933	201,943
Railways	932	819	707	644	624	600	600
Navigation	13,731	14,687	14,865	12,915	12,170	11,288	10,590
1A4. Other Sectors	161,641	179,115	186,615	193,419	177,975	168,436	161,813
Commercial/Institutional	83,593	93,269	101,450	110,678	102,731	98,756	93,568
Residential	56,668	66,320	68,958	67,583	62,590	59,023	57,792
Agriculture/Forestry/Fisheries	21,380	19,526	16,207	15,158	12,653	10,657	10,453
1B. Fugitive Emissions from Fuels	37	51	36	38	38	38	35
2. Industrial Processes	59,934	61,338	53,983	50,031	49,345	45,739	40,309
Mineral Products	55,369	56,761	49,842	46,903	46,142	43,009	37,708
Chemical Industry	4,209	4,220	3,893	2,887	2,990	2,574	2,488
Metal Production	356	357	248	242	212	156	112
5. LULUCF	-69,676	-81,583	-87,330	-90,298	-83,761	-78,351	-71,541
6. Waste	12,966	16,534	17,494	14,491	14,009	14,886	14,497
Total (including LULUCF)	1,071,520	1,142,110	1,164,227	1,191,957	1,212,545	1,134,902	1,073,029
Total (excluding LULUCF)	1,141,196	1,223,693	1,251,557	1,282,256	1,296,307	1,213,253	1,144,569

* LULUCF: Land Use, Land-Use Change and Forestry

2.2.2. CH$_4$

Methane emissions in FY 2009 were 20.7 million tonnes (in CO$_2$ eq., including LULUCF), accounting for 1.7% of total GHGs emissions. They decreased by 35.1% since FY 1990 and decreased by 2.4% compared to the previous year. Their decrease since FY 1990 (-56.8%) is mainly a result of a decrease in emissions from the Waste sector (e.g. Solid Waste Disposal on Land (SWDS)).

The breakdown of CH$_4$ emissions in FY 2009 shows that the largest source is the Enteric Fermentation, which accounts for 33%. It is followed by the Rice Cultivation (27%) and the SWDS (16%).

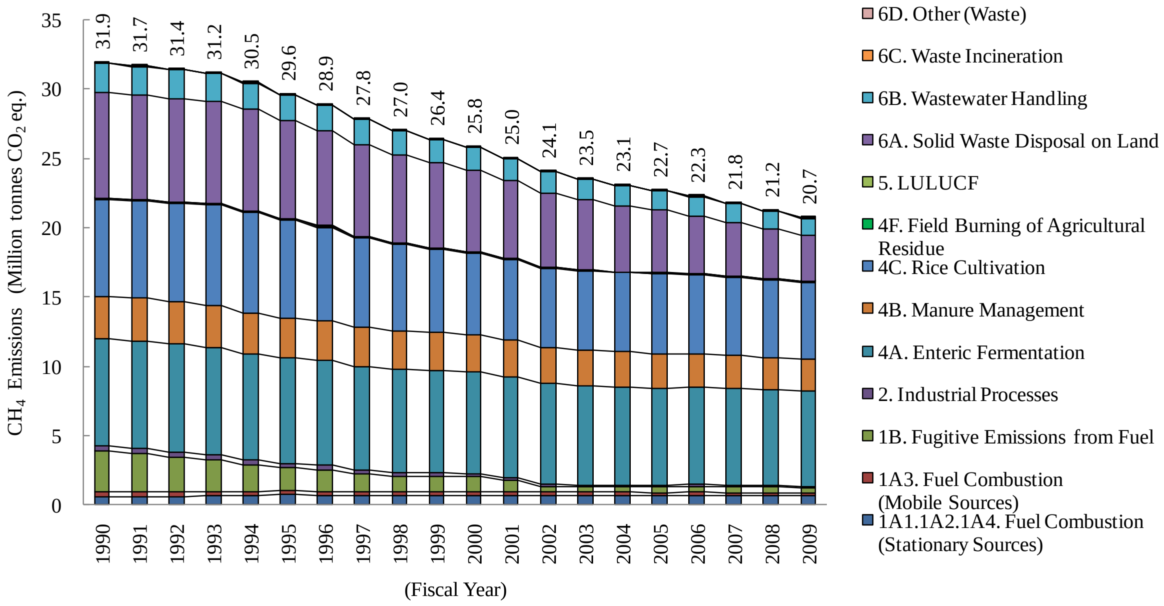

Figure 2-6 Trends in CH$_4$ emissions

Table 2-3 Trends in CH$_4$ emissions

[Thousand tonnes CO$_2$ eq.]

Category	1990	1995	2000	2005	2007	2008	2009
1A. Fuel Combustion	890	1,038	963	887	874	857	839
1A1. Energy Industries	30	34	44	37	45	44	42
1A2. Industries	355	438	352	351	370	360	364
1A3. Transport	297	308	298	237	207	190	186
1A4. Other Sectors	207	257	270	262	252	263	248
1B. Fugitive Emissions from Fuels	3,037	1,610	1,043	396	416	408	394
1B1. Solid Fuels	2,806	1,345	769	74	51	46	46
1B2. Oil & Natural Gas	231	265	274	322	365	362	348
2. Industrial Processes	358	322	196	134	134	121	110
4. Agriculture	17,831	17,676	16,045	15,310	15,068	14,898	14,779
4A. Enteric Fermentation	7,677	7,606	7,370	7,002	6,974	6,914	6,849
4B. Manure Management	3,094	2,893	2,678	2,503	2,376	2,321	2,300
4C. Rice Cultivation	6,960	7,083	5,920	5,739	5,652	5,599	5,567
4F. Field Burning of Agricultural Residue	101	94	77	65	65	64	63
5. LULUCF	8	9	8	9	2	22	9
6. Waste	9,786	8,959	7,543	5,949	5,270	4,928	4,587
6A. Solid Waste Disposal on Land	7,640	7,074	5,881	4,517	3,910	3,586	3,303
6B. Wastewater Handling	2,118	1,859	1,635	1,403	1,327	1,310	1,247
6C. Waste Incineration	13	15	13	14	12	12	11
6D. Other (Waste)	14	11	13	16	21	21	25
Total (including LULUCF)	31,910	29,614	25,797	22,685	21,764	21,235	20,717
Total (excluding LULUCF)	31,901	29,605	25,789	22,676	21,762	21,213	20,708

* LULUCF: Land Use, Land-Use Change and Forestry

2.2.3. N_2O

Nitrous oxide emissions in FY 2009 were 22.1 million tonnes (in CO_2 eq., including LULUCF), accounting for 1.8% of total GHGs emissions. They decreased by 30.1% since FY 1990 and decreased by 1.4% compared to the previous year. Their decrease since FY 1990 (-81%) is mainly a result of a decrease in emissions from Industrial Processes (e.g. adipic acid production). There is a sharp decline in emissions from the Industrial Processes from FY 1998 to 1999, as N_2O abatement equipment came on stream in the adipic acid production plant in March 1999. However the N_2O emissions increased in FY 2000 because of a decrease in the equipment's efficiency; the emissions decreased again in FY 2001 with the resumption of normal operation.

The breakdown of N_2O emissions in FY 2009 shows that the largest source is the Agricultural Soils accounting for 26%. It is followed by the Manure Management (22%) and the Fuel Combustion (Stationary Sources) (20%).

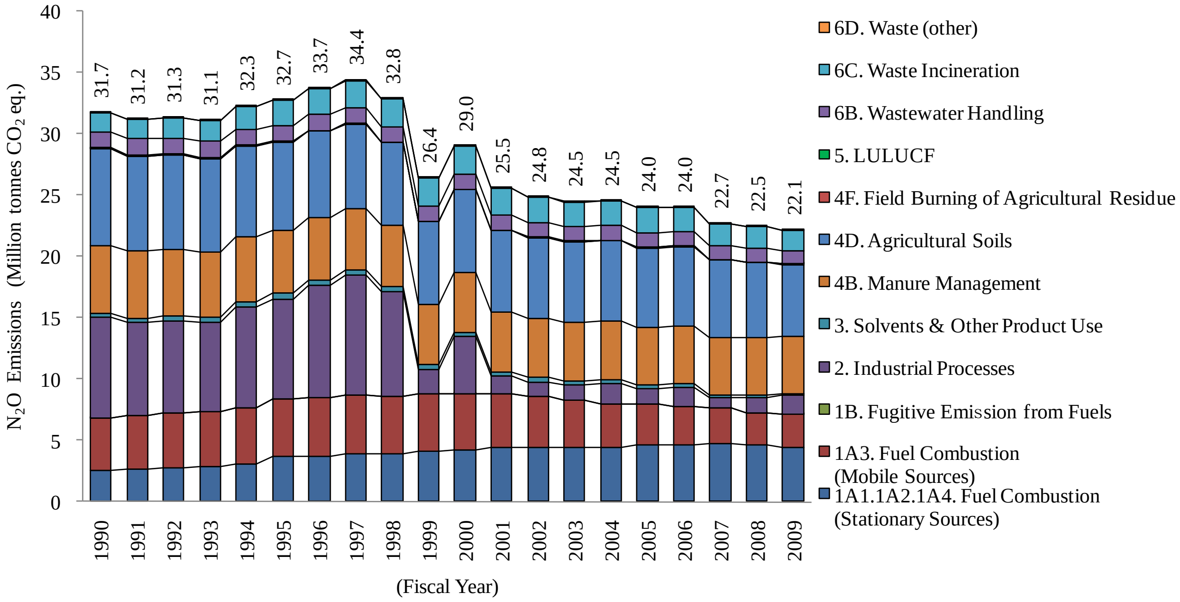

Figure 2-7 Trends in N_2O emissions

Table 2-4 Trends in N_2O emissions

[Thousand tonnes CO_2 eq.]

Category	1990	1995	2000	2005	2007	2008	2009
1A. Fuel Combustion	6,778	8,346	8,821	7,945	7,641	7,279	7,091
1A1. Energy Industries	927	1,433	1,719	2,157	2,220	2,156	2,070
1A2. Industries	1,374	1,916	2,153	2,118	2,173	2,104	2,023
1A3. Transport	4,204	4,650	4,587	3,289	2,891	2,678	2,667
1A4. Other Sectors	273	348	363	380	357	342	330
1B. Fugitive Emissions from Fuels	0.1	0.2	0.1	0.1	0.1	0.1	0
2. Industrial Processes	8,267	8,213	4,690	1,300	860	1,262	1,559
3. Solvent & Other Product Use	287	438	341	266	160	129	120
4. Agriculture	13,464	12,394	11,613	11,239	11,061	10,860	10,624
4B. Manure Management	5,533	5,152	4,885	4,749	4,773	4,762	4,761
4D. Agricultural Soils	7,898	7,210	6,703	6,468	6,267	6,077	5,842
4F. Field Burning of Agricultural Residue	33	32	25	21	21	21	20
5. LULUCF	91	62	33	16	12	11	8
6. Waste	2,819	3,266	3,481	3,271	2,968	2,914	2,747
6B. Wastewater Handling	1,287	1,244	1,209	1,160	1,140	1,157	1,087
6C. Waste Incineration	1,519	2,012	2,260	2,096	1,809	1,738	1,637
6D. Waste (other)	13	10	12	14	18	18	22
Total (including LULUCF)	31,706	32,719	28,979	24,036	22,701	22,455	22,150
Total (excluding LULUCF)	31,615	32,657	28,946	24,021	22,689	22,444	22,141

* LULUCF: Land Use, Land-Use Change and Forestry

2.2.4. HFCs

Hydrofluorocarbons emissions in CY 2009[9] were 16.7 million tonnes (in CO_2 eq.), accounting for 1.4% of total GHGs emissions. They decreased by 17.7% since CY 1995, and increased by 9.0% compared to the previous year. Their decrease since CY 1995 (-99.8%) is mainly a result of a decrease in HFC-23, a by-product of HCFC-22 production.

The breakdown of HFCs emissions in CY 2009 shows that the largest source is refrigerants of the Refrigeration and Air Conditioning Equipment accounting for 92%, and is followed by the Aerosols / MDI (5%).

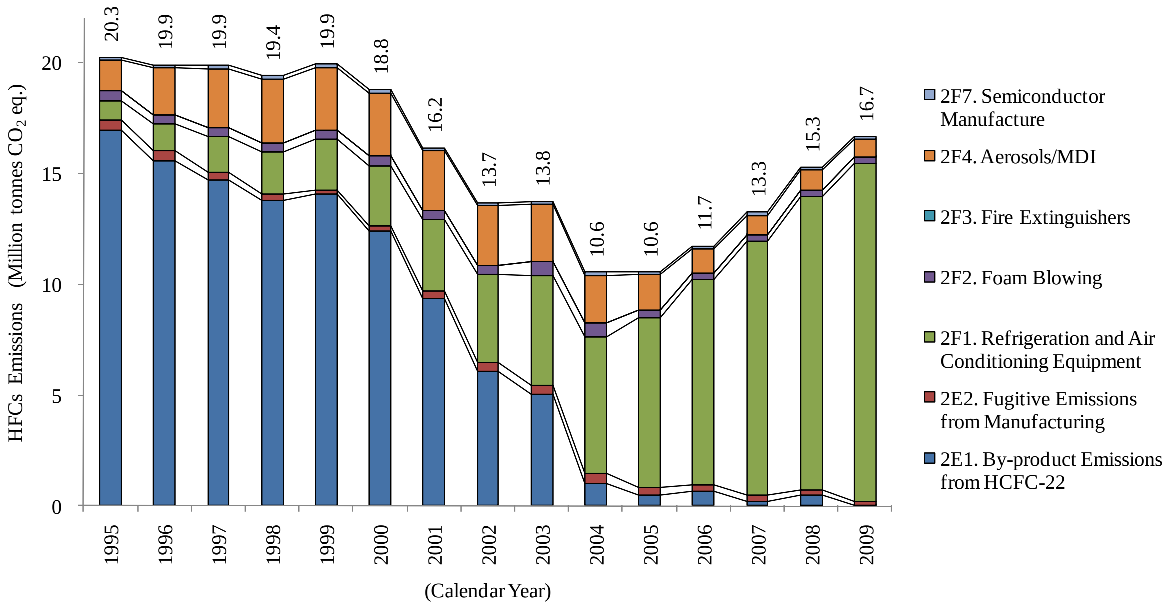

Figure 2-8 Trends in HFCs emissions

Table 2-5 Trends in HFCs emissions

[Thousand tonnes CO_2 eq.]

Category	1995	2000	2005	2007	2008	2009
2E. Productions of F-gas	17,445	12,660	816	498	701	222
2E1. By-product Emissions from Production of HCFC-22	16,965	12,402	463	218	469	40
2E2. Fugitive Emissions	480	258	353	280	232	182
2F. Consumption of F-gases	2,815	6,141	9,750	12,782	14,597	16,450
2F1. Refrigeration and Air Conditioning Equipment	840	2,689	7,667	11,445	13,269	15,251
2F2. Foam Blowing	452	440	364	317	286	290
2F3. Fire Extinguishers	NE,NO	3.7	5.9	6.2	6.3	7
2F4. Aerosols/MDI	1,365	2,834	1,572	850	890	809
2F7. Semiconductor Manufacture	158	174	141	164	146	92
Total	20,260	18,800	10,566	13,279	15,298	16,672

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[9] Emissions of HFCs, PFCs and SF_6 are estimated on a calendar year (CY) basis.

2.2.5. PFCs

Perfluorocarbons emissions in CY 2009 were 3.3 million tonnes (in CO_2 eq.), accounting for 0.3% of total GHGs emissions. They decreased by 77.0% since CY 1995, and decreased by 29.1% compared to the previous year. Their decrease since CY 1995 (-89%) is mainly a result of a decrease in emissions from the Solvents.

The breakdown of PFCs emissions in CY 2009 shows that the largest source is the Semiconductor for Manufacture accounting for 52%. It is followed by the Solvents such as the ones for washing metals (35%) and the Fugitive Emissions from manufacturing (12%).

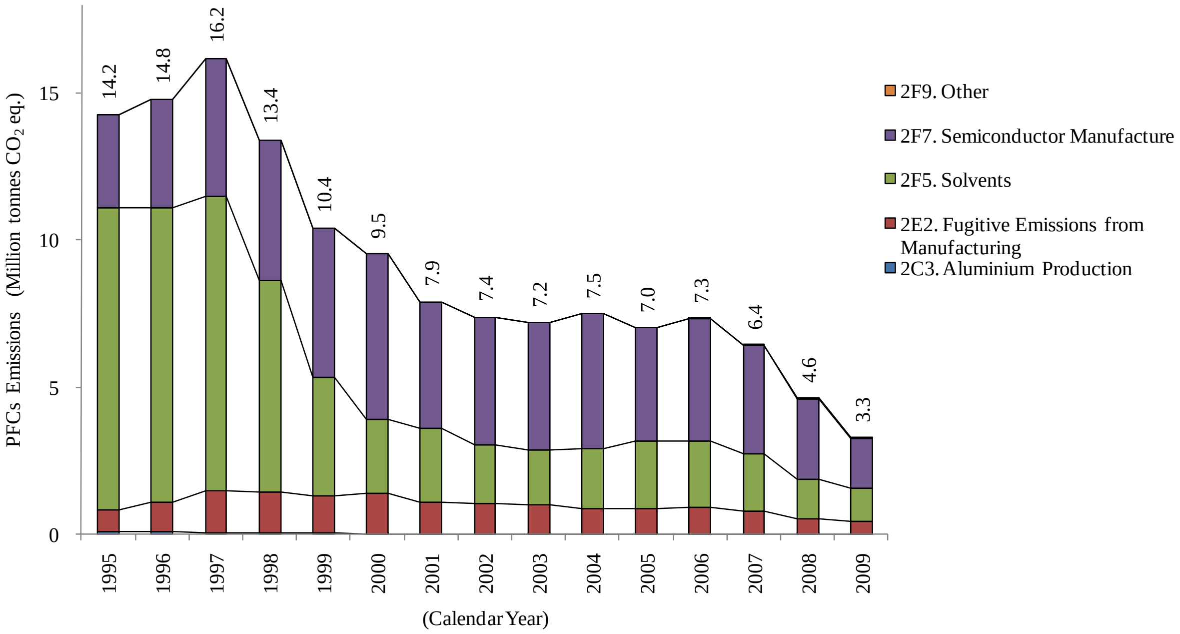

Figure 2-9 Trends in PFCs emissions

Table 2-6 Trends in PFCs emissions

[Thousand tonnes CO_2 eq.]

Category	1995	2000	2005	2007	2008	2009
2C3. Aluminium Production	70	18	15	15	15	11
2E2. Fugitive Emissions	763	1,359	837	783	524	399
2F. Consumption of F-gases	13,408	8,143	6,150	5,614	4,078	2,861
2F5. Solvents	10,264	2,506	2,289	1,927	1,318	1,142
2F7. Semiconductor Manufacture	3,144	5,637	3,861	3,685	2,756	1,715
2F9. Other	NE,NO	NE,NO	NE,NO	1.9	2.8	4
Total	14,240	9,519	7,002	6,412	4,616	3,271

2.2.6. SF_6

Sulphur hexafluoride emissions in CY 2009 were 1.9 million tonnes (in CO_2 eq.), accounting for 0.2% of total GHGs emissions. They decreased by 89.1% since CY 1995, and decreased by 51.2% compared to the previous year. Their decrease since CY 1995 (-93%) is mainly a result of a decrease from the Electrical Equipment, due to the strengthening of the management of gases largely in electric power companies.

The breakdown of SF_6 emissions in CY 2009 shows that the largest source is Electrical Equipment accounting for 40%. It is followed by Semiconductor Manufacture (33%) and Fugitive Emissions (14%).

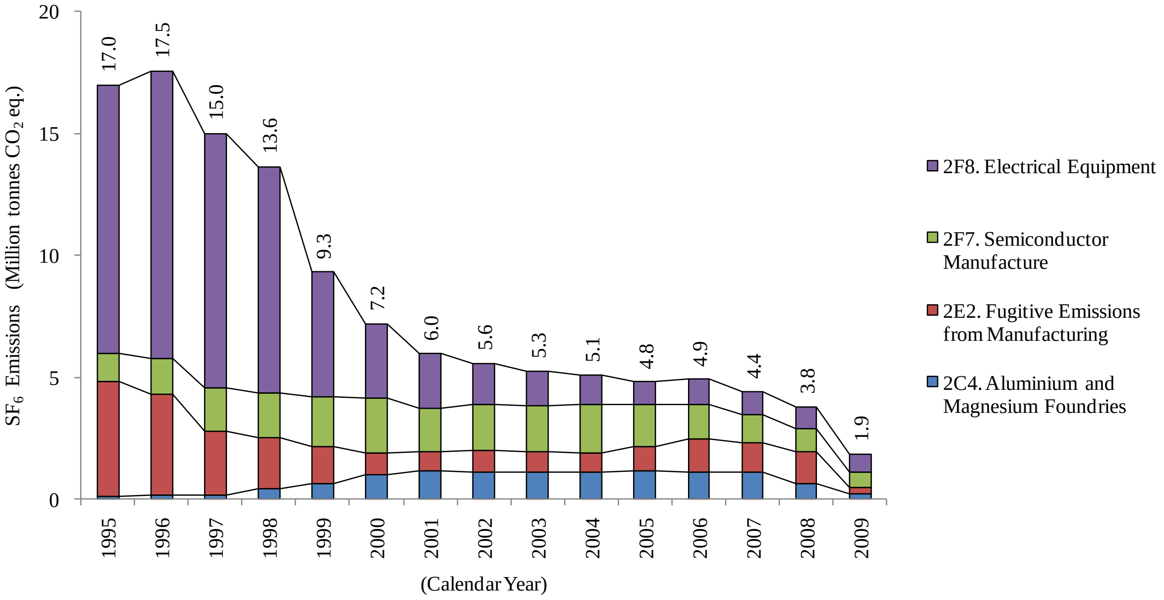

Figure 2-10 Trends in SF_6 emissions

Table 2-7 Trends in SF_6 emissions

[Thousand tonnes CO_2 eq.]

Category	1995	2000	2005	2007	2008	2009
2C4. SF_6 Used in Aluminium and Magnesium Foundries	120	1,028	1,157	1,089	652	239
2E2. Fugitive Emissions	4,708	860	975	1,199	1,288	261
2F. Consumption of F-gases	12,134	5,300	2,676	2,119	1,855	1,352
2F7. Semiconductor Manufacture	1,129	2,250	1,733	1,197	952	606
2F8. Electrical Equipment	11,005	3,050	943	922	902	745
Total	16,961	7,188	4,808	4,407	3,795	1,851

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

The breakdown of GHGs emissions and removals in FY 2009 by sector[10] shows that the Energy accounts for 90.8% of total GHGs emissions. It is followed by the Industrial Processes (5.3%), the Agriculture (2.1%), the Waste (1.8%) and the Solvents and Other Product Use (0.01%).

Removals by the LULUCF in FY 2009 were equivalent to 5.9% of total GHGs emissions.

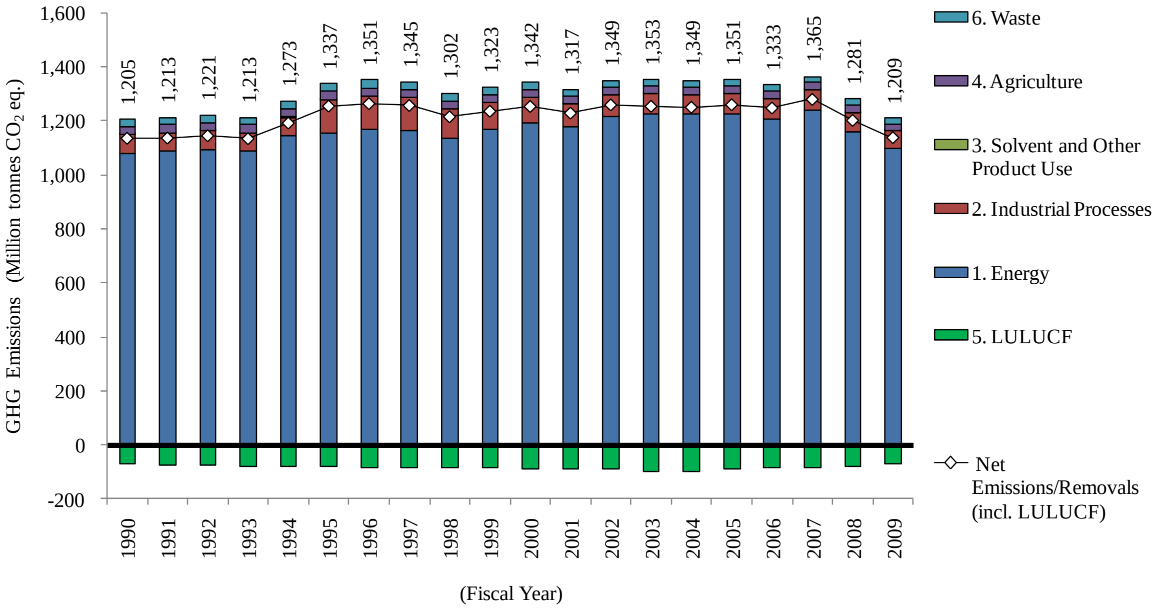

Figure 2-11 Trends in greenhouse gas emissions and removals in each sector

Table 2-8 Trends in greenhouse gas emissions and removals in each sector

[Million tonnes CO_2 eq.]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy	1,079.0	1,086.9	1,094.2	1,087.7	1,143.7	1,156.8	1,169.0	1,165.9	1,135.7	1,171.0	1,190.9
2. Industrial Processes	68.6	68.9	68.8	67.6	69.8	121.3	123.5	120.1	108.6	95.3	94.4
3. 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
4. Agriculture	31.3	31.2	31.2	31.1	30.7	30.1	29.4	28.8	28.3	27.9	27.7
5. LULUCF	-69.6	-76.8	-76.5	-79.4	-81.1	-81.5	-86.2	-86.5	-86.4	-86.6	-87.3
6. Waste	25.6	25.5	26.6	26.2	28.6	28.8	29.1	29.5	29.1	28.7	28.5
Net Emissions/Removals (incl. LULUCF)	1,135.1	1,136.1	1,144.7	1,133.7	1,192.2	1,255.9	1,265.1	1,258.2	1,215.8	1,236.7	1,254.5
Emissions (excl. LULUCF)	1,204.7	1,212.9	1,221.2	1,213.1	1,273.3	1,337.4	1,351.3	1,344.7	1,302.2	1,323.3	1,341.8

[Million tonnes CO_2 eq.]	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Energy	1,178.0	1,217.8	1,223.5	1,223.3	1,227.0	1,208.4	1,241.9	1,161.2	1,098.1
2. Industrial Processes	84.4	78.0	76.7	73.9	73.8	75.8	74.4	70.8	63.8
3. Solvent and Other Product Use	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1
4. Agriculture	27.4	27.1	26.9	26.7	26.5	26.5	26.1	25.8	25.4
5. LULUCF	-87.4	-88.6	-97.7	-97.2	-90.3	-84.5	-83.7	-78.3	-71.5
6. Waste	26.8	25.7	25.4	24.5	23.7	22.4	22.2	22.7	21.8
Net Emissions/Removals (incl. LULUCF)	1,229.5	1,260.4	1,255.1	1,251.5	1,261.1	1,248.8	1,281.1	1,202.3	1,137.7
Emissions (excl. LULUCF)	1,317.0	1,349.0	1,352.8	1,348.7	1,351.3	1,333.3	1,364.9	1,280.6	1,209.2

* LULUCF: Land Use, Land-Use Change and Forestry

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

2.3.1. Energy

Emissions from the Energy sector in FY 2009 were 1,098 million tonnes (in CO_2 equivalents). They increased by 1.8% since FY 1990 and decreased by 5.4% compared to the previous year.

The breakdown of GHGs emissions from this sector in FY 2009 shows that CO_2 from Fuel Combustion accounts for 99.2%. The largest source within the Fuel Combustion is the Liquid Fuel CO_2, which accounted for 43%, and is then followed by the Solid Fuel CO_2 (37%) and the Gaseous Fuel CO_2 (18%).

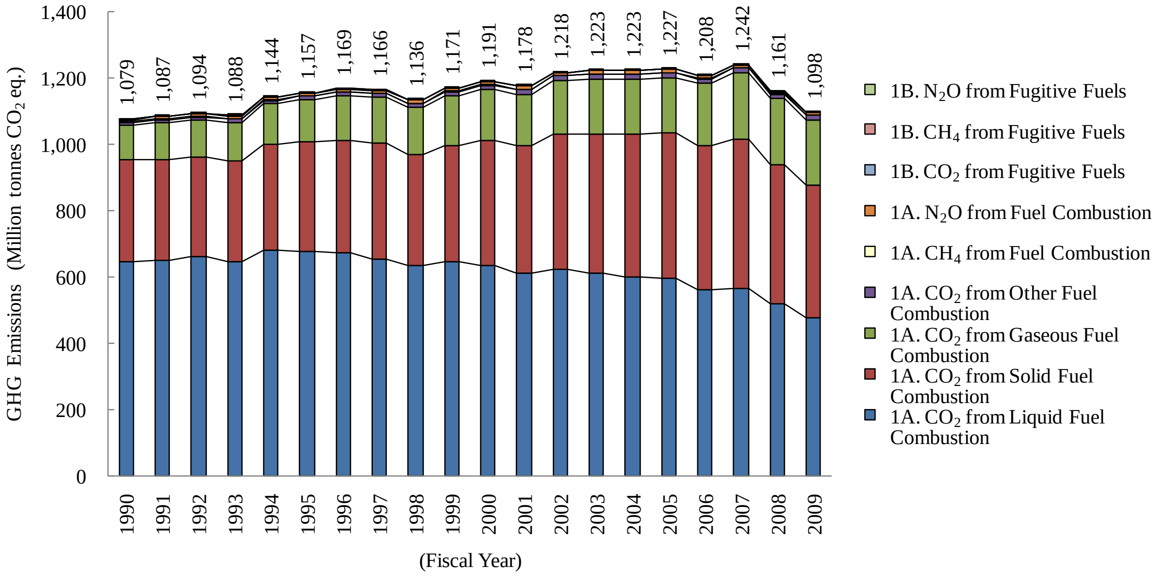

Figure 2-12 Trends in greenhouse gas emissions from the Energy sector

Table 2-9 Trends in greenhouse gas emissions from the Energy sector

[Thousand tonnes CO_2 eq.]

Source Category	1990	1995	2000	2005	2007	2008	2009
1A. Fuel Combustion	1,075,928	1,155,153	1,189,828	1,226,528	1,241,430	1,160,727	1,097,658
Liquid Euel CO_2	646,223	677,349	635,121	597,813	563,675	518,395	475,108
Solid Fuel CO_2	308,620	331,720	376,521	437,937	451,548	420,521	401,542
Gaseous Fuel CO_2	104,301	126,198	155,261	166,823	203,273	199,525	198,689
Other Fuels CO_2 (Waste)	9,116	10,503	13,142	15,122	14,419	14,149	14,390
CH_4	890	1,038	963	887	874	857	839
N_2O	6,778	8,346	8,821	7,945	7,641	7,279	7,091
1B. Fugitive Emissions from Fuel	3,074	1,661	1,079	433	454	446	429
CO_2	37	51	36	38	38	38	35
CH_4	3,037	1,610	1,043	396	416	408	394
N_2O	0.1	0.2	0.1	0.1	0.1	0.1	0.1
Total	1,079,002	1,156,814	1,190,907	1,226,961	1,241,884	1,161,173	1,098,088

2.3.2. Industrial Processes

Emissions from the Industrial Processes sector in FY 2009 were 63.8 million tonnes (in CO_2 eq.). They decreased by 7.0% since FY 1990, and decreased by 10.0% compared to the previous year.

It should be noted that actual emissions of HFCs, PFCs, and SF_6 are not estimated (NE) for CY 1990 to 1994.

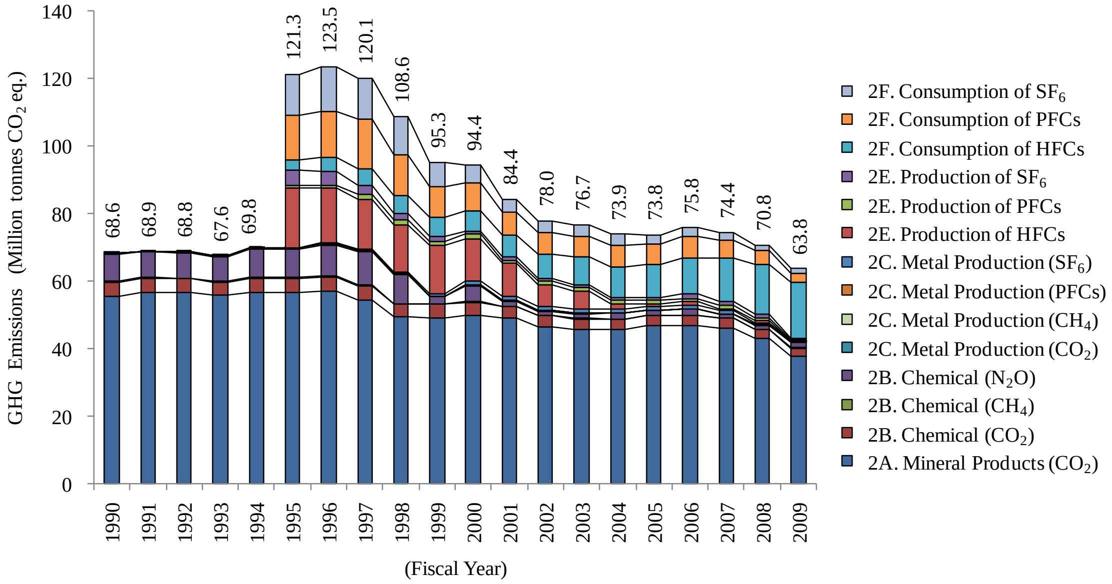

Figure 2-13 Trends in greenhouse gas emissions from the Industrial Processes sector

The breakdown of GHGs emissions from this sector in FY 2009 shows that the largest source is the Mineral Products such as CO_2 emissions from limestone in the cement production, accounting for 59%. It is followed by the Consumption of HFCs (26%) and the Consumption of PFCs (4%).

The main driving factors for decreases in CO_2, CH_4 and N_2O emissions since FY 1990 are the decrease in CO_2 emissions from cement production as the clinker production declined, and the decrease in N_2O emissions from adipic acid production as the N_2O abatement equipment came on stream. The main driving factors for decreases in HFCs, PFCs and SF_6 emissions since CY 1995 are the promotion of substitute materials use and of the capture and destruction of these gases.

Table 2-10 Trends in greenhouse gas emissions from the Industrial Processes sector

[Thousand tonnes CO_2 eq.]

Category	1990	1995	2000	2005	2007	2008	2009
2A. Mineral Products (CO_2)	55,369	56,761	49,842	46,903	46,142	43,009	37,708
2B. Chemical Industry	12,814	12,737	8,762	4,304	3,967	3,943	4,144
CO_2	4,209	4,220	3,893	2,887	2,990	2,574	2,488
CH_4	338	304	179	117	117	106	97
N_2O	8,267	8,213	4,690	1,300	860	1,262	1,559
2C. Metal Production	375	564	1,311	1,431	1,333	838	375
CO_2	356	357	248	242	212	156	112
CH_4	19	18	17	17	17	15	13
PFCs	NE	70	18	15	15	15	11
SF_6	NE	120	1,028	1,157	1,089	652	239
2E. Production of F-gas	NE	22,916	14,879	2,629	2,479	2,513	882
HFCs	NE	17,445	12,660	816	498	701	222
PFCs	NE	763	1,359	837	783	524	399
SF_6	NE	4,708	860	975	1,199	1,288	261
2F. Consumption of F-gas	NE	28,356	19,584	18,576	20,515	20,529	20,662
HFCs	NE	2,815	6,141	9,750	12,782	14,597	16,450
PFCs	NE	13,408	8,143	6,150	5,614	4,078	2,861
SF_6	NE	12,134	5,300	2,676	2,119	1,855	1,352
Total	68,559	121,335	94,377	73,842	74,438	70,832	63,772

2.3.3. Solvent and Other Product Use

Emissions from the Solvents and Other Product Use sector in FY 2009 were 120 thousand tonnes (in CO_2 eq.). They decreased by 58.0% since FY 1990, and decreased by 6.7% compared to the previous year. The only substance subject for estimation in this sector is laughing gas (N_2O) used as a general anesthetic in hospitals.

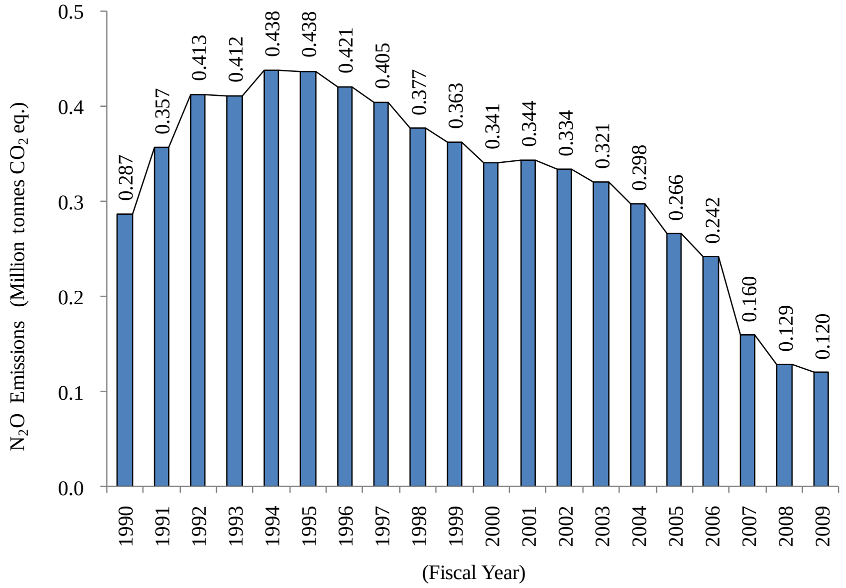

Figure 2-14 Trends in greenhouse gas emissions from the Solvent and Other Product Use sector

2.3.4. Agriculture

Emissions from the Agriculture sector in FY 2009 were 25.4 million tonnes (in CO_2 eq.). They decreased by 18.8% since FY 1990 and decreased by 1.4% compared to the previous year.

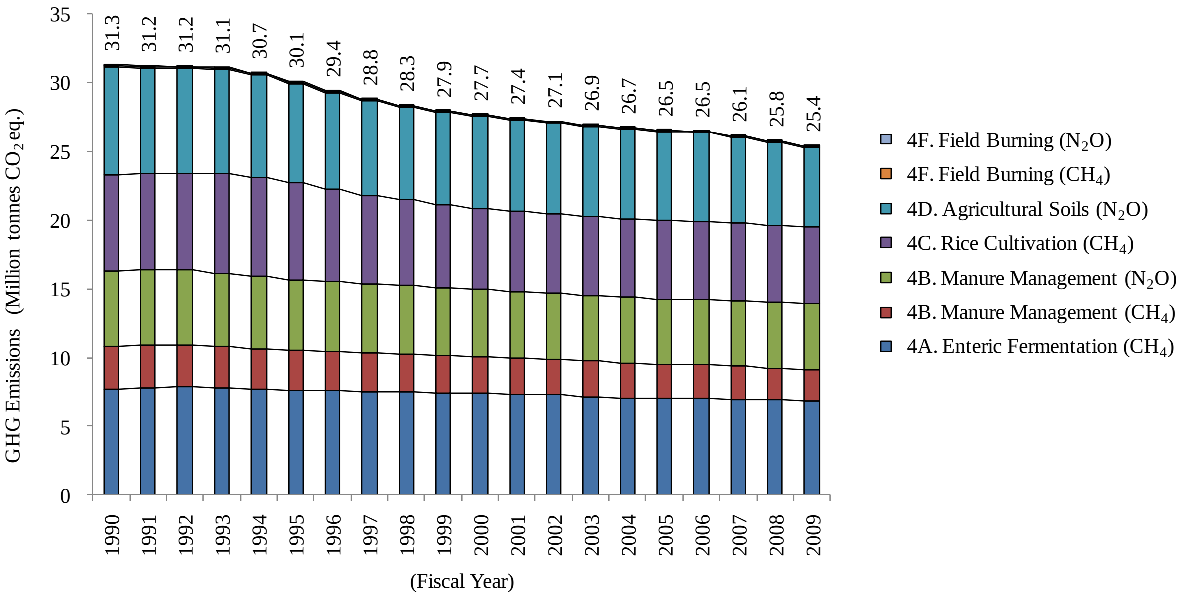

Figure 2-15 Trends in greenhouse gas emissions from the Agriculture sector

The breakdown of GHGs emissions from this sector in FY 2009 shows that the largest source is the Enteric Fermentation accounting for 27%. It is followed by the Agricultural Soils (23%) as a result of the nitrogen-based fertilizer applications, and the Rice Cultivation (22%).

The main driving factor for decrease in emissions since FY 1990 is the decrease in CH_4 emissions from the Rice Cultivation as a result of crop acreage decline, and the decrease in N_2O emissions from the Agricultural Soils, because the amount of nitrogen fertilizers applied to cropland had decreased.

Table 2-11 Trends in greenhouse gas emissions from the Agriculture sector

[Thousand tonnes CO_2 eq.]

Category	1990	1995	2000	2005	2007	2008	2009
4A. Enteric Fermentation(CH_4)	7,677	7,606	7,370	7,002	6,974	6,914	6,849
4B. Manure Management	8,627	8,045	7,563	7,253	7,150	7,083	7,061
CH_4	3,094	2,893	2,678	2,503	2,376	2,321	2,300
N_2O	5,533	5,152	4,885	4,749	4,773	4,762	4,761
4C. Rice Cultivation(CH_4)	6,960	7,083	5,920	5,739	5,652	5,599	5,567
4D. Agricultural Soils (N_2O)	7,898	7,210	6,703	6,468	6,267	6,077	5,842
4F. Field Burning of Agricultural Res	133	126	103	87	85	85	83
CH_4	101	94	77	65	65	64	63
N_2O	33	32	25	21	21	21	20
Total	31,295	30,070	27,658	26,549	26,128	25,757	25,402

2.3.5. Land Use, Land Use Change and Forestry (LULUCF)

Net Removals (including CO_2, CH_4 and N_2O emissions) from the LULUCF sector in FY 2009 was 71.5 million tonnes (in CO_2 eq.). They increased by 2.8% since FY 1990 and decreased by 8.7% compared to the previous year.

The breakdown of GHGs emissions and removals from this sector in FY 2009 shows that the largest sink is the Forest land and its removals were 73.7 million tonnes accounting for 103% of this sector's net total emissions / removals.

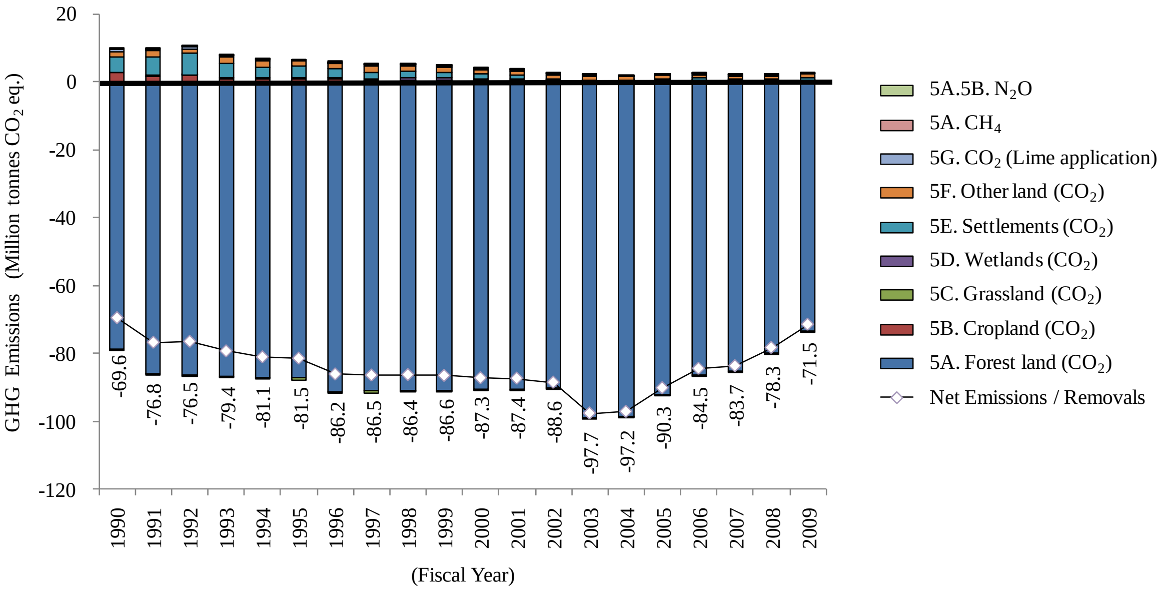

Figure 2-16 Trends in greenhouse gas emissions and removals from the LULUCF sector

Table 2-12 Trends in greenhouse gas emissions and removals from the LULUCF sector

[Thousand tonnes CO_2 eq.]

Category	1990	1995	2000	2005	2007	2008	2009
5A. Forest land	-78,627	-87,350	-90,696	-92,010	-85,233	-79,910	-73,668
CO_2	-78,636	-87,359	-90,705	-92,020	-85,235	-79,934	-73,678
CH_4	8	9	8	9	2	22	9
N_2O	0.8	0.9	0.8	0.9	0.2	2.2	1
5B. Cropland	2,623	886	388	292	270	233	265
CO_2	2,533	826	356	277	259	224	258
CH_4	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
N_2O	90	61	32	15	11	8	8
5C. Grassland	-441	-481	-406	-336	-315	-303	-276
CO_2	-441	-481	-406	-336	-315	-303	-276
CH_4	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
5D. Wetlands	87	363	453	16	29	16	23
CO_2	87	363	453	16	29	16	23
CH_4	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
5E. Settlements	4,665	3,278	1,407	578	623	506	816
CO_2	4,665	3,278	1,407	578	623	506	816
CH_4	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
5F. Other land	1,567	1,487	1,231	955	553	834	1,049
CO_2	1,567	1,487	1,231	955	553	834	1,049
CH_4	NO	NO	NO	NO	NO	NO	NO
N_2O	NO	NO	NO	NO	NO	NO	NO
5G. Other	550	303	333	231	325	306	268
CO_2	550	303	333	231	325	306	268
Total	-69,577	-81,513	-87,289	-90,273	-83,748	-78,318	-71,523

2.3.6. Waste

Emissions from the Waste sector in FY 2009 were 21.8 million tonnes (in CO_2 eq.). They decreased by 14.6% since FY 1990 and decreased by 4.0% compared to the previous year.

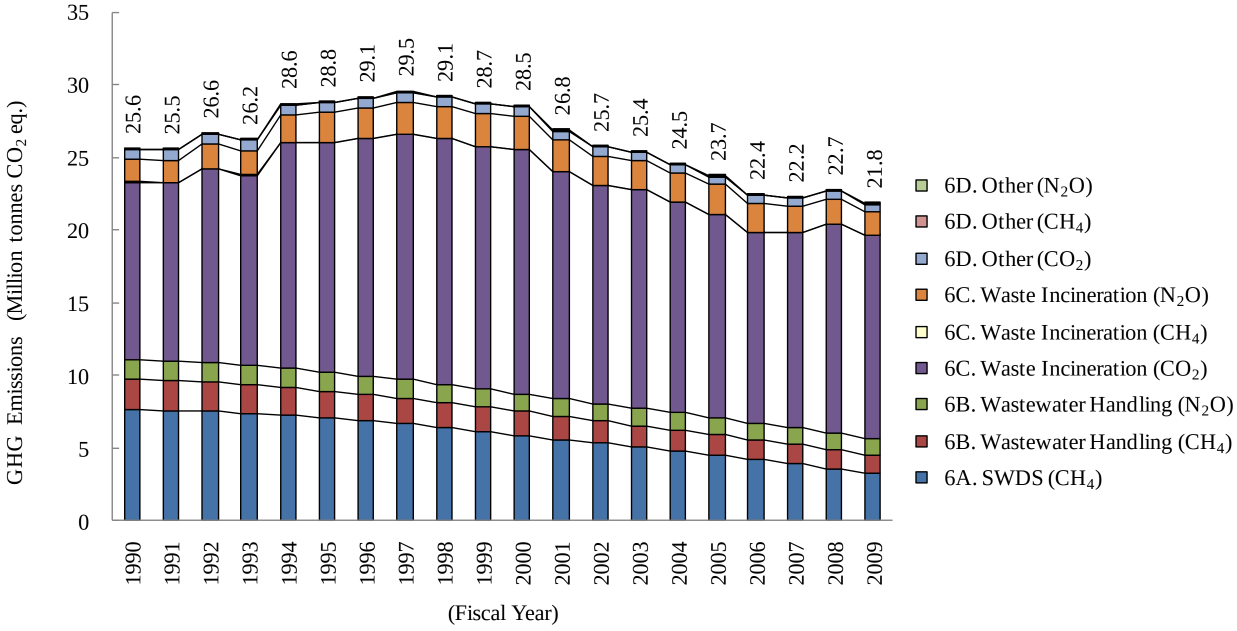

Figure 2-17 Trends in greenhouse gas emissions from the Waste sector

The breakdown of GHGs emissions from this sector in FY 2009 shows that the largest source is the Waste Incineration (CO_2), associated with waste derived from fossil fuels such as waste plastic and waste oil, accounting for 64%. It is followed by the SWDS (CH_4) (15%) and the Waste Incineration (N_2O) (8%), associated with waste substances including those that do not have a fossil fuel origin.

The main driving factor for decrease in emissions since FY 1990 is the decrease in CH_4 emissions from the SWDS as a result of decrease in the amount of waste to be disposed of.

Table 2-13 Trends in greenhouse gas emissions from the Waste sector

[Thousand tonnes CO_2 eq.]

Category	1990	1995	2000	2005	2007	2008	2009
6A. Solid Waste Disposal on Land (CH_4)	7,640	7,074	5,881	4,517	3,910	3,586	3,303
6B. Wastewater Handling	3,405	3,103	2,844	2,563	2,467	2,466	2,335
CH_4	2,118	1,859	1,635	1,403	1,327	1,310	1,247
N_2O	1,287	1,244	1,209	1,160	1,140	1,157	1,087
6C. Waste Incineration	13,796	17,894	19,111	16,095	15,269	16,106	15,632
CO_2	12,263	15,867	16,838	13,984	13,448	14,356	13,984
CH_4	13	15	13	14	12	12	11
N_2O	1,519	2,012	2,260	2,096	1,809	1,738	1,637
6D. Other	730	689	681	537	600	570	560
CO_2	703	668	656	507	561	530	514
CH_4	14	11	13	16	21	21	25
N_2O	13	10	12	14	18	18	22
Total	25,571	28,760	28,517	23,711	22,247	22,728	21,831

2.4. Description and Interpretation of Emission Trends for Indirect GHGs and SO_2

Under the UNFCCC, it is required to report emissions not only 6 types of GHGs (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) that are controlled by the Kyoto Protocol, but also emissions of indirect GHGs (NO_X, CO and NMVOC) as well as SO_2. Their emission trends are indicated below.

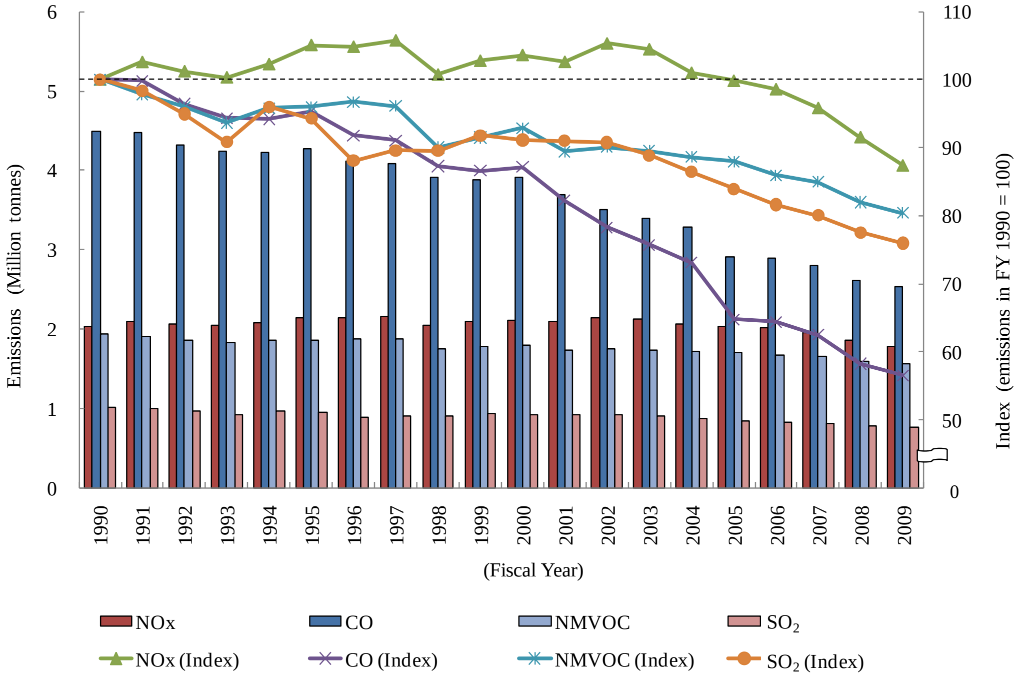

Figure 2-18 Trends in emissions of indirect greenhouse gases and SO_2

Nitrogen oxide (NO_X) emissions in FY 2009 were 1,782 thousand tonnes. They decreased by 12.6% since FY 1990 and decreased by 4.5% compared to the previous year.

Carbon monoxide (CO) emissions in FY 2009 were 2,535 thousand tonnes. They decreased by 43.5% since FY 1990 and decreased by 3.0% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY 2009 were 1,563 thousand tonnes. They decrease by 19.6% since FY 1990 and decreased by 1.9% compared to the previous year.

Sulfur dioxide (SO_2) emissions in FY 2009 were 769 thousand tonnes. They decreased by 24.0% since FY 1990 and decreased by 2.0% compared to the previous year.

References

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2. Intergovernmental Panel on Climate Change, *Second Assessment Report, 1995.*
3. Ministry of Public Management, Home Affairs, Posts and Telecommunications Japan, *Annual Report on Current Population Estimates.*
4. Ministry of Public Management, Home Affairs, Posts and Telecommunications Japan, *Population Census.*
5. Ministry of the Environment, Committee for the Greenhouse Gases Emissions Estimation Methods, GHGs Estimation Methods Committee Report, February 2006.

Chapter 3. Energy (CRF sector 1)

3.1. Overview of Sector

Emissions from the energy sector consist of two main categories: fuel combustion and fugitive emissions from fuels. Fuel combustion includes emissions released into the atmosphere when fossil fuels (e.g., coal, oil products, and natural gas) are combusted. Fugitive emissions are intentional or unintentional releases of gases from fossil fuels by anthropogenic activities.

In Japan, fossil fuels are used to produce energy for a wide variety of purposes (e.g., production, transportation, and consumption of energy products) and CO_2 (Carbon dioxide), CH_4 (Methane), N_2O (Nitrous Oxide), NO_x (Nitrogen Oxide), CO (Carbon Monoxide), and NMVOC (Non-Methane Volatile Organic Compounds) are emitted in the process.

In 2009, GHG emissions from energy sector accounted to 1,098,088 Gg-CO_2 eq., and represented 90.8% of the Japan’s total GHG emissions (excluding LULUCF). The emissions from energy sector had increased by 1.8% compare to 1990.

3.2. Fuel Combustion (1.A.)

This category covers GHG emissions from combustion of fossil fuels such as coal, oil, and natural gas, and incineration of waste for energy purposes and with energy recovery.[1]

This section includes GHG emissions from five sources: Energy Industries (1.A.1)—emissions from power generation and heat supply; Manufacturing Industries and Construction (1.A.2)—emissions from manufacturing industry and construction; Transport (1.A.3)—emissions from aviation, railways, road transport and shipping; Other Sectors (1.A.4)—emissions from commercial/institutional, residential, and agriculture/forestry/fishing sources; and Other (1.A.5)—emissions from the other sector.

In FY 2009, emissions from fuel combustion were 1,097,658 Gg-CO_2 eq., and represented 90.8% of GHG of the Japan’s total GHG emissions (excluding LULUCF). The emissions had increased by 2.0% compared to 1990.

GHG emissions from fuel combustion in FY 2009 had decreased by 5.4% compared to FY 2008. The primary reason for the emission reduction in FY 2009 as compared to FY 2008 was the drop in energy demand within all the sectors including the Industries sector as the result of the severe economic recession.

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[1] These emissions from waste incineration had been reported in the waste sector in 2008 submissions, regardless of use as energy or energy recovery. However, to comply with ERT observations and the requirements of IPCC Guidelines, the emissions are reported in the energy sector since 2009 submissions.

Table 3-1 Trends in GHGs emissions from fuel combustion (1.A)

Gas	Item		Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	1.A.1. Energy Industries	a. Public Electricity and Heat Production	Gg-CO_2	297,074	315,399	330,863	378,920	423,153	394,442	357,595
		b. Petroleum Refining	Gg-CO_2	15,893	16,956	17,285	16,441	16,018	14,324	14,564
		c. Manufacture of Solid Fuels and Other Energy Industries	Gg-CO_2	11,286	12,592	9,426	10,677	7,684	11,225	14,270
	1.A.2. Manufacturing Industries and Construction	a.Iron and Steel	Gg-CO_2	149,600	141,862	150,776	152,741	159,979	143,269	134,525
		b. Non-Ferrous Metals	Gg-CO_2	6,092	4,770	3,042	2,634	2,659	2,333	2,120
		c. Chemicals	Gg-CO_2	64,736	74,806	67,216	58,650	59,320	53,325	52,532
		d. Pulp, Paper and Print	Gg-CO_2	25,825	29,449	29,035	26,552	24,920	22,843	21,240
		e. Food Processing, Beverages and Tobacco	Gg-CO_2	13,129	14,407	13,161	11,326	9,776	8,862	8,728
		f. Other	Gg-CO_2	111,929	105,245	113,547	119,326	113,601	105,432	99,427
	1.A.3. Transport	a. Civil Aviation	Gg-CO_2	7,162	10,278	10,677	10,799	10,876	10,277	9,781
		b. Road Transportation	Gg-CO_2	189,228	225,381	232,827	222,652	214,161	205,933	201,943
		c. Railways	Gg-CO_2	932	819	707	644	624	600	600
		d. Navigation	Gg-CO_2	13,731	14,687	14,865	12,915	12,170	11,288	10,590
	1.A.4. Other Sectors	a. Commercial/Institutional	Gg-CO_2	83,593	93,269	101,450	110,678	102,731	98,756	93,568
		b. Residential	Gg-CO_2	56,668	66,320	68,958	67,583	62,590	59,023	57,792
		c.Agriculture/Forestry/Fisheries	Gg-CO_2	21,380	19,526	16,207	15,158	12,653	10,657	10,453
	1.A.5 Other	a. Stationary	Gg-CO_2	NO	NO	NO	NO	NO	NO	NO
		b. Mobile	Gg-CO_2	NO	NO	NO	NO	NO	NO	NO
	Total		Gg-CO_2	1,068,260	1,145,769	1,180,044	1,217,696	1,232,916	1,152,590	1,089,728
CH_4	1.A.1. Energy Industries	a. Public Electricity and Heat Production	Gg-CH_4	1.35	1.55	1.95	1.66	1.90	1.84	1.76
		b. Petroleum Refining	Gg-CH_4	0.05	0.06	0.07	0.07	0.07	0.06	0.06
		c. Manufacture of Solid Fuels and Other Energy Industries	Gg-CH_4	0.02	0.03	0.06	0.05	0.17	0.17	0.18
	1.A.2. Manufacturing Industries and Construction	a.Iron and Steel	Gg-CH_4	4.59	4.22	4.49	3.95	4.24	3.88	4.09
		b. Non-Ferrous Metals	Gg-CH_4	0.29	0.25	0.20	0.16	0.16	0.15	0.13
		c. Chemicals	Gg-CH_4	0.23	0.28	0.25	0.24	0.24	0.22	0.22
		d. Pulp, Paper and Print	Gg-CH_4	1.10	1.08	1.11	1.39	1.63	1.70	1.68
		e. Food Processing, Beverages and Tobacco	Gg-CH_4	0.11	0.14	0.13	0.13	0.12	0.12	0.12
		f. Other	Gg-CH_4	10.60	14.88	10.57	10.83	11.22	11.08	11.07
	1.A.3. Transport	a. Civil Aviation	Gg-CH_4	0.14	0.17	0.21	0.23	0.23	0.22	0.22
		b. Road Transportation	Gg-CH_4	12.70	13.11	12.54	9.79	8.44	7.75	7.59
		c. Railways	Gg-CH_4	0.06	0.05	0.05	0.04	0.04	0.03	0.03
		d. Navigation	Gg-CH_4	1.26	1.35	1.39	1.21	1.13	1.05	0.99
	1.A.4. Other Sectors	a. Commercial/Institutional	Gg-CH_4	1.02	3.19	4.38	4.46	4.70	5.69	5.12
		b. Residential	Gg-CH_4	8.23	8.61	8.15	7.76	7.05	6.64	6.49
		c.Agriculture/Forestry/Fisheries	Gg-CH_4	0.63	0.45	0.32	0.28	0.24	0.22	0.21
	1.A.5 Other	a. Stationary	Gg-CH_4	NO	NO	NO	NO	NO	NO	NO
		b. Mobile	Gg-CH_4	NO	NO	NO	NO	NO	NO	NO
	Total		Gg-CH_4	42.37	49.41	45.85	42.24	41.60	40.83	39.97
			Gg-CO_2 eq.	890	1,038	963	887	874	857	839
N_2O	1.A.1. Energy Industries	a. Public Electricity and Heat Production	Gg-N_2O	2.89	4.46	5.33	6.75	6.94	6.73	6.46
		b. Petroleum Refining	Gg-N_2O	0.08	0.14	0.20	0.19	0.19	0.18	0.18
		c. Manufacture of Solid Fuels and Other Energy Industries	Gg-N_2O	0.02	0.02	0.02	0.02	0.04	0.04	0.04
	1.A.2. Manufacturing Industries and Construction	a.Iron and Steel	Gg-N_2O	1.11	1.34	1.34	1.19	1.30	1.16	1.09
		b. Non-Ferrous Metals	Gg-N_2O	0.20	0.18	0.15	0.03	0.03	0.03	0.03
		c. Chemicals	Gg-N_2O	0.59	1.08	1.07	0.94	0.93	0.88	0.86
		d. Pulp, Paper and Print	Gg-N_2O	0.49	0.93	0.95	0.97	0.98	1.15	1.19
		e. Food Processing, Beverages and Tobacco	Gg-N_2O	0.24	0.27	0.26	0.26	0.25	0.24	0.24
		f. Other	Gg-N_2O	1.80	2.38	3.18	3.44	3.53	3.32	3.12
	1.A.3. Transport	a. Civil Aviation	Gg-N_2O	0.23	0.30	0.34	0.35	0.35	0.33	0.32
		b. Road Transportation	Gg-N_2O	12.59	13.96	13.76	9.65	8.39	7.76	7.76
		c. Railways	Gg-N_2O	0.39	0.34	0.29	0.27	0.26	0.25	0.25
		d. Navigation	Gg-N_2O	0.36	0.39	0.40	0.35	0.32	0.30	0.28
	1.A.4. Other Sectors	a. Commercial/Institutional	Gg-N_2O	0.38	0.59	0.69	0.77	0.75	0.74	0.71
		b. Residential	Gg-N_2O	0.29	0.33	0.34	0.33	0.29	0.27	0.26
		c.Agriculture/Forestry/Fisheries	Gg-N_2O	0.21	0.20	0.14	0.13	0.11	0.10	0.09
	1.A.5 Other	a. Stationary	Gg-N_2O	NO	NO	NO	NO	NO	NO	NO
		b. Mobile	Gg-N_2O	NO	NO	NO	NO	NO	NO	NO
	Total		Gg-N_2O	21.87	26.92	28.46	25.63	24.65	23.48	22.87
			Gg-CO_2 eq.	6,778	8,346	8,821	7,945	7,641	7,279	7,091
Total of all gases			Gg-CO_2 eq.	1,075,928	1,155,153	1,189,828	1,226,528	1,241,430	1,160,727	1,097,658

3.2.1. Energy Industries (1.A.1.)

a） Source/Sink Category Description

This source category provides methods estimating CO_2 emissions from Public Electricity and Heat Production (1.A.1.a), Petroleum Refining (1.A.1.b), and Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c).

b） Methodological Issues

The estimation methods, activity data, emission factors, and other parameters used in the Energy Industry (1.A.1), Manufacturing Industry and Construction (1.A.2) and Other Sectors (1.A.4) are basically common. Therefore, the estimation method and data used for all of them is summarized in this section.

The estimation method for waste incineration with energy use and energy recovery is described in Chapter.8.

【CO_2】

- ***Estimation Method***

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

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

E : CO_2 emissions from fossil fuel combustion [t-CO_2]
A : Energy consumption [t, kl, 10^3×m^3]
N : Non-energy product use of fossil fuels [t, kl, 10^3×m^3]
GCV : Gross calorific value [MJ/kg, MJ/l, MJ/m^3]
EF : Carbon content of the fuel [t-C/TJ]
OF : Oxidation factor
i : Type of energy
j : Sector

The calories and emissions from waste incineration with energy recovery are reported in Fuel Combustion (1.A.) in accordance with the *1996 Revised IPCC Guidelines* and the *Good Practice Guidance (2000)*. The fuel type is classified as “Other fuels”.

Estimation method, emission factors and activity data for emission from waste incineration with energy recovery is same as those used in the waste incineration (6.C.) in accordance with the *1996 Revised IPCC Guidelines*. Please refer to Chapter 8 for further details on estimation methods.

- ***Emission Factors***

➢ *Carbon emission factors*

The carbon content of fuels expressed as the unit of calorific value (Gross Calorific Value) was used for carbon emission factors. The emission factors are country-specific values except a part of fuels that applied the default value provided in the *2006 IPCC Guidelines*.

Table 3-2 Emission factors for fuel combustion in gross calorific value

	Fuel	Unit	1990	1995	2000	2005	2007	2008	2009	References
Coal	Steel Making Coal	tC/TJ	24.5	24.5	24.5	24.5	24.5	24.5	24.5	-
	Coking Coal	tC/TJ	24.5	24.5	24.5	24.5	24.5	24.5	24.5	2006 IPCC Guidelines for National Greenhouse Gas Inventories
	PCI Coal	tC/TJ	24.5	24.5	24.5	24.5	24.5	24.5	24.5	same as Coking Coal
	Imported Steam Coal	tC/TJ	24.7	24.7	24.7	24.7	24.7	24.7	24.7	-
	Imported Coal : for general use	tC/TJ	24.7	24.7	24.7	24.7	24.7	24.7	24.7	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Imported Coal : for power	tC/TJ	24.7	24.7	24.7	24.7	24.7	24.7	24.7	same as Imported Coal : for general use
	Indigenous Steam Coal	tC/TJ	24.9	24.9	24.9	24.9	24.9	24.9	24.9	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Underground	tC/TJ	24.9	24.9	24.9	24.9	24.9	24.9	24.9	same as Indigenous Steam Coal
	Open Pit	tC/TJ	24.9	24.9	24.9	24.9	24.9	24.9	24.9	same as Indigenous Steam Coal
	Hard Coal, Anthracite & Lignite	tC/TJ	25.5	25.5	25.5	25.5	25.5	25.5	25.5	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Coal Products	Coke	tC/TJ	29.4	29.4	29.4	29.4	29.4	29.4	29.4	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Coal Tar	tC/TJ	20.9	20.9	20.9	20.9	20.9	20.9	20.9	2006 IPCC Guidelines for National Greenhouse Gas Inventories
	Coal Briquette	tC/TJ	29.4	29.4	29.4	29.4	29.4	29.4	29.4	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Coke Oven Gas	tC/TJ	11.0	11.0	11.0	11.0	11.0	11.0	11.0	2006 IPCC Guidelines for National Greenhouse Gas Inventories
	Blast Furnace Gas	tC/TJ	27.3	26.9	26.6	26.5	26.3	26.4	26.5	established with annually calculated value in order to keep carbon balance in blast furnace and L.D. converter
	Converter Furnace Gas	tC/TJ	38.4	38.4	38.4	38.4	38.4	38.4	38.4	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Oil	Crude Oil for Refinery	tC/TJ	18.7	18.7	18.7	18.7	18.7	18.7	18.7	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Crude Oil for Power Generation	tC/TJ	18.7	18.7	18.7	18.7	18.7	18.7	18.7	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Bituminous Mixture Fuel	tC/TJ	20.0	20.0	20.0	20.0	20.0	20.0	20.0	2006 IPCC Guidelines for National Greenhouse Gas Inventories
	Natural Gas Liquid & Condensate	tC/TJ	18.4	18.4	18.4	18.4	18.4	18.4	18.4	GHGs Estimation Methods Committee Report（Ministry of the Environment, Committee for the Greenhouse Gases Emissions Estimation Methods）
Oil Products	Slack Gasoline	tC/TJ	18.2	18.2	18.2	18.2	18.2	18.2	18.2	adopted the value of Naphtha
	Slack Kerosene	tC/TJ	18.5	18.5	18.5	18.5	18.5	18.5	18.5	adopted the value of Kerosene
	Slack Diesel Oil or Gas Oil	tC/TJ	18.7	18.7	18.7	18.7	18.7	18.7	18.7	adopted the value of Diesel Oil or Gas Oil
	Slack Fuel Oil	tC/TJ	19.5	19.5	19.5	19.5	19.5	19.5	19.5	adopted the value of Heating Oil C
	Cracked Gasoline	tC/TJ	18.2	18.2	18.2	18.2	18.2	18.2	18.2	adopted the value of Naphtha
	Cracked Diesel Oil or Gas Oil	tC/TJ	18.7	18.7	18.7	18.7	18.7	18.7	18.7	adopted the value of Diesel Oil or Gas Oil
	Feedstock Oil for Refinery and Mixing	tC/TJ	18.7	18.7	18.7	18.7	18.7	18.7	18.7	adopted the value of Crude Oil for Refinery
	Naphtha	tC/TJ	18.2	18.2	18.2	18.2	18.2	18.2	18.2	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Reformed Material Oil	tC/TJ	18.3	18.3	18.3	18.3	18.3	18.3	18.3	adopted the value of Gasoline
	Gasoline	tC/TJ	18.3	18.3	18.3	18.3	18.3	18.3	18.3	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Premium Gasoline	tC/TJ	18.3	18.3	18.3	18.3	18.3	18.3	18.3	same as Gasoline
	Regular Gasoline	tC/TJ	18.3	18.3	18.3	18.3	18.3	18.3	18.3	same as Gasoline
	Jet Fuel	tC/TJ	18.3	18.3	18.3	18.3	18.3	18.3	18.3	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Kerosene	tC/TJ	18.5	18.5	18.5	18.5	18.5	18.5	18.5	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Gas Oil or Diesel Oil	tC/TJ	18.7	18.7	18.7	18.7	18.7	18.7	18.7	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Fuel Oil A	tC/TJ	18.9	18.9	18.9	18.9	18.9	18.9	18.9	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Fuel Oil C	tC/TJ	19.5	19.5	19.5	19.5	19.5	19.5	19.5	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Fuel Oil B	tC/TJ	19.2	19.2	19.2	19.2	19.2	19.2	19.2	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Fuel Oil C	tC/TJ	19.5	19.5	19.5	19.5	19.5	19.5	19.5	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Fuel Oil C for Power Generation	tC/TJ	19.5	19.5	19.5	19.5	19.5	19.5	19.5	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Lublicating Oil	tC/TJ	19.2	19.2	19.2	19.2	19.2	19.2	19.2	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Asphalt	tC/TJ	20.8	20.8	20.8	20.8	20.8	20.8	20.8	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Non Asphalt Heavy Oil Products	tC/TJ	20.8	20.8	20.8	20.8	20.8	20.8	20.8	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Oil Coke	tC/TJ	25.4	25.4	25.4	25.4	25.4	25.4	25.4	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Galvanic Furnace Gas	tC/TJ	38.4	38.4	38.4	38.4	38.4	38.4	38.4	adopted the value of Converter Furnace Gas
	Refinary Gas	tC/TJ	14.2	14.2	14.2	14.2	14.2	14.2	14.2	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Liquified Petroleum Gas	tC/TJ	16.3	16.3	16.3	16.1	16.1	16.1	16.1	GHGs Estimation Methods Committee Report（Ministry of the Environment, Committee for the Greenhouse Gases Emissions Estimation Methods）
Natural Gas	Liquefied Natural Gas	tC/TJ	13.5	13.5	13.5	13.5	13.5	13.5	13.5	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Indigenous Natural Gas	tC/TJ	13.9	13.9	13.9	13.9	13.9	13.9	13.9	2006 IPCC Guidelines for National Greenhouse Gas Inventories
	Indigenous Natura l Gas	tC/TJ	13.9	13.9	13.9	13.9	13.9	13.9	13.9	adopted the value of Indigenous Natural Gas
	Coal Mining Gas	tC/TJ	13.5	13.5	13.5	13.5	13.5	13.5	13.5	Environmental Agency, The Report on Estimation of CO_2 Emissions in Japan
	Off-gas from Crude Oil	tC/TJ	13.9	13.9	13.9	13.9	13.9	13.9	13.9	adopted the value of Indigenous Natural Gas
Town Gas	Town Gas	tC/TJ	14.0	14.0	13.8	13.6	13.6	13.7	13.6	same as Town Gas
	Town Gas	tC/TJ	14.0	14.0	13.8	13.6	13.6	13.7	13.6	established with annually calculated value in order to keep carbon balance in prodeced town gas
	Small Scale Town Gas	tC/TJ	16.3	16.3	16.3	16.1	16.1	16.1	16.1	adopted the value of LPG

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

Table 3-2 provides the emission factors for CO_2 by fuel types.

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

Carbon emission factors of energy sources other than Blast Furnace Gas (BFG) and Town gas were used values provided in "The Report on Estimation of CO_2 Emissions in Japan (Environmental Agency, 1992)", "GHGs Estimation Methods Committee Report (Committee for the Greenhouse Gases Emissions Estimation Methods, The Ministry of Environment)" and "2006 IPCC Guidelines".

The result of evaluation in *Evaluating and Analyzing the Validity of Carbon Emission Factors for Different Fuels* (Kainou, 2005) were adopted for setting emission factors. In the choice of carbon emission factors, adequacy assessment was conducted for emission factors in *the Report on Estimation of CO_2 Emissions in Japan* (Environmental Agency, 1992), which were used in the inventories submitted up to 2005. These were assessed based on the following three criteria, and the values assessed as adequate continue to be used in this inventory.

1) Evaluation and analysis by comparison of theoretical upper and lower limits
2) Evaluation and analysis by comparison with *1996 IPCC Guidelines* default values
3) Group evaluation and analysis by carbon balance using the General Energy Statistics

Summaries of evaluations were indicated below.

1) Evaluation and analysis by comparison of theoretical upper and lower limits

The validity of carbon emission factors is evaluated to compare intended emission factor and emission factor calculated by theoretical from standard enthalpy change of formation of pure matter, such as hydrogen, methane and carbon monoxide, because most of the fuels required to evaluate carbon emission factors are hydrocarbons containing a few impurities, and because a physicochemical correspondence exists between the standard gross calorific values of pure hydrocarbons and carbon emission factors.

2) Evaluation and analysis by comparison with *1996 IPCC Guidelines* default values

The validity of carbon emission factors is judged by using the *1996 IPCC Guidelines* default values or the *2006 IPCC Guidelines* reference values[2] and their statistical reliability (uncertainty) information. However, because the average properties of fuels envisaged in the IPCC Guidelines and those of fuels used in Japan are not necessarily the same, carbon emission factors can be appropriately judged based on statistical examination of group evaluation and analysis mentioned below even when figures deviate, as long as a valid reason for the deviation exists.

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[2] When *Evaluating and Analyzing the Validity of Carbon Emission Factors for Different Fuels* was submitted, the *2006 IPCC Guidelines* was not submitted. These values were reference values, some of these reference values were revised.

3) Group evaluation and analysis by carbon balance using the General Energy Statistics

The validity of fuel-specific carbon emission factors for some petroleum product and coal product factor groups can be evaluated using the General Energy Statistics to analyze carbon balance in coal products and oil products.

The values assessed as inadequate were substituted by the values given in *GHGs Estimation Methods Committee Report* (Committee for the Greenhouse gases Emissions Estimation Methods, Ministry of the Environment) and *2006 IPCC Guidelines*.

(b) Blast Furnace Gas (BFG)

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

Emission factor for BFG was established with annually calculated value in order to keep carbon balance in blast furnace and converter furnace during iron and steel production process. The amount of carbon excluded carbon contained in CFG from carbon (contained in ‘Coke’ and ‘PCI coal’) injected to blast furnace indicated under ‘Steel process gas’ is considered to be carbon contained in BFG. Emission factor for BFG was established as carbon described above divided by calorific values of BFG generated. The equation for emission factor and the overview of carbon flow for iron & steel and calculation process are shown below.

Calculation to establish emission factor for BFG is conducted every year.

$$EF_{BFG} = \left[\left(A_{coal} \times EF_{coal} + A_{coke} \times EF_{coke}\right) - A_{CFG} \times EF_{CFG}\right] / A_{BFG}$$

EF : Carbon emission factor [tC/TJ]
A : Fuel consumption [TJ]
BFG : Blast Furnace Gas
coal : PCI coal
coke : coke
CFG : Converter Furnace Gas

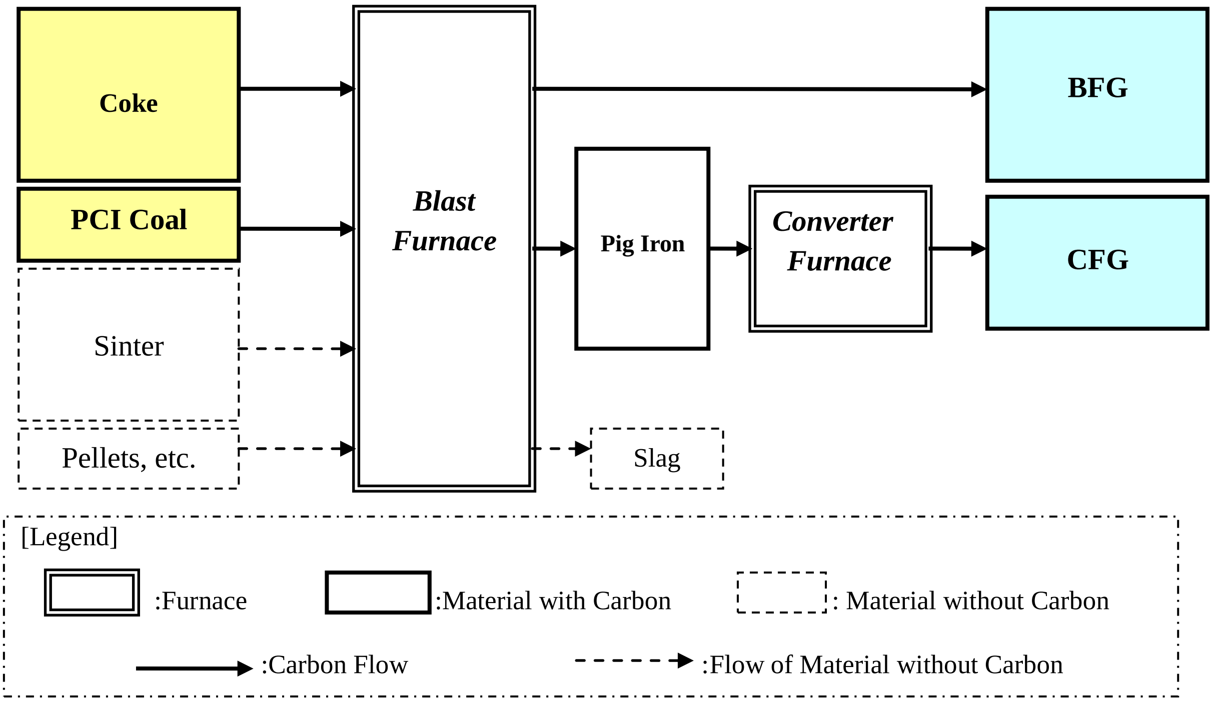

Figure 3-1 Manufacturing Flow for Coke, Coke Oven Gas and Blast Furnace Gas
(Overview of carbon flow for iron & steel)

Table 3-3 Calculation of Emission Factors for BFG

Steel Process Gas		1990	1995	2000	2005	2007	2008	2009	Note
Input									
PCI Coal	Gg-C	1,574	2,593	3,518	3,111	3,515	2,950	2,659	A
Coke	Gg-C	12,830	11,432	12,021	11,382	11,782	10,818	10,358	B
Input Total	Gg-C	14,404	14,024	15,539	14,492	15,297	13,768	13,017	C: A + B
Output									
CFG(LDG)	Gg-C	2,541	2,359	2,726	2,804	3,038	2,727	2,589	D
Difference	Gg-C	11,863	11,665	12,813	11,688	12,259	11,041	10,428	E: C - D
Output									
BFG	TJ	434,801	433,504	481,768	441,357	465,388	417,636	393,685	F
EF BFG	t-C/TJ	27.3	26.9	26.6	26.5	26.3	26.4	26.5	E / F

(c) Town gas

‘Town gas’ consists of ‘Town gas’ provided by town gas supplier and ‘Small scale town gas’ provided by small scale town gas supplier.

In the case of small scale town gas supplier:

Because most part of small scale town gas is LPG, the same emission factor for LPG was adopted for small scale town gas

In the case of town gas supplier:

Town gas is produced from the mixture of raw materials and air dilution. In order to calculate town gas emission factors, total carbon contained in fossil fuel used as raw materials was divided by the total calorific value of produced town gas. Emission factors for town gas were established based on carbon balance in ‘Town gas production’. To calculate town gas emission factors, the total carbon in fossil fuel inputs used as raw materials (COG, Kerosene, Refinery gas, LPG, LNG and Indigenous natural gas) was divided by the total calorific value of the town gas production. Calculation to establish emission factor for town gas is conducted every year.

$$EF_{TG} = \sum \left(A_i \times EF_i \right) / P_{TG}$$

EF : Carbon emission factor [tC/TJ]
A : Fuel consumption [TJ]
P : Calorific value of the town gas production [TJ]
TG : Town gas
i : Feedstocks (COG, Kerosene, Refinery gas, LPG, LNG, Indigenous natural gas)

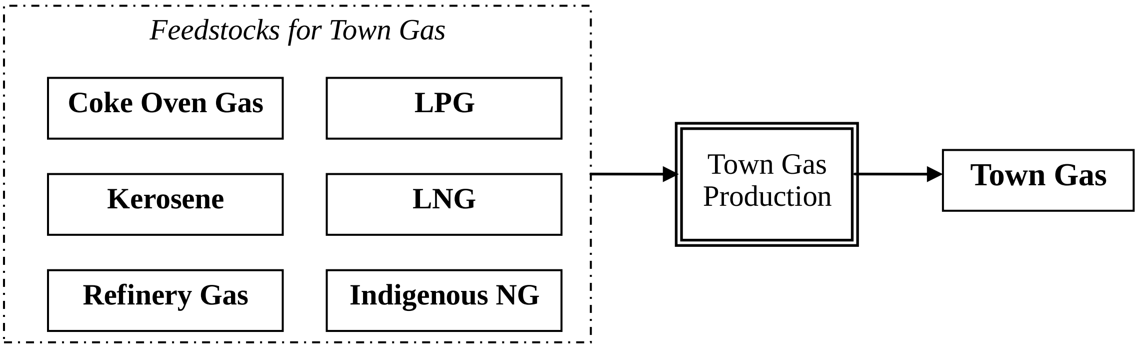

Figure 3-2 Manufacturing Flow for Town Gas

Table 3-4 Calculation of Emission Factors for Town Gas

Town Gas Production		1990	1995	2000	2005	2007	2008	2009	Note
Input									
COG	Gg-C	211	134	105	22	0	0	0	a1
Kerosene	Gg-C	200	275	69	6	0	0	0	a2
Refinery Gas	Gg-C	186	199	186	145	95	88	13	a3
LPG	Gg-C	1,931	2,104	1,791	1,069	727	679	700	a4
LNG	Gg-C	6,253	9,107	11,642	16,563	19,774	19,378	19,181	a5
Indigenous NG	Gg-C	551	661	848	1,190	1,748	1,822	1,768	a6
Input Total	Gg-C	9,331	12,480	14,641	18,994	22,344	21,967	21,663	A: Σa
Output									
Town Gas	TJ	664,661	892,307	1,061,122	1,391,962	1,644,783	1,607,991	1,593,032	B

EF Town Gas	t-C/TJ	14.0	14.0	13.8	13.6	13.6	13.7	13.6	A/B

- *Oxidation factor*

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

Gaseous Fuels

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

Table 3-5 Data of gaseous fuel combustion

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

Liquid Fuels (Petroleum Fuels)

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

Solid Fuels

Oxidation factor for solid fuels varies depending on fired condition, type of furnace, and coal property; therefore, it is quite difficult to obtain representational data set of actual measurement of unburned fuel loss. Meanwhile, almost all the unburned carbon generated during combustion in furnace is considered to be contained in coal ash. Coal ash is effectively utilized or landfilled. Carbon contained in coal ash which is used as raw material of cement is oxidized to CO_2 and emitted into the atmosphere during calcinations processes.

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

- ***Activity Data***

The data given in the *General Energy Statistics* compiled by the Agency for Natural Resources and Energy were used for the activity data. The *General Energy Statistics* (Energy Balance Table) provides a comprehensive overview of domestic energy supply and demand to grasp what are converted from energy sources, such as coal, oil, natural gas and others, provided in Japan and what are consumed in what sectors. The objective of this *General Energy Statistics* is to help to quantitatively understand energy supply and demand and to make judgments about the situation, in addition to helping with planning for energy and environmental policy, and with measuring, assessing, and otherwise gauging policy effectiveness.

General Energy Statistics (Energy Balance Table) indicates an overview of domestic energy supply and demand, shows the main energy sources used in Japan as “Columns” and the supply, conversion and consumption sectors as “Rows”, in a matrix. Specifically, columns comprise 11 major categories (coal, coal products, oil, oil products, natural gas, town gas, new and renewable energy, large-scale hydropower, nuclear power, electricity, and heat) and the necessary sub-categories and a more detailed breakdown of the sub-categories. Rows comprise 3 major sectors — primary energy supply (primary supply), energy conversion (conversion), and final energy consumption (final consumption) — plus the necessary sub-categories and a more detailed breakdown of the sub-categories.

In calculating the energy supply and demand amounts for *General Energy Statistics*, it is assumed that each energy source, such as gasoline or electricity, is homogeneous in terms of gross calorific value per original unit (MJ/kg, MJ/L, MJ/m^3), and that homogeneous energy sources are supplied, converted, and consumed. Values for supply, conversion, and consumption in original units as determined from official statistical sources are multiplied by gross calorific value per original unit to obtain energy supply and demand amounts.

The calculation process in the *General Energy Statistics* is as follows:

(1) Set calorific values and carbon emission factors.
(2) Build energy supply and demand modules.
(3) Prepare original unit tables (integrate modules and prepare main table and summary table) (units in t, kl, m^3, etc).
(4) Prepare energy unit tables (Units are J).
(5) Prepare energy-derived carbon tables (given are carbon content).

General Energy Statistics adopts "actual calorific values" based on calculation based on annual official statistics for some fuel types which can be recalculated. For other fuel types which cannot be recalculated and whose composition is stable, "standard calorific values" based on relevant official statistics and document are adopted.

The complete Energy Balance Tables for the years since FY 1990 are available on the following internet site:

http://www.enecho.meti.go.jp/info/statistics/jukyu/result-2.htm (Japanese version only)

Please refer to the simplified energy balance tables provided in Annex 2.

For the activity data for energy industries, the data reported in the following sectors in the *General Energy Statistics* were used: "Power Generation, General Electric Utilities" [#2110, codes in bracket indicate column and row number indicated in the *Interpretation of General Energy Statistics*] which reports energy consumption associated with electric power generation by electric power suppliers, and "Power Generation, Independent Power Producing" [#2150]; "District Heat Supply" [#2350] which provides energy consumption associated with heat energy and cold energy by thermal energy suppliers; "Own use, General Electric Utilities" [#2911] which reports energy consumption associated with captive (own) use of energy industries; "Own use, Independent Power Producing" [#2912]; "Own use, District Heat Supply" [#2913]; "Own use, Oil Refinery" [#2916]; "Own use, Town Gas" [#2914]; "Own Use, Steel Coke" [#2915]; and "Own use, Other Conversion" [#2917] (Numbers in parentheses indicate corresponding sector numbers in the *General Energy Statistics*).

Table 3-6 shows the correspondence between sectors of Japan's Energy Balance Table from the *General Energy Statistics* and those of the CRF.

Table 3-6 Correspondence between sectors of Japan’s Energy Balance Table and of the CRF (1.A.1)

CRF			Japan's Energy Balance Table	
1A1		Energy Industries		
	1A1a	Public Electricity and Heat Production	Power Generation, General Electric Utilities	#2110
			Own use, General Electric Utilities	#2911
			Power Generation, Independent Power Producing	#2150
			Own use, Independent Power Producing	#2912
			District Heat Supply	#2350
			Own use, District Heat Supply	#2913
	1A1b	Petroleum Refining	Own use, Oil Refinary	#2916
	1A1c	Manufacture of Solid Fuels and Other Energy Industries	Own use, Coal Products	#2500
			Own use, Town Gas	#2914
			Own use, Steel Coke	#2915
			Own use, Other Conversion	#2917

➢ *Gross calorific value*

Gross calorific values used in Japan’s Energy Balance Table (*General Energy Statistics*) are adopted. Table 3-7 shows trends in gross calorific value for each fuel type. Japan’s Energy Balance Table (*General Energy Statistics*) is adopting actual calorific values based on calculation based on annual official statistics for some fuel types which can be recalculated. For other fuel types which cannot be recalculated and whose composition is stable, “standard calorific values” based on relevant official statistics and documents are adopted. The “standard calorific value" is revised approximately once in every 5 years.

Table 3-7 Trends in gross calorific value of each fuel type

Fuel		Code	Unit	1990	1995	2000	2005	2007	2008	2009
Coal	Steel Making Coal	$110	MJ/kg	31.8	31.8	28.9	29.0	29.0	29.0	29.0
	Coking Coal	$111	MJ/kg	31.8	30.5	29.1	29.1	29.1	29.1	29.1
	PCI Coal	$112	MJ/kg	31.8	30.5	28.2	28.2	28.2	28.2	28.2
	Imported Steam Coal	$130	MJ/kg	26.0	26.0	26.6	25.7	25.7	25.7	25.7
	Imported Coal : for general use	$131	MJ/kg	26.0	26.0	26.6	25.7	25.7	25.7	25.7
	Imported Coal : for power generation	$132	MJ/kg	24.9	26.1	26.4	25.5	25.5	25.3	25.4
	Indigenous Steam Coal	$135	MJ/kg	24.3	24.3	22.5	22.5	22.5	22.5	22.5
	Underground	$136	MJ/kg	24.3	24.3	23.2	23.2	23.2	23.2	23.2
	Open Pit	$137	MJ/kg	18.7	18.7	18.7	18.7	18.7	18.7	18.7
	Hard Coal, Anthracite & Lignite	$140	MJ/kg	27.2	27.2	27.2	26.9	26.9	26.9	26.9
Coal Products	Coke	$161	MJ/kg	30.1	30.1	30.1	29.4	29.4	29.4	29.4
	Coal Tar	$162	MJ/kg	37.3	37.3	37.3	37.3	37.3	37.3	37.3
	Coal Briquette	$163	MJ/kg	23.9	23.9	23.9	23.9	23.9	23.9	23.9
	Coke Oven Gas	$171	MJ/m^{3}N	21.5	21.6	21.3	21.4	21.3	21.2	21.1
	Blast Furnace Gas	$172	MJ/m^{3}N	3.5	3.6	3.6	3.4	3.4	3.4	3.4
	Converter Furnace Gas	$173	MJ/m^{3}N	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Oil	Crude Oil for Refinery	$210	MJ/l	38.3	38.3	38.2	38.1	38.1	38.2	38.1
	Crude Oil for Power Generation	$220	MJ/l	39.1	39.2	39.6	38.5	39.5	39.5	39.7
	Bituminous Mixture Fuel	$221	MJ/kg	30.1	30.3	29.9	22.4	22.4	22.4	22.4
	Natural Gas Liquid & Condensate	$230	MJ/l	35.7	35.5	35.4	35.0	35.5	32.9	34.8
Oil Products	Slack Gasoline	$271	MJ/l	33.6	33.6	33.6	33.5	33.5	33.5	33.5
	Slack Kerosene	$272	MJ/l	36.8	36.8	36.8	36.7	36.7	36.7	36.7
	Slack Diesel Oil or Gas Oil	$273	MJ/l	38.6	38.6	38.6	38.6	38.6	38.6	38.6
	Slack Fuel Oil	$274	MJ/l	41.8	41.8	41.8	41.8	41.8	41.8	41.8
	Cracked Gasoline	$275	MJ/l	33.6	33.6	33.6	33.5	33.5	33.5	33.5
	Cracked Diesel Oil or Gas Oil	$276	MJ/l	38.6	38.6	38.6	38.6	38.6	38.6	38.6
	Feedstock Oil for Refinery and Mixing	$277	MJ/l	38.3	38.3	38.2	38.1	38.1	38.2	38.1
	Naphtha	$281	MJ/l	33.6	33.6	33.6	33.5	33.5	33.5	33.5
	Reformed Material Oil	$282	MJ/l	35.1	35.1	35.1	35.1	35.1	35.1	35.1
	Gasoline	$310	MJ/l	34.6	34.6	34.6	34.6	34.6	34.6	34.6
	Premium Gasoline	$311	MJ/l	35.1	35.1	35.1	35.1	35.1	35.1	35.1
	Regular Gasoline	$312	MJ/l	34.5	34.5	34.5	34.5	34.5	34.5	34.5
	Jet Fuel	$320	MJ/l	36.4	36.4	36.7	36.7	36.7	36.7	36.7
	Kerosene	$330	MJ/l	36.8	36.8	36.8	36.7	36.7	36.7	36.7
	Gas Oil or Diesel Oil	$340	MJ/l	38.1	38.1	38.2	37.8	38.0	37.9	37.9
	Fuel Oil A	$351	MJ/l	39.7	39.6	39.3	39.1	40.0	39.9	39.9
	Fuel Oil C	$355	MJ/l	42.7	42.2	42.0	42.0	42.2	42.2	42.0
	Fuel Oil B	$356	MJ/l	40.2	40.2	40.4	40.4	40.4	40.4	40.4
	Fuel Oil C	$357	MJ/l	42.7	42.2	42.0	42.0	42.2	42.2	42.0
	Fuel Oil C for Power Generation	$358	MJ/l	41.1	41.1	41.3	41.2	41.2	41.2	41.2
	Lublicating Oil	$365	MJ/l	40.2	40.2	40.2	40.2	40.2	40.2	40.2
	Asphalt	$371	MJ/kg	41.6	41.2	40.9	41.0	41.1	41.1	41.0
	Non Asphalt Heavy Oil Products	$372	MJ/kg	41.6	41.2	40.9	41.0	41.1	41.1	41.0
	Oil Coke	$375	MJ/kg	35.6	35.6	35.6	29.9	29.9	29.9	29.9
	Galvanic Furnace Gas	$376	MJ/m^{3}N	8.4	8.4	8.4	8.4	8.4	8.4	8.4
	Refinary Gas	$380	MJ/m^{3}N	39.3	39.3	44.9	44.9	44.9	44.9	44.9
	Liquified Petroleum Gas	$390	MJ/kg	50.2	50.2	50.2	50.8	50.8	50.8	50.8
Natural Gas	Liquefied Natural Gas	$410	MJ/kg	54.6	54.6	54.6	54.6	54.5	54.6	54.6
	Indigenous Natural Gas	$420	MJ/m^{3}N	42.1	42.4	42.6	42.9	44.6	44.7	44.8
	Indigenous Natura l Gas	$421	MJ/m^{3}N	42.1	42.4	42.6	42.9	44.6	44.7	44.8
	Coal Mining Gas	$422	MJ/m^{3}N	36.0	36.0	16.7	16.7	16.7	16.7	16.7
	Off-gas from Crude Oil	$423	MJ/m^{3}N	42.1	42.4	42.6	42.9	44.6	44.7	44.8
Town Gas	Town Gas	$450	MJ/m^{3}N	41.9	41.9	41.1	44.8	44.8	44.8	44.8
	Town Gas	$460	MJ/m^{3}N	41.9	41.9	41.1	44.8	44.8	44.8	44.8
	Small Scale Town Gas	$470	MJ/m^{3}N	100.5	100.5	100.5	100.5	100.5	100.5	100.5

【CH_4, N_2O】

- ***Estimation Method***

Because it is possible to use fuel-specific, sector-specific and furnace-specific activity data, and also to set country-specific emission factors, CH_4 and N_2O emissions from fuel combustion in this category is calculated by using Tier 2 country-specific emission factors in accordance with the *1996 Revised IPCC Guidelines* and *Good Practice Guidance (2000)*. However, in residential and other sectors in which activity data for different furnace types cannot be used, Tier 1 IPCC default emission factors were used.

Estimation equation is as follows. Emissions were calculated by multiplying fuel-specific, furnace-specific and sector-specific activity data by fuel-specific and furnace-specific emission factors.

$$E = \sum \left(EF_{ij} \times A_{ijk} \right)$$

E : Emissions from combustion of fuel by stationary sources (kgCH_4, kgN_2O)

EF_{ij} : Emission factor for fuel type i, furnace type j (kgCH_4/TJ, kgN_2O/TJ)

A_{ijk} : Fuel consumption for fuel type i, furnace type j, sector k (TJ)

i : Fuel type

j : Furnace type

k : Sector

- ***Emission Factors***

Based on data obtained from surveys conducted in Japan (Table 3-9), chimney flue CH_4, N_2O and O_2 concentrations, and the theoretical (dry) exhaust gas volumes, theoretical air volumes, and higher heating values (gross calorific values) shown in Table 3-8 were employed to establish emission factors for each kind of facility using the following combustion calculation formula.

$$EF = C_{CH_4,N_2O} \times \left\{ G_0' + (m-1) \times A_0 \right\} \times MW \div V_m \div GCV$$

EF : emission factor [kgCH_4/TJ, kgN_2O/TJ]

$C_{CH4 \text{ or } N2O}$: CH_4 or N_2O concentration in exhaust gas [ppm]

G_0’ : theoretical exhaust gas volume for each fuel combustion (dry) [m^3N/ original unit]

A_0 : theoretical air volume for each fuel combustion [m^3N/ original unit]

m : air ratio ≡ actual air volume/ theoretical air volume (-)

MW : molecular weight of CH_4(constant)=16 [g/mol]
molecular weight of N_2O(constant)=44 [g/mol]

V_m : one mole ideal gas volume in standardized condition (constant)=22.4 [$10^{-3}m^3$/mol]

GCV : gross calorific value for each fuel combustion [MJ/ original unit]

However, air ratio “m” is approximately provided with O_2 concentration in exhaust gas, as the equation below.

$$m = \frac{21}{21 - C_{O_2}}$$

C_{O_2} : O_2 concentration in exhaust gas (%)

CH_4 and N_2O emission factors by each fuel and furnace types were averaged after dividing emission factor of each kind of facilities according to fuel and furnace types (Table 3-10, Table 3-11). Anomalous values were excluded according to t-testing or expert opinion when calculating average values.

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

Table 3-8 Theoretical exhaust gas and air volumes, higher heating value for different fuels

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

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

Table 3-9 References for measurement data used in establishment of emission factors

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

Table 3-10 CH_4 emission factors for different fuels and furnaces (unit: kg-CH_4/TJ)

Furnace type	Fuel type	Emission factor	Remarks
Boiler	Fuel oils B and C, crude oil	0.10	Average of 9 facilities
Boiler	Fuel oil A, diesel oil, kerosene, naphtha, other liquid fuels	0.26	Average of 2 facilities
Boiler	Gaseous fuel	0.23	Average of 5 facilities
Boiler	Steam coal, coke, other solid fuels	0.13	Average of 7 facilities
Boiler	Harvested wood, charcoal	75	Average of 4 facilities
Boiler	Pulping waste liquor	4.3	Average of 2 facilities
Sintering furnace for smelting of metals (except copper, lead, zinc)	Solid fuel, liquid fuel, gaseous fuel	31	Average of 6 facilities
Pelletizing furnace (steel and non-ferrous metal)	Solid fuel, liquid fuel, gaseous fuel	1.7	Average of 2 facilities
Metal rolling furnace, metal treating furnace, metal forging furnace	Liquid fuel, gaseous fuel	0.43	Average of 11 facilities
Petroleum and gas furnaces	Liquid fuel, gaseous fuel	0.16	Average of 27 facilities
Catalytic regenerator	Coke, carbon	0.054	Average of 11 facilities
Brick kiln, ceramic kiln, and other kiln	Solid fuel, liquid fuel, gaseous fuel	1.5	Average of 2 facilities
Aggregate drying kiln, cement raw material drying kiln, brick raw material drying kiln	Solid fuel, liquid fuel, gaseous fuel	29	Average of 6 facilities
Other drying kilns	Solid fuel, liquid fuel, gaseous fuel	6.6	Average of 8 facilities
Electric arc furnace	Electricity	13	Average of 6 facilities
Other industrial furnaces	Solid fuel	13	Average of 14 facilities
Other industrial furnaces	Liquid fuel	0.83	Average of 14 facilities
Other industrial furnaces	Gaseous fuel	2.3	Average of 6 facilities
Gas turbine	Liquid fuel, gaseous fuel	0.81	Average of 11 facilities
Diesel engine	Liquid fuel, gaseous fuel	0.70	Average of 8 facilities
Gas engine, petrol engine	Liquid fuel, gaseous fuel	54	Average of 6 facilities
Household equipment	Solid fuel	290	IPCC default value converted to higher heating value
Household equipment	Liquid fuel	9.5	IPCC default value converted to higher heating value
Household equipment	Gaseous fuel	4.5	IPCC default value converted to higher heating value
Household equipment	Biomass fuel	290	IPCC default value converted to higher heating value

Table 3-11 N_2O emission factors for different fuels and furnaces (unit: kg-N_2O/TJ)

Furnace type	Fuel type	Emission factor	Remarks
Boiler	Fuel oils B and C, crude oil	0.22	Average of 10 facilities
Boiler	Fuel oil A, diesel oil, kerosene, naphtha, other liquid fuels	0.19	Average of 2 facilities
Boiler	Gaseous fuel	0.17	Average of 5 facilities
Boiler (other than fluidized-bed boilers)	Solid fuel	0.85	Average of 9 facilities
Normal pressure fluidized-bed boiler	Solid fuel	54	Average of 11 facilities
Pressurized fluidized-bed boiler	Steam coal	5.2	Data from 1 facility
Boiler	Pulping waste liquor	0.17	Average of 2 facilities
Blast furnace	Coke oven gas, blast furnace gas, other gaseous fuel	0.047	Average of 2 facilities
Petroleum furnace, gas furnace	Liquid fuel, gaseous fuel	0.21	Average of 27 facilities
Catalytic regenerator	Coke, carbon	7.3	Average of 12 facilities
Electric arc furnace	Electricity	3.3	Average of 6 facilities
Coke oven	Town gas, coke oven gas, blast furnace gas, converter gas, offgas, other gaseous fuels	0.14	Average of 3 facilities
Other industrial furnace	Solid fuel	1.1	Average of 20 facilities
Other industrial furnace	Liquid fuel	1.8	Average of 31 facilities
Other industrial furnace	Gaseous fuel	1.2	Average of 18 facilities
Gas turbine	Liquid fuel, gaseous fuel	0.58	Average of 12 facilities
Diesel engine	Liquid fuel, gaseous fuel	2.2	Average of 9 facilities
Gas engine, petrol engine	Liquid fuel, gaseous fuel	0.85	Average of 7 facilities
Household equipment	Solid fuel	1.3	IPCC default value converted to higher heating value
Household equipment	Liquid fuel	0.57	IPCC default value converted to higher heating value
Household equipment	Gaseous fuel	0.090	IPCC default value converted to higher heating value
Household equipment	Biomass fuel	3.8	IPCC default value converted to higher heating value

- ***Activity Data***

The data are estimated in the General Survey of the Emissions of Air Pollutants which provides details on fuel consumption for each type of furnaces and fuels, because stationary combustion fuel consumption data for the each type of furnaces are not available in the *General Energy Statistics*.

Fuel consumption by each sector (Energy Conversion, Industry, Commercial & Others, and Residential) for each type of fuels as presented in the *General Energy Statistics* was further divided among each furnace types proportionally to fuel consumption data in the General Survey of the Emissions of Air Pollutants to obtain the activity data for each sector, each fuel type and each furnace type. However, because the data in the General Survey of the Emissions of Air Pollutants does not differentiate between the pressurized fluidized-bed boiler, normal pressure fluidized-bed boiler, and other boilers, the fuel consumptions of these fluidized-bed boilers are calculated separately. Fuel consumption data of pressurized fluidized-bed furnace were provided by Federation of Electric Power Companies. Fuel consumption data of normal pressure fluidized-bed furnace were provided from companies which had past operation records of normal pressure fluidized-bed furnaces since 1990.

The data of solid fuel boilers excepted for fluidized-bed furnaces are estimated by subtracting the data of fluidized-bed furnace from the data of whole solid fuel boiler.

The exhaustive General Survey of the Emissions of Air Pollutants for all facilities emitting soot and smoke were carried out in fiscal 1992, 1995, 1996, and 1999. For years in which exhaustive General Survey of the Emissions of Air Pollutants were not carried out, the percentages of fuel consumption accounted for by each furnace type were interpolated using the data obtained in the years exhaustive survey carried out.

The procedure for calculating activity data is as follows:

1) Fuel consumption data from the General Survey of the Emissions of Air Pollutants is collated respectively for each fuel type, furnace type and sector.

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

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

$$A_{ijk} = A_{EBik} \times w_{ijk}$$

A_{ijk} : Activity data for fuel type i, furnace type j, sector k (TJ)
A_{EBik} : Fuel consumption for fuel type i, sector k from General Energy Statistics (TJ)
w_{ijk} : Ratio of furnace type j associated with consumption of fuel type i in sector k
i : Fuel type
j : Furnace type
k : Sector

$$w_{ijk} = A_{MAPijk} \Big/ \sum_{m} A_{MAPimk}$$

A_{MAPijk} : Fuel consumption for fuel type i, furnace type j, sector k according to General Survey of the Emissions of Air Pollutants (TJ)

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

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

The N_2O emissions from solid fuel in 1.A.1.a (Public Electricity and Heat Production) increased between 1994 and 1995. The reason for the increase is that a new large sized fluidized-bed boiler for power generation went on line in 1995. As a result, the solid fuel consumption of fluidized-bed boiler for public power generation increased in 1995, resulting in an increase of N_2O emissions from solid fuel in this category.

- *Outline of the General Survey of the Emissions of Air Pollutants*

The General Survey of the Emissions of Air Pollutants is a statistical survey conducted to (1) promote reasonable and effective atmospheric environmental policy, (2) obtain information on current activities within the context of the Air Pollutant Control Law (e.g., the current status of regulation of stationary sources that emit soot and smoke in facilities that are registered to a local government and in facilities that emit ordinary soot or particular soot, and the current status of air pollutant control), (3) develop the submitted data on facilities emitting soot and smoke, and (4) estimate the amounts of air pollutant emissions from facilities that emit soot and smoke. This survey is conducted with survey questionnaires. The response sheets and this survey's explanations are distributed to target facilities mentioned above.

c）Uncertainties and Time-series Consistency

- ***Uncertainties***

【CO_2】

Carbon-Hydrogen ratio of hydrocarbons is strongly correlating with calorific value in theory, then, standard deviation of sample data of each fuel's calorific value are used for uncertainty assessment of emission factors based on assumption that deviation of carbon content and that of calorific value is equal. The uncertainty of energy consumption in TJ given in the *General Energy Statistics* was assessed based on the given statistical error of solid fuels, liquid fuels, and gaseous fuels. As a result, the uncertainty for emissions was determined to be 1% for CO_2 emissions from fuel combustion. A summary of uncertainty assessment methods is provided in Annex 7.

【CH_4, N_2O】

The uncertainties for emission factors were evaluated on the basis of applied statistical procedures, expert judgment, and default data for each energy type. The uncertainties of activity data were estimated by using standard deviation and the percentage of data collection indicated in General Survey of the Emissions of Air Pollutants. The uncertainties for emissions from fuel combustion were estimated to be 47% for CH_4 emissions and 33% for N_2O emissions. A summary of uncertainty assessment methods are provided in Annex 7.

- ***Time-series Consistency***

The emissions were calculated in a consistent manner in all time series.

The carbon emission factors of all energy sources have been calculated by a consistent estimation method in all time series.

The emission factors for CH_4 and N_2O have been calculated by a consistent estimation method since FY 1990.

The activity data was used from data in *General Energy Statistics* in all time series, and the statistics are made by a consistent estimation method in all time series.

d）Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)*. The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e）Source-specific Recalculations

GHG emissions in FY 2008 were recalculated with the revision of the fuel consumption in FY 2008 *General Energy Statistics*.

CH_4 and N_2O emissions from biomass in 1.A.1.a (public electricity and heat production) were recalculated, because of changed activity data for biomass consumption to statistical value from notation key (NO). As well as scrutinizing the data of fuel consumption for each type of furnaces, CH_4 and N_2O emissions were recalculated.

f） Source-specific Planned Improvements

As well as investigation for revised the standard calorific value, investigation for calorific value and carbon content by energy source will be considered to revised carbon emission factor due to refine carbon emission factors.

The use of fuel consumption data in the General Survey of the Emissions of Air Pollutants for FY 2002 onward was prohibited for any purposes other than the original one specified for the General Survey of the Emissions of Air Pollutants, while that is not the case with the data in the General Survey of the Emissions of Air Pollutants for FY 1999 and earlier years. The use of General Survey of the Emissions of Air Pollutants in the GHG inventory was added to the purpose of the General Survey of the Emissions of Air Pollutants by the current examination toward the reuse of the General Survey of the Emissions of Air Pollutants and was recently officially accepted. Japan will keep consider applying the latest the General Survey of the Emissions of Air Pollutants data in the future inventory.

3.2.2. Manufacturing Industries and Construction (1.A.2)

a） Source/Sink Category Description

This category provides the estimation methods for determining CO_2 emissions from Iron and Steel (1.A.2.a); Non-ferrous Metals (1.A.2.b); Chemicals (1.A.2.c); Pulp, Paper, and Print (1.A.2.d); Food Processing, Beverages, and Tobacco (1.A.2.e); and Other (1.A.2.f).

b） Methodological Issues

- ***Estimation Method***

  See Section 3.2.1 b) (1.A.1).
- ***Emission Factors***

  See Section 3.2.1 b) (1.A.1).
- ***Activity Data***

  The data presented in *General Energy Statistics* were used for activity data, as was the case for the Energy Industry (1.A.1).

  Activity data for manufacturing industry sectors were calculated by totaling energy consumption from production activities in factories and offices (final energy consumption), energy consumption related to non-utility power generation for use in one’s own factories and offices (non-utility power generation), and energy consumption related to steam production for use in own factories and offices (industrial steam) shown in *General Energy Statistics*. Because the energy consumption for production activities in factories and offices contained a certain amount used as raw materials (non-energy use), this amount was subtracted.

  The non-utility power generation and industrial steam generation sectors are included in the energy conversion sector in *General Energy Statistics*. However, the *Revised 1996 IPCC Guidelines for*

National Greenhouse Gas Inventories allocates CO_2 emissions from energy consumption for power or steam generation to the sectors generating that power or steam. As such, these CO_2 emissions are added to those from each industry in the final energy consumption sector and are provided in 1.A.2.

The IEF of CO_2 emissions from liquid fuels in 1.A.2.f (Other) decreases between 1997 and 1998, and increases between 1998 and 1999 because of revisions made to statistics on the manufacturing sector. The manufacturing sector data in Japan's Energy Balance Table (*General Energy Statistics*), the activity data, are based on the Ministry of Economy, Trade and Industry's *Yearbook of the Current Survey of Energy Consumption.* Subjects to be surveyed to obtain the data for the *Yearbook of the Current Survey of Energy Consumption* were changed in December, 1997. The survey for the industries of Dyeing, Rubber Product and Non-ferrous metal Product has been discontinued since 1998. Also, since 1998, business institutions or designated items to be surveyed for the industries of Chemicals, Cement & Ceramics, Glass Wares, Iron and Steel, Non-ferrous Metals and Machinery has been changed. For these reasons, and the IEF of CO_2 emissions from liquid fuels in 1.A.2.f (Other) changed. The details are documented and described in Annex.2.

Table 3-12 shows correspondence between sectors of Japan's Energy Balance Table and of the CRF (1.A.2).

Table 3-12 Correspondence between sectors of Japan's Energy Balance Table and of the CRF (1.A.2)

CRF			Japan's Energy Balance Table	
1A2		Manufacturing Industries and Construction		
	1A2a	Iron and Steel	Auto: Iron & Steel	#2217
			Steam Generation: Iron & Steel	#2307
			Final Energy Consumption, Iron & Steel	#6580
			Non-Energy, Iron & Steel	#9680
	1A2b	Non-Ferrous Metals	Auto: Non-Ferrous Metal	#2218
			Steam Generation: Non-Ferrous Metal	#2308
			Final Energy Consumption, Non-Ferrous Metal	#6590
			Non-Energy, Non-Ferrous Metal	#9690
	1A2c	Chemicals	Auto: Chemical Textiles	#2212
			Steam Generation: Chemical Textiles	#2302
			Final Energy Consumption, Chemical Textiles	#6530
			Non-Energy, Chemical Textiles	#9630
			Auto: Chemical	#2214
			Steam Generation: Chemical	#2304
			Final Energy Consumption, Chemical	#6550
			Non-Energy, Chemical	#9650
	1A2d	Pulp, Paper and Print	Auto: Pulp & Paper	#2211
			Steam Generation: Pulp & Paper	#2301
			Final Energy Consumption, Pulp & Paper	#6520
			Non-Energy, Pulp & Paper	#9620
	1A2e	Food Processing, Beverages and Tobacco	Final Energy Consumption, Food	#6510
			Non-Energy, Non-Manufacturing Industry (Food)	#9610
	1A2f	Other		
		Mining	Final Energy Consumption, Mining	#6120
			Non-Energy, Non-Manufacturing Industry (Mining)	#9610
		Construction	Final Energy Consumption, Construction	#6150
			Non-Energy, Non-Manufacturing Industry (Construction)	#9610
		Oil Products	Auto: Oil products	#2213
			Steam Generation: Oil products	#2303
			Final Energy Consumption, Oil products	#6540
			Non-Energy, Oil products	#9640
		Glass Wares	Auto: Glass Wares	#2215
			Steam Generation: Glass Wares	#2305
			Final Energy Consumption, Glass Wares	#6560
			Non-Energy, Glass Wares	#9660
		Cement&Ceramics	Auto: Cement & Ceramics	#2216
			Steam Generation: Cement & Ceramics	#2306
			Final Energy Consumption, Cement & Ceramics	#6570
			Non-Energy, Cement & Ceramics	#9670
		Machinery	Auto: Machinery & Others	#2219
			Steam Generation: Machinery & Others	#2309
			Final Energy Consumption, Machinery	#6600
			Non-Energy, Machinery	#9700
		Duplication Adjustment	Auto: Duplication Adjustment	#2220
			Steam Generation: Duplication Adjustment	#2310
			Final Energy Consumption, Duplication Adjustment	#6700
			Non-Energy, Duplication Adjustment	#9710
		Other Industries & SMEs	Auto: Others	#2250
			Final Energy Consumption, Other Industries & SMEs	#6900
			Non-Energy, Other Industries & SMEs	#9720

・Auto: Non-utility power generation

・#9xxx items are not energy use activity.

c） Uncertainties and Time-series Consistency

See Section 3.2.1 c).

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)*. The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

See Section 3.2.1 e).

CH_4 and N_2O emissions from biomass in 1.A.2.d (Pulp, Paper and Print), 1.A.2.f (Machinery) and 1.A.2.f (Duplication Adjustment) were recalculated, because of changed activity data for biomass consumption to statistical value from notation key. As well as scrutinizing the data of fuel consumption for each type of furnaces, CH_4 and N_2O emissions were recalculated.

f） Source-specific Planned Improvements

See Section 3.2.1 f)

3.2.3. Transport (Mobile Combustion) (1.A.3.:CO_2)

a） Source/Sink Category Description

This category provides the methods used to estimate CO_2 emissions from Civil Aviation (1.A.3.a), Road Transportation (1.A.3.b), Railways (1.A.3.c), and Navigation (1.A.3.d).

b） Methodological Issues

● ***Estimation Method***

See Section 3.2.1 b).

Because CO_2 emissions from natural gas-powered vehicles and steam locomotives are included in Commercial /Institutional section of Other Sectors (1.A.4), CO_2 emissions from these source are reported as “IE.”

● ***Emission Factors***

See Section 3.2.1 b).

The carbon emission factor for liquid fuels (diesel oil) in 1.A.3.b (Road Transportation) is the lowest in Annex I Parties for two reasons. One is because the quality standard for diesel oil in Japan is different from other countries. Crude oil with high sulphur content imported from Middle East must be decomposed and go through ultradeep desulfurization to be low-sulphur diesel oil (<10ppm) according to Japanese automobile exhaust gas regulations. The other reasons is because gas oil used for purposes other than road transport is called "Fuel oil A" to distinguish it from diesel oil. The carbon balance of Japanese petroleum refineries including diesel oil and Fuel oil A nearly matches according to statistics, so these carbon emission factors are not irregular.

● ***Activity Data***

The data given in the *General Energy Statistics* were used for activity data.

Values subtracting final energy consumption reported under ‘Non-energy’ [#9850] from energy consumption reported under ‘Civil Aviation’ [#8140] [#8540], ‘Road Transportation’ [#8110] [#8510]

[#8115] [#8190] [#8590], ‘Railways’ [#8120] [#8520] and ‘Navigation’ [#8130] [#8530]in Japan’s Energy Balance Table (*General Energy Statistics*) are used for activity data. Because energy consumption reported under ‘Non-energy’ was used for the purposes other than combustion and was considered not emitting CO_2, these values were deducted. (see Table 3-13)

Table 3-13 Correspondence between sectors of Japan’s Energy Balance Table and of the CRF (1.A.3)

CRF			Japan's Energy Balance Table	
1A3		Transport		
	1A3a	Civil Aviation	Final Energy Consumption, Passenger Air	#8140
			Final Energy Consumption, Freight Air	#8540
			Non-Energy, Transportation (Air)	#9850
	1A3b	Road Transportation	Final Energy Consumption, Passenger Car	#8110
			Final Energy Consumption, Freight, Freight Truck & Lorry	#8510
			Final Energy Consumption, Passenger Bus	#8115
			Final Energy Consumption, Passenger, Transportation fraction estimation error	#8190
			Final Energy Consumption, Freight, Transportation fraction estimation error.	#8590
			Non-Energy, Transportation (Car, Truck & Lorry, Bus)	#9850
	1A3c	Railways	Final Energy Consumption, Passenger Rail	#8120
			Final Energy Consumption, Freight Rail	#8520
			Non-Energy, Transportation (Rail)	#9850
	1A3d	Navigation	Final Energy Consumption, Passenger Ship	#8130
			Final Energy Consumption, Freight Ship	#8530
			Non-Energy, Transportation (Ship)	#9850
	1A3e	Other Transportation	-	-

・#9xxx items are not energy use activity.

c） *Uncertainties and Time-series Consistency*

See Section 3.2.1 c).

d） *Source-specific QA/QC and Verification*

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000).* The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） *Source-specific Recalculations*

GHG emissions in FY 2008 were recalculated due to the revision of the fuel consumption in FY 2008 in *General Energy Statistics*.

f） *Source-specific Planned Improvements*

There are no major planned improvements in this source category.

3.2.4. Transport (Mobile Combustion) (1.A.3.:CH_4 , N_2O)

This section provides the estimation methods for CH_4 and N_2O emissions from Civil Aviation (1.A.3.a), Road Transportation (1.A.3.b), Railways (1.A.3.c), and Navigation (1.A.3.d).

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

a） *Source/Sink Category Description*

This section provides the estimation methods for CH_4 and N_2O emissions from energy consumption in civil aviation. Greenhouse gases associated with the domestic operation of Japanese airliners are mainly emitted from jet fuels. In addition, a small amount of aviation gasoline used by light aircraft and helicopters is also a source of CH_4 and N_2O emission.

b） Methodological Issues

- ***Estimation Method***

Emissions have been calculated using the Tier 2a method for jet fuel and the Tier 1 for aviation gasoline, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.58, Fig. 2.7).

CH_4 and N_2O emissions associated with landing and take-off (LTO) of domestic airliners using jet fuel
= Emission factor per LTO 1 cycle per domestic airliner × Number of LTO cycles of aircraft in domestic routes

CH_4 and N_2O emissions from domestic airliner during cruising using jet fuel
= Emission factor associated with jet fuel consumption × Jet fuel consumption by aircraft during cruising in domestic routes

CH_4 and N_2O emission associated with flight of gasoline-powered domestic aircraft
= Emission factor associated with consumption of aviation gasoline × Consumption of aviation gasoline by aircraft in domestic routes

- ***Emission Factors***

➢ *Jet fuel*

The default values given in the *Revised 1996 IPCC Guidelines* are used for emission factors for CH_4 and N_2O for LTO. The values used for emission factors for CH_4 and N_2O for cruising were calculated by converting the default values given in the *Revised 1996 IPCC Guidelines* into kg-CH_4/l using the specific gravity of jet fuel (0.78 t/kl). (See the following table)

➢ *Aviation gasoline*

The default values given in the *Revised 1996 IPCC Guidelines* are used for emission factors for CH_4 and N_2O (See the following table).

Table 3-14 CH_4 and N_2O emission factors for aircraft

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

* LTO=Landing/takeoff cycle

Source: Ministry of the Environment, *Results of Review of Greenhouse Gases Emissions Estimations Part 3* (August 2002). *Revised 1996 IPCC Guidelines*, Volume 3, Table 1-47

- ***Activity Data***

➢ *Jet fuel*

The number of takeoffs and landings given in the *Statistical Yearbook of Air Transport* of the Ministry of Land, Infrastructure, Transport and Tourism 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 guidelines, by the number of takeoffs and landings given above.

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

➢ *Aviation gasoline*

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

Table 3-15 Activity Data used for estimation of emissions from aircraft

Item	Unit	1990	1995	2000	2005	2007	2008	2009
number of LTO cycle	LTO	430,654	532,279	667,559	715,767	741,430	726,415	716,804
Jet fuel comsumption of Cruise	kl	2,330,514	3,223,547	3,537,205	3,543,856	3,560,400	3,334,851	3,146,174
Gasoline comsumption	kl	5,345	6,029	4,287	7,662	4,184	2,773	2,352

c） Uncertainties and Time-series Consistency

● *Uncertainties*

As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (200% for CH_4 and 10,000% for N_2O) were applied. The uncertainty of activity data was 10%; determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 200% for CH_4 and 10,000% for N_2O. The uncertainty assessment methods are summarized in Annex 7.

● *Time-series Consistency*

Emission factors were used same values since FY 1990. Activity data for jet fuel from the *Statistical Yearbook of Air Transport* and aviation gasoline from the *General Energy Statistics* have been used consistently since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.

e） Source-specific Recalculations

No recalculations were performed.

f） Source-specific Planned Improvements

No improvements are planned.

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

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

Table 3-16 Reporting categories and definitions of emissions from automobiles

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

Different estimation methods are used for the categories of Light Passenger Vehicles, Light Cargo Trucks, Passenger Vehicles, Buses, Small Cargo Trucks, Regular Cargo Trucks, and Special-purpose Vehicles (3.2.4.2.a), Natural gas-powered Vehicles (3.2.4.2.b), and Motorcycles (3.2.4.2.c). Thus, they are described in the following sections.

3.2.4.2.a. Light Passenger Vehicles, Light Cargo Trucks, Passenger Vehicles, Buses, Small Cargo Trucks, Regular Cargo Trucks, and Special-purpose Vehicles

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions from light passenger vehicles, light cargo trucks, passenger vehicles, buses, small cargo trucks, regular cargo trucks, and special-purpose vehicles.

b） Methodological Issues

- ***Estimation Method***

Emissions have been calculated distance traveled per vehicle type by emission factors using the Tier 3 method, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.45, Fig. 2.5). The country-specific emission factors were used for some vehicle type, and the default emission factors were used for the other vehicle type. The activity data was estimated by using distance traveled and fuel efficiency which were provided from the Ministry of Land, Infrastructure, Transport and Tourism's *Statistical Yearbook of Motor Vehicle Transport*.

- ***Emission Factors***

Emission factors for CH_4 and N_2O have been established for each type of fuel in each vehicle type, using the data shown in Table 3-17. "JAMA data" means that the raw emission factors of Japan Automobile Manufacturers Association are arranged as combine mode emission factors[3] etc. by car regulation year. The emission factors are estimated by multiplying arranged emission factors of JAMA by number of vehicles per car regulation year of each car classification (see Table 3-18, Table 3-19). "Measured data" means that the emission factor is based on actual Japanese data. The emission factors were weighted averages of actual Japanese data estimated per each class of running speed, by proportion of distance traveled per each class of running speed given in the Ministry of Land, Infrastructure, Transport and Tourism's *Road Transport Census*. The emission factors reflect the actual motor vehicle operation in Japan because the proportion of distance traveled by each class of running speed during congestion was applied. "1996GL" and "GPG(2000)" mean the emission factors were established using the default values in IPCC guidelines.

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

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

Table 3-17 Data source of the emission factors of vehicle

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

JAMA data: Calculated by using driving mode test data provided by Japan Automobile Manufacturers Association

Measured data: Using actual Japanese data other than above JAMA data

1996GL: Using the default values in 1996 revised IPCC guidelines.

GPG(2000)+ : Calculated by using default data indicated in GPG (2000) in consideration of the fuel consumption by car type indicated in the *Statistical Yearbook of Motor Vehicle Transport* and calorific value indicated in the *General Energy Statistics*.

Table 3-18 CH_4 emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	2000	2005	2007	2008	2009
Gasoline	Light Passenger Vehicle	g-CH_4/km	0.008	0.008	0.008	0.007	0.006	0.006	0.006
	Passenger Vehicle (including LPG)	g-CH_4/km	0.015	0.015	0.014	0.011	0.010	0.009	0.009
	Light Cargo Truck	g-CH_4/km	0.020	0.020	0.019	0.013	0.010	0.009	0.009
	Small Cargo Truck	g-CH_4/km	0.022	0.021	0.021	0.015	0.012	0.011	0.011
	Regular Cargo Truck	g-CH_4/km	0.035	0.035	0.035	0.035	0.035	0.035	0.035
	Bus	g-CH_4/km	0.035	0.035	0.035	0.035	0.035	0.035	0.035
	Special Vehicle	g-CH_4/km	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Diesel	Passenger Vehicle	g-CH_4/km	0.011	0.012	0.012	0.013	0.013	0.013	0.013
	Small Cargo Truck	g-CH_4/km	0.010	0.011	0.010	0.009	0.009	0.009	0.009
	Regular Cargo Truck	g-CH_4/km	0.017	0.016	0.015	0.014	0.013	0.013	0.013
	Bus	g-CH_4/km	0.019	0.018	0.017	0.017	0.017	0.017	0.017
	Special Vehicle	g-CH_4/km	0.017	0.015	0.013	0.013	0.013	0.013	0.013

Table 3-19 N_2O emission factors for road transportation

Fuel	Vehicle Type	Unit	1990	1995	2000	2005	2007	2008	2009
Gasoline	Light Passenger Vehicle	g-N_2O/km	0.015	0.015	0.014	0.009	0.008	0.007	0.007
	Passenger Vehicle (including LPG)	g-N_2O/km	0.024	0.024	0.020	0.012	0.010	0.009	0.009
	Light Cargo Truck	g-N_2O/km	0.024	0.024	0.022	0.013	0.010	0.009	0.009
	Small Cargo Truck	g-N_2O/km	0.020	0.021	0.021	0.013	0.010	0.009	0.009
	Regular Cargo Truck	g-N_2O/km	0.039	0.041	0.038	0.037	0.035	0.035	0.035
	Bus	g-N_2O/km	0.045	0.046	0.044	0.041	0.040	0.042	0.040
	Special Vehicle	g-N_2O/km	0.039	0.042	0.037	0.031	0.030	0.030	0.028
Diesel	Passenger Vehicle	g-N_2O/km	0.006	0.005	0.004	0.004	0.004	0.004	0.004
	Small Cargo Truck	g-N_2O/km	0.009	0.010	0.011	0.012	0.012	0.012	0.012
	Regular Cargo Truck	g-N_2O/km	0.015	0.015	0.015	0.016	0.019	0.021	0.022
	Bus	g-N_2O/km	0.025	0.025	0.025	0.025	0.025	0.025	0.025
	Special Vehicle	g-N_2O/km	0.025	0.025	0.025	0.025	0.025	0.025	0.025

- ***Activity Data***

Estimates of annual distance traveled by each vehicle type and by each type of fuel have been used as activity data. The method of estimating activity data was to multiply the proportion of distance traveled for each fuel, which was calculated from fuel consumption and fuel efficiency, by the distance traveled for each vehicle type given in the Ministry of Land, Infrastructure, Transport and

Tourism's *Statistical Yearbook of Motor Vehicle Transport*.

Table 3-20 Distance traveled per vehicle type

vehicle type	fuel type	Unit	1990	1995	2000	2005	2007	2008	2009
Light vehicle	Gasoline	10^6 vehicle-km	15,281	39,386	70,055	102,601	116,442	121,327	128,585
Passenger vehicle	Gasoline	10^6 vehicle-km	289,697	323,022	363,991	372,663	363,707	351,943	355,499
	Diesel Oil	10^6 vehicle-km	42,252	66,787	58,832	30,902	21,445	17,692	14,879
	LPG	10^6 vehicle-km	18,368	17,192	15,382	13,971	13,427	12,864	12,362
Bus	Gasoline	10^6 vehicle-km	95	32	21	46	69	73	85
	Diesel Oil	10^6 vehicle-km	7,016	6,736	6,598	6,605	6,658	6,503	6,464
Light cargo truck	Gasoline	10^6 vehicle-km	85,336	84,534	74,914	73,789	73,382	73,312	72,382
Small cargo truck + Cargo passenger truck	Gasoline	10^6 vehicle-km	36,981	25,892	24,988	26,597	27,051	26,345	26,054
	Diesel Oil	10^6 vehicle-km	55,428	62,032	57,221	41,674	38,064	36,295	33,281
Regular cargo truck	Gasoline	10^6 vehicle-km	447	361	331	741	993	1,059	1,088
	Diesel Oil	10^6 vehicle-km	66,434	78,086	82,693	78,866	80,516	77,887	74,146
Special vehicle	Gasoline	10^6 vehicle-km	827	851	1,584	1,556	1,690	1,726	1,822
	Diesel Oil	10^6 vehicle-km	10,420	15,373	19,115	18,869	20,185	19,851	19,361

- ***N_2O emissions from gasoline vehicle in Japan***

With the stipulation of the "1978 Emissions Regulation," the Three-way Catalyst started to be installed in gasoline automobiles in Japan. Then N_2O emissions per distance traveled increased. Until around 1986 when The Three-way Catalyst became widely used, N_2O emissions per distance traveled kept on increasing. New emission regulation on automobile were not stipulated until 1997, therefore, N_2O emissions per distance traveled were stable from 1986 to 1997. From 1997, Low Emission Vehicles were introduced. From 2000, with the stipulation of the "2000 Emission Regulation," N_2O emissions per distance traveled started to decrease in response to the introduction of the Close-coupled Catalytic Converter. Since 1997, the trend of N_2O emissions per distance traveled is on the decrease.

- ***Completeness***

➢ *Biomass fuels*

Currently, since very little ethanol fuel exists in Japan, there are very few ethanol-powered vehicles. For that reason, the emissions of CH_4 and N_2O 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 19 at the end of March 2007 (data surveyed by the Ministry of Land, Infrastructure, Transport and Tourism). Therefore activity data is negligible, and has not been reported, as it is assumed that the emissions are also negligible.

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

As the uncertainty of emission factors for the CH_4 and N_2O emissions from all types of vehicles, default values given in the *Good Practice Guidance (2000)* (40% for CH_4 and 50% for N_2O) were applied. For the uncertainty for activity data, 50% for standard values determined by the Committee for the Greenhouse Gas Emission Estimation Methods was applied. As a result, the uncertainties of the emission from all road transportation including natural gas-powered vehicles and motorcycles were determined to be 64% for CH_4 and 71% for N_2O. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emission factors were developed by using same method since FY 1990. Activity data have been estimated using the data in the *Statistical Yearbook of Motor Vehicle Transport*, in a consistent estimation method from FY 1990 onward.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.

e） Source-specific Recalculations

For gasoline passenger vehicle, gasoline light vehicle, gasoline light cargo truck, and diesel small cargo, new emission factors for CH_4 and N_2O in response to the enforcement of the New Long-term Regulation for exhaust gas (from FY 2005) were provided by JAMA, and emission factors for CH_4 and N_2O were revised. As a result, emissions for CH_4 and N_2O from FY 2005 to FY 2008 were revised.

f） Source-specific Planned Improvements

For some types of vehicles, it is necessary to consider whether more suitable emission factors, representing Japan’s circumstances should be established on the basis of actual measurements, because the default values presented in the *Revised 1996 IPCC Guidelines* and *Good Practice Guidance (2000)* are currently used.

3.2.4.2.b. Natural gas-powered vehicles

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions from natural gas-powered vehicles.

b） Methodological Issues

● ***Estimation Method***

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

● ***Emission Factors***

CH_4 emission factors for natural gas-powered small cargo trucks, passenger vehicle, light vehicle, light cargo trucks, regular cargo trucks and bus were determined using JAMA data and the same method used for the same type of gasoline or diesel powered vehicles.

N_2O emission factors for small cargo trucks and regular cargo trucks were determined using the emission factors established for each travel speed category, based on the actual measurements taken in Japan, and weighted by the percentage of distance traveled for each travel speed category reported in the *Road Transport Census* (Ministry of Land, Infrastructure, Transport and Tourism).

In the absence of actual measurement data in Japan, N_2O emission factors for passenger vehicle, light passenger vehicle, light cargo trucks, Special-purpose vehicles and bus and CH_4 emission factor for special-purpose vehicles were determined by the method indicated in the following Table 3-21.

Table 3-21 CH_4 and N_2O emission factors for natural gas-powered vehicles

Vehicle Type	Calculation Method for Emission Factor		Average Emission Factor	
	CH_4	N_2O	CH_4 [g-CH_4/km]	N_2O [g-N_2O/km]
Small cargo truck	JAMA data	Determined based on actual measurements	0.020	0.0002
Passenger vehicle	JAMA data	Used the emission factors for small cargo truck, taking the specifications of each vehicle type into account.	0.019	0.0002
light passenger vehicle, light cargo truck	JAMA data		0.013	
Regular cargo truck	JAMA data	Determined based on actual measurements	0.082	0.0128
Special-purpose vehicle	Determined from the percentage of distance traveled per travel speed category which was adjusted by the emission factor per travel speed category for regular cargo trucks, taking travel patterns of natural gas-powered special-purpose vehicles into consideration.		0.093	0.0145
Bus	JAMA data	Determined from the emission factor for regular cargo truck which was adjusted by the ratio of equivalent inertia weight, taking vehicle weight into consideration.	0.050	0.0384

- ***Activity Data***

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

Table 3-22 Annual distance traveled by natural gas-powered vehicles per vehicle type

vehicle type	Unit	1990	1995	2000	2005	2007	2008	2009
Passenger vehicle	1,000 vehicle-km	54	104	6,516	13,528	14,110	14,016	14,271
Bus	1,000 vehicle-km	0	1,860	18,743	53,936	61,444	64,005	65,079
Truck	1,000 vehicle-km	91	2,459	77,394	384,460	512,957	565,364	572,016
Small cargo truck	1,000 vehicle-km	184	8,088	32,426	57,045	67,137	72,550	75,529
Light vehicle	1,000 vehicle-km	0	301	12,934	49,543	62,894	69,299	74,951
Garbage vehicle	1,000 vehicle-km	0	300	6,955	38,816	47,039	50,304	52,287

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

The uncertainty of emission factors for both CH_4 and N_2O were determined as 1000% by expert judgment. The uncertainty of activity data was 50%; determined as a standard value by the 2002 Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties of the emissions were determined to be 1001% for both CH_4 and N_2O. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

The same emission factors were used since FY 1990. Activity data were estimated by using the data in the *Statistical Yearbook of Motor Vehicle Transport* and the *Natural Gas Mining Association Data*, in the same estimation method consistently since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.

e） Source-specific Recalculations

No recalculations were performed.

f） Source-specific Planned Improvements

To set more precise emission factors that better reflect actual conditions, it is needed to stock much more data on the annual distance traveled per vehicle type and improve the estimation methods used.

3.2.4.2.c. Motorcycles

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions from motorcycles.

b） Methodological Issues

- ***Estimation Method***

Emissions from motorcycles were estimated based on the method developed in Japan by the Ministry of Environment for the estimation of emissions from vehicles not subject to the PRTR[4].System. The emissions were calculated for two emission sources of “Hot start” and “Increment at cold start”, using the equations below. For details of the calculation method, see the *Greenhouse Gases Estimation Methods Committee Report – Transportation* (February, 2006).

CH_4 and N_2O emissions from hot-starting of motorcycles
= Emission factor for vehicle-km per type of motorcycle × Total annual distance traveled by motorcycles per type

CH_4 emissions from increment at cold starting of motorcycles
= Emission factor per start per type × Number of engine start-ups per year by each type of motorcycle

- ***Emission Factors***

➢ *Hot start*

The THC (Total Hydro Carbon) emission factor for hot starts, derived from the actual measurement data in Japan, was multiplied by the ratio of the CH_4 emission factor to the THC emission factor, obtained from actual measurements. The THC emission factors for motorcycles were established for each vehicle type, stroke, and unregulated/regulated status. Accordingly, the emission factor per travel speed was determined for each type of motorcycle by apportioning the number of motorcycles in operation to these categories based on the estimated component ratio.　For N_2O, the default emission factor for *US Motorcycles/European Motorcycles* given in the *Revised 1996 IPCC Guidelines* [0.002(gN_2O/km)]is used.

➢ *Increment at cold start*

The emission factor was determined for each type of motorcycle by multiplying the THC emission factor for cold-start increment, derived from the actual measurement data in Japan, by the CH_4 and THC emission factors for hot start, and apportioning the results based on the ownership component ratio. No emission factor is set for N_2O because the increment at cold start for N_2O is assumed to be included in the default emission factor for hot start

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[4] Pollutant Release and Transfer Register

Table 3-23 CH_4 emission factors for motorcycles

Emission Source	Vehicle Type	Unit	1990	1995	2000	2005	2007	2008	2009
Two-wheel vehicle (hot start)	Small motor vehicle: first kind	g-CH_4/km	14756	11264	7366	7335	6445	6295	6548
	Small motor vehicle: second kind	g-CH_4/km	2045	1860	1520	1821	1874	1943	1947
	Light two-wheel vehicle	g-CH_4/km	3986	3401	2696	3321	3362	3400	3257
	Small two-wheel vehicle	g-CH_4/km	2521	2670	2291	2472	2628	2679	1716
Two-wheel vehicle (cold start)	Small motor vehicle: first kind	g-CH_4/number	0.124	0.118	0.101	0.064	0.048	0.042	0.037
	Small motor vehicle: second kind	g-CH_4/number	0.088	0.090	0.082	0.050	0.038	0.030	0.026
	Light two-wheel vehicle	g-CH_4/number	0.155	0.159	0.137	0.071	0.050	0.043	0.038
	Small two-wheel vehicle	g-CH_4/number	0.117	0.119	0.112	0.069	0.054	0.046	0.041

- ***Activity Data***

➢ *Hot start*

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

➢ *Increment at cold start:*

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

Number of engine startups

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

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (40% for CH_4 and 50% for N_2O) were applied. The uncertainty of activity data was 50%; this was determined as a standard value by the 2002 Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties of the emissions were determined to be 64% for CH4 and 71% for N2O. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Same Estimation Methods were used since FY 1990. Activity data were estimated using the data in the *Statistical Yearbook of Motor Vehicle Transport* in a consistent estimation method since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.

e） Source-specific Recalculations

CH_4 and N_2O emissions of FY 2008 were recalculated due to the fact that statics of number of motorcycles owned (The number of vehicle owned by Automobile Inspection and Registration Association and JAMA data) were revised.

f） Source-specific Planned Improvements

- There is a need to stock much more data of annual distance traveled per vehicle type in order to set the emission factors more precisely.
- To set much more accurate activity data, the data from four-wheeled vehicles is needed to be replaced with the data from two-wheeled vehicles.

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

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions from railways. Emissions from railways come mainly from diesel-engine railway cars and locomotives that use diesel oil. In addition, there are small amounts of emissions from coal-fired steam locomotives.

b） Methodological Issues

● Estimation Method

Emissions were calculated by multiplying emission factor by fuel consumption on a calorific basis. The *Good Practice Guidance (2000)* does not provide a decision tree for a calculation method for this source.

CH_4 and N_2O emissions from diesel engines in railways
= Emission factor for diesel engines in railways × Annual consumption of diesel oil by diesel engines in railways

CH_4 and N_2O emissions from steam locomotives
= Emission factor for coal in rail transportation × Annual consumption of coal by steam locomotives

● Emission Factors

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

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

Table 3-24 Default values for railway emission factors

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

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

● Activity Data

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

Coal consumption by steam locomotives was considered to be the value shown in the Statistical

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

Table 3-25 Activity Data used for estimation of emissions from railways

Fuel type	Unit	1990	1995	2000	2005	2007	2008	2009
Diesel oil	kl	356,224	313,235	269,711	248,211	239,334	230,381	230,381
Coal	kt	17	19	28	13	9	7	7

c） Uncertainties and Time-series Consistency

- **Uncertainties**

The uncertainties for emission factors were determined to be 5.0% for CH_4 and 5.0% for N_2O in accordance with the Committee for the Greenhouse Gas Emission Estimation Methods. For the uncertainty of activity data of diesel-engine locomotive, 10% given in the *Statistical Yearbook of Railway Transport*, was applied. For the uncertainty of activity data of coal-fired steam locomotives, 105% aggregated by the values given in the *Statistical Yearbook of Railway Transport* and the *Directory of Energy and Economics Statistics*, was applied. As a result, the uncertainties of the emissions were determined to be 11% for CH_4 and N_2O from diesel-engine locomotives and 101% for CH_4 and N_2O from coal-fired steam locomotives. The uncertainty assessment methods are summarized in Annex 7.

- **Time-series Consistency**

The same emission factors were used since FY 1990. The data given in the *General Energy Statistics* for diesel-engine locomotives were used as activity data consistently since FY 1990. Activity data for coal-fired steam locomotives were calculated using the data in the *Statistical Yearbook of Railway Transport* and the *Directory of Energy and Economics Statistics*, in a consistent estimation method in all time-series.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.

e） Source-specific Recalculations

GHG emissions in FY 2008 were recalculated with the revision of the fuel consumption described in the *General Energy Statistics* in FY 2008. For emissions of CH_4 and N_2O from coal-fired steam locomotives, activity data (coal consumption) of FY 2008 are revised responding to the publication of the *Statistical Yearbook of Railway Transport of FY 2008*. As a result, emissions for CH_4 and N_2O of FY 2008 are revised.

f） Source-specific Planned Improvements

For the emission factor for diesel engine-railways, it is needed to discuss whether more suitable emission factors (i.e., those that better reflect Japan's circumstances) should be established on the basis of actual measurements, because the default values presented in the *Revised 1996 IPCC Guidelines* and *Good Practice Guidance (2000)* are currently used.

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

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions from navigation. Ships emit CH_4 and N_2O through the use of diesel oil and fuel oils A, B and C during their navigation.

b） Methodological Issues

- ***Estimation Method***

Emissions were calculated using the default values for CH_4 and N_2O given in the *Revised 1996 IPCC Guidelines,* in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.52, Fig. 2.6).

CH_4 and N_2O emissions associated with navigation of domestic vessels
= Emission factors for diesel oil and fuel oils A, B and C relating to domestic vessels × Consumption of each type of fuel by domestic vessels

- ***Emission Factors***

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

Table 3-26 Default emission factors for navigation

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

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

- ***Activity Data***

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

Table 3-27 Activity Data used for estimation of emissions from ships

Fuel type	Unit	1990	1995	2000	2005	2007	2008	2009
Diesel oil	1,000 kl	133	208	204	195	189	189	189
Fuel oil (A)	1,000 kl	1,602	1,625	1,728	1,324	1,126	1,046	966
Fuel oil (B)	1,000 kl	526	215	152	63	42	25	19
Fuel oil (C)	1,000 kl	2,446	3,002	3,055	2,873	2,792	2,592	2,450

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (200% for CH_4 and 1,000% for N_2O) were applied. The uncertainty of activity data was 13%. This was a precision value (95% confidence interval) provided in the *Statistical Yearbook of Coastwise Vessel Transport* that was an original statistic of the *General Energy Statistics*. As a result, the uncertainties of the emissions were determined to be 64% for CH_4 and 71% for N_2O. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emission factors were used same values since FY 1990. The activity data given in the *General Energy Statistics* were used as the activity data for navigation consistently since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.

e） Source-specific Recalculations

GHG emissions in FY 2008 were recalculated with the revision of the fuel consumption described in the *General Energy Statistics* in FY 2008.

f） Source-specific Planned Improvements

For the emission factor for navigation, it is needed to discuss to set more suitable factors (i.e., those that better reflect Japan's circumstances) that are based on actual measurements, because the default values presented in the *Revised 1996 IPCC Guidelines* are currently used.

3.2.5. Other Sectors (1.A.4)

a） Source/Sink Category Description

This category provides the estimation methods for CO_2 emissions from Commercial /Institutional (1.A.4.a), Residential (1.A.4.b) and Agriculture / Forestry / Fisheries (1.A.4.c).

b） Methodological Issues

- ***Estimation Method***

  See Section 3.2.1 b).
- ***Emission Factors***

  See Section 3.2.1 b).
- ***Activity Data***

  The data given in the *General Energy Statistics* compiled by the Agency for Natural Resources and Energy were used for activity data as well energy industry (1.A.1).

  Activity data for each sub-category are the values for final energy consumption in Commercial/Institutional (#7500), Residential (#7100), and Agriculture/Forestry/Fisheries (#6110) sector in *General Energy Statistics*. Because the energy consumption above includes the amount of Non-energy use which was used for purposes other than combustion, these values were deducted from the energy consumption in each category.

Table 3-28 Correspondence between sectors of Japan's Energy Balance Table and of the CRF (1.A.4)

CRF			Japan's Energy Balance Table	
1A4		Other Sectors		
	1A4a	Commercial/Institutional	Final Energy Consumption, Commercial & Others	#7500
			Non-Energy, ResCom & others (Commercial & Others)	#9800
	1A4b	Residential	Final Energy Consumption, Residential	#7100
			Non-Energy, ResCom & others (Residential)	#9800
	1A4c	Agriculture/Forestry/Fisheries	Final Energy Consumption, Agruculture, Forestry & Fishery	#6110
			Non-Energy, Non-Manufacturing Industry (Agruculture, Forestry & Fishery)	#9610

・#9xxx items are not energy use activity.

c） Uncertainties and Time-series Consistency

See Section 3.2.1 c).

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000).* The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6

e） Source-specific Recalculations

GHG emissions in FY 2008 were recalculated due to the revision of the fuel consumption in FY 2008 in *General Energy Statistics*.
CH_4 and N_2O emissions were recalculated, because of scrutinizing the data of fuel consumption for each type of furnaces as well energy industry (1.A.1).

f） Source-specific Planned Improvements

There are no major planned improvements in this source category.

3.2.6. Distinctive trend

ERT recommend that Japan provide clear explanations of trends of such as GHG emissions, activities, and emission factors. In this section, these explanations were described.

The N_2O emissions from solid fuel in 1.A.1.a (Public Electricity and Heat Production) increased between 1994 and 1995. The reason for the increase is that a new large sized fluidized-bed boiler for power generation went on line in 1995. As a result, the solid fuel consumption of fluidized-bed boiler for public power generation increased in 1995, resulting in an increase of N_2O emissions from solid fuel in this category.

The IEFs (Implied Emission Factor) of CO_2 emissions from solid fuels in 1.A.1.c (Manufacture of Solid Fuels and Other Energy Industries) have been pulled up and down by “emission from carbon balances” derived from transformation of solid fuel by manufacture of solid fuels. The apparent annual change of this category is caused by the difference of mass-balance between Coking coal and Coke and other coal products, may be caused by statistical error, unobserved stockpiles in the process and/or spontaneous input-output unbalance.

Furthermore, the gross calorific value (GCV) trends for solid fuel are declining since 1990. In 1970 to 1990, Japanese steel manufacturers used conventional coking coal for feedstock for Coke, but due to the shortage of coking coal and price increase, they developed new Coke making technology to use steam coal with pre-treatment as feedstock for Coke instead. Similarly, they changed PCI coal from coking coal and steam coal mixture to steam coal with pre-treatment. Japanese steel manufacturers have been trying to make high-quality coke from cheap coal for economic reasons. Because conventional coking coal has a high carbon content and GCV than steam coal, and the new technology has introduced step-by-step, so apparent GCV gradually decreased in these years.

3.2.7. Comparison of Sectoral and Reference Approaches

This comparison is documented and described in Annex 4.

3.2.8. International Bunker Fuels

a） Source/Sink Category Description

This sector provides the estimation methods for determining CO_2, CH_4, and N_2O emissions from the fuel consumed for international navigation and aviation.

Exclusion of emissions from bunker fuels used for international navigation and aviation from the national totals has been reported as a memo item.

b） Methodological Issues

- ***Estimation Method***

Emissions of CO_2, CH_4 and N_2O from this source are derived by multiplying the consumption of each type of fuel handled by bonds by the emission factor.

- ***Emission Factors***

【CO_2】

The emission factors used for CO_2 are the same as those for the energy sectors, fuel combustion (CO_2) in energy sectors (Refer to Section 3.2.1).

【CH_4, N_2O】

Default values given in the *Revised 1996 IPCC Guidelines* are used for CH_4 and N_2O emission factors.

Table 3-29 Emission factors for CH_4 and N_2O 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	Fuel oil A, Fuel oil B, Fuel oil C, Diesel oil, Kerosene	0.007 [g-CH_4/MJ] [c]	0.002 [g-N_2O/MJ] [c]

a. Revised 1996 IPCC Guidelines Vol. 3, Table 1-47

b. Revised 1996 IPCC Guidelines Vol. 3, Table 1-52

c. Revised 1996 IPCC Guidelines Vol. 3, Table 1-48

- ***Activity Data***

Totals for bonded imports and bonded exports given in the Ministry of Economy, Trade and Industry's Yearbook of Mineral Resources and Petroleum Products Statistics (former Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke) are used for emissions of CO_2, CH_4, and N_2O from the relevant source.

A and B in the diagram below correspond to the items under bonded exports and bonded imports, respectively, in the Yearbook of Mineral Resources and Petroleum Products Statistics (former Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke). C equals to the sum of A and B and it is used as the activity data for this source of emissions. This is considered to be approximately equivalent to the amount of the fuels sold in Japan for the international aviation and navigation.

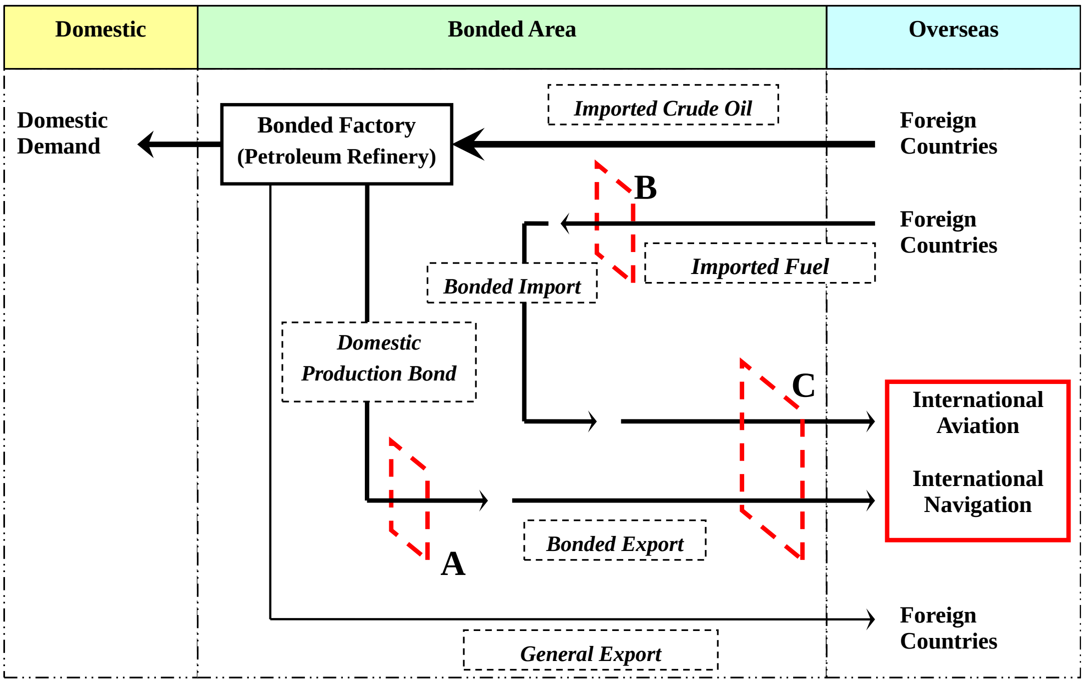

Figure 3-3 Activity data for international bunkers

It is assumed that jet fuel is used by aircraft, while fuel oil A, B, C, diesel oil and kerosene are used by vessels. Fuel oil A, B, and C are used for propulsion of international water-borne vessels. Diesel oil and kerosene are used only for fuels of private power generator (eg. Air heating).

【CO_2】

The kiloliter-based consumption data given in the Ministry of Economy, Trade and Industry's Yearbook of Mineral Resources and Petroleum Products Statistics (former Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke) is converted to a Joule-based data using the standard calorific values given in the Agency for Natural Resources and Energy's General Energy Statistics.

【CH_4, N_2O】

The *Revised 1996 IPCC Guidelines* provide a default emission factor that is based on net calorific values. Therefore, activity data in gross calorific values are converted to net calorific values by multiplying them by 0.95.

In addition, regarding activity data of N_2O from an international aviation, the *Revised 1996 IPCC Guidelines* provide a default emission factor in weight units. In order to adapt the activity data to this unit, the kiloliter-based consumption data is multiplied by the density identified by the Petroleum Association of Japan for N_2O from aircraft (0.78 [g/cm^3]).

c） Other issues

The desk review report in 2004 indicated that there was a significant difference between bunker active data reported in the CRF (table 1.C) and bunker consumption data reported to the International Energy Agency (IEA).   The followings explain the causes for the difference.

➢ *Data Update*

The ERT in 2004 used the following IEA energy balances for analysis.

- Data for 2000-2001: ” ENERGY BALANCES OF OECD COUNTRIES 2000-2001」 II 94-95”
- Data for 2002-2003: “ ENERGY BALANCES OF OECD COUNTRIES 2002-2003」 II 94-95”

After the publication of the data, it was found out that there were some errors in data of 2000 and 2001 submitted to IEA, including omission of full counting of imported bunker fuel and errors in the values of exported diesel oil. In March 2006, Japan reported the revision of these errors and the errors have been corrected since then.

➢ *Difference of fuel types reported as “bunker”*

Up to Japan’s national greenhouse gas inventories submitted in May 2004, Japan reported the bonded imports and exports of fuel oil A, B, and C as navigation bunker. In IEA energy balance, navigation bunker reported includes bonded diesel oil, kerosene and lubricant, other than bonded fuel oil A, B and C. This difference causes the variation between inventory data and IEA data.

Japan revised the estimation method in the inventory submitted in August 2004 and has reported bonded diesel oil and kerosene consumption as navigation bunker since then[5].

➢ *Errors of density and conversion factor*

Data for the IEA energy balance need to be reported in the metric-ton unit. Japan calculates and reports to IEA values in metric-ton by multiplying the volume of fuel combustion given in the *Yearbook of Mineral Resources and Petroleum Products Statistics* by the density of each fuel type given in the *information of petroleum*, Sekiyu –Tsushin. IEA converts the values in metric ton into tons of oil equivalent (TOE) by using conversion factors. Given that the values are expressed in net calorific-based value equivalent, and the conversion factors used in IEA are net calorific value.

Conversion of a unit to TOE by using information given in the inventory can be conducted by multiplying the volume of fuel consumption by gross calorific-based values.

This difference in the conversion process causes the variation between IEA energy balance and Japans energy statistics for inventory preparation.

Glossary

Bonded Jet Fuel

Under the Tariff Law, aircrafts (Japanese and non-Japanese) flying international routes are deemed to be “aircraft for international use”, and the fuel they consume is tariff-free, subject to the completion of the required procedures. The application of this legislation means that if fuel is refined from crude oil imported to Japanese refinery, both the crude oil import tariff and the petroleum tax are waived. Similarly, if fuel has been imported as a product, the product import tariff is waived. The foregoing is termed as “bonded jet fuel”.

Bonded Fuel Oil

Vessels that ply voyages between Japan and other countries are deemed to be “foreign trade vessels”, under the Tariff Law. The majority of their fuel is consumed outside Japanese territorial waters, and,

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[5] Lubricant is not included because lubricant is not combusted by use.

therefore both tariffs and the petroleum tax are waived. The foregoing is termed as "bonded fuel oil".

Bonded Export
The demand for fuel supplied to aircrafts (Japanese and non-Japanese) flying international routes and ships (Japanese and non-Japanese) that ply foreign ocean routes is termed as "bonded demand". Jet fuel is supplied to aircrafts while fuel oil is supplied to ships. Of these bonded demand, the fuel supplied from products that was produced from crude oil is counted as bonded exports by the Ministry of Economy, Trade and Industry.

Bonded Import (Bond to Bond)
Fuel products that are imported from foreign countries, landed in a bonded area and supplied from the bonded area to bonded demand without going through domestic customs, is counted as bonded imports by the Ministry of Economy, Trade and Industry.

3.2.9. Feedstocks and Non-Energy Use of Fuels

In the method used to estimate GHG emissions from fuel combustion (1.A.), the energy consumption in the category of Non-energy use (#9500) in *General Energy Statistics* was deducted from the total energy consumption, because these amounts of fuel was used as feedstocks without combustion and oxidation process.

The Non-energy category consists of the following two requirements: (1) Consumption which can be confirmed as clearly being employed for non-energy uses by official statistics, such as surveys of feedstocks inputs according to *Current Survey of Energy Consumption* which is the data source of *General Energy Statistics*; and (2) Products which are from the outset produced for the purpose of non-energy use.
(However, that portion which is confirmed from official statistics such as *Current Survey of Energy Consumption* as having been employed for energy uses is treated as energy consumption and excluded from non-energy use.)

CO_2 emissions from combustion and oxidation in the process of production, use and abandonment of the amount of feedstocks and non-energy use which were deducted from 1.A are separately reported in the following sectors.

- Ammonia Production (2.B.1)
- Silicon Carbide Production (2.B.4)
- Calcium Carbide Production (2.B.4)
- Ethylene Production (2.B.5)
- Use of Electric Arc Furnaces in Steel Production (2.C.1)
- Wastes Incineration (Simple Incineration) (waste oil and waste plastics) (6.C)
- Emissions from the Decomposition of Petroleum-Derived Surfactants (6.D)

3.2.10. CO_2 capture from flue gases and subsequent CO_2 storage

The amount of CO_2 capture from flue gases and subsequent CO_2 storage was not estimated in Japan.

3.2.11. Emission from waste incineration with energy recovery

Below three cases that utilize waste as crude material meets definition of the emission from waste incineration with energy recovery.

- Waste incineration with energy recovery
- Direct use of waste as fuel
- Use of waste processed as fuel

Estimation method for emission from these sources is applied waste incineration (6.C.) method in accordance with the *1996 Revised IPCC Guidelines*. The value of emission is included in fuel combustion (1.A.1. and 1.A.2.) in accordance with the *1996 Revised IPCC Guidelines* and the *Good Practice Guidance (2000).* Please refer to Chapter 8 for the details of the estimation methods.

The reporting category of the emissions for each type of waste is, according to its use as fuel or raw material, classified to either “Energy Industry (Category 1.A.1.)” or “Manufacturing and Construction (1.A.2)”. The fuel type is classified as “Other fuels”.
Greenhouse gas emissions during the direct use of waste as a raw material, such as plastics used as reducing agents in blast furnaces or as a chemical material in coking furnaces, or use of intermediate products manufactured using the waste as a raw material, are estimated in this category.

Refuse-derived solid fuels (RDF: Refuse Derived Fuel, RPF: Refuse Paper and Plastic Fuel) are used for the estimation of emissions from fuels produced from waste. The reporting categories of the above emissions are included in “Energy Industry (Category 1.A.1.)” or “Manufacturing/Construction (1.A.2)” according to the use of waste as fuels. The fuel type is classified as “Other fuels”.

Table 3-30 Categories for the calculation of emissions from waste incineration with energy recovery

Incineration	Waste category	Estimation classification	Category of estimation	CO_2	CH_4	N_2O
Waste incineration with energy recovery	Municipal solid waste	Plastic	1.A.1	○	○ Estimated in bulk	○ Estimated in bulk
		Synthetic textile	1.A.1	○		
		Other (biogenic)	1.A.1			
	Industrial solid waste	Waste oil	1.A.1	○	○	○
		Waste plastic	1.A.1	○	○	○
		Other (biogenic)	1.A.1		○	○
Direct use of waste as fuel	Municipal solid waste	Plastic	1.A.1/2	○	○	○
	Industrial solid waste	Waste oil	1.A.2	○	○	○
		Waste plastic	1.A.2	○	○	○
		Waste wood	1.A.2		○	○
	Waste tire	Fossil origin	1.A.1/2	○	○	○
		Biogenic origin	1.A.1/2			
Use of waste processed as fuel	Refuse derived fuel （RDF・RPF）	Fossil origin	1.A.1/2	○	○	○
		Biogenic origin	1.A.1/2			

* CO_2 emissions from the incineration of biomass-derived waste (including biomass-based plastics and waste animal and vegetable oil) is not included in the total emissions in accordance with the Revised 1996 IPCC Guidelines; instead it is estimated as a reference value and reported under “ Biogenic” in Table 6.A,C of the CRF.

The greenhouse gas emissions from waste incineration for energy purpose and with energy recovery are shown in Table 3-31.

Table 3-31 GHG Emission from waste incineration with energy recovery

Gas	Item			Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	1.A.1 Energy Industries	a. Public Electricity and Heat Production		Gg-CO_2	6,493	7,080	9,075	7,965	6,409	6,435	7,286
		b. Petroleum Refining		Gg-CO_2	NO	NO	1	6	5	4	5
		c. Manufacture of Solid Fuels and Other Energy		Gg-CO_2	NO	NO	15	239	194	193	204
	1.A.2. Manufacturing Industries and Construction	a. Iron and Steel		Gg-CO_2	NO	NO	308	634	507	377	444
		b. Non-Ferrous Metals		Gg-CO_2	118	63	51	17	13	3	2
		c. Chemicals		Gg-CO_2	14	64	89	66	62	66	67
		d. Pulp, Paper and Print		Gg-CO_2	NO	55	113	993	1,595	1,604	1,651
		e. Food Processing, Beverages and Tobacco		Gg-CO_2	IE	IE	IE	IE	IE	IE	IE
		f. Other	Mining	Gg-CO_2	IE	IE	IE	IE	IE	IE	IE
			Construction	Gg-CO_2	IE	IE	IE	IE	IE	IE	IE
			Oil Products	Gg-CO_2	IE	IE	IE	IE	IE	IE	IE
			Glass Wares	Gg-CO_2	IE	IE	IE	IE	IE	IE	IE
			Cement & Ceramics	Gg-CO_2	597	1,122	1,876	2,317	2,612	2,467	2,428
			Machinery	Gg-CO_2	41	26	20	10	NO	NO	NO
			Duplication Adjustment	Gg-CO_2	NO	NO	NO	NO	NO	NO	NO
			Other Industries & Small & Medium Enterprise	Gg-CO_2	1,854	2,092	1,595	2,877	3,021	3,001	2,305
	Total			Gg-CO_2	9,116	10,503	13,142	15,122	14,419	14,149	14,390
CH_4	1.A.1 Energy Industries	a. Public Electricity and Heat Production		Gg-CH_4	0.54	0.54	0.60	0.15	0.14	0.14	0.13
		b. Petroleum Refining		Gg-CH_4	NO	NO	0.000002	0.000018	0.000015	0.000010	0.000013
		c. Manufacture of Solid Fuels and Other Energy		Gg-CH_4	NO	NO	IE	IE	IE	IE	IE
	1.A.2. Manufacturing Industries and Construction	a. Iron and Steel		Gg-CH_4	NO	NO	NA	0.00036	0.00057	0.00065	0.00065
		b. Non-Ferrous Metals		Gg-CH_4	0.00032	0.00018	0.00014	0.00008	0.00006	0.00002	0.00001
		c. Chemicals		Gg-CH_4	0.00006	0.00013	0.00019	0.00019	0.00017	0.00019	0.00019
		d. Pulp, Paper and Print		Gg-CH_4	NO	0.0001	0.0002	0.0027	0.0044	0.0045	0.0046
		e. Food Processing, Beverages and Tobacco		Gg-CH_4	IE	IE	IE	IE	IE	IE	IE
		f. Other	Mining	Gg-CH_4	IE	IE	IE	IE	IE	IE	IE
			Construction	Gg-CH_4	IE	IE	IE	IE	IE	IE	IE
			Oil Products	Gg-CH_4	IE	IE	IE	IE	IE	IE	IE
			Glass Wares	Gg-CH_4	IE	IE	IE	IE	IE	IE	IE
			Cement & Ceramics	Gg-CH_4	0.04	0.08	0.15	0.21	0.24	0.25	0.24
			Machinery	Gg-CH_4	0.00018	0.00012	0.00009	0.00005	NO	NO	NO
			Duplication Adjustment	Gg-CH_4	NO	NO	NO	NO	NO	NO	NO
			Other Industries & Small & Medium Enterprise	Gg-CH_4	1.77	1.77	2.22	2.90	3.29	3.69	4.02
	Total			Gg-CH_4	2.34	2.39	2.98	3.26	3.68	4.08	4.39
				Gg-CO_2 eq.	49.20	50.28	62.52	68.53	77.18	85.62	92.18
N_2O	1.A.1 Energy Industries	a. Public Electricity and Heat Production		Gg-N_2O	1.20	1.33	1.56	1.14	1.07	1.03	0.96
		b. Petroleum Refining		Gg-N_2O	NO	NO	0.00001	0.00012	0.00009	0.00006	0.00008
		c. Manufacture of Solid Fuels and Other Energy		Gg-N_2O	NO	NO	IE	IE	IE	IE	IE
	1.A.2. Manufacturing Industries and Construction	a. Iron and Steel		Gg-N_2O	NO	NO	NA	0.0007	0.0011	0.0013	0.0013
		b. Non-Ferrous Metals		Gg-N_2O	0.00024	0.00013	0.00011	0.00006	0.00004	0.00001	0.00001
		c. Chemicals		Gg-N_2O	0.00004	0.00060	0.00092	0.00107	0.00106	0.00110	0.00113
		d. Pulp, Paper and Print		Gg-N_2O	NO	0.0007	0.0014	0.0175	0.0278	0.0279	0.0286
		e. Food Processing, Beverages and Tobacco		Gg-N_2O	IE	IE	IE	IE	IE	IE	IE
		f. Other	Mining	Gg-N_2O	IE	IE	IE	IE	IE	IE	IE
			Construction	Gg-N_2O	IE	IE	IE	IE	IE	IE	IE
			Oil Products	Gg-N_2O	IE	IE	IE	IE	IE	IE	IE
			Glass Wares	Gg-N_2O	IE	IE	IE	IE	IE	IE	IE
			Cement & Ceramics	Gg-N_2O	0.01	0.02	0.04	0.05	0.06	0.05	0.05
			Machinery	Gg-N_2O	0.00013	0.00008	0.00007	0.00003	NO	NO	NO
			Duplication Adjustment	Gg-N_2O	NO	NO	NO	NO	NO	NO	NO
			Other Industries & Small & Medium Enterprise	Gg-N_2O	0.03	0.03	0.03	0.05	0.05	0.06	0.06
	Total			Gg-N_2O	1.24	1.38	1.63	1.26	1.21	1.17	1.10
				Gg-CO_2 eq.	385.39	428.89	506.38	391.20	374.46	362.94	339.97

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

The Fugitive Emissions subsector consists of intentional and unintentional emissions of CO_2, CH_4, and N_2O from unburned fossil fuels during their mining, production, processing, refining, transportation, storage, and distribution.

There are two main source categories in this sector: Solid Fuels (1.B.1), emissions from coal mining and handling, and Oil and Natural Gas (1.B.2), emissions from the oil and natural gas industries. The main source of emissions from solid fuels is CH_4 contained in coal bed, whereas fugitive emissions, venting, flaring, volatilization, and accidents are the main emission sources in the oil and natural gas industries.

In 2009, GHG emissions from fugitive emission from fuels were 429 Gg-CO_2 eq. and accounted for 0.04 % of the Japan's total GHG emissions (excluding LULUCF). The emissions have decreased by 86 % compared to 1990.

Table 3-32 Emission trends of the fugitive emissions subsector (1.B)

Gas	IPCC Category			Unit	1990	1995	2000	2005	2007	2008	2009
CH_4	1.B.1 Solid Fuels	a. Coal Mining	i. Underground Mines	Gg-CH_4	132.63	63.45	36.11	3.07	1.90	1.55	1.67
			ii. Surface Mines	Gg-CH_4	1.01	0.58	0.51	0.43	0.55	0.63	0.53
	1.B.2 Oil and Natural Gas	a. Oil		Gg-CH_4	1.35	1.75	1.42	1.41	1.33	1.30	1.21
		b. Natural Gas		Gg-CH_4	8.95	9.87	10.98	13.30	15.44	15.35	14.80
		c. Venting and Flaring	- Venting	Gg-CH_4	0.58	0.86	0.53	0.51	0.46	0.47	0.43
			- Flaring	Gg-CH_4	0.11	0.14	0.11	0.13	0.14	0.14	0.13
	Total			Gg-CH_4	144.63	76.66	49.67	18.84	19.82	19.44	18.77
				Gg-CO_2 eq.	3,037.14	1,609.87	1,043.15	395.74	416.20	408.29	394.20
CO_2	1.B.1 Solid Fuels	a. Coal Mining	i. Underground Mines	Gg-CO_2	NE	NE	NE	NE	NE	NE	NE
			ii. Surface Mines	Gg-CO_2	NE	NE	NE	NE	NE	NE	NE
	1.B.2 Oil and Natural Gas	a. Oil		Gg-CO_2	0.14	0.20	0.14	0.15	0.11	0.12	0.11
		b. Natural Gas		Gg-CO_2	0.25	0.27	0.31	0.38	0.46	0.45	0.43
		c. Venting and Flaring	- Venting	Gg-CO_2	0.005	0.007	0.005	0.004	0.004	0.004	0.004
			- Flaring	Gg-CO_2	36.22	50.44	35.58	37.06	36.95	37.27	34.60
	Total			Gg-CO_2	36.62	50.92	36.03	37.60	37.53	37.85	35.15
N_2O	1.B.1 Solid Fuels	a. Coal Mining	i. Underground Mines	Gg-N_2O	NE	NE	NE	NE	NE	NE	NE
			ii. Surface Mines	Gg-N_2O	NE	NE	NE	NE	NE	NE	NE
	1.B.2 Oil and Natural Gas	a. Oil		Gg-N_2O	3.06E-07	3.40E-07	3.74E-07	5.10E-07	2.04E-07	2.38E-07	2.38E-07
		b. Natural Gas		Gg-N_2O							
		c. Venting and Flaring	- Venting	Gg-N_2O							
			- Flaring	Gg-N_2O	0.00036	0.00050	0.00036	0.00038	0.00039	0.00039	0.00036
	Total			Gg-N_2O	0.00036	0.00050	0.00036	0.00038	0.00039	0.00039	0.00036
				Gg-CO_2 eq.	0.11	0.16	0.11	0.12	0.12	0.12	0.11
ガス合	Total of all gas			Gg-CO_2 eq.	3,073.88	1,660.95	1,079.29	433.46	453.84	446.26	429.46

3.3.1. Solid Fuels (1.B.1.)

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

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

a） Source/Sink Category Description

Coal contains CH_4 that forms during the coalification process. Most will have been naturally released from the ground surface before mine development, but mining releases the CH_4 remaining in coal beds into the atmosphere.

The number of operational coal mines in Japan has decreased and coal production has decreased greatly as well. As a result, the amount of the CH_4 emissions from coal mining has shown a yearly decrease.

Furthermore, the coal mining practices have changed recently, resulting in the decreasing trend of CH_4 IEF. Specifically, coal is now mined in more shallow areas, therefore emitting less CH_4. This is because deep areas are costly to mine compared to coal in shallow areas. Additionally, areas which have been previously mined, therefore already releasing CH_4, are re-mined for coal, using the latest technology. This contributes to low CH_4 emission per amount of coal mined also if compared with other countries.

Although a reporting column is provided for CO_2 emissions associated with coal mining, in the absence of a default emission factor, emissions from this source were reported as "NE". Coal mining exists in Japan, and, depending on the CO_2 concentration in the coal being mined, the CO_2 may be released into the atmosphere during mining activity. Although it is believed that coal beds in Japan do not contain CO_2 at a concentration level that is higher than that in the atmosphere, emissions cannot be calculated because of the absence of actual measurements. Because of the absence as well of a default value for CO_2 emissions associated with coal mining, emissions from this source are not reported.

b） Methodological Issues

● Estimation Method

➢ *Mining Activities*

Emissions from mining activities were drawn from actual measurements obtained from individual coal mines using the Tier 3 method, in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.72, Fig. 2.10).

➢ *Post-Mining Activities*

Emissions from post-mining activities were estimated using the Tier 1 method, which uses default emission factors in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.73, Fig. 2.11). It was estimated by multiplying the amount of coal mined from underground mining by the emission factor.

● Emission Factors

➢ *Mining Activities*

The emission factor for mining activities was established by dividing the emissions of CH_4 gas identified in a survey by Japan Coal Energy Center (J-COAL), by the production volume of coal from underground mines.

Table 3-33 Emission factors for mining activities – Underground mines

Item	Unit	1990	1995	2000	2005	2007	2008	2009	Reference
Coal Production of Underground Mines	kt	6,775	5,622	2,364	738	617	536	575	Surveyed by J-COAL
CH_4 Total Emissions	1000 m^3	181,358	80,928	48,110	2,781	1,319	1,001	1,089	Surveyed by J-COAL
CH_4 Total Emissions	Gg-CH_4	121.5	54.2	32.2	1.9	0.9	0.7	0.7	=CH_4 [1000m^3] / 1000 X 0.67 [Gg/$10^6 m^3$]
Emission Factor	kg-CH_4/t	17.9	9.6	13.6	2.5	1.4	1.3	1.3	CH_4 Total Emissions / Coal Production of Underground Mines

➢ *Post-Mining Activities*

Due to the lack of data for emissions from post-mining activities in Japan, emission factors were calculated (1.64 [kg CH_4/t]) by converting the median value (2.45 m^3/t) of the default values (0.9 – 4.0 m^3/t) given in the *Revised 1996 IPCC Guidelines* by the density of CH_4, 0.67 (1,000 t/10^6 m^3) at 20°C and 1 atmosphere.

- ***Activity Data***

➢ *Mining Activities, Post-Mining Activities*

The value used for activity data for underground mining and post-mining activities was derived by subtracting the surface mining production from the 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 and the data provided by Japan Coal Energy Center (J-COAL).

Table 3-34 Trends in coal production

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Total Coal Production	kt	7,980	6,317	2,974	1,249	1,280	1,290	1,206
Surface Mines	kt	1,205	695	610	511	663	754	631
Underground Mines	kt	6,775	5,622	2,364	738	617	536	575

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

Uncertainty for CH_4 emissions from mining activities was calculated to be 5% based on the values of measurement error and error of gas flow velocity fluctuation.

Uncertainty for CH_4 emissions from post-mining activities was 5%, which is the value of the default data in *Good Practice Guidance (2000)*. A summary of uncertainty assessment methods is provided in Annex 7.

- ***Time-series Consistency***

The CH_4 emissions data for mining activities in underground mines have been derived from *Japan Coal Energy Center* (J-COAL) statistics consistently since FY 1990.

Total coal production and coal production on surface mines were provided by the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* prepared by the Ministry of Economy, Trade and Industry from FY 1990 to FY 2000. Thereafter, they have been provided by the Japan Coal Energy Center (J-COAL), because categories of surface mining production and total coal production in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* is no longer conducted. The data from the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* prepared by the Ministry of Economy, Trade and Industry until 2000 are provided by Japan Coal Energy Center (J-COAL). Therefore, total coal production data from both of these sources are same and have been used in a consistent manner since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)*. The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

In order to ensure safety of coal mine workers in Japan, monitoring the concentration of CH_4 and CO in coal mines is ordained by law. Under the law, mining companies must set rules on monitoring management. Mining companies monitor accurately under strict management and checks, and compile relevant reports. Furthermore, national authorities regularly check monitoring measurements and safety reports.

e） Source-specific Recalculations

There have been no recalculations to emissions from this source category.

f） Source-specific Planned Improvements

There are no major planned improvements in this source category.

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

a） Source/Sink Category Description

This category provides the estimation methods for fugitive emissions of CH_4 occur during the coal mining and post-mining activities on surface mines.

b） Methodological Issues

- ***Estimation Method***

➢ *Mining Activities*

CH_4 emissions were calculated using the Tier 1 method and the default emission factor in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.71, Fig. 2.9).

➢ *Post-Mining Activities*

CH_4 emissions were calculated using the Tier 1 method and the default emission factor in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.73, Fig. 2.11).

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

- ***Emission Factors***

➢ *Mining Activities*

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

➢ *Post-Mining Activities*

A value (0.067 [kg-CH_4/t-coal]) was used as emission factor for post-mining activities. It was derived by converting the median (0.1 [m^3/t]) of the default values given in the Revised 1996 IPCC Guidelines (0–0.2 [m^3/t]), using the concentration of CH_4 at one atmospheric pressure and 20°C (0.67 [Gg/10^6m^3]).

- ***Activity Data***

The figure for the surface production given in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* prepared by the Ministry of Economy, Trade and Industry and the data provided by the Japan Coal Energy Center (J-COAL) were used as the activity data for mining and post-mining activities (see Table 3-34).

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

The uncertainties for emission factors were applied 200% of default data indicated in the *Good Practice Guidance (2000)*. The uncertainty of activity data was 10%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties of CH_4 emissions from surface mines were estimated to 200% for both mining and post-mining activities. Summary of uncertainty assessment methods are provided in Annex 7.

- ***Time-series Consistency***

Total coal production and coal production on surface mines were provided by the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* prepared by the Ministry of Economy, Trade and Industry from FY 1990 to FY 2000. Thereafter, they have been provided by the Japan Coal Energy Center (J-COAL), because categories of surface mining production and total coal production in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* is no longer conducted. The data from the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* prepared by the Ministry of Economy, Trade and Industry until 2000 are provided by Japan Coal Energy Center (J-COAL). Therefore, total coal production data from both of these sources are same and have been used in a consistent manner since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000).* The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

There have been no recalculations to emissions from this source category.

f） Source-specific Planned Improvements

There are no major planned improvements in this source category.

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

In Japan, the production of briquettes is believed to meet the description of the activity of conversion to solid fuel. The process of coal briquette production includes introducing water to coal, and squeeze-drying it. Therefore, the process is not thought to involve any chemical reactions, but the emission of CO_2, CH_4 or N_2O cannot be denied. However, as no actual measurements have been taken, however, it is not presently possible to calculate emissions. CO_2, CH_4 and N_2O emissions associated with the conversion to solid were reported as “NE” in the absence of default values.

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

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

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

a） Source/Sink Category Description

This category provides the estimation methods for fugitive emissions of CO_2, CH_4 and N_2O occur during the exploratory drilling of oil and gas fields and pre-production tests.

b）Methodological Issues

- ***Estimation Method***

CO_2, CH_4 and N_2O emissions associated with oil exploration drilling and pre-production testing was calculated using the Tier 1 Method in accordance with the Decision Tree of *Good Practice Guidance (2000)*. Emissions were calculated by multiplying the number of exploratory drilling wells, and the number of wells tested for oil and gas during pre-production testing, by their respective emission factors.

- ***Emission Factors***

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

Table 3-35 Emission factors for exploratory drilling and testing wells [Gg/number of wells]

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

Source: Good Practice Guidance (2000), p. 2.86, Table 2.16

- ***Activity Data***

➢ *Drilling*

The data given in the *Natural Gas Data Year Book* compiled by the Natural Gas Mining Association were used for exploratory drilling wells.

➢ *Testing*

It was not possible to readily ascertain statistically the number of wells in which oil and gas testing had been carried out, and even where such tests are conducted, not all wells are successful. For that reason, the number of wells tested for oil and gas used the median values of the number of exploratory drilling wells and the number of successful wells shown in the *Natural Gas Data Year Book*. As for the most recent year, the data of the previous year were provisionally used.

Table 3-36 Trends in the number of exploratory drilling wells and those tested for oil and gas

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Number of Wells Drilled	wells	8	7	7	10	6	6	6
Number of Wells Succeeded	wells	1	3	4	5	0	1	1
Number of Wells Tested	wells	5	5	6	8	3	4	4

c）Uncertainties and Time-series Consistency

- ***Uncertainties***

Because all emission factors for exploration of oil and natural gas were the default values in *Good Practice Guidance (2000)*, the uncertainties for emission factors were assessed based on default values (25%) described in *Good Practice Guidance (2000)*. The uncertainty of activity data was 10%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for emissions were estimated to be 27% each for the fugitive emissions of CO_2, CH_4, and N_2O that occur during the exploration of oil and natural gas. A summary of uncertainty assessment methods are provided in Annex 7.

- ***Time-series Consistency***

Emission factors have used consistent values since FY 1990. Activity data have been calculated by using annual data from the *Natural Gas Data Year Book* and a consistent estimation method since FY

1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)*. The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

Since the activity data of FY 2008 were obtained, the GHG emissions of FY 2008 were recalculated.

f） Source-specific Planned Improvements

There have been no major planned improvements in this source category.

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

a） Source/Sink Category Description

This category provides the estimation methods for fugitive emissions of CO_2 and CH_4 occur during production of crude oil, as well as when measuring instruments are lowered into oil wells during inspection of operating oil fields.

b） Methodological Issues

- ***Estimation Method***

Emissions relating to fugitive emissions from petroleum production and servicing of oilfield production wells were calculated using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.81, Fig. 2.13). Emissions were calculated by multiplying the amount of crude oil production by the emission factor.

- ***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 CH_4).

Table 3-37 EF for fugitive emissions from petroleum production [Gg/10^3kl]

		CH_4 1)	CO_2	N_2O 2)
Conventional Oil	Fugitive emissions	1.45×10^{-3}	2.7×10^{-4}	0

Source: GPG (2000) Table 2.16

1) The default value is $1.4\times10^{-3} - 1.5\times10^{-3}$

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

➢ *Servicing*

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

Table 3-38 Emission factors for fugitive emissions from servicing of petroleum production wells [Gg/number of wells]

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

Source: GPG (2000) Table 2.16

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

- ***Activity Data***

➢ *Production*

The values for production of crude oil in Japan given in the Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke and the Yearbook of Mineral Resources and Petroleum Products Statistics prepared by the Ministry of Economy, Trade and Industry were used as the activity data for fugitive emissions from production. However, condensates were not included.

➢ *Servicing*

Because the number of oil wells and natural gas wells cannot be separated, the total fugitive emissions from servicing of oil and natural gas wells are reported in the subcategory *1.B.2.b.ii. Exploration*. The oil is reported as “IE” here.

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (25% for CO_2 and 25% for CH_4) were applied. The uncertainty of activity data was 5%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 25% for CO_2 and for CH_4. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emission factors have been used consistent values since FY 1990. Activity data have been calculated using annual data from the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* prepared by the Ministry of Economy, Trade and Industry, in a consistent manner since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000).* The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

There have been no recalculations to emissions from this source category.

f） Source-specific Planned Improvements

There are no major planned improvements in this source category.

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

a）Source/Sink Category Description

This category provides the estimation methods for fugitive emissions of CO_2 and CH_4 occur during the transportation of crude oil and condensate through pipelines, tank trucks, and tank cars to refineries.

b）Methodological Issues

- ***Estimation Method***

Emissions relating to fugitive emissions associated with transport were calculated using the Tier 1 method in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.81, Fig. 2.13). Emissions were calculated by multiplying the amount of crude oil or condensate production by the emission factors.

Fugitive emissions from transporting oil from domestic oilfield at sea to land and fugitive emissions from land transport were estimated. Crude oil for sea transport is carried out entirely by pipeline, and is not expected to generate any fugitive emissions from other transportation mode. Land transport includes a number of methods, including pipeline, tank trucks, and tank cars, but it is difficult to differentiate them statistically. For that reason, it has been assumed that all of the produced oil is transported by tank trucks or tank cars in estimations.

- ***Emission Factors***

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

Table 3-39 Emission factors for transportation of crude oil and condensate [Gg/10^3kl]

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

Source: GPG (2000) Table 2.16

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

- ***Activity Data***

The values for production of oil in Japan given in the Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke and the Yearbook of Mineral Resources and Petroleum Products Statistics prepared by the Ministry of Economy, Trade and Industry, were used as the activity data for fugitive emissions from transport.

Table 3-40 Production of crude oil and condensate in Japan

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Oil Production Excluding Condensate	kl	420,415	622,679	385,565	370,423	334,467	340,593	309,526
Condensate Production	kl	234,111	242,859	375,488	540,507	644,525	632,654	607,672
Oil Production (Total)	kl	654,526	865,538	761,053	910,930	978,992	973,247	917,198

c）Uncertainties and Time-series Consistency

- ***Uncertainties***

As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (25% for CO_2 and 25% for CH_4) were applied. The uncertainty of activity data was 5%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 25% for CO_2 and for CH_4. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emission factors have been used consistent values since FY 1990. Activity data have been calculated using annual data from the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* prepared by the Ministry of Economy, Trade and Industry, in a consistent estimation method since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000).* The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

There have been no recalculations to emissions from this source category.

f） Source-specific Planned Improvements

There are no major planned improvements in this source category.

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

a） Source/Sink Category Description

This category provides the estimation methods for fugitive emissions of CH_4 occur when crude oil is refined or stored at oil refineries.

CO_2 emissions from this source were reported as “NE”. Refining / Storage activities exist in Japan and extremely small amount of CO_2 may be released into the atmosphere from the activities if CO_2 is included in crude oil. Because there is no examples of actual measurements of the CO_2 content of crude oil as well as a default value, CO_2 emissions from this source were not estimated.

b） Methodological Issues

- ***Estimation Method***

➢ *Oil Refining*

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

➢ *Oil Storage*

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

- ***Emission Factors***

➢ *Oil Refining*

With respect to the emissions factors for the fugitive emissions during the refining processes, the amount of CH_4 emitted during crude oil refining processes was considered to be negligible because fugitive emission of CH_4 was unlikely to occur in Japan during crude oil refining at normal operation.

For that reason, the lower limit of the default values shown in the *Revised 1996 IPCC Guidelines* was adopted.

Table 3-41 Emission factor during refining of crude oil

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

Source: Revised1996 IPCC Guidelines, Volume 3 Table1-58

1) The default value is 90–1,400

- *Oil Storage*

Oil is stored in either corn-roof tanks or floating-roof tanks. All oil storage in Japan adopts floating-roof tanks, which means that fugitive CH_4 emissions are considered to be very small. If fugitive CH_4 emissions were to occur, they could only occur by vaporization of oil left on the exposed wall wet with oil when the floating roof descends as the stored oil is removed; thus, the amount of fugitive CH_4 emissions would be small.

The Petroleum Association of Japan has conducted experiments relating to the evaporation of CH_4 from tank walls by modeling the floating-roof tank to calculate estimates of CH_4 emissions.

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

Table 3-42 Assumptions for calculation of emission factor during oil storage

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

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

2) Net Calorific Value = Gross Calorific Value ×0.95

- ***Activity Data***

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

Table 3-43 Amount of crude and NGL refined in Japan

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Oil and NGL Refined	PJ:NCV	7,732	8,907	8,898	8,820	8,438	8,054	7,540

c） *Uncertainties and Time-series Consistency*

- ***Uncertainties***

For the uncertainty of emission factors for fugitive emissions of CH_4 occurring when crude oil is refined or stored at oil refineries, values shown in the *Revised 1996 IPCC Guidelines* are applied. The uncertainties for emission factors were applied 25% of default data indicated in the *Good Practice Guidance (2000)* in accordance with Decision Tree of uncertainty assessment of emission factor. The uncertainty for activity data was evaluated to be 0.9% by combing the uncertainty of crude oil and NGL indicated in the *General Energy Statistics*. As a result, the uncertainties for emissions were determined to 25% for CH_4 emissions from the source. Summary of uncertainty assessment methods are provided in Annex 7.

- ***Time-series Consistency***

Emission factors have been used consistent values since FY 1990. Activity data have been calculated using annual data from the *General Energy Statistics*, in a consistent estimation method since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)*. The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

GHG emissions from FY 2006 to FY 2008 were recalculated because of the revision of the fuel consumption from FY 2006 to FY 2008 in *General Energy Statistics*.

f） Source-specific Planned Improvements

There are no major planned improvements in this source category.

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

Petroleum products are distributed in Japan, and where CO_2 and CH_4 are dissolved, it is conceivable that either or both will be emitted as a result of the relevant activity. The level of CO_2 or CH_4 emitted by the activity is probably negligible, in light of the composition of the petroleum products, but because there are no examples of measurement of the CO_2 or CH_4 content of petroleum products, it is not currently possible to calculate emissions. Emissions were reported as “NE” in the absence of the default emission factors.

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

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

There are test drillings of oil and gas fields in Japan, and it is conceivable that the activity could give rise to emissions of CO_2, CH_4, or N_2O. It is difficult, however, to distinguish between oilfields and gas fields prior to test drilling, therefore the emissions were reported as “IE” because the calculation was combined with the subcategory of *1.B.2.a.i. Fugitive Emissions Associated with Oil Exploration*.

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

a） Source/Sink Category Description

This category provides the estimation methods for CO_2 and CH_4 emissions of fugitive emissions from the production of natural gas, processing through the adjusting of its constituent elements, and through the lowering of measurement instruments during servicing of natural gas production wells.

b） Methodological Issues

- ***Estimation Method***

Fugitive emissions from the production of natural gas, processing through the adjusting of its constituent elements, and through the lowering of measurement instruments during servicing of natural gas production wells was calculated using the Tier 1 method, and in accordance with Decision Tree of the *Good Practice Guidance (2000)* (Page 2.80, Fig. 2.12).

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

- ***Emission Factors***

➢ *Production*

The default values given in the *Good Practice Guidance (2000)* were used for the emission factors of fugitive emissions during the production of natural gas. (The median of the default values was used for CH_4).

Table 3-44 Emission factors of fugitive emissions during production of natural gas [Gg/10^6 m^3]

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

Source: GPG (2000) Table 2.16

1) The default values are 2.6×10^{-3} – 2.9×10^{-3}

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

➢ *Processing*

The default values given in the *Good Practice Guidance (2000)* for the emission factors of fugitive emissions during processing of natural gas were used. (The median of the default values was used for CH_4).

Table 3-45 Emission factors during processing of natural gas [Gg/10^6 m^3]

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

Source: GPG (2000) Table 2.16

1) The default values are 6.9×10^{-4} – 10.7×10^{-4}

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

➢ *Servicing*

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

Table 3-46 Emission factors during servicing of natural gas production wells [Gg/number of wells]

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

Source: GPG (2000) Table 2.16

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

- ***Activity Data***

➢ *Production and Processing*

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

- *Servicing*

  Because the number of oil wells and natural gas wells cannot be separated for the entire time series, the total fugitive emissions from servicing of oil and natural gas wells are reported here. The number of oil/natural gas wells shown in the *Natural Gas Data Year Book* published by the Japan Natural Gas Association was used. As for the most recent year, the data of the previous year was provisionally used.

Table 3-47 Natural gas production and the number of producing and capable wells

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Natural Gas Production	10^6m^3	2,066	2,237	2,499	3,140	3,729	3,706	3,555
Number of Producing and Capable Wells	wells	1,230	1,205	1,137	1,115	1,099	1,065	1,065

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

  As the uncertainty of emission factors for the CO_2 and CH_4 emissions from fugitive emissions of the production and processing of natural gas, default values given in the *Good Practice Guidance (2000)* (25% for CO_2 and 25% for CH_4) were applied. The uncertainty of activity data was 5%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 25% for CO_2 and for CH_4.

  As the uncertainty of emission factors for the CO_2 and CH_4 emissions from fugitive emissions from servicing of oil and natural gas wells , default values given in the *Good Practice Guidance (2000)* (25% for CO_2 and 25% for CH_4) were applied. The uncertainty of activity data was 10%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 27% for CO_2 and for CH_4.

  The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

  Emission factors have used consistent values since FY 1990. Activity data have been calculated by using annual data on the production volume of natural gas from the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics* prepared by the Ministry of Economy, Trade and Industry, and on the number of oil/natural gas wells from the *Natural Gas Data Year Book*. A consistent estimation method has been used since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)*. The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

Since the activity data of FY 2008 was obtained, the GHG emission of FY 2008 was recalculated.

f） Source-specific Planned Improvements

There are no major planned improvements in this source category.

3.3.2.2.c. Transportation (1.B.2.b.iii.)

a） Source/Sink Category Description

This category provides the estimation methods for CH_4 emissions in conjunction with transportation of domestically produced natural gas, such as the release of gas when relocating and building pipelines, and the release of gas used to operate pressure regulators.

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

b） Methodological Issues

- ***Estimation Method***

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

- ***Emission Factors***

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

i） Gas Releases Due To Pipeline Relocation

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

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

ii） Gas Releases Due To Pipeline Installation

After installation work is complete, it is necessary to flush the pipeline with natural gas, which is released before introduction into the pipeline. The amount of CH_4 is determined by measuring with a gas meter or calculating it using means such as pipeline pressure when gas is introduced, and their annual cumulative total determined.

ⅲ） *Release of Gas for Operating Pressure Regulators*

The amount of natural gas used in accordance with specifications of pressure regulators for reducing gas supply pressure is calculated as follows.

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

Table 3-48 FY2004 CH_4 emissions as a concomitant of natural gas transportation

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

- *Total Pipeline Length*

We used 2,090 km as the total length of natural gas pipeline of the main association members covered by an FY2004 study by the Japan Natural Gas Association, which is the pipeline whose emissions are of concern here.

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

- ***Activity Data***

The length of natural gas pipeline laid in Japan given by the Japan Natural Gas Association in its *Natural Gas Data Year Book* was used as the activity data of the length of natural gas pipeline laid. As for the most recent year, the data of the previous year was provisionally used.

Table 3-49 Length of natural gas pipeline installation

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Natural Gas Pipeline Length	km	1,984	2,195	2,434	2,721	2,987	3,016	3,016

c） *Uncertainties and Time-series Consistency*

- ***Uncertainties***

A country-specific emission factor is used for CH_4 in conjunction with transportation. As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (25% for CH_4) were applied because according to the Decision Tree, either expert judgement or the default value given in the *Good Practice Guidance (2000)* is to be adopted. The uncertainty of activity data was 10%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 27% for CH_4. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emission factors have been used consistent values since FY 1990. Activity data have been calculated using annual data from the *Natural Gas Data Year Book,* in a consistent estimation method since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000).* The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

Since the activity data of FY 2008 was obtained, the GHG emission of FY 2008 was recalculated.

f） Source-specific Planned Improvements

The CH_4 emissions in conjunction with transportation of domestically produced natural gas are estimated on the premise that the full transportation of natural gas is sent to pipelines(1.B.2.b.iii.), however, recently there are some cases of the transportation of LNG by tank trucks or tank cars. LNG transported by tank trucks and tank cars is basically sealed. There is no research on the actual situation for whole in Japan, and no default value, so this current estimation method is continuously adopted. If sufficient data on CH_4 emissions from transportation of natural gas by the tank trucks or tank cars is obtained in the future, the possibilities of estimation methods for this category should be considered.

3.3.2.2.d. Distribution (1.B.2.b.iv.-)

a） Source/Sink Category Description

This category provides the estimation methods for CH_4 emitted from the normal operation of LNG receiving terminals, town gas production facilities, and satellite terminals, as well as during regular maintenance or construction, and for CH_4 emitted from town gas supply networks.

In Japan, liquefied petroleum gas, coal, coke, naphtha, crude oil, and natural gas are refined and blended at gas plants into gas, which, after being conditioned to produce a certain calorific value, is supplied to urban areas through gas lines. Such gas fuel is called “town gas”, of which more than 90% is LNG-based.

Japan reports the emissions associated with the production of town gas (Natural Gas Supplies) in the category of *1.B.2.b. Natural Gas Distribution*. The town gas production is accounted for in this category, even though it may not meet the definition in the *Revised 1996 IPCC Guidelines* exactly, because of the lack of a category more appropriate for reporting of emissions from town gas production.

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

b） Methodological Issues

- ***Estimation Method***

- *LNG Receiving Terminals, Town Gas Production Facilities, and Satellite Terminals (Natural Gas Supplies)*

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

- *Town Gas Supply Networks*

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

- ***Emission Factors***

- *LNG Receiving Terminals, Town Gas Production Facilities, and Satellite Terminals (Natural Gas Supplies)*

The emission factor was calculated by dividing emission of CH_4 during the normal operation of LNG receiving terminals, town gas production facilities, and satellite terminals in Japan, as well as during regular maintenance or construction, by the calorific value of the raw material input (LNG, natural gas). The emission factor calculated using FY1998 data was 905.41 (kgCH_4/PJ), while that calculated using FY2007 data was 264.07 (kgCH_4/PJ). The main reason for the emission factor change was the reduction in CH_4 emissions, which was due to progress in reduction measures such as the installation of new sampling and recovery lines used for gas analyses (changes to lines that recover gas from atmospheric dispersion) in LNG receiving terminals and town gas production facilities. Because measures to reduce CH_4 emissions have been gradually implemented, emission factors for the period from FY1999 to FY2006 were set by linear interpolation. At this time, measures to reduce CH_4 emissions have been generally implemented, thereby affording little expectation of major change in the emission factor for the time being. Therefore, the FY2007 emission factor value will be kept the same for FY2008 and subsequent years.

- *Town Gas Supply Networks*

Emission sources in the supply of domestically produced town gas are (i) high-pressure pipelines, (ii) medium- and low-pressure pipelines and holders, and (iii) service pipes. FY2004 data were used to calculate CH_4 emissions for each of the minor categories of each of the emission sources shown in Table 3-50. The emission factor for high-pressure pipelines and for medium- and low-pressure pipelines and holders was set using the CH_4 amount emitted from 1 km of the town gas pipeline length during 1 y, while that for service pipes was set using the CH_4 amount emitted from 1000 users' homes during 1 y.

Table 3-50 CH_4 emissions from town gas pipelines and emission factors (Established by FY2004 data)

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

- ***Activity Data***

➢ *LNG Receiving Terminals, Town Gas Production Facilities, and Satellite Terminals (Natural Gas Supplies)*

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

Table 3-51 Liquefied natural gas and natural gas used as material for town gas

Item	Unit	1990	1995	2000	2005	2007	2008	2009
LNG Consumption with Town Gas Production	PJ	464	676	864	1,230	1,468	1,439	1,424
Natural Gas Consumption with Town Gas Production	PJ	40	48	61	86	126	131	127

➢ *Town gas supply networks*

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

Table 3-52 High-pressure pipeline length, total medium- and low-pressure pipeline length, and number of users

Item	Unit	1990	1995	2000	2005	2007	2008	2009
High-pressure Pipeline Length	km	1,067	1,281	1,443	1,898	2,098	2,029	2,066
Total Medium- and Low-pressure Pipeline Length	km	180,239	197,474	214,312	230,430	236,729	239,336	241,675
Number of Users	10^3 houses	21,334	23,580	25,858	27,762	28,377	28,599	28,774

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

Although CH_4 emission factor of natural gas supplies is country-specific, the uncertainty of emission factor is the default value (25%) given in the *Good Practice Guidance (2000)* because the application of statistical treatment was considered to be unsuitable. The uncertainty of activity data was determined to be 8.7% by combining of the uncertainty of LNG and natural gas presented in *General Energy Statistics*. As a result, the uncertainties for emissions were estimated to be 26% for CH_4 emissions from natural gas supplies.

A country-specific emission factor is used for CH_4 emissions from town gas supply networks. The uncertainties for emission factors of town gas supply network were the default values presented in *Good Practice Guidance (2000)* (25% for CH_4) were applied because default value of expert opinion or *Good Practice Guidance (2000)* is adopted in accordance with Decision Tree of uncertainty assessment of emission factor. For the uncertainty for activity data, the value set by the Committee for Greenhouse Gas Emission Estimation Methods (10%) was applied. As a result, the uncertainties for emissions were estimated to be 27% for CH_4 emissions from town gas supply network. A summary of uncertainty assessment methods are provided in Annex 7.

- ***Time-series Consistency***

Emission factors have used consistent values as described above since FY 1990. Activity data have been calculated using annual data on LNG and natural gas consumption and town gas production from *General Energy Statistics* and data on the town gas supply network from the *Gas Industry Yearbook.* A consistent estimation method has been used since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)*. The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

There have been no recalculations to emissions from this source category.

f） Source-specific Planned Improvements

There are no major planned improvements in this source category.

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

Conceivable sources of these CH_4 emissions include gas pipe work in buildings, but because these emissions are included in those of “Natural Gas Distribution” (distribution through the town gas network) (1.B.2.b.iv), CH_4 emissions from this source are reported as “IE.” Additionally, because CO_2 is basically not included among town gas constituents, CO_2 emissions from this source are reported as “NA.”

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

This section includes fugitive emissions of CO_2 and CH_4 occur from venting during oil field development, crude oil transportation, refining processes, and product transportation in the petroleum industry and as well as during gas field development, natural gas production, transportation, and processing in natural gas industry.

It also includes CO_2, CH_4, N_2O emissions from flaring during the above processes.

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

a） Source/Sink Category Description

This category provides the estimation methods for CO_2 and CH_4 from venting in the petroleum industry.

b） Methodological Issues

- ***Estimation Method***

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

- ***Emission Factors***

The default values for conventional oil given in the *Good Practice Guidance (2000)* were used for the emission factors of oilfield venting. (The median of the default values was used for CH_4).

Table 3-53 Emission factors of oilfield venting

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

Source: GPG (2000) Table 2.16

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

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

- ***Activity Data***

The production volume of oil in Japan given by the Ministry of Economy, Trade and Industry in its Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke and the Yearbook of Mineral Resources and Petroleum Products Statistics was used as the activity data of fugitive emissions from oilfield venting. The production of condensate was excluded from the calculation (see Table 3-40).

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (25% for CO_2 and CH_4) were applied. The uncertainty of activity data was 5%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 25% for CO_2 and CH_4. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emission factors have been used consistent values as described above since FY 1990. Activity data have been calculated using annual data from the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics,* in a consistent estimation method since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000).* The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

There have been no recalculations to emissions from this source category.

f） Source-specific Planned Improvements

There have been no major planned improvements in this source category.

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

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

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

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

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

a） Source/Sink Category Description

This category provides the estimation methods for CO_2, CH_4, and N_2O from flaring in the petroleum industry.

b） Methodological Issues

- ***Estimation Method***

CO_2, CH_4, and N_2O emissions from flaring in the petroleum industry were calculated using the Tier 1 Method in accordance with the Decision Tree of *Good Practice Guidance (2000)*, by multiplying the amount of crude oil production in Japan by the default emissions factors.

- ***Emission Factors***

In the absence of actual measurement data or country-specific emission factors in Japan, the default values shown in *Good Practice Guidance* (2000) were used. It should be noted that the median values were used for CH_4 emissions.

Table 3-54 Emission factors for flaring in the oil industry

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

Source: Good Practice Guidance (2000), Table 2.16

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

- ***Activity Data***

For the calculation of activity data for this emission source, the amounts of crude oil production shown in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Natural Resources and Petroleum Products*, both published by Ministry of Economy, Trade and Industry, were used. The production of condensate was excluded from the calculation (see Table 3-40).

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (25% for CO_2, CH_4, and N_2O) were applied. The uncertainty of activity data was 5%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 25% for CO_2, CH_4, and N_2O. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emission factors have been used consistent values as described above since FY 1990. Activity data have been calculated using annual data from the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics*, in a consistent estimation method since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000)*. The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

There have been no recalculations to emissions from this source category.

f） Source-specific Planned Improvements

There have been no major planned improvements in this source category.

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

a） Source/Sink Category Description

This category provides the estimation methods for CO_2, CH_4, and N_2O from flaring in the natural gas industry.

b） Methodological Issues

- ***Estimation Method***

CO_2, CH_4, and N_2O emissions associated with flaring in the natural gas industry were calculated using the Tier 1 Method in accordance with the Decision Tree of *Good Practice Guidance (2000)*. Emissions were calculated by multiplying the amount of production of natural gas by the emission factors. The total emissions associated with flaring both during gas production and processing were reported as the emissions from flaring in the natural gas industry.

- ***Emission Factors***

The default values for fugitive emissions from flaring (Natural Gas) given in the *Good Practice Guidance (2000)* were used.

Table 3-55 Emission factors for flaring in the natural gas industry

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

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

- ***Activity Data***

For the calculation of activity data for this emission source, the amounts of domestic production of natural gas shown in the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Natural Resources and Petroleum Products*, both published by Ministry of Economy, Trade and Industry, were used (see Table 3-47).

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

As the uncertainty of emission factors, default values given in the *Good Practice Guidance (2000)* (25% for CO_2, CH_4, and N_2O) were applied. The uncertainty of activity data was 5%; this was determined as a standard value by the Committee for the Greenhouse Gas Emission Estimation Methods. As a result, the uncertainties for the emissions were determined to be 25% for CO_2, CH_4, and N_2O. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emission factors have been used consistent values as described above since FY 1990. Activity data have been calculated using annual data from the *Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke* and the *Yearbook of Mineral Resources and Petroleum Products Statistics*, in a consistent estimation method since FY 1990.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *Good Practice Guidance (2000).* The QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. Details of the QA/QC activities are provided in Annex 6.

e） Source-specific Recalculations

There have been no recalculations to emissions from this source category.

f） Source-specific Planned Improvements

There have been no major planned improvements in this source category.

3.3.2.3.f. Flaring (Oil and Gas) (1.B.2.c.-flaring iii.)

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

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Chapter 4. Industrial Processes (CRF sector 2)

4.1. Overview of Sector

Chemical and physical transformation in industrial processes produce atmospheric GHG emissions. This chapter describes the methodologies of estimating industrial process emissions shown in Table 4-1.

In 2009, total GHG emissions from the industrial processes sector amounted to approximately 63,772 Gg-CO_2 eq., accounting for 5.3% of national total emissions (excluding LULUCF) in Japan. The emissions (excluding F-gases) from this sector has decreased by 38.8% compared to 1990. The emissions of halocarbons and SF_6 from this sector has decreased by 57.6% compared to 1995.

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

Emission source categories				CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
2.A Mineral Products	2.A.1	Cement Production		○					
	2.A.2	Lime Production		○					
	2.A.3	Limestone and Dolomite Use		○					
	2.A.4	Soda Ash Production and Use		○					
	2.A.5	Asphalt Roofing		NE					
	2.A.6	Road Paving with Asphalt		NE					
	2.A.7	Other		IE, NO	NA, NO	NA, NO			
2.B Chemical Industry	2.B.1	Ammonia Production		○	NE	NA			
	2.B.2	Nitric Acid Production				○			
	2.B.3	Adipic Acid Production		NA		○			
	2.B.4	Carbide Production	Silicon Carbide	○	○				
			Calcium Carbide	○	NA				
	2.B.5	Other	Carbon Black		○				
			Ethylene	○	○	NA			
			1,2-Dichloroethane		○				
			Styrene		○				
			Methanol		NO				
			Coke	IE	○	NA			
2.C Metal Production	2.C.1	Iron and Steel Production	Steel	IE	NA				
			Pig Iron	IE	NA				
			Sinter	IE	IE				
			Coke	IE	IE				
			Use of Electric Arc Furnaces in Steel Production	○	○				
	2.C.2	Ferroalloys Production		IE	○				
	2.C.3	Aluminium Production		IE	NE			○	
	2.C.4	SF6 Used in Aluminium and Magnesium Foundaries	Aluminium						NO
			Magnesium						○
	2.C.5	Other		NO	NO	NO			
2.D Other Production	2.D.1	Pulp and Paper							
	2.D.2	Food and Drink		IE					
2.E Production of Halocarbons and SF_6	2.E.1	By-product emissions: Production of HCFC-22					○		
	2.E.2	Fugitive emissions					○	○	○

(continued on next page)

Emission source categories						CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
2.F Consumption of Halocarbons and SF_6	2.F.1	Refrigeration and Air Conditioning Equipment	Domestic Refrigeration		manufacturing				○	NO	NO
					stocks				IE	NO	NO
					disposal				IE	NO	NO
			Commercial Refrigeration	Commercial Refrigeration	manufacturing				○	NO	NO
					stocks				IE	NO	NO
					disposal				IE	NO	NO
				Automatic Vending Machine	manufacturing				○	NO	NO
					stocks				IE	NO	NO
					disposal				IE	NO	NO
			Transport Refrigeration		manufacturing				IE	NO	NO
					stocks				IE	NO	NO
					disposal				IE	NO	NO
			Industrial Refrigeration		manufacturing				IE	NO	NO
					stocks				IE	NO	NO
					disposal				IE	NO	NO
			Stationary Air-Conditioning (Household)		manufacturing				○	NO	NO
					stocks				IE	NO	NO
					disposal				IE	NO	NO
			Mobile Air-Conditioning (Car Air Conditioners)		manufacturing				○	NO	NO
					stocks				IE	NO	NO
					disposal				IE	NO	NO
	2.F.2	Foam Blowing	Hard Foam	Urethane Foam	manufacturing				○	NO	NO
					stocks				○	NO	NO
					disposal				IE	NO	NO
				High Expanded Polyethylene Foam	manufacturing				○	NO	NO
					stocks				NO	NO	NO
					disposal				NO	NO	NO
				Extruded Polystyrene Foam	manufacturing				○	NO	NO
					stocks				○	NO	NO
					disposal				IE	NO	NO
				Phenol Foam					NO	NO	NO
			Soft Foam						NO	NO	NO
	2.F.3	Fire Extinguishers			manufacturing				NO	NO	NO
					stocks				○	NO	NO
					disposal				NO	NO	NO
	2.F.4	Aerosols/Metered Dose Inhalers	Aerosols		manufacturing				○	NO	NO
					stocks				○	NO	NO
					disposal				IE	NO	NO
			Metered Dose Inhalers		manufacturing				○	NO	NO
					stocks				○	NO	NO
					disposal				IE	NO	NO
	2.F.5	Solvents			manufacturing				IE	IE	NO
					stocks				IE	○	NO
					disposal				IE	IE	NO
	2.F.6	Other Applications Using ODS Substitutes							IE	NA	NA
	2.F.7	Semiconductors	Semiconductors		manufacturing				IE	IE	IE
					stocks				○	○	○
					disposal				NA	NA	NA
			Liquid Crystals		manufacturing				IE	IE	IE
					stocks				○	○	○
					disposal				NA	NA	NA
	2.F.8	Electrical Equipment			manufacturing						○
					stocks						○
					disposal						IE
	2.F.9	Other							NA	NE, ○	IE

Emissions reported indicated as ○, and refer to Abbreviations list for notation keys.

4.2. Mineral Products (2.A.)

This category covers CO_2 emissions from the calcination of mineral raw material such as $CaCO_3$, $MgCO_3$, Na_2CO_3, etc. This section includes GHG emissions from Cement Production (2.A.1), Lime Production (2.A.2.), Limestone and Dolomite Use (2.A.3.) and Soda Ash Production and Use (2.A.4.). In 2009, emissions from Mineral Products were 37,708 Gg-CO_2 eq. and represented 3.1% of total

GHG emissions (excluding LULUCF). The emissions decreased by 31.9% compared to 1990.

Table 4-2 CO_2 Emissions from 2.A. Mineral Products

Gas	Emission sub-category			Units	1990	1995	2000	2005	2007	2008	2009
CO_2	2.A Mineral Products	2.A.1	Cement Production	Gg-CO_2	37,905	41,275	34,394	31,579	29,989	27,925	24,755
		2.A.2	Lime	Gg-CO_2	6,674	5,795	5,900	6,646	7,012	6,594	5,371
		2.A.3	Limestone and Dolomite Use	Gg-CO_2	10,522	9,441	9,339	8,480	8,959	8,332	7,445
		2.A.4	Soda Ash Production and Use	Gg-CO_2	267	250	209	197	182	159	138
	Total			Gg-CO_2	55,369	56,761	49,842	46,903	46,142	43,009	37,708

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

a） Source/Sink Category Description

CO_2 is emitted by the calcination of limestone, the main component of which is calcium carbonate, during the production of clinker, an intermediate product of cement and the main component of which is calcium oxide.

CO_2 emission mechanism of the cement production process

$$CaCO_3 \rightarrow CaO + CO_2$$

b） Methodological Issues

- ***Estimation Method***

Following the *GPG (2000)* decision tree, the CO_2 emissions from this source was estimated by multiplying the amount of clinker produced by an emission factor.

CO_2 emissions (t-CO_2) from cement production

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

- ***Emission Factors***

Multiplying the CaO content of clinker by the molecular weight ratio of CaO and CO_2 (0.785) yields the emission factor. Because Japan's cement industry takes in large amounts of waste and byproducts from other industries and recycles them as substitute raw materials for cement production, clinker contains CaO from sources other than carbonates. This CaO does not go through the limestone calcination stage and therefore does not emit CO_2 during the clinker production process. For that reason, emission factors were determined by estimating the CaO content of clinker from carbonates, by subtracting CaO originating from waste and other sources from the total CaO content of clinker. Japan applies 1.00 for the cement kiln dust (CKD) correction coefficient, because normally almost all CKD is recovered and used again in the production process, as confirmed by the Cement Association.

The emission factors for CO_2 emitted from cement production were calculated using the following procedure.

1 Estimate dry weight of waste and other materials input in raw material processing.
2 Estimate the amount and content of CaO from waste and other materials in clinker.

3 Estimate the CaO content of clinker, excluding the CaO from waste and other materials.
4 Determine the clinker emission factor.

Emission factors of CO_2 emissions from cement production
= [(CaO content of clinker) – (CaO content of clinker from waste and other materials)] × 0.785

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

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

The following 13 types of waste and other materials were chosen for this calculation: coal ash (incineration residue), sewage sludge incineration ash, municipal solid waste incineration ash, glass refuse/ceramics refuse, concrete refuse, blast furnace slag (water granulated), blast furnace slag (slow-cooled), steelmaking slag, nonferrous slag, casting sand, particulates/dust, coal ash (fluidized bed furnace ash), and coal ash (from dust collectors) (these waste account for over 90% of the CaO from waste and other materials). Waste amounts (emission-based) and the water content of each waste and other material were determined from studies by the Cement Association of Japan (only for 2000 and thereafter).

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

The dry weights of each type of waste and other materials found above are multiplied by the CaO content for each type as found by the Cement Association, thereby calculating the total CaO amount in clinker derived from waste and other materials. This is divided by clinker production volume to find the CaO content from waste and other materials in clinker. Because data for 1990 to 1999 are unavailable, averages for 2000 through 2003 were used.

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

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

Table 4-3 Composition of Waste Origin Material

Group	Types of waste	Water content	CaO content
Incineration residue	Coal ash	7.2 - 14.5%	5.0 - 5.8%
	Sewage sludge incineration ash *	11.6 - 14.9%	7.4 - 12.5%
	Municipal solid waste incineration ash *	20.3 - 24.4%	10.0 - 26.5%
Glass refuse, Concrete refuse, and Ceramics refuse	Glass refuse, Ceramics refuse *	16.8 - 32.7%	17.5 - 31.1%
	Concrete refuse *	10.0 - 22.2%	6.4 - 43.9%
Slag	Blast furnace slag (water granulated)	5.0 - 8.7%	40.0 - 42.4%
	Blast furnace slag (slow-cooled)	5.7 - 6.5%	40.8 - 41.5%
	Steelmaking slag	7.7 - 11.4%	34.8 - 40.5%
	Nonferrous slag	5.6 - 8.4%	6.4 - 10.0%
	Casting sand *	9.8%	6.5%

Particulates (dust collector dust)	Particulates/dust	8.9 - 14.3%	9.0 - 13.4%
	Coal ash (fluidized bed furnace ash) *	0.1 - 1.7%	14.5 - 20.7%
	Coal ash	1.4 - 3.9%	4.6 - 5.0%

* Newly added from FY2009.

Table 4-4 Emission factors of CO_2 from cement production

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Average CaO content in clinker	%	65.9	65.9	66.0	65.9	65.9	65.9	65.8
Waste Origin CaO content in clinker	%	2.6	2.6	2.9	2.0	2.0	1.9	1.7
CaO content in clinker excluding waste origin CaO	%	63.3	63.3	63.0	63.9	63.8	63.9	64.1
CO_2/CaO		0.785	0.785	0.785	0.785	0.785	0.785	0.785
EF	t-CO_2/t	0.497	0.497	0.495	0.501	0.501	0.502	0.503

● *Activity Data*

Cement Association provides the data on the amount of clinker produced. Because there is no statistics on clinker production from 1990 to 1999, an estimation is made for past (1990–1999) clinker production using the average values of the 2000–2003 ratios of clinker production (Cement Association data) to limestone consumption (Ministry of Economy, Trade and Industry, Yearbook of Ceramics and Building Materials Statistics).

Table 4-5 Clinker production

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Consumption of Limestone (actual)	kt (dry)	89,366	97,311	81,376	-	-	-	-
Clinker Production (actual)	kt	-	-	69,528	63,003	59,885	55,647	49,195
Clinker Production (actual) / Consumption of Limestone (actual)*		0.853	0.853					
Estimated Clinker Production after correction**	kt	76,253	83,032	69,528	63,003	59,885	55,647	49,195

* Clinker Production (actual) / Consumption of Limestone (actual) for 1990-1999 is the average value of 2000-2003.

** Values for FY 1990-1999 are corrected using estimation, and values for FY2000 and on are actual.

c） Uncertainties and Time-series Consistency

● *Uncertainty*

For the uncertainty of the CO_2 emission factor from cement production, the standard value given in the *GPG (2000)* was applied. For the uncertainty of activity data, the value of 10% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used. As a result, the uncertainty of emissions was estimated to be 10%. The uncertainty assessment methods are summarized in Annex 7.

● *Time-series Consistency*

CO_2 emissions from cement production from 1990 to 1999 is estimated using estimated activity data and emission factors based on values provided by the Cement Association. For years from 2000 and onward, the methodology described in the sections above is consistently applied using the data provided by Cement Association.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)*. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.

e） Source-specific Recalculations

Recalculation was conducted for all years, due to the re-establishment of the emission factor based on the data of 13 types of waste origin materials.

f） Source-specific Planned Improvements

No improvements are planned.

4.2.2. Lime Production (2.A.2.)

a） Source/Sink Category Description

CO_2 is emitted during the calcination of $CaCO_3$, $MgCO_3$ in limestone used as raw material to produce quicklime.

CO_2 generation mechanism of quicklime production process

$$CaCO_3 \rightarrow CaO + CO_2$$

$$MgCO_3 \rightarrow MgO + CO_2$$

b） Methodological Issues

- ***Estimation Method***

CO_2 emissions are calculated by multiplying limestone consumption by the country-specific emission factor.

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

= raw material-specific emission factor (t-CO_2/t-raw material) × amount of limestone consumption) (t-product)

- ***Emission Factors***

An emission factor per unit raw material (limestone) (0.428 t-CO_2/t-raw material) provided by the Japan Lime Association was used.

The Emission factor per unit raw material was calculated by finding the CO_2 emissions per unit raw material estimated from the amounts of carbon and other substances in raw material constituents and quicklime products, and then finding the weighted average using production amounts of each district. The emission factor for lime production is the same for all years because annual change is thought to be small.

- ***Activity Data***

Limestone consumption data for quicklime and slaked lime use, categorized under 'Ceramic industry - other ceramics and quarry products' in the Adjusted Price Transaction Table is used. It is converted to dry weight using the water content from limestone used for cement.

The Adjusted Price Transaction Table (RIETI, 2010):

The Adjusted Price Transaction Table is a table created from the monetary input table in the Input-Output Table and the consumption data provided in industrial statistics, and is an application of similar estimation methods as in the General Energy Statistics.

In the existing transaction table attached to the Input-Output Table, although expressing the domestic supply and demand of products without any omission/duplication, there exists the possibility of over/under evaluation of transaction depending on the sector if the actual price differs, since transaction in each sector is based on the input from the average price across all industries. In contrast, the Adjusted Price Transaction Table attempts to eliminate differences between sectors, by taking into consideration the uneven transaction prices based on the differences in product quality/form in each sector, and through using statistical values in industrial statistics etc to the extent which possible.

By using consumption data in the Adjusted Price Transaction Table as activity data, it is considered possible to capture activity data for all industries without omission/duplication, and to achieve a correct categorization of emission/non-emission related use, based on its detailed breakdown of sectors.

In the inventory, limestone/dolomite consumption data by sector in the Adjusted Price Transaction Table will be used as activity data for each limestone related source, excluding that for ‘Cement Production (2.A.1.)’.

As for the dolomite consumed in dolomitic lime production, it is accounted for under ‘Limestone and Dolomite Use (2.A.3.),’ therefore it will not be included under ‘Lime Production (2.A.2).’ As for the re-absorption of CO_2 by the production of light calcium carbonate, it is already deducted by accounting for limestone consumption equivalent to the amount of light calcium carbonate production subtracted from lime production, under the lime production sector,

Table 4-6　Limestone Consumption

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Limestone consumption (dry)	kt	15,595	13,540	13,785	15,527	16,383	15,406	12,548

c）Uncertainties and Time-series Consistency

● *Uncertainty*

The uncertainty for CO_2 emissions from quicklime lime production was estimated.　The uncertainty of 15% as given in the *GPG (2000)* was used for emission factors for both types of lime.　For the uncertainty of activity data, 5% was used.　As a result, the uncertainty of emissions was estimated to be 16%.　The uncertainty assessment methods are summarized in Annex 7.

● *Time-series consistency*

Limestone consumption data provided in the Adjusted Price Transaction Table is used as lime production activity data for all years from FY1990. The emission factors are constant for all years from FY1990.　Therefore, CO_2 emission from lime production has been estimated in a consistent manner throughout the time-series.

d）Source-specific QA/QC and Verification

See section 4.2.1. d）.

e）Source-specific Recalculations

In response to comments made in the process of UNFCCC review regarding possible omission or double-counting of limestone related emissions, a full re-examination was conducted through the use of the Adjusted Price Transaction Table and omission/double-counting has been resolved in this Inventory submission. Recalculation was conducted for all years, due to the revision of the activity data based on the Adjusted Price Transaction Table.

f）Source-specific Planned Improvements

The further improvement of the accuracy of the Adjusted Price Transaction Table will be considered.

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

a） Source/Sink Category Description

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

CO_2 generating mechanism of limestone and dolomite use

$$CaCO_3 \rightarrow CaO + CO_2$$

$$MgCO_3 \rightarrow MgO + CO_2$$

b） Methodological Issues

- ***Estimation Method***

The volumes of limestone and dolomite used are multiplied by the emission factors to calculate emissions.

- ***Emission Factors***

➢ *Limestone*

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

$CaCO_3 \rightarrow CaO + CO_2$

$MgCO_3 \rightarrow MgO + CO_2$

- Proportion of CaO extractable from limestone: 55.4 %
  (Median of 54.8% to 56.0%: Japan Lime Association, The Story of Lime)
- Proportion of MgO extractable from limestone: 0.5 %[b]
  (Median of 0.0% to 1.0%: Japan Lime Association, The Story of Lime)
- Molecular weight of $CaCO_3$ (primary constituent of limestone) : 100.0869[a]
- Molecular weight of $MgCO_3$: 84.3139[a]
- Molecular weight of CaO: 56.0774[a]
- Molecular weight of MgO: 40.3044[a]
- Molecular weight of CO_2: 44.0095[a]
- $CaCO_3$content = proportion of CaO extractable from limestone × molecular weight of $CaCO_3$ / molecular weight of CaO
  = (55.4% × 100.0869) / 56.0774 × 100 = 98.88%
- $MgCO_3$content = proportion of MgO extractable from limestone × molecular weight of $MgCO_3$ / molecular weight of MgO
  = 0.5% × 84.3139 / 40.3044 = 1.05%

○Emission factor = (molecular weight of CO_2 / molecular weight of $CaCO_3$ × $CaCO_3$ content)
+ (molecular weight of CO_2 / molecular weight of $MgCO_3$ × $MgCO_3$ content)
＝44.0095 / 100.0869*0.9888+44.0095/84.3139*0.0105
＝0.4348＋0.0055＝0.4402 ［t-CO_2/t］
＝440 ［kg-CO_2/t］

Sources)

a. IUPAC “Atomic Weights of the Elements 1999” (http://www.chem.qmul.ac.uk/iupac/AtWt/AtWt99.html)

b. Japan Lime Association “The Story of Lime”

➢ *Dolomite*

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

$CaCO_3 \rightarrow CaO + CO_2$
$MgCO_3 \rightarrow MgO + CO_2$

・Proportion of CaO extractable from dolomite: 34.5％
(Median value of the 33.1% to 35.85% range given in *The Story of Lime* [Japan Lime Association])
・Proportion of MgO extractable from dolomite: 18.3%
(Median value of the 17.2% to 19.5% range given in The Story of Lime [Japan Lime Association])
・Molecular weight of $CaCO_3$ (major constituent of dolomite): 100.0869
・Molecular weight of $MgCO_3$ (major constituent of dolomite): 84.3142
・Molecular weight of CaO: 56.0774
・Molecular weight of MgO: 40.3044
・Molecular weight of CO_2: 44.0098

・$CaCO_3$ content = proportion of CaO extractable from dolomite × molecular weight of $CaCO_3$ / molecular weight of CaO
= 34.5% × 100.0869 / 56.0774
= 61.53%

・$MgCO_3$ content = proportion of MgO extractable from dolomite × molecular weight of $MgCO_3$ / molecular weight of MgO
= 18.3% × 84.3142 / 40.3044
= 38.39%

○Emission factor = molecular weight of CO_2 / molecular weight of $CaCO_3$ × $CaCO_3$ content
+ molecular weight of CO_2 / molecular weight of $MgCO_3$ × $MgCO_3$ content
＝ 44.0098 / 100.0869×0.6153＋44.0098 / 84.3142×0.3839
＝ 0.2706＋0.2004
＝ 0.4709 ［t-CO_2/t］
＝ 471[kg-CO_2/t]

● *Activity Data*

Of the limestone and dolomite consumption data in the Adjusted Price Transaction Table, all limestone and dolomite consumption categorized under 'emission use,' excluding sectors that correspond to ‘Cement Production (2.A.1.)’ and ‘Lime Production (2.A.2),’ i.e., ‘Ceramic industry – cement’ and ‘Ceramic industry - other ceramic, stone, and clay products - quicklime and slaked lime,’ will be accounted for. (For dolomite, all sectors excluding ‘Ceramic industry – cement’). Activity data is in dry weight, converted using the water content from limestone used for cement.

The sectors in the Adjusted Price Transaction Table corresponding to the five main uses are as follows:

Table 4-7 Main uses and corresponding sectors in the Adjusted Price Transaction Table

Main uses	Corresponding sectors in the Adjusted Price Transaction Table (Limestone)	Corresponding sectors in the Adjusted Price Transaction Table (Dolomite)
Steel/Refining	2611-01 Steel - pig iron to 2611-04 Steel - crude ore (electric furnace)	2611-01 Steel - pig iron to 2631-03 Steel - cast and forged materials (iron)
	2631-02 Steel - cast iron pipe, -03 cast and forged materials (iron)	
	2711-01 Non-ferrous metal - copper, -02 lead and zinc	2711-02 Non-ferrous metal - lead and zinc
	2722-03 Non-ferrous metal - non-ferrous metal cast and forged products	
Glass products	2511-01 Ceramic industry - sheet glass to 2519-09 Ceramic industry - other glass products	2511-01 Ceramic industry - sheet glass/safety glass
Desulfurization of exhaust gas	0621-01 Mining industry - materials for ceramics	
Ceramics products		0621-01 Mining industry - raw minerals for ceramics
		0621-09 Mining industry – other non-metal ore
	2531-01 Ceramic industry - pottery, china and earthenware	2531-01 Ceramic industry - ceramics
	2599-01 Ceramic industry - clay refractories	2599-01 Ceramic industry - refractory, -03 carbon graphite
		2599-09 Ceramic industry - other ceramic, stone, and clay products
		2811-01 Metal Products - metal products for construction use to 2899-09 Metal Products - other metal products
		8611-09 Private services – other amusement and recreation services
Chemical products	2011-02 Chemical Products - chemical fertilizers	2011-02 Chemical Products - chemical fertilizers
	2022-09 Chemical Products - other inorganic chemical industry products	2022-09 Chemical Products - other inorganic chemical industry products
		2039-02 Chemical Products - processed oil and fat products
	2039-09 Chemical Products - other organic chemical industry products	2039-09 Chemical Products - other organic chemical industry products
		2061-01 Chemical Products - medicaments
		2079-09 Chemical Products – other chemical end products

Note: The numbers before the sector names are categorization numbers in the Adjusted Price Transaction Table.

Table 4-8 Amounts of limestone and dolomite consumption

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Limestone consumption								
For Steel and Refinement (dry)	kt	14,415	13,588	13,593	12,542	12,854	12,164	10,988
For Glass Products (dry)	kt	66	42	26	31	25	16	12
For Flue Gas Desulfurization (dry)	kt	2,048	2,157	2,134	2,503	2,573	2,334	2,075
For Ceramic Products (dry)	kt	435	1,108	1,108	424	580	490	337
For Chemical Products (dry)	kt	3,614	1,714	1,725	624	833	695	473
Dolomite consumption								
For Steel and Refinement (dry)	kt	1,144	1,089	1,160	1,530	1,738	1,534	1,096
For Glass Products (dry)	kt	264	250	203	230	197	160	126
For Ceramic Products (dry)	kt	1,561	1,227	1,020	1,130	1,289	1,295	1,577
For Chemical Products (dry)	kt	147	96	84	53	43	35	36

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

The uncertainty of emission factors for limestone and dolomite were estimated using expert judgment. The uncertainty of emission factors for limestone and dolomite were determined to be 16.4%, 3.5% respectively. The uncertainty for activity data were estimated as 4.8% and 3.9% for limestone and dolomite, respectively, and the uncertainty for emissions were estimated as 17% and 5%, respectively. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series consistency***

Limestone and dolomite consumption data provided in the Adjusted Price Transaction Table is used as limestone and dolomite use activity data for all years from FY1990. The emission factors are constant for all years from FY1990. Therefore, CO_2 emission from limestone and dolomite use has been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

In response to comments made in the process of UNFCCC review regarding possible omission or double-counting of limestone related emissions, a full re-examination was conducted through the use of the Adjusted Price Transaction Table and omission/double-counting has been resolved in this Inventory submission. Recalculation was conducted for all years, due to the revision of the activity data based on the Adjusted Price Transaction Table.

f） Source-specific Planned Improvements

The further improvement of the accuracy of the Adjusted Price Transaction Table will be considered.

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

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

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

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

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

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

a） Source/Sink Category Description

CO_2 is released during the use of soda ash (Na_2CO_3).

b） Methodological Issues

- ***Estimation Method***

CO_2 emissions from soda ash use are calculated by multiplying soda ash consumption by the country-specific emission factor.

- ***Emission Factors***

Soda ash consumption data categorized under 'for emission purpose' in the Adjusted Price Transaction Table does not differentiate between domestic products and imported products, therefore the emission factor is established by taking a weighted average of the below emission factors for domestic soda ash and imports, by total domestic shipment and total import amounts.
For domestic soda ash, the emission factor is set as follows using data on the purity of soda ash. (The annual fluctuation in purity of soda ash is small, therefore the emission factor will be set constant over the time-series.)

Emission factor for domestic soda ash
= purity of soda ash (arithmetic mean between the 2 domestic companies)
x molecular weight of CO_2 / molecular weight of Na_2CO_3
= 0.995 × 44.01 / 105.99
= 0.413

For soda ash imported, and other disodium carbonate imported, there is not enough information to set representative emission factors, therefore the default value (0.415 $t\text{-}CO_2/t\text{-}Na_2CO_3$) specified in the *Revised 1996 IPCC Guidelines* (vol. 3 p. 2.13) is used continuously.

- ***Activity Data***

Soda ash consumption data categorized under 'for emission purpose' in the Adjusted Price Transaction Table is used.

Table 4-9   Soda ash consumption (limestone)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Soda ash consumption (soda ash)	kt	647	605	504	476	439	384	334

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

For the uncertainty of the emission factor from soda ash use, the lime production value was applied since it is a similar source category to soda ash. For the uncertainty of activity data, 6.3% uncertainty was applied. The uncertainty of CO_2 emissions from soda ash use was estimated as 16%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series consistency***

Soda ash consumption data provided in the Adjusted Price Transaction Table is used as soda ash use activity data for all years from FY1990. The emission factor is constant for all years from FY1990.

Therefore, CO_2 emission from soda ash use has been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

In response to comments made in the process of UNFCCC review regarding possible omission or double-counting of limestone related emissions, a full re-examination was conducted through the use of the Adjusted Price Transaction Table and omission/double-counting has been resolved in this Inventory submission. Recalculation was conducted for all years, due to the revision of the activity data based on the Adjusted Price Transaction Table, and the re-establishment of the emission factor based on the weighted average of the emission factors of domestic soda ash and imports.

f） Source-specific Planned Improvements

The further improvement of the accuracy of the Adjusted Price Transaction Table will be considered.

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

Asphalt roofing is manufactured in Japan, but information on the manufacturing process and activity data is inadequate, and it is not possible to definitively conclude that CO_2 is not emitted from the manufacturing of asphalt roofing. Emissions have also never been actually measured, and as no default emission value is available, it is not currently possible to calculate emissions. Therefore, it has been reported as “NE”.

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

Roads in Japan are paved with asphalt, but almost no CO_2 are thought to be emitted in the process. It is not possible, however, to be completely definitive about the absence of emissions. Emissions have also never been actually measured, and as no default emission value is available, it is not currently possible to calculate emissions. Therefore, it has been reported as “NE”.

4.3. Chemical Industry (2.B.)

This category covers CO_2, CH_4, and N_2O emissions from the processes of chemical productions.

This section includes GHG emissions from five sources: Ammonia Production (2.B.2), Nitric Acid Production (2.B.2.), Adipic Acid Production (2.B.3.), Carbide Production (2.B.4.), Other (2.B.5.).

In 2009, emissions from Chemical Industry were 4,144 Gg-CO_2 eq. and represented 0.3% of GHG of the Japan’s total GHG emissions (excluding LULUCF). The emissions had decreased by 67.7% compared to 1990.

Table 4-10 Emissions from 2.B. Chemical Industry

Gas	Emission sub-category				Units	1990	1995	2000	2005	2007	2008	2009
CO_2	2.B Chemical Industry	2.B.1	Ammonia Production		Gg-CO_2	3,385	3,436	3,188	2,155	2,241	1,990	1,909
		2.B.4	Carbide Production	Silicon Carbide	Gg-CO_2	C	C	C	C	C	C	C
				Calcium Carbide	Gg-CO_2	C	C	C	C	C	C	C
		2.B.5	Other	Ethylene	Gg-CO_2	C	C	C	C	C	C	C
	Total				Gg-CO_2	4,209	4,220	3,893	2,887	2,990	2,574	2,488
CH_4	2.B Chemical Industry	2.B.4	Carbide Production	Silicon Carbide	Gg-CH_4	0.02	0.05	0.03	0.03	0.03	0.03	0.03
		2.B.5	Other	Carbon Black	Gg-CH_4	0.28	0.27	0.27	0.28	0.29	0.25	0.22
				Ethylene	Gg-CH_4	0.09	0.10	0.11	0.11	0.11	0.10	0.11
				1,2-Dichloroethane	Gg-CH_4	0.01	0.02	0.02	0.02	0.02	0.02	0.02
				Styrene	Gg-CH_4	0.07	0.09	0.09	0.10	0.11	0.08	0.09
				Methanol	Gg-CH_4	0.17	0.15	NO	NO	NO	NO	NO
				Coke	Gg-CH_4	15.47	13.82	8.00	5.02	5.00	4.59	4.13
	Total				Gg-CH_4	16.11	14.50	8.52	5.57	5.56	5.07	4.60
	Total				Gg-CO_2 eq.	338	304	179	117	117	106	97
N_2O	2.B Chemical Industry	2.B.2	Nitric Acid Production		Gg-N_2O	2.47	2.46	2.57	2.52	1.90	1.62	1.54
		2.B.3	Adipic Acid Production		Gg-N_2O	24.20	24.03	12.56	1.68	0.87	2.45	3.49
	Total				Gg-N_2O	26.67	26.49	15.13	4.19	2.77	4.07	5.03
	Total				Gg-CO_2 eq.	8,267	8,213	4,690	1,300	860	1,262	1,559
Total of All Gases					Gg-CO_2 eq.	12,814	12,737	8,762	4,304	3,967	3,943	4,144

C: Confidential

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

a） *Source/Sink Category Description*

1） *CO_2*

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

CO_2 generating mechanism of ammonia production

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

Ammonia synthesis

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

2） *CH_4*

Emission of CH_4 from the ammonia production has been confirmed by actual measurements. As there are not enough sufficient examples to enable the establishment of an emission factor, it is not currently possible to calculate emissions. The *Revised 1996 IPCC Guidelines* also do not give a default emission factor. Therefore, CH_4 was reported as “NE”.

3） *N_2O*

Emission of N_2O from ammonia production is theoretically impossible, and given that even in actual measurements the emission factor for N_2O is below the limits of measurement, N_2O was reported as “NA”.

b） *Methodological Issues*

- ***Estimation Method***

CO_2 emissions are calculated by multiplying the amount of fuels consumed as ammonia feedstock by emission factors.

- ***Emission Factors***

The same emission factors that are used to calculate CO_2 emissions from the fuel combustion sector

(Chapter 3) are used for each feedstock listed in Table 4-11. It should be noted that the implied emission factor changes every year, since the composition of the feedstocks consumed for ammonia production varies annually.

Table 4-11 Emission factors and calorific values of feedstocks used when producing ammonia

Feedstock	Emission Factors (tC/TJ)	Calorific value		(Units)
		1990	2005	
Naphtha	18.17	33.5	33.6	MJ/l
Liquefied petroleum gas (LPG)	16.13	50.2	50.8	MJ/kg
Petroleum-derived hydrocarbon gases (petrochemical offgases)	14.15	39.3	44.9	MJ/m^3
Natural gas	13.90	41.0	43.5	MJ/m^3
Coal (thermal coal, imports)	24.71	26.0	25.7	MJ/kg
Petroleum coke	25.35	35.6	29.9	MJ/kg
Liquefied natural gas (LNG)	13.47	54.4	54.6	MJ/kg
Coke oven gas (COG)	10.99	20.1	21.1	MJ/m^3

(Reference) General Energy Statistics, Agency for Natural Resources and Energy

- ***Activity Data***

The fixed units (including weight and volume) for the fuel types in Table 4-12 below, which are from the Ministry of Economy, Trade and Industry's Yearbook of the Current Survey of Energy Consumption, were converted using the calorific values in the Agency for Natural Resources and Energy's General Energy Statistics, and results were used as activity data. Consumption data on some fuel types are confidential.

Table 4-12 Amount of feedstocks used for ammonia production

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Naphtha	kl	189,714	477,539	406,958	92,453	77,214	67,062	72,045
LPG	t	226,593	45,932	5,991	0	0	0	0
Off gas	10^3m^3	C	230,972	240,200	147,502	144,196	151,553	140,783
Natural Gas	10^3m^3	C	100,468	86,873	77,299	50,986	50,260	21,773
Coal	t	C	209,839	726	1,239	763	802	522
Oil Coke	t	C	273,125	420,862	353,983	407,213	336,633	351,594
LNG	t	C	46,501	23,395	165,606	180,161	162,342	145,699
COG	10^3m^3	C	35,860	55,333	0	0	0	0

C: Confidential

- ***Point to Note***

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

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

The uncertainty of each fuel was estimated. For the uncertainty of emission factors, the values given in Chapter 3 were applied. The standard value, 5%, given by the Committee for the Greenhouse Gas Emission Estimation Methods was used. As a result, the uncertainty of emissions from the fuels are of the following: naphtha 7%; LPG 6%; hydrocarbon gas 22%; natural gas 7%; coal (steam coal, imported coal) 7%; petroleum coke 23%; LNG 10%; and COG 25%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For activity data, the same sources are used throughout the time series, from the Current Survey of Energy Consumption. The emission factor is constantly based on the General Energy Statistics throughout the time series. Therefore, CO_2 emission from ammonia production has been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

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

a） Source/Sink Category Description

N_2O is emitted when nitric acid (HNO_3) is produced from ammonia.

<u>N_2O generating mechanism in nitric acid production</u>

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

$$2NO + H_2O \rightarrow 2NO_2$$

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

In Japan, the main processes used in nitric acid production are the New Fauser Process (medium pressure) and Chemico Process (high pressure), both based on the Ostwald chemical process. With regard to N_2O decomposition, there are catalytic decomposition units in operation.

b） Methodological Issues

- ***Estimation Method***

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

<u>N_2O emissions (kg-N_2O) from nitric acid production</u>

= emission factor [kg-N_2O/t] × nitric acid production volume [t]

- ***Emission Factors***

Because data for individual factories are confidential, the emission factor was set by using each factory's nitric acid production volume to find the weighted average of Japan's 10 nitric acid producing factories' emission factors (measurement data). These emission factors take N_2O recovery and destruction into account.

Table 4-13　N_2O emission factors for nitric acid production

Item	Unit	1990	1995	2000	2005	2007	2008	2009
EF for Nitric Acid Production	kg-N_2O/t	3.50	3.51	3.92	4.18	3.22	3.35	3.34

- ***Activity Data***

Production volumes of nitric acid are directly provided by the Ministry of Economy, Trade and Industry.

Table 4-14　Amount of Nitric acid production

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Nitric Acid Production	t	705,600	701,460	655,645	602,348	590,332	484,070	460,600

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

The uncertainty of the emission factor was estimated using a 95% confidence interval for emission factors.　For the uncertainty of activity data, the standard value of 5% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used.　As a result, the uncertainty of emissions was estimated as 46%.　The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emissions throughout the time series are consistently estimated using the activity data and emission factors provided by the Ministry of Economy, Trade and Industry.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

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

a） Source/Sink Category Description

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

b） Methodological Issues

- ***Estimation Method***

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

N_2O emissions from adipic acid production

= [N_2O generation rate × (1 – N_2O generation rate × decomposition unit operation rate)]
× adipic acid production rate

- ***Emission Factors***

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

➢ ***Rate of generation of nitrous oxide***

Actual measurement data provided from the sole producer of adipic acid as an end product in Japan.

➢ ***Rate of decomposition of nitrous oxide***

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

➢ ***Operating rate of decomposition unit***

A full-scale survey on the number of operation hours is conducted annually for N_2O decomposition units and adipic acid production plants. The operating rate is based on this survey.

Calculation of operating ratio of decomposition unit

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

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

- ***Activity Data***

The activity data for nitrous oxide emissions associated with the manufacturing of adipic acid is the amount of adipic acid produced provided to the Ministry of Economy, Trade and Industry by the manufacturer. Relevant data used in estimation is confidential.

- ***Point to Note***

From 1990 to 1997, N_2O emissions from adipic acid production increased gradually. However, N_2O decomposition units were installed in adipic acid production plants in March 1999, and emissions since then have decreased dramatically. There was a temporary growth in the emissions in 2000 due to the low operating ratio of N_2O decomposition units caused by a breakdown of the decomposition units.

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

The uncertainty of the emission factor for adipic acid was estimated by combining the uncertainty of the N_2O generation rate, N_2O decomposition rate, and the operating rate of the decomposition unit. As a result, the uncertainty of the emission factor was estimated as 9%. A 2% uncertainty given by the *GPG (2000)* was applied for activity data. As a result, the uncertainty for adipic acid was estimated as 9%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Activity data and emission factors consistently provided by the producer of adipic acid are used to estimate emissions throughout the time series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

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

4.3.4.1. Silicon Carbide Production (2.B.4.-)

a） Source/Sink Category Description

1） CO_2

CO_2 is emitted by the reaction of petroleum coke with silica as raw materials in the production of silicon carbide.

CO_2 generating mechanism in the silicon carbide production process

$$SiO_2 + 3C \rightarrow SiC + 2CO \quad (\rightarrow CO_2)$$

2） CH_4

In Japan, silicon carbide is produced in electric arc furnaces, and it is believed that CH_4 is generated from the oxidation of coke, which is used as a reducing agent in silicon carbide production.

b） Methodological Issues

1） CO_2

- ***Estimation Method***

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

- ***Emission Factors***

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

- ***Activity Data***

The activity data for CO_2 emissions from silicon carbide production is the amount of petroleum coke consumed, which is provided by Japan's only silicon carbide production facility. The data is confidential.

2） CH_4

- ***Estimation Method***

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

- ***Emission Factors***

The emission factor of energy consumption in electric arc furnaces (12.8 kg-CH_4/TJ) was determined by using the formula for calculating fuel combustion and actual data from Japanese measurement surveys of CH_4 concentrations in gas ducts, concentrations of O_2 and theoretical flue gas amounts (dry), theoretical air demand, and high calorific values. See Chapter 3 3.2.1 Stationary Combustion (1.A.1., 1.A.2., 1.A.4.: CH_4 and N_2O)

- ***Activity Data***

Energy consumption amounts included in the "electric furnace" category for the iron and steel industries of the General Survey of the Emissions of Air Pollutants were used. (From 2000 and onward, 1999 values are used.)

Table 4-15 Energy consumption from electric arc furnaces (for carbide)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Furnaces (for Carbide)	TJ	1,576	4,277	2,454	2,454	2,454	2,454	2,454

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

1） CO_2

For the uncertainty of the CO_2 emission factor, 100% was applied as provided by the *GPG (2000)* for a similar category. For the uncertainty of activity data, the standard value of 10% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used. The uncertainty assessment methods are summarized in Annex 7.

2） CH_4

The uncertainty of the CH_4 emission factor and activity data were estimated as 163％ and 5%, respectively, as estimated in Chapter 3. The uncertainty for emissions is estimated as 163%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For CO_2 and CH_4 activity data, the same sources are consistently used throughout the time series-the former from the manufacturing facility, and the latter from the General Survey of the Emissions of Air

Pollutants. The emission factors for both gases are constant throughout the time series. Therefore, CO_2 and CH_4 emissions from silicon carbide have been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

The use of fuel consumption data in the General Survey of the Emissions of Air Pollutants for FY 2002 onward was prohibited for any purposes other than the original one specified for the General Survey of the Emissions of Air Pollutants, while that is not the case with the data in the General Survey of the Emissions of Air Pollutants for FY 1999 and earlier years. The use of General Survey of the Emissions of Air Pollutants in the GHG inventory was added to the purpose of the General Survey of the Emissions of Air Pollutants by the current examination toward the reuse of the General Survey of the Emissions of Air Pollutants and was recently officially accepted. Japan will continue to consider applying the latest the General Survey of the Emissions of Air Pollutants data in the future inventory.

4.3.4.2. Calcium Carbide Production and Use (2.B.4.-)

a） Source/Sink Category Description

1） CO_2

CO_2 is generated in the process of making the quicklime, and is also emitted by the combustion of CO occurring from calcium carbide production. However, the former is included in emissions from Chemical Products in “Limestone and Dolomite Use (2.A.3.),” therefore only reducing agent-origin emissions are accounted for here. Further, CO_2 is generated by the combustion of acetylene, which is generated by reacting calcium carbide with water, and these emissions is reported here.

CO_2 generator mechanism in the calcium carbide production process

(Production)

$$CaCO_3 \rightarrow CaO + CO_2$$

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

(Use)

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

2） CH_4

Byproduct gases (mainly CO) generated in carbide production include a small amount of CH_4, all of which is recovered and burned as fuel, with none being emitted outside the system. Therefore emissions from this source are reported as “NA”.

b） Methodological Issues

- **Estimation Method**

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

- ***Emission Factors***

For years FY1990 to 2007, because Japan does not have measurement data or emission factor data, the default value in the *Revised 1996 IPCC Guidelines* is used.

Table 4-16 CO_2 Emission factors for calcium carbide production and consumption (FY1990-2007)

Units	From reducing agent in production	From use
t-CO_2/t	1.09	1.10

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

For years after FY2008, country-specific emission factors from reducing agents during production are used, which are based on measurement data from the two calcium carbide producing companies in Japan. These emission factors are confidential.
The default emission factor (1.10 t-CO_2/t) for calcium carbide use is also used for FY2008 and onwards.

- ***Activity Data***

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

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

For the uncertainty of the CO_2 emission factor, 100% was applied as provided by the *GPG (2000)* for a similar category. For the uncertainty of activity data, the standard value of 10% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used. As a result, the uncertainty for CO_2 emissions from calcium carbide was estimated as 100%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For activity data, the same sources are used throughout the time series. The emission factor is constant from 1990 to 2007 and for years after 2008, the country-specific emission factor will be used. This is because there is no data available on emission factors for previous years, and because emission factors may fluctuate over time due to changes in scale of production or improvements in manufacturing technology, therefore the default emission factors will be used for FY1990 to FY2007.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

In response to comments made in the process of UNFCCC review regarding possible omission or double-counting of limestone related emissions, a full re-examination was conducted through the use of the Adjusted Price Transaction Table and omission/double-counting has been resolved in this Inventory submission. Recalculation was conducted for all years, since limestone-origin emissions from calcium carbide production has been accounted for under “Limestone and Dolomite Use (2.A.3.).”

f） *Source-specific Planned Improvements*

No improvements are planned.

4.3.5. Other (2.B.5.)

4.3.5.1. Carbon Black Production (2.B.5.-)

a） *Source/Sink Category Description*

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

b） *Methodological Issues*

- ***Estimation Method***

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

- ***Emission Factors***

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

Table 4-17 CH_4 emissions and carbon black production by five main domestic producers

	Carbon black production [t/year]	CH_4 emissions [kg-CH_4/year]	Emission factor [kg-CH_4/t]
Total from five main companies	701,079	246,067	0.35

Source: Data provided by the Carbon Black Association (1999 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 CH_4 emissions associated with the manufacturing of carbon black.

Table 4-18 Carbon black production volume

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Carbon Black Production	t	792,722	758,536	771,875	805,461	840,634	725,113	634,733

c） *Uncertainties and Time-series Consistency*

- ***Uncertainty***

The uncertainty for the emission factor for carbon black was calculated by finding the 95% confidence interval of emission factors. The estimated uncertainty was 54.8%. For the uncertainty of activity data, the standard value of 5% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used.　As a result, the uncertainty of carbon black production emissions was estimated at 55%.　The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For activity data, the same source-the Yearbook of Chemical Industries Statistics are used throughout the time series. The emission factor is constant throughout the time series. Therefore, CH_4 emissions from carbon black production have been estimated in a consistent manner throughout the time-series.

d）Source-specific QA/QC and Verification

See section 4.2.1. d）.

e）Source-specific Recalculations

There have been no source-specific recalculations.

f）Source-specific Planned Improvements

The possibility of double counting of CH_4 from furnaces in the Energy sector should be investigated.

4.3.5.2. Ethylene Production (2.B.5.-)

a）Source/Sink Category Description

1）CO_2, CH_4

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

2）N_2O

There is almost no nitrogen contained in naphtha, the raw material of ethylene, and the ethylene production process takes place under conditions that are almost completely devoid of oxygen. Emissions are reported as “NA” in accordance with the judgment of experts that theoretically there are no N_2O emissions.

b）Methodological Issues

- ***Estimation Method***

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

- ***Emission Factors***

➢ ***CO_2***

The emission factor was set, based on a survey conducted by the Japan Petrochemical Industry Association in 2009 on the CO_2 emission factor from ethylene production.　This emission factor is confidential.

- ***CH_4***

Estimates of volume of exhaust gas from flare stacks at a normal operation and an unsteady operation at operating sites in Japan (assuming that 98% of the volume that enters is combusted), and measured volume of exhaust gas from naphtha cracking furnaces and furnaces heated by re-cycled gas, were divided by the production volume to calculate emission factors for each company. The weighted average based on production from each company was then applied to establish the emission factor of 0.015 [kg-CH_4/t]. (Surveyed 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 CH_4 and CO_2 from ethylene production.

Table 4-19 Ethylene production volume

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Ethylene Production	kt	5,966	6,951	7,566	7,549	7,559	6,520	7,219

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

The uncertainty for both CO_2 and CH_4 emission factors for ethylene were calculated by finding the 95% confidence interval of emission factors, based on the decision tree for uncertainty assessment. The estimated uncertainty for both CO_2 and CH_4 were 77.2%. For the uncertainty of activity data, the standard value of 5% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used. As a result, the uncertainty for both CO_2 and CH_4 were estimated as 77%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For activity data, the same sources are used throughout the time series. The emission factor is constant throughout the time series. Therefore, CO_2 and CH_4 emissions from ethylene production have been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.3.5.3. 1,2-Dichloroethane (2.B.5.-)

a） Source/Sink Category Description

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

b） Methodological Issues

- ***Estimation Method***

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

- ***Emission Factors***

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

- ***Activity Data***

1,2-Dichloroethane production volumes from the Yearbook of Chemical Industries Statistics compiled by the Ministry of Economy, Trade and Industry were used as activity data for CH_4 emissions from 1,2-dichloroethane production.

Table 4-20　1,2-Dichloroethane production volume

Item	Unit	1990	1995	2000	2005	2007	2008	2009
1,2-Dichloroethane Production	kt	2,683	3,014	3,346	3,639	3,517	3,243	3,213

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

The uncertainty of the CH_4 emission factor for 1,2-dichloroethane production were estimated by finding the 95% confidence interval, based on expert judgment. The uncertainty was estimated as 100.7%. For the uncertainty of activity data, the standard value of 5% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used. As a result, the uncertainty of 1,2-dichloroethane production was estimated as 101%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For activity data, the same sources are used throughout the time series. The emission factor is constant throughout the time series. Therefore, CH_4 emissions from 1,2-Dichloroethane production have been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.3.5.4. Styrene Production (2.B.5.-)

a）Source/Sink Category Description

CH_4 is emitted in the styrene production process.

b）Methodological Issues

- ***Estimation Method***

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

- ***Emission Factors***

Estimates of volume of exhaust gas from flare stacks at a normal operation and an unsteady operation at operating sites in Japan (assuming that 98% of the volume that enters is combusted), and measured volume of waste gas from heating furnaces, were divided by the production volume to calculate emission factors for each company. The weighted average by production from each company was then applied to establish the emission factor. The emission factor is 0.031 [kg-CH_4/t]. (Surveyed 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 CH_4 emissions from styrene production.

Table 4-21 Styrene production volume

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Styrene Production	kt	2,227	2,952	3,020	3,375	3,417	2,699	3,043

c）Uncertainties and Time-series Consistency

- ***Uncertainty***

The uncertainty for the CH_4 emission factor for styrene production was estimated by finding the 95% confidence interval of emission factors, based on the decision tree for uncertainty assessment. The estimated uncertainty was 113.2%. For the uncertainty of activity data, the standard value of 5% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used. As a result, the uncertainty of emissions was estimated as 113%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For activity data, the same sources are used throughout the time series. The emission factor is constant throughout the time series. Therefore, CH_4 emissions from styrene production have been estimated in a consistent manner throughout the time-series.

d）Source-specific QA/QC and Verification

See section 4.2.1. d）.

e）Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.3.5.5. Methanol Production (2.B.5.-)

a） Source/Sink Category Description

CH_4 is emitted in the production of methanol.

b） Methodological Issues

● Estimation Method

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

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

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

● Emission Factors

The default value for methanol given in the *Revised 1996 IPCC Guidelines* was used. The emission factor is 2 [kg-CH_4/t] (Refer to *Revised 1996 IPCC Guidelines* Vol. 2 p 2.22, Table 2-9).

● Activity Data

Production volumes of methanol (on calendar year basis) given by the Methanol and Formalin Association were used as activity data for CH_4 emissions from methanol production.

Table 4-22 Methanol production volume

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Methanol Production	t	83,851	75,498	NO	NO	NO	NO	NO

c） Uncertainties and Time-series Consistency

● Uncertainty

The uncertainty is not estimated.

● Time-series Consistency

For activity data, the same sources are used throughout the time series. The emission factor is constant throughout the time series. Therefore, CH_4 emissions from methanol production have been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e）Source-specific Recalculations

There have been no source-specific recalculations.

f）Source-specific Planned Improvements

No improvements are planned.

4.3.5.6. Coke Production (2.B.5.-)

a）Source/Sink Category Description

1）CO_2

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

2）CH_4

CH_4 is emitted in coke production.

3）N_2O

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

b）Methodological Issues

● *Estimation Method*

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

● *Emission Factors*

CH_4 emissions from coke production come from two sources: CH_4 in combustion exhaust gas from gas leakage from the carbonization chamber to the combustion chamber, and CH_4 emitted from the coking furnace lid, the desulfurization tower, or the desulfurization recycling tower, in the carbonization process of coal.

➢ *Combustion exhaust gas*

The concentration of CH_4 in the exhaust gas from coking furnaces operated by five companies at seven operating sites (surveyed by the Japan Iron and Steel Federation, actual results for FY1999) was weighted by the production volume of coke to derive a weighted average, which was established as the emission factor. The emission factor is 0.089 [kg-CH_4/t].

➢ *Coking furnace lid, desulfurization tower, and desulfurization recycling tower*

The Japan Iron and Steel Federation has had a voluntary plan in place since fiscal year 1997 to manage noxious atmospheric pollutants, and CH_4 emissions have been estimated from emissions of other substances from the lid of coking furnaces. The emission factor has been established by taking a weighted average using this data and the volume of production of coke.

Table 4-23 Emission factor of CH_4 from coking furnace lids, desulfurization towers, and desulfurization recycling towers

Item	Unit	1990-1996	1997-1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
CH_4 emission factors	[kg-CH_4/t]	0.238	0.180	0.119	0.062	0.052	0.042	0.055	0.043	0.039	0.040	0.037	0.032

* Emission factor change is assumed to be small for FY1990-1996, therefore actual data values for FY1995 is used for other years with no data. For Fy1997-1999, it is assumed that values for 1998 and 1999 are the same as those of 1997. For FY2000 and on, actual data values are adopted.

Source: Japan Iron and Steel Federation data

➢ CH_4 emission factor for coke production

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

● Activity Data

As the activity of CH_4 emissions from coke production, the inventory used the coke production volume given in the Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke and the Yearbook of Mineral Resources and Petroleum Products Statistics compiled by the Ministry of Economy, Industry and Trade.

Table 4-24 Coke production volume

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Coke Production	kt	47,338	42,279	38,511	38,009	38,867	36,551	34,140

● Completeness

The SBDT[1] (Table 2(I).A-Gs2) in the CRF requires emissions of CO_2 and CH_4 from coke production to be reported as a sub-category of 2.C.1. Steel Manufacture, but coke is also manufactured in Japan in industries other than the steel industry. The emissions have therefore been counted in this category.

c) Uncertainties and Time-series Consistency

● Uncertainty

For the uncertainty of the emission factor for coke production, the uncertainty of fuel combustion emissions from the coking furnace and coking furnace lids were estimated separately. The uncertainty of fuel combustion emissions from the coking furnace and coking furnace lids was estimated as 98.5% and 61.8%, respectively. For the uncertainty of activity data, the standard value of 5% given by the Committee for the Greenhouse Gas Emission Estimation Methods was used. The uncertainty assessment methods are summarized in Annex 7.

● Time-series Consistency

For activity data, the same sources are used throughout the time series. The emission factor is based on the information provided by the Japan Iron and Steel Federation estimated using a consistent methodology throughout the time series. Therefore, CH_4 emissions from coke production have been

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[1] SBDT: Sectoral Background Data Table

estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.4. Metal Production (2.C.)

This category covers CO_2, CH_4, PFCs and SF_6 emissions from the manufacturing processes of metal products.

This section includes GHG emissions from three sources: Iron and Steel Production (2.C.1), Ferroalloys Production (2.C.2.), Aluminium Production (2.C.3.), and SF_6 Used in Aluminium and Magnesium Foundries (2.C.4.).

In 2009, emissions from Metal Production were 375 Gg-CO_2 eq. and represented 0.03% of GHG of the Japan’s total GHG emissions (excluding LULUCF). The total emissions of CO_2 and CH_4 from this category had decreased by66.7% compared to 1990. The total of halocarbons and SF_6 had increased by 32.1% compared to 1995.

Table 4-25 Emissions from 2.C. Metal Production

Gas	Emission sub-category				Units	1990	1995	2000	2005	2007	2008	2009
CO_2	2.C Metal Production	2.C.1	Iron and Steel Production	Use of Electric Arc Furnaces in Steel Production	Gg-CO_2	356	357	248	242	212	156	112
CH_4	2.C Metal Production	2.C.1	Iron and Steel Production	Use of Electric Arc Furnaces in Steel Production	Gg-CH_4	0.74	0.72	0.67	0.68	0.71	0.61	0.51
		2.C.2	Ferroalloys Production		Gg-CH_4	0.19	0.14	0.13	0.13	0.11	0.11	0.11
	Total				Gg-CH_4	0.92	0.85	0.80	0.80	0.82	0.72	0.62
	Total				Gg-CO_2 eq.	19	18	17	17	17	15	13
Total of Gases					Gg-CO_2 eq.	375	375	265	259	229	171	125
Gas	Emission sub-category				Units	1990	1995	2000	2005	2007	2008	2009
PFCs	2.C Metal Production	2.C.3	Aluminium Production		Gg-CO2 eq.		69.74	17.78	14.80	14.69	14.67	11.02
SF_6	2.C Metal Production	2.C.4	SF_6 Used in Aluminium and Magnesium Foundaries		t		5.00	43.00	48.42	45.58	27.30	10.00
					Gg-CO_2 eq.		119.50	1,027.70	1,157.31	1,089.34	652.47	239.00
Total of Gases					Gg-CO_2 eq.		189.24	1,045.48	1,172.11	1,104.03	667.14	250.02

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

4.4.1.1. Steel Production (2.C.1.-)

1） CO_2

Coke oxidizes when it is used as a reduction agent in steel production, and CO_2 is generated. The volume of coke used has been included under consumption of fuel in the Fuel Combustion Sector (1.A.), and the CO_2 generated through the oxidization of coke used as a reducing agent has already been calculated under Fuel Combustion Sector (1.A.). Therefore, it has been reported as “IE”.

4.4.1.2. Pig Iron Production (2.C.1.-)

1） CO_2

CO_2 generated from pig iron production is emitted when coke is used as a reduction agent. The amount of coke used has been included under consumption of fuel in the Fuel Combustion Sector (1.A.), and the CO_2 generated through the oxidization of coke used as a reducing agent has already been calculated under Fuel Combustion Sector (1.A.). Therefore, it has been reported as “IE”.

2） CH_4

It is theoretically impossible for CH_4 generation in association with pig iron production, and it has been confirmed that CH_4 is not emitted from actual measurements. Therefore, emissions have been reported as “NA”.

4.4.1.3. Sinter Production (2.C.1.-)

1） CO_2

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

CO_2 emissions from limestone and dolomite used when making sinter are counted under “4.2.3. Limestone and Dolomite Use”.

2） CH_4

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

4.4.1.4. Coke Production in Iron and Steel Production (2.C.1.-)

1） CO_2

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

2） CH_4

Emissions of CH_4 were calculated at 4.3.5.6. Coke (2.B.5.-), and have been reported as “IE”.

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

a） *Source/Sink Category Description*

CO_2 is emitted from carbon electrodes when using electric arc furnaces to make steel. CH_4 is also emitted from electric arc furnaces during steel production.

b） Methodological Issues

1） CO_2

- ***Estimation Method***

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

- ***Activity Data***

Production of carbon electrodes given in Yearbook of Ceramics and Building Materials Statistics compiled by the Ministry of Economy, Trade and Industry, and import and export of carbon electrodes given in Trade Statistics of Japan, Ministry of Finance are used.

Table 4-26 CO_2 emission from carbon electrodes of furnaces

	Unit	1990	1995	2000	2005	2007	2008	2009
#A Import	t	12,341	18,463	11,363	15,075	15,035	15,116	11,218
#B Domestic production	t	211,933	186,143	184,728	216,061	229,734	201,256	169,545
#C Export	t	87,108	92,812	107,998	138,409	150,491	134,509	116,489
#D Electric furnaces gas	t	39,983	14,300	20,293	26,700	36,415	39,349	33,709
Domestic consumptions (#A + #B - #C - #D)	t	97,184	97,493	67,800	66,028	57,864	42,514	30,564
CO_2 emissions	Gg-CO_2 eq.	356	357	248	242	212	156	112

2） CH_4

- ***Estimation Method***

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

- ***Emission Factors***

The emission factor of energy consumption of electric arc furnaces (12.8 kg-CH_4/TJ) was determined by using the data from actual measurement surveys. (See Chapter 3, 3.2.1 and Chapter 4, 4.3.4.1)

- ***Activity Data***

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

Table 4-27 Energy consumption from electric arc furnaces

Consumption	Unit	1990	1995	2000	2005	2007	2008	2009
Furnaces	TJ	57,564	55,986	52,457	52,747	55,687	47,316	39,705

c） Uncertainties and Time-series Consistency

1） CO_2

- ***Uncertainty***

Because all CO_2 from electric arc furnaces are assumed to escape into the atmosphere, no emission factor has been set. Therefore, by assessing the uncertainty for activity data the uncertainty for emissions is assessed. As a result of combining the uncertainties of the parameters for activity data, the uncertainty was estimated as 4.5%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For activity data (emissions), the same sources are used throughout the time series. Therefore, CO_2 emissions from electric arc furnaces have been estimated in a consistent manner throughout the time-series.

2） CH_4

- ***Uncertainty***

The uncertainty for the emission factor has been estimated as 163% and the uncertainty for activity data has been estimated as 5% (see chapter 3). As a result, the uncertainty for CH_4 emissions has been estimated as 163%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For activity data, the same sources are used throughout the time series. The emission factor is constant throughout the time series. Therefore, CH_4 emissions from electric arc furnaces in steel production have been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

Recalculations were conducted for FY2008, since the renewed value of the energy consumption in electric arc furnaces was provided.

f） Source-specific Planned Improvements

No improvements are planned.

4.4.2. Ferroalloys Production (2.C.2.)

a） Source/Sink Category Description

1） CO_2

Ferroalloys are produced in Japan, and the CO_2 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 the Fuel Combustion Sector (1.A.), and CO_2 generated as a consequence of the oxidization of coke used as a reduction agent has already been calculated under the Fuel Combustion Sector (1.A.). Residual carbon in the ferroalloys is oxidized when the ferroalloys are used in the production of steel, and are released into the atmosphere as CO_2. Therefore, it has been reported as “IE”.

2） CH_4

Ferroalloys are manufactured in Japan in electric arc furnaces, small-scale blast furnaces, and Thermit furnaces. CH_4 generated in association with ferroalloy production is thought to be generated when the oxidization of coke, a reduction agent, takes place.

b） Methodological Issues

● Estimation Method

CH_4 emissions from ferroalloy production were calculated by multiplying an emission factor based on actual measurements obtained in Japan by the energy consumption of electric arc furnaces. This is the same method used for calculating CH_4 emissions in the Fuel Combustion Sector (1.A.1 Energy Industries).

● Emission Factors

The value for the emission factor of electric arc furnaces (12.8 kg-CH_4/TJ) was used because these furnaces produce ferroalloys.

● Activity Data

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

Table 4-28 Energy consumption from ferroalloy production

Consumption	Unit	1990	1995	2000	2005	2007	2008	2009
Furnaces (for Ferroalloys)	TJ	14,456	10,699	10,181	10,072	8,676	8,578	8,458

c） Uncertainties and Time-series Consistency

● Uncertainty

The uncertainty for the emission factor has been estimated as 163% and the uncertainty for activity data has been estimated as 5% (see chapter 3). As a result, the uncertainty for CH_4 emissions has been estimated as 163%. The uncertainty assessment methods are summarized in Annex 7.

● Time-series Consistency

For activity data, the same sources are used throughout the time series. The emission factor is constant throughout the time series. Therefore, CH_4 emissions from furnaces for ferroalloy have been estimated in a consistent manner throughout the time-series.

d） Source-specific QA/QC and Verification

See section 4.2.1. d） .

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

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

a） Source/Sink Category Description

1） CO_2

Aluminum refining is conducted in Japan. CO_2 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 the Fuel Combustion Sector (1.A.), and the CO_2 that is generated by the oxidization of coke used as a reducing agent has already been calculated under the Fuel Combustion Sector (1.A.). Therefore, it has been reported as “IE”.

2） CH_4

Aluminum refining is conducted in Japan.   There is a small amount of hydrogen in the pitch that acts as a raw material for the anode paste used in aluminum smelting. Theoretically, therefore, it is possible that CH_4 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 can be obtained. As it is not possible to estimate an emission factor, emissions have been reported as “NE”.

3） PFCs

PFCs are emitted during aluminum refining.

b） Methodological Issues

- ***Estimation Method***

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

- ***Emission Factors***

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

Table 4-29   PFCs emission factor of aluminum production

Item	Unit	1995	2000	2005	2007	2008	2009
PFC-14 (CF_4)	kgPFC-14/t	0.542	0.369	0.307	0.300	0.300	0.301
PFC-116 (C_2F_6)	kgPFC-116/t	0.0542	0.0369	0.0307	0.0300	0.0300	0.0301

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

- ***Activity Data***

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

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

For the uncertainty of the emission factor, 33% was applied, according to the *GPG (2000)* default value. For the uncertainty of the activity data, 5%, the value set by the Committee for Greenhouse Gas Estimation Methods was applied. As a result, the uncertainty of the emissions was determined to be 33%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emissions from 1990 to 1994 have not been estimated due to the lack of data. For years after 1995, The Chemical and Bio Sub-Group, Ministry of Economy, Trade and Industry annually collects and estimates F gas emissions.

d） Source-specific QA/QC and Verification

The data collected and estimated by the Chemical and Bio Sub-Group, Ministry of Economy, Trade and Industry is verified by the Committee for Greenhouse Gas Estimation Methods and is used in the inventory.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

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

4.4.4.1. Aluminium Foundry

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

4.4.4.2. Magnesium Foundry

a） Source/Sink Category Description

SF_6 is emitted in magnesium foundries.

b） Methodological Issues

Emissions are an aggregation of all SF_6 used by magnesium foundries. The data that has been reported is given in documentation prepared by the Chemical and Bio Sub-Group of the Ministry of Economy, Trade and Industry’s Industrial Structure Council, for emissions of SF_6 used in magnesium foundries. The associated indices are given in the table below.

Table 4-30 Indices related to SF_6 emitted from magnesium foundries

Item	Unit	1995	2000	2005	2007	2008	2009
Consumption of SF_6	t	5	43	48	46	27	10

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

For the uncertainty of the emission factor, 0% was applied, due to the fact that the amount of emissions is equal to the amount of magnesium used. For the uncertainty of the activity data, 5% was applied, according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainty of the emissions was determined to be 5%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

For both data obtained through associations and through the Greenhouse Gas Accounting and Reporting System[2] etc, the emission data for SF_6 were reviewed.

f） Source-specific Planned Improvements

No improvements are planned.

4.5. Other Production (2.D.)

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

Pulp and Paper production possibly emit nitrogen oxides (NO_X), carbon monoxide (CO), non-CH_4 volatile organic compounds (NMVOC), and sulfur dioxide (SO_2). These emissions are reported in Annex 3.

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

Foods and drinks are manufactured in Japan, and because CO_2 is used in the manufacturing process (frozen CO_2 and raw material for carbonated drinks, etc.), it is conceivable that CO_2 is emitted into the atmosphere in the course of manufacturing. The CO_2 used in the process of manufacturing foods and drinks, however, is a by-product gas of petrochemical products, and as such emissions have already been incorporated into the Fuel Combustion Sector (1.A.), they have been reported as “IE”.

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

This category covers HFCs, PFCs and SF_6 emissions from the manufacturing processes of Halocarbons and SF_6.

This section includes GHG emissions from two sources: By-product Emissions: Production of HCFC-22 (2.E.1) and Fugitive Emissions (2.E.2.).

In 2009, emissions from Production of Halocarbons and SF_6 were 882 Gg-CO_2 eq. and represented 0.07% of GHG of Japan’s total GHG emissions (excluding LULUCF). The emissions had decreased by 96.2% compared to 1995.

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[2] The system was enforced in 2006, based on the Law Concerning the Promotion of the Measures to Cope with Global Warming.

Table 4-31 Emissions from 2.E. Production of Halocarbons and SF_6

Gas	Emission sub-category			Units	1995	2000	2005	2007	2008	2009
HFCs	2.E Production of Halocarbons and SF_6	2.E.1	By-product emissions: Production of HCFC-22	Gg-CO_2 eq.	16,965.00	12,402.00	463.32	217.62	469.17	39.78
		2.E.2	Fugitive emissions	Gg-CO_2 eq.	480.12	257.84	352.69	279.99	232.24	182.36
	Total			Gg-CO_2 eq.	17,445.12	12,659.84	816.01	497.61	701.41	222.14
PFCs	2.E Production of Halocarbons and SF_6	2.E.2	Fugitive emissions	Gg-CO_2 eq.	762.85	1,359.00	837.49	783.02	523.80	399.48
SF_6		2.E.2	Fugitive emissions	t	197.00	36.00	40.80	50.16	53.90	10.90
				Gg-CO_2 eq.	4,708.30	860.40	975.12	1,198.82	1,288.21	260.51
Total of All Gases				Gg-CO_2 eq.	22,916.27	14,879.24	2,628.62	2,479.45	2,513.42	882.13

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

a） Source/Sink Category Description

HFC-23 is generated as a by-product of HCFC-22 production.

b） Methodological Issues

● Estimation Method

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

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

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

- Amount of recovery and destruction (t)

Table 4-32 Indices related to By-product Emissions of HFC-23: Production of HCFC-22

Item	Unit	1995	2000	2005	2007	2008	2009
Production of HCFC-22	t	81,000	95,271	65,715	61,197	60,401	26,682
Rate of generation of HFC-23	%	2.13%	1.70%	1.90%	1.82%	2.00%	2.34%
Emission rate to production	%	1.79%	1.11%	0.06%	0.03%	0.07%	0.01%
Emissions	t	1,450	1,060	40	19	40	3
	Mt-CO_2 eq.	16.97	12.40	0.46	0.22	0.47	0.04

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

*Emissions decreased because all manufacturing facilities were equipped with recovery/destruction units in 2004. The low emission rate to production is due to efforts made in preventing the fall of the operating rates through the improvement in techniques of operation management of destruction facilities and maintenance.

c） Uncertainties and Time-series Consistency

● Uncertainty

For the uncertainty of the emission factor, 2% was applied, according to the *IPCC 2006 Guidelines* default value. For the uncertainty of the activity data, 5% was applied, according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainty of the emissions was determined to be 5%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.6.2. Fugitive Emissions (2.E.2.)

a） Source/Sink Category Description

HFCs, PFCs, SF_6 are emitted as fugitive emissions during their manufacturing.

b） Methodological Issues

- ***Estimation Method***

Emissions were reported based on measurement data at each of HFCs, PFCs, SF_6 manufacturing plant in Japan. Recovery etc is hereby taken into account. Fugitive emissions in production from this source category were reported by subtracting the amount of production from the amount of HFCs, PFCs, SF_6 generated at each gas manufacturing facility. Emissions of HFCs for each year were given by the Japan Fluorocarbon Manufactures Association, and emissions of PFCs and SF_6 were given by the Japan Chemical Industry Association.

The associated indices are given in the table below.

Table 4-33 Indices related to fugitive emissions from HFCs production

Item	Unit	1995	2000	2005	2007	2008	2009
Emissions	Mt-CO_2 eq.	0.480	0.258	0.353	0.280	0.232	0.182

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

Table 4-34 Indices related to fugitive emissions from PFCs production

Item	Unit	1995	2000	2005	2007	2008	2009
Production of PFCs	t	1,207	2,336	2,726	3,216	2,802	2,028
Emissions	t	107	181	107	99	67	50
	Mt-CO_2 eq.	0.763	1.359	0.837	0.783	0.524	0.399

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

Table 4-35 Indices related to fugitive emissions from SF_6 production

Item	Unit	1995	2000	2005	2007	2008	2009
Production of SF_6	t	2,392	1,556	2,313	2,723	2,647	2,562
Emissions	t	197.0	36.0	40.8	50.2	53.9	10.9
	Mt-CO_2 eq.	4.708	0.860	0.975	1.199	1.288	0.261

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

c） *Uncertainties and Time-series Consistency*

- ***Uncertainty***

For the uncertainties of the emission factors, 100% was applied for all HFCs, PFCs and SF_6, according to the *GPG (2000)* default value. For the uncertainties of the activity data, 10% was applied for all HFCs, PFCs and SF_6, according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainties of the emissions for all HFCs, PFCs and SF_6 were determined to be 100%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） *Source-specific QA/QC and Verification*

See section 4.4.3. d）.

e） *Source-specific Recalculations*

The SF_6 emission data were reviewed for 2005.

f） *Source-specific Planned Improvements*

No improvements are planned.

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

This category covers HFCs, PFCs and SF_6 emissions from the manufacturing, utilization and disposal processes of the products of Halocarbons and SF_6 used. This section includes GHG emissions from nine sources: Refrigeration and Air Conditioning Equipment (2.F.1), Foam Blowing (2.F.2.), Fire Extinguishers (2.F.3.), Aerosols (2.F.4.) Solvents (2.F.5.), Other applications using ODS substitutes (2.F.6.), Semiconductors (2.F.7.), Electrical Equipment (2.F.8.) and Other (2.F.9.).

In 2009, emissions from Consumption of Halocarbons and SF_6 were 20,662 Gg-CO_2 eq., and represented 1.7% of GHG of Japan’s total GHG emissions (excluding LULUCF). The emissions had decreased by 27.1% compared to 1995.

Table 4-36 Emissions from 2.F. Consumption of Halocarbons and SF_6

Gas	Emission sub-category			Units	1995	2000	2005	2007	2008	2009
HFCs	2.F Consumption of Halocarbons and SF_6	2.F.1	Refrigeration and Air Conditioning Equipment	Gg-CO_2 eq.	840.40	2,688.60	7,667.03	11,444.52	13,268.94	15,251.25
		2.F.2	Foam Blowing	Gg-CO_2 eq.	451.76	440.31	364.40	316.64	286.38	290.18
		2.F.3	Fire Extinguishers	Gg-CO_2 eq.	NO	3.73	5.92	6.24	6.35	6.55
		2.F.4	Aerosols/Metered Dose Inhalers	Gg-CO_2 eq.	1,365.00	2,834.35	1,571.89	849.75	889.55	809.25
		2.F.7	Semiconductors	Gg-CO_2 eq.	157.89	173.60	141.06	164.49	145.68	92.36
	Total			Gg-CO_2 eq.	2,815.05	6,140.59	9,750.31	12,781.64	14,596.89	16,449.59
PFCs	2.F Consumption of Halocarbons and SF6	2.F.5	Solvents	Gg-CO_2 eq.	10,263.55	2,505.63	2,289.26	1,926.97	1,318.27	1,142.15
		2.F.7	Semiconductors	Gg-CO_2 eq.	3,144.23	5,637.07	3,860.52	3,685.45	2,756.49	1,715.19
		2.F.9	Other-Railway Silicon Rectifiers	Gg-CO_2 eq.	NO	NO	NO	1.86	2.79	3.63
	Total			Gg-CO_2 eq.	13,407.78	8,142.70	6,149.78	5,614.28	4,077.55	2,860.96
SF_6	2.F Consumption of Halocarbons and SF6	2.F.7	Semiconductors	t	47.22	94.16	72.50	50.08	39.85	25.37
		2.F.8	Electrical Equipment	t	460.46	127.62	39.45	38.59	37.74	31.19
	Total			t	507.68	221.77	111.95	88.67	77.60	56.56
	Total			Gg-CO_2 eq.	12,133.65	5,300.39	2,675.51	2,119.29	1,854.54	1,351.76
Total of All Gases				Gg-CO_2 eq.	28,356.48	19,583.69	18,575.60	20,515.20	20,528.97	20,662.32

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

4.7.1.1. Domestic Refrigeration Production, Use and Disposal (2.F.1.-)

a） Source/Sink Category Description

1） HFCs

HFCs are emitted from the production, use (including failure of devices), and disposal of domestic refrigeration.

2） PFCs

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

b） Methodological Issues

- ***Estimation Method***

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

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

Emissions of HFCs from Domestic Refrigeration

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

The associated indices are given in the table below.

Table 4-37 Indices related to emissions of HFCs from domestic refrigeration

Item	Unit	1995	2000	2005	2007	2008	2009
Total HFC charged in the year of production	t	520	590	0.3	0.3	0	0
Fugitive refrigerant ratio at production	%	1.00%	1.00%	0.17%	0%	0%	0%
Number of operated HFC devices	1,000 devices	7,829	33,213	41,796	37,225	34,509	31,471
Refrigerant charged per device at production	g	150	125	125	125	125	125
Operational fugitive ratio (including failure)	%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Number of HFC devices disposed	1,000 devices	0	177	1,839	2,771	3,154	3,445
Volume of HFC collected under law	t/year	－	－	52	91	111	111
Emissions	t	8.7	40.1	187.8	259.5	283.9	283.9
	Mt-CO_2 eq.	0.011	0.052	0.244	0.337	0.369	0.369

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

c） Uncertainties and Time-series Consistency

● *Uncertainty*

For the uncertainties of the emission factors, 50% was applied for all production, use, and disposal, according to the values used in a similar category. For the uncertainties of the activity data, 40% was applied for all production, use, and disposal, according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainties of the emissions for all production, use, and disposal were determined to be 64%. The uncertainty assessment methods are summarized in Annex 7.

● *Time-series Consistency*

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

The HFC-134a emission data were reviewed for 2008.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.1.2. Commercial Refrigeration Production, Use and Disposal (2.F.1.-)

4.7.1.2.a. Commercial Refrigeration

a） Source/Sink Category Description

1） HFCs

HFCs are emitted from the manufacturing, operation, maintenance, accidents, and disposal of commercial refrigeration.

2） PFCs

Emissions from this source in the "production" category were reported as "NO" as Japan had no record of their use in the production of the products. The emission was also reported as "NO" in the "use" and "disposal" categories, because it was unlikely that PFCs were used in imported products, or refrigerants were refilled.

b） Methodological Issues

- ***Estimation Method***

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

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

Emissions of HFCs from Commercial Refrigeration

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

1) manufacturing
Emissions from manufacturing = Σ (number of device produced × volume of refrigerant contained × fugitive refrigerant ratio from manufacturing)
2) installation
Emissions from operation = Σ (number of device charged refrigerant in place produced × volume of refrigerant contained × fugitive refrigerant ratio from installation)
3) operation
Emissions from maintenance = Σ (number of devices operated × volume of refrigerant contained × fugitive refrigerant ratio from operation) - volume collected
4) disposal
Emissions from disposal = Σ (number of devices disposed × average volume of refrigerant contained) - volume collected

* "number of devices operated" and "number of devices disposed" are estimated from the volume of shipment and lifetime of device.

The associated indices are given in the table below.

Table 4-38 Indices related to emissions of HFCs from commercial refrigeration

Item	Unit	1995	2000	2005	2007	2008	2009
Number of HFC devices produced	1,000 devices	222	380	1,413	1,391	1,445	987
Average volume of refrigerant charged at	g/device	358	587	3,377	3,547	3,532	3,276
Fugitive refrigerant ratio at production	%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%
Number of devices charged in production	1,000 devices	9	32	138	190	199	175
Average volume of refrigerant during	g/device	17,806	9,221	23,914	25,170	26,529	25,361
Fugitive refrigerant ratio during installation	%	1.2%	1.4%	1.8%	1.7%	1.7%	1.6%
Number of devices operated	1,000 devices	375	1,957	6,770	8,983	10,027	10,847
Volume of refrigerant during operation	g/device	1,012	1,043	4,549	5,361	5,629	5,791
Fugitive refrigerant ratio during use	%	2-17% (depending on the kind of device)					
Number of devices disposed	1,000 devices	1	23	127	220	248	260
Volume of HFC collected under law during	t	0	0	0	236	436	503
Volume of HFC collected under law at	t	0	0	183	186	200	230
Emissions	t	32.7	189.2	2,006.1	3,630.4	4,233.5	4,863.1
	Mt-CO_2 eq.	0.042	0.283	3.527	6.886	8.258	9.746

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

* From 2002 onward, “volume of refrigerant” and “fugitive refrigerant ratio from operation” increased because devices became larger with the increase of commercial package AC devices.

Table 4-39 Type of HFC and emission factors during use, by type of commercial refrigeration

Type of commercial refrigeration	Type of HFC	Emission factor during use
Small-size refrigerators (built-ins etc)	R-404A, HFC-134a etc	2%
Separately installed showcases	R-404A, R-407C etc	16%
Mid-size refrigerators (excluding Separately installed showcases)	R-404A, R-407C etc	13 - 17%
Large-size refrigerators	HFC-134a, R404A etc	7 - 12%
All-in-one air conditioning systems for buildings	R-410A, R-407C etc	3.5%
Other commercial air conditioning devices (excluding All-in-one air conditioning systems for buildings)	R-410A, R-407C etc	3 - 5%

Source: Documents of the Refrigerant Policy Working Group, Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

See section 4.7.1.1. c）.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

The emission data for halocarbons and SF6 were reviewed.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.1.2.b. Automatic Vending machine Production, Use and Disposal

a） Source/Sink Category Description

1） HFCs

HFCs are emitted from manufacturing, accidents, and disposals of automatic vending machines.

2） PFCs

Emission from this source in the “production” category was reported as “NO” as Japan had no record of their use in production. The emissions were also reported as “NO” in the “use” and “disposal” categories, because it was unlikely that PFCs were used in imported products or refrigerants were refilled..

b） Methodological Issues

● Estimation Method

Emissions of F-gases from 1) manufacturing, 2) accidents and 3) disposals are estimated, based on production and shipment amounts and amounts of refrigerants charged.

Emissions of HFCs from Automatic Vender machine

1) manufacturing
Emissions from manufacturing = Σ (number of device produced × volume of refrigerant contained
× fugitive refrigerant ratio from manufacturing)
2) accident
Emissions from accident = Σ (number of devices operated × volume of refrigerant contained× incidence rate
× average fugitive rate in accident)
3) disposal
(a) until 2001
Emissions from disposal = Σ {number of devices disposed × volume of refrigerant contained
× (1 - collection rate) }
(b) from 2002 onward
Emissions from disposal = Σ (number of devices disposed × average volume of refrigerant contained)
- volume collected

The associated indices are given in the table below.

Table 4-40 Indices related to emissions of HFCs from automatic vender machines

Item	Unit	1995	2000	2005	2007	2008	2009
Number of HFC devices produced	1,000 devices	0	272	355	301	270	173
Refrigerant charged per device	g	0	300	220	219	219	219
Fugitive refrigerant ratio at production	%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%
Number of devices operated	1,000 devices	0	284	1,999	2,393	2,384	2,368
Incidence rate	%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%
Fugitive refrigerant ratio (failure)	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Fugitive refrigerant ratio (fixing)	%	0.9%	0.9%	0.5%	0.5%	0.4%	0.4%
Number of devices disposed	1,000 devices	0	0	0	183	213	293
Emissions	t	0.00	0.39	0.57	0.56	12.44	17.48
	Mt-CO_2 eq.	0.000	0.001	0.001	0.001	0.019	0.027

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

* Accidents of devices charged with HFCs almost never occurred in 1999 and 2000, therefore, were reported as 0. After 2001 onward, the number of accidents are reflected in the estimation.

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

See section 4.7.1.1. c）.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

For both data obtained through associations and through the Greenhouse Gas Accounting and Reporting System etc, the emission data for HFC were reviewed.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.1.3. Transport Refrigeration Production, Use and Disposal (2.F.1.-)

1） HFCs

Emission was reported as “IE” since HFCs in this category had been included in the total reported in 4.7.1.2. Commercial Refrigeration (2.F.1.-).

2） PFCs

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

4.7.1.4. Industrial Refrigeration Production, Use and Disposal (2.F.1.-)

1） HFCs

HFCs emissions have been reported as “IE”, as they are included in 4.7.1.2. Commercial Refrigeration (2.F.1.-).

2） PFCs

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

4.7.1.5. Stationary Air-Conditioning (Household) Production, Use and Disposal (2.F.1.-)

a） Source/Sink Category Description

1） HFCs

HFCs are emitted from the manufacturing, operation, and disposals of household stationary air-conditioning devices.

2） PFCs

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

b） Methodological Issues

● *Estimation Method*

In accordance with the IPCC Guidelines, emissions of each species of F-gases from 1) manufacturing, 2) operation, 3) disposals are estimated, based on production and shipment amounts and amounts of refrigerants charged.

Emissions of HFCs from Stationary Air-Conditioning (Household)

1) manufacturing
Emissions from manufacturing = Σ (number of devices produced × volume of refrigerant contained
× fugitive refrigerant ratio from manufacturing)
2) operation
Emissions from operation = Σ (number of devices for shipment
× volume of refrigerant contained × fugitive refrigerant ratio from operation
3) disposals
Emissions from disposal = Σ (number of devices disposed × average volume of refrigerant contained)
- volume collected

* “number of devices for shipment” and “number of devices disposed” are estimated from volume of shipment and lifetime of device.

The associated indices are given in the table below.

Table 4-41 Indices related to emissions of HFCs (R-410a) from stationary air-conditioning (household)

Item	Unit	1995	2000	2005	2007	2008	2009
Number of HFC devices produced	1,000 devices	0	1,077	3,981	4,172	3,970	2,618
Refrigerant charged per device	g	1,000	1,000	1,000	1,000	1,000	1,000
Fugitive refrigerant ratio at production	%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Number of devices operated	1,000 devices	0	1,726	26,091	40,356	47,584	53,966
Average refrigerant charged during use	g/device	0	1,000	1,000	1,000	1,000	1,000
Fugitive refrigerant ratio during use	%	2%	2%	2%	2%	2%	2%
Number of devices disposed	1,000	0	2	83	227	351	524
Average refrigerant stock in device disposed	g/device	0	954	911	884	870	856
Volume of HFC collected under law	t/year	-	-	10	40	67	67
Emissions	t	0	38	596	981	1,206	1,517
	Mt-CO_2 eq.	0.000	0.066	1.029	1.693	2.080	2.617

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

See section 4.7.1.1. c）.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

For both data obtained through associations and through the Greenhouse Gas Accounting and Reporting System etc, the emission data for HFC were reviewed.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.1.6. Mobile Air-Conditioning (Car Air Conditioners) Production, Use and Disposal (2.F.1.-)

a） Source/Sink Category Description

1） HFCs

HFCs are emitted from manufacturing, operation, breakdowns, accidents, and disposals of mobile air-conditioning devices.

2） PFCs

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

b） Methodological Issues

- ***Estimation Method***

In accordance with the IPCC Guidelines, emissions of each species of F-gases from 1) manufacturing, 2) operation, 3)breakdowns, 4) accidents and 5) disposals are estimated.

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

Methods below are applied for each type of car

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

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

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

4) accidents
Emissions from accident =Σ (number of cars in completely destroyed
× volume of refrigerant contained at time of accident)

5) disposal
(a) until 2001
Emissions from disposal =Σ {number of cars disposed × volume of refrigerant contained
× (1 - collection rate) }

(b) from 2002 onward
Emissions from disposal =Σ (number of cars disposed × average volume of refrigerant contained)
- volume collected

Table 4-42 Indices related to emissions of HFC-134a from car air conditioners

Item	Unit	1995	2000	2005	2007	2008	2009
Number of cars produced	1,000 devices	9,745	9,761	10,407	11,191	11,163	7,653
Refrigerant charged per device at production	g	4	4	3	3	3	1
Number of cars operated with HFC air conditioners	1,000 devices	15,655	42,374	60,364	63,687	64,543	64,407
Average refrigerant charged per device	g	700	615	548	522	520	497
Fugitive refrigerant ratio during use per year per device (normal car)	g	15	15	10	10	10	10
Breakdown incidence	%	4%	4%	4%	4%	4%	4%
Fugitive refrigerant ratio from breakdown cars	%	50%	50%	50%	50%	50%	50%
Number of cars completely destroyed	1,000 devices	50	136	193	204	207	206
Average refrigerant charged in completely destroyed car	g	681	610	522	490	475	460
Number of cars disposed	1,000 devices	116	789	2,058	1,893	2,176	2,498
Average refrigerant charged upon disposal	g	676	593	522	475	466	456
Volume of HFC collected (under law from FY2002 and beyond)	t/year	-	-	531	604	686	787
Emissions	t	605	1,759	2,205	1,944	1,956	1,917
	Mt-CO_2 eq.	0.787	2.287	2.866	2.528	2.543	2.492

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

Table 4-43 Type of HFC in car air conditioners and emission factor during use

Type of HFC	Emission factor during use
HFC-134a	5.2%

Source: Documents of the Refrigerant Policy Working Group, Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

c） Uncertainties and Time-series Consistency

● *Uncertainty*

See section 4.7.1.1. c）.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

The HFC-134a emission data were reviewed for 2007 and 2008.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.2. Foam Blowing (2.F.2.)

4.7.2.1. Hard Foam Production (2.F.2.-)

4.7.2.1.a. Urethane Foam

a） Source/Sink Category Description

HFC-134a is emitted as a result of foam blowing agent use.

b） Methodological Issues

- ***Estimation Method***

In accordance with the IPCC Guidelines (closed-cell foams), emissions were calculated assuming that 10% of the emission from foam blowing agents used each year occurred within the first year after production, with the remainder emitted over 20 years at the rate of 4.5% per year. The data on the amount of foam blowing agents used each year was provided by the Japan Urethane Foam Association, Japan Urethane Raw Materials Association.

It is difficult to separate the “use” emission from that at the time of “disposal” because urethane foams were disposed of at various times. Accordingly, the emissions in the “use” and “disposal” categories were combined and reported under the “use” category, while the emission in the “disposal” category was reported as “IE”.

Urethane-related HFC-134a emissions

HFC-134a emissions
= Amount of HFC-134a used [t] × Leakage during foam blowing [%]
+ Total amount used upto the previous year [t] × Percentage of annual emissions during use [%]
= (Emission during production) + (Emission during use)

Table 4-44 Indices related to emissions of HFC-134a from urethane foam

Item	Unit	1995	2000	2005	2007	2008	2009
HFC-134a Use	t	0	167	224	216	145	109
Leakage during foam blowing	%	10%	10%	10%	10%	10%	10%
Annual emissions rate during use	%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Emissions within the first year after production	t	0	17	35	28	15	11
Emissions during use	t	0	0	44	65	75	82
Emissions	t	0.0	16.7	78.8	92.8	89.5	92.4
Emissions during production	Mt-CO_2 eq.	0.000	0.022	0.046	0.036	0.019	0.014
Emissions during use	Mt-CO_2 eq.	0.000	0.000	0.057	0.085	0.098	0.106
Emissions	Mt-CO_2 eq.	0.000	0.022	0.102	0.121	0.116	0.120

Source: For HFC-134a Use, leakage during foam blowing, and annual emissions rate during use, Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

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

c） *Uncertainties and Time-series Consistency*

- ***Uncertainty***

For the uncertainties of the emission factors, 50% was applied for both production and use, according to the values used in a similar category. For the uncertainties of the activity data, 50% was applied for both production and use, according to *GPG (2000)*'s default value. As a result, the uncertainties of the emissions for both production and use were determined to be 71%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） *Source-specific QA/QC and Verification*

See section 4.4.3. d）.

e） *Source-specific Recalculations*

There have been no source-specific recalculations.

f） *Source-specific Planned Improvements*

No improvements are planned.

4.7.2.1.b. High Expanded Polyethylene Foam (2.F.2.-)

a） *Source/Sink Category Description*

HFC-134a is emitted as a result of foam blowing agent use.

b） *Methodological Issues*

- ***Estimation Method***

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

Table 4-45 Indices related to emissions of HFC-134a from high expanded polyethylene foam

Item	Unit	1995	2000	2005	2007	2008	2009
HFC-134a Use	t	346	322	128	120	100	100
Emissions	t	346	322	128	120	100	100
	Mt-CO_2 eq.	0.450	0.419	0.166	0.156	0.130	0.130

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

Table 4-46 Indices related to emissions of HFC-152a from high expanded polyethylene foam

Item	Unit	1995	2000	2005	2007	2008	2009
HFC-152a Use	t	14	NO	NO	NO	NO	NO
Emissions	t	14	NO	NO	NO	NO	NO
	Mt-CO_2 eq.	0.002	0	0	0	0	0

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

c） Uncertainties and Time-series Consistency

● Uncertainty

See section 4.7.2.1.a. c).

● Time-series Consistency

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.2.1.c. Extruded Polystyrene Foam Production (2.F.2.-)

a） Source/Sink Category Description

HFC-134a is emitted as a result of foam blowing agent use.

b） Methodological Issues

● Estimation Method

Emissions were calculated assuming that 25% of the emission of foam blowing agents occurs within the first year after production, with the remainder emitted over 30 years at the rate of 2.5% per year. The amount of the emissions from foam blowing agents used each year was provided by the Extruded Polystyrene Foam Industry Association. This assumption is consistent with the IPCC Good Practice Guidance and the estimation method under PRTR for the amount of transferred HCFC at polystyrene foam production sites.

It is difficult to separate the “use” emission from that at the time of “disposal” because heat insulation material is disposed of at various times such as the renovation and dismantling of buildings, and in times of disaster. Since disposed polystyrene foam is considered to be emitting HFCs as same as that in use, these emissions are combined and reported under “use”, while the emissions from “disposal” were reported as “IE”.

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

Table 4-47 Indices related to emissions of HFC-134a from extruded polystyrene foam

Item	Unit	1995	2000	2005	2007	2008	2009
HFC-134a Use	t	0	0	26	0	0	0
Foam productization rate	%	75%	75%	75%	75%	75%	75%
Annual emission rate during use	%	-	-	2.5%	2.5%	2.5%	2.5%
Emissions during production	t	0	0	7	0	0	0
Emissions during use	t	0	0	67	31	31	31
Emissions	t	0	0	74	31	31	31
Emissions during production	Mt-CO_2 eq.	0.00	0.00	0.01	0.00	0.00	0.00
Emission during use	Mt-CO_2 eq.	0.00	0.00	0.09	0.04	0.04	0.04
Emissions	Mt-CO_2 eq.	0.00	0.00	0.10	0.04	0.04	0.04

Source: For HFC-134a Use, foam productization rate, and annual emissions rate during use, Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry
The amount of HFC-134a used in 1995-2000 was zero.

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

See section 4.7.2.1.a. c).

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.2.2. Soft Foam (2.F.2.-)

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

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

a）Source/Sink Category Description

HFCs are emitted by the use of halogen fire extinguishers.

b）Methodological Issues

● *Estimation Method*

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

HFCs emission from this category was reported as “NO” by expert judgment since HFC-227ea was a very small amount, 0.0007(t) (= 700g) when emission from production in FY2004 was estimated. For use, at the time around 1995, almost no HFC filled fire extinguishers existed on the market, therefore it is assumed that there was not any use, resulting in NO for 1995 emissions.

For 1996 and following years, calculations were performed using the following equation and based on the HFC extinguishing agent installations and stocks.

HFC emissions from use of fire extinguishers

HFC emissions [t] ＝ HFC extinguishing agent installations and stocks [t] ×
Emission factor during use

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

● *Emission Factors*

There are still no findings on the emission factor of HFC extinguishing agents when using them. The emission rate (0.00088) determined from refills of halons (provided by the Fire Defense Agency), which are similar extinguishing agents, was adopted as the emission factor for this category.

Table 4-48 References for the Emission factor of fire extinguishers

(The emission ratio of halon fire extinguishers)

	Unit	2002	2003	2004	2005	2006	2007	Average
Installations of halon 1301 (A)	t	17,094	17,090	17,060	16,994	17,075	16,889	17,034
Refills of halon 1301 (B)	t	13	13	22	13	14	15	15
(B) / (A)		0.00076	0.00076	0.00129	0.00076	0.00082	0.00089	0.00088

● *Activity Data*

HFC stock amounts provided by the Fire Defense Agency were used as activity data for HFC emissions from fire extinguishing agents use.

Table 4-49 The amounts of the HFC extinguishing agent installations and stocks

Item	Unit	1995	2000	2005	2007	2008	2009
Installations and stocks of HFC-23	t	NO	306	478	496	501	512
HFC-23 emissions	t	NO	0.27	0.42	0.44	0.44	0.45
	Gg-CO_2 eq.	NO	3.15	4.92	5.11	5.16	5.27
Installations and stocks of HFC-227ea	t	NO	225	392	442	467	498
HFC-227ea emissions	t	NO	0.20	0.34	0.39	0.41	0.44
	Gg-CO_2 eq.	NO	0.57	1.00	1.13	1.19	1.27
Total emissions	Gg-CO_2 eq.	NO	3.73	5.92	6.24	6.35	6.55

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

For the uncertainties of the emission factor for fire extinguisher use, 50% was applied, according to the values used in a similar category. For the uncertainties of the activity data, 40% was applied according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainties of the emissions during use for the category were determined to be 64%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Calculations are performed with a method consistently used from FY1995, based on an emission factor and activity data received from the Fire Defense Agency.

d） Source-specific QA/QC and Verification

The data received from the Fire Defense Agency is compiled by the Chemical and Bio Sub-Group, Ministry of Economy, Trade and Industry. It is verified by the Committee for Greenhouse Gas Estimation Methods and is used in the inventory.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.4. Aerosols (2.F.4.)

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

a） Source/Sink Category Description

HFCs are emitted from the manufacturing and use of aerosols.

b） Methodological Issues

- ***Estimation Method***

In accordance with the IPCC Guidelines, emissions were calculated on the assumption that 50% of the emission from the amount of aerosol filled in the products (potential emissions) occurred in the year of production, with the remaining 50% emitted in the following year. Fugitive emissions from manufacturing is considered as the balance between the amount used for production and the actual measurement amount filled in the products, and it is included in the emissions. The data on the amount used for production and the amount filled in the products were provided by the Aerosol

Industry Association of Japan. HFC is considered to be actually remaining in disposed aerosols at some level. However, the amount of emission at the time of “disposal” was reported as “IE” since it is included in the calculation for the “use” category.

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

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

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

The associated indices are given in the table below.

Table 4-50 Indices related to emissions of HFC-134a from aerosols

Item	Unit	1994	1995	2000	2005	2007	2008	2009
Potential Emissions	t	800	1,300	2,044	604	307	343	230
Fugitive emissions during production*	t	-	-	80.2	24.9	13.2	12.8	10.0
Emissions in the year produced, during use	t	400	650	1,022	302	154	172	115
Remaining (emissions in the next year)	t	400	650	1,022	302	154	172	115
Emissions	t	-	1,050	2,137	908	347	338	297
	Mt-CO_2 eq.	-	1.365	2.778	1.181	0.452	0.439	0.386

* under investigation

Source: Potential Emissions: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

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

Table 4-51 Indices related to emissions of HFC-152a from aerosols

Item	Unit	1995	2000	2005	2007	2008	2009
Potential Emissions	t	NO	34	1,300	1,193	1,416	764
Fugitive emissions during production*	t	NO	1.1	28.9	123.8	380.5	494.0
Emissions in the year produced, during use	t	NO	17	650	596	708	382
Remaining (emissions in the next year)	t	0	17	650	596	708	382
Emissions	t	0	18	1,217	1,439	1,685	1,584
	Mt-CO_2 eq.	0.000	0.003	0.170	0.201	0.236	0.222

* under investigation

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

c） Uncertainties and Time-series Consistency

● Uncertainty

For the uncertainties of the emission factors, 0% was applied for all production, use and disposal, due to the fact that the amount of emissions is equal to the amount of aerosols used. For the uncertainties of the activity data, 40% was applied for all production, use, and disposal, according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainties of the emissions for all production, use and disposal were determined to be 40%. The uncertainty assessment methods are summarized in Annex 7.

● Time-series Consistency

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

The HFC-152a emission data were reviewed for 2008.

f） Source-specific Planned Improvements

No improvements are planned.

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

a） Source/Sink Category Description

HFCs are emitted from the use and disposal of metered dose inhaler (MDI) s.

b） Methodological Issues

● Estimation Method

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

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

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

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

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

The associated indices are given in the table below.

Table 4-52   Indices related to emissions of HFC-134a from MDI

Item	Unit	1995	2000	2005	2007	2008	2009
Purchases of F-gas	t	0.0	1.4	1.1	0.7	1.1	0.9
Usage of domestic MDI	t	0.0	1.4	0.9	0.6	0.9	0.9
Usage of imported MDI	t	0	42	71	60	62	57
Amount collected and destroyed	t	0.0	0.1	1.9	1.3	0.5	0.4
Emissions	t	NO	37	63	64	61	60
	Mt-CO_2 eq.	0.000	0.048	0.082	0.083	0.080	0.078

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

Table 4-53 Indices related to emissions of HFC-227ea from MDI

Item	Unit	1995	2000	2005	2007	2008	2009
Purchases of F-gas	t	0.0	0.0	42.8	38.0	48.0	29.3
Usage of domestic MDI	t	0.0	0.0	41.0	36.2	45.9	27.8
Usage of imported MDI	t	0.0	3.6	2.1	0.7	9.0	1.6
Amount collected and destroyed	t	0.0	0.0	1.2	1.3	1.6	0.9
Emissions	t	NO	1.8	48.1	39.3	46.4	42.8
	Mt-CO_2 eq.	0.000	0.005	0.139	0.114	0.135	0.124

For the Usage of domestic MDI, Usage of imported MDI, and Amount collected and destroyed:
Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

For the uncertainties of the emission factors, 0% was applied for all production, use and disposal, due to the fact that the amount of emissions is equal to the amount of MDI used. For the uncertainties of the activity data, 40% was applied for all production, use and disposal, according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainties of the emissions for all production, use and disposal were determined to be 40%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.5. Solvents (2.F.5.)

a） Source/Sink Category Description

HFCs and PFCs are emitted from the use of solvents. The liquids PFCs used were C_5F_{12} (PFC-41-12) and C_6F_{14} (PFC-51-14). HFCs used as solvents correspond to confidential data; therefore, these data are reported as included numbers in the total of PFCs.

b） Methodological Issues

- ***Estimation Method***

Assuming that almost all of the total amount of liquid PFC shipment was used in cleaners and for cleaning purposes each year, the entire amount was reported in the "use" category as the amount of emissions. Emission during production was reported as "IE" as it was believed to be included in "Fugitive Emissions (2.E.2)". Emission at the time of disposal was reported as "IE" on the assumption, from the point of view of conservativeness, that the entire amount including that was disposed of, was emitted during use, because of the difficulty in determining the status of the disposal of PFCs. It is confirmed that no disposals were identified in 1995. The associated indices are given in the table below. Emissions from PFCs contained in railway rectifiers are subtracted from liquid PFC emissions to yield the total PFC emissions.

Table 4-54　Indices related to emissions of PFCs etc. from solvents use

Item	Unit	1995	2000	2005	2007	2008	2009
Liquid PFC emissions	Gg-CO_2 eq.	10356.1	2624.0	2289.3	1927.0	1318.3	1142.1
Liquid PFC contained in Railway rectifiers	Gg-CO_2 eq.	92.5	118.4	0.0	0.0	0.0	0.0
PFC emissions from solvents	Gg-CO_2 eq.	10263.6	2505.6	2289.3	1927.0	1318.3	1142.1

Source for liquid PFC: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy Trade and Industry

c）Uncertainties and Time-series Consistency

● ***Uncertainty***

For the uncertainties of the emission factors, 0% was applied for solvent use, due to the fact that the amount of emissions is equal to the amount of solvent used.　For the uncertainties of the activity data, 40% was applied for solvent using according to the value set by the Committee for Greenhouse Gas Estimation Methods.　As a result, the uncertainties of the emissions were determined to be 40%. The uncertainty assessment methods are summarized in Annex 7.

.

● ***Time-series Consistency***

Emissions are estimated in a manner consistent over the time-series methodologically and from the point of view of data source.

d）Source-specific QA/QC and Verification

See section 4.4.3. d）.

e）Source-specific Recalculations

There have been no source-specific recalculations.

f）Source-specific Planned Improvements

No improvements are planned.

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

Refrigerants filled in research and medical equipment are captured and included in other refrigerant categories, therefore the emissions from this category is reported as "IE", based on expert judgment.

4.7.7. Semiconductors Manufacture (2.F.7.)

4.7.7.1. Semiconductors (2.F.7.-)

a）Source/Sink Category Description

HFCs, PFCs and SF_6, are emitted from the manufacturing of semiconductors.

b） Methodological Issues

● Estimation Method

Methods of emissions from semiconductors are in line with the IPCC *GPG (2000)*. These emissions are estimated with purchase of F-gases, process supply rate, use rate of F-gas, removal rate, by-product generation ratio and removal ratio for by-products.

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

Japan Electronics and Information Technology Industries Association data are used for F-gases purchased.

Emissions from manufacturing (during F-gas charging to containment shell for shipment) are already reported in “2.E.2. Production of Halocarbons and SF_6”, therefore, are reported as “IE” for this category. Theoretically, emissions from disposal can not be generated, therefore are reported as “NA”.

F-gas emissions in Semiconductor Manufacturing

Methods below are applied for each F-gas:

(i) HFC-23, PFCs (PFC-14, PFC-116, PFC-218, PFC-c318), SF_6 emissions

Emissions
= Total CO_2 equivalent emissions from all production lines
- Total CO_2 equivalent amount destroyed in all production lines

Total CO_2 equivalent emissions from all production lines
$= \Sigma$ each production line Σ {amount purchased per F-gas × process supply rate × (1 - use rate of F-gas) × GWP}

Total CO_2 equivalent amount destroyed in all production lines
$= \Sigma$ each production line Σ {amount purchased per F-gas × process supply rate × (1 - use rate of F-gas) × fraction of F-gas destroyed × GWP}

(For production lines without destruction facilities: fraction of F-gas destroyed = 0)

(ii) By-produced PFC-14 emissions

Emissions
= Total CO_2 equivalent emissions from all production lines
- Total CO_2 equivalent amount destroyed in all production lines

Total CO_2 equivalent emissions from all production lines
$= \Sigma$ each production line Σ (purchases of PFCs × process supply rate × by production rate × GWP)

Total CO_2 equivalent amount destroyed in all production lines
$= \Sigma$ each production line Σ (purchases of PFCs × process supply rate × by production rate × fraction of F-gas destroyed × GWP)

(For production lines without destruction facilities: fraction of F-gas destroyed = 0)

Relevant indices are shown in Table below.

Table 4-55 Indices related to emissions of F-gases from manufacturing of semiconductors

Item	Unit	1995	2000	2005	2007	2008	2009
PFC-14 purchased	t	313.0	299.9	231.5	277.5	276.9	208.9
PFC-116 purchased	t	209.5	561.2	393.2	321.0	284.9	171.5
PFC-218 purchased	t	0.0	9.9	181.8	195.1	181.0	129.5
PFC-c318 purchased	t	0.6	38.6	24.8	33.4	40.2	33.3
HFC-23 purchased	t	47.8	49.4	42.1	62.1	73.7	53.8
SF_6 purchased	t	90.8	131.9	96.8	82.9	79.1	60.2
Process supply rate	%	90%	90%	90%	90%	90%	90%
Use rate of PFC etc	%	20%-70% (depending on the kind of F-gas)					
Fraction of F-gas destroyed	%	90%	90%	90%	90%	90%	90%
CF_4 by-production rate	%	C_2F_6 (PFC-116): 10%, C_3F_8 (PFC-218): 20%					
By-production CF_4 removal rate	%	90%	90%	90%	90%	90%	90%
HFCs emissions	Mt-CO_2 eq.	0.158	0.172	0.138	0.161	0.142	0.090
PFCs emissions	Mt-CO_2 eq.	3.046	5.409	3.712	3.567	2.665	1.672
SF_6 emissions	Mt-CO_2 eq.	1.005	1.484	1.111	0.878	0.694	0.433

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

Table 4-56 Use rate of HFCs, PFCs, and SF6 during semiconductor manufacturing

Item	Unit	1995 - 2007
Use rate of PFC-14	%	20
Use rate of PFC-116	%	30
Use rate of PFC-218	%	60
Use rate of PFC-c318	%	70
Use rate of HFC-23	%	70
Use rate of SF_6	%	50

*: use rate of PFC etc is a default value from the IPCC guidelines.

c） Uncertainties and Time-series Consistency

● Uncertainty

For the uncertainties of the emission factors, 50% was applied for all HFCs, PFCs and SF_6, according to the values used in a similar category. For the uncertainties of the activity data, 40% was applied for all HFCs, PFCs and SF_6, according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainties of the emissions for all HFCs, PFCs and SF_6 were determined to be 64%. The uncertainty assessment methods are summarized in Annex 7.

● Time-series Consistency

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.7.2. Liquid Crystals (2.F.7.-)

a） Source/Sink Category Description

HFCs, PFCs and SF_6, are emitted from the manufacturing of liquid crystals.

b） Methodological Issues

- ***Estimation Method***

Same methods applied to semiconductors are also applied to emissions from manufacturing of liquid crystals. World LCD Industry Cooperation Committee has established a voluntary action plan to reduce PFCs emissions and has engaged in reducing PFC emissions. In these activities, it should be applied IPCC methods.

Table 4-57 Indices related to emissions of F-gases from manufacturing of liquid crystals

Item	Unit	1995	2000	2005	2007	2008	2009
PFC-14 purchased	t	20.7	47.3	77.8	80.4	69.3	51.9
PFC-116 purchased	t	0.4	2.7	9.9	5.2	4.1	2.3
PFC-c318 purchased	t	0.0	0.0	0.8	2.0	1.9	1.7
HFC-23 purchased	t	0.1	0.7	1.6	1.7	1.5	1.1
SF_6 purchased	t	11.5	85.3	101.4	117.4	146.8	127.1
Use rate of PFC	%	90%	90%	90%	90%	90%	90%
Fraction of F-gas destroyed	%	20-70% (depending on the kind of F-gas)					
CF_4 by-production rate	%	90%	90%	90%	90%	90%	90%
By-production CF_4 removal rate	%	C_2F_6 (PFC-116): 10%					
Desellection Efficiency of CF_4	%	90%	90%	90%	90%	90%	90%
HFCs emissions	Mt-CO_2 eq.	0.000	0.002	0.003	0.003	0.003	0.003
PFCs emissions	Mt-CO_2 eq.	0.099	0.228	0.149	0.119	0.092	0.043
SF_6 emissions	Mt-CO_2 eq.	0.124	0.766	0.622	0.319	0.259	0.174

Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

*: use rate of PFC etc is a default value from the IPCC guidelines.

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

See section 4.7.7.1. c).

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

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

a）Source/Sink Category Description

SF_6 are emitted during the manufacturing and use of electrical equipment.

b）Methodological Issues

- ***Estimation Method***

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

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

SF_6 emissions from the production of electrical equipment

SF_6 Emissions from the production ＝ SF_6 purchased（t）×assembly fugitive rate（%）

SF_6 emission from the use of electrical equipment

SF_6 emission from the use

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

SF_6 emission from the inspection of electrical equipment

SF_6 emission from the inspection ＝ actual measurements of SF_6

SF_6 emission from the disposal of electrical equipment

SF_6 emission from the disposal ＝ actual measurements of SF_6

The associated indices are given in the table below.

Table 4-58　Indices related to emissions of SF_6 from electrical equipment assembly

Item	Unit	1995	2000	2005	2007	2008	2009
SF_6 purchased	t	1,380	649	629	619	784	459
SF_6 charged to electrical equipment	t	1,464	450	582	555	726	410
Stocks (other than in electrical equipment)	t	-	105	29	47	40	38
Assembly fugitive rate	%	29%	15%	3%	3%	2%	2%
Emissions	t	400	100	23	20	19	11
	Mt-CO_2 eq.	9.560	2.402	0.548	0.482	0.444	0.263

For SF_6 purchased, SF_6 charged to electrical equipment, Stocks in other than electrical equipment, Assembly fugitive rate:
Source: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

Table 4-59 Indices related to emissions of SF_6 during the use of electrical equipment

Item	Unit	1995	2000	2005	2007	2008	2009
Stocks of SF_6	t	6,300	8,000	8,700	8,900	9,000	9,000
Operational fugitive rate	%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
SF_6 emissions during use *	t	6.3	8.0	8.7	8.9	9.0	9.0
SF_6 emissions during maintenance and disposal *	t	54.00	14.00	2.50	4.00	5.10	3.40
SF_6 emissions during use, maintenance, and disposal	t	60.46	27.13	16.51	18.44	19.17	20.19
	Gg-CO_2 eq.	1444.99	648.36	394.48	440.80	458.19	482.56

* excluding data from the Greenhouse Gas Accounting and Reporting System

Source: For Stocks of SF_6, Operational fugitive rate, SF_6 emissions during use, maintenance, and disposal: Documents of Group for Prevention of Global Warming, Chemical and Bio Sub-Group, Industrial Structure Council, Ministry of Economy, Trade and Industry

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

For the uncertainties of the emission factors, 30% was applied for production, and 50% was applied for use and disposal, according to the *GPG (2000)'*s default value. For the uncertainties of the activity data, 40% was applied for all production, use and disposal, according to the value set by the Committee for Greenhouse Gas Estimation Methods. As a result, the uncertainty of the emissions for production was determined to be 50%, and 64% for use and disposal. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

See section 4.4.3. c）.

d） Source-specific QA/QC and Verification

See section 4.4.3. d）.

e） Source-specific Recalculations

For data obtained through the Greenhouse Gas Accounting and Reporting System, the emission data for SF_6 were reviewed.

f） Source-specific Planned Improvements

No improvements are planned.

4.7.9. Other - Railway Silicon Rectifiers (2.F.9.)

a） Source/Sink Category Description

PFCs are emitted at disposal of railway silicon rectifiers.

b） Methodological Issues

- ***Estimation Method***

Based on the number of devices containing PFC-51-14, the amount of PFC-51-14 contained, and lifetime of the devices, given in the Survey on Management Methods of Halons/Liquid PFCs etc, the amount of PFC-51-14 disposed after use in railway silicon rectifiers in each fiscal year was estimated. This was done by multiplying the number of railway silicon rectifiers disposed per year, by the amount of PFC contained in each device. PFC emissions are calculated by subtracting the amount of PFC-51-14 destroyed in a specific fiscal year from the PFC disposed after use in railway silicon rectifiers in the same fiscal year.

PFC emissions at disposal of railway silicon rectifiers
= PFC disposed after use in railway silicon rectifiers - PFC destroyed

Table 4-60 Amounts of PFC Disposed from Railway Silicon Rectifiers

Item	Unit	1995	2000	2005	2007	2008	2009
Amount of PFC disposed	Gg-CO_2 eq.	NO	NO	NO	1.86	2.79	3.63

c） Uncertainties and Time-series Consistency

- **Uncertainty**

For the uncertainty of the emission factor from railway silicon rectifiers, the 0% value for solvents was applied since it is a similar source category. For the uncertainties of the activity data, 40% was applied. As a result, the uncertainties of the emissions were determined to be 40%. The uncertainty assessment methods are summarized in Annex 7.

- **Time-series Consistency**

Emissions are estimated in a manner consistent over the time-series methodologically and from the point of view of data source.

d） Source-specific QA/QC and Verification

See section 4.2.1. d）.

e） Source-specific Recalculations

There have been no source-specific recalculations.

f） Source-specific Planned Improvements

No improvements are planned.

References

1. IPCC, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, 1997
2. IPCC, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000
3. IUPAC website “Atomic Weights of the Elements 1999” （http://www.chem.qmul.ac.uk/iupac/AtWt/AtWt99.html）
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5. Ministry of Economy, Trade and Industry, Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke
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Chapter 5. Solvent and Other Product Use (CRF sector 3)

5.1. Overview of Sector

CO_2, N_2O, and NMVOC are emitted from solvent and other product use. In this chapter, CO_2 and N_2O emissions due to the following product uses are discussed (see Annex 3 for NMVOC):

- Paint application
- Degreasing and dry-cleaning
- Chemical products, manufacture and processing
- Other (e.g. anesthesia)

In 2009, total GHG emissions from the solvent and other product use sector amounted to 121 Gg-CO_2 eq., accounting for 0.01% of total national emissions (excluding LULUCF) from Japan. "3.D.1. Use of Nitrous Oxide for Anesthesia" is the only greenhouse gas emission source in this sector.

5.2. Paint Application (3.A.)

Paint solvents are used in Japan, but their application is basically restricted to mixing, therefore are assumed not to entail chemical reactions. Therefore, they do not generate CO_2 or N_2O. They have been reported as "NA."

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

1） CO_2

Degreasing and dry-cleaning are practiced in Japan.

Degreasing is defined as, "washing processes that do not involve chemical reactions", and it is assumed that it does not generate CO_2. Although the CO_2 emissions may occur in association with washing methods involving dry ice or carbonic gas, such methods are not thought to be used in Japan.

There are no processes in dry-cleaning in which chemical reactions may occur, and it is basically assumed that it does not generate CO_2. However washing methods using liquefied carbonic gas are being used experimentally in research facilities and it is not possible to completely negate the possibility of CO_2 emissions.

As a result, these activities have been reported as "NE" due to the fact that there are no sufficient data available on the actual condition of emissions from degreasing and dry-cleaning and the absence of a default emission factor prevents any calculations from being performed.

2） N_2O

Degreasing and dry-cleaning are practiced in Japan, but degreasing is defined as, 'washing processes that do not involve chemical reactions', and there are no processes in dry-cleaning in which chemical reactions may occur. Therefore, it is assumed that N_2O is not generated. In Japan, there are also no methods which have the potential to emit N_2O used for degreasing or dry-cleaning, and they have therefore been reported as "NA".

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

NMVOC emissions occur from production and use of chemical products. NMVOC is reported in Annex 3.

5.5. Other (3.D.)

5.5.1. Use of Nitrous Oxide for Anesthesia (3.D.1)

a） Source/Sink Category Description

Nitrous oxide is emitted during anesthetics (laughing gas) use. Since 2006, some hospitals have installed N_2O destruction units, and the reductions achieved are reflected in the total emissions. Only N_2O is used as an anesthetic in Japan, and CO_2 is not. Therefore, CO_2 emissions have been reported as “NA”.

In 2009, total GHG emissions from this category amounted to 121 Gg-CO_2 eq., accounting for 0.01% of total national emissions (excluding LULUCF) from Japan.

Table 5-1 N_2O emissions during anesthetics (laughing gas) use

Gas	Category			Units	1990	1995	2000	2005	2007	2008	2009
N_2O	3.D Other	3.D.1	Use of N_2O for Anesthesia	Gg-N_2O	0.93	1.41	1.10	0.86	0.52	0.42	0.39
				Gg-CO_2 eq.	287.07	437.58	340.99	266.41	159.95	129.10	120.50

b） Methodological Issues

● *Estimation Method*

In relation to emissions of N_2O from use of anesthetics, the actual amount of N_2O shipped as an anesthetic by pharmaceutical manufacturers or importers has been reported for 2005 and preceding years. For 2006 and beyond, the amount of N_2O collected is calculated using the amount of Laughing Gas used in three domestic hospitals equipped with N_2O destruction units for anesthesia, and a destruction rate of 99.9 %. This is subtracted from the N_2O shipped for medical use to yield the amount of N_2O emitted.

Amount of N_2O emitted during the use of laughing gas
= N_2O shipped for medical use
－Amount of laughing gas used in 3 hospitals equipped with N_2O destruction units
× destruction rate

● *Emission Factors*

It is assumed that all of the N_2O used as medical gas escapes into the atmosphere, unless collected. Therefore, no emission factor has been established.

● *Activity Data*

The volume of shipments of N_2O for anesthetics (on calendar year basis) is given in the Ministry of Health, Labour and Welfare’s Statistics of Production by Pharmaceutical Industry. This is used for 2005 and preceding years, and for 2006 and beyond, the amount of N_2O collected in three domestic hospitals equipped with N_2O destruction units is subtracted from the above-mentioned shipment.

Table 5-2 Laughing gas shipment amount and N_2O collected in three domestic hospitals (calendar year basis)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Laughing gas shipment amount	kg-N_2O	926,030	1,411,534	1,099,979	859,389	519,011	417,919	389,749
N_2O collected in three domestic hospitals	kg-N_2O	-	-	-	-	3,042	1,454	1,049

c） Uncertainties and Time-series Consistency

- ***Uncertainty***

Because all N_2O used for anesthetics are assumed to escape into the atmosphere, no emission factor has been set. Therefore, the uncertainty for activity data is also the uncertainty for emissions. As Statistics of Production by Pharmaceutical Industry is a fundamental statistic based on statistical law, a 5% uncertainty was given for this emission source.

- ***Time-series Consistency***

The volumes of shipments are taken from the Statistics of Production by Pharmaceutical Industry in a consistent manner throughout the time series.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the GPG (2000). Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.

e） Source-specific Recalculations

Recalculations were conducted for 2008, since the final value of the laughing gas shipment amount was provided.

f） Source-specific Planned Improvements

No improvements are planned.

5.5.2. N_2O from Fire Extinguishers (3.D.2)

1） CO_2

Many types of fire extinguishers in Japan are filled with CO_2, which is emitted into the atmosphere when a fire extinguisher is used. All of the CO_2 with which the fire extinguishers are filled, however, is the by-product gas generated from petrochemicals or petroleum refining. Such emissions are included in the calculation of Chapter 1, section 1.A.1.b. Petroleum Refining, and therefore, have been reported as “IE”.

2） N_2O

N_2O is not used in the fire extinguishers in Japan. Therefore the N_2O emissions from this category are reported as “NO”.

5.5.3. N_2O from Aerosol Cans (3.D.-)

1） CO_2

Aerosol products, which fill spray cans with CO_2, are manufactured in Japan. It is assumed that CO_2 could be emitted into the atmosphere when the aerosol products are used. However, because the CO_2 used in the aerosol industry is a by-product gas of petrochemical products, these emissions are counted in the Combustion of Fuel sector (1.A.), and have been reported as “IE” here.

2） N_2O

Aerosol products manufactured in Japan do not use N_2O.Theoretically, no N_2O is emitted, and it has been reported as “NA” here.

References

1. Ministry of the Environment Committee for the Greenhouse Gases Emissions Estimation Methods, *Review of Greenhouse Gases Emissions Estimation Methods Part 2*, August 2002.
2. Ministry of Health, Labour and Welfare’s *Statistics of Production by Pharmaceutical Industry*.

Chapter 6. Agriculture (CRF sector 4)

6.1. Overview of Sector

Greenhouse gas emissions from the agricultural sector are calculated in five categories: 4A, 4B, 4C, 4D, and 4F. In 4A: Enteric Fermentation, CH_4 gas generated and emitted by cattle, buffalo, sheep, goats, horses, and swine as the result of enteric fermentation is reported. In 4B: Manure Management, CH_4 and N_2O generated by treatment of manure excreted by cattle, buffalo, sheep, goats, horses, swine and poultry are reported. In 4C: Rice Cultivation, CH_4 emissions from paddy fields (continuously flooded and intermittently flooded) cultivated for rice production are reported. In 4D: Agricultural Soils, CH_4 and N_2O emitted directly and indirectly from agricultural soil as well as pastures, ranges, and paddocks manure are reported. Emissions for 4E Prescribed Burning of Savannas are reported as NO, since Japan has no emission source in this category, while CH_4 and N_2O (as well as CO, which is described in Annex 3) emissions from field burning of grains, legumes, root crops, and sugar cane during agricultural activities are reported in 4F: Field Burning of Agricultural Residues.

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

GHG emissions in the Agricultural Sector in FY 2009 were 25,402 Gg-CO_2 eq., comprising 2.1% of total emissions (excluding LULUCF). The value represents a reduction by 18.8% from FY 1990.

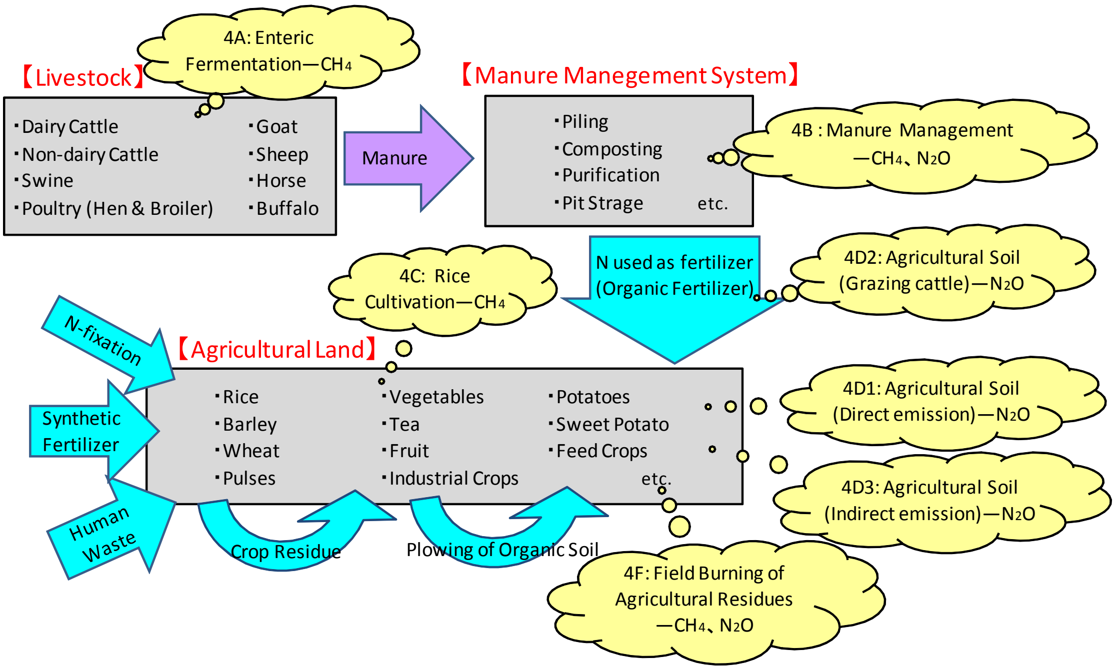


Figure 6-1 Relationships among the categories in the agricultural sector

6.2. Enteric Fermentation (4.A.)

Ruminants such as cattle, buffalo, sheep, and goats have multi-chamber stomachs. The rumen carries out anaerobic fermentation to break down cellulose and other substances, thereby releasing CH_4.

Horses and swine are not ruminants and have monogastric stomachs, but fermentation in their digestive tracts produces small amounts of CH_4, which is released into the atmosphere
These CH_4 emissions are calculated and reported in the *Enteric Fermentation (4.A.)* section.

GHG emissions from Enteric Fermentation in FY 2009 were 6,849 Gg-CO_2 eq., comprising 0.6% of total emissions (excluding LULUCF). The Value represents a reduction by 10.8% from FY 1990.

Table 6-1 CH_4 emissions from enteric fermentation

Gas	Livestock species	Unit	1990	1995	2000	2005	2007	2008	2009
CH_4	4.A.1.- Dairy Cattle	Gg-CH_4	192.6	184.4	172.8	162.9	157.8	154.7	152.8
	4.A.1.- Non-Dairy Cattle	Gg-CH_4	158.2	164.6	165.5	158.2	162.0	162.1	160.9
	4.A.2. Buffalo	Gg-CH_4	0.012	0.007	0.005	0.004	0.004	0.004	0.004
	4.A.3. Sheep	Gg-CH_4	0.09	0.06	0.05	0.04	0.04	0.05	0.05
	4.A.4. Goats	Gg-CH_4	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	4.A.6. Horses	Gg-CH_4	2.1	2.1	1.9	1.6	1.5	1.5	1.5
	4.A.8. Swine	Gg-CH_4	12.5	11.0	10.7	10.6	10.7	10.8	10.8
	Total	Gg-CH_4	365.6	362.2	351.0	333.4	332.1	329.2	326.2
		Gg-CO_2eq	7,677	7,606	7,370	7,002	6,974	6,914	6,849

6.2.1. Cattle (4.A.1.)

a） *Source/Sink Category Description*

This section provides the estimation methods for CH_4 emissions from enteric fermentation in Cattle.

b） *Methodological Issues*

●***Estimation Method***

In accordance with Decision Tree of the *GPG (2000)* (Page 4.24 Fig. 4.2), calculations for dairy and non-dairy cattle should be performed using the Tier 2 method. The Tier 2 method requires the total energy intake of livestock to be multiplied by the CH_4 conversion factor to derive the emission factor, but it has been in practice in Japan on livestock-related research to use amount of dry matter intake. It is considered that, by applying the results of previous researches, the estimation method using amount of dry matter intake provides more accurate data. For that reason, a technique similar to the Tier 2 Method but specific to Japan was used for the calculation of CH_4 emissions associated with enteric fermentation by cattle. The emissions were calculated by multiplying the cattle population (dairy and non-dairy) by the emission factors established based on their dry matter intake.

As cattle begin to eat normal feed at the age of five to six months, the calculation of the CH_4 emissions associated with enteric fermentation includes cattle aged five months or older.
To reflect the actual situation of emissions in Japan, categorization of cattle is defined as shown below, and the estimation of CH_4 emissions is conducted by type and age.

Table 6-2 Categorization and assumptions underlying calculation of CH_4 emissions associated with enteric fermentation in cattle

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

●*Emission Factors*

The emission factor for CH_4 associated with enteric fermentation in cattle has been established on the basis of breath testing of ruminant livestock in Japan; it is based on the measured data for volume of CH_4 generated from dry matter intake. Results of measurements have made it clear that it is possible to estimate CH_4 from enteric fermentation in ruminant livestock using the equation given below, which uses dry matter intake as the explanatory variable (Shibata et al.,(1993), Reference 30).

CH_4 Emission Factor for associated with enteric fermentation in cattle (kg-CH_4/head)

＝(Volume of CH_4 generated [l/day/head]) / (Volume of 1 mol) × (molecular weight of CH_4) × (No. of days in year)

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

Volume of CH_4 generated per head per day (=Y) (l/mol/head)

$$= -17.766 + 42.793\ DMI - 0.849\ (DMI)^2$$

DMI：Dry matter intake [kg/day/head]

Average dry matter intake estimated from *Japan Feed Standards* compiled by the Japan Livestock Industry Association is applied to the above equation to establish emission factors. The dry matter intake was calculated by substituting fat corrected milk, body weight, and weight gain by daily growth into the equation established for each type of cattle. Data for the fat corrected milk was obtained from the *Statistics on Milk and Dairy Products* (Ministry of Agriculture, Fisheries and Forestry; MAFF) and the *Statistics on Livestock* (MAFF), and those for the fat content in milk from the *Statistics of Livestock Production Costs* (MAFF). Both sets of the data are updated on a yearly basis. Data for body weight and weight gain by daily growth were obtained from the table of weight by age (months) for each type of cattle included at the back of the *Japanese Feeding Standards* (Japan Livestock Industry Association). Equations to estimate Dry Matter Intake were revised in 2006 for daily cattle

(Lactating and Non-lactating) and in 2008 for non-daily cattle (Japanese cattle(M)).

Comparison between results of Japan’s estimation method and IPCC Tier 2 method was conducted. As a result, for dairy cattle, considering the error of CH_4 conversion factor ($Ym = 0.60 \pm 0.05$), the emissions of Japan’s method were in the range which emission calculated by IPCC Tier 2 method can cover. Therefore, it is considered that there were no significant differences between emissions of Japan’s method and IPCC Tier 2 method. On the other hand, for non-dairy cattle, it became clear that the emissions of Japan’s method are about 10% higher than IPCC Tier 2 method. Analysis of the factor about this difference will be continued.

Table 6-3 Equation to estimate Dry Matter Intake (DMI) by cattle

Animal type		Equation
Dairy cattle	Lactating	After 2006: $DMI=1.3922+0.05839\times W^{0.75}+0.40497\times FCM$ $FCM=(15\times FAT/100+0.4)\times MILK$ Before 2005: $DMI=2.98120+0.00905\times W+0.41055\times FCM$ $FCM=(15\times FAT /100+0.4)\times MILK$
	Non-lactating	After 2006: $DMI=0.017\times W$ Before 2005: $DMI=(0.1163\times W^{0.75}/0.82)/4.41/0.52*1.1$
	Heifers	$DMI=0.49137+0.01768\times W+0.91754\times DG$
Non-dairy cattle	Breeding cows	$DMI= [0.1067\times W^{0.75} +(0.0639\times W^{0.75}\times DG)/(0.78\times q+0.006)]/(q\times 4.4)$ $q=0.4213+0.1491\times DG$
	Japanese cattle (M)	After 2008: $DMI=-3.481+2.668\times DG+4.548\times 10^{-2}\times W-7.207\times 10^{-5}\times W^2+3.867\times 10^{-8}\times W^3$ Before 2007: $DMI= [0.1124\times W^{0.75}+(0.0546\times W^{0.75}\times DG)/(0.78\times q+0.006)]/\{q\times(1.653-0.00123\times W)\}$ $q=0.5304+0.0748\times DG$
	Japanese cattle (F)	$DMI=[0.1108\times W^{0.75}+(0.0609\times W{}^\wedge 0.75\times DG)/(0.78\times q+0.006)]/(q\times 4.4)$ $q= 0.5018+0.0956\times DG$
	Dairy breeds (excluding 5- and 6-month old)	$DMI=[0.1291\times W^{0.75}+(0.0510\times W^{0.75}\times DG)/(0.78\times q+0.006)]/(q\times 4.4)$ $q=(0.933+0.00033\times W)\times(0.498+0.0642\times DG)$
	Dairy breeds (5 to 6 months old)	$DMI=[0.1291\times W^{0.75}+\{(1.00+0.030\times W{}^\wedge 0.75)\times DG\}/(0.78\times q+0.006)]/(q\times 4.4)$ $q=(0.859-0.00092\times W)\times(0.790+0.0411\times DG)$

W: Weight, FCM: Fat Corrected Milk, FAT: Fat content in milk, MILK: Milk Yield, DG: Daily Growth, q: Energy metabolic rate

Source: Japan Livestock Industry Association, *Japan Feed Standards*

Table 6-4 Fat content in milk (FAT) and Milk Yield (MILK) by cattle

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Milk yield (Lactating)	kg/head/day	24.9	26.8	28.1	30.1	30.5	30.8	30.8
Fat content in milk (Lactating)	%	3.7	3.8	3.9	4.0	4.0	3.9	3.9

Table 6-5 Weight by cattle (W)

Animal Type			Unit	1990	1995	2000	2005	2008	2009	2010
Dairy Cattle	Lactating		kg/head	595.9	602.8	621.4	622.7	623.0	623.0	623.0
	Non-lactating		kg/head	595.9	602.8	621.4	622.7	623.0	623.0	623.0
	Heifer: Under Two Years, over six months		kg/head	342.4	349.3	364.9	374.2	376.1	376.1	376.1
	Heifer: Five and six months		kg/head	140.0	140.6	146.3	162.8	166.1	166.1	166.1
Non-Dairy Cattle	Breeding Cows	One Year and Over	kg/head	426.6	426.6	487.3	450.9	429.1	429.1	429.1
		Under One Year, over six months	kg/head	230.2	230.2	279.7	259.3	247.0	247.0	247.0
		Fiveand six months	kg/head	141.0	141.0	157.1	146.8	140.7	140.7	140.7
	fattening cattle	Japanese cattle (M): One Year and Over	kg/head	574.3	574.3	574.3	572.3	571.0	571.0	571.0
		Japanese cattle (M): Under One Year, over six months	kg/head	273.4	273.4	273.4	274.6	275.4	275.4	275.4
		Japanese cattle (M): Five and six months	kg/head	146.7	146.7	146.7	147.9	148.6	148.6	148.6
		Japanese cattle (F): One Year and Over	kg/head	388.0	388.0	462.5	427.7	406.8	406.8	406.8
		Japanese cattle (F): Under One Year, over six months	kg/head	230.2	230.2	279.7	259.3	247.0	247.0	247.0
		Japanese cattle (F): Fiveand six months	kg/head	141.0	141.0	157.1	146.8	140.7	140.7	140.7
		Dairy breed: Over six months	kg/head	479.8	479.8	479.8	479.8	479.8	479.8	479.8
		Dairy breed: Five and six months	kg/head	194.8	194.8	194.8	194.8	194.8	194.8	194.8

Table 6-6 Daily Growth by cattle (DG)

Animal Type			Unit	1990	1995	2000	2005	2008	2009	2010
Dairy Cattle	Lactating		kg/head/day	—	—	—	—	—	—	—
	Non-lactating		kg/head/day	—	—	—	—	—	—	—
	Heifer: Under Two Years, over six months		kg/head/day	0.60	0.63	0.65	0.59	0.58	0.58	0.58
	Heifer: Five and six months		kg/head/day	0.69	0.70	0.76	0.88	0.90	0.90	0.90
Non-Dairy Cattle	Breeding Cows	One Year and Over	kg/head/day	0.17	0.17	0.14	0.13	0.13	0.13	0.13
		Under One Year, over six months	kg/head/day	0.70	0.70	0.94	0.86	0.81	0.81	0.81
		Fiveand six months	kg/head/day	0.74	0.74	1.04	0.96	0.91	0.91	0.91
	fattening cattle	Japanese cattle (M): One Year and Over	kg/head/day	0.60	0.60	0.60	0.59	0.58	0.58	0.58
		Japanese cattle (M): Under One Year, over six months	kg/head/day	1.07	1.07	1.07	1.07	1.07	1.07	1.07
		Japanese cattle (M): Five and six months	kg/head/day	0.94	0.94	0.94	0.95	0.95	0.95	0.95
		Japanese cattle (F): One Year and Over	kg/head/day	0.28	0.28	0.27	0.25	0.24	0.24	0.24
		Japanese cattle (F): Under One Year, over six months	kg/head/day	0.70	0.70	0.94	0.86	0.81	0.81	0.81
		Japanese cattle (F): Fiveand six months	kg/head/day	0.74	0.74	1.04	0.96	0.91	0.91	0.91
		Dairy breed: Over six months	kg/head/day	0.92	0.92	0.92	0.92	0.92	0.92	0.92
		Dairy breed: Five and six months	kg/head/day	1.10	1.10	1.10	1.10	1.10	1.10	1.10

Table 6-7 Dry matter intake by cattle (DMI)

Animal Type			Unit	1990	1995	2000	2005	2008	2009	2010
Dairy Cattle	Lactating		kg/head/day	18.2	19.2	20.0	20.9	21.0	21.0	21.0
	Non-lactating		kg/head/day	8.2	8.3	8.5	8.5	10.6	10.6	10.6
	Heifer: Under Two Years, over six months		kg/head/day	7.1	7.2	7.5	7.7	7.7	7.7	7.7
	Heifer: Five and six months		kg/head/day	3.6	3.6	3.8	4.2	4.3	4.3	4.3
Non-Dairy Cattle	Breeding Cows	One Year and Over	kg/head/day	6.6	6.6	7.1	6.6	6.3	6.3	6.3
		Under One Year, over six months	kg/head/day	5.5	5.5	6.7	6.2	5.9	5.9	5.9
		Fiveand six months	kg/head/day	3.8	3.8	4.4	4.1	4.0	4.0	4.0
	fattening cattle	Japanese cattle (M): One Year and Over	kg/head/day	8.4	8.4	8.4	8.3	7.7	7.7	7.7
		Japanese cattle (M): Under One Year, over six months	kg/head/day	6.8	6.8	6.8	6.8	7.2	7.2	7.2
		Japanese cattle (M): Five and six months	kg/head/day	4.3	4.3	4.3	4.4	4.4	4.4	4.4
		Japanese cattle (F): One Year and Over	kg/head/day	5.7	5.7	6.4	6.0	5.7	5.7	5.7
		Japanese cattle (F): Under One Year, over six months	kg/head/day	4.9	4.9	6.1	5.6	5.3	5.3	5.3
		Japanese cattle (F): Fiveand six months	kg/head/day	3.4	3.4	4.1	3.8	3.6	3.6	3.6
		Dairy breed: Over six months	kg/head/day	8.7	8.7	8.7	8.7	8.7	8.7	8.7
		Dairy breed: Five and six months	kg/head/day	5.3	5.3	5.3	5.3	5.3	5.3	5.3

Table 6-8 Emission factor associated with enteric fermentation by cattle

Animal Type			Unit	1990	1995	2000	2005	2008	2009	2010
Dairy Cattle	Lactating		kgCH$_4$/head/year	125.0	128.3	130.0	131.9	132.0	132.1	132.1
	Non-lactating		kgCH$_4$/head/year	72.0	72.7	74.0	74.1	88.7	88.7	88.7
	Heifer: Under Two Years, over six months		kgCH$_4$/head/year	63.4	64.7	66.9	67.8	68.0	68.0	68.0
	Heifer: Five and six months		kgCH$_4$/head/year	32.7	32.9	34.4	38.1	38.8	38.8	38.8
Non-Dairy Cattle	Breeding Cows	One Year and Over	kgCH$_4$/head/year	59.0	59.2	63.1	59.3	57.0	57.0	57.0
		Under One Year, over six months	kgCH$_4$/head/year	49.8	50.0	60.1	56.3	53.8	53.8	53.8
		Fiveand six months	kgCH$_4$/head/year	34.9	35.0	40.4	37.8	36.2	36.2	36.2
	fattening cattle	Japanese cattle (M): One Year and Over	kgCH$_4$/head/year	73.2	73.4	73.2	72.8	68.5	68.5	68.5
		Japanese cattle (M): Under One Year, over six months	kgCH$_4$/head/year	61.1	61.3	61.1	61.2	64.5	64.5	64.5
		Japanese cattle (M): Five and six months	kgCH$_4$/head/year	39.6	39.7	39.6	39.9	39.8	39.8	39.8
		Japanese cattle (F): One Year and Over	kgCH$_4$/head/year	51.8	51.9	58.1	54.2	51.9	51.9	51.9
		Japanese cattle (F): Under One Year, over six months	kgCH$_4$/head/year	44.3	44.5	55.3	51.2	48.7	48.7	48.7
		Japanese cattle (F): Fiveand six months	kgCH$_4$/head/year	31.0	31.0	37.4	34.6	32.9	32.9	32.9
		Dairy breed: Over six months	kgCH$_4$/head/year	75.6	75.8	75.6	75.6	75.6	75.6	75.6
		Dairy breed: Five and six months	kgCH$_4$/head/year	48.0	48.1	48.0	48.0	48.0	48.0	48.0

●*Activity Data*

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

Table 6-9 Livestock population for cattle (Single year)

Animal Type			Unit	1990	1995	2000	2005	2008	2009	2010
Dairy Cattle	Lactating		1000 head	1,082	1,035	971	900	848	830	*830*
	Non-lactating		1000 head	332	299	249	231	207	200	*200*
	Heifer: Under Two Years, over six months		1000 head	491	445	379	379	334	341	*341*
	Heifer: Five and six months		1000 head	55	49	42	42	37	38	*38*
Non-Dairy Cattle	Breeding Cows	One Year and Over	1000 head	679	646	612	594	650	651	*651*
		Under One Year, over six months	1000 head	17	13	12	14	16	17	*17*
		Fiveand six months	1000 head	6	4	4	5	5	6	*6*
	fattening cattle	Japanese cattle (M): One Year and Over	1000 head	368	412	385	374	414	425	*425*
		Japanese cattle (M): Under One Year, over six months	1000 head	125	133	114	119	130	132	*132*
		Japanese cattle (M): Five and six months	1000 head	42	44	38	40	43	44	*44*
		Japanese cattle (F): One Year and Over	1000 head	197	265	246	290	323	339	*339*
		Japanese cattle (F): Under One Year, over six months	1000 head	102	105	93	89	105	106	*106*
		Japanese cattle (F): Fiveand six months	1000 head	34	35	31	30	35	35	*35*
		Dairy breed: Over six months	1000 head	805	808	845	789	775	726	*726*
		Dairy breed: Five and six months	1000 head	89	90	94	88	86	81	*81*

** Data for 2010 are substituted by data for 2009*

c） Uncertainties and Time-series Consistency

●Uncertainties

An uncertainty assessment was conducted for the categories indicated in Table 6-2, there were 4 categories for dairy cattle and 11 categories for non-dairy cattle. The uncertainties for emission factors were calculated by finding the 95% confidence interval in accordance with the equation indicated in the section *Emission Factors*. Populations of cattle (Activity data) are decided by survey of total population in the *Livestock Statistics*, but standard error for cattle is not described. Therefore, the uncertainties for activity data were determined to be 5% in accordance with decision tree indicated in Annex 7. As a result, the uncertainties of the emissions were determined to be 15% for dairy cattle and 19% for non-dairy cattle. The uncertainty assessment methods are summarized in Annex 7.

●Time-series Consistency

Emission factors were calculated consistently from FY 1990 onward by the method mentioned in the section on Emission Factors. Activity data were used consistently from FY 1989 onward from the data in Livestock Statistics.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

In the agricultural sector, a 3-year average has been used. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f） Source-specific Planned Improvements

- It is expected that the improvements in nutrition management techniques and techniques to suppress CH_4 fermentation by controlling fermentation in the rumen (such as by the addition of fatty acid calcium and polyphenols to feed) will spread in the future. But estimation methods which can reflect them in emissions are not developed (amount of CH_4 inhabitation changes by the composition of feed, quantity and unsaturation degrees of fatty acid calcium, but so far it has not been generalized.). It is necessary to develop estimation methods that can reflect measures to control CH_4 generation.

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

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 emissions from enteric fermentation in Buffalo, Sheep, Goats, Horses and Swine.

b） Methodological Issues

●*Estimation Method*

CH_4 emissions were calculated using the Tier 1 Method in accordance with the Decision Tree of the *GPG (2000)*.

●*Emission Factors*

The emission factor for CH_4 associated with sheep and goats has been established in the same way as for cattle, based on the emissions of CH_4 estimated from dry matter intake.

In Japan, most of sheep are farmed for meat and they are smaller than sheep for wool production assumed in the *Revised 1996 IPCC Guidelines* and *GPG (2000)* as default. Therefore, it is considered that emission factor for sheep in Japan is lower than default in IPCC guidelines. As for goats, research findings in this regard do not exist in Japan. However, the emission factor for goat was regarded as equivalent to the one for sheep by the experts (the expert judgment). Therefore, the emission factor for sheep is also used for goats.

The emission factor for swine has been established on the basis of results of research conducted in Japan. The emission factor used for horses and buffalo is the default value given in the *Revised 1996 IPCC Guidelines*.

Table 6-10Emission factors for CH_4 associated with enteric fermentation in sheep, goats, horses, swine and buffalo

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

a: Calculated by the formula: (CH_4 generated [l/day/head]) / (Volume of 1 mol) × (molecular weight of CH_4) × (no. of days in year)
b: Mamoru Saito, *Methane emissions from fattening swine and expectant swine* (1988) (Reference 29)
c: *Revised 1996 IPCC Guidelines*

●*Activity Data*

The values used for activity data are used for sheep and goats given in the *Statistical Document of Livestock Breeding* offered by the Japan Livestock Industry Association. The values used for activity data for swine are the herd size at February 1st in each year, as recorded by the Ministry of Agriculture, Forestry and Fisheries in its *Livestock Statistics*. The values used for activity data for horses given in the *Statistical Document of Horse* offered by the Ministry of Agriculture, Forestry and Fisheries, for buffalo given *Statistics on Livestock in Okinawa Prefecture*.

Table 6-11 Activity data associated with enteric fermentation by buffalo, sheep, goats, swine, and horses

Type of	Unit	1990	1995	2000	2005	2008	2009	2010
Sheep	1000 head	21	14	12	9	12	12	*12*
Goats	1000 head	26	19	22	16	14	14	*14*
Swine	1000 head	11,336	9,900	9,788	9,621	9,900	9,900	*9,900*
Horses	1000 head	116	118	105	87	*83*	83	*83*
Buffalo	1000 head	0.21	0.12	0.10	0.08	0.08	0.08	*0.08*

** Data for 2010 are substituted by data for 2009*

c） Uncertainties and Time-series Consistency

●***Uncertainties***

An uncertainty assessment was conducted by each livestock category. The uncertainties for emission factors were applied 50% of default data given in the *GPG (2000)*. As the uncertainty for activity data, 0.69% of standard error for swine given in the *Livestock Statistic* was applied to swine. Since sample standard deviation can’t be obtained and expert judgment is impossible, and non-fundamental statistics, 100% was applied to other livestock in accordance with the decision tree of uncertainty assessment. As a result, the uncertainties of the emissions were determined to be 50% for swine and 112% for buffalo, sheep and goats. The uncertainty assessment methods are summarized in Annex 7.

●***Time-series Consistency***

For emission factors, same values were used consistently from FY 1990 to FY 2009. Activity data for sheep and goats applied the data given in the *Statistical Document of Livestock Breeding*, those for swine applied the data given in the *Livestock Statistics*; those for horses applied the data given in *Statistical Document of Horse*, and those for buffalo applied the data given in the *Livestock Statistics of Okinawa*, consistently since FY 1989.

d） Source-specific QA/QC and Verification

Refer to section ”6.2.1. Cattle ”.

e） Source-specific Recalculations

Since minor discrepancies between total values and integrated values from detail level for swine population were resolved, emissions for this category from FY1990 to FY 2008 were revised. In the agricultural sector, a 3-year average has been used. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f） Source-specific Planned Improvements

Although the default emission factor in the *Revised 1996 IPCC Guidelines* or the *GPG (2000)* has been used for some livestock categories, there is a need to discuss whether it is possible to establish country-specific emission factors for Japan.

6.2.3. Poultry (4.A.9.)

It is conceivable that CH_4 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 *GPG (2000)* offer default emission factors. Therefore, this category has been reported as “NE”. In addition, poultry other than hens and broiler are not covered by official statistics, suggesting that they may be assumed to be negligible.

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

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

6.2.5. Other (4.A.10.)

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

6.3. Manure Management (4.B.)

Livestock manure generates CH_4 when its organic content is converted to CH_4 gas through CH_4 fermentation, or when CH_4 from enteric fermentation dissolved in manure is released by aeration or agitation. In manure management, N_2O is produced mainly by microorganism via nitrification and denitrification processes.

CH_4 and N_2O emissions from manure management in FY 2009 are 2,300 Gg-CO_2 eq. and 4,761 Gg-CO_2 eq., comprising 0.2% and 0.4% of total emissions (excluding LULUCF), respectively. The value represents a reduction by 25.7% and 13.9% from FY 1990, respectively.

Table 6-12 CH_4 and N_2O emissions from livestock manure management

Gas	Livestock species	Unit	1990	1995	2000	2005	2007	2008	2009
CH_4	4.B.1.- Dairy Cattle	Gg-CH_4	123.2	115.7	106.2	98.2	91.8	89.1	88.0
	4.B.1.- Non-Dairy Cattle	Gg-CH_4	4.5	4.6	4.5	4.4	4.6	4.6	4.6
	4.B.2. Buffalo	Gg-CH_4	0.0004	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
	4.B.3. Sheep	Gg-CH_4	0.006	0.004	0.003	0.003	0.003	0.003	0.003
	4.B.4. Goats	Gg-CH_4	0.005	0.003	0.004	0.003	0.003	0.003	0.003
	4.B.6. Horses	Gg-CH_4	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	4.B.8. Swine	Gg-CH_4	15.9	13.9	13.6	13.5	13.6	13.7	13.8
	4.B.9. Poultry	Gg-CH_4	3.5	3.2	3.0	2.9	3.0	3.0	3.0
	Total	Gg-CH_4	147.3	137.8	127.5	119.2	113.2	110.5	109.5
		Gg-CO_2eq	3,094	2,893	2,678	2,503	2,376	2,321	2,300
N_2O	4.B.1.- Dairy Cattle	Gg-N_2O	2.7	2.6	2.3	2.2	2.0	2.0	2.0
	4.B.1.- Non-Dairy Cattle	Gg-N_2O	2.8	2.9	2.8	2.8	2.9	2.9	2.9
	4.B.2. Buffalo	Gg-N_2O	0.00012	0.00007	0.00005	0.00004	0.00004	0.00004	0.00004
	4.B.3. Sheep	Gg-N_2O	0.007	0.005	0.004	0.003	0.004	0.004	0.004
	4.B.4. Goats	Gg-N_2O	0.03	0.02	0.03	0.02	0.02	0.02	0.02
	4.B.6. Horses	Gg-N_2O	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	4.B.8. Swine	Gg-N_2O	4.8	4.2	4.1	4.1	4.1	4.1	4.1
	4.B.9. Poultry	Gg-N_2O	7.4	6.8	6.4	6.2	6.3	6.3	6.3
	Total	Gg-N_2O	17.8	16.6	15.8	15.3	15.4	15.4	15.4
		Gg-CO_2eq	5,533	5,152	4,885	4,749	4,773	4,762	4,761
Total of all gases		Gg-CO_2eq	8,627	8,045	7,563	7,253	7,150	7,083	7,061

6.3.1. Cattle, Swine and Poultry (4.B.1., 4.B.8., 4.B.9.)

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions for manure management from cattle (Daily cattle and Non-daily cattle), swine and poultry (Hen and Broilers). The estimations for cattle were conducted separately for "shed" and "pastured" cattle. CH_4 emissions were reported in this category and N_2O emissions for “pastured” were reported in “4.D.2 Pasture, Range and Paddock Manure”.

b） Methodological Issues

i) Cattle, Swine and Poultry in shed and barn

●***Estimation Method***

CH_4 emissions in shed associated with the management of manure were calculated by multiplying the amount of organic matter contained in manure from each type of livestock by the emission factor for each type of treatment method.

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

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

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

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

N_2O emissions were calculated by multiplying the amount of nitrogen contained in manure of each type of animal by the emission factor for each type of treatment method.

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

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

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

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

●***Emission Factors***

Emission factors for CH_4 and N_2O associated with Animal Waste Management System (hereafter, AWMS) have been established for each treating method of for each type of livestock, on the basis of the results of research carried out in Japan after reviewing its validity in accordance with the decision tree shown in Figure 6-2.

Moisture for dairy cattle feces is high, and they easily make anaerobic condition. It is considered to be the reason for high CH_4 emission factor of piling.

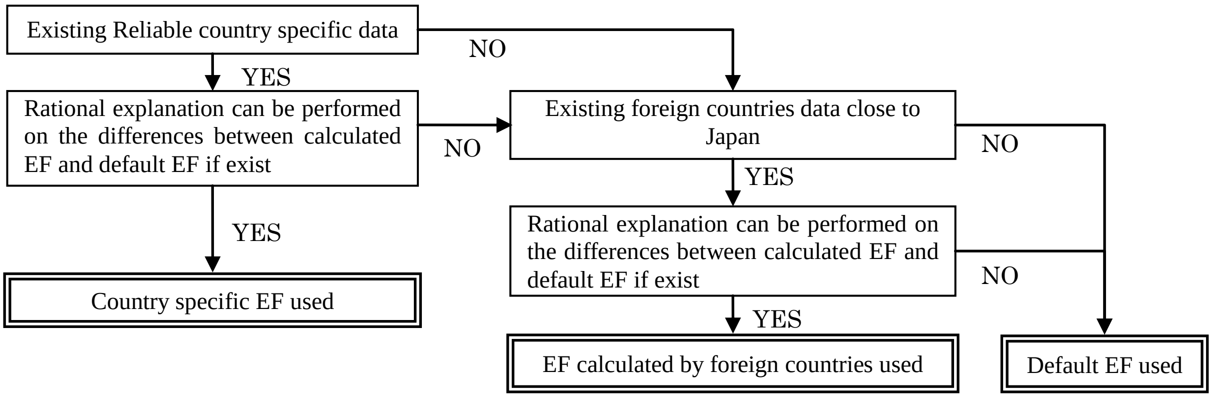


Figure 6-2 Decision tree for determination of EF

Table 6-13CH_4 Emission factors for each method of treating manure from cattle, Swine, Hen & Broiler

treating method		Daily Cattle		Non-daily cattle		Swine		Hen, Broiler	
12. Pit storage		3.90 %	D[1]	3.00 %	D[1]	8.7 %	D[1]	–	
13. Sun drying		0.20 %	J[3]	0.20 %	J[3]	0.20 %	J[3]	0.20 %	J[3]
14. Other	14a. Thermal drying	0 %							Z[4]
	14b. Composting (feces)	0.044 %	D[1]	0.034 %	D[1]	0.080 %	J[9]	0.080%	J[9]
	14c. Piling	3.80 %	J[5]	0.13 %	J[5]	0.16 %	J[5]	0.14 %	J[5]
	14d. Incineration	0.4 %							O[4,6]
	14e. Composting (urine)	0.044 %	D[1]	0.034 %	D[1]	0.097 %	D[1]	–	
	14e. Composting (feces and urine mixed)					0.080 %	J[9]		
	14f. Purification	0.0087%	D[1]	0.0067%	D[1]	0.019%	D[1]		

Table 6-14 N_2O Emission factors for each method of treating manure from cattle, Swine Hen & Broiler

treating method		Daily Cattle		Non-daily cattle		Swine		Hen, Broiler	
12. Pit storage		0.10 %					D[1]		
13. Sun drying		2.0 %							D[1]
14. Other	14a. Thermal drying	2.0 %							D[1]
	14b. Composting (feces)	0.25 %			J[7]	0.16 %			J[9]
	14c. Piling	2.40 %	J[5]	1.60 %	J[5]	2.50 %	J[5]	2.0 %	D[1]
	14d. Incineration	0.1 %							O[4]
	14e. Composting (urine)	2.0%	D[1]	0.25%	J[7]	2.0 %	D[1]	–	
	14e. Composting (feces and urine mixed)					0.16%	J[9]		
	14f. Purification	5.0 %					J[8]		

D: Default value of Revised 1996 IPCC Guidelines

J: Established by data of Japan

O: Established by data of other countries

Z: Emission can not occur because of mechanism

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

Sources for Table 6-13 and Table 6-14

1: GPG (2000) (Reference 4)

2: IPCC, *Revised 1996 IPCC Guidelines* (Reference 3)

3: Makoto Ishibashi et al., *"Development of technology of reducing GHG on the livestock industry(second report)"* (2003) (Reference 34)

4: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*, (2002) (Reference 22)

5: Takashi Osada et al., Greenhouse gas generation from livestock waste composting (2005) (Reference 38)

6: IPCC(1995): IPCC 1995 Report (Reference 2)

7: Takashi Osada et al., Determination of nitrous oxide, methane, and ammonia emissions from a swine waste composting process (2000) (Reference 36)

8: Takashi Osada, Nitrous Oxide Emission from Purification of Liquid Portion of Swine Wastewater (2003) (Reference 37)

9: Project Report of Survey on Prevention of Global Warming in the Agriculture, Forest and Fisheries Sector within the Environment and Biomass Comprehensive Strategy Promotion Project in FY 2008 (Nationwide Survey) (Reference 47)

●*Activity Data*

The values used for the activity data are estimates of the amount of organic matter and the amount of nitrogen excreted annually by various types of livestock, respectively.

Total annual amount of organic matter by domestic livestock was calculated by multiplying the population of each type of animal by the amount of manure per head by the proportion of organic matter in feces or urine. Total nitrogen amount was calculated by multiplying the population of each type of animal by the nitrogen content amount of feces or urine excreted per head. The amount of organic matter and nitrogen amount was allocated to each category of manure management by multiplying the total amount by the percentage of manure treated separately and the percentage per treatment method. For livestock population, same references indicated in '4.A. Enteric Fermentation' are used.

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

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

Amount of organic matter excreted [Gg] ＝ Livestock population [1000 head] × Amount of feces and urine excreted [kg/head/day] × days per year [day] × organic matter content in feces and urine [%] × proportions of feces and urine separated [%] × share of each treating method [%] / 1000

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

Amount of nitrogen excreted [Gg-N] ＝ Livestock population [1000 head]
× Nitrogen content amount of feces and urine excreted [kg-N/head/day] × Days per year [day]
× Proportion of feces and urine separated [%] × Share of each treating method [%] / 1000

Table 6-15 Amount of feces and urine excreted and Nitrogen content amount by type of livestock

Type of livestock		Amount of feces or urine excreted [kg/head/day]		Nitrogen content amount in feces or urine excreted [g-N/head/day]	
		feces	urine	Feces	urine
Dairy Cattle	Lactating	45.5	13.4	152.8	152.7
	Non-lactating and Inexperienced Birthing	29.7	6.1	38.5	57.8
	Heifer: Under Two Years	17.9	6.7	85.3	73.3
Non-Dairy Cattle	Under Two years	17.8	6.5	67.8	62.0
	Over Two Years	20.0	6.7	62.7	83.3
	Dairy breed	18.0	7.2	64.7	76.4
Swine	Growing-Finishing	2.1	3.8	8.3	25.9
	Breeding	3.3	7.0	11.0	40.0
Hen	poult	0.059	-	1.54	-
	adult	0.136	-	3.28	-
Broiler		0.130	-	2.62	-

Source: M, Tsuiki et al.., A Computer Program for Estimating the Amount of Livestock Wastes. (Reference 44)

Table 6-16 Organic matter content in feces and urine, by type of livestock（wet base）

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

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*. (2002) (Reference 22)

Table 6-17 Proportion of separated and mixed treatment of manure, by type of livestock

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

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*. (2002) (Reference 22)

Table 6-18 Percentage of manure management by type of animal

State of Manure (Separated or Mixed)		Treating method	Dairy Cattle	Non-Dairy Cattle	Swine	Hen	Broiler
Separated	Feces	Sun 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%
		Piling	88.0%	87.0%	29.6%	23.0%	66.9%
		Incineration	0.2%	0.5%	0.7%	2.0%	13.0%
	Urine	Composting (urine)	1.5%	9.0%	10.0%	―	―
		Purification	2.5%	2.0%	45.0%	―	―
		Pit storage	96.0%	89.0%	45.0%	―	―
Mixed		Sun drying	4.7%	3.4%	6.0%	―	―
		Thermal drying	0.0%	0.0%	0.0%	―	―
		Composting (urine)	20.0%	22.0%	29.0%	―	―
		Piling	14.0%	74.0%	20.0%	―	―
		Purification	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*. (1999) (Reference 23)

●***Completeness***

Poultry other than hens and broiler are not covered by official statistics, and they are assumed to be negligible. Therefore, only hens and broiler are considered as estimation target from poultry.

●***Climate Regions***

In the Tier 1 method, the *GPG (2000)* requires that emissions be calculated using herd size by climate regions.

In accordance with the climate categories given in the *Revised 1996 IPCC Guidelines*, Japan should be divided into temperate and cool zones. The average temperature over all prefectures in Japan is around 15 ºC. This figure is almost the same as the threshold given in the *Revised 1996 IPCC Guidelines*. Therefore, emissions have been calculated on the assumption that all of Japan falls into the temperate zone, without a need to categorize regions into temperate or cool zone.

ii) Cattle under grazing

Organic matter contained in manure excreted by livestock during grazing (i.e. dung and urine deposited onto grazing and watering grounds by the grazing livestock) is converted to CH_4 through the CH_4 fermentation process, and emitted into the atmosphere. The nitrogen-containing manure also generates ammonium ions, which in turn generates N_2O in the process of oxidation to nitrate from ammonium ions under aerobic conditions.

Emissions in this category are reported for cattle grazing owing to the unavailability of statistics and other information regarding the grazing of other animals. CH_4 emissions are reported in this category and N_2O emissions from grazing cattle are reported in 4D2.

●*Estimation Method*

For CH_4 and N_2O emitted from pasture, range, and paddock manure, the amount of emissions was calculated for cattle by multiplying the Japan-specific emission factors by the total grazing population in accordance with the Decision Tree in the *GPG (2000)* (page 4.55, Fig. 4.7).

●*Emission Factors*

Data for the amounts (g) of CH_4 and N_2O emitted from manure excreted per head of cattle per day were used as the emission factors. The data were established by multiplying the model output value of carbon content in manure excreted by grazing cattle during the grazing period by the actual measurement values of CH_4 and N_2O generated per amount of carbon contained in the manure of the grazing cattle.

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

Table 6-19 Emission factors for grazing cattle

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.* (2001) (Reference 24)

●*Activity Data*

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

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

Table 6-20 Trends in the population of grazing cattle

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Amount of grazing daily cattle	head	302,219	281,603	252,088	245,100	297,000	293,911	*293,911*
Amount of grazing non-daily cattle	head	99,734	103,162	99,759	116,300	132,100	130,739	*130,739*

** Data for 2010 are substituted by data for 2009*

iii) Reporting in Common Reporting Format (CRF)

In the CRF, with regard to CH_4 emissions from this category, it is required to report emissions by each livestock. However, for N_2O emissions from this category, it is required to report emissions by AWMS (11. Anaerobic Lagoons, 12. Liquid Systems, 13. Solid Storage and Dry Lot, 14. Other).

For cattle, swine, and poultry, Japan's country-specific manure management categories and the implementation rates of the management categories have been established for each type of animal. For details, see Table 6-17 below.

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

Table 6-21 Correspondence between the Japanese and CRF manure management categories

Japan			CRF	Description of Treatment
Manure treatment		Manure management category		
Separate treatment	Feces	Sun drying	13. Solid Storage and Dry Lot	Dried under sunlight to facilitate handling (for storage and odor prevention).
		Thermal drying	14. Other (a. Thermal drying)	Dried by heat to facilitate handling.
		Composting	14. Other (b. Composting)	Fermented for several days to several weeks with forced aeration and agitation in lidded or closed tanks.
		Piling	14. Other (c. Piling)	Piling system is a method of composting. Piled about 1.5-2m height on compost bed or in shed to ferment for several months with occasional turning.
		Incineration	14. Other (d. Incineration)	For amount reduction or disposal, and use as an energy source (e.g. chicken manure boiler).
	Urine	Liquid Composting	14. Other (e. Composting (liquid))	Treated in an aeration storage tank.
		Purification	14. Other (f. Purification)	Separate pollutants using aerobic microbes, such as activated sludge.
		Pit storage	12. Liquid systems	Stored in a storage tank.
Mixed treatment		Sun drying	13. Solid Storage and Dry Lot	Dried under sunlight to facilitate handling.
		Thermal drying	14. Other (a. Thermal drying)	Same as above, Thermal drying.
		Liquid Composting	14. Other (e. Composting (liquid))	Treated in an aeration storage tank.
		Piling	14. Other (c. Piling)	Same as above, Piling.
		Purification	14. Other (f. Purification)	Same as above, Purification.
		Pit storage	12. Liquid systems	Stored in a storage tank (e.g. slurry storage).

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

"11. Anaerobic Lagoons" have been reported as "NO". Because there are quite small number of livestock farmers who has enough area of field to spread manure, and it is assumed that there are no livestock farmers who use anaerobic lagoons. There are cases when manure is spread to fields in Japan, but even in these cases, stirring is conducted before the spreading. Therefore, there are no anaerobic manure management systems.

iv) Nitrogen in Livestock Manure Applied to Agricultural Soil

At present, the amount of manure-derived organic fertilizer application in *4.D.3 Indirect Emissions* is calculated by subtracting the amount of volatilization into the atmosphere, the amount treated by "Incineration" and "Purification", and the amount disposed in landfill as waste from the total nitrogen content of livestock manure. Buffalo, sheep, goats, and horses are excluded from the calculation in 4.D.3 because they produce very small amounts of manure and details of their management in Japan are unknown.

●*Estimation Method*

The percentage of application of manure-derived organic fertilizers was calculated by subtracting the nitrogen contents in the livestock manure disposed of in the "direct final disposal", the nitrogen volatized as N_2O, the nitrogen volatilized as ammonia and nitrogen oxides, and the nitrogen eliminated by the "incineration" and "purification", from the total nitrogen contained in livestock manure excreted in a shed and barn.

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

$N_{D:}$	Amount of nitrogen in manure-derived fertilizer applied to agricultural soil (kg-N)
$N_{all:}$	Total amount of nitrogen excreted by livestock (deposited in shed and barn) (kg-N)
$N_{N2O:}$	Nitrogen in livestock manure volatilized as N_2O(deposited in shed and barn) (kg-N)
$N_{NH3+NOx:}$	Nitrogen in manure volatilized as NH_3 and NO_X (deposited in shed and barn) (kg-NH_3-N + NO_X-N)
$N_{inc+waa:}$	Nitrogen eliminated by "incineration" and "purification(deposited in shed and barn) (kg-N)
$N_{waste:}$	Amount of nitrogen in manure that is disposed of in the "final direct disposal" (kg-N)

➢ *Amount of N_2O volatilized into the atmosphere*

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

➢ *Amount volatilized as ammonia and nitrogen oxides*

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

Table 6-22 Estimated percentage of volatilized ammonia from livestock manure

Type of Animal	Value
Dairy and non-dairy cattle	10%
Swine	20%
Hen and broiler	30%

Source: Japan Livestock Technology Association, *GHGs emissions control in livestock Summary*. (2002) (Reference 22)

- ***Nitrogen eliminated by incineration or purification***

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

- ***Nitrogen in manure disposed of in direct final disposal***

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

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

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

Nitrogen content in livestock manure disposed in the direct final disposal

＝Total amount of direct final disposal and treated final disposal × Average nitrogen contents in manure treated by storage system

＝Total amount of direct final disposal and treated final disposal × Nitrogen amount in manure treated by storage system / Manure amount treated by storage system

Table 6-23 Nitrogen in livestock manure applied to agricultural soil

Item	Unit	1990	1995	2000	2005	2008	2009	2010
the amount of N in animal manure（N_{all}）	tN	789,405	748,584	708,663	683,651	687,188	684,051	684,051
the amount of N_2O-N released from animal (except Incineration method and Wastewater manage method)	tN	8,934	8,485	7,981	7,690	7,744	7,708	7,708
the amount of NH_3-N and NOx-N released from animal manure（$N_{NH3+Nox}$）	tN	144,935	137,392	130,075	125,673	127,017	126,705	126,705
the amount of N vanished by Incineration method and Wastewater manage method（$N_{inc+waa}$）	tN	69,056	60,313	57,938	56,691	58,159	58,142	58,142
the amount of N vanished by burying in the ground.（N_{waste}）	tN	489	464	429	417	512	427	427
the amount of N used as fertilizer（N_D）	tN	565,991	541,931	512,239	493,180	493,756	491,070	491,070

c） Uncertainties and Time-series Consistency

●*Uncertainties*

An uncertainty assessment was conducted for individual livestock categories. For cattle, uncertainty assessments were conducted separately for “shed” and “pastured” cattle and both uncertainties combined.

For the uncertainties of the emission factors for livestock, excluding pastured cattle, the values given in the *GPG (2000)* and the values calculated by expert judgment in accordance with the decision tree for uncertainty assessment, were applied. For the uncertainties of emission factors for pastured cattle, the values calculated by expert judgment were applied in accordance with the decision tree for uncertainty assessment.

For the uncertainties of the activity data, 0.69% (the standard error for swine given in the *Livestock Statistics*) was applied to swine, and 10.68% (the standard error for hens given in the *Livestock Statistics*) was applied to hens, and broilers. For cattle (total population), 5% is adopted, same as “6.2.1. Enteric Fermentation, Cattle”. Activity data for pastured cattle is indicated in the Livestock Statistics, but standard error is not indicated and it is difficult to judge applying above precision for cattle (total). Therefore, 50% was applied for pastured cattle in accordance with the decision tree of uncertainty.

As a result, the uncertainties of the emissions for CH_4 and N_2O were determined to be 78% and 91% for dairy cattle, 73% and 125% for non-dairy cattle, 106% and 92% for Swine, 54% and 80% for Poultry, respectively. The uncertainty assessment methods are summarized in Annex 7.

●*Time-series Consistency*

Emission factors were used consistently from FY 1989 onward by the method. Activity data were calculated consistently from FY 1989 onward from the data in *Livestock Statistics*.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. For some country specific emission factors, there were significant differences between the default emission factors. In the case, the factors of differences were analyzed. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

Since minor discrepancies between total values and integrated values from detail level for poultry population were resolved, emissions for this category from FY1998 to FY2000 and FY2005 to FY 2008 were revised. In the agricultural sector, a 3-year average has been used. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f） Source-specific Planned Improvements

As research on actual emissions has been continuously conducted by the organizations and agencies concerned, a review of emission factors and parameters will be implemented when the new data are obtained.

In addition, since the estimation of the amount of nitrogen fertilized in agricultural soil from livestock manure has a possibility of overestimate, this issue has been continuously discussed in the Committee for Greenhouse Gas Emission Estimation Methods.

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

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions for manure management from Buffalo, Sheep, Goats and Horses.

b） Methodological Issues

●***Estimation Method***

CH_4 and N_2O emissions were calculated by using the Tier 1 method in accordance with the Decision Tree of the *GPG (2000)* (Page 4.33, Fig. 4.3 and Fig. 4.4).

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

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

●***Emission Factors***

For the emission factors for CH_4, the default values for temperate zones in industrialized nations, given in the *Revised 1996 IPCC Guidelines* were used. For buffalo, the default value given for the temperate zone in Asia was used.

For the emission factors for N_2O, the default values of "Other animals" for temperate zones in Asia & Far East, given in the *Revised 1996 IPCC Guidelines* were used.

Table 6-24 Emission factors for sheep, goats and horses

Type of livestock	Emission Factors [kg-CH_4/head/year]	reference
Sheep	0.28	*Revised 1996 IPCC Guidelines* Vol. 2 p. 4.6 Table 4-4
Goats	0.18	
Horses	2.08	
Buffalo	2	*Revised 1996 IPCC Guidelines*, Vol. 3, p. 4.13, Table 4-6

Table 6-25 Emission factors for buffalo, sheep, goats and horses

Manure Management Category		[kg-N_2O-N/ kg-N]
11. Anaerobic Lagoons		0.1%
12. Liquid Systems (Pit storage)		0.1%
13. Solid Storage and Dry Lot (Sun drying)		2.0%
14. Other	g. Daily Spread	0.0%
	h. Pasture Range and Paddock	2.0%
	i. Used Fuel	0.0%
	j. Other system	0.5%

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

- ***Activity Data***

For CH_4, same as '4.A. Enteric Fermentation', Calculation of activity data for sheep and goats used the values listed in the *Statistical Document of Livestock Breeding* offered by the Japan Livestock Industry Association and horses used the values listed in the *Statistical Document of Horse* offered by the MAFF. Data for buffalo in the calculation used the population of buffalo listed in the *Statistics on Livestock in Okinawa Prefecture* (Table 6-14).

For N_2O, in order to determine the activity data for buffalo, sheep, goats, and horses, first, the total nitrogen was calculated by multiplying the population of each type of animal by the nitrogen content of manure per head of animal. Then, the amount of nitrogen per manure management category was calculated by multiplying the total nitrogen by the percentage of each management category. For the nitrogen contents of manure and the percentage of each manure management category, the default values given in the *Revised 1996 IPCC Guidelines* were used. For the population size per type of livestock, the same values used in the calculation of CH_4 emissions were used.

Table 6-26 Amounts of nitrogen in manure excreted by buffalo, sheep, goats, and horses

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

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

* Value for "Other animals" was used.

Table 6-27 Percentage of each manure management category for buffalo, sheep, goats, and horses

Treatment Category		Percentage of Treatment			
		Buffalo	Sheep	Goats	Horses
11. Anaerobic Lagoons		0%	0%	0%	0%
12. Liquid Systems (Pit storage)		0%	0%	0%	0%
13. Solid Storage and Dry Lot (Sun drying)		14%	0%	0%	0%
14. Other	g. Daily Spread	16%	0%	0%	0%
	h. Pasture, Range and Paddock	29%	83%	95%	95%
	i. Used as Fuel	40%	0%	0%	0%
	j. Other system	0%	17%	5%	5%

Source: *Revised 1996 IPCC Guidelines*

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

An uncertainty assessment was conducted for individual livestock categories. With respect to the uncertainties for emission factors for CH_4 and N_2O from each livestock, 100%—the concerned or similar sources given in the *GPG (2000)*—were applied in accordance with the decision tree for uncertainty assessment. For the uncertainty of the activity data in each livestock, 100% was applied in accordance with decision tree. As a result, the uncertainties of the emissions were determined to be 141% for each livestock. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

For emission factors, same values were used consistently from FY 1989 to FY 2008. Activity data were calculated consistently from FY 1989 onward from the data in the *Statistical Document of Livestock Breeding,* the *Statistical Document of Horse* and the L*ivestock Statistics of Okinawa*.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

In the agricultural sector, a 3-year average has been used. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f） Source-specific Planned Improvements

There is a need to discuss whether Japan's country-specific emission factors will be established on the basis of actual measurements.

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

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

6.3.4. Other (4.B.10.)

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

6.4. Rice Cultivation (4.C.)

CH_4 is generated under anaerobic conditions by the action of microbes. Therefore, paddy fields provide favorable conditions for CH_4 generation.

Intermittently and continuously flooded paddy fields are targeted in this category. In Japan, Rice cultivation is practiced mainly on intermittently flooded paddy field.

CH_4 emissions from Rice Cultivation in FY 2009 are 5,567 Gg-CO_2 eq., comprising 0.5% of total emissions (excluding LULUCF). The value represents a reduction by20.0% from FY 1990.

Table 6-28 CH_4 emissions from rice cultivation

Gas	Item	Unit	1990	1995	2000	2005	2007	2008	2009
CH_4	4.C.1.- Intermittently Flooded	Gg-CH_4	319.9	325.5	272.1	263.8	259.8	257.3	255.8
	4.C.1.- Continuously Flooded	Gg-CH_4	11.6	11.8	9.8	9.5	9.4	9.3	9.2
	Total	Gg-CH_4	331.4	337.3	281.9	273.3	269.2	266.6	265.1
		Gg-CO_2eq	6,960	7,083	5,920	5,739	5,652	5,599	5,567

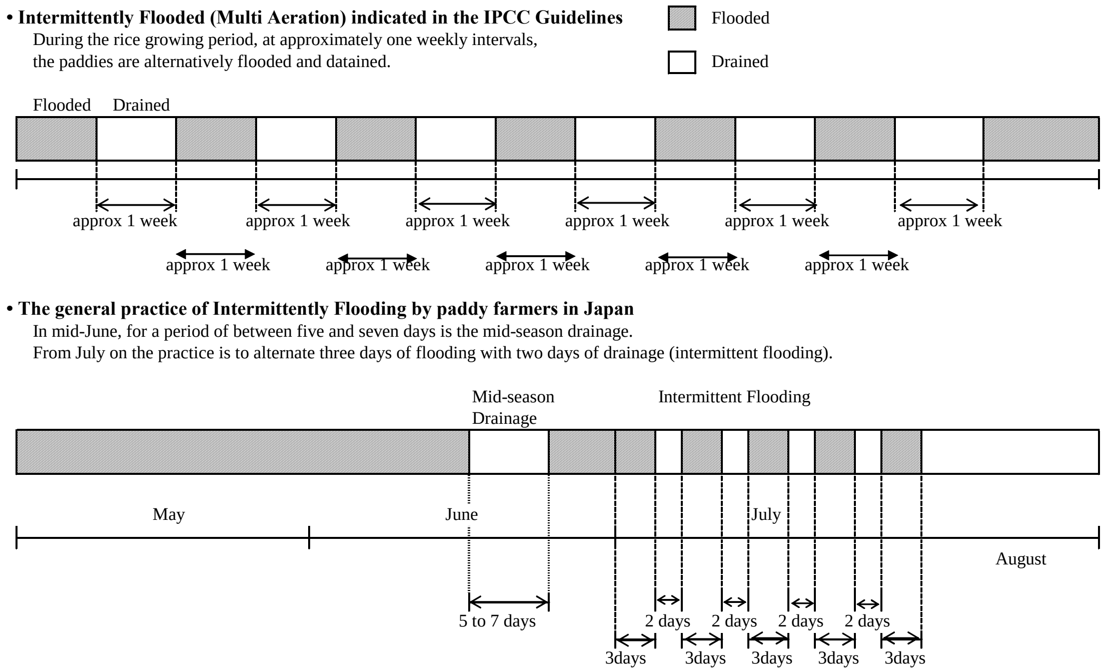
6.4.1. Intermittently Flooded (Single Aeration) (4.C.1.-)

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 emissions from intermittently flooded rice cultivation.

●***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 (multi aeration) concept in the *Revised 1996 IPCC Guidelines*. The diagram below presents the outline.



• Intermittently Flooded (Multi Aeration) indicated in the IPCC Guidelines
During the rice growing period, at approximately one weekly intervals, the paddies are alternatively flooded and datained.

• The general practice of Intermittently Flooding by paddy farmers in Japan
In mid-June, for a period of between five and seven days is the mid-season drainage.
From July on the practice is to alternate three days of flooding with two days of drainage (intermittent flooding).

Figure 6-3 Comparison of water management regime in Japan and intermittent flooding (Multi aeration) indicated in the *IPCC Guidelines*

b） *Methodological Issues*

●*Estimation Method*

CH_4 emissions from intermittently flooded paddy fields (single aeration) were calculated by taking the overall usage of organic matter management into account, since the actual measurements of emission factors per soil type for each type of organic matter management (type of applied organic matter) existed.

The amount of CH_4 generated per type of soil for each method of organic matter management was calculated by multiplying the area of intermittently flooded paddy fields by the “amount of CH_4 generated per type of soil per unit area for each management method”, “proportion of the area of each type of soil”, and “proportion of each organic management method”.

$\underline{CH_4\text{ emission from intermittently flooded paddy fields (single aeration) (kg-}CH_4\text{)}}$

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

●*Emission Factors*

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

The established emission factors are based on actual measurements of five soil types, with and without straw amendment. Actual data on soil types subject to composting is not available, but the CH_4 emission of composted soil is 1.2 to 1.3 times 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 6-29 CH_4 emission factor for intermittently flooded paddy fields (single aeration)

Type of soil	Straw amendment [g-CH_4/m²/year]	Various compost amendment [g-CH_4/m²/year]	No-amendment [g-CH_4/m²/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 (2000)　(Reference 31)

●***Activity Data***

It is assumed that intermittently flooded paddy fields (single aeration) comprise some 98% of planted paddy area and continuously flooded paddies comprise the remaining 2%[1].

The method of establishing activity data for emissions of CH_4 from intermittently flooded paddy fields (single aeration) was to multiply the planted paddy area given in the Ministry of Agriculture, Forestry and Fisheries in *Statistics of Cultivated and Planted area*, by the proportion of area by each soil types (Takata et al.. (2009)), and then by the proportion subject to organic matter management. Since the survey for proportion of organic matter management was conducted in FY2008 and FY 2009, their data was reflected to the estimation.

Table 6-30 Proportion of Japan's surface area represented by specific soil types

Soil type		~1991	1992	1997	2001	2002~
Andosol	Andosol, moist andosol, andosol gley soil	13.06%	**13.06%**	13.14%	**13.20%**	13.20%
Yellow soil	Brown forest soil, gray ground soil, gley ground soil, yellow soil, dark red soil, red soil, lithosol	11.31%	**11.31%**	11.03%	**10.80%**	10.80%
Lowland soil	Brown lowland soil, grey lowland soil, regosol	40.82%	**40.82%**	40.62%	**40.46%**	40.46%
Gley soil	Gley soil, strong gley soil	28.94%	**28.94%**	29.20%	**29.40%**	29.40%
Peat soil	Black peat, peat soil	5.85%	**5.85%**	6.02%	**6.15%**	6.15%

*1992 data and 2001 data were original data indicated in Takata et al..(2009). 1993-2000 data were calculated by using interpolation between 1992 and 2001. 1992 data was used for data before FY1991 and 2001 data was used for data after FY2002.

Source: Calculated from Takata et al..(2009) (Reference 48)

Table 6-31 Proportion of organic matter management in Japan

Organic matter	1990~2007	2008	2009
Straw amendment	60%	65%	61%
Various compost amendment	20%	18%	23%
No-amendment	20%	17%	16%

Source : 1990～2007: MAFF, *"Basis Survey of Soil Environment"* (Reference 49)
After 2008: MAFF, "Project for Development of Preventive System for Greenhouse Gas Emissions from Paddy Soils" (Reference 50)

Table 6-32 Area of paddy fields

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Area of paddy field	kha	2,055	2,106	1,763	1,702	1,624	1,621	1,625

Source: *Statistics of Cultivated and Planted Area* (MAFF) (Reference 13)

c） Uncertainties and Time-series Consistency

●***Uncertainties***

The uncertainties for CH_4 emissions from intermittently flooded (single aeration) paddy fields are assessed with respect to each organic matter management method (straw amendment, various compost amendment and no-amendment), because the uncertainty assessment methods differ for each management regime.

For the uncertainties of the emission factors the values given in the *GPG (2000)* or the values calculated by expert judgment were applied in accordance with the decision tree for uncertainty assessment. For the uncertainty of the activity data, 0.32% for area of paddy fields given in the *Statistics of Cultivated and Planted Area* was applied.

As a result, the uncertainties of the emissions were determined to be 32% for straw amendment, 32% for various compost amendment and 46% for no-amendment. The uncertainty assessment methods are summarized in Annex 7.

●***Time-series Consistency***

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

In the agricultural sector, 3-year average values have been used for estimation and report. Thus, cause of revision for proportion of organic matter management for FY 2009 and revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f） Source-specific Planned Improvements

The Ministry of Agriculture, Forestry and Fisheries is currently conducting a comprehensive study aimed at agricultural land. A part of results of this study were reflected for estimation in this year. There will be a review to be conducted on the estimation methods and parameter when new results of the study become available.

Work is progressing on developing an estimation method that uses the DNDC model, and the application of Tier 3 will be discussed in the future.

6.4.2. Continuously Flooded (4.C.1.-)

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 emissions from continuously flooded rice cultivation.

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

b） Methodological Issues

●Estimation Method

CH_4 emissions have been calculated by using country-specific emission factors for different soil types and for different organic amendments, in accordance with Decision Tree of the *GPG (2000)* (Page 4.79, Fig. 4.9).

●Emission Factors

Research results in Japan (Association for Advancement of Agricultural Science (2000), Reference 28) indicate that emissions of CH_4 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 CH_4 from continuously flooded paddy fields: divide the implied emission factor, which is gotten by divided emissions by crop field area, for intermittently flooded paddy fields by 0.565 (1-0.435). Since proportion of area by soil types and proportion of organic matter management change every year, the implied emission factor for intermittently flooded paddy fields changes every year. Therefore, the emission factor for continuously flooded paddy fields changed annually.

Table 6-33 Emission factor for CH_4 from continuously flooded paddy fields

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Continuously flooded paddy fields	$gCH_4/m^2/year$	28.12	28.12	28.12	28.12	28.62	28.38	28.38
Intermittently flooded paddy fields (single aeration)*	$gCH_4/m^2/year$	15.89	15.89	15.89	15.89	16.17	16.04	16.04

* Implied emission factor

●Activity Data

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

The method of establishing activity data for emissions of CH_4 from continuously 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%.

c） Uncertainties and Time-series Consistency

●Uncertainties

The uncertainties for emission factors were calculated from the uncertainties of each parameter decided by expert judgment. For the uncertainty for activity data, 0.32% of standard error for area of paddy field given in the *Statistics of Cultivated and Planted Area* was applied. As a result, the uncertainty of the emissions was determined to be 116%. The uncertainty assessment methods are summarized in Annex 7.

●Time-series Consistency

Refer to section *6.4.1. Intermittently Flooded*.

d） Source-specific QA/QC and Verification

Refer to section *6.4.1. Intermittently Flooded*.

e） Source-specific Recalculations

In the agricultural sector, 3-year average values have been used for estimation and report. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f）Source-specific Planned Improvements

Japan’s CH_4 emission ratio of “Intermittently Flooded / Continuously Flooded” are measured on only one site; therefore, further data collection is regarded as necessary.

6.4.3. Rainfed & Deep Water (4.C.2., 4.C.3.)

As indicated in the IRRI (International Rice Research Institute) *World Rice Statistics 1993–94*, rainfed and deep water paddy fields do not exist in Japan. Therefore, this category has been reported as “NO”.

6.4.4. Other (4.C.4.)

Just as indicated in the IRRI (International Rice Research Institute) *World Rice Statistics 1993-94*, a possible source of emissions in this category is upland rice field, but since upland rice field are not flooded, like the soil of fields, they are aerobic and do not become anaerobic. The bacteria that generate CH_4 are obligatory anaerobic bacterium, and unless the soil is maintained in an anaerobic state, there will be no generation of CH_4. As generation of CH_4 is not feasible, this category was reported as “NA”.

6.5. Agricultural Soils (4.D.)

This section provides the estimation methods for N_2O direct emissions from soils (by applied synthetic fertilizers, organic fertilizers, nitrogen fixation by N-fixing crops, crop residue and plowing of organic soil), and for N_2O indirect emissions (by atmospheric deposition and nitrogen leaching and run-off).

●***Direct Emissions (N_2O)***

Application of synthetic fertilizers, organic fertilizers, nitrogen fixation by N-fixing crops or use of crop residues for soil amendment generates ammonium ions in the soil. The soil emits N_2O in the process of oxidizing the ammonium ions into nitrate-nitrogen under aerobic conditions. N_2O is emitted via denitrification of nitrate. N_2O is generated when organic soil containing nitrogen is plowed.

●***Indirect Emissions (N_2O)***

Nitrogen compounds such as ammonia, that volatilize and are released into the atmosphere from synthetic fertilizers applied to agricultural soils and organic fertilizers derived from livestock manure are deposited on soil as the results of various actions, including turbulent diffusion, molecular diffusion, effect of electrostatic forces, chemical reactions, plant respiration, and being washed put of the air by rain. In this section, the amount of N_2O generated by microbe activity on the deposited nitrogen compounds was calculated.

N_2O is generated by the action of microbes on nitrogen that leaches or runs off as nitrate from synthetic fertilizers and manure-derived fertilizers applied to agricultural soil.

N_2O emissions from agricultural soils in FY 2009 are 5,842 Gg-CO_2 eq., comprising 0.5% of total emissions (excluding LULUCF). The value represents a reduction by 26.0% from FY 1990.

Table 6-34 N_2O emissions from agricultural soils

Gas	Item		Unit	1990	1995	2000	2005	2007	2008	2009
N_2O	4.D.1. Direct Emission	Synthetic Fertilizers	Gg-N_2O	6.2	5.4	4.9	4.8	4.4	4.1	3.7
		Organic Fertilizers	Gg-N_2O	4.3	3.9	3.6	3.5	3.4	3.4	3.4
		N-fixing Crops	Gg-N_2O	0.3	0.2	0.3	0.3	0.3	0.3	0.3
		Crop Residue	Gg-N_2O	2.2	2.2	2.1	2.0	2.0	2.0	2.0
		Plowing of Organic Soil	Gg-N_2O	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	4.D.2. Pasture, Range and Paddock Manure		Gg-N_2O	0.04	0.04	0.03	0.03	0.04	0.04	0.04
	4.D.3. Indirect Emission	Atmospheric Deposition	Gg-N_2O	5.1	4.8	4.4	4.3	4.3	4.2	4.1
		Nitrogen Leaching and Run-off	Gg-N_2O	6.9	6.4	5.8	5.6	5.4	5.2	5.0
	Total		Gg-N_2O	25.5	23.3	21.6	20.9	20.2	19.6	18.8
			Gg-CO_2eq	7,898	7,210	6,703	6,468	6,267	6,077	5,842

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

6.5.1.1. Synthetic Fertilizers (4.D.1.-)

a） Source/Sink Category Description

This section provides the estimation methods for N_2O emissions by the application of synthetic fertilizers.

b） Methodological Issues

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

N_2O emissions were calculated, using country-specific emission factors in accordance with Decision Tree of the *GPG (2000)* (Page. 4.55 Fig. 4.7).

N_2O emissions associated with the application of synthetic fertilizer in agricultural soil (crop field) (kg-N_2O)

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

●***Emission Factors***

Emission factors were established based on actual data measurement conducted in Japan.

Emission factors for N_2O associated with the application of synthetic fertilizers and organic fertilizers were defined as the same value, because there was no significant difference between emission factors of synthetic fertilizers and organic fertilizers, analyzing data for N_2O emissions from agricultural fields in Japan.

Comparing emission factors among various crops, it was identified that emission factor of tea was significantly higher and emission factor of rice was significantly lower than those of other crops. As there were not significant differences among the other crops, three emission factors were defined (for rice, tea and other crops). Emission factor of Japan is lower than that of default value in the *Revised 1996 IPCC Guidelines*. It is the reason that the volcanic ash soil that is widely distributed in Japan releases little N_2O emissions. The emission factor of rice is adopted as a default value within the 2006 IPCC Guidelines and its validity has been internationally confirmed.

Table 6-35 N_2O emission factor for synthetic fertilizer to agricultural soil

Crop species	Emission Factor（kg-N_2O-N/kgN）
Paddy rice	0.31 %
Tea	2.9 %
Other species	0.62 %

（Reference）Akiyama et al., Direct N_2O emissions and estimate of N_2O emission factors from Japanese agricultural soils. (2006) (Reference 39)

Akiyama et al., Estimations of emission factors for fertilizer-induced direct N_2O emissions from agricultural soils in Japan: Summary of available data (2006) (Reference 40)

●*Activity Data*

For coordination with the way emission factors have been set, the amount of synthetic fertilizer used by crop type is used as the activity data. The amount of synthetic fertilizer used can be ascertained from statistical information on the total amount used, but because there are no data enabling one to determine the annual amounts applied by crop type, values corresponding to the amounts of nitrogen applied for each crop type are found by taking the area of land planted with each crop type that can be found using statistical information and multiplying by the results of studies on the amounts of synthetic fertilizers applied per unit area for each crop type in Japan. Total synthetic fertilizer demand is apportioned to each crop type in accordance with the corresponding application amount for each crop type.

Activity data for N_2O emissions from the application of synthetic fertilizers to crop field

Amount of nitrogen-based fertilizer applied to agricultural soil of each crop field [t]
＝ Demand for synthetic fertilizer [tN] × (Area of each crop field [ha] × Amount of synthetic fertilizer used in each crop field [kgN/10a]) / (Σ Area of each crop field [ha] × Amount of synthetic fertilizer used in each crop field [kgN/10a])

The amounts of fertilizer applied by crop type are known because the amounts of synthetic and organic fertilizers applied for each crop type were determined by a farming study conducted in 2000 (*A report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000 F.Y.* (Reference 28)). Because experts reason that there is likely little year-on-year change in application amounts to crops except for paddy rice and tea, data on the amounts of synthetic fertilizer applied per unit area according to the 2000 study (Reference 28) were applied uniformly for these crops in all years.

Because of regulations and other factors, fertilizer application amounts for tea change from year to year. Nonaka (2005) (Reference 45) has found the amounts of nitrogen applied to tea fields (the total of synthetic and organic) in 1993, 1998, and 2002. For these application amounts, the ratio of synthetic fertilizer to organic fertilizer applied to tea according to the 2000 study (Reference 28) was used to estimate the amounts of synthetic and organic fertilizer applied, which were then used in calculations. Time-series data were prepared by interpolating from 1993 to 2002, using the 1993 data for previous years, and using the 2002 data for subsequent years (see Table 6-34). For paddy rice, the report uses application amount data for years that can be determined using Statistical Survey on Farm Management and Economy (Ministry of Agriculture, Forestry and Fisheries). The value of paddy rice was substituted for upland rice.

Table 6-36 Demand for synthetic fertilizer

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Demand for Synthetic Fertilizer	tN	611,955	527,517	487,406	471,190	360,056	*360,056*	*360,056*

** The data for 2009 and 2010 are substituted by the data for 2008*

Table 6-37 Amount of synthetic fertilizers application per area by each type of crop (other than rice and tea)

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

Table 6-38 Amount of synthetic fertilizers application per area (rice and tea)

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Amount of synthetic fertilizers application per area (rice)	kg-N/10a	9.65	8.71	7.34	6.62	6.47	*6.47*	*6.47*
Amount of synthetic fertilizers application per area (tea)	kg-N/10a	57.23	54.88	48.06	44.76	44.76	44.76	44.76

** The data of rice for 2009 and 2010 are substituted by the data for 2008*

Table 6-39 Area of cropping by each type of crop

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Vegetables *	ha	620,100	564,400	524,900	476,300	469,500	468,700	*468,700*
Rice	ha	2,055,000	2,106,000	1,763,000	1,702,000	1,624,000	1,621,000	1,625,000
Fruit *	ha	346,300	314,900	286,200	265,400	254,700	250,700	*250,700*
Tea	ha	58,500	53,700	50,400	48,700	48,000	47,300	46,800
Potatoes *	ha	115,800	104,400	94,600	86,900	84,900	83,100	*83,100*
Pulse *	ha	256,600	155,500	191,800	193,900	199,700	197,500	*197,500*
Feed crops	ha	1,096,000	1,013,000	1,026,000	1,030,000	1,012,000	1,008,000	1,012,000
Sweet potato *	ha	60,600	49,400	43,400	40,800	40,700	40,500	*40,500*
Wheat	ha	366,400	210,200	236,600	268,300	265,400	266,200	265,700
Coarse cereal	ha	29,600	23,400	38,400	45,900	49,100	47,500	*47,500*
Mulberries *	ha	59,500	26,300	5,880	2,998	2,011	2,011	*2,011*
Industrial crops	ha	142,900	124,500	116,300	110,300	107,520	106,430	107,580
Tobacco	ha	30,000	26,400	24,000	19,100	16,780	15,770	15,120
Upland rice	ha	18,900	11,600	7,060	4,470	3,200	3,000	2,890

** Data for 2010 are substituted by data for 2009*

data	references
Demand for synthetic (chemical) fertilizer	*Yearbook of Fertilizer Statistics (Pocket Edition)*
Amount of synthetic fertilizers application per area (rice)	Ministry of Agriculture, Forestry and Fisheries (MAFF) *: "Reserch of agricultural management"*
Amount of synthetic fertilizers application per area (tea)	Kunihiko Nonaka (2005) (References 45),
Amount of synthetic fertilizers application per area by each type of crop (other than rice and tea）	*Establishment of GHGs reduction model, Incorporated foundation, Association for Advancement of Agricultural Science* (2002), (References 28)
Area of cropping: Vegetables, rice, Fruit, Tea, Pulse, Feed crops, Sweet potato, Wheat, Buckwheat, Mulberries(-2001), Industrial crops	*MAFF, Statistics of Cultivated and Planted Area* *Note: The values of "Potatoes" is excluded in "Vegetable", and "Tea" and "Tobacco" is excluded in "Industrial crops".*
Area of cropping: Potatoes	*MAFF, Vegetable Production and Shipment Statistics*
Area of cropping: Tobacco	*Japan Tobacco Survey*
Mulberries(2002-)	*MAFF Survey*

c） Uncertainties and Time-series Consistency

●*Uncertainties*

N_2O emissions by the application of synthetic fertilizers were estimated for each crop species. Thus, the uncertainties of N_2O emissions by the application of synthetic fertilizers were also calculated for each crop species and then finally combined as total uncertainties. The uncertainties for the emission factors were calculated by combining the uncertainties of parameters, estimated by expert judgment or using sample standard deviations. As a result, the uncertainties for emission factors were determined to be 220.0% for paddy rice, 211.7% for tea, 181.7% for other crops. For the uncertainty for activity data, 0.32% for paddy rice and 0.28% for other crops (the value for area of upland fields), which is standard error given in the Statistics of Cultivated and Planted Area, was applied. As a result, the uncertainties of the emissions were determined to be 139%. The uncertainty assessment methods are summarized in Annex 7.

●*Time-series Consistency*

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

Because the agriculture sector uses three-year averages, FY2008 emission recalculation results are influenced by FY2009 revisions and updates of activity data for each crop type.

f） Source-specific Planned Improvements

The same emission factor has been used for synthetic and organic fertilizers. Thus, it is needed to discuss whether it is possible to obtain separate emission factors for these two types of fertilizer.

6.5.1.2. Organic Fertilizer (Application of Animal Waste) (4.D.1.-)

a） Source/Sink Category Description

This section provides the estimation methods for N_2O emissions by application of organic fertilizer (livestock and other compost and barnyard manure).

b） Methodological Issues

●Estimation Method

Emissions of N_2O have been calculated in accordance with Decision Tree of the *GPG (2000)* (Page 4.55, Fig. 4.7).

N_2O emissions from the application of organic fertilizers to agricultural soils (kg-N_2O)

＝ $\Sigma_{\text{Type of crop}}$ ｛Emission factor by type of crop (kg-N_2O-N/kg-N）
×amount of nitrogen applied, by type of crop (kg-N)｝ ×44/28

●Emission Factors

The same country specific emission factor used for synthetic fertilizer is used. (Table 6-35)

●Activity Data

Activity data was derived by multiplying the area of cultivation for each type of crop, by the amount of nitrogen applied per unit area for each type of crop (excluding tea). Because of regulations and other factors, fertilizer application amounts for tea change from year to year, same as the synthetic fertilizers. Nonaka (2005) (Reference 45) has found the amounts of nitrogen applied to tea fields (the total of synthetic and organic) in 1993, 1998, and 2002. For these application amounts, the ratio of synthetic fertilizer to organic fertilizer applied to tea according to the 2000 study (Reference 28) was used to estimate the amounts of synthetic and organic fertilizer applied, which were then used in calculations. Time-series data were prepared by interpolating from 1993 to 2002, using the 1993 data for previous years, and using the 2002 data for subsequent years (see Table 6-37). Area of cultivated land by type of crop is same as synthetic fertilizers.

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

Table 6-40 Amount of nitrogen as organic fertilizers application per area by each type of crop (excluding tea)

Type of crop	Amount of application [kg-N/10a]
Vegetables	23.62
Paddy rice *	3.2
Fruit	10.90
Potatoes	7.94
Pulse	6.24
Feed crops	10.00
Sweet potato	8.85
Wheat	5.70
Coarse cereal (including Buckwheat)	1.81
Mulberries	0.00
Industrial crops	3.96
Tobacco	11.41

*the value of paddy rice was substituted for upland rice.

Table 6-41 Amount of nitrogen as organic fertilizers application per area for tea

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Amount of organic fertilizers application per area (tea)	kg-N/10a	20.77	19.92	17.44	16.24	16.24	16.24	16.24

Data	Source
Amount of nitrogen applied per unit area, by type of crop (excluding tea)	*Association for Advancement of Agricultural Science, A report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000 F.Y.. (Reference 28)*
Amount of nitrogen applied per unit area for tea	*Total amount of synthetic and organic fertilizers : Nonaka (2005) (Referenace 45)*

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

An uncertainty assessment was conducted by the same method as in *6.5.1.1. Synthetic Fertilizers*. As a result, the uncertainty of the emissions was determined to be 152%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

In the agricultural sector, a 3-year average has been used. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f） Source-specific Planned Improvements

Refer to section *6.5.1.1. Synthetic Fertilizers*.

6.5.1.3. N-fixing Crops (4.D.1.-)

a） Source/Sink Category Description

This section provides the estimation methods for N_2O emissions from nitrogen fixed by N-fixing crops.

b） Methodological Issues

- ***Estimation Method***

Emissions are calculated by taking the amount of nitrogen fixed by nitrogen-fixing crops, which is estimated using Japan’s observation data, and multiplying by country-specific emission factor.

$$E = EF * F_{BN} * 44/28$$

E : N_2O emission associated with N-fixation by N-fixing crops (kg-N_2O)
EF : Emission factor (kg-N_2O- N/kg-N)
F_{BN} : Amount of nitrogen fixed by N-fixing crops (kg-N)

- ***Emission Factors***

The N_2O emission factor for emissions from application of synthetic fertilizer, which is set using

Japan's measurement results, is set on the basis of emissions from both nitrogen from fertilizer application and the amount of nitrogen fixed by nitrogen-fixing crops. Therefore, it is set as the emission factor of N_2O emissions from nitrogen fixed by N fixing crops. Although there are three kinds of emission factors for synthetic fertilizers, such as for "rice", "tea", and "other crops", (see Table 6-35), the EF of "other crops" (0.0062[kgN_2O-N/kg-N]) is applied in view of the target crops.

- ***Activity Data***

The amount of nitrogen in the above-ground part biomass of N fixing crops is considered to be reasonably substituted for the amount of annual nitrogen fixation by the N fixing crops cultivated in one year. The nitrogen content data in the harvest in the crops and a harvest residue of our country in Owa (1996) was used, and the nitrogen amounts fixed by N fixing crops are calculated by the following methods. The target crops are broadly classified into "pulse (dried grain) and vegetables", and "feed crops."

- ***Pulse (dried grain) and Vegetables***

Included in calculations for nitrogen-fixing crops are the pulses (dried seeds) of soybeans, adzuki beans, kidney beans, and peanuts, and the vegetables of string beans, snow peas, broad beans, and green soybeans.

The amount of nitrogen fixed by nitrogen-fixing crops (F_{BN}) was set by transforming Tier 1b Equation 4.26 of GPG (2000) and multiplying the crop yield for N-fixing crops ($Crop_{BFi}$) by the amount of nitrogen per crop yield and crop residue, which was determined by Japanese research data.

$$F_{BN} = \sum_i \left[Crop_{BFi} \bullet (Frac_{NCRBFi} + Frac_{NRESBFi}) \right]$$

F_{BN} : The amount of nitrogen fixed by N-fixing crops (kg-N)

$Crop_{BFi}$: Actual crop yield for N-fixing crops *i* (t)

$Frac_{NCRBFi}$: Amount of nitrogen per crop yield for N-fixing crops *i* (kg-N/t)

$Frac_{NRESBFi}$: Amount of nitrogen per crop residue for N-fixing crops *i* (kg-N/t)

- ***Feed crops***

In Japan, grass and legume feed crops are sown together. Statistical information enables one to ascertain only the crop yield and planted areas of grass-only feed crops and mixed grass–legume feed crops. Because that makes it impossible to directly find the harvest amount and planted area of legume-only feed crops, for the sake of convenience, it is used 10% for the proportion of legume feed crops in mixed-sown in accordance with the judgments of experts based on a Japanese study[2] and other sources, and estimated the crop yield of legume feed crops.

Japanese research data include those on the nutrient content in the stubble and roots of grass–legume mixed feed crops, and taking into account that calculations for nitrogen-fixing crops in the *2006 IPCC Guidelines* cover the amount of aboveground biomass residue and underground biomass plowed into soil, it was decided that calculation of the nitrogen amount fixed by legume feed crops would directly use the amount of nitrogen in stubble and root residue instead of the amount of nitrogen in harvested aboveground biomass, and estimates were made with the following equation, obtained by

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[2] Research results of Hokkaido prefectural Agricultural Experiment Stations" Current status and issues of feed crop production in meadow in Hokkaido I. Current status of crop yield and nutrient value" http://www.agri.pref.hokkaido.jp/center/kenkyuseika/gaiyosho/h12gaiyo/20003161.htm

transforming GPG (2000) Equation 4.27.

$$F_{BN} = \sum_i \left[Crop_{BF} \bullet Frac_{NCBGF} \right]$$

F_{BN} : Amount of nitrogen fixed by leguminous feed crops (kg-N)

$Crop_{BF}$: Actual crop yield for leguminous feed crop (t)

$Frac_{NCBGF}$: Amount of nitrogen contained in the underground part per crop yield for leguminous feed crop (kg-N/t)

Table 6-42 Parameters used in estimating for N-fixing crops

Type of crop	Amount of fixed nitrogen per unit crop yield (kg-N/t)	Proportion of dry matter
Soybeans	69.17	1.000
Adzuki beans	40.68	1.000
Kidney beans	50.13	1.000
Peanuts	63.00	1.000
Strings beans	1.98*[2]	0.302*[1]
Snow pea	2.65*[2]	0.302*[1]
Broad beans	9.57*[1]	0.302*[1]
Green soybeans	9.57	0.302
Leguminous feed crop	2.74	0.200

*1 The value for green soybeans is substituted.

*2 Each crop value are calculated by using nitrogen ratio included in harvest for each crop and green soybeans and by using the amount of fixed nitrogen per unit crop yield for green soybeans .

c）Uncertainties and Time-series Consistency

- ***Uncertainties***

N_2O emissions for nitrogen fixed by N fixing crops were estimated for each crop species. Thus, the uncertainties of N_2O emissions for nitrogen fixed by N fixing crops were also calculated for each crop species and then finally combined as total uncertainties. The uncertainties for the emission factors were calculated by combining the uncertainties of parameters decided by expert judgment and indicated in GPG (2000). The uncertainties for activity data were determined to be 0.28% of standard error for the area of crop field indicated in the Statistics of Cultivated and Planted Area. As a result, the uncertainties for emission from nitrogen fixed by N fixing crops were determined to be 99%.

- ***Time-series Consistency***

Emissions are estimated by using consistent estimation methods and data sources.

d）Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e）Source-specific Recalculations

In the agricultural sector, a 3-year average has been used. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f）Source-specific Planned Improvements

More detailed work is needed on the percentage of legume feed crops in mixed-sown pastures. Currently there are insufficient data on crop residue plowed into soil, which is needed for the transition to calculations conforming to those of the *2006 IPCC Guidelines*. For that reason this will be set aside as a matter for future consideration, along with improving the calculation method for crop residue plowed into soil.

6.5.1.4. Crop Residue (4.D.1.-)

a） Source/Sink Category Description

This section provides the estimation methods for N_2O emissions by crop residue plowed into soil.

b） Methodological Issues

●***Estimation Method***

N_2O emissions associated with the application of crop residues to agricultural soils were calculated by multiplying the default emissions factors given in the Revised 1996 IPCC Guidelines by the nitrogen input through the use of crop residues plowed into soil.

N_2O emission associated with the use of crop residues plowed into soil (kg-N_2O)
= Default emission factor [kg-N_2O-N/kg-N] × Nitrogen input through the use of crop residues plowed into soil [kg-N] ×44/28

●***Emission Factors***

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

●***Activity Data***

[Rice]

For the amount of rice crop residue plowed into soil, the data for rice straw and rice chaff indicated in the survey of MAFF was used. The nitrogen content of this crop was calculated by multiplying the aforementioned data by nitrogen content in crop residue (kgN/t) calculated from Matsumoto (2000).

[Wheat, Barley]

The total amount of nitrogen in residue for wheat and barley was calculated by multiplying the amount of crop production by nitrogen content in residue per crop production calculated from Matsumoto (2000). Amount of nitrogen in residue plowed into soil was calculated by multiplying the total amount of nitrogen in residue by the proportion of the amount of nitrogen in residue plowed into soil estimated from crop area of each treatment for wheat straw surveyed by MAFF.

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

The amount of nitrogen in each crop residue plowed into soil were calculated by multiplying nitrogen content in residue per crop production calculated from Matsumoto (2000) by annual crop production by the ratio other than burned in the field (burned in the field: 0.1, the default value in the *Revised 1996 IPCC Guidelines*).

For the amount of nitrogen in crop residue plowed into soil, the data of the *Document of Kagoshima prefectural Institute for Agricultural Development* was used for sweet potato and sugarcane, and the data of *Hokkaido Fertiliser Recommendations 2010* was used for sugarbeets and potato.

When any crop has no available data with respect to nitrogen content included in crop residue per crop production, the value for a similar type of crop was used. The same values were adopted for all fiscal years. For feed crops, the area not plowed into soil was excluded. For the crops which were assumed that field burning is not practiced in Japan, and which were not included in the calculation for the Field Burning of Crop Residues (4.F), “Proportion burned in field” were considered as “zero”.

Amount of nitrogen in crop residue plowed into soil (kg-N) (rice)
＝Annual amount of residue plowed into soil [t] × Nitrogen content in crop residue [kgN/t]

Amount of nitrogen in crop residue plowed into soil (kg-N) (wheat and barley)
$= \Sigma_{\text{crop}}$\{ Annual crop production [t] × Proportion crop residue plowed into soil per crop production [%] × Nitrogen content in residue per crop production [kgN/t]

Amount of nitrogen in crop residue plowed into soil (kg-N) (crops other than rye, oats, tea, rice, wheat and barley)
$= \Sigma_{\text{crop}}$\{ Annual crop production [t] × Nitrogen content in residue per crop production [kgN/t]×(1－Proportion burned in field)\}

Table 6-43 Residue/Crop production ratio, Nitrogen content in residue and Nitrogen content in residue per crop production for main crops

Crop type	Residue /Crop production ratio [t (residue)/ t (crop yield)] (A)	Nitrogen content in residue [kg-N/t (residue)] (B)	Nitrogen content in residue per crop production [kg-N/t (crop yield)] (A)×(B)	Note
Rice	-	6.88 [a]	-	Wet weight
Barley	1.39 [a]	3.68 [a]	0.511	Wet weight
Wheat	1.39 [a]	3.68 [a]	0.511	Wet weight
Soy	1.40 [a]	10.9 [a]	15.19	Wet weight
Potatoes	0.0321 [d]	2.22 [b]	0.71	Wet weight
Sweet potatoes	0.808 [c]	2.29 [c]	1.85	Wet weight
Sugarbeets	0.0617 [d]	15.4 [b]	0.95	Wet weight
Sugarcane	0.102 [c]	5.48 [c]	0.56	Wet weight
Maize	1.20 [a]	3.52 [a]	4.22	Wet weight

a: Matsumoto N., Development of Estimation Method and Evaluation of Nitrogen Flow in Regional Areas (2000) (Reference 55)

b: Hokkaido Government, Hokkaido Fertiliser Recommendations 2010. (2010) (Reference 56)

c: Document of Kagoshima prefectural Institute for Agricultural Development

d: Owa N., *New Trends in Technology for Efficient Use of Nutrients – Nutritional Balance of Crops in Japan* (1996) (Reference 33)

Data	Source
Percentage burned in field	*Revised 1996 IPCC Guidelines*
Cultivated area of vegetables	*Vegetable Production and Shipment Statistics* (MAFF)
Cultivated area of crops other than vegetables, and rice	*Statistics of Cultivated and Planted Area* (MAFF)
Annual amount of residue plowed into soil (rice)	*Survey by MAFF*
Proportion of crop residue for wheat and barley plowed into soil per crop yield	*Survey by MAFF*

[Rye and Oats (for grain)]

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

Nitrogen plowed into soil with crop residues (kg-N) (rye and oats)
= Annual crop yield (t) × Proportion of residue to crop yield × Average proportion of dry matter in crop residue(t-dm/t) × (1 – Proportion burned in field) × Nitrogen content(t-N/t-dm) × 10^3

The production amount of rye and oats were calculated by multiplying the planted area by the yield per unit area. The planted area was divided into the area used for grain, for green crops and for others. However, the available statistics were not reported the category of rye for grain, (the survey has been discontinued since 1992 production) and therefore the value of the “total planted area” less the “area planted for green crops” taken from the available statistics was used as the area cultivated for grain expediently, even though the planted area in this report covers the planting for grain only.

Table 6-44 Planted area of rye and oats (for grain)

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Rye	ha	50	119	110	120	150	170	170
Oats	ha	4,000	2,517	1,600	800	600	500	500

Source: The data are calculated by using the *Statistics of Cultivated and Planted Area* (MAFF) (Reference 13)

Table 6-45 Yields of rye and oats per unit area

Crop	Yield per unit area	Note
Rye	424 [kg/10a]	Data determined by specialists based on the results of rye cultivation tests in Japan
Oats	223 [kg/10a]	Data available only up to FY 1994. The 1994 figures were used for all fiscal years since most of the data before 1994 were available for major prefectures only.

Table 6-46 Proportion of residue to crop production, average proportion of dry matter in crop residues, nitrogen content

Crop	Proportion of residue	Average proportion of dry matter in residue	Nitrogen content	Proportion burned in field
Rye	2.84	0.90	0.0048	0.10
Oats	2.23	0.92	0.0070	0.10
Source	Determined by specialists	*GPG (2000)*, p. 4.58, Table 4.16		*Revised 1996 Guidelines,* Vol. 3, p. 4.83

[Tea]

For tea, "Leaf fall" and "Autumn pruning" were targeted as the residues which return into soils annually. In addition, as residues return into soil once in several years, "Medium pruning", which prunes the part of 30-50 cm from the ground and carried out once in about five years, was targeted. For the "Medium pruning", it assumed that it carried out by one fifth in every year in all area of tea field, and all of tea field will be renewal in five years. The residues’ nitrogen contents were calculated by multiplying by nitrogen contents per unit area of “Leaf fall”, “Autumn pruning” and “Medium pruning” by crop field areas. The crop field areas used for this were the data indicated in the *Statistics of Cultivated and Planted Area* by MAFF.

Nitrogen plowed into soil with crop residues (kgN) *(Tea)*
＝(Nitrogen amount included in residue by autumn pruning [kgN/10a]＋Nitrogen amount included in residue by leaf fall [kgN/10a]) ×10× Cultivated area of tea [ha] + Nitrogen amount included in the residue by medium pruning [kgN/10a]×10×1/5×Cultivated area of tea [ha]

Table 6-47 Amount of nitrogen content included in tea residue of branch pruning

Kind of branch pruning		Amount of Nitrogen content (kg-N/10a)	Reference
Autumn pruning	Annual	7.7	Hoshina et al..(1982) (Reference 51), Kinoshita et al.. (2005) (Reference 52), Tachibana et al.. (1996) (Reference 53)
Medium pruning	Once in five years	19.4	Ohta et al.. (1996) (Reference 54)
Leaf fall	Annual	11.5	Hoshina et al..(1982) (Reference 51)

c） Uncertainties and Time-series Consistency

●*Uncertainties*

Because the estimation methods differ from one crop to the other, their uncertainties were calculated for respective crops.

The uncertainties of emission factors for crops other than rye and oats were assessed for each crop by combining the uncertainties for each parameter calculated by expert judgment and given for standard values in the *GPG (2000)*. The uncertainties of emission factors for rye and oats were calculated to combine each parameter determined by expert judgment or standard values in the *GPG (2000)*, and were determined to be 388% for rye and 392% for oats.

The uncertainties for activity data were assessed as 0.28% for tea and 0.15% for other crops by applying the standard errors in the *Crop statistics* and the *Statistics of Cultivated and Planted Area*, respectively.

As a result, the uncertainty of the emission combined from each crop uncertainty was determined to be 211%. The uncertainty assessment methods are summarized in Annex 7.

●*Time-series Consistency*

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

Since the revision of nitrogen content in crop residue for each crop, nitrogen amount put in soil as crop residue were revised, and the emissions from 1990 to 2008 were revised. In the agricultural sector, a 3-year average has been used. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f） Source-specific Planned Improvements

It is needed to discuss whether it will be possible to establish country-specific emission factors for Japan.

6.5.1.5. Plowing of Organic Soil (4.D.1.-)

a） *Source/Sink Category Description*

In Japan, there are organic soils in Hokkaido. Two types, “muck soil” and “peat soil”, are treated as organic soils. In Japan, the creation of farmland on organic soils was mostly completed by the 1970s, and in general farmers till land that has had soil dressing.

b） *Methodological Issues*

●*Estimation Method*

Emissions of N_2O from the plowing of organic soil were calculated by multiplying the area of the plowed organic soil of paddy field and upland field by the emission factor in accordance with the *Revised 1996 IPCC Guidelines* and the *GPG (2000)*.

N_2O emission associated with the plowing of organic soil (kg-N_2O)
= Emission factor for plowing of organic soil [kg-N_2O/ha] × Area of plowed organic soil [ha] × 44/28

●*Emission Factors*

For paddy cultivation in organic soils, it is known that N_2O emission in paddy field is lower than the one in upland field. In Japan, Nagata (2006) (Reference 43) observed N_2O emissions for paddy of organic soil in Hokkaido, but the observations included emissions from applied nitrogen. Therefore, country-specific emission factor is determined to be 0.30 [kgN2 O-N/ha/year] by deducting country-specific emission factor of fertilizers indicated in Akiyama (2006). For the upland field of organic soil, some observation results exists (Nagata 2006, Nagata 2009 (Reference 46)), but there is not much difference from the default of temperate region (8[kgN_2O-N/ha/year]) indicated in GPG(2000) p4.60 Table4.17. Therefore, default value is used for upland field.

●*Activity Data*

The area of plowed organic soil was established by multiplying the cultivated areas of paddy fields and common upland fields, obtained from the *Statistics of Cultivated and Planted Area* (MAFF), by the percentage of organic soils (peat soil and muck soil) in paddy fields and common upland fields in Japan. The percentage of organic soils was used data made from Takata et al..(2009)

Table 6-48 Percentage of organic soil

Soil type	~1991	1992	1997	2001	2002~
Paddy field	5.85%	**5.85%**	6.02%	**6.15%**	6.15%
Upland field	1.94%	**1.94%**	2.01%	**2.07%**	2.07%

*1992 data and 2001 data were original data. 1993-2000 data were calculated by using interpolation between 1992 and 2001. 1992 data was used for data before 1991 and 2001 data was used for data after 2002.

Source: Calculated from Takata et al..(2009) (Reference 48)

Table 6-49 Areas of organic soil

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Area of organic soil (paddy field)	ha	166,491	163,328	161,541	157,194	154,734	154,119	153,504
Area of organic soil (field)	ha	24,735	24,296	24,420	24,281	24,240	24,198	24,198

c） Uncertainties and Time-series Consistency

●***Uncertainties***

N_2O emissions by plowing of organic soil were calculated in two category, paddy field and upland field. Therefore, the uncertainties were also calculated separately, and finally two uncertainties were combined as total uncertainty.

The uncertainties for emission factors were calculated aggregating the uncertainties of each parameter given in the *GPG (2000)* and references or calculated from the data of references. The combined uncertainties for emission factor were determined to be 248% for paddy field and 900% for upland field. For the uncertainty for activity data, 0.12% of the standard error for paddy rice and 0.28% of the standard error for upland field crops given in the *Statistics of Cultivated and Planted Area* were applied. As a result, the uncertainties of the emissions were determined to be 712%. The uncertainty assessment methods are summarized in Annex 7.

●***Time-series Consistency***

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

In the agricultural sector, a 3-year average has been used. Thus, cause of revision and update of the activity data for FY 2009, the emissions for FY 2008 were revised accordingly.

f） Source-specific Planned Improvements

For paddy field, the country-specific emission factor is used. However, there are issues such as the exclusion of influence for stubble which remains in the ground surface after harvest and influence of the plowing into soil of crop residue such as straw to avoid double counting of N_2O emission with plowing-in of crop residue. It is necessary to advance further detailed checking so that the more suitable national condition can be reflected to the emission factor, including upland field which use default emission factor.

6.5.1.6. Direct Emissions (CH_4)

CH_4-generating bacteria are absolutely anaerobic, and if soil is not maintained in an anaerobic state, CH_4 generation is not possible. Upland soils are normally oxidative and in aerobic condition. Therefore, CH_4 is not produced by these soils. For that reason, direct emission of CH_4 from soil has been reported as “NA”.

6.5.2. Pasture, Range and Paddock Manure (4.D.2.)

The method for calculating CH_4 and N_2O emissions from pasture, range, and paddock cattle manure is described in 6.3.1 “Livestock Waste Management: Cattle, Swine and Poultry (4.B.1., 4.B.8., 4.B.9.)” (see 6.3.1). N_2O emissions are counted in 4.D.2.

6.5.3. Indirect Emissions (4.D.3.)

6.5.3.1. Atmospheric Deposition (4.D.3.-)

a） Source/Sink Category Description

This section provides the estimation methods for N_2O indirect emissions caused by atmospheric deposition of nitrogen compounds volatilized as NH_3 and NOx from synthetic fertilizer or domestic livestock manure.

b） Methodological Issues

●***Estimation Method***

N_2O emissions have been calculated in accordance with Decision Tree of the *GPG (2000)* (Page 4.69, Fig. 4.8).

Calculation of N_2O emissions associated with atmospheric deposition

Emissions of N_2O from atmospheric deposition [kg-N_2O]
＝ emission factor [kg-N_2O-N/kg-NH_3-N+NO_X-N]
× Amount of nitrogen volatilized from ammonia and nitrogen oxides from livestock manure and synthetic fertilizers [kg-NH_3-N+NO_X-N] × 44/28

●***Emission Factors***

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

Table 6-50 Emission factor for N_2O emissions associated with atmospheric deposition

	Emission Factor [kg-N_2O-N/kg-NH_3-N & NO_X-N deposited]
N_2O emissions associated with atmospheric deposition	0.01

Source: *Revised 1996 IPCC Guidelines* Vol.2 Table 4-18 (*GPG (2000)* Table4.18) (Reference 3)

●***Activity Data***

The amounts of nitrogen (kg) contained in ammonia and nitrogen oxides that volatilize from synthetic fertilizers and livestock manure applied to agricultural soil were calculated for activity data. For the amount of manure-derived nitrogen applied to agricultural soil, the portion of nitrogen content in the livestock manure in Japan which was returned to agricultural soil, calculated in the *4.B. Manure Management* section, was used to maintain consistency in the nitrogen cycle. Also, the portion of human waste which was returned to agricultural soil as fertilizer was added to the activity data reported in this section.

$$A = N_{FERT} * Frac_{GASF} + N_{ANI}$$
$$= N_{FERT} * Frac_{GASF} + N_B * Frac_{GASM1} + (N_D + N_{FU}) * Frac_{GASM2}$$

A:	Amount of nitrogen that volatilizes as ammonia and nitrogen oxides from synthetic fertilizers, livestock manure, and human waste (kg-NH_3-N+NO_x-N)
N_{FERT}:	Demand for synthetic nitrogen fertilizers (kg-N)
$Frac_{GASF}$:	Percentage of volatilization as ammonia and nitrogen oxides from synthetic fertilizers (kg-NH_3-N + NO_X-N/kg-N)
N_{ANI}:	Amount of nitrogen that volatilizes as ammonia and nitrogen oxides from livestock manure and human waste (kg-NH_3-N + NO_X-N/kg-N)
N_B:	Amount of nitrogen included in livestock manure (kg-N)

$Frac_{GASM1}$:	Percentage of volatilization as ammonia and nitrogen oxides from livestock manure during treatment (kg NH_3-N + NO_X-N/kgN)
N_D:	Amount of manure-derived fertilizer applied to agricultural soil (kg-N)
N_{FU}:	Amount of human waste-derived fertilizer applied to agricultural soil (kg-N)
$Frac_{GASM2}$:	Percentage of volatilization as ammonia and nitrogen oxides from nitrogen contained in livestock manure and human waste applied to agricultural soils(kg-NH_3-N + NO_X-N/kg-N)

For synthetic fertilizers, "demand for nitrogen-based fertilizers" given in the Ministry of Agriculture, Forestry and Fisheries *Yearbook of Fertilizer Statistics (Pocket Edition)* was used for the amount of fertilized nitrogen (N_{FERT}), and the default value given in the *Revised 1996 IPCC Guidelines* was used for the percentage of volatilization ($Frac_{GASF}$).

For livestock manure, the values determined in the *Manure Management (4.B.)* section (excluding the amount dispersed in the atmosphere as N_2O as well as the amount treated by the "Incineration" or "Purification" in the *Manure Management (4.B.)*) (Table 6-19) was used for livestock manure applied to farmland (N_D), and the default value given in the *Revised 1996 IPCC Guidelines* was used for the percentage of volatilization ($Frac_{GASM}$).

Activity data of human waste was calculated by multiplying the amount of human waste-derived nitrogen calculated with *Waste Treatment in Japan* by the value indicated in Table 6-19.

The amount of nitrogen volatilized in the process of treating livestock manure as NH_3 and NOx was calculated by multiplying the nitrogen amount of livestock manure excreted in shed and pasture (N_B) by the figures indicated in Table 6-19.

Table 6-51 Proportion of nitrogen volatilized from synthetic fertilizers and livestock manure as ammonia or nitrogen oxides

	Value	Unit
$Frac_{GASF}$	0.1	[kg-NH_3-N + NO_X-N/kg of synthetic fertilizer nitrogen applied]
$Frac_{GASM}$	0.2	[kg-NH_3-N + NO_X-N/kg of nitrogen excreted by livestock]

Source: *Revised 1996 Guidelines* Vol. 2, Table 4-17 (Reference 3)

Table 6-52 Nitrogen returned to agricultural soil

Item	Unit	1990	1995	2000	2005	2008	2009	2010
N applied to agriclutural soil from livestock waste	tN	565,991	541,931	512,239	493,180	493,756	491,070	491,070
N applied to agriclutural soil from human waste	tN	10,394	4,747	2,116	874	1,702	457	457

c） Uncertainties and Time-series Consistency

●Uncertainties

N_2O emissions volatilized from atmospheric deposition were calculated in two categories, nitrogen compounds derived from synthetic fertilizer and from livestock manure (including human waste). Therefore, the uncertainties were also calculated separately, and finally two uncertainties were combined as total uncertainty.

The uncertainties for emission factors were calculated by aggregating the uncertainty of each parameter, estimated by expert judgment or given as the standard values in the *GPG (2000)*. The aggregated uncertainty of emission factor was 107% for the application of synthetic fertilizer, and 71% for the application of livestock manure. For the uncertainties of the activity data for applied synthetic fertilizers, the same values as in *6.5.1.1. [Direct Soil Emission:] Synthetic Fertilizers* were applied. For applied livestock manure, the uncertainties of the activity data were calculated from *6.3.1. [Manure Management:] Cattle, Swine, and Poultry*. The total emissions uncertainty aggregated from all the uncertainties was 75%. The uncertainty assessment methods are summarized in Annex 7.

●***Time-series Consistency***

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

In responding to the revision of livestock population for poultry in the Manure Management (4.B.), the amount of livestock-origin nitrogen returns into crop field soil was changed; therefore, emissions for this category from FY1998 to FY2000 and FY2005 to FY 2008 were revised.

f） Source-specific Planned Improvements

It is needed to discuss the establishment of country-specific emission factors and the ratios of volatile nitrogen compounds in synthetic fertilizers.

6.5.3.2. Nitrogen Leaching and Run-off (4.D.3.-)

a） Source/Sink Category Description

This section provides the estimation methods for N_2O emissions from Nitrogen Leaching and Run-off.

b） Methodological Issues

●***Estimation Method***

N_2O emissions were calculated according to the Decision Tree in the *GPG (2000)* (Page 4.69, Fig. 4.8), by multiplying Japan’s country-specific emission factors by the amount of nitrogen that leached and run-off.

N_2O emission associated with nitrogen that leached and run-off (kg-N_2O)
= Emission factor associated with nitrogen leaching and run-off [kg-N_2O-N/kg-N] × Nitrogen that leached and run-off [kg-N] × 44/28

●***Emission Factors***

The N_2O emission from this source was calculated using the Japan-specific emission factor that had been established by various studies.

Table 6-53 Emission factor for N_2O emissions associated with nitrogen leaching and run-off

	[kg-N_2O-N/kg-N]
N_2O emission from nitrogen that leaches or runs off	0.0124

Source: Takuji Sawamoto et al., Evaluation of emission factors for indirect N_2O emission due to nitrogen leaching in agro－ecosystems. (Reference 35)

- ***Activity Data***

Activity data was calculated by multiplying the default value of proportion of leaching and run-off given in the *Revised 1996 IPCC Guidelines* by the amount of nitrogen in livestock manure applied to agricultural soil and synthetic fertilizer derived from atmospheric deposition.

Table 6-54 $Frac_{LEACH}$: Proportion of nitrogen applied subject to leaching and run-off

Value	Unit
0.3	[kg-N/kg nitrogen of fertilizer or manure]

Source: *Revised 1996 IPCC Guidelines* Vol. 2, Table 4-17 (Reference 3)

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

N_2O emissions for nitrogen leaching and run-off were calculated in two category, synthetic fertilizer and livestock manure (including human waste). Therefore, the uncertainties were also calculated separately, and finally two uncertainties were combined as total uncertainty.

The uncertainties for emission factors were calculated aggregating the uncertainties of each parameter, estimated by expert judgments or given for standard values in the *GPG (2000)*. The aggregated uncertainty for emission factor was determined to be 113% for both synthetic fertilizers and livestock manure. For the uncertainty of activity data, the same method used at “6.5.3.1. Atmospheric Deposition” was applied. As a result, the uncertainty of the emissions was determined to be 97%. The uncertainty assessment methods are summarized in Annex 7.

- ***Time-series Consistency***

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

In responding to the revision of livestock population for poultry in the Manure Management (4.B.), the amount of livestock-origin nitrogen returns into crop field soil was changed; therefore, emissions for this category from FY1998 to FY2000 and FY2005 to FY 2008 were revised.

f） Source-specific Planned Improvements

Refer to section” 6.5.3.1. Atmospheric Deposition”.

6.5.3.3. Indirect Emissions (CH_4) (4.D.3.-)

Direct CH_4 emissions were zero, and indirect CH_4 emissions from crop fields were also taken as zero. Therefore, these sources have been reported as “NA”.

Except for atmospheric deposition or nitrogen leaching and run-off, there is no conceivable source of CH_4 emissions from cultivated farmland soil other than direct emissions from soil, animal production, and indirect emissions. Therefore, they have been reported as “NO”.

6.5.4. Other (4.D.4)

Because it is not likely that agricultural sources of CH_4 and N_2O emissions exist in Japan other than the direct soil emissions, and indirect emissions, these sources were reported as “NO” as was the case in previous years.

6.6. Prescribed Burning of Savannas (4.E.)

This source is given in the *Revised 1996 IPCC Guidelines* as “being for the purpose of managing pastureland in sub-tropical zones”. There is no equivalent activity in Japan, and this source has been reported as “NO”.

6.7. Field Burning of Agricultural Residues (4.F.)

Incomplete burning of crop residues in field releases CH_4 and N_2O into the atmosphere. CH_4 and N_2O emissions from this source are calculated and reported in this category.

Table 6-55 CH_4 and N_2O emissions from field burning of agriculture residues

Gas	Item		Unit	1990	1995	2000	2005	2007	2008	2009
CH_4	4.F.1. Cereals	Wheet	Gg-CH_4	0.42	0.23	0.30	0.40	0.41	0.38	0.33
		Barley	Gg-CH_4	0.15	0.10	0.09	0.08	0.09	0.09	0.08
		Maize	Gg-CH_4	1.89	1.66	1.48	1.32	1.34	1.37	1.38
		Oats	Gg-CH_4	0.02	0.02	0.04	0.04	0.04	0.04	0.04
		Rye	Gg-CH_4	0.002	0.002	0.002	0.002	0.002	0.002	0.002
		Rice	Gg-CH_4	2.06	2.27	1.53	1.06	0.98	0.96	0.96
	4.F.2. Pulses	Peas	Gg-CH_4	0.008	0.006	0.005	0.004	0.004	0.004	0.004
		Soybeans	Gg-CH_4	0.08	0.04	0.08	0.07	0.08	0.08	0.08
		Adzuki beans	Gg-CH_4	0.02	0.02	0.02	0.02	0.01	0.01	0.01
		Kidney beans	Gg-CH_4	0.005	0.005	0.003	0.003	0.003	0.003	0.003
		Peanuts	Gg-CH_4	0.008	0.007	0.006	0.005	0.004	0.004	0.004
	4.F.3. Tubers and Roots	Potatoes	Gg-CH_4	0.03	0.03	0.02	0.02	0.02	0.02	0.02
		Sugarbeat	Gg-CH_4	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	4.F.4. Sugarcane		Gg-CH_4	0.06	0.04	0.04	0.03	0.04	0.04	0.04
	Total		Gg-CH_4	4.8	4.5	3.7	3.1	3.1	3.1	3.0
			Gg-CO_2eq	101	94	77	65	65	64	63
N_2O	4.F.1. Cereals	Wheet	Gg-N_2O	0.006	0.003	0.005	0.006	0.006	0.006	0.005
		Barley	Gg-N_2O	0.002	0.002	0.001	0.001	0.001	0.001	0.001
		Maize	Gg-N_2O	0.03	0.02	0.02	0.02	0.02	0.02	0.02
		Oats	Gg-N_2O	0.001	0.001	0.002	0.002	0.002	0.002	0.002
		Rye	Gg-N_2O	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
		Rice	Gg-N_2O	0.056	0.062	0.042	0.029	0.027	0.026	0.026
	4.F.2. Pulses	Peas	Gg-N_2O	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
		Soybeans	Gg-N_2O	0.003	0.002	0.003	0.003	0.004	0.004	0.004
		Adzuki beans	Gg-N_2O	0.001	0.001	0.001	0.001	0.001	0.001	0.001
		Kidney beans	Gg-N_2O	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
		Peanuts	Gg-N_2O	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
	4.F.3. Tubers and Roots	Potatoes	Gg-N_2O	0.003	0.002	0.002	0.002	0.002	0.002	0.002
		Sugarbeat	Gg-N_2O	0.004	0.003	0.004	0.004	0.004	0.004	0.003
	4.F.4. Sugarcane		Gg-N_2O	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Total		Gg-N_2O	0.11	0.10	0.08	0.07	0.07	0.07	0.06
			Gg-CO_2eq	33	32	25	21	21	21	20
Total of all gases			Gg-CO_2eq	133	126	103	87	85	85	83

CH_4 and N_2O emissions from Field Burning of Agricultural Residues in FY 2009 are 63 Gg-CO_2 eq.

and 20 Gg-CO_2 eq., comprising 0.01% and 0.002% of total emissions (excluding LULUCF), respectively. The value represents a reduction by 37.3% and 38.4% for CH_4 and N_2O from FY 1990, respectively.

6.7.1. Rice, Wheat, Barley, Rye, and Oats (4.F.1.)

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions from field burning of agricultural residues of rice, wheat, barley, rye, and oats.

b） Methodological Issues

●*Estimation Method*

CH_4 and N_2O emissions were calculated, using the default method indicated in the *Revised 1996 IPCC Guidelines* and the *GPG (2000)*, by multiplying the amounts of carbon and nitrogen released by field burning by the CH_4 emission factor and N_2O emission factor, respectively.

Wheat, barley, rye, and oats were cultivated either as grain or green crops. The portions of the green crops which were cultivated for use of the entire aboveground mass for cattle feed were excluded from the calculation of emissions.

CH_4 emission associated with field burning of agricultural residues(kg-CH_4)
= CH_4 emission factor (kg-CH_4-C/kgC) × Total carbon released(kg-C) × 16/12

N_2O emission associated with field burning of agricultural residues(kg-N_2O)
= N_2O emission factor (kg-N_2O-N/kgN) × total nitrogen released(kg-N) × 44/28

●*Emission Factors*

The default values shown in the Revised 1996 IPCC Guidelines and the *GPG* (2000) were used.

Table 6-56 Emission factors for CH_4 and N_2O emissions associated with field burning of rice, wheat, barley, rye, and oats residues

	Value	Unit
CH_4	0.005	[kg-CH_4/kg-C]
N_2O	0.007	[kg-N_2O/kg-N]

Source: Revised IPCC Guidelines Vol.2 Table 4-16 (Reference 3)

●*Activity Data*

[Crops other than rice]

Activity data was calculated in accordance with the default method technique shown in the *Revised 1996 IPCC Guidelines* and the *GPG (2000)*, by multiplying by the crop yield by “Proportion of residue to crop yield”, “Proportion of dry matter in residue”, “Proportion burned in field”,” Oxidation rate” and “Carbon/nitrogen content of residues”.

Total carbon/total nitrogen released by field burning of agricultural residues(kg-C, kg-N)
= Annual crop yield (t) × Proportion of residue to crop yield × Proportion of dry matter in residue (t-dm/t) × Proportion burned in field × Oxidation rate × Carbon/nitrogen content of residues(t-C/t-dm, t-N/t-dm) × 10^3

[Rice]

For rice, Amount of burning rice straw and rice chaff on crop field is surveyed by MAFF. The residues' nitrogen content was calculated by multiplying by the aforementioned data by nitrogen content (kgN/t) indicated in Japan's country-specific data of nutrient balance for each crop (Matsumoto, 2000). Therefore, emission was calculated by multiplying by the crop yield by "Amount of burning rice straw and rice chaff", "Proportion of dry matter in residue", " Oxidation rate" and "Carbon/nitrogen content of residues".

Total carbon/total nitrogen released by field burning of agricultural residues(kgC, kgN) (Rice)

＝Amount of burning rice straw and rice chaff [t]×proportion of dry matter in residue [t-dm/t]× Oxidation rate× Carbon/nitrogen content of residues [t-C/t-dm, t-N/t-dm]×10^3

Table 6-57 Amount of burning rice straw and rice chaff on crop field

Item	Unit	1990	1995	2000	2005	2008	2009	2010
Rice straw	t	438,197	536,908	429,091	276,619	203,588	203,588	203,588
Rice chaff	t	581,302	528,290	291,260	260,289	249,870	249,870	249,870
Total	t	1,019,499	1,065,198	720,350	536,908	453,458	453,458	453,458

Reference: Survey by MAFF

- ***Annual crop yield***

[Wheat (grain), and barley (grain)]

The values reported in the *Crop Statistics* were used for the yield of wheat, and barley (grain).

- ***Wheat and barley (green crops)***

Because data of the yields of green crop wheat and barley (excluding those for fodder) were not directly available, the annual yields were calculated by multiplying the area planted with wheat for green crops and other purposes, as shown in the *Statistics of Cultivated and Planted Area*, by the yield per unit area established for green crop rye and oats (excluding those for fodder) and proportionally divided by the yield of wheat and barley (grain)..

- ***Rye and oats***

Because data of the yields of rye and oats were not directly available, the total annual yields were calculated by multiplying the area planted with rye or oats, as indicated based on the *Statistics of Cultivated and Planted Area*, by the yield per unit area

Table 6-58 Yield of rye and oats per unit area (kg/10a)

Crop	Yield per unit area	Data Source
Rye (grain)	424	Determined by specialists (based on rye crop tests in Japan)
Oats (grain)	223	MAFF, *Crop Statistics* (Reference 14)
Rye and Oats (green crops)	1,100	Determined by specialists (based on literature)

- ***Residue/ Crop production ratio, dry matter fraction in residue, carbon content, proportion burned in field, and oxidation rate.***

Table 6-55 shows the parameters for each crop. For wheat, Barley, Rye and Oats, proportion of burned in field was decided as 0.135 by using data of crop area by treating method for wheat straw surveyed by MAFF.

➢ *Nitrogen content*

The specific nitrogen content value was determined for each of rice, wheat, barley, and oats (green crop), based on the results of various studies carried out in Japan. The nitrogen content of green crop wheat/barley was calculated using the average of nitrogen contents in wheat and barley weighted by yield. The default nitrogen content values in the *GPG (2000)* were used for rye and oats (grain). The nitrogen content for rye (green crop) was calculated by multiplying Japan's country-specific value for oats (green crop) by the value resulting from "rye (grain) / oats (grain)".

Table 6-59 Proportions of residue to crop yield, dry matter in residue, carbon content, proportion burned in field, and oxidation rate

Crop	Residue/ Crop product ratio	Dry matter fraction in residue [a)]	Carbon content	Nitrogen content	Proportion burned in field	Oxidation rate
Rice	---	0.85 [a]	0.4144 [a]	0.00688 [i]	---	0.90 [b]
Wheat (grain)	1.39 [i]	0.85 [a]	0.4853 [a]	0.00368 [i]	0.135 [b]	
Barley (grain)	1.39 [i]	0.85 [a]	0.4567 [a]	0.00368 [i]	0.135 [b]	
Wheat/barley (green crop)	---	0.17 [c]	0.48 [d,g]	0.017 [h,g]	0.135 [b]	
Rye	2.84 [e]	0.90 [c]	0.4710 [f]	0.0048 [f]	0.135 [b]	
Oats	2.23 [e]	0.92 [c]	0.4710 [f]	0.007 [f]	0.135 [b]	
Rye (green crop)	---	0.17 [c]	0.4710 [f]	0.0116 [h]	0.135 [b]	
Oats (green crop)	---	0.17 [c]	0.4710 [f]	0.0169 [h]	0.135 [b]	

a: *GPG (2000)*, p. 4.58, Table 4.16 (Reference 4)

b: Survey by MAFF

c: Determined based on the percentage of dry matter in green crop wheat indicated in the *Standard Table of Feed Composition in Japan* (National Agriculture Research Organization, pub. by Japan Livestock Association)

d: Determined based on the values shown in the *GPG (2000)* for wheat (grain) and barley (grain) by apportioning for yields

e: Determined based on the results of crop tests for rye and oats in Japan

f: Used the average of the values shown for "wheat" and "barley" in the *Good Practice Guidance (2000).*

g: Values change over the years

h: Owa, *New Trends in Technology for Efficient Use of Nutrients – Nutritional Balance of Crops in Japan* (1996) (Reference 33)

i: Matsumoto N., Development of Estimation Method and Evaluation of Nitrogen Flow in Regional Areas (2000) (Reference 55)

c） Uncertainties and Time-series Consistency

●Uncertainties

The uncertainty assessment was conducted by each crop. The uncertainties for emission factors were calculated to combine the uncertainty of each parameter determined by expert judgment or given in the *GPG (2000)* as the default values. The uncertainties for activity data applied the standard error in each statistics (the *Crop Statistics* and the *Statistics of Cultivated and Planted Area*) or the value decided by the 2002 Committee for Greenhouse Gas Emission Estimation Methods. The uncertainty assessment results of the emissions by each crop were provided in Annex 7 Table 11. The uncertainty assessment methods are summarized in Annex 7.

●Time-series Consistency

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Tier 1 QC activities have been conducted in accordance with the *GPG (2000)* methods. Tier 1 QC activities focus on the verification of the parameters for activity data and emission factors and the archive of reference materials. QA/QC activities are summarized in Annex 6.1.

e） Source-specific Recalculations

In responding to the revision of residue/crop product ratio and nitrogen content for each crop, emissions from FY1990 to FY2008 were revised.

f） Source-specific Planned Improvements

For the use of the default parameter in the *Revised 1996 IPCC Guidelines* or the *GPG (2000)*,it is needed to discuss whether country-specific parameter can be established for Japan.

6.7.2. Maize, Peas, Soybeans, Adzuki beans, Kidney beans, Peanuts, Potatoes, Sugarbeets & Sugar cane (4.F.1., 4.F.2., 4.F.3., 4.F.4.)

a） Source/Sink Category Description

This section provides the estimation methods for CH_4 and N_2O emissions from field burning of agricultural residues by Maize, Peas, Soybeans, Adzuki beans, Kidney beans, Peanuts, Potatoes, Sugarbeet & Sugar cane.

b） Methodological Issues

●*Estimation Method*

CH_4 and N_2O emissions were calculated in accordance with the relevant Decision Tree in the *GPG (2000)* (page 4.52, Fig. 4.6), by multiplying the total carbon released or total nitrogen released, as calculated by the default method, by the emission factors.

●*Emission Factors*

Same emission factors used for rice, wheat, and barley residues were used (Table 6-56)

●*Activity Data*

Activity data was calculated by multiplying the yield of each crop shown in the *Crop Statistics* and the *Vegetable Production and Shipment Statistics* published by MAFF by the parameters shown in the following calculation formula.

Total carbon released by field burning of agricultural residues [kg-C] (Potatoes, Sugarbeets, Sugarcane)

= Annual crop production [t] × Residue/Crop product ratio × Dry matter fraction in residue [t-dm/t] × Proportion burned in field × Oxidation rate × Carbon content of residues [t-C/t-dm] × 10^3

Total carbon released by field burning of agricultural residues [kg-C] (Crops other than Potatoes, Sugarbeets, Sugarcane)

= Annual crop production [t] × Residue/Crop product ratio [t-dm/t] × Proportion burned in field × Oxidation rate × Carbon content of residues [t-C/t-dm] × 10^3

Total nitrogen released by field burning of agricultural residues [kg-N]

= Annual crop production [t] × Residue/Crop product ratio × Proportion burned in field × Oxidation rate × Carbon/nitrogen content of residues [t-N/t-dm or t-N/t] × 10^3

Table 6-60 Residue/ crop product ration, dry matter, carbon content, nitrogen content, proportion burned in field , and oxidation rate

Crop	Residue/ Crop product ratio	Dry matter fraction in residue	Carbon content	Nitrogen content	Proportion burned in field	Oxidation rate
Maize	1.20 [e A]	0.86 [h]	0.4709 [h D]	0.0035 [e E]	0.10[c]	0.90[c]
Peas	0.60 [e A]	0.87 [h]	0.45 [a D]	0.0101 [e E]		
Soybean	1.40 [e A]	0.89 [h]	0.45 [a D]	0.0109 [e E]		
Adzuki beans	0.89 [e A]	0.89 [h]	0.45 [a D]	0.0098 [e E]		
Kidney beans	0.60 [e A]	0.89 [h]	0.45 [a D]	0.0101 [e E]		
Peanuts	0.94 [e A]	0.86 [h]	0.45 [a D]	0.0054 [e E]		
Potatoes	0.032 [b B]	-	0.4226 [h D]	0.0222 [f D]		
Sugarbeets	0.062 [b B]	-	0.4072 [h D]	0.0154 [f D]		
Sugar cane	0.102 [g B]	-	0.4235 [h D]	0.0055 [g D]		

A: Residue (wet) / Crop production (wet)

B: Residue (dry) / Crop production (wet)

D: N content (or C content) / Residue (dry)

E: N content (or C content) / Residue (wet)

Source:

a. In the absence of default values, the values for dicotyledonous and monocotyledonous plants were used. Murayama, N., et al.., *Alimentation of Crops and Fertilizer*, Buneido, p. 26 (Bowen: Trace Elements in Biochemistry, 1966)

b. Owa, *New Trends in Technology for Efficient Use of Nutrients – Nutritional Balance of Crops in Japan* (1996) (Reference 33)

c: *Revised 1996 IPCC Guidelines*

d: Although default values are not available, the median value of the values indicated in the *Revised 1996 IPCC Guidelines*, Vol. 2, p. 4.30 (0.001 – 0.02) were used.

e: Matsumoto N., Development of Estimation Method and Evaluation of Nitrogen Flow in Regional Areas (2000) (Reference 55)

f: Hokkaido Government, Hokkaido Fertiliser Recommendations 2010. (2010) (Reference 56)

g: Document of Kagoshima prefectural Institute for Agricultural Development

h: *GPG (2000)*, p. 4.58, Table 4.16 (Reference 4)

c） Uncertainties and Time-series Consistency

●*Uncertainties*

The uncertainty assessment was conducted by each crop. The uncertainties for emission factors were calculated to aggregate the uncertainty of each parameter determined by expert judgment and given for default values in *the GPG (2000)*. For the uncertainties of the activity data, the value decided by the Committee for Greenhouse Gas Emission Estimation Methods in 2002 was applied. The uncertainty assessment results of the emissions by each crops were provided in Annex 7 Table 11. The uncertainty assessment methods are summarized in Annex 7.

●*Time-series Consistency*

Emissions are estimated by using consistent estimation methods and data sources.

d） Source-specific QA/QC and Verification

Refer to section” 6.7.1. Rice, Wheat, Barley, Rye, and Oats”.

e） Source-specific Recalculations

In responding to the revision of residue/crop product ratio and nitrogen content for each crop, emissions from FY1990 to FY2008 were revised.

f） *Source-specific Planned Improvements*

For the use of the default parameter in the *Revised 1996 IPCC Guidelines* or the *GPG (2000)*, it is needed to discuss whether country-specific parameter can be established for Japan.

6.7.3. Dry bean (4.F.2.-)

Dry beans are a type of kidney beans, and the term refers to the mature, husked vegetable. Kidney beans in Japan are eaten before ripening, however, which means there is little of this type of product. Kidney beans are included in Beans (4.F.2.), under ‘Other crops’ and, therefore, the dry beans have been reported as “IE”.

6.7.4. Other (4.F.5.)

It is possible that agricultural residue other than cereals, pulse, root vegetables and sugar canes are burnt in the fields. However, data on actual activity is not available and it is not possible to establish the emission factor. Therefore, these sources have been reported as “NE”.

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Chapter 7. Land Use, Land-Use Change and Forestry (CRF sector 5)

7.1. Overview of Sector

The land use, land-use change, and forestry (LULUCF) sector deals with greenhouse gas (GHG) emissions and removals resulting from land use such as forestry activities and land-use change. Japan classifies its national land into six categories—Forest land, Cropland, Grassland, Wetlands, Settlements, and Other land—and subdivides each of them into two subcategories by distinguishing them on the basis of whether or not land conversion has been occurred, in accordance with the GPG-LULUCF. It also uses 20 years, a default value in the GPG-LUULCF when distinguishing the land conversion. GHG emissions and removals in this sector consist of carbon stock changes in five carbon pools (aboveground biomass, belowground biomass, dead wood, litter, and soil), direct N_2O emissions from N fertilization, N_2O emissions from drainage of soils, N_2O emissions from disturbance associated with land-use conversion to cropland, CO_2 emissions from agricultural lime application, and non-CO_2 emissions from biomass burning. In this chapter, above- and belowground biomass are referred to collectively as “living biomass”, and dead wood and litter collectively as “dead organic matter”.

Japan’s total land area as of FY2009 is about 37.8 million ha. The largest portion of the national land is Forest land, which covers about 24.9 million ha. The second-largest portion is Cropland, which covers about 3.99 million ha. In addition, Grassland, Wetlands, Settlements, and Other land cover about 0.90 million ha, 1.33 million ha, 3.76 million ha, and 2.86 million ha, respectively.

Japan’s national land is an archipelago consisting of Hokkaido, Honshu, Shikoku, Kyushu and other islands, and lies off the east coast of the Eurasian Continent. The archipelago has the general shape of a crescent and extends from northeast to southwest. Its northernmost point is located at latitude about 45 degrees north latitude, and its southernmost point is located at about 20 degrees north latitude. Most of Japan’s national land is located in a temperate, humid climate zone. Some islands in the southern part of Japan belong to a subtropical climate zone, and the northern part of Japan is located in a cool-temperate climate zone. The average annual temperature and precipitation in Tokyo, the capital city of Japan located in the temperate, humid climate zone, are 15.9 degrees centigrade and 1,466.7 mm; those in Sapporo, Hokkaido prefecture, located in the cool-temperate climate zone, are 8.5 degrees centigrade and 1,127.6 mm; and those in Naha, Okinawa prefecture, located in the subtropical climate zone, are 22.7 degrees centigrade and 2,036.9 mm, respectively.[1]

The LULUCF sector contains both sources and sinks; however, in Japan, it has been a net sink continuously since FY1990. Net removals in FY2009 were 71,523 Gg-CO_2; this accounts for 5.9% of the total national emissions (excluding LULUCF). The net removals in FY2009 also represent an increase of 2.8% over the FY1990 value and a decrease of 8.7% below the FY2008 value.

This chapter is divided into 14 sections. Section 7.2 describes the method of determining land-use categories. Section 7.3 describes general parameters for estimating carbon stock changes from land use conversion. Sections 7.4 to 7.9 explain the estimation methods of carbon stock changes in each land-use category. GHG emissions by the LULUCF sector resulting from other than carbon stock changes are described in sections 7.10 to 7.14.

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[1] The average annual temperatures and precipitations are the average of those between FY 1971 and 2000. See National Astronomical Observatory, *2011 Chronological Scientific Tables* (Tokyo: Maruzen Inc., 2010) pp.182-183 and pp.194-195. With respect to the degrees of latitude, see Geographical Survey Institute, *Degrees of Latitudes and Longitude of Japan’s Northernmost, Southernmost, Easternmost and Westernmost Points* <http://www.gsi.go.jp/KOKUJYOHO/center.htm>.

7.2. Method of determining land-use categories

7.2.1. Basic approach

In accordance with 6 land-use categories in the GPG-LULUCF, land is classified on the basis of the definitions in existing statistics and others. As for Forest land and Cropland, subcategories are determined nationally (Forest land: forests with standing trees (intensively managed forests / semi-natural forests) / forests with less standing trees / bamboo; Cropland: rice fields / upland fields / orchard).

"Land remaining Land" and "Land converted to Land" in each land use category are determined based on existing statistics. Land-use categories that cannot be directly determined from existing statistics are determined using estimation measures such as allocation of areas of land conversion by means of the ratio of actual land areas for each land use categories.

Table 7-1 Land-use Transition Matrix for Japan in FY1990

Before Conversion After Conversion	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Total
Forest Land	24,946.8	2.7	0.7	IE	IE	0.1	24,950.3
Cropland	7.0	4,587.8	0.002	0.3	IE	1.3	4,596.4
Grassland	1.0	0.9	926.3	0.1	IE	2.0	930.3
Wetlands	0.3	0.02	0.01	1,319.6	0.002	0.1	1,320.0
Settlements	19.3	21.4	3.2	IE	3,175.2	IE	3,219.0
Other land	4.8	15.4	3.9	IE	IE	2,730.0	2,754.0
Total	24,979.1	4,628.2	934.0	1,320.0	3,175.2	2,733.4	37,770.0

Table 7-2 Land-use Transition Matrix for Japan in FY2009

(kha)

Before Conversion After Conversion	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Total
Forest Land	24,947.4	0.4	0.1	IE	IE	0.01	24,947.9
Cropland	0.6	3,989.1	0.004	0	IE	0.5	3,990.2
Grassland	0.1	0.7	903.8	0	IE	0.4	904.9
Wetlands	0.1	0.02	0.004	1,329.8	0.001	0.1	1,330.0
Settlements	4.9	8.2	1.3	IE	3,745.5	IE	3,760.0
Other land	2.6	8.8	4.7	IE	IE	2,840.9	2,857.0
Total	24,955.8	4,007.1	909.9	1,329.8	3,745.5	2,841.9	37,790.0

(Note) The conversion areas indicated as "IE" are included in the following categories.

- Wetlands, Settlements converted to Forest land → Other land converted to Forest land
- Settlements converted to Cropland → Other land remaining Other land
- Settlements converted to Grassland → Other land remaining Other land
- Wetlands, Other land converted to Settlements → Other land remaining Other land
- Wetlands, Settlements converted to Other land → Other land remaining Other land

7.2.2. Method of determining land-use categories and areas

Japan determines land-use categories and areas on the basis of existing statistics (Table 7-3). Among them, areas of Land converted to Forest land are estimated based on data of the areas of afforestation and reforestation under Article 3, paragraph 3, of the Kyoto Protocol, which are determined by utilizing orthophotos at the end of 1989 and recent satellite images, in addition to existing statistics.

Areas of Forest land converted to other land-use categories are estimated based on data of the areas of deforestation determined by the same way as afforestation and reforestation, in addition to data of the *World Census of Agriculture and Forestry* and the Forestry Agency's records. For detailed information on determining the areas of afforestation, reforestation and deforestation, see section A11.3.2.3 in Annex 11.

Table 7-3 Method of determining land use categories and areas

Land use category	Method of determining land use category	Method of determining area
Forest	Forests under Forest Law Article 5 and 7.2.	Forest with standing trees (intensively managed forests, semi-natural forests), forests with less standing trees and bamboo* in the forests which are included in the regional forests plan according to the *Forestry Status Survey* [-2004] and the *National Forest Resources Database* [2005-] (Forestry Agency).[2]
Cropland	Rice fields, upland fields and orchard.	Rice fields, upland fields and orchard according to *Statistics of Cultivated and Planted Area* by the MAFF.
Grassland	Pasture land, grazed meadow land and grassland other than pasture land and grazed meadow land[3].	Pasture land according to *Statistics of Cultivated and Planted Area* by the MAFF, grazed meadow land according to *World Census of Agriculture and Forestry* and *A Move and Conversion of Cropland* by the MAFF, and grassland other than pasture land and grazed meadow land identified in *Land Use Status Survey* by the MLITT.
Wetlands	Bodies of water (such as dams), rivers, and waterways.	Bodies of water, rivers, and waterways according to *Land Use Status Survey, Survey of Forestry regions* by the MLITT.
Settlements	Urban areas that do not constitute Forest land, Cropland, Grassland or Wetlands. Urban green areas are all wooded and planted areas that do not constitute Forest land.	Settlements are roads, residential land, school reservations, park and green areas, road sites, environmental facility sites, golf courses, ski courses and other recreation sites identified in *Land Use Status Survey* by the MLITT. The included figures for urban green areas are taken from *Urban Parks Status Survey*, *Road Tree Planting Status Survey, Sewage Treatment Facility Status Survey, Urban Greening Status Survey, Survey on Carbon Dioxide Absorption at Source in River Works, Progress Survey on Tree Planting for Public Rental Housing* by the MLITT.
Other land	Any land that does not belong to the above land use categories.	Determined by subtracting the total area belonging to the other land-use categories from the total area of national land according to *Land Use Status Survey* by the MLITT.

MAFF: Ministry of Agriculture, Forestry and Fisheries; MLITT: Ministry of Land, Infrastructure, Transport and Tourism

Note: Forest with standing trees (intensively managed forests, semi-natural forests), forests with less standing trees and bamboo are defined as below.

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[2] The *Forestry Status Survey* and the *National Forest Resources Database* use the same definitions and survey methods for forests, and these two data have time-series consistency.

[3] Grassland other than pasture land and grazed meadow land is the land that remains after subtracting grazed meadow land and national land under the jurisdiction of Forestry Agency from "grassland other than forests" in the *World Census of Agriculture and Forestry*. Its present status is mainly wild grassland (including perennial pasture land, degenerated pasture land, and areas abandoned after cultivation and becoming wild).

Forest with standing trees: Forest that does not fall under "Forest with less standing trees" and has the tree crown cover of standing trees 30% or higher (including young stands with the degree of stocking[4] of 3 or higher). Even if the tree crown cover of standing trees is less than 30%, forest in which the sum of the crown covers of both standing trees and bamboo is 30% or higher, while dominated by standing trees, is also included.	Intensively managed forests: Forest land that is subject to artificial regeneration such as tree planting and seeding, and in which no less than 50% of the volume (or the number) of standing trees are of tree species subject to artificial regeneration
	Semi-natural forests: Forest with standing trees which is not classified as intensively managed forests
Forest with less standing trees: Forest in which the sum of the tree crown covers of both standing trees and bamboo is less than 30 percent.	
Bamboo: Forest that does not fall under “forest with standing trees” and has the tree crown cover of bamboo (excluding “sasa” (a genus of running bamboo)) 30% or higher. Even if the tree crown cover of bamboo is less than 30%, forest in which the sum of the crown covers of both standing trees and bamboo is 30% or higher, while dominated by bamboo is also included.	

Reference: Forestry Agency of Japan, *Forest Status Survey* (March, 2007)

7.2.3. Survey methods and due dates of major land area statistics

Table 7-4 shows survey methods and due dates of major land area statistics;

Table 7-4 Survey method and due date of major land area statistics

Name of the statistics / census	Survey method	Survey due date	Frequency	Presiding ministry
Forest Status Survey	Complete count survey	March, 31st	Approximately 5 years	MAFF (Forestry Agency)
National Forest Resources Database	Complete count survey	April, 1st	Every year (Since 2005)	MAFF (Forestry Agency)
Statistics of Cultivated and Planted Area (Survey of cropland area)	[Cropland area] Ground measurement survey (sample) [Expansion area and converted area of cropland] Tabular survey (using documents from relevant agency and aerial photograph, etc.)	[Cropland area] July, 15th [Expansion area and converted area of cropland] July, 15th in the previous year until July, 14th	Every year	MAFF
World Census of Agriculture and Forestry (Survey of Forestry Regions~2000)	Complete count survey	August, 1st	Every 10 years	MAFF
Land Use Status Survey	Complete count Survey	March, 31st	Every year	MLITT
Urban Parks Status Survey	Complete count survey	March, 31st	Every year	MLITT

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[4] The degree of stocking is the ratio of actual volume to the expected volume of the forest stand, multiplied by 10.

Table 7-4 Survey method and due date of major land area statistics (continued)

Name of the statistics / census	Survey method	Survey due date	Frequency	Presiding ministry
Road Tree Planting Status Survey	Complete count survey	March, 31st	5 years (from FY1987 until FY2007) Every year (Since FY2008)	MLITT
Sewage Treatment Facility Status Survey	Complete count survey	March, 31st	Every year	MLITT
Urban Greening Status Survey	Complete count survey	March, 31st	Every year	MLITT
Survey on Carbon Dioxide Absorption at Source in River Works	Complete count survey	March, 31st	Every year	MLITT
Progress Survey on Tree Planting for Public Rental Housing	Complete count survey	March, 31st	Every year	MLITT

MAFF: Ministry of Agriculture, Forestry and Fisheries; MLITT: Ministry of Land, Infrastructure, Transport and Tourism

7.2.4. Land area estimation methods

Some land areas cannot be directly determined from existing statistics; therefore, they are estimated using of following methods;

- Interpolation or trend extrapolation
- Allocation of areas of land conversion by means of the ratio of actual land areas for each land use categories
- Allocation of areas of land conversion by means of the ratio of converted land areas for a certain year

- ***Interpolation and trend extrapolation***

➢ ***Method***

The areas of Forest land before 2004 were surveyed at an interval of approximately five years, and it was difficult to directly determine the areas of Forest land in unsurveyed years. Therefore, they were estimated by interpolation or extrapolation by means of liner expressions based on the areas in surveyed years.

➢ ***Land use category***

5.A.2. Land converted to Forest land (FY1991- 1994, 1996- 2001 and 2003- 2004).

- ***Allocation of areas of land conversion by means of the ratio of actual land areas for each land use categories***

➢ ***Method***

In Japan, it is difficult to obtain areas of “upland field converted to Forest land”, “orchard converted to Forest land” and “pasture land converted to Forest land” directly from existing statistics, since those are collectively reported as “arable land”. Therefore, these land areas were estimated by multiplying the “arable land converted to Forest land” by the ratios of actual land areas for each of the land-use categories (upland field, orchard and pasture land).

- ***Land use category***

5.A.2. Land (Cropland and Grassland) converted to Forest land
5.B.2. Land (Forest land, Grassland, Wetlands and Other land) converted to Cropland
5.C.2. Land (Forest land, Cropland, Wetlands and Other land) converted to Grassland
5.E.2. Land (Cropland and Grassland) converted to Settlements
5.F.2. Land (Cropland and Grassland) converted to Other land

- ***Allocation of areas of land conversion by means of the ratio of converted land area for a certain year***

- ***Method***

In Japan, it is difficult to directly obtain annual land areas of Cropland, Grassland, Settlements and Other land converted to Wetlands, respectively. Therefore, the annual land ratios of Cropland, Grassland, Settlements and Other land converted to Wetlands to "Land converted to Wetlands" in FY1998, which are assumed to be the same as the land ratio in each year, are multiplied by the areas of "Land converted to Wetlands" in each year to obtain the area of respective land use category converted to Wetlands.

- ***Land use category***

5.D.2. Land (Cropland, Grassland, Settlements and Other land) converted to Wetlands

7.3. Parameters for estimating carbon stock changes from land use conversions

Prior to the sections describing detailed methods for each land-use category, basic parameters used for estimating carbon stock changes due to land use conversions are shown in Table 7-5 to Table 7-8, since land conversions are cross-cutting activities between land-use categories. For some parameters and estimation methods, details are given in the section indicated in "Note".

Table 7-5 Living biomass stocks for each land use category before and after conversion

Land use category			Biomass stock [t-d.m./ha]	Note
Before conversion	Forest land		135.23 (FY2009)	Calculated by utilizing biomass stocks in land of deforestation under Article 3, paragraph 3, of the Kyoto Protocol, which are provided from the NFRDB. In addition, the values before 2004 are extrapolated by means of trend from 2005 to the latest year. (Reference values [t-d.m./ha]: FY1990: 103.01, FY2005: 129.02, FY2008: 133.17)
	Cropland	Rice field	0	Assume that biomass stocks are “0”.
		Upland field	0	Assume that biomass stocks are “0”.
		Orchard	30.63	Calculate by multiplying average age and growth rate given in Ito *et al.* “*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*”
	Grassland		13.50	*GPG-LULUCF* Table 3.4.2 and Table 3.4.3 (warm temperate wet)
	Wetlands, Settlements and Other land		0	Assume that biomass stocks are “0”.
Immediately after conversion	All land-uses		0	Assume that biomass stocks immediately after conversion are “0”.
After conversion	Forest land		-	The removal in this land is directly estimated based on implied emission/removal factor of AR activity under the Kyoto Protocol. See section 7.4.2.b)1)
	Cropland	Rice field	0	Assume that biomass stocks are “0”.
		Upland field	0	Assume that biomass stocks are “0”.
		Orchard	0	Assume that biomass stocks are “0”.
	Grassland		2.70	One fifth of the value of *GPG-LULUCF* Table 3.4.2 and Table 3.4.3 (warm temperate wet)
	Settlements		-	See section 7.8.2.b)1)
	Wetlands and Other land		0	Assume that biomass stocks are “0”.

Table 7-6 Carbon stocks of dead wood for each land use category before and after conversion

Land-use Category		Carbon Stock [t-C/ha]	Note
Before Conversion	Forest land	15.05 (FY2009)	Calculated from carbon stocks in dead wood in all forests. (Reference values [t-C/ha]: FY1990: 16.35, FY2005: 16.35, FY2007: 15.96)
	Cropland, Grassland, Wetlands, Settlements, Other land	0*	Assumed as zero (Section 4.3.2 in Volume 4 of the 2006 IPCC Guidelines, Tier.1)
Immediately after conversion	All land-uses	0	Assume that biomass stocks immediately after conversion are “0”.
After conversion	Forest land	13.01	Average carbon stocks per unit area in 20-year-old forests obtained by the CENTURY-jfos model
	Cropland, Grassland, Wetlands, Other land	0*	Assumed as zero (Section 4.3.2 in Volume 4 of the 2006 IPCC Guidelines, Tier.1)
	Settlements	0	Assumed as zero

* For some subcategories, stock changes are estimated as zero despite carbon stock values exist. See each section for detail.

Table 7-7 Carbon stocks of litter for each land use category before and after conversion

Land-use Category		Carbon Stock [t-C/ha]	Note
Before Conversion	Forest land	7.28 (FY2009)	Calculated from carbon stocks in litter in all forests. (Reference values [t-C/ha]: FY1990: 7.18, FY2005: 7.18, FY2008: 7.03)
	Cropland, Grassland, Wetlands, Settlements, Other land	0*	Assumed as zero (Section 4.3.2 in Volume 4 of the 2006 IPCC Guidelines, Tier.1)
Immediately after conversion	All land-uses	0	Assume that biomass stocks immediately after conversion are “0”.
After conversion	Forest land	5.644	Average carbon stocks per unit area in 20-year-old forests obtained by the CENTURY-jfos model
	Cropland, Grassland, Wetlands, Other land	0*	Assumed as zero (Section 4.3.2 in Volume 4 of the 2006 IPCC Guidelines, Tier.1)
	Settlements	—	See section 7.8.2.b)2)

* For some subcategories, stock changes are estimated as zero despite carbon stock values exist. See each section for detail.

Table 7-8 Carbon stocks of soil for each land use category before and after conversion

Land-use Category		Carbon Stock [t-C/ha]	Note
Before conversion	Forest land	85.31 (FY2009)	Value of soil carbon stocks for 0-30 cm depth in the previous year to the inventory year. National average value calculated by the CENTURY-jfos model. In addition, the value in FY2006 is applied to the values before 2005. (Reference values [t-C/ha]: FY1990: 85.74, FY2005: 85.74, FY2008: 84.21)
After conversion	Forest land	82.954	Value of soil carbon stocks for 0-30 cm depth. Average carbon stocks per unit area in 20-year-old forests obtained by the CENTURY-jfos model.
Commonly used before and after conversion	Rice field	71.38	Value of soil carbon stocks for 0-30 cm depth. Data provided from Dr. Makoto Nakai , National Institute for Agro-Environmental Sciences (Undisclosed) Cropland: see section 7.5.2.b)3) Grassland (pasture land): see section 7.6.2.b)2)
	Upland field	86.97	
	Orchard	77.46	
	Cropland (average)	76.40	
	Grassland	134.91	
	Wetlands	-	Under investigation
	Settlements	-	Under investigation
	Other land	-	Under investigation

7.4. Forest land (5.A.)

Forests absorb CO_2 from the atmosphere by photosynthesis, fix carbon as organic substances, and store these substances for a given period. In contrast, forests emit CO_2 due to effects of events such as logging and natural disturbances.

All forests in Japan are managed forests, and they consist of intensively managed forests, semi-natural forests, bamboo, and forests with less standing trees. Japan’s forest land area in FY2009 was about

24.9 million ha—about 66.0% of the total national land area. The net removal by this category in FY2009 was 73,678 Gg-CO_2 (excluding 9.61 Gg-CO_2 eq. of CH_4 and N_2O emissions resulting from biomass burning); this represents a decrease of 6.3% over the FY1990 value, and a decrease of 7.8% below the FY2008 value.

In this section, Forest land is divided into two subcategories, "Forest land remaining Forest land (5.A.1.)" and "Land converted to Forest land (5.A.2.)", and they are described separately in the following subsections.

Table 7-9 Emissions and removals in Forest land resulting from carbon stock changes

Gas	Category	Carbon pool	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	5.A. Forest land	Total	Gg-CO_2	-78,636.2	-87,359.2	-90,704.7	-92,020.1	-85,235.0	-79,934.3	-73,677.9
		Living Biomass	Gg-CO_2	-72,574.4	-79,578.6	-83,710.7	-86,949.1	-81,333.1	-76,505.5	-70,945.9
		Dead Wood	Gg-CO_2	-2,853.2	-3,798.1	-2,848.3	-1,094.6	-179.8	188.1	703.8
		Litter	Gg-CO_2	-2,694.5	-2,355.2	-1,779.1	-1,039.1	-797.1	-720.6	-604.0
		Soil	Gg-CO_2	-514.1	-1,627.2	-2,366.6	-2,937.3	-2,925.0	-2,896.2	-2,831.9
	5.A.1. Forest land remaining Forest land	Total	Gg-CO_2	-76,762.1	-86,456.3	-90,066.3	-91,548.0	-84,812.8	-79,535.4	-73,331.6
		Living Biomass	Gg-CO_2	-71,107.2	-78,851.8	-83,188.5	-86,556.8	-80,980.4	-76,171.6	-70,657.7
		Dead Wood	Gg-CO_2	-2,512.3	-3,629.3	-2,727.0	-1,003.5	-97.9	265.6	770.8
		Litter	Gg-CO_2	-2,546.7	-2,282.0	-1,726.4	-999.5	-761.6	-687.0	-575.0
		Soil	Gg-CO_2	-595.9	-1,693.3	-2,424.3	-2,988.1	-2,972.9	-2,942.5	-2,869.8
	5.A.2. Land converted to Forest land	Total	Gg-CO_2	-1,874.1	-902.8	-638.3	-472.1	-422.2	-398.9	-346.3
		Living Biomass	Gg-CO_2	-1,467.2	-726.8	-522.2	-392.2	-352.6	-333.9	-288.2
		Dead Wood	Gg-CO_2	-340.9	-168.9	-121.3	-91.1	-81.9	-77.6	-67.0
		Litter	Gg-CO_2	-147.9	-73.3	-52.6	-39.5	-35.5	-33.7	-29.0
		Soil	Gg-CO_2	81.8	66.1	57.8	50.8	47.9	46.2	37.9

7.4.1. Forest land remaining Forest land (5.A.1.)

a） Source/Sink Category Description

This subcategory deals with carbon stock changes in Forest land remaining Forest land, which has remained forested without conversion for the past 20 years as of FY2009. The net removal by this subcategory in FY2009 was 73,332 Gg-CO_2 (excluding 9.61 Gg-CO_2 eq. of CH_4 and N_2O emissions resulting from biomass burning); this represents a decrease of 4.5% over the FY1990 value and a decrease of 7.8% below the FY2008 value.

b） Methodological Issues

1） Carbon stock change in Living Biomass in Forest land remaining Forest land

- ***Estimation Method***

In accordance with the decision tree provided in the GPG-LULUCF, carbon stock changes in living biomass in all Forest land are estimated by the Tier 2 stock change method using country specific value of the amount of biomass accumulation. In this method, a carbon stock change in the living biomass pool is estimated by calculating a difference between the absolute amounts of carbon stocks in the pool at two points of time.

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

ΔC_{LB} : annual change in carbon stocks in living biomass (t-C/yr)
t_1, t_2 : time points of carbon stock measurement
C_{t1} : total carbon in biomass calculated at time t_1 (t-C)
C_{t2} : total carbon in biomass calculated at time t_2 (t-C)
k : type of forest management

The carbon stocks in the living biomass are calculated by multiplying a stand volume of each tree species by a wood density, a biomass expansion factor, a root-to-shoot ratio and a carbon fraction of dry matter. These parameters except the carbon fraction are determined for each tree species.

$$C = \sum_j \left\{ [V_j \cdot D_j \cdot BEF_j] \cdot (1 + R_j) \cdot CF \right\}$$

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

Since Japan calculates carbon stock change of living biomass in the total forest land in this manner, the carbon stock change of living biomass in “Forest land remaining Forest land” is obtained by subtracting the carbon stock change in “Land converted to Forest land” from this total change. For the method of estimating carbon stock change in “Land converted to Forest land”, see section 7.4.2.b)1).

- ***Parameters***

➢ ***Volume***

The Forestry Agency has developed the National Forest Resources Database (NFRDB) in order to estimate GHG emissions/removals from forests. The data in the NFRDB are based on the information on areas, tree species and forest ages, which are contained in the “Forest Registers”.

Merchantable volumes are estimated by multiplying areas for each tree species and forest age stored in the NFRDB by merchantable volumes per area for each tree species and forest age in yield tables. Base data for the volumes per area are shown in Table 7-10 below. With respect to estimating volumes of Japanese cedar, Hinoki cypress and Japanese larch in private forests, which are major tree species of intensively managed forests in Japan, volumes per area reported in new yield tables, to which the newest survey results are reflected, are applied.

$$V = \sum_{m,j} (A_{m,j} \cdot v)$$

V : merchantable volume (m^3)
A : area (ha)
v : merchantable volume per area (m^3/ha)
m : age class or forest age
j : tree species

Table 7-10 Yield tables used to estimate merchantable volume

Tree species			Yield tables	
			Private Forest	National Forest
Intensively managed forests	Conifer	Japanese cedar, Hinoki cypress, Japanese larch	New yield tables	Yield tables developed by Regional Forest Offices
		Other conifer	Yield tables developed by prefectures	
	Broad leaf			
Semi-natural forests				

- ***Forest Registers and yield tables developed by prefectures or Regional Forest Offices***

When forest plans are established for private and national forests (all forest lands are divided into 158 planning areas, and forest plans are established by 1/5 of them [about 30 planning areas] each year), field surveys are implemented in these forests to develop Forest Register which includes data on area, forest age, volume by tree species and so on. When forest plans are established (private forests: by each prefecture, national forests: by Regional Forest Offices of National Forests), Forest Registers are updated to reflect change in volume due to growth, cutting and disturbances. In general, volume data described in the Forest Registers are estimated based on land area data and yield tables, which provide stand growth in the case that typical forest practices are implemented for each region, tree species and site class (yield tables show relationship between forest age or age class and volume per area).

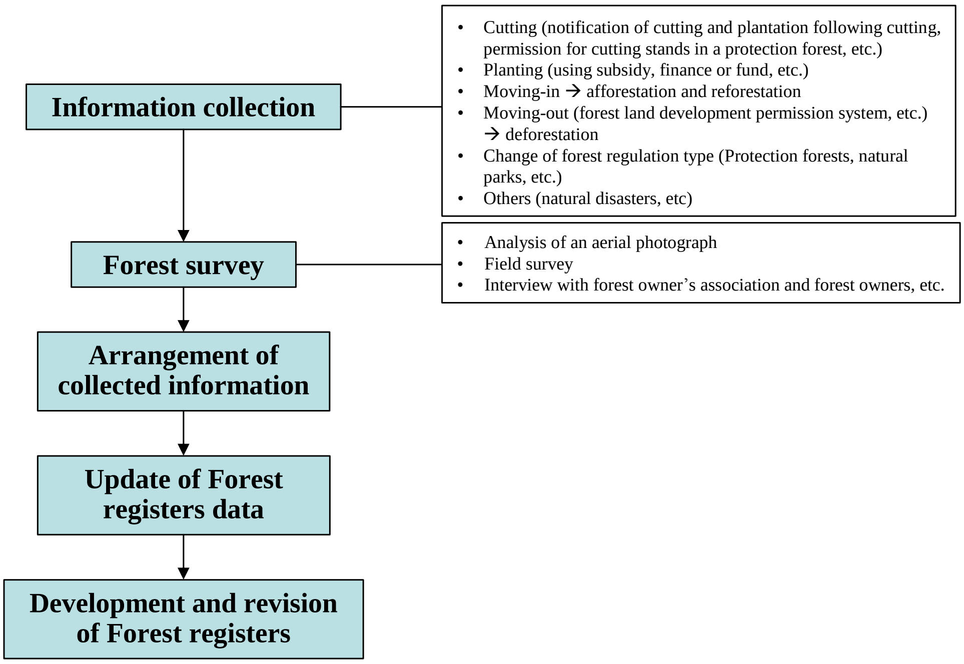

Figure 7-1 Procedures of Forest Registers development

- ***New yield tables (Japanese cedar, Hinoki cypress, Japanese larch)***

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

The new yield tables for Japanese cedar were established for 7 regions, Hinoki cypress for 4 regions and Japanese larch for 2 regions.

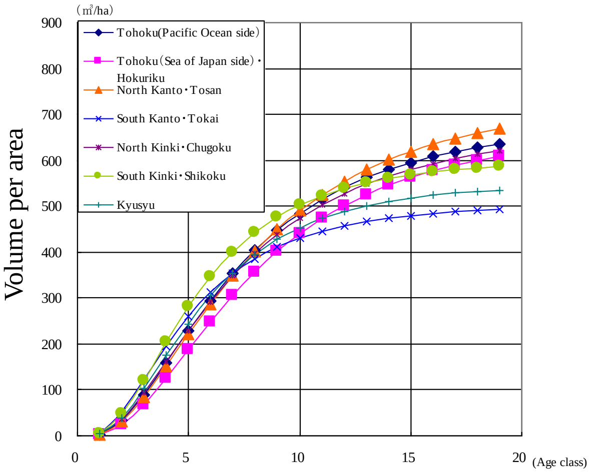

Figure 7-2 Yield tables made from forest resources monitoring survey data (Japanese cedar：7 areas)

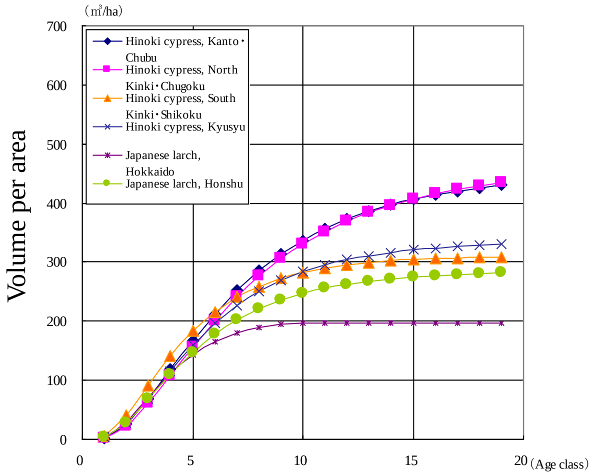

Figure 7-3 Yield tables made from forest resources monitoring survey data (Hinoki cypress：4 areas, Japanese larch：2 areas)

- ***Biomass expansion factor and Root-to-shoot ratio***

Biomass expansion factor (BEF) and root-to-shoot ratio (R) were set based on the results from biomass survey on dominant tree species and existing research reports which were implemented by the Forestry and Forest Products Research Institute (Table 7-11).

BEFs were calculated for two age classes (20 years and below / 21 years and above) and for each tree species, because it was identified that BEFs differ between young forests and mature forests as apparent in Figure 7-4 below. On the other hand, R values were established only for each tree species, because root-to-shoot ratio was not correlated with forest age (Figure 7-5).

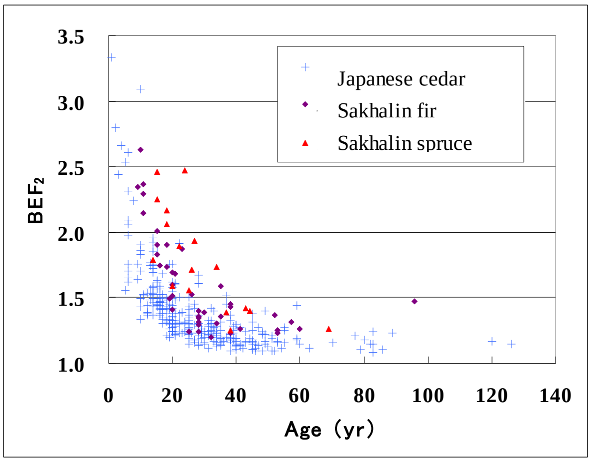

Figure 7-4 Biomass expansion factor (BEF) with forest age

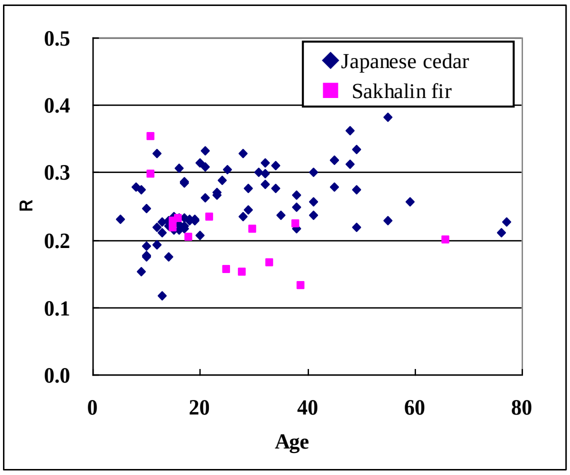

Figure 7-5 Root-to-shoot ratio (R) with forest age

- ***Wood density***

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

Institute (Table 7-11). These D values were established for each tree species, because wood density was not correlated with forest age.

- ***Carbon fraction of dry matter***

The default value given in the GPG-LULUCF has been adopted as the carbon fraction (CF) of dry matter (Table 7-11).

Table 7-11 BEF, Root-Shoot ratio, wood density for tree species and carbon fraction

		BEF [-]		R	D	CF	Note
		≦20	＞20	[-]	[t-d.m./m^{3}]	[t-C./t-d.m]	
Conifer trees	Japanese cedar	1.57	1.23	0.25	0.314	0.5	
	Hinoki cypress	1.55	1.24	0.26	0.407		
	Sawara cypress	1.55	1.24	0.26	0.287		
	Japanese red pine	1.63	1.23	0.26	0.451		
	Japanese black pine	1.39	1.36	0.34	0.464		
	Hiba arborvitae	2.38	1.41	0.20	0.412		
	Japanese larch	1.50	1.15	0.29	0.404		
	Momi fir	1.40	1.40	0.40	0.423		
	Sakhaline fir	1.88	1.38	0.21	0.318		
	Japanese hemlock	1.40	1.40	0.40	0.464		
	Yezo spruce	2.18	1.48	0.23	0.357		
	Sakhaline spruce	2.17	1.67	0.21	0.362		
	Japanese umbrella pine	1.39	1.23	0.20	0.455		
	Japanese yew	1.39	1.23	0.20	0.454		
	Ginkgo	1.50	1.15	0.20	0.450		
	Exotic conifer trees	1.41	1.41	0.17	0.320		
	Other conifer trees	2.55	1.32	0.34	0.352		Applied to Hokkaido, Aomori, Iwate, Miyagi, Akita, Yamagata, Fukushima, Tochigi, Gunma, Saitama, Niigata, Toyama, Yamanashi, Nagano, Gifu, Shizuoka
		1.39	1.36	0.34	0.464		Applied to Okinawa
		1.40	1.40	0.40	0.423		Applied to prefectures other than above
Broad leaf trees	Japanese beech	1.58	1.32	0.26	0.573		
	Oak (evergreen tree)	1.52	1.33	0.26	0.646		
	Japanese chestnut	1.33	1.18	0.26	0.419		
	Japanese chestnut oak	1.36	1.32	0.26	0.668		
	Oak (deciduous tree)	1.40	1.26	0.26	0.624		
	Japanese popular	1.33	1.18	0.26	0.291		
	Alder	1.33	1.25	0.26	0.454		
	Japanese elm	1.33	1.18	0.26	0.494		
	Japanese zelkova	1.58	1.28	0.26	0.611		
	Cercidiphyllum	1.33	1.18	0.26	0.454		
	Japanese big-leaf	1.33	1.18	0.26	0.386		
	Maple tree	1.33	1.18	0.26	0.519		
	Amur cork	1.33	1.18	0.26	0.344		
	Linden	1.33	1.18	0.26	0.369		
	Kalopanax	1.33	1.18	0.26	0.398		
	Paulownia	1.33	1.18	0.26	0.234		
	Exotic broad leaf trees	1.41	1.41	0.16	0.660		
	Japanese birch	1.31	1.20	0.26	0.468		
	Other broad leaf trees	1.37	1.37	0.26	0.469		Applied to Chiba, Tokyo, Kochi, Fukuoka, Nagasaki, Kagoshima, and Okinawa
		1.52	1.33	0.26	0.646		Applied to Mie, Wakayama, Oita, Kumamoto, Miyazaki, and Saga
		1.40	1.26	0.26	0.624		Applied to prefectures other than above

BEF: Biomass expansion factor (20 = age class)
R: Root-to-shoot ratio
D: Wood density
CF: Carbon Fraction

- ***Activity Data (Area)***

➢ *Determining the forest area*

Forest areas of intensively managed forests, semi-natural forests, forests with less standing trees and bamboo under the forest planning system are obtained from the “Forest Status Survey” for years earlier than FY2004 and from the National Forest Resource Database (NFRDB) for FY2005 and onward. Data for FY1991 through FY1994, FY1996 through FY2001, and FY2003 through FY2004 are estimated by interpolation by means of linear expression. In addition, area data of Sakhalin fir, Yezo spruce, Japanese chestnut oak and Oak (deciduous tree) before FY1990, which do not exist individually, are estimated from “other conifer” and “other broad leaf” area divided by area ratio in FY1995.

Table 7-12 Classifications in Survey on Status Forest Resources and National Forest resource Database

Conifer trees		Broad leaf trees	
Before 2004	After 2005	Before 2004	After 2005
Japanese cedar	Japanese cedar	Japanese chestnut oak	Japanese chestnut oak
Hinoki cypress	Hinoki cypress	Oak (deciduous tree)	Oak (deciduous tree)
Pine	Japanese red pine	Other broad leaf	Japanese beech
	Japanese black pine		Oak (evergreen tree)
Japanese larch	Japanese larch		Japanese chestnut
Sakhalin fir	Sakhalin fir		Japanese popular
Yezo spruce	Yezo spruce		Alder
	Sakhalin spruce		Japanese elm
Other conifer	Sawara cypress		Japanese zelkova
	Hiba arborvitae		Cercidiphyllum
	Momi fir		Japanese big-leaf magnolia
	Japanese hemlock		Maple tree
	Japanese umbrella pine		Amur cork
	Japanese yew		Japanese lime
	Ginkgo		Linden
	Exotic conifer trees		Kalopanax
	Other needle leaf		Paulownia
			Exotic broad leaf trees
			Other broad leaf

➢ *Obtaining land area of “Forest land remaining Forest land”*

It is estimated by subtracting the cumulative total area of “Land converted to Forest land” during the past 20 years from the total area of “Forest land” in the year subject to estimation. All areas of “Land converted to Forest land” are assumed to be intensively managed forests. For activity data of “Land converted to Forest land”, see section 7.4.2.b)1).

Table 7-13 Area of Forest land remaining Forest land

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Forest land remaining Forest land		kha	24,807.4	24,826.1	24,825.2	24,954.0	24,948.3	24,936.6	24,919.8
	Intensively managed forests	kha	10,144.9	10,284.8	10,279.7	10,298.3	10,285.9	10,275.9	10,270.4
	Semi-natural forests	kha	13,354.5	13,220.3	13,195.2	13,315.7	13,321.5	13,333.5	13,349.6
	Cut-over forests and lesser stocked forests	kha	1,159.0	1,171.0	1,197.4	1,186.0	1,184.7	1,170.8	1,142.8
	Bamboo	kha	149.0	150.0	152.9	154.0	156.2	156.4	157.1

Source: Forestry Status Survey, National Forest Resources Database (Forest Agency)

2） Carbon Stock Changes in Dead Organic Matter and Soils in Forest land remaining Forest land

- ***Estimation Method***

In accordance with the decision tree provided in the GPG-LULUCF, these pools are estimated by Tier 3 model method. Emissions and removals from organic soils are reported as “IE” because emissions from and removals by mineral and organic soils are estimated in the model in an integrated manner.

Carbon emissions/removals in each pool per unit area are estimated by using CENTURY-jfos model and are multiplied by land area of each forest management type. The sum of the emissions/removals of all forest management types are the annual changes in total carbon stocks in dead wood, litter and soil.

$$\Delta C_{dls} = \sum_{k,m,j} (A_{k,m,j} \times (d_{k,m,j} + l_{k,m,j} + s_{k,m,j}))$$

$\triangle C_{dls}$: Annual change in carbon stocks in dead wood, litter and soil (t-C/yr)
A : Area (ha)
d : Average carbon stock change per unit area in dead wood (t-C/ha/yr)
l : Average carbon stock change per unit area in litter (t-C/ha/yr)
s : Average carbon stock change per unit area in soil (t-C/ha/yr)
k : Type of forest management
m : Age class or forest age
j : Tree species

- ***Parameters***

Average carbon stock changes per unit area for dead wood, litter and soils are calculated by CENTURY-jfos model, which was modified from the CENTURY model (Colorado State University) to be applicable to Japanese climate, soil, and vegetation conditions.

➢ ***Assumption and Parameters as the Keys for the CENTURY-jfos Model***

Amounts of tree growth and stable soil carbon stocks are regarded as being different depending on climatic or locational conditions; therefore, we aggregated data of climatic values and soil carbon stocks for each tree species in each prefecture (Table 7-14). We assumed that forests continually existed and were routinely utilized, and that their soil carbon stocks were in a nearly steady state. Next, we adjusted parameters in the CENTURY-jfos model. First, we adjusted growth parameters of above-ground biomass so that they showed the growth in the yield tables in association with climatic values calculated per prefecture and per tree species. Second, we adjusted parameters so that soil carbon stocks after 60-year cutting age and spinup of 3,000 years fitted those calculated by Morisada *et al.* (2004) for each of prefectures and tree species. The methodologies of adjusting each parameter are in accordance with Sakai *et al.* (submitted).

Tuning of the CENTURY-jfos Model

The Forestry and Forest Products Research Institute adjusted the CENTURY model in order to apply it to the Japanese forest environment. That is, forests were classified by predominant tree species (Japanese Cedar, Hinoki Cypress, Pine species, Japanese Larch, Sakhaline Fir, Sakhaline Spruce, broad leaf trees, and other conifer trees), and the geographical distribution of the tree species and soil types underneath was identified for each prefecture. Climate conditions to run the model were prepared from the mesh climate data provided by the Meteorological Agency of Japan (Japan Meteorological Agency, 2002). The model was adjusted with parameters on tree growth so that tree growth in the model conformed to yield tables, and it was also tuned so that its output of carbon stocks in soil conformed to actual values based on field surveys for each prefecture and tree species (Table 7-14). The model after these modifications was named as the CENTURY-jfos model. After the tuning, carbon stocks in dead wood, litter and soil, and their stock changes were calculated by the CENTURY-jfos for different types of forest management such as management with thinning or without thinning.

Average annual carbon stock changes per unit area in dead wood, litter and soil are calculated for 1 – 19 age classes (for 100 years) for each type of forest management by means of CENTURY-jfos in order to estimate carbon stock changes in these carbon pools using the same activity data as for living biomass.

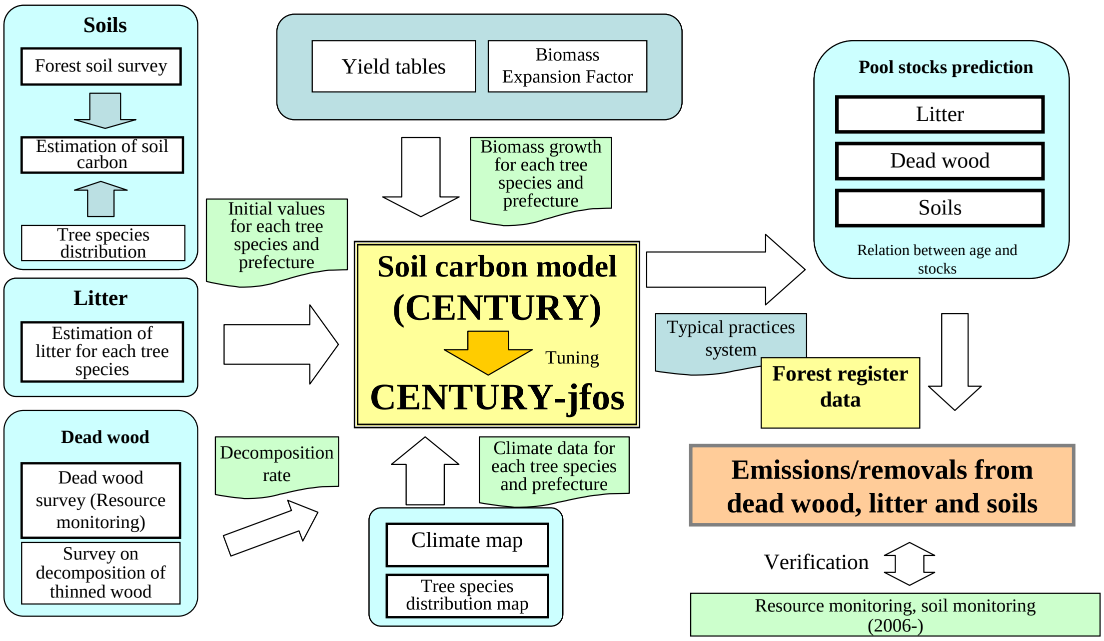

Figure 7-6 Estimation of emissions/removals in dead wood, litter and soils

Table 7-14 Standard Soil Carbon Stocks used for the CENTURY-jfos Model

(kg-C/m^2 [30 cm depth])

Prefecture	Tree Species							
	Japanese Cedar	Hinoki Cypress	Pine species	Japanese Larch	Sakhaline Fir	Sakhaline Spruce	Broad Leaf Trees	Other Conifer Trees
Hokkaido	98.0	NA	100.6	91.0	88.0	93.7	91.0	89.4
Aomori	92.1	NA	94.3	83.3	109.1	NA	89.0	89.8
Iwate	89.5	93.6	92.7	93.9	98.1	NA	91.3	93.3
Miyagi	86.1	70.8	78.5	90.3	110.9	NA	82.8	80.5
Akita	81.1	NA	72.4	81.0	108.5	NA	82.6	79.6
Yamagata	83.2	79.7	68.0	81.0	97.4	NA	74.4	76.9
Fukushima	84.3	83.7	81.1	89.3	108.6	NA	81.4	85.0
Ibaraki	84.3	83.4	97.6	NA	NA	NA	91.2	90.8
Tochigi	83.0	86.1	91.6	100.6	133.4	NA	93.1	96.4
Gunma	88.7	88.3	93.9	95.1	98.1	NA	86.5	93.9
Saitama	81.3	82.4	96.2	106.8	NA	NA	85.8	94.7
Chiba	93.9	85.7	65.6	NA	NA	NA	84.6	76.4
Tokyo	79.2	81.6	85.7	94.7	NA	NA	63.9	84.3
Kanagawa	91.9	99.8	89.8	NA	NA	NA	94.9	99.1
Niigata	83.9	51.3	63.4	86.7	133.0	NA	85.3	86.9
Toyama	90.3	NA	72.5	88.5	106.0	NA	94.5	100.2
Ishikawa	82.7	80.2	70.2	NA	133.4	NA	86.6	74.3
Fukui	88.7	85.8	79.8	NA	NA	NA	90.1	80.6
Yamanashi	93.0	93.9	98.0	99.3	NA	NA	93.9	95.6
Nagano	102.1	100.5	96.0	108.4	106.0	NA	97.9	103.3
Gifu	100.5	94.8	79.1	99.6	107.8	NA	95.8	93.9
Shizuoka	94.6	96.7	69.1	90.7	NA	NA	90.0	93.7
Aichi	91.2	85.0	60.1	NA	NA	NA	78.5	77.2
Mie	92.1	84.4	63.8	97.1	NA	NA	78.7	80.5
Shiga	83.5	73.0	59.6	NA	NA	NA	79.5	65.8
Kyoto	74.0	67.4	63.3	NA	NA	NA	66.4	64.6
Osaka	78.9	74.0	60.9	NA	NA	NA	67.5	66.0
Hyogo	88.3	71.8	53.0	123.6	NA	NA	63.4	61.9
Nara	79.6	69.8	65.5	NA	NA	NA	73.4	69.4
Wakayama	72.1	70.5	58.2	NA	NA	NA	62.8	69.9
Tottori	73.8	74.9	75.6	121.2	NA	NA	72.3	75.4
Shimane	69.0	66.6	61.2	77.3	NA	NA	64.6	63.2
Okayama	80.3	73.7	51.4	121.2	NA	NA	65.2	63.6
Hiroshima	74.0	71.8	54.0	71.2	NA	NA	65.0	58.7
Yamaguchi	64.9	60.9	49.3	NA	NA	NA	55.2	54.8
Tokushima	72.9	63.7	63.6	NA	NA	NA	66.7	63.7
Kagawa	57.7	61.9	56.6	NA	NA	NA	57.2	57.7
Ehime	80.1	75.1	63.2	85.4	NA	NA	67.4	74.1
Kochi	81.4	76.1	73.8	NA	NA	NA	74.1	76.2
Fukuoka	97.3	88.9	77.5	NA	NA	NA	86.5	88.3
Saga	83.6	83.0	69.1	NA	NA	NA	79.6	82.9
Nagasaki	82.9	84.5	82.6	NA	NA	NA	78.9	84.5
Kumamoto	108.7	96.0	79.3	NA	NA	NA	93.5	95.6
Oita	109.9	100.5	108.3	130.3	NA	NA	99.1	101.4
Miyazaki	106.1	102.0	93.7	NA	NA	NA	98.0	99.6
Kagoshima	108.4	102.4	75.7	NA	NA	NA	90.8	97.0
Okinawa	58.5	NA	58.9	NA	NA	NA	58.0	58.5

- ***Activity Data (Area)***

Forest area data provided by the NFRDB were applied to the estimation.

c）Uncertainties and Time-series Consistency

- ***Uncertainty Assessment***

The uncertainties of the parameters and activity data for living biomass were individually assessed on the basis of field study results, expert judgment, or the default values described in the GPG-LULUCF. The uncertainty estimates for dead organic matter and soil were assessed by calculating the variance of outputs from the CENTURY-jfos model. As a result, the uncertainty estimate was 5% for the entire removal by Forest land remaining Forest land. The methodology used in the uncertainty assessment is described in Annex 7. Uncertainty estimates regarding major parameters in this category are shown in Table 7-15.

Table 7-15 Uncertainty estimates regarding major parameters in the Forest land category

			Uncertainty Estimates (%)	Country Specific (CS) or Default(D)	Remarks
Forest land Area	Intensively Managed Forest		5.9	CS	Estimated based on uncertainty estimates of land areas in the NFRDB. Used 5.9% without distinguishing tree species.
	Semi-natural Forest		5.9	CS	
Biomass Expansion Factor	Japanese cedar	≦20	3.5	CS	Estimated based on measured values
		＞20	1.1	CS	
	Hinoki cypress	≦20	3.2	CS	
		＞20	1.6	CS	
	Oak (deciduous tree)	≦20	8.6	CS	
		＞20	2.1	CS	
Wood Density	Japanese cedar		2.5	CS	
	Hinoki cypress		1.7	CS	
	Oak (deciduous tree)		1.6	CS	
Carbon Fraction of dry matter	All tree species		2.0	D	GPG-LULUCF default value. Used 2.0% without distinguishing tree species.

- ***Time-series Consistency***

There were no data for forest areas for FY1991 to FY1994, FY1996 to FY2001, and FY2003 to FY2004. Therefore, the time-series consistency was ensured by estimating these forest areas by means of interpolation.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described by GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. The QA/QC activity procedures are described in section 6.1 of Annex 6.

e） Source-/Sink-specific Recalculations

- ***Carbon stock changes in living biomass***

In the 2010 inventory submission, carbon stock changes in living biomass in "Land converted to Forest land" were included in "Forest land remaining Forest land" and reported as "IE". However, carbon stock change in living biomass in "Land converted to Forest land" was estimated by multiplying the converted area by carbon removal per unit area of AR activities under the Kyoto Protocol. As a result, Japan reallocated it and reported those two separately.

- ***Carbon stock changes in living biomass and soil in FY2008***

Carbon stock changes in "Forest land remaining Forest land" are estimated by subtracting carbon stock changes in "Lands converted to Forest land" from those of the total Forest land. Since the activity data (area) of "Grassland converted to Forest land" in FY2008 was updated, carbons stock changes in living biomass and soils were recalculated.

- ***Carbon stock changes in living biomass before FY2006***

Some biomass expansion factors, root-to-shoot ratios and wood densities had been updated based on newly obtained data and have been applied to the estimates since FY2007. To ensure time-series consistency, the estimates for FY1990 to FY2006 were recalculated using the same parameters for the estimates since FY2007.

- ***Carbon stock changes in dead organic matter and soil before FY2007***

For estimates of carbon stock changes in dead organic matter and soil for FY2005 to FY2007, values averaged throughout a life cycle of forests estimated by CENTURY-jfos model had been used as carbon stock change per unit area. However, for estimates since FY2008, the model output has been used in order to reflect the area distribution of the age class. To ensure time-series consistency, the estimates for FY2005 to FY2007 were recalculated using the same method as the estimation since FY2008. In addition, carbon stock changes in dead organic matter and soil for FY1990 to FY2004 were estimated since necessary data are now available, which had not been estimated due to lack of data in the 2010 inventory.

f） Source-/Sink-specific Planned Improvements

None.

7.4.2. Land converted to Forest land (5.A.2)

a） Source/Sink Category Description

This subcategory deals with the carbon stock changes in lands converted to Forest land, which were converted from other land-use categories to Forest land within 20 years. The net removal by this subcategory in FY2009 was 346.33 Gg-CO_2; this represented a decrease of 81.5% below the FY1990 value and a decrease of 13.2% below the FY2008 value.

b） Methodological Issues

1） Carbon stock change in Living Biomass in Land converted to Forest land

- ***Estimation Method***

Under the Tier 2 method, annual carbon stock change in Land converted to Forest land (ΔC_{LF}) is to be estimated by summing the loss of dry matter biomass weight due to conversion and the change of dry matter biomass weight accumulated after conversion. However, it is difficult to extract forest biomass accumulation from data of the NFRDB because it deals with the living biomass of both "Forest land remaining Forest land" and "Land converted to Forest land" collectively. On the other hand, it can be assumed that “Forest land subjected to AR activities under Article 3, paragraph 3 of the Kyoto Protocol” and “Land converted to Forest land” have similar nature. Therefore, ΔC_{LF} was estimated by multiplying the area of converted land by carbon stock change per unit area due to AR activities[5]. The estimated value is reported under “Rice field converted to Forest land” in a CRF.

$$\Delta C_{LF} = A_{LF} \times IEF_{AR}$$

ΔC_{LF} : annual carbon stock change in Land converted to Forest land (t-C/yr)

A_{LF} : area of converted Forest land within 20 years (ha)

IEF_{AR} : average carbon stock change per unit area due to AR activities (equal to the implied emission/removal factor) (t-C/ha/yr)

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[5] In the FY 2009 estimation, the average value of carbon stock change per unit area between FY 2005 and 2008 was adopted. This value includes the loss of dry matter biomass weight due to conversion.

- ***Parameters***

➢ Per unit area removals of Afforestation and Reforestation activities

The average value of carbon stock change per unit area due to AR activities for FY2005 up to FY2008 (2.8 t-C/ha) were applied to all reporting years.

- ***Activity Data (Area)***

The areas of land converted to Forest land within 20 years were calculated by summing annually converted areas during the past 20 years. The estimation methods for annually converted area from each land-use category are described below.

➢ Total areas of Land converted to Forest land

It is presumed that the areas of Land converted to Forest land include AR areas, forest land restored from degraded land by natural succession, and land whose land-use categories are changed to “Forest land” due to other reasons. It is tentatively regarded that the areas of Land converted to Forest land are similar with the AR areas, and the areas are determined in accordance with the concept of “overlap” described as a recalculation approach in page 7-19 in GPG (2000), by using the AR areas and areas of forested cropland reported in the *Statistics of Cultivated and Planted Area*. In concrete terms, the AR areas are identified in detail by utilizing orthophotos at the end of 1989 and recent satellite images, but they are provided only from the FY2006 values. Therefore, the areas of Land converted to Forest land are estimated by setting an adjustment factor from the ratio between the AR areas since FY2006 and areas of forested cropland provided by the *Statistics of Cultivated and Planted Area*, and multiplying the areas of forested cropland since FY1990 by the adjustment factor. For further information on determining AR areas, see section A11.3.2.3 in Annex 11.

➢ Areas of Cropland and Grassland converted to Forest Land

The areas of Cropland converted to Forest land are determined by utilizing areas of forested cropland reported in the *Statistics of Cultivated and Planted Area*. As its subcategories, areas of Cropland converted to Forest land are categorized to rice field converted to Forest land, upland fields converted to Forest land and orchards converted to Forest land. Areas of rice fields converted to Forest land are determined by utilizing areas of rice fields converted to forests provided by the *Statistics of Cultivated and Planted Area*. Areas of upland fields and orchards converted to Forest land are estimated by dividing areas of arable land converted to forests, which are also provided by the *Statistics of Cultivated and Planted Area*, by means of the existing area ratios of upland fields, orchards and pasture land.

The areas of Grassland converted to Forest land are calculated by summing areas of pasture land converted to forests reported in the *Statistics of Cultivated and Planted Area* and those of grazed meadow converted to forests reported in *A Move and Conversion of Cropland*.

➢ Areas of Other land converted to Forest land

The areas of Wetlands, Settlements, and Other land converted to Forest land are not able to be obtained directly from statistics. Therefore, they are estimated by subtracting the summed areas of “Cropland converted to Forest land” and “Grassland converted to Forest land” from the total area of “Land converted to Forest land”, and the areas of Wetlands, Settlements, and Other land converted to Forest land are reported collectively in “Other land converted to Forest land”.

Table 7-16 Land converted to Forest land within the past 20 years

Category	Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Forest land	kha	142.9	70.8	50.9	38.2	34.3	32.5	28.1
Cropland converted to Forest land	kha	121.9	57.7	40.6	30.0	26.8	25.3	21.9
Rice field	kha	53.8	23.7	15.9	11.0	9.6	9.0	8.4
Upland field	kha	46.8	23.7	17.7	14.0	12.8	12.2	10.2
Orchard	kha	21.4	10.3	6.9	4.9	4.4	4.1	3.3
Grassland converted to Forest land	kha	19.3	11.6	9.0	7.3	6.7	6.4	5.4
Wetlands converted to Forest land	kha	IE	IE	IE	IE	IE	IE	IE
Settlements converted to Forest land	kha	IE	IE	IE	IE	IE	IE	IE
Other land converted to Forest land	kha	1.7	1.5	1.2	0.9	0.8	0.8	0.7

2） *Carbon Stock Change in Dead Organic Matter and Soils in Land converted to Forest land*

● *Estimation Method*

Carbon stock changes in dead wood, litter and soils were calculated under the assumption that these carbon stocks change linearly over 20 years from those in land-use categories other than Forest land to those in Forest land. The calculation was implemented by applying average carbon stocks obtained by the CENTURY-jfos model, in which mineral soils and organic soils are integrated. Therefore, emissions from organic soils were reported as “IE”.

$$\Delta C_{LF,i} = A_i \times (C_{after} - C_{before,i}) / 20$$

$\Delta C_{LF,\ i}$: annual change in carbon stocks in dead wood, litter or soils in land-use category *i* converted to Forest land (t-C/yr)

A_i : area of land-use category *i* being converted to Forest land within the past 20 years (ha)

C_{after} : average carbon stocks per unit area in land-use category after conversion (forests) (t-C/ha)

$C_{before,\ i}$: average carbon stocks per unit area in land-use category *i* before conversion (t-C/ha)

i : land-use category (Cropland, Grassland, Wetlands, Settlements, or Other land)

● *Parameters*

Parameters for each carbon pool in Table 7-6 (dead wood), Table 7-7 (litter) and Table 7-8 (soil) were used, in particular, for the categories Cropland, Grassland, Wetlands, Settlements and Other land before conversion and for the category Forest land after conversion.

● *Activity Data (Area)*

➢ *Total areas of Land converted to Forest land*

See Table 7-16.

c） *Uncertainties and Time-series Consistency*

● *Uncertainty Assessment*

The uncertainties of the parameters and activity data for living biomass, dead organic matter, and soil were individually assessed on the basis of field study results, expert judgment, or the default values described in the GPG-LULUCF. As a result, the uncertainty estimate was 16% for the entire removal by land converted to Forest land. The methodology used in the uncertainty assessment is described in Annex 7. In addition, concrete uncertainty estimates for individual parameters in this category will be illustrated in future submissions after investigation is completed.

● *Time-series Consistency*

Time-series consistency for this subcategory is ensured.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described by GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. The QA/QC activity procedures are described in section 6.1 of Annex 6.

e） Source-/Sink-specific Recalculations

- ***Carbon stock changes in living biomass in "Land converted to Forest land"***

In the previous inventory submission, carbon stock changes in living biomass in "Land converted to Forest land" were included in "Forest land remaining Forest land" and reported as "IE". However, carbon stock change in living biomass in "Land converted to Forest land" was estimated by multiplying the converted area by carbon removal per unit area of AR activities under the Kyoto Protocol. As a result, Japan reallocated it and reported those two separately.

- ***Carbon stock changes in Grassland converted to Forest land in FY2008***

Since the activity data (area) of "Grassland converted to Forest land" in FY2008 was updated, carbons stock changes in living biomass and soils were recalculated.

f） Source-/Sink-specific Planned Improvements

- ***Breakdown of the area of Land converted to Forest Land***

Although the area of "Land converted to Forest land" reported under the Convention and AR area under the Kyoto Protocol are nearly consistent, there is a discrepancy between them in estimating carbon stock change. The reason for this is that the estimation of breakdown of the area of "Land converted to Forest land" to its subcategories for the Convention reporting is based on statistics, while that for the Kyoto Protocol reporting is based on the AR survey utilizing orthophotos and satellite images. Hence, the validity of the estimation method is presently being reviewed, including a method which does not subcategorize the conversion area.

- ***Carbon Stock Changes in Soils in Cropland and Grassland converted to Forest Land***

Areas converted to Forest land from upland fields, orchards and pasture land are estimated by multiplying the total areas converted from Cropland to Forest land by each area ratio of upland fields, orchards and pasture land. However, this estimation method may not represent the true status of these areas. Hence, the validity of the estimation method is presently being reviewed.

- ***Carbon Stock Changes in Soils in Other land converted to Forest Land***

Reporting carbon stock changes in soils in Other land converted to Forest land presently continues to be examined with respect to set values and setting methods of carbon stock changes in land before conversion.

7.5. Cropland (5.B)

Cropland is the land that produces annual and perennial crops; it includes temporarily fallow land. Cropland in Japan's inventory consists of rice fields, upland fields and orchards.

In FY2009, Japan's Cropland area was about 3.99 million ha, which is equivalent to about 10.6% of the national land. The area of organic soil in the Cropland is about 0.18 million ha. The emissions from this category in FY2009 were 258 Gg-CO_2 (excluding 7.6 Gg-CO_2 eq. of N_2O emissions resulting from disturbance associated with land-use conversion to Cropland and 268 Gg-CO_2 of CO_2

emissions resulting from lime application to agricultural soils); this represents a decrease of 89.8% below the FY1990 value and an increase of 14.9% over the FY2008 value.

This section divides cropland into two subcategories, “Cropland remaining Cropland (5.B.1.)” and “Land converted to Cropland (5.B.2.)”, and describes them separately in the following subsections.

Table 7-17 Emissions and Removals in Cropland resulting from Carbon Stock Changes

Gas	Category	Carbon pool	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	5.B. Cropland	Total	Gg-CO_2	2,532.8	825.5	356.2	277.1	259.0	224.2	257.5
		Living Biomass	Gg-CO_2	1,318.2	290.2	99.9	129.7	133.3	124.3	154.7
		Dead Wood	Gg-CO_2	418.4	85.0	27.2	32.7	32.9	29.8	34.4
		Litter	Gg-CO_2	183.7	37.3	11.9	14.4	14.6	13.1	16.7
		Soil	Gg-CO_2	612.5	413.1	217.1	100.3	78.2	57.0	51.7
	5.B.1. Cropland remaining Cropland	Total	Gg-CO_2	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
		Living Biomass	Gg-CO_2	NA	NA	NA	NA	NA	NA	NA
		Dead Wood	Gg-CO_2	NA	NA	NA	NA	NA	NA	NA
		Litter	Gg-CO_2	NA	NA	NA	NA	NA	NA	NA
		Soil	Gg-CO_2	NE	NE	NE	NE	NE	NE	NE
	5.B.2. Land converted to Cropland	Total	Gg-CO_2	2,532.8	825.5	356.2	277.1	259.0	224.2	257.5
		Living Biomass	Gg-CO_2	1,318.2	290.2	99.9	129.7	133.3	124.3	154.7
		Dead Wood	Gg-CO_2	418.4	85.0	27.2	32.7	32.9	29.8	34.4
		Litter	Gg-CO_2	183.7	37.3	11.9	14.4	14.6	13.1	16.7
		Soil	Gg-CO_2	612.5	413.1	217.1	100.3	78.2	57.0	51.7

7.5.1. Cropland remaining Cropland (5.B.1)

a） Source/Sink Category Description

This subcategory deals with carbon stock changes in the Cropland, which has remained as Cropland during the past 20 years.

With respect to living biomass, the carbon stock change in perennial tree crops (fruit trees) is the subject of estimation according to the GPG-LULUCF. However, in Japan, tree growth is limited by trimming in order to have high productivity by keeping the tree height low, and managed and improved the tree shape by pruning lateral branches. Therefore, carbon accumulation because of the tree growth can not expected, and the annual carbon fixing volume of perennial tree crops in all orchards is stated as “NA.”

Carbon stock changes in dead organic matter are estimated as zero (0) by applying Tier 1 method, which assumes the carbon stocks are not changed, according to section 3.3.1.2.1 in the GPG-LULUCF. Thus, the carbon stock changes are reported as “NA”.

Carbon stock changes in and CO_2 emissions from soils are presently not estimated due to lack of data for estimation. Hence, this carbon pool is reported as “NE”.

Table 7-18 Areas of Cropland remaining Cropland within the past 20 years

Category	Unit	1990	1995	2000	2005	2007	2008	2009
Cropland remaining Cropland	kha	4,063.8	4,016.5	3,968.9	3,930.0	3,919.7	3,911.8	3,907.6

b） Source-/Sink-specific Recalculations

- ***Area of Cropland remaining Cropland***

Until the 2010 submission, area of “Cropland remaining Cropland” was estimated by multiplying the total area of Cropland 21 year ago of the inventory year by the product of a sequence of conversion rate for 20 years. However, this approach may lose touch with actual conditions. Thus, estimating area of "Cropland remaining Cropland" was changed to the total area of Cropland on the statistics within the inventory year subtracted by the sum of land areas, which were converted to Cropland during the 20 years before the inventory year.

c） Source-/Sink-specific Planned Improvements

- ***Carbon Stock Changes in Soils in Cropland remaining Cropland***

Research and data collection activities for estimating carbon stock changes in cropland soils have been in progress. Japan is planning to report the carbon stock changes in its future submission when their estimation and reporting become possible.

- ***CO_2 Emissions from Cultivated Organic Soils in Cropland***

Actual conditions of CO_2 emissions resulting from plowing or organic soils in Cropland are presently under investigation. Japan is planning to report the carbon stock changes in its future submission when their estimation and reporting become possible after the investigation is completed.

7.5.2. Land converted to Cropland (5.B.2)

a） Source/Sink Category Description

This subcategory deals with the carbon stock changes, which occurred in the lands that were converted from other land use categories to Cropland, within the past 20 years. The emissions from this subcategory in FY2009 were 258 Gg-CO_2 (excluding 7.6 Gg-CO_2 eq. of N_2O emissions resulting from disturbance associated with land-use conversion to Cropland and 268 Gg-CO_2 of CO_2 emissions resulting from lime application to agricultural soils); this represents a decrease of 89.8% below the FY1990 value and an increase of 14.9% over the FY2008 value.

With respect to living biomass, its carbon stock change as a result of land use conversion from other land use to Cropland is estimated. This process includes both temporary loss and subsequent gain of living biomass in the land before and after conversion.

With respect to dead organic matter, Japan used the CENTURY-jfos model to estimate carbon stocks of dead organic matter in Forest land, and then estimated carbon stock change in "Forest land converted to Cropland". Carbon stock changes in other subcategories were reported as "NA", supposing that no carbon stock change occur, or "NE" where suitable knowledge for estimating carbon stocks for the land-use categories was not available.

With respect to soil, its carbon stock change as a result of land use conversion from other land use to Cropland is estimated. Carbon stock changes in organic soils were reported as "NE" due to lack of data for estimation.

b） Methodological Issues

1） Carbon stock change in Living Biomass in Land converted to Cropland

- ***Estimation Method***

The Tier 2 method is applied to the case of Forest land converted to Cropland using country specific value of the amount of biomass accumulation. The Tier 1 method is applied for the case of land uses other than Forest land converted to Cropland using provisional and default values.

$$\Delta C = \Delta C_i + \Delta C_j$$
$$\Delta C_i = A\ (CR_a - CR_i) \times CF$$
$$\Delta C_j = A \times CR_j \times CF$$

ΔC : annual carbon stock change in the converted land (t-C/yr)
ΔC_i : annual carbon stock change at the land conversion (t-C/yr)
ΔC_j : annual carbon stock change in the converted land after conversion (t-C/yr)
i : land use before conversion
j : land use after conversion
A : area of converted land for the current year (ha)
CR_a : dry matter biomass weight per unit area immediately following conversion (t-d.m./ha), default value=0
CR_i : dry matter biomass weight per unit area before land converted from land use type i (t-d.m./ha)
CR_j : change of dry matter biomass weight per unit area accumulated after conversion (t-d.m./ha/yr)
CF : carbon fraction of dry matter (t-C/t-d.m.)

- ***Parameters***

The values shown in Table 7-5 are used for the estimation of biomass stock changes upon land use conversion and subsequent changes in biomass stock due to biomass growth in the converted land.

- ***Carbon Fraction of Dry Matter***

0.5 (t-C/t-d.m.) (GPG-LULUCF, default value)

- ***Activity Data (Area)***

Annually converted areas to Cropland were used for estimating carbon stock changes in living biomass in Land converted to Cropland.

It was assumed that areas of Forest land converted to other land use (Cropland, Grassland, Wetlands, Settlement and Other land) were consistent with the area of deforestation (D area) reported under Article 3, paragraph 3, of the Kyoto Protocol. Thus, the area of Forest land converted to Cropland was estimated by allocating D area. Since the D survey has been conducted since FY2005, the applied method to calculate the D area for FY1990 to FY2004 and for post FY2005 are as follows, respectively.

- ***From FY1990 to FY2004***

The areas of Forest land converted to Cropland, Grassland, Settlements and Other land are estimated by multiplying the areas, which are calculated by subtracting the area of Forest land converted to Wetlands from total areas converted from Forest land, by land ratios of Forest land converted to Cropland, Grassland, Settlements and Other land, respectively.

The total areas converted from Forest land were determined based on areas provided by the *World Census of Agriculture and Forestry*, the Forestry Agency's records, and D areas under Article 3, paragraph 3, of the Kyoto Protocol. In concrete terms, the D areas are identified in detail by utilizing orthophotos at the end of 1989 and recent satellite images, but they are provided only from the FY1990 values. Therefore, the total areas converted from Forest land are estimated by setting an adjustment factor from the ratio between the D areas since FY1990 and areas converted from forests provided by the *World Census of Agriculture and Forestry* and the Forestry Agency's records, and multiplying the areas converted from forests since FY1970 by the adjustment factor. For further information on determining D areas, see section A11.3.2.3 in Annex 11.

The respective ratios of Forest land converted to other land-use categories except Wetlands are estimated from areas of private forests converted to other land-use categories resulting from forest land development, based on the Forestry Agency's records, and the ratios are regarded as the same for national forests.

- ***After FY2005***

The areas of Forest land converted to Cropland, Grassland, Wetlands, Settlements and Other land were estimated by multiplying the D area by land ratios of Forest land converted to each land-use category. Both ratio and area were determined by the D survey.

Areas of land converted from land-use categories other than Forest land to Cropland are determined by applying expansion area values provided by the *Statistics of Cultivated and Planted Area*. The converted areas are divided into rice fields, upland fields, orchards, and pasture land proportionately by means of the current area ratios. The areas of rice fields, upland fields, and orchards are allocated to Cropland, while that of pasture land is allocated to Grassland.

It should be noted that the area presented in the CRF "Table 5.B SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY－Cropland" is not the annually converted area in FY2009 but the sum of annually converted areas during the past 20 years.

Table 7-19 Area of land annually converted to Cropland (single year)

Category			Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Cropland			kha	8.6	4.4	3.1	2.0	1.8	1.5	1.1
	Forest land converted to Cropland		kha	7.0	1.4	0.5	0.5	0.6	0.5	0.6
		Rice field	kha	0.011	0.018	0.002	0.000	0.018	0.045	0.023
		Upland field	kha	7.0	1.4	0.5	0.5	0.5	0.5	0.6
		Orchard	kha	IE	IE	IE	IE	IE	IE	IE
	Grassland converted to Cropland		kha	0.002	0.022	0.012	0.027	0.004	0.005	0.004
	Wetlands converted to Cropland		kha	0.34	0.03	0.07	0	0	0.47	0.00
	Settlements converted to Cropland		kha	IE	IE	IE	IE	IE	IE	IE
	Other land converted to Cropland		kha	1.3	2.9	2.5	1.4	1.3	0.5	0.5
		Rice field	kha	0.2	1.1	1.3	0.3	0.6	0.1	0.1
		Upland field	kha	1.1	1.9	1.2	1.1	0.7	0.4	0.5
		Orchard	kha	IE	IE	IE	IE	IE	IE	IE

2） *Carbon Stock Change in Dead Organic Matter in Land converted to Cropland*

- ***Estimation Method***

Carbon stock changes in dead organic matter in "Forest land converted to Cropland" were estimated by applying Tier 2 estimation method using the value of carbon stock in dead organic matter obtained by CENTURY-jfos model. All carbon stocks in dead organic matter in the subcategory are assumed oxidized and emitted as CO_2 within the year of conversion in accordance with the description in section 3.4.2.2.1 in the GPG-LULUCF. In addition, as described in the Parameters section below, carbon stocks of dead organic matter in Cropland is assumed to be zero.

$$\Delta C_{DOM} = \sum((C_{after,i} - C_{before,i}) \times A)$$

ΔC_{DOM} : Carbon stock changes in dead organic matter in the converted land (t-C/yr)

$C_{after,i}$: Average carbon stock per unit area in dead wood or litter after the conversion (t-C/ha)
Note: carbon stocks after conversion are assumed as “0” (zero).

$C_{before,i}$: Average carbon stock per unit area in dead wood or litter before the conversion (t-C/ha)

A : Area of converted land within the year of conversion (ha)

i : type of dead organic matter (dead wood or litter)

With regard to “Grassland converted to Cropland”, carbon stocks of dead wood and litter carbon pools were assumed to be minor and the stock changes could be ignored, and were thus reported as “NA”. With regard to “Wetlands and Settlements converted to Cropland”, these were also reported as “NA”, since carbon stock changes were assumed as zero to zero, supposing that basically no such carbon pools exist in reclaimed wetland where were object of estimating “Wetlands converted to Cropland”, and that carbon stocks of dead organic matter in Settlements before conversion were assumed as negligible. “Other land converted to Cropland”, which is estimated to be cropland restoration, was reported as “NE”, because suitable knowledge for estimating carbon stock changes for this land use conversion was not available.

- ***Parameters***

Average carbon stocks in dead wood and litter in Forest land before conversion are shown in Table 7-6 and Table 7-7. In addition, it is assumed that they come to be zero immediately after conversion, and are not accumulated after conversion.

- ***Activity Data (Area)***

Annually converted areas to Cropland are used for estimating carbon stock changes in dead organic matter in Land converted to Cropland.

3） Carbon Stock Change in Soils in Land converted to Cropland

- ***Estimation Method***

Carbon stock changes in soils were calculated by applying Tier 2 estimation method in accordance with the estimation method for “Land converted to Cropland” (GPG-LULUCF, page 3-89) using the value of carbon stock in soil which are country specific or obtained by CENTURY-jfos model.

$$\Delta C_i = A_i \times (C_{after,i} - C_{before,i}) / 20$$

ΔC_i : Annual change in carbon stocks in soils in converted land (t-C/yr)

A_i : Area being converted to the land-use category *i* within the past 20 years (ha)

$C_{after,\ i}$: Average carbon stocks per unit area in land-use category *i* after conversion (t-C/ha)

$C_{before,\ i}$: Average carbon stocks per unit area in land-use category *i* before conversion (t-C/ha)

i : Land-use category

- ***Parameters***

Average soil carbon stocks in each land-use categories shown in Table 7-8 were used. For reference, soil carbon stocks of Cropland (rice field, upland field and orchard) are described below in detail:

- ***Soil carbon stocks in Rice field, Upland field and Orchard***

For the carbon stocks in rice fields, upland fields and orchard soils, the country-specific soil survey data is applied. As soil carbon stocks per unit area vary from one soil group to another (such as Andosols, Gray lowland soils and Gley soils), the average soil carbon stocks in rice field, upland field and orchard are calculated by weighted averaging of soil carbon stock data per unit area at 0-30 cm depth by area for each soil group.

Table 7-20 Soil carbon stocks in rice field

Soil Type	Area [ha]	Proportion	Carbon Stock / ha [t-C/ha]	Carbon Stock [t-C]	
Lithosols	*	---	*	---	
Sand-Dune Regosols	*	---	89.04	---	
Andisols	17,169	0.6%	125.24	2,150,246	
Wet Andosols	274,319	9.5%	113.68	31,184,584	
Gleyed Andosols	50,760	1.8%	101.74	5,164,322	
Cambisols	6,640	0.2%	59.48	394,947	
Gray Upland Soils	79,236	2.7%	60.37	4,783,477	
Gley Upland Soils	40,227	1.4%	60.71	2,442,181	
Red Soils	*	---	*	---	
Yellow Soils	144,304	5.0%	63.21	9,121,456	
Dark Red Soils	1,770	0.1%	56.26	99,580	
Fluvisols	141,813	4.9%	59.71	8,467,654	
Gleysols	1,056,571	36.6%	61.59	65,074,208	
Gleysols	889,199	30.8%	64.83	57,646,771	
Muck Soils	75,944	2.6%	91.89	6,978,494	
Histosols	109,465	3.8%	114.95	12,583,002	
Total	2,887,417	100.0%		206,090,923	
Average			80.19		
Weighted Average			71.38	Applied Value	

*: This mark means the data that are difficult to obtain with high-accuracy.

Table 7-21 Soil carbon stocks in upland field

Soil Type	Area [ha]	Proportion	Carbon Stock / ha [t-C/ha]	Carbon Stock [t-C]
Lithosols	7,148	0.4%	69.25	494,999
Sand-Dune Regosols	22,297	1.2%	21.49	479,163
Andisols	851,061	46.5%	109.15	92,893,308
Wet Andosols	72,195	3.9%	149.51	10,793,874
Gleyed Andosols	1,850	0.1%	120.98	223,813
Cambisols	287,464	15.7%	65.16	18,731,154
Gray Upland Soils	71,855	3.9%	79.77	5,731,873
Gley Upland Soils	4,324	0.2%	*	---
Red Soils	25,243	1.4%	42.23	1,066,012
Yellow Soils	105,641	5.8%	47.13	4,978,860
Dark Red Soils	29,130	1.6%	45.15	1,315,220
Fluvisols	231,051	12.6%	50.05	11,564,103
Gleysols	75,095	4.1%	53.75	4,036,356
Gleysols	13,163	0.7%	65.94	867,968
Muck Soils	1,673	0.1%	78.72	131,699
Histosols	32,316	1.8%	184.91	5,975,552
Total	1,831,506	100.0%		159,283,954
Average			78.88	
Weighted Average			86.97	Applied Value

*: This mark means the data that are difficult to obtain with high-accuracy.

Table 7-22 Soil carbon stocks in Orchard

Soil Type	Area [ha]	Proportion	Carbon Stock / ha [t-C/ha]	Carbon Stock [t-C]
Lithosols	7,682	1.9%	66.48	510,699
Sand-Dune Regosols	1,897	0.5%	27.77	52,680
Andisols	86,083	21.3%	119.03	10,246,459
Wet Andosols	2,530	0.6%	103.82	262,665
Gleyed Andosols	*	---	115.08	---
Cambisols	148,973	36.9%	68.35	10,182,305
Gray Upland Soils	6,424	1.6%	70.55	453,213
Gley Upland Soils	*	---	*	---
Red Soils	19,937	4.9%	63.68	1,269,588
Yellow Soils	75,973	18.8%	64.48	4,898,739
Dark Red Soils	6,141	1.5%	54.61	335,360
Fluvisols	35,261	8.7%	69.32	2,444,293
Gleysols	10,075	2.5%	57.35	577,801
Gleysols	2,065	0.5%	*	---
Muck Soils	135	0.0%	59.44	8,024
Histosols	130	0.0%	*	---
Total	403,306	100.0%		31,241,826
Average			72.30	
Weighted Average			77.46	Applied Value

*: This mark means the data that are difficult to obtain with high-accuracy.

- ***Activity Data (Area)***

Areas of Land converted to Cropland during the past 20 years are assumed as summed areas of annually converted land to Cropland during the past 20 years. The assumed areas are applied to estimation of the carbon stock changes in soils in Land converted to Cropland. The areas are shown in Table 7-23 below.

Table 7-23 Area of land converted to Cropland within the past 20 years

Category			Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Cropland			kha	493.1	319.7	183.7	108.5	86.6	74.8	65.3
	Forest land converted to Cropland		kha	279.3	203.0	120.6	54.6	41.2	35.5	28.0
		Rice field	kha	279.3	203.0	120.6	54.6	41.2	35.5	28.0
		Upland field	kha	IE	IE	IE	IE	IE	IE	IE
		Orchard	kha	IE	IE	IE	IE	IE	IE	IE
	Grassland converted to Cropland		kha	8.6	4.8	0.6	0.5	0.5	0.5	0.5
	Wetlands converted to Cropland		kha	11.9	3.9	2.0	1.2	0.9	1.2	1.1
	Settlements converted to Cropland		kha	IE	IE	IE	IE	IE	IE	IE
	Other land converted to Cropland		kha	193.3	108.0	60.4	52.2	44.0	37.6	35.8
		Rice field	kha	27.7	16.2	11.2	9.9	11.6	11.6	11.5
		Upland field	kha	165.6	91.8	49.2	42.3	32.4	26.0	24.3
		Orchard	kha	IE	IE	IE	IE	IE	IE	IE

c） Uncertainties and Time-series Consistency

- ***Uncertainty Assessment***

Uncertainties of the parameters and the activity data for living biomass, dead organic matter, and soil were individually assessed on the basis of field study results, expert judgment, or the default values described in the GPG-LULUCF. The uncertainty was estimated as 20% for the entire emission from the land converted to Cropland. More detailed information on the uncertainty assessment is described in Annex 7. Uncertainty estimates of some major parameters, which were used for the uncertainty assessment for this category, are shown in Table 7-24 as an example.

Table 7-24 Uncertainty estimates regarding major parameters in the category of Cropland category

		Uncertainty (%)	Country Specific (CS) or Default (D)	
Cropland Area	Rice Field	0.15	CS	Original uncertainty of statistics
	Upland Field	0.27	CS	

- ***Time-series Consistency***

Although methods to estimate area of Forest land converted to other land use are different between FY1990-2004 and post FY2005 as described in section 7.5.2.b)1), time-series consistency for this subcategory is basically ensured.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described in GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. More detailed information on the QA/QC activity procedures is described in section 6.1 of Annex 6.

e） Source-/Sink-specific Recalculations

- ***Areas of land converted to Cropland within 20 years***

Until the 2010 submission, total area of “Land converted to Cropland” had been determined by subtracting the area of “Cropland remaining Cropland” from total Cropland in the statistics as described in 7.5.1.b). It is now calculated by summation of the annual area of “Land converted to Cropland” for the previous 20 years.

- ***Areas of Forest land converted to Cropland***

Due to the change in allocation method of “Forest land converted to other land-use categories” after FY2005, as described in 7.5.2.b)1), the area of “Forest land converted to Cropland” was recalculated. In line with this, the biomass stock changes in living biomass, dead organic matter and soils in the land were also recalculated.

- ***Carbon Stock Changes in Forest land converted to Cropland***

Living biomass accumulation in Forest land subjected to conversion has been estimated by extrapolation of the trend of living biomass accumulation in the D area during the period between 2005 and the latest year. In line with this, the carbon stock changes were recalculated in accordance with the updated living biomass accumulation reflecting the value of FY2009.

- ***Carbon Stock Changes in Dead Organic Matter in Lands (Grassland, Wetlands and Settlements) converted to Cropland***

Until the 2010 submission, Cropland converted from Grassland and Wetlands have been reported as “NE”. They are now reported as “NA”. Settlements converted to Cropland was “IE” but has been changed to “NA” as well.

f） Source-/Sink-specific Planned Improvements

- ***Method of Obtaining Data of the Area converted from Grassland to Cropland***

Data on the area of land converted from Grassland to Cropland other than "land converted from Grassland (pasture land) to Cropland (rice field)" cannot be obtained from currently available statistics, so the carbon stock changes in the areas have not been estimated. Therefore, the methods of obtaining the following area data need to be investigated.

- from pasture land to upland field
- from pasture land to orchard
- from grazing meadow to rice field
- from grazing meadow to upland field
- from grazing meadow to orchard

- ***Estimation Method of Soil Carbon Stock Change upon Land Use Conversion from Other Land to Cropland***

The estimation method will be considered, when new data and information are obtained.

7.6. Grassland (5.C)

Grassland is generally covered with perennial pasture and is used mainly for harvesting fodder or grazing.

In FY2009, Japan's grassland area was about 0.90 million ha, which is equivalent to about 2.4% of the national land. The area of organic soil in the Grassland is about 0.04 million ha. The net removals from this category in FY2009 were 276 Gg-CO_2 (excluding 268 Gg-CO_2 of CO_2 emissions resulting from lime application to agricultural soils); this represents a decrease of 37.4% below the FY1990 value and a decrease of 8.7% below the FY2008 value.

This section divides grassland into two subcategories, "Grassland remaining Grassland (5.C.1.)" and "Land converted to Grassland (5.C.2.)", and describes them separately in the following subsections.

Table 7-25 Emissions and Removals in Grassland resulting from Carbon Stock Changes

Gas	Category	Carbon pool	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	5.C. Grassland	Total	Gg-CO_2	-441.3	-480.7	-405.7	-335.6	-314.9	-302.6	-276.2
		Living Biomass	Gg-CO_2	50.7	-16.7	-26.5	-28.4	-31.9	-31.2	-21.4
		Dead Wood	Gg-CO_2	58.9	12.8	4.2	4.5	4.2	4.0	4.6
		Litter	Gg-CO_2	25.8	5.6	1.8	2.0	1.9	1.7	2.2
		Soil	Gg-CO_2	-576.7	-482.4	-385.3	-313.7	-289.1	-277.1	-261.7
	5.C.1. Grassland remaining Grassland	Total	Gg-CO_2	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
		Living Biomass	Gg-CO_2	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
		Dead Wood	Gg-CO_2	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
		Litter	Gg-CO_2	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
		Soil	Gg-CO_2	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
	5.C.2. Land converted to Grassland	Total	Gg-CO_2	-441.3	-480.7	-405.7	-335.6	-314.9	-302.6	-276.2
		Living Biomass	Gg-CO_2	50.7	-16.7	-26.5	-28.4	-31.9	-31.2	-21.4
		Dead Wood	Gg-CO_2	58.9	12.8	4.2	4.5	4.2	4.0	4.6
		Litter	Gg-CO_2	25.8	5.6	1.8	2.0	1.9	1.7	2.2
		Soil	Gg-CO_2	-576.7	-482.4	-385.3	-313.7	-289.1	-277.1	-261.7

7.6.1. Grassland remaining Grassland (5.C.1)

a） Source/Sink Category Description

This category reports carbon stock changes in Grassland remaining Grassland during the past 20 years, by dividing three subcategories: "pasture land", "grazed meadow" and "wild land".

With respect to living biomass, carbon stock changes in pasture land and grazed meadow are assumed to be in a steady state and reported as "NA" in accordance with the Tier 1 estimation method in section 3.4.1.1.1.1 in the GPG-LULUCF. Carbon stock changes in living biomass in wild land are reported as "NE" because status of carbon pools in wild land is under survey.

Carbon stock changes in dead organic matter in pasture land and grazed meadow are estimated as zero (0) by applying Tier 1 method in section 3.4.1.2.1 in the GPG-LULUCF, which assumes the carbon stocks are not changed. Thus, the carbon stock changes are reported as “NA”. Carbon stock changes in dead organic matter in wild land are reported as “NE” because status of carbon pools in wild land is under survey.

With respect to soil, carbon stock changes in soil in pasture land are presently not estimated because information on carbon stocks and management state in the pasture land is not collected sufficiently for estimating the carbon stock changes. Hence, this carbon pool is reported as “NE”. On the other hand, grazed meadows are non-degraded and sustainably managed grassland, but without significant management improvements. Therefore, the default value of carbon stock change factor for “Nominally managed (non-degraded)” in table 3.4.5 of the GPG-LULUCF, which is “1.0”, is applied to the grazed meadows. In this case, soil carbon stocks are not changed over time; therefore, the soil carbon stock changes in grazed meadows are reported as “NA”. Carbon stock changes in soil in wild land are reported as “NE” because actual condition of the carbon stock changes is not clear. CO_2 emissions from organic soils are reported as “NE” because estimation of the emissions is under examination.

Table 7-26 Areas of Grassland remaining Grassland within the past 20 years

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Grassland remaining Grassland		kha	777.9	808.9	837.5	857.1	858.4	860.4	861.0
	Pasture land	kha	494.2	537.2	557.7	569.4	571.5	573.8	574.9
	Grazed meadow	kha	13.7	11.7	9.7	7.7	6.9	6.5	6.1
	Wild land	kha	270.0	260.0	270.0	280.0	280.0	280.0	280.0

b） Source-/Sink-specific Recalculations

- ***Area of Grassland remaining Grassland***

Until the 2010 submission, area of “Grassland remaining Grassland” was estimated by multiplying the total area of Grassland 21 year ago of the inventory year by the product of a sequence of conversion rate for 20 years. However, this approach may lose touch with actual conditions. Thus, estimating area of “Grassland remaining Grassland” was changed to the total area of Grassland on the statistics within the inventory year subtracted by the sum of land areas, which were converted to Grassland during the 20 years before the inventory year.

c） Source-/Sink-specific Planned Improvements

- ***Carbon Stock Changes in Mineral Soils in Grassland remaining Grassland***

Carbon stock changes in mineral soils in this category are presently not estimated. However, research projects on soil carbon stocks in pasture land have been progressed. Therefore, Japan is planning to report the carbon stock changes when they become able to be estimated in the future.

- ***CO_2 Emissions from Cultivated Organic Soils in Grassland***

With respect to CO_2 emissions from organic soils in Grassland, CO_2 emissions from organic soils are being examined in a cross-cutting manner through the LULUCF sector, including the emissions in Cropland.

7.6.2. Land converted to Grassland (5.C.2)

a） Source/Sink Category Description

This subcategory deals with the carbon stock changes, which occurred in the lands that were converted from other land use categories to grassland, within the past 20 years. The net removal from this subcategory in FY2009 was 276 Gg-CO_2 (excluding 268 Gg-CO_2 of CO_2 emissions resulting from lime application to agricultural soils); this represents a decrease of 37.4% below the FY1990 value and a decrease of 8.7% below the FY2008 value.

With respect to living biomass, its carbon stock changes as a result of land use conversion from other land use to Grassland are estimated. The carbon stock changes include both temporary loss and subsequent gain of living biomass in the land before and after conversion.

With respect to dead organic matter, Japan used the CENTURY-jfos model to estimate carbon stocks in dead organic matter in Forest land, and then estimated carbon stock change in “Forest land converted to Grassland”. Carbon stock changes in Grassland converted from other land-use other than Forest land were reported as “NE” or “NA” because suitable knowledge for estimating carbon stocks for the land-use categories were not available, or supposing that no carbon stock change occurred, respectively.

Carbon stock changes in soils as a result of land use conversion from other land use to Grassland are estimated. All soils are temporarily regarded as mineral soils because actual condition of organic soils is presently being assessed.

b） Methodological Issues

1） Carbon stock change in Living biomass in Land converted to Grassland

- ***Estimation Method***

The Tier 2 method was applied to the cases of Forest land and Cropland (rice fields) converted to Grassland (pasture lands) using country specific and provisional values of the amount of biomass accumulation. The Tier 1 method was used for land uses other than Forest land and Cropland (rice fields) converted to Grassland (pasture lands) using default value. Equations are given in section 7.5.2.b)1). While annually converted area was used for estimating the loss of living biomass upon land use conversion; the biomass growth after land-use conversion was estimated with the summed conversion area for the latest five years, assuming that the biomass growth reaches a steady state at a constant rate over subsequent five years after conversion.

- ***Parameters***

➢ ***Biomass stock in each Land Use Category***

The values shown in Table 7-5 are used for the estimation of biomass stock changes upon land use conversion and subsequent changes in biomass stock due to biomass growth in converted land.

➢ ***Carbon Fraction of Dry Matter***

0.5 (t-C/t-d.m.) (GPG-LULUCF, default value)

- ***Activity Data (Area)***

As shown in Table 7-3, Grassland is treated as a part of Cropland. Therefore, the procedure to obtain the area of the Grassland converted from other land use categories is as described in 7.5.2.b)1).

It should be noted that the area presented in the CRF “Table 5.C SECTORAL BACKGROUND DATA

FOR LAND USE, LAND-USE CHANGE AND FORESTRY－Grassland" is not the annually converted area in FY2009 but the sum of annually converted areas during the past 20 years.

Table 7-27 Area of land annually converted to Grassland (single year)

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Grassland		kha	4.0	1.9	1.7	2.4	1.6	1.4	1.1
	Forest land converted to Grassland	kha	1.0	0.2	0.1	0.1	0.1	0.1	0.1
	Cropland converted to Grassland	kha	0.9	0.6	1.0	1.7	1.0	0.8	0.7
	Wetlands converted to Grassland	kha	0.12	0.01	0.03	0	0	0.20	0
	Settlements converted to Grassland	kha	IE	IE	IE	IE	IE	IE	IE
	Other land converted to Grassland	kha	2.0	1.1	0.6	0.6	0.4	0.3	0.4

Table 7-28 Area of Land converted to Grassland within the past 5 years

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Grassland		kha	33.7	15.7	13.0	15.5	16.6	16.0	14.2
	Forest land converted to Grassland	kha	4.9	1.8	0.6	0.3	0.3	0.3	0.3
	Cropland converted to Grassland	kha	6.5	3.4	4.5	6.2	6.7	6.4	5.7
	Wetlands converted to Grassland	kha	0.32	0.07	0.03	0	0	0.20	0.20
	Settlements converted to Grassland	kha	IE	IE	IE	IE	IE	IE	IE
	Other land converted to Grassland	kha	15.5	6.9	3.3	2.8	2.9	2.7	2.3

2） *Carbon Stock Change in Dead organic Matter and Soils in Land converted to Grassland*

- ***Estimation Method***

➢ ***Carbon Stock Changes in Dead Organic Matter***

In this category, carbon stock changes in dead organic matter in Forest land converted to Grassland were estimated. Tier.2 estimation method was applied to the subcategory using country specific values of the carbon stocks before and after conversion. It should be noted that carbon stocks of dead organic matter after conversion to Grassland are assumed as zero (Tier.1 method in 2006 IPCC Guideline Vol.4 section 6.3.2), because there are no quantitative data of them although subtle but certain amount of carbon stocks do generally exist on the soil surface. As described in section 7.5.2.b)2), Cropland and Settlements converted to Grassland were reported as "NA" since the carbon stocks before and after conversion were assumed as zero. As for Wetlands and Other land converted to Grassland, they are estimated to be reclamation and restoration. Thus they were reported as "NA" and "NE", respectively[6], for the similar reason described in section 7.5.2.b)2).

➢ ***Carbon Stock Changes in Soils***

Carbon stock changes in soils were estimated as described in section 7.5.2.b)3). In addition, organic soils were reported as "NE".

- ***Parameters***

➢ ***Carbon Stocks in Dead Organic Matter***

Average carbon stocks in dead wood and litter in Forest land before conversion are shown in Table 7-6 and Table 7-7. The average carbon stocks in these categories from FY1990 to FY2004 are not estimated; therefore those in FY2005 are substituted for them. In addition, it is assumed that they come to be zero immediately after conversion, and are not accumulated after conversion. All carbon stocks in dead organic matter in the subcategory are assumed oxidized and emitted as CO_2 within the year of conversion in accordance with the description in section 3.4.2.2.1 in the GPG-LULUCF.

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[6] Cropland on Japanese statistics includes Pasture land which falls into Grassland.

- ***Carbon Stocks in Soils***

Data listed in Table 7-8 are applied as average carbon stocks before and after conversion. For reference, soil carbon stocks of Grassland in detail are described below.

- ***Soil carbon stocks in Grassland***

Data from the country-specific soil survey data is applied for the carbon stocks in Grassland soils. Although it is difficult to obtain area data by soil types for Grassland, it could be viewed that the area by soil types and the numbers of samples by soil types have a high correlation; therefore, it is calculated by weighted averaging of soil carbon stock data by the number of samples for each soil group.

Table 7-29 Soil carbon stocks in Grassland

Soil Type	Area [ha]	Proportion	Carbon Stock / ha [t-C/ha]	Carbon Stock [t-C]
Lithosols	*	---	*	---
Sand-Dune Regosols	140	0.6%	79.28	11,099
Andisols	11,364	48.8%	152.19	1,729,487
Wet Andosols	459	2.0%	207.40	95,197
Gleyed Andosols	*	---	*	---
Cambisols	4,071	17.5%	101.27	412,270
Gray Upland Soils	2,008	8.6%	126.44	253,892
Gley Upland Soils	228	1.0%	110.51	25,196
Red Soils	*	---	*	---
Yellow Soils	796	3.4%	74.36	59,191
Dark Red Soils	695	3.0%	54.55	37,912
Fluvisols	2,658	11.4%	107.69	286,240
Gleysols	215	0.9%	78.76	16,933
Gleysols	*	---	*	---
Muck Soils	*	---	*	---
Histosols	663	2.8%	325.18	215,594
Total	23,297	100.0%		3,143,012
Average			128.88	
Weighted Average			134.91	Applied Value

*: This mark means the data that are difficult to obtain with high-accuracy.

- ***Activity Data (Area)***

The sum of annually converted area from other land-use categories to Grassland for the past 20 years was regarded as the area of Land converted to Grassland during the past 20 years. The areas are shown in Table 7-30.

Table 7-30 Area of Land converted to Grassland within the past 20 years

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Grassland		kha	144.8	114.3	80.0	57.2	48.5	43.8	40.1
	Forest land converted to Grassland	kha	30.6	25.3	16.5	7.7	5.8	5.1	4.0
	Cropland converted to Grassland	kha	25.2	21.2	19.8	20.7	20.1	19.4	19.0
	Wetlands converted to Grassland	kha	0.8	0.9	0.7	0.4	0.3	0.5	0.4
	Settlements converted to Grassland	kha	IE	IE	IE	IE	IE	IE	IE
	Other land converted to Grassland	kha	88.1	67.0	43.0	28.4	22.3	18.8	16.6

c) Uncertainties and Time-series Consistency

- ***Uncertainty Assessment***

Uncertainties of the parameters and the activity data for living biomass, dead organic matter, and soil were individually assessed on the basis of field study results, expert judgment, or the default values described in the GPG-LULUCF. The uncertainty was estimated as 37% for the entire removal from the land converted to grassland. More detailed information on the uncertainty assessment is described in Annex 7. In addition, concrete uncertainty estimates for individual parameters in this category will be illustrated in future submissions after investigation is completed.

- ***Time-series Consistency***

Although methods to estimate area of Forest land converted to other land use are different between FY1990-2004 and post FY2005, as described in section 7.5.2.b)1), time-series consistency for this subcategory is basically ensured.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described in GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. More detailed information on the QA/QC activity procedures is described in section 6.1 of Annex 6.

e） Source-/Sink-specific Recalculations

- ***Areas of land converted to Grassland within 20 years***

Until the 2010 submission, total area of “Land converted to Grassland” had been determined by subtracting the area of “Grassland remaining Grassland” from total Grassland in the statistics as described in 7.5.1.b). It is now calculated by summation of the annual area of “Land converted to Grassland” for the previous 20 years.

- ***Areas of Forest land converted to Grassland***

Due to the change in allocation method of “Forest land converted to other land-use categories” after FY2005, as described in 7.5.2.b)1), the area of “Forest land converted to Grassland” was recalculated. In line with this, the biomass stock changes in living biomass, dead organic matter and soils were also recalculated.

- ***Carbon Stock Changes in Forest land converted to Grassland***

Living biomass accumulation in Forest land subjected to conversion has been estimated by extrapolation of the trend of living biomass accumulation in D area during the period between 2005 and the latest year. In line with this, the carbon stock changes were recalculated in accordance with the updated living biomass accumulation reflecting the value of FY2009.

- ***Carbon Stock Changes in Dead Organic Matter in Lands (Cropland, Wetlands and Settlements) converted to Grassland***

Until the 2010 submission, Grassland converted from Cropland and Wetlands have been reported as “NE”. They are now reported as “NA”. Settlements converted to Grassland was “IE” but has been changed to “NA” as well.

f） Source-/Sink-specific Planned Improvements

- ***Method of Obtaining Data of the Areas converted from Other Land-use Categories to Grassland***

The method used to obtain data on the area converted to Grassland needs to be improved. For example, currently, the area of lands converted from Forest land to Grassland is estimated by multiplying the summed areas of Forest land converted to Cropland and Grassland by the ratio of grazing land to the summed area. However, this estimation method may not represent the actual status of these areas.

Therefore, the validity of the estimation method needs to be reviewed, and, if necessary, a new method of obtaining the area data should be considered.

- ***Method of Obtaining Data of the Area converted from Cropland to Grassland***

With respect to the method of obtaining data of the area converted from Cropland to Grassland, the converted area cannot be obtained from statistics except for the land use conversion from Cropland (rice field) to Grassland (pasture land). For this reason, the estimates of the carbon stock changes in this land use category may not fully reflect the actual conditions. Therefore, the methods used to obtain the following area data need to be investigated.

- from upland field to pasture land
- from orchard to pasture land
- from rice field to grazing meadow
- from upland field to grazing meadow
- from orchard to grazing meadow

- ***Estimation Method of Soil Carbon Stock Change upon Land Use Conversion from Other Land to Cropland***

The estimation method will be considered, when new data and information are obtained.

- ***Method of Obtaining Data and Revising Estimation Methodologies for Living Biomass Stock in the " Grassland other than Pasture Land and grazed Meadow Land"***

It was pointed out by experts that the living biomass stock of the “grassland other than pasture land and grazed meadow land” is not necessarily identical to the one of “pasture land and grazed meadow land”, which were originally classified in Grassland. Therefore, it is necessary to obtain data, which reflect living biomass stock in grassland other than pasture land and grazed meadow land, and to revise the estimation method for that accordingly.

7.7. Wetlands (5.D)

Wetlands are the land that are covered with or soaked in water throughout the year. They do not fall under the categories of Forest land, Cropland, grassland, or Settlements. The GPG-LULUCF divides Wetlands into two large groups: peat land and flooded land.

In FY2009, Japan’s wetland area was about 1.33 million ha, which is equivalent to about 3.5% of the national land. The emissions from this category in FY2009 were 22.7 Gg-CO_2; this represents a decrease of 73.8% below the FY1990 value and an increase of 39.4% over the FY2008 value.

This section divides Wetlands into two subcategories, “Wetlands remaining Wetlands (5.D.1.)” and “Land converted to Wetlands (5.D.2.)”, and describes them separately in the following subsections.

Table 7-31 Emissions and Removals in Wetlands resulting from Carbon Stock Changes

Gas	Category	Carbon pool	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	5.D. Wetlands	Total	Gg-CO_2	86.7	362.8	453.0	15.8	28.7	16.3	22.7
		Living Biomass	Gg-CO_2	59.7	255.6	325.6	11.6	21.4	12.3	17.1
		Dead Wood	Gg-CO_2	18.8	74.5	88.6	2.9	5.0	2.8	3.8
		Litter	Gg-CO_2	8.3	32.7	38.9	1.3	2.2	1.2	1.8
		Soil	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
	5.D.1. Wetlands remaining Wetlands	Total	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
		Living Biomass	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
		Dead Wood	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
		Litter	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
		Soil	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
	5.D.2. Land converted to Wetlands	Total	Gg-CO_2	86.7	362.8	453.0	15.8	28.7	16.3	22.7
		Living Biomass	Gg-CO_2	59.7	255.6	325.6	11.6	21.4	12.3	17.1
		Dead Wood	Gg-CO_2	18.8	74.5	88.6	2.9	5.0	2.8	3.8
		Litter	Gg-CO_2	8.3	32.7	38.9	1.3	2.2	1.2	1.8
		Soil	Gg-CO_2	NE	NE	NE	NE	NE	NE	NE

7.7.1. Wetlands remaining Wetlands (5.D.1)

a） Source/Sink Category Description

This subcategory deals with carbon stock changes in the Wetlands, which have remained as Wetlands during the past 20 years.

Carbon stock changes in organic soils that are managed for peat extraction are reported as “NO”, since the peat extraction is not carried out in Japan. (Default value for Japan is not provided in the GPG-LULUCF p.3.282 Table 3A3.3).

Flooded land remaining flooded land is not calculated at the present time as this will be treated in an appendix, and reported as “NE”.

Table 7-32 Areas of Wetlands remaining Wetlands within the past 20 years

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Wetlands remaining Wetlands		kha	1,236.3	1,257.7	1,285.4	1,299.0	1,300.1	1,300.6	1,300.7
	Organic soils managed for peat extraction	kha	NO	NO	NO	NO	NO	NO	NO
	Flooded land	kha	1,236.3	1,257.7	1,285.4	1,299.0	1,300.1	1,300.6	1,300.7

7.7.2. Land converted to Wetlands (5.D.2)

a） Source/Sink Category Description

This subcategory deals with the carbon stock changes, which occurred in the land that was converted from other land use categories to Wetlands, particularly to flooded land (i.e., dams), within the past 20 years. The emissions from this subcategory in FY2009 were 23 Gg-CO_2; this represents a decrease of 73.8% below the FY1990 value and an increase of 39.4% over the FY2008 value.

With respect to living biomass, its carbon stock change as a result of land use conversion from other land use to Wetlands is estimated. This process includes both temporary loss and subsequent gain of living biomass in the land before and after conversion.

With respect to dead organic matter, Japan used the CENTURY-jfos model to estimate carbon stocks in dead organic matter in Forest land, and then estimated carbon stock change in Wetlands converted from Forest land. Carbon stock changes in other subcategories were reported as “NA”, supposing that no carbon stock change occur, or “NE” where suitable knowledge for estimating carbon stocks for the land-use categories were not available.

Carbon stock changes in soils in Land converted to Wetlands were not estimated due to lack of data. Therefore, the carbon stock changes in the carbon pool were reported as “NE”.

b） Methodological Issues

1） Carbon stock change in Living biomass in Land converted to Wetlands

- ***Estimation Method***

The Tier 2 method was applied for the land converted to Wetlands (flooded land). The equations are given in section 7.5.2.b)1).

- ***Parameters***

➢ ***Biomass stock in each Land Use Category***

The values shown in Table 7-5 above are used for the estimation of biomass stock changes resulting from land-use conversion and subsequent changes in biomass stock due to biomass growth in converted land.

➢ ***Carbon Fraction of dry matter***

0.5 (t-C/t-d.m.) (GPG-LULUCF, default value)

- ***Activity Data (Area)***

The area converted from other land use to Wetlands (dam) were estimated based on the area of dam converted from Forest land and the ratio of Forest land among those of other land use categories before conversion. The area for Forest land converted to Wetlands was calculated by the method described in section 7.5.2.b)1). As for the land use other categories, the area of converted Cropland is divided proportionately into Cropland and grassland according to the current area ratios of land use categories. After deducting the areas converted from Forest land, Cropland, grassland, and Settlements from the total dam conversion area, the remainder is considered to be the area converted from other land use categories.

It should be noted that the area presented in the CRF “Table 5.D SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY－Wetlands” is not the annually converted area in FY2009 but the sum of annually converted areas during the past 20 years.

Table 7-33 Area of Land annually converted to Wetlands (single year)

Category			Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Wetlands			kha	0.43	1.72	2.04	0.26	0.57	0.38	0.17
	Forest land converted to Wetlands		kha	0.31	1.24	1.48	0.05	0.08	0.05	0.07
	Cropland converted to Wetlands		kha	0.02	0.10	0.13	0.05	0.11	0.08	0.02
		Rice field	kha	0.01	0.02	0.09	0.05	0.06	0.05	0.01
		Upland field	kha	0.01	0.05	0.03	0.01	0.04	0.02	0.01
		Orchard	kha	0.005	0.018	0.010	0.002	0.010	0.006	0.002
	Wetlands converted to Wetlands		kha	0.007	0.029	0.019	0.003	0.019	0.012	0.004
	Settlements converted to Wetlands		kha	0.002	0.006	0.007	0.003	0.006	0.004	0.001
	Other land converted to Wetlands		kha	0.09	0.34	0.41	0.16	0.35	0.24	0.07

2） Carbon Stock Change in Dead Organic Matter in Land converted to Wetlands

- ***Estimation Method***

➢ ***Carbon stock changes in dead organic matter***

Carbon stock changes in dead organic matter in Forest land converted to Wetlands were estimated by applying Tier.2 estimation method as described in section 7.5.2.b)2). With regard to “Cropland, Grassland and Settlements converted to Wetlands”, carbon stocks of dead wood and litter carbon pools were assumed to be minor and the stock changes were ignorable as described in section 7.5.2.b)2) and 7.6.2.b)2), and were thus reported as “NA”. “Other land converted to Wetlands” was reported as “NE”, because suitable knowledge of carbon pool condition from the land cover point of view for estimating carbon stock changes are not available.

- ***Parameters***

➢ ***Carbon Stocks in Dead Organic Matter***

Average carbon stocks in dead wood and litter in Forest land before conversion are shown in Table 7-6 and Table 7-7. It is assumed that they come to be zero immediately after conversion, and are not accumulated after conversion.

- ***Activity Data (Area)***

The area of land that was converted to Wetlands during the past 20 years is determined by subtracting the estimated area that was not converted during the past 20 years from the total area of Wetlands in those years. The areas are shown in Table 7-34 below.

Table 7-34 Area of Land converted to Wetlands within the past 20 years

Category			Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Wetlands			kha	83.7	62.3	64.6	41.0	29.9	29.4	29.3
	Forest land converted to Wetlands		kha	60.6	45.1	46.7	29.4	20.7	20.0	19.8
	Cropland converted to Wetlands		kha	5.2	3.7	3.8	2.5	2.0	2.1	2.1
		Rice field	kha	1.9	1.3	1.5	1.2	1.0	1.0	1.1
		Upland field	kha	2.2	1.7	1.7	1.0	0.8	0.8	0.8
		Orchard	kha	1.0	0.7	0.6	0.3	0.3	0.2	0.2
	Grassland converted to Wetlands		kha	0.9	0.8	0.9	0.5	0.4	0.4	0.4
	Settlements converted to Wetlands		kha	0.3	0.2	0.2	0.1	0.1	0.1	0.1
	Other land converted to Wetlands		kha	16.7	12.5	12.9	8.4	6.6	6.8	6.8

c） *Uncertainties and Time-series Consistency*

- ***Uncertainty Assessment***

Uncertainties of the parameters and the activity data for living biomass, dead organic matter, and soil were individually assessed on the basis of field study results, expert judgment, or the default values described in the GPG-LULUCF. The uncertainty was estimated as 38% for the entire emission from the land converted to Wetlands. More detailed information on the uncertainty assessment is described in Annex 7. In addition, concrete uncertainty estimates for individual parameters in this category will be illustrated in future submissions after investigation is completed.

- ***Time-series Consistency***

Although methods to estimate area of Forest land converted to other land use are different between FY1990-2004 and post FY2005, as described in section 7.5.2.b)1), time-series consistency for this subcategory is basically ensured.

d） *Source-/Sink-specific QA/QC and Verification*

QC is implemented in accordance with the Tier 1 approach described in the GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. More detailed information on the QA/QC activity procedures is described in section 6.1 of Annex 6.

e） Source-/Sink-specific Recalculations

- ***Area of Forest land converted to Wetlands***

Until the 2010 inventory, it had been estimated based on both *World Census of Agriculture and Forestry* and the Forestry Agency records; however, the method was questionable in regards to whether it contributed to better accuracy, due to use of many assumptions. Thus, the area before FY2004 is now estimated simply based on the Forestry Agency records. In the case of after FY2005, due to the change in allocation method of “Forest land converted to other land-use categories” as described in section 7.5.2.b)1), the area of “Forest land converted to Wetlands” was recalculated.

- ***Living Biomass Stocks before Conversion in Forest land converted to Wetlands***

In line with the change in the method to estimate area of Forest land converted to Wetlands, the biomass stock changes in living biomass, dead organic matter and soils in the land were also recalculated. In addition, living biomass accumulation in Forest land subjected to conversion has been estimated by extrapolation of trend of living biomass accumulation in D area during the period between 2005 and the latest year. In line with this, the carbon stock changes were recalculated in accordance with the updated living biomass accumulation reflecting the value of FY2009.

f） Source-/Sink-specific Planned Improvements

- ***Validity of the Assumption used in the Method of Estimating the Area of Wetlands***

Under the present estimation method, Wetlands are assumed to consist of as “water surfaces”, “rivers” and “canals”, as defined in the national land-use classification, and its whole area is estimated by summing the areas covered by these three features. However, this estimation method may fail to cover the whole wetland area. The validity of the assumption used in the estimation method is now under revision.

- ***Method of Obtaining Data of the Area of Storage Reservoirs***

Moreover, storage reservoirs (excluding dams) can be considered as artificial flooded land, but the area that they cover are not included in the area of flooded land. Therefore, a method used to obtain data on the area covered by the reservoirs needs to be considered.

- ***Estimation Method of Soil Carbon Stock Change upon Land Use Conversion from Other Land to Wetlands***

The estimation method will be considered, when new data and information are obtained.

7.8. Settlements (5.E)

Settlements are all developed land, including transportation infrastructure and human habitats, and preclude lands that have been placed in other land-use categories. In Settlements, trees existing in urban green areas such as urban parks and special greenery conservation zones absorb carbon.

In FY2009, Japan’s settlement area was about 3.76 million ha, equivalent to about 9.9% of the national land. The net emissions by this category in FY2009 were 816 Gg-CO_2; this represents a decrease of 82.5% below the FY1990 value and an increase of 61.2% over the FY2008 value. The biggest driver for the increase over the previous year is that the single-year converted area from Forest land to Settlements in FY2009 was increased 24.4% comparing to the area in FY2008, and the emission resulting from the carbon stock loss in living biomass in Forest land converted to Settlements in FY2009 was increased 28.1% over the 2008 value.

This section divides Settlements into two subcategories, “Settlements remaining Settlements (5.E.1.)” and “Land converted to Settlements (5.E.2.)”, and describes them separately in the following subsections.

Carbon pools estimated in Settlements are living biomass and dead organic matter. Soil carbon stock changes in Settlements are not estimated because their estimation methods are not described in the GPG-LULUCF. Nonetheless, the soil carbon stock changes will be estimated, if necessary, when data are obtained from researches.

With respect to activity data, Tier 1a and Tier 1b of the GPG-LULUCF assume that removals derived from biomass growth are equal to emissions derived from biomass loss where the average tree age in a green area is older than 20 years. Therefore, carbon stock changes in urban green areas more than 20 years after establishment are regarded as zero and not estimated. Moreover, urban green areas included in the activity data are divided into two categories; one is urban green facilities established as urban parks and others, and the other is special greenery conservation zones on which conservation measures are applied and permanent protection is ensured.

<Urban green areas>

- Urban Green Facilities (urban parks, green areas in road, green areas on port, green areas around sewage treatment facility green areas by greenery promoting system for private green space, green areas along river and erosion control site, green areas around government buildings and green areas around public rental housing, which are within 20 years after establishment),
- Special Greenery Conservation Zones, which are within 20 years after designation.

Table 7-35 Emissions and Removals in Settlements resulting from Carbon Stock Changes

Gas	Category	Carbon pool	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	5.E. Settlements	Total	Gg-CO_2	4,664.6	3,278.4	1,407.5	578.5	623.4	506.3	816.0
		Living Biomass	Gg-CO_2	3,020.2	2,120.4	815.6	225.6	267.8	189.1	429.0
		Dead Wood	Gg-CO_2	1,155.7	817.7	424.2	257.9	259.0	232.8	273.0
		Litter	Gg-CO_2	488.7	340.3	167.7	94.9	96.6	84.4	114.1
		Soil	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
	5.E.1. Settlements remaining Settlements	Total	Gg-CO_2	-621.9	-677.0	-707.2	-737.6	-749.3	-756.2	-765.2
		Living Biomass	Gg-CO_2	-609.4	-663.7	-693.5	-723.5	-735.0	-741.7	-750.6
		Dead Wood	Gg-CO_2	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
		Litter	Gg-CO_2	-12.5	-13.3	-13.7	-14.1	-14.4	-14.5	-14.6
		Soil	Gg-CO_2	NE	NE	NE	NE	NE	NE	NE
	5.E.2. Land converted to Settlements	Total	Gg-CO_2	5,286.5	3,955.4	2,114.7	1,316.1	1,372.8	1,262.4	1,581.2
		Living Biomass	Gg-CO_2	3,629.6	2,784.1	1,509.1	949.1	1,002.8	930.8	1,179.6
		Dead Wood	Gg-CO_2	1,155.7	817.7	424.2	257.9	259.0	232.8	273.0
		Litter	Gg-CO_2	501.2	353.6	181.3	109.0	110.9	98.9	128.7
		Soil	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE

7.8.1. Settlements remaining Settlements (5.E.1)

a） Source/Sink Category Description

This subcategory deals with carbon stock changes in living biomass and dead organic matters in urban green areas (special greenery conservation zones, urban parks, green areas in road, green areas on port, green areas around sewage treatment facility green areas by greenery promoting system for private green space, green areas along river and erosion control site, green areas around government buildings and green areas around public rental housing) in Settlements remaining Settlements, which has remained Settlements without conversion during the past 20 years. This subcategory is divided into three subparts: “Special Greenery Conservation Zones”, “Urban Green Facilities” and “Other”. In these subparts, carbon stock changes in the Special Greenery Conservation Zones and the Urban Green Facilities are estimated. In addition, carbon stock changes reported in "Revegetation" activities under Article 3, paragraph 3, of the Kyoto Protocol correspond to those in the Urban Green Facilities constructed in and after 1990[7], and Special Greenery Conservation Zones are not included in areas of the Revegetation activities. In the CRF tables, "Special Greenery Conservation Zones" are described as "Urban Green Areas not subject to RV", "Urban Green Facilities" as "Urban Green Areas subject to RV", and "Other" as "Other than Urban Green Areas", respectively. Carbon stock changes that are possibly included in the subpart "Other", such as trees in gardens in personal residences, are reported as "NE" because their activity data are not available. Moreover, with respect to dead organic matter, only carbon stock changes in litter in urban parks and green areas on port are reported due to availability of parameters. The net removal by this subcategory in FY2009 was 765 Gg-CO_2; this represents an increase of 23.0% over the FY1990 value and an increase of 1.2 % over the FY2008 value.

b） Methodological Issues

1） Carbon Stock Changes in Living Biomass in Settlements remaining Settlements

- ***Estimation Method***

Due to the differences of characteristics of urban green areas, Tier 1a method is used for special greenery conservation zones that are communal green areas, and Tier 1b is used for urban green facilities that are urban parks, green areas in road, green areas on port, green areas around sewage treatment facility, green areas by greenery promoting system for private green space, green areas along river and erosion control site, green areas around government buildings, green areas around public rental housing.

➢ ***Tier 1a: Special Greenery Conservation Zones***

$$\Delta C_{SSaLB} = \Delta C_{LBaG} - \Delta C_{LBaL}$$

$$\Delta C_{LBaG} = A \times PW \times BI$$

ΔC_{SSaLB} : changes in carbon stocks in living biomass in special greenery conservation zones (t-C/yr)

ΔC_{LBaG} : gains in carbon stocks due to growth in living biomass in special greenery conservation zones (t-C/yr)

ΔC_{LBaL} : losses in carbon stocks due to losses in living biomass in special greenery conservation zones (t-C/yr) note: assumed as "0" (zero) in accordance with the GPG-LULUCF

A : area of special greenery conservation zones less than or equal to 20 years since designation (ha)

PW : forested area rate (forested area rate per park area) note: assumed as 100%

BI : growth per crown cover area (t-C/ha crown cover/yr)

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[7] Special Greenery Conservation Zones are not included in Revegetation because they do not meet its definition. In addition, Urban Green Facilities include a little land area corresponding to Wetland remaining Wetland, such as green areas along river and erosion control site.

- ***Tier 1b: Urban green facilities (urban parks, green areas on road, green areas on port, green areas around sewage treatment facility green areas by greenery promoting system for private green space, green areas along river and erosion control site, green areas around government buildings, green areas around public rental housing)***

$$\Delta C_{SSbLB} = \sum (\Delta C_{LBbGi} - \Delta C_{LBbLi})$$
$$\Delta C_{LBbGi} = \Delta B_{LBbG}$$
$$\Delta B_{LBbGi} = \sum NT_{i,j} * C_{Ratei,j}$$

ΔC_{SSbLB} : changes in carbon stocks in living biomass in urban green areas other than special greenery conservation zones (t-C/yr)

ΔC_{LBbG} : gains in carbon stocks due to growth in living biomass in urban green areas other than special greenery conservation zones (t-C/yr)

ΔC_{LBbL} : losses in carbon stocks due to losses in living biomass in urban green areas other than special greenery conservation zones (t-C/yr) Note: assumed as “0” (zero) in accordance with the GPG-LULUCF

ΔB_{LBbG} : Annual biomass growth in urban green areas other than special greenery conservation zones (t-C/yr)

C_{Rate} : Annual biomass growth per tree (t-C/tree/yr)

NT : Number of trees

i : Land type (urban parks, green areas in road, green areas on port, green areas around sewage treatment facility, green areas by greenery promoting system for private green space, green areas along river and erosion control site, green areas around government buildings, or green areas around public rental housing)

j : Tree species

- ***Parameters***

- ***Tier 1a: Annual biomass growth rate per crown cover area (special greenery conservation areas)***

The annual biomass growth rate of trees per crown cover area in special greenery conservation zones is taken as 2.9 t-C/ha crown cover/yr, the default value indicated in the GPG-LULUCF (p. 3.297).

- ***Tier 1b: Annual biomass growth rate per tree (urban green facilities)***

The following parameters are taken as the annual biomass growth rates per tree in urban green areas other than special greenery conservation zones.

Table 7-36 Annual biomass growth rate per tree in urban green areas

Land use category		Annual biomass growth per tree [t-C/tree/yr]	Remarks
Urban green areas	Hokkaido	0.0097	Combined default values shown in table 3A.4.1 in page 3.297 in the GPG-LULUCF by the distribution ratio of tree types in sampled urban parks.
	Areas other than Hokkaido	0.0091	

- ***Activity Data***

The areas of “Settlements remaining Settlements” in a certain year reported in CRF tables are estimated by subtracting the cumulative total area of “Land converted to Settlements” during the past 20 years to a year subject to estimation from the total area of “Settlements” in the year subject to estimation. Moreover, in the CRF tables, the areas of “Settlements remaining Settlements” are reported by dividing three subparts: “Special Greenery Conservation Zones”, “Urban Green Facilities" and "Other". Within these subparts, carbon stock changes in trees less than or equal to 20-year growth in Special Greenery Conservation Zones and Urban Green Facilities are estimated.

Japan assumes trees less than or equal to 20-year growth as those growing in urban green areas less than or equal to 20 years since establishment or designation. With respect to tier 1a, tree crown areas in the Special Greenery Conservation Zones (estimated by multiplying areas of the Zones less than or equal to 20 years since designation by percentages of planted tree areas) are applied as activity data. Tier 1b applies the number of tall trees planted in the Urban Green Facilities as activity data.

Table 7-37 Areas of Settlements remaining Settlements within the past 20 years

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Settlements remaining Settlements		kha	2,350.6	2,655.7	2,863.6	3,049.5	3,126.4	3,171.5	3,209.4
	Urban green facilities	kha	0.06	0.06	0.07	0.07	0.07	0.07	0.07
	Special greenery conservation zones	kha	1.9	3.6	4.8	5.5	5.6	5.6	5.8
	Other	kha	2,348.6	2,652.0	2,858.7	3,043.9	3,120.8	3,165.8	3,203.5

- ***Tier 1a: Tree crown areas (special greenery conservation zones)***

To determine the amount of activity regarding changes in the amount stored in trees in special greenery conservation zones, the area of special greenery conservation zones determined by the Ministry of Land, Infrastructure, Transport and Tourism is multiplied by the tree crown area rate, which is assumed to be 100%.

Table 7-38 Areas of special greenery conservation zones less than or equal to 20 years since designation

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Total		kha	1.9	3.6	4.8	5.5	5.6	5.6	5.8
	Green space conservation zones	kha	0.6	0.9	1.4	2.0	2.1	2.1	2.3
	Suburban green space conservation zones	kha	1.2	2.7	3.4	3.5	3.5	3.5	3.5

- ***Tier 1b: Number of tall trees (urban green facilities)***

Numbers of tall trees in urban green areas mentioned above are calculated according to the same methods used for revegetation activities under Article 3, paragraph 4, of the Kyoto Protocol. Brief descriptions of the calculation methods for each urban green area are stated below. In addition, for detailed description of these calculation methods see section A11.3.2.5.a. in Annex 11 in this NIR.

- ***Urban parks, green areas on port, green areas around sewage treatment facility, green areas along river and erosion control site, green areas around government buildings, and green areas around public rental housing***

Numbers of tall trees in these subcategory are calculated by (1) calculating the areas falling under this category by multiplying each whole area by the area ratio of land conversion for the whole country, and then (2) calculating the numbers of tall trees in the calculated areas by multiplying each of the areas by the number of tall trees per area. The numbers of tall trees per area for each subcategory are shown in the table below.

Table 7-39 Number of tall trees per area

Item	Unit	Number of tall trees per area	
		Hokkaido	Areas other than Hokkaido
Urban parks	tree/ha	340.1	203.3
Green areas on port	tree/ha	340.1	203.3
Green areas around sewage treatment facility	tree/ha	129.8	429.2
Green areas along river and erosion control site	tree/ha	1470.8	339.0
Green areas around government buildings	tree/ha	112.1	112.1
Green areas around public rental housing	tree/ha	262.4	262.4

- ***Green areas in road***

Activity data (the number of tall trees) in "Remaining green area on road" is calculated by the following procedures.

1. Calculate the number of tall trees planted during 20 years after establishing green areas in road by using data from the "Road Tree Planting Status Survey" which had been implemented in FY1987, FY1992, FY2007, FY2008 and FY2009,
2. Multiply the number of tall trees calculated in Step 1 by the ratio of the number of tall trees planted on the road which planted area is more than 500 m^2,
3. Multiply the number of tall trees calculated in Step 2 by the area ratio of land remaining Settlements.

The values of Step 3 become the number of tall trees that are activity data on green areas in road.

- ***Green areas by greenery promoting system for private green space***

Activity data (the numbers of tall trees) are available for each facility. Therefore, total number of tall trees is used as activity data.

2） *Carbon Stock Changes in Dead Organic Matters in Settlements remaining Settlements*

This category estimates carbon stock changes in litter in urban parks and green areas on port. Carbon stock changes in dead wood result in "IE" because they are included in carbon stock changes in living biomass. Carbon stock changes in litter in the subcategories other than urban parks and green areas on port are not estimated due to the difficulty of obtaining their activity data.

● ***Estimation Method***

A country-specific method is applied for this estimation because a method for carbon stock changes in litter in Settlements is not provided in the GPG-LULUCF. The estimation method is described below.

$$\Delta C_{SSLit} = \sum (A_i \times L_{it,i})$$

ΔC_{SSLit} : Carbon stock changes in litter in Settlements remaining Settlements (t-C/yr)

A : Area of urban parks and green areas on port in Settlements remaining Settlements (ha)

L_{it} : Carbon stock change per area in urban parks or green areas on port (t-C/ha/yr)

i : Land type (urban parks or green areas on port)

● ***Parameters***

For litter, Japan estimates carbon stock changes only in branches and leaves dropped naturally from tall trees. Carbon stock changes in litter per urban park area is calculated by using annual accumulation of litter per a tall tree (Hokkaido: 0.0006 t-C/tree/yr, other prefectures: 0.0009 t-C/tree/yr) based on results of field survey in urban parks, and the number of tall trees per area and ratio of litter moved to off-site due to management including cleaning (54.4%). As a result of calculation, carbon stock changes in litter per urban park area are 0.0984 t-C/ha/yr for Hokkaido and 0.0830 t-C/ha/yr for other prefectures. In addition, carbon fraction in litter is assumed to be 0.5 t-C/t-d.m. which is a default value provided in the GPG-LULUCF.

- ***Activity Data***

Activity data on this category are the same as those on living biomass in urban parks and green areas on port.

c） Uncertainties and Time-series Consistency

- ***Uncertainty Assessment***

The default values shown in the GPG-LULUCF page 3.297 were applied to the annual carbon stock changes for trees in urban parks and special greenery conservation zones. The uncertainty estimates for the emission and removal factors were determined by using the decision tree, to be ±50% through application of the standard value shown in the GPG-LULUCF page 3.298.

Moreover, the uncertainty estimates for living biomass in special greenery conservation zones applies expert judgment according to the decision tree for activity data in the GPG-LULUCF. These estimates were determined as 10% for the number of tall trees and existing trees and the areas of existing special greenery conservation zones, 17% for wooded areas, and 20% for forested area rate.

Meanwhile, the uncertainty estimates for activity data and parameters on urban parks, green areas in road, green areas on port, green areas around sewage treatment facility green areas by greenery promoting system for private green space, green areas along river and erosion control site, green areas around government buildings and green areas around public rental housing are 67% and 48%, respectively.

As a result, the uncertainty estimate was 78% for the entire removal by Settlements remaining Settlements. The methodology of uncertainty assessment was described in Annex 7. In addition, concrete uncertainty estimates for individual parameters in this category will be illustrated in future submissions after investigation is completed.

- ***Time-series Consistency***

Although methods to estimate area of Forest land converted to other land use are different between FY1990-2004 and post 2005, as described in section 7.5.2.b)1), time-series consistency for this subcategory is basically ensured.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described by GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. The QA/QC activity procedures are described in section 6.1 of Annex 6.

e） Source-/Sink-specific Recalculations

- ***The area of Settlements***

"School reservations", "park and green areas", "road sites", "environmental facility sites", "golf courses", "ski courses" and "other recreation sites" that fall under "Other land" have been regarded as Settlements. Until 2010 submission, as a matter of convenience, all of these areas for each year were those of FY1992. After the reexaminations, however, the areas of “School reservations”, “road sites”, “golf courses”, and “other recreation sites” for each year were obtained. Thus, the Settlements area was recalculated.

f）Source-/Sink-specific Planned Improvements

- ***Growth Rate of Living Biomass per Unit of Greening Area in Special Greenery Conservation Zones***

The default values in the GPG-LULUCF were applied to the biomass growth rate per unit of greening area in special greenery conservation zones. However, the growth rate needs to be further examined, and a parameter that can be finally applied as the growth rate should be determined. Therefore, Japan is considering the characteristics of greening activity and will seek a parameter that most suits the actual situation.

- ***Carbon Stock Changes in Soil***

The carbon stock changes in soil are currently reported as “NE”. The estimation method will be considered, when new data and information are obtained.

- ***Validity of the Assumption used in the Method of Estimating the Area of Settlements***

The present estimation method assumes settlement areas as “roads” and “human habitats” in the land use categorization. However, the validity of the assumption is under re-examination.

7.8.2. Land converted to Settlements (5.E.2)

a）Source/Sink Category Description

Land conversion to Settlements results in carbon stock changes in the living biomass, dead organic matter, and soil in the land areas subject to the conversion. This subcategory deals with the carbon stock changes in lands converted to Settlements, which were converted from other land-use categories to Settlements within the past 20 years. With respect to dead organic matter, Japan used the CENTURY-jfos model to estimate carbon stocks in dead organic matter in Forest land, and then estimated carbon stock change in “Wetlands converted from Forest land”. In addition, the area of “Wetlands converted to Settlements” and “Other land converted to Settlements” cannot be obtained by the current method. Thus, carbon stock changes in these carbon pools were reported as “NO”.

The net emissions by this subcategory in FY2009 were 1,581 Gg-CO_2; this represents a decrease of 70.1% below the FY1990 value and an increase of 25.2% over the FY2008 value.

b）Methodological Issues

1）Carbon stock change in Living Biomass in Land converted to Settlements

- ***Estimation Method***

Carbon stock changes in living biomass under the land converted to Settlements are estimated by calculating the carbon stock changes before and after conversion and adding annual carbon stock changes in land converted to urban green facilities. The Carbon stock changes in living biomass before and after conversion are estimated by applying the equation of section 3.6.2 in the GPG-LULUCF (multiplying the land area converted from each land use to Settlements by the difference between the values of biomass stock before and after conversion, and by the carbon fraction). Biomass stocks in land converted to urban green areas are increased because due to growth of trees planted after conversion. Hence, carbon stock changes in living biomass in land converted to urban green facilities are estimated by making carbon stock changes before and after conversion plus annual carbon stock changes after conversion that are estimated by applying Tier 1b method in section 3A.4.1.1.1 in the GPG-LULUCF.

$$\Delta C_{LSLB} = \sum (A_I \times (CR_a - CR_{b,I}) \times CF) + \sum (\Delta C_{LS\,(UG)Gi} - \Delta C_{LS\,(UG)Li})$$
$$\Delta C_{LS\,(UG)G} = \Delta B_{LS\,(UG)G}$$
$$\Delta B_{LS\,(UG)G} = \sum NT_j \times C_{Ratej}$$

ΔC_{LSLB} : carbon stock changes in living biomass in land converted to Settlements (t-C/yr)

A_I : area of land converted annually to Settlements from land use type *i* (ha/yr)

CR_a : carbon reserves immediately following conversion to Settlements (t-d.m./ha), default ＝0

$CR_{b,I}$: carbon reserves in land use type *i* immediately before conversion to Settlements (t-d.m./ha)

CF : carbon fraction of dry matter (t-C/t-d.m.)

I : type of land before conversion

$\Delta C_{LS(UG)Gi}$: annual carbon stock gain in living biomass in land converted to urban green areas due to growth in living biomass (t-C/yr)

$\Delta C_{LS(UG)Li}$: annual carbon stock loss in living biomass due to loss of living biomass (t-C/yr) Note: the averaged ages of estimated trees are less than or equal to 20 years old; therefore, the loss are assumed as “0” (zero) in accordance with the GPG-LULUCF

$\Delta B_{LS(UG)G}$: annual biomass growth in land converted to urban green areas (t-C/yr)

C_{Rate} : annual biomass growth per tree (t-C/tree/yr)

NT : number of trees

i : type of urban green areas after conversion (urban parks, green areas on road, green areas on port, green areas around sewage treatment facility green areas by greenery promoting system for private green space, green areas along river and erosion control site, green areas around government buildings, or green areas around public rental housing)

j : tree species

- ***Parameters***

➢ ***Biomass stocks for each land use category***

Table 7-5 shows the biomass stocks before and after conversion. Carbon stock losses due to loss of living biomass are assumed as “0” (zero) in accordance with the GPG-LULUCF, because trees subject to estimation are all less than or equal to 20 years old. Table 7-36 shows the annual biomass growth of trees in land converted to urban green areas.

➢ ***Carbon fraction of dry matter***

0.5 (t-C/t-d.m.) (default value, GPG-LULUCF)

- ***Activity Data***

➢ ***Land Areas converted to Settlements***

With respect to area of land converted to Settlements, only the areas converted to Settlements from

Forest land, Cropland and Grassland are determined. Since no data is available on the area converted to Settlements from Wetlands or other land use categories, no figures are reported in those land use categories. Instead, they are reported as "NO". It should be noted that the area presented in the CRF "Table 5.E SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY－Settlements" are not the annually converted area in FY2009 but the sum of annually converted areas during the past 20 years.

- ***Conversion from Forest land***

Areas of Forest land converted to Settlements were estimated as described in section 7.5.2.b).1).

- ***Conversion from Cropland***

For former rice fields, upland fields, and orchards (according to "Area Statistics for Cultivated and Commercially Planted Land"), the areas of land converted to factories, roads, housing, and forest roads are used.

- ***Conversion from Grassland***

For former pasture land and grazed meadow land constituting moved or converted Cropland which is converted to Settlements (according to "Area Statistics for Cultivated and Commercially Planted Land"), the areas of land converted to factories, roads, housing, and forest roads are used.

Table 7-40 Area of Land annually converted to Settlements (single year)

Category	Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Settlements	kha	43.8	36.3	23.8	14.8	16.2	16.5	14.5
Forest land converted to Settlements	kha	19.3	13.6	7.1	4.3	4.3	4.0	4.9
Cropland converted to Settlements	kha	21.4	19.5	14.5	9.2	10.2	10.9	8.2
Rice field converted to Settlements	kha	13.0	12.1	9.5	6.0	6.5	7.1	5.0
Upland field converted to Settlements	kha	6.1	5.6	3.8	2.5	2.9	3.0	2.5
Orchard converted to Settlements	kha	2.3	1.8	1.1	0.7	0.8	0.8	0.7
Grassland converted to Settlements	kha	3.2	3.1	2.2	1.4	1.6	1.6	1.3
Wetlands converted to Settlements	kha	IE	IE	IE	IE	IE	IE	IE
Other land converted to settlements	kha	IE	IE	IE	IE	IE	IE	IE

➢ ***Area and number of trees in land converted to urban green areas***

Areas of land converted to urban green areas are calculated by multiplying the whole areas of each urban green area (urban parks, green areas on road, green areas on port, green areas around sewage treatment facility green areas by greenery promoting system for private green space, green areas along river and erosion control site, green areas around government buildings, or green areas around public rental housing) by area ratio of land conversion for the whole country. Numbers of trees are calculated by multiplying each urban green area converted from other land-use categories by number of trees per area. For detailed information regarding these activity data see section A11.3.2.5.a. in Annex 11 in this NIR.

2） *Carbon Stock Change in Dead Organic Matter in Land converted to Settlements*

This category estimates carbon stock changes in dead wood and litter in Settlements converted from Forest land, and those in litter in land converted to urban parks and green areas on port.

With respect to dead wood, only the carbon stock change in Forest land converted to Settlements was estimated. Tier 2 method was applied to the estimation in accordance with the method for "conversion from other land use to Cropland" in the GPG-LULUCF. Carbon stock changes in dead wood in Land converted to urban green facilities are reported as "IE" because they are included in those in their living biomass.

In regard to litter, the carbon stock changes in Settlements converted from Forest land and land converted to urban parks and green areas on port are estimated. Tier 2 method is applied to estimation of the carbon stock changes in Settlements converted from Forest land in accordance with the method for "conversion from other land use to Cropland" in the GPG-LULUCF. Carbon stock changes in litter in land converted to urban parks and green areas on port are estimated by applying Japan's country-specific estimation method due to lack of an estimation method in the GPG-LULUCF. Carbon stock changes in litter in land converted to urban green areas other than urban parks and green areas on port are not estimated due to the difficulty of obtaining their activity data.

The area of "Wetlands converted to Settlements" and "Other land converted to Settlements" cannot be obtained by the current method. Thus, carbon stock changes in these carbon pools were reported as "NO".

- ***Estimation Method***

$$\Delta C_{LS} = \Delta C_{FS} + \Delta C_{LSLit}$$

ΔC_{FS} : Carbon stock changes in dead organic matter in Settlements converted from Forest land (t-C/yr)

ΔC_{LSLit} : Carbon stock changes in litter in urban parks and green areas on port converted from land use categories other than Forest land (t-C/yr)

➢ ***Carbon stock changes in dead organic matter in Settlements converted from Forest land***

Carbon stock changes in dead organic matter in Forest land converted to Settlements are estimated by applying Tier 1 estimation method described in section 2.3.2.2 in Volume 4 of the 2006 IPCC Guidelines. In addition, all carbon stocks in dead organic matter in the subcategory are assumed oxidized and emitted as CO_2 within the year of conversion.

$$\Delta C_{FS} = \sum((C_{after,i} - C_{before,i}) \times A)$$

ΔC_{FS} : Carbon stock changes in dead organic matter in Forest land converted to Settlements (t-C/yr)

$C_{after,i}$: Carbon stock in dead wood or litter after conversion (t-C/ha) Note: carbon stocks after conversion are assumed as "0" (zero).

$C_{before,i}$: Carbon stock in dead wood or litter before conversion (t-C/ha)

A : Area of Forest land converted to Settlements in a year subject to estimation (ha)

i : type of dead organic matter (dead wood or litter)

➢ ***Carbon stock changes in dead organic matter in Settlements converted from Forest land***

Carbon stock changes in dead organic matter in Forest land converted to Settlements are estimated by applying Tier 1 estimation method described in section 2.3.2.2 in Volume 4 of the 2006 IPCC Guidelines. In addition, all carbon stocks in dead organic matter in the subcategory are assumed oxidized and emitted as CO_2 within the year of conversion.

$$\Delta C_{LSLit} = \sum (A_i \times (C_{AfterLit,i} - C_{BeforeLit,I}) + A_i \times Lit_i)$$

ΔC_{LSLit} :Carbon stock changes in litter in urban parks and green areas on port converted from land use categories other than Forest land (t-C/yr)

A : Area of urban parks or green areas on port converted from land use categories other than Forest land for one past year (ha)

$C_{AfterLit,}$: Carbon stock in litter after conversion (t-C/ha)

$C_{BeforeLit}$: Carbon stock in litter before conversion (t-C/ha)

Lit : Annual carbon stock changes per area in litter in urban parks or green areas on port converted from land use categories other than Forest land (t-C/ha/yr)

I : Land-use type before conversion

i : Land-use type after conversion (urban parks or green areas on port)

- ***Parameters***

➢ ***Carbon stocks in dead organic matter in Forest land converted to Settlements***

Average carbon stocks in dead wood and litter in Forest land before conversion are shown in Table 7-6 and Table 7-7. The average carbon stocks in these categories from FY1990 to FY2004 are not estimated; therefore the carbon stocks in FY2005 are substituted for them. In addition, it is assumed that they come to be zero immediately after conversion, and are not accumulated after conversion.

➢ ***Carbon stocks in litter in urban parks and green areas on port converted from land use categories other than Forest land***

When urban parks and green areas on port are converted from land use categories other than Forest land, litter stocked before conversion is not moved to off-site because ground before conversion, including litter, are continuously used after conversion or covered with additional soils brought externally. Hence, litter stocked before conversion does not decrease after conversion. In addition, litter stocks scarcely increased immediately after conversion because newly planted trees do not immediately produce litter. Due to these facts, carbon stock changes before and after conversion are regarded as “0” (zero). Litter stocks accumulated in a year after conversion are calculated by the same method used for urban parks and green areas on port in Settlements remaining Settlements due to the research result that the litter stocks are accumulated as same as those in Settlements remaining Settlements by natural drop of fallen leaves and branches from trees in land converted to the urban parks and green areas.

- ***Activity Data (Area)***

➢ ***Carbon stocks in dead organic matter in Forest land converted to Settlements***

The area of land that was converted from Forest land to Settlements during the past 20 years is determined by aggregating areas converted from Forest land to Settlements during the past 20 years. For the areas, see Table 7-41 below.

Table 7-41 Area of Land converted to Settlements within the past 20 years

Category	Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Settlements	kha	868.4	773.3	730.4	648.5	606.6	581.5	550.6
Forest land converted to Settlements	kha	288.5	307.0	298.3	259.3	232.7	215.1	196.7
Cropland converted to Settlements	kha	520.6	409.1	376.8	338.8	325.3	318.8	307.8
Rice field converted to Settlements	kha	320.9	252.1	236.6	215.2	207.8	204.6	197.6
Upland field converted to Settlements	kha	137.2	110.5	101.8	91.9	88.2	86.1	83.4
Orchard converted to Settlements	kha	62.4	46.5	38.5	31.6	29.3	28.1	26.8
Grassland converted to Settlements	kha	59.3	57.2	55.4	50.5	48.7	47.6	46.1
Wetlands converted to Settlements	kha	IE	IE	IE	IE	IE	IE	IE
Other land converted to settlements	kha	IE	IE	IE	IE	IE	IE	IE

➢ *Carbon stock changes in litter in Land converted to urban parks and green areas on port*

Areas of land converted to urban green areas are calculated as same as the carbon stock changes in living biomass in land converted to urban green areas. The calculation is to multiply the whole areas of urban parks and green areas on port by area ratio of land conversion for the whole country, respectively. For detailed information regarding these areas see section A11.4.1.1.d f) in Annex 11 in this NIR.

c） Uncertainties and Time-series Consistency

● *Uncertainty Assessment*

The uncertainties of the parameters and activity data for living biomass and dead organic matter were individually assessed on the basis of field study results, expert judgment, or the default values described in the GPG-LULUCF. The uncertainty estimate was 8% for the entire emission from land converted to Settlements. The methodology used in the uncertainty assessment is described in Annex 7. In addition, concrete uncertainty estimates for individual parameters in this category will be illustrated in future submissions after investigation is completed.

● *Time-series consistency*

Although methods to estimate area of Forest land converted to other land use are different between FY1990-2004 and post FY2005, as described in section 7.5.2.b)1), time-series consistency for this subcategory is basically ensured.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described by GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. The QA/QC activity procedures are described in section 6.1 of Annex 6.

e） Source-/Sink-specific Recalculations

● *Areas of Forest land converted to Settlements*

Due to the change in allocation method of “Forest land converted to other land-use categories” after FY2005, as described in 7.5.2.b)1), the area of “Forest land converted to Settlements” was recalculated. In line with this, the biomass stock changes in living biomass, dead organic matter and soils in the land were also recalculated.

● *Carbon Stock Changes in Forest land converted to Settlements*

Living biomass accumulation in Forest land subjected to conversion has been estimated by extrapolation of trend of living biomass accumulation in the D area during the period between 2005 and the latest year. In line with this, the carbon stock changes were recalculated in accordance with the updated living biomass accumulation reflecting the value of FY2009.

- ***Carbon stock changes in Grassland converted to Settlements in FY2008***

  Since the activity data (area) of “Grassland converted to Settlements” in FY2008 was updated, carbons stock changes in living biomass were recalculated.

- ***Carbon Stock Changes in Dead Organic Matter in Lands (Wetlands and Other land) converted to Settlements***

  Until the 2010 submission, Settlements converted from Wetlands and Other land were reported as “IE”, but now reported as “NO”, because the areas of these subcategories cannot be obtained by the current method.

f） Source-/Sink-specific Planned Improvements

- ***Carbon Stock Changes in Soil***

  The carbon stock changes in soil are currently reported as “NE”. The estimation method will be considered, when new data and information are obtained.

- ***Validity of the Assumption used in the Method of Estimating the Area of Settlements***

  Furthermore, the areas of Forest land converted to Settlements are presently assumed as “roads”, “human habitats”, “school reservations”, “park and green areas”, “road sites”, “environmental facility sites”, “golf courses”, “ski courses” and “other recreation sites” in the national land-use categorization; however, this assumption may fail to cover all the areas. Therefore, the validity of the assumption needs to be re-examined.

7.9. Other land (5.F)

Other land consists of land areas that are not included in the other five land-use categories. As concrete examples of Other land, the GPG-LULUCF indicates bare land, rock, ice, and unmanaged land areas. In FY2009, Japan’s Other land area was about 2.86 million ha, which is equivalent to about 7.6% of the national land and disaggregated as shown in Table 7-42 below[8].

Table 7-42 Land included in the Other Land Category

Category		Unit	1990	1995	2000	2005	2007	2008	2009
Other land		kha	2,381.0	2,511.0	2,556.0	2,592.0	2,637.0	2,647.0	2,670.0
	Defense Facility Site	kha	139.0	140.0	140.0	140.0	140.0	140.0	140.0
	Cultivation Abandonment Area	kha	217.0	244.0	343.0	386.0	390.0	392.0	394.0
	Coast	kha	46.0	46.0	46.0	46.0	46.0	46.0	46.0
	Northern Territories	kha	503.6	503.6	503.6	503.6	503.6	503.6	503.6
	Other	kha	1,475.4	1,577.4	1,523.4	1,516.4	1,557.4	1,565.4	1,586.4

The emissions from this category in FY2009 were 1,049 Gg-CO_2; this represents a decrease of 33.1% below the FY1990 value and an increase of 25.8% over the FY2008 value.

This section divides Other land into two subcategories, “Other land remaining Other land (5.F.1.)” and “Land converted to Other land (5.F.2.)”, and describes them separately in the following subsections.

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[8] These land areas are based on the following statistics: “*Defense of Japan*” by Ministry of Defense for “Defense Facility Site”, “*World Census of Agriculture and Forestry*” for “Cultivation Abandonment Area”, “digital national land information” by MLIT for “Coast” and “Land Survey of Prefectures, Shi, Ku, Machi and Mura” by the Geographical Survey Institute for “Northern Territories”.

Table 7-43 Emissions and Removals in Other land resulting from Carbon Stock Changes

Gas	Category	Carbon pool	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	5.F. Other land	Total	Gg-CO_2	1,567.3	1,486.8	1,231.0	954.8	552.6	834.0	1,049.0
		Living Biomass	Gg-CO_2	1,155.5	1,149.0	986.8	751.9	454.3	659.1	834.4
		Dead Wood	Gg-CO_2	286.2	234.8	169.7	141.0	68.1	121.4	144.6
		Litter	Gg-CO_2	125.6	103.1	74.5	61.9	30.2	53.5	70.0
		Soil	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
	5.F.1. Other land remaining Other land	Total	Gg-CO_2							
		Living Biomass	Gg-CO_2							
		Dead Wood	Gg-CO_2							
		Litter	Gg-CO_2							
		Soil	Gg-CO_2							
	5.F.2. Land converted to Other land	Total	Gg-CO_2	1,567.3	1,486.8	1,231.0	954.8	552.6	834.0	1,049.0
		Living Biomass	Gg-CO_2	1,155.5	1,149.0	986.8	751.9	454.3	659.1	834.4
		Dead Wood	Gg-CO_2	286.2	234.8	169.7	141.0	68.1	121.4	144.6
		Litter	Gg-CO_2	125.6	103.1	74.5	61.9	30.2	53.5	70.0
		Soil	Gg-CO_2	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE

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

a） Source/Sink Category Description

This subcategory deals with carbon stock changes in the Other land remaining Other land during the past 20 years. The land area of this subcategory are determined by subtracting the summed areas of the other five land-use categories from the total national land area shown in *the Land Use Status Survey* compiled by the Ministry of Land, Infrastructure, Transport, and Tourism. In concrete terms, the land area of this category includes defense facility sites, cultivation abandonment areas, coasts, and northern territories. However, carbon stock changes in this subcategory are not considered in accordance with the GPG-LULUCF.

Table 7-44 Areas of Other land remaining Other land within the past 20 years

Category	Unit	1990	1995	2000	2005	2007	2008	2009
Other land remaining Other land	kha	2,209.7	2,358.1	2,387.0	2,280.3	2,316.0	2,340.9	2,387.8

b） Source-/Sink-specific Recalculations

- ***Breakdown of the area of Other Land***

Areas of "Defense Facility Site", "Cultivation Abandonment Area", "Coast" and "Northern Territories" that fall into "Other land" were obtained for each year.

c） Source-/Sink-specific Planned Improvements

- ***Method of Defining Land Areas***

7.6% of the nation's land is categorized as "Other land remaining Other land", but validity of the categorization is presently under examination in a cross-cutting manner through the LULUCF sector.

- ***Carbon Stock Changes in Living Biomass of Other land remaining Other land***

The carbon stock changes in the living biomass of "Other land remaining Other land" are assumed to be zero, but this assumption may differ from the actual situation. Therefore, the land-use types in the "Other land" category will be investigated, and the validity of the assumption will be re-examined. If there are some land-use types that contain living biomass, reclassification of land-use categories will be examined.

7.9.2. Land converted to Other land (5.F.2)

a） Source/Sink Category Description

This subcategory deals with carbon stock changes in the land converted to Other land within the past 20 years. The land area of this subcategory includes land converted for soil and stone mining, land damaged by natural disasters, and land in which cultivation is abandoned. The emissions from this subcategory in FY2009 were 1,049 Gg-CO_2; this represents a decrease of 33.1% below the FY1990 value and an increase of 25.8% over the FY2008 value.

With respect to living biomass, its carbon stock change as a result of land use conversion from other land use to Other land was estimated.

With respect to dead organic matter, Japan used the CENTURY-jfos model to estimate carbon stocks in dead organic matter in Forest land, and then estimated carbon stock changes in “Forest land converted to Other land”. Carbon stock changes of dead organic matter in other subcategories (conversion from Cropland and Grassland) were reported as “NA”, since dead organic matter pools before and after conversion were assumed to be zero, as described in section 7.5.2.b)2) and 7.6.2.b)2).

Carbon stock changes in soils in Land converted to Other land are not estimated due to lack of data. Therefore, the carbon stock changes in the carbon pool were reported as “NE”.

In addition, the area of “Wetlands converted to Other land” and “Settlements converted to Other land” cannot be obtained by the current method. Thus, carbon stock changes in these carbon pools were reported as “NO”.

b） Methodological Issues

1） Carbon stock change in Living Biomass in Land converted to Other land

- ***Estimation Method***

The Tier 2 method was applied as described in section 7.5.2.b)1). Biomass stock change due to its growth in Other land was assumed as zero.

- ***Parameters***

➢ ***Biomass stock in each Land Use Category***

The values shown in Table 7-5 are used for the estimation of biomass stock changes upon land use conversion and subsequent changes in biomass stock due to biomass growth in converted land.

➢ ***Carbon Fraction of dry matter***

0.5 (t-C/t-d.m.) (GPG-LULUCF, default value)

- ***Activity Data (Area)***

Only the areas converted from Forest land and Cropland to Other land are determined. Since no data was available on the area converted from Wetlands and Settlements to Other land, estimations for those land use categories were not possible. Therefore, they were reported as “NO.” It should be noted that the areas presented in the CRF “Table 5.F SECTORAL BACKGROUND DATA FOR LAND USE, LAND-USE CHANGE AND FORESTRY－Other land” are not the annually converted area in FY2009 but the sum of annually converted areas during the past 20 years.

➢ ***Conversion from Forest Land***

See section 7.5.2.b)1).

➢ ***Conversion from Cropland***

For former rice fields, upland fields, and orchards, the area classified as “other, natural disaster damage” is used according to *the Area Statistics for Cultivated and Commercially Planted Land*.

➢ ***Conversion from Grassland***

For former pasture land and grazed meadow land, the area of former pasture land classified as “other, natural disaster damage” (according to *the Area Statistics for Cultivated and Commercially Planted Land*) and the area of former grazed meadow land which is classified as “other, classification unknown” (*the Moving and Conversion of Cropland*) are used.

Table 7-45 Area of land annually converted to Other land (single year)

Category	Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Other land	kha	24.0	30.1	28.9	20.4	14.6	14.7	16.0
Forest land converted to Other land	kha	4.8	3.9	2.8	2.4	1.1	2.1	2.6
Cropland converted to Other land	kha	15.4	20.3	17.1	13.2	9.0	8.8	8.8
Rice field	kha	5.0	5.8	6.1	7.2	3.5	4.0	2.9
Upland field	kha	7.6	10.9	8.4	4.7	4.4	3.8	4.6
Orchard	kha	2.8	3.6	2.5	1.3	1.2	1.0	1.2
Grassland converted to Other land	kha	3.9	5.9	9.0	4.9	4.5	3.8	4.7
Wetlands converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE
Settlements converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE

2） Carbon Stock Change in Dead Organic Matter in Land converted to Other land

● ***Estimation Method***

Carbon stock changes in dead organic matter in Forest land converted to Other land were estimated by applying Tier.2 estimation method as described in section 7.5.2.b)2). With regard to “Cropland and Grassland converted to Other land” where Cropland conversion occurred mainly due to abandonment and natural disaster, they were reported as “NE” because suitable knowledge for estimating carbon stock changes from the land use conversion are not available. The area of “Wetlands converted to Other land” and “Settlements converted to Other land” cannot be obtained by the current method. Thus, carbon stock changes in these carbon pools were reported as “NO”.

● ***Parameters***

➢ ***Carbon Stocks in Dead Organic Matter in Other Land converted from Forest Land***

Average carbon stocks in dead wood and litter in Forest land before conversion are shown in Table 7-6 and Table 7-7. In addition, it is assumed that they become zero immediately after conversion, and are not accumulated after conversion.

● ***Activity Data (Area)***

The values of annually converted area from each land use category to Other land during the past 20 years are summed up to obtained the total area that is converted to Other land during the same time period.

Table 7-46 Area of Land converted to Other land within the past 20 years

Category	Unit	1990	1995	2000	2005	2007	2008	2009
Land converted to Other land	kha	591.4	516.5	512.9	526.7	515.2	506.3	490.4
Forest land converted to Other land	kha	103.5	103.6	97.3	81.0	73.4	70.6	67.4
Cropland converted to Other land	kha	419.6	338.1	316.5	324.8	317.4	311.2	299.7
Rice field	kha	181.2	120.3	105.0	108.4	106.4	106.3	105.1
Upland field	kha	164.2	153.7	154.8	161.8	158.9	154.9	147.9
Orchard	kha	74.2	64.1	56.6	54.6	52.0	50.0	46.8
Grassland converted to Other land	kha	68.3	74.7	99.1	120.9	124.4	124.4	123.2
Wetlands converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE
Settlements converted to Other land	kha	IE	IE	IE	IE	IE	IE	IE

c） Uncertainties and Time-series Consistency

- ***Uncertainty Assessment***

Uncertainties of the parameters and the activity data for living biomass and dead organic matter, were individually assessed on the basis of field study results, expert judgment, or the default values described in the GPG-LULUCF. The uncertainty was estimated as 12% for the entire emission from the land converted to Other land. More detailed information on the uncertainty assessment is described in Annex 7. In addition, concrete uncertainty estimates for individual parameters in this category will be illustrated in future submissions after investigation is completed.

- ***Time-series Consistency***

Although methods to estimate area of Forest land converted to other land use are different between FY1990-2004 and post FY2005, as described in section 7.5.2.b)1), time-series consistency for this subcategory is basically ensured.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described in the GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. More detailed information on the QA/QC activity procedures is described in section 6.1 of Annex 6.

e） Source-/Sink-specific Recalculations

- ***Areas of Forest land converted to Other land***

Due to the change in allocation method of “Forest land converted to other land-use categories” after FY2005, as described in 7.5.2.e), the area of “Forest land converted to Other land” was recalculated. In line with this, the biomass stock changes in living biomass, dead organic matter and soils in the land were also recalculated.

- ***Carbon Stock Changes in Forest land converted to Other land***

Living biomass accumulation in Forest land subjected to conversion has been estimated by extrapolation of trend of living biomass accumulation in the D area during the period between 2005 and the latest year. In line with this, the carbon stock changes were recalculated in accordance with the updated living biomass accumulation reflecting the value of FY2009.

- ***Carbon Stock Changes in Dead Organic Matter in Wetlands and Settlements converted to Other land***

Until the 2010 submission, they were reported as “IE” but now reported as “NO”, because the areas of these subcategories cannot be obtained by the current method.

f） Source-/Sink-specific Planned Improvements

- ***Breakdown Analysis of Other Land and Reclassification into Other Land Use Categories***

  Further breakdown analysis of the Other land is required, since it may still include some areas that are supposed to be classified into other land-use categories even after the reallocation carried out in this year.

- ***Carbon Stock Changes in Living Biomass of Land converted to Other Land***

  The carbon stock changes in living biomass of land converted to Other land were assumed to be zero because of a lack of reference information for Other land. However, this assumption may differ from the actual situation. Therefore, methods used to quantifying the carbon stock are being examined.

- ***Estimation Method of Soil Carbon Stock Change in Forest land, Cropland and Grassland converted to Other Land***

  The estimation method will be considered, when new data and information are obtained.

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

a） Source/Sink Category Description

It is assumed that volume of nitrogen-based fertilizer applied to forest soils is included in the amount of applied nitrogen-based fertilizers in Agriculture sector, although fertilization application in Forest land may rarely conducted in Japan. Therefore, these sources have been reported as “IE”.

7.11. N_2O emissions from drainage of soils (5.(II))

a） Source/Sink Category Description

Regarding the N_2O emissions from soil drainage activities in Forest land and Wetlands, experts advised that the N_2O emissions are extremely low, because the soil drainage activities are very rarely carried out in Japan. Based on this advice, this category is reported as “NO”.

7.12. N_2O emissions from disturbance associated with land-use conversion to Cropland (5.(III))

a） Source/Sink Category Description

This category deals with N_2O emissions from disturbance associated with land-use conversion to Cropland. The emission by this subcategory in FY2009 was 7.6 Gg-CO_2; this represents a decrease of 91.6% below the FY1990 value and a decrease of 9.2% below the FY2008 value.

Table 7-47 N_2O emissions from disturbance associated with land-use conversion to Cropland

Gas	Category			Unit	1990	1995	2000	2005	2007	2008	2009
N_2O	Total			Gg-N_2O	0.29	0.20	0.10	0.05	0.04	0.03	0.02
				Gg-CO_2 eq.	90.02	60.71	31.91	14.74	11.50	8.37	7.60
		Cropland		Gg-N_2O	0.29	0.20	0.10	0.05	0.04	0.03	0.02
			Forest land converted to Cropland	Gg-N_2O	0.23	0.17	0.10	0.04	0.03	0.02	0.02
			Grassland converted to Cropland	Gg-N_2O	0.05	0.03	0.004	0.003	0.003	0.003	0.003
			Wetlands converted to Cropland	Gg-N_2O	0.01	0.003	0.001	0.0003	0.0003	0.0003	0.0003
			Other land converted to Cropland	Gg-N_2O	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
		Other		Gg-N_2O	NA	NA	NA	NA	NA	NA	NA

b） Methodological Issues

- **Estimation Method**

According to the GPG-LULUCF, Tier 1 method is used.

$$N_2O - N_{conv} = N_2O_{net-\min} - N$$
$$N_2O_{net-\min} - N = EF \times N_{net-\min}$$
$$N_{net-\min} = C_{released} \times 1 / CN_{ratio}$$

N_2O - N_{conv} : N_2O emission due to land-use conversion to Cropland (kgN_2O-N)

$N_2O_{net\text{-}min}$ - N : N_2O emission due to land-use conversion to Cropland (kgN_2O-N/ha/yr)

$N_{net\text{-}min}$: annual N emission from soil disturbance associated with mineralization of soil organic matter (kgN/ha/yr)

EF : emission factor

CN_{ratio} : Carbon Nitrogen ratio of the biomass

$C_{released}$: soil carbon stock that has been mineralized within the past 20 years

- **Parameters**

➢ **CN ratio for soils**

11.3 (Country specific data (Ministry of the Environment, 2006))

➢ **N-N_2O emission factor for soils**

0.0125 kg-N_2O-N/kg-N (default value stated in the GPG-LULUCF, Page 3.94)

- **Activity Data**

Areas of land converted to Cropland and carbon emissions from soils due to this conversion are used. The areas are the same as those shown in Table 7-23.

c） Uncertainties and Time-series Consistency

- **Uncertainty Assessment**

The uncertainties of parameters were individually assessed on the basis of field studies, expert judgment, or default values described in the GPG-LULUCF, and the uncertainty estimates for the carbon emissions from soil in land converted to Cropland were applied to the activity data of this category. As a result, the uncertainty estimates of N_2O emissions from disturbance associated with land-use conversion to Cropland were 95%. The methodology of uncertainty assessment was described in Annex 7.

- **Time-series Consistency**

Time-series consistency for this category is ensured.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described by the GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. The QA/QC activity procedures are described in section 6.1 of Annex 6.

e） *Source-/Sink-specific Recalculations*

- ***Areas of Forest land converted to Cropland***

Areas of "Forest land converted to Cropland" were recalculated as mentioned in section 7.5.2.e). As a result, N_2O emissions from this category were also recalculated.

f） *Source-/Sink-specific Planned Improvements*

- ***Estimation Method of the Area converted from Forest Land to Cropland and from Grassland to Cropland***

The methods used to obtain data on the area of Forest land converted to Cropland and Grassland converted to Cropland need to be improved as mentioned in section 7.5.2.f). Therefore, validity of the estimates is being reviewed, and the estimation method is being reexamined.

- ***Method of Obtaining Data of the Area converted from Grassland to Cropland***

Moreover, data on the area of land converted from grassland to Cropland cannot be obtained from current statistics, so the carbon stock changes in the areas have not been estimated. Therefore, the methods used to obtain the following area data need to be investigated.

・from pasture land to upland field
・from pasture land to orchard
・from grazing meadow to rice field
・from grazing meadow to upland field
・from grazing meadow to orchard

7.13. CO_2 emissions from agricultural lime application (5.(IV))

a） *Source/Sink Category Description*

This category deals with CO_2 emissions from agricultural lime application. The emissions from this category in FY2009 were 268 Gg-CO_2; this represents a decrease of 51.2% below the FY1990 value and a decrease of 12.2% below the FY2008 value. One of the reasons for the decline compared to FY1990 is that the amount of calcium carbonate fertilizer applied in Japan has decreased because chemical nature of soils was progressively improved by soil amendment.

Table 7-48 CO_2 Emissions from Agricultural Lime Application

Gas	Category			Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	Total			Gg-CO_2	550.2	303.5	332.9	231.3	325.0	305.6	268.3
		Cropland		Gg-CO_2	IE	IE	IE	IE	IE	IE	IE
		Grassland		Gg-CO_2	IE	IE	IE	IE	IE	IE	IE
		Other		Gg-CO_2	550.2	303.5	332.9	231.3	325.0	305.6	268.3
			Limestone	Gg-CO_2	549.9	303.0	332.4	230.7	324.3	304.1	267.7
			Dolomite	Gg-CO_2	0.3	0.5	0.5	0.6	0.7	1.6	0.6

b） *Methodological Issues*

- ***Estimation Method***

Tier 1 method is used in accordance with the GPG-LULUCF (page 3.80).

$$\Delta C_{CCLime} = \left(M_{Limestone} \times EF_{Limestone} + M_{Dolomite} \times EF_{Dolomite}\right) \times 44/12$$

ΔC_{CCLime} : annual CO_2 emissions from agricultural lime application (t-CO_2/yr)
$M_{Limestone}$: annual amount of calcic limestone (t/yr)
$M_{Dolomite}$: annual amount of dolomite (t/yr)
$EF_{Limestone}$: emission factor of calcic limestone (t-C/t)
$EF_{Dolomite}$: emission factor of dolomite (t-C/t)

- ***Parameters***

➢ ***Emission factor of calcic limestone ($CaCO_3$)***

0.120 [t-C/t] (default value, GPG-LULUCF)

➢ ***Emission factor of dolomite($CaMg(CO_3)_2$)***

0.122 [t-C/t] (default value, GPG-LULUCF)

- ***Activity Data***

➢ ***Annual amount of lime applied to Cropland***

These data were calculated by adding up lime production and import quantities as listed in *the Yearbook of Fertilizer Statistics (Pocket Edition)* published by the Ministry of Agriculture, Forestry and Fisheries of Japan. Based on expert judgment, all of the “Calcium carbonate fertilizer” and 70% respectively of “Fossil seashell fertilizer”, “Crushed limestone” and “Seashell fertilizer” listed in the Yearbook was classified as calcic limestone ($CaCO_3$), and all of the “Magnesium carbonate fertilizer” and 74% of “Mixed magnesium fertilizer” as dolomite ($CaMg(CO_3)_2$).

c） Uncertainties and Time-series Consistency

- ***Uncertainty Assessment***

The uncertainty for this category was assessed based on the uncertainty of the emission factor (see 2006GL, p.11.27) and that of the statistics that provided the activity data. Consequently, the uncertainty of CO_2 emissions from this category was assessed and estimated as 51%. More detailed information on the uncertainty assessment is described in Annex 7. In addition, concrete uncertainty estimates for each parameter in this category will be illustrated in future submissions after investigation is completed.

- ***Time-series Consistency***

Time-series consistency for this category is ensured.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described in the GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. More detailed information on the QA/QC activity procedures is described in section 6.1 of Annex 6.

e） Source-/Sink-specific Planned Improvements

None.

7.14. Biomass burning (5.(V))

a） Source/Sink Category Description

This category deals with emissions of CH_4, CO, N_2O and NOx from biomass burning resulting from forest fires. The emissions resulting from wildfires in Forest land remaining Forest land and Land converted to Forest land are reported in a lump in the cell for wildfires in Forest land remaining Forest land in the CRF tables, because the data in the statistics for forest fires includes the wildfires occurred in both of the categories. Moreover, controlled burning activities in forests are quite rarely implemented in Japan because the activities are stringently restricted by the “Waste Management and Public Cleansing Law” and “Fire Defense Law”. Hence, the emissions resulting from controlled burning in Forest land are reported as “NO”.

Controlled burning resulting from land conversion from land-use categories other than Forest land to Forest land is also very rarely carried out in Japan because of heavy restrictions imposed under the “Waste Management and Public Cleansing Law” and the “Fire Defense Law”. Hence, $CH_{4,}$ CO, N_2O, and NOx emissions derived from controlled burning other than in Forest land are reported as “NO”.

CH_4, CO, N_2O and NOx emissions from controlled burning in Cropland are reported as “NE” because they are not estimated due to lack of data. CH_4, CO, N_2O and NOx emissions from wildfires in Cropland are reported as “NO”. One of the characteristics of Japan’s cropland is intensive management. Under the management style, occurrence of wildfire is regarded as negligible small. CH_4, CO, N_2O and NOx emissions from wildfires in land other than Forest land and Cropland are reported as “NE” because information on the wildfires is not sufficiently collected.

The emission by this subcategory in FY2009 was 9.61 Gg-CO_2; this represents an increase of 5.0% over the FY1990 value and a decrease of 59.7% below the FY2008 value. These variations are mainly originated from those of the damaged timber volume from wildfires in private forests (Table 7-51).

Table 7-49 Non-CO_2 Emissions from Biomass Burning

Gas	Category		Unit	1990	1995	2000	2005	2007	2008	2009
All	Total		Gg-CO_2 eq.	9.2	9.5	8.5	10.1	2.2	23.8	9.6
CH_4	Total		Gg-CH_4	0.4	0.4	0.4	0.4	0.1	1.0	0.4
			Gg-CO_2 eq.	8.3	8.7	7.8	9.1	2.0	21.6	8.7
		Forest land	Gg-CH_4	0.4	0.4	0.4	0.4	0.1	1.0	0.4
		Cropland	Gg-CH_4	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
		Grassland	Gg-CH_4	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
		Wetlands	Gg-CH_4	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
		Settlements	Gg-CH_4	NO	NO	NO	NO	NO	NO	NO
		Other land	Gg-CH_4	NO	NO	NO	NO	NO	NO	NO
		Other	Gg-CH_4	NA	NA	NA	NA	NA	NA	NA
N_2O	Total		Gg-N_2O	0.003	0.003	0.003	0.003	0.001	0.007	0.003
			Gg-CO_2 eq.	0.8	0.9	0.8	0.9	0.2	2.2	0.9
		Forest land	Gg-N_2O	0.003	0.003	0.003	0.003	0.001	0.007	0.003
		Cropland	Gg-N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
		Grassland	Gg-N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
		Wetlands	Gg-N_2O	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
		Settlements	Gg-N_2O	NO	NO	NO	NO	NO	NO	NO
		Other land	Gg-N_2O	NO	NO	NO	NO	NO	NO	NO
		Other	Gg-N_2O	NA	NA	NA	NA	NA	NA	NA

b） Methodological Issues

- ***Estimation Method***

For $CH_{4,}$ CO, N_2O and NOx emissions due to biomass burning, Tier 1 method is used.

- ***Forest land***

(CH_4、CO)

$$bbGHG_f = L_{forestfire\,s} \times ER$$

(N_2O、NOx)

$$bbGHG_f = L_{forestfire\,s} \times ER \times NC_{ratio}$$

$bbGHG_f$: GHG emissions due to forest biomass burning

$L_{forest\,fires}$: Carbon released due to forest fires(tC/yr)

ER : Emission ratio (CO：0.06、CH_4：0.012、N_2O：0.007、NO_x：0.121)

NC_{ratio} : Nitrogen Carbon ratio of the biomass

- ***Parameters***
- ***Emission ratio***

The following values are applied to emission ratios for non-CO_2 gases due to biomass burning.
CO: 0.06, CH_4: 0.012, N_2O: 0.007, NOx: 0.121
(default value stated in the GPG-LULUCF, Table 3A.1.15)

- ***NC ratio***

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

- ***Activity Data***
- ***Forest land***

For activity in Forest land, carbon released due to forest fire is used. Carbon released due to forest fire is estimated by the Tier 3 method in the GPG-LULUCF. For each of national forest land and private forest land, carbon emissions are calculated from the fire-damaged timber volume multiplied by wood density, biomass expansion factor and carbon fraction of dry matter.

$$\Delta C = \Delta C_i + \Delta C_c$$

$L_{forest\,fires}$: carbon emissions due to fire (t-C/yr)

ΔC_{fn} : carbon emissions due to fire in national forests (t-C/yr)

ΔC_{fP} : carbon emissions due to fire in private forests (t-C/yr)

- ***National forest***

$$\Delta C_{fn} = Vf_n \times D_n \times BEF_n \times CF$$

ΔC_{fn} : carbon emissions due to national forest fires (t-C/yr)

Vf_{fn} : damaged timber volume due to fire in national forest (m^3/yr)

D_n : wood density for national forest (t-d.m./m^3)

BEF_n : biomass expansion factor for national forest

CF : carbon fraction of dry matter (t-C/t-d.m.)

- ***Private forest***

$$\Delta C_{fP} = Vf_p \times D_P \times BEF_P \times CF$$

ΔC_{fp} : carbon emissions due to private forest fires (t-C/yr)
Vf_p : damaged timber volume due to fire in private forest (m^3/yr)
D_p : wood density for private forest (t-d.m./m^3)
BEF_p : biomass expansion factor for private forest
CF : carbon fraction of dry matter (t-C/t-d.m.)

The values for wood density and biomass expansion factors for national and private forest land are determined as weighted averages using the ratios of intensively managed forest and semi-natural forests.

Table 7-50 Wood density and biomass expansion factors for national and private forest

Type	Wood density [t-d.m./m^3]	Biomass expansion factor
National forest	0.49	1.61
Private forest	0.46	1.61

Source: Based on Forestry Agency data

Biomass stock change due to fires is separately estimated for national forests and private forests respectively.

With regard to national forests, volume of standing timbers damaged due to fires in national forests in *Handbook of Forestry Statistics* is used.

With regard to private forests, damaged timber volume due to fires is estimated by using actual damaged area and damaged timber volume by age class (inquiry survey by Forestry Agency). Damaged timber volume for age class equal to or under 4 is estimated by multiplying the cumulative volume per unit area of age class equal to or under 4 estimated by the Forestry Status Survey and the NFRDB by loss ratio (ratio of damaged timber volume to cumulative volume) of age class equal to or over 5 in private forests. The loss ratio is assumed to be constant regardless of age classes.

Table 7-51 Damaged Timber Volume due to Wild Fire

Category			Unit	1990	1995	2000	2005	2007	2008	2009
Damaged timber volume due to disturbance in national fore			m^3	3,688.0	1,014.0	1,599.0	359.0	969.0	1,901.0	1,901.0
Damaged timber volume due to disturbance in private fores			m^3	62,009.2	67,771.0	60,012.3	72,307.1	15,181.4	170,073.3	67,331.6
	≧5	Actual damaged area	kha	0.29	0.94	0.48	0.35	0.15	0.57	0.37
		Damaged timber volume	m^3	47,390.0	58,129.0	54,487.0	59,235.0	11,930.0	119,900.0	55,628.0
	≦4	Actual damaged area	kha	0.27	0.51	0.16	0.27	0.14	0.85	0.28
		Damaged timber volume	m^3	14,619.2	9,642.0	5,525.3	13,072.1	3,251.4	50,173.3	11,703.6

Source: Based on "Handbook of Forestry Statistics" for national forest, and Forestry Agency data for private forest

Note

In Japan, emissions due to biomass burning are estimated separately for national forests and for private forest, because of different reporting procedures in regards to forest fire information. However, forest fire in Japan is covered by set of data for both national forests and private forests, and the emissions are thus appropriately estimated.

c） Uncertainties and Time-series Consistency

- ***Uncertainly Assessment***

The uncertainties for parameters and activity data related to biomass burning were individually assessed on the basis of field studies, expert judgment, or default values described in the GPG-LULUCF. As a result, the uncertainty estimates for the emissions resulting from biomass burning were 87% for CH_4 and 113% for N_2O, respectively. The methodology of uncertainty assessment is described in Annex 7. In addition, concrete uncertainty estimates for individual parameters in this category will be illustrated in future submissions after investigation is completed.

- ***Time-series Consistency***

Time-series consistency for biomass burning in the Forest Land remaining Forest Land is ensured by using the same data sources (*Handbook of Forestry Statistics* compiled by the Forestry Agency, and the data provided by the Agency) and the same methodology from 1990 to 2006.

d） Source-/Sink-specific QA/QC and Verification

QC is implemented in accordance with the Tier 1 approach described by GPG (2000) and the GPG-LULUCF. The Tier 1 approach includes procedures for checking parameters and activity data, and for archiving references. The QA/QC activity procedures are described in section 6.1 of Annex 6.

e） Source-/Sink-specific Planned Improvements

None.

f） Source-/Sink-specific Planned Improvements

- ***Burning of pruned branches from orchard trees***

Although woody biomass such as pruned branches from orchard trees may partially be burnt, non-CO_2 emissions from this burning are not estimated. When data for treatment of orchard tree residues became available, the emissions will be estimated and reported in the inventories.

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Chapter 8. Waste (CRF Sector 6)

8.1. Overview of Sector

In the waste sector, greenhouse gas emissions from treatment and disposal of waste are estimated for solid waste disposal on land (6.A.), wastewater handling (6.B.), waste incineration (6.C.), and other (6.D.)[1] in accordance with treatment processes.

Waste to be covered in this sector is the waste as defined in the Revised 1996 IPCC Guidelines. In the case of Japan, the waste does not only include municipal waste and industrial waste as defined by the Waste Disposal and Pubic Cleansing Law, but also recyclables and valuables that are re-used within a company. Since waste statistics are compiled separately for municipal waste and industrial waste in Japan, estimation methodologies for many of emission sources in the waste sector are discussed respectively for municipal waste and industrial waste.

In FY 2009, emissions from the waste sector amounted to 21,831 Gg-CO_2 eq. and represented 1.8% of Japan's total greenhouse gas emissions (excluding LULUCF). These emissions had decreased by 14.6% compared to those of FY 1990.

In Japan, annual waste generation is amounted to around 600 Mt and it has hardly changed since FY 1990. According to the latest results, the FY 2007 data, waste of biogenic-origin, waste of fossil-origin, and metal and nonmetallic mineral wastes accounted respectively for 54%, 3% and 43% of total amount of waste. With regard to the recycle flow for the waste in FY 2007, for overall waste activities generated, natural decomposition, recycling, volume reduction and final disposal accounted for 26%, 17%, 55% and 3%, respectively, for waste of biogenic-origin; while for waste of fossil-origin, recycling, volume reduction and final disposal accounted for 37%, 46% and 17%, respectively. The final disposal amount in Japan has been decreasing year by year.

8.2. Solid Waste Disposal on Land (6.A.)

This category covers CH_4 emissions from solid waste disposal on land. For this emission source category, estimation methodologies were discussed separately for municipal waste and industrial waste in accordance with Japan's waste classification system, and emissions were estimated for the sources presented in Table 8-1.

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[1] Data for some emission source categories in the waste sector are complemented by estimation, when statistical data or related data are not available. The methodologies for this estimation are not described in this chapter. For details, refer to the *Report of the Waste Panel on Greenhouse Gas Emission Estimate (2006)* (hereinafter referred to as Reference #7).

Table 8 - 1Categories whose emissions are estimated for solid waste disposal on land (6.A.)

Category	Waste types estimated			Treatment type
6.A.1. (8.2.1)	Municipal solid waste	Kitchen garbage		Anaerobic landfill
				Semi-aerobic landfill
		Waste paper		Anaerobic landfill
				Semi-aerobic landfill
		Waste wood		Anaerobic landfill
				Semi-aerobic landfill
		Waste textiles (natural fiber) [a]		Anaerobic landfill
				Semi-aerobic landfill
		Human waste treatment, Septic tank sludge		Anaerobic landfill
				Semi-aerobic landfill
	Industrial waste	Kitchen garbage		Anaerobic landfill [b]
		Waste paper		
		Waste wood		
		Waste textiles (natural fiber) [a]		
		Sewage sludge	Digested sewage sludge [c]	
			Other sewage sludge	
		Waterworks sludge		
		Organic sludge from manufacturing industries		
		Livestock waste [d]		
6.A.3. (8.2.3)	Inappropriate disposal [e]			Anaerobic landfill

a) Only natural fiber waste textiles are included in the estimation under the assumption that synthetic fiber waste is not biologically decomposed in landfills.

b) For landfill disposal of industrial waste, the entire volume is deemed to have been disposed of in an anaerobic landfill because the percentage disposed of in semi-aerobic landfill is not identified.

c) "Digested sewage sludge" includes sewage sludge landfilled after digested and dehydrated. Because digestion treatment reduces the amount of carbon content biodegraded in sludge decreases, CH_4 emissions were estimated separately by landfilled sewage sludge with and without digestion treatment.

d) Although livestock waste is not classified as "sludge" under Japanese law, emissions from it were estimated within the category of sludge because of the similarities in their properties.

e) Waste inappropriately disposed of and containing biodegradable carbon is considered to include waste wood, waste paper, and sludge. However, only the emissions from waste wood were calculated, because only its state of dumping is known at present.

Table 8 - 2 GHG emissions from solid waste disposal on land (6.A.)

Gas	Category	Item		Unit	1990	1995	2000	2005	2007	2008	2009
CH_4	6.A.1. Managed Solid Waste Disposal site	Kitchen garbage		Gg CH_4	62.9	60.6	52.3	34.7	26.1	22.0	19.0
		Waste paper		Gg CH_4	145.7	133.0	109.2	84.9	74.1	67.9	62.2
		Waste textile (natural fiber)		Gg CH_4	9.5	8.2	6.8	5.4	4.7	4.4	4.0
		Waste wood		Gg CH_4	46.0	50.1	49.3	47.0	45.9	45.2	44.6
		sewage sludge	Digested sewage sludge	Gg CH_4	5.6	5.3	4.2	2.8	2.2	1.9	1.6
			Other sewage sludge	Gg CH_4	28.1	26.2	21.1	13.7	10.8	9.4	8.1
		Human waste treatment, Septic tank sludge		Gg CH_4	12.4	9.0	6.5	4.8	4.3	3.7	3.3
		Waterworks sludge		Gg CH_4	3.5	3.3	2.8	2.2	1.9	1.7	1.7
		Organic sludge from industry		Gg CH_4	49.0	39.4	24.6	16.0	12.8	11.4	10.0
		Livestock waste		Gg CH_4	1.4	1.4	1.4	1.3	1.3	1.3	1.3
		Recovery		Gg CH_4	-0.8	-0.7	-0.7	0.0	-0.3	-0.3	-0.3
		Total		Gg CH_4	363.5	336.0	277.6	212.7	183.9	168.7	155.4
	6.A.3. Other	Inappropriate disposal		Gg CH_4	0.3	0.8	2.4	2.4	2.3	2.1	1.8
	Total			Gg CH_4	363.8	336.8	280.0	215.1	186.2	170.8	157.3
				Gg CO_2 eq	7,640	7,074	5,881	4,517	3,910	3,586	3,303

Estimated greenhouse gas emissions from solid waste disposal on land are shown in Table 8-2. In FY 2009, greenhouse gas emissions from this source category were 3,303 Gg-CO_2 eq. and accounted for 0.3% of the national total emissions (excluding LULUCF). Emissions from this category decreased by 56.8% compared to the emissions in FY 1990. This CH_4 emissions decrease is the result of decrease in the amount of biodegradable waste landfilled due to the increase in the practice of waste incineration to reduce waste volume in Japan.

8.2.1. Emissions from Managed Landfill Sites (6.A.1.)

a） Source/Sink Category Description

In Japan, part of kitchen garbage, waste paper, waste textiles, waste wood, and sludge in municipal solid waste (MSW) and industrial waste is landfilled without incineration; therefore, CH_4 is generated as a result of biodegradation of organic materials from the landfill sites. Because Japanese landfill sites are appropriately managed pursuant to the Waste Disposal and Public Cleansing Law, the amount of CH_4 emitted from there is reported under this category "Emissions from Managed Landfill Sites (6.A.1.)". Emissions of CO_2 from waste incineration at the managed landfill sites are reported as NO, because waste incineration is not implemented at that site in Japan.

b） Methodological Issues

- ***Estimation Method***

In accordance with the decision tree in the 2006 IPCC Guidelines, emissions from this source were estimated with the revised FOD methods given in the 2006 IPCC Guidelines with Japan's country-specific parameters (Tier 3). In Japan, emission factor is defined as "CH_4 emissions from biodegradable waste", and activity data are defined as "the amount of waste biodegraded within the reporting fiscal year".

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

Where:

E : CH_4 emissions from landfill sites (kg CH_4)

EF_{ij} : Emission factor for a biodegradable waste i (dry basis) that is damped into a landfill site j without incineration (kg CH_4/t)

A_{ij} : Amount of a biodegradable waste i (dry basis) that is damped into a landfill site j without incineration and is biodegraded within an inventory year)

R : Recovered CH_4 in an inventory year (kg CH_4)

OX : Oxidation factor of CH_4 related to soil cover

- ***Emission Factors***

Emission factors were defined as the amount of CH_4 (kg) generated through decomposition of one ton of unburned biodegradable landfill wastes (dry basis). They were established by the type of biodegradable waste (i.e., kitchen garbage, waste paper, waste natural fibers, waste wood, sewage sludge, human waste, waterworks sludge, organic sludge from manufacturing industries and livestock waste) and by the type of landfill site (i.e., anaerobic or semi-aerobic landfill). Emission factors were estimated as indicated below.

Emission factor
= (Carbon content) × (Gas conversion rate) × (Methane correction factor) × (Percentages of CH_4 in landfill gas) ×1000 × 16/12

➢ *Carbon Content (per dry weight)*

Carbon content per dry weight, which is used as uniform value every year because the property of each waste type does not vary significantly over time, was determined based on the "*Ministry of the Environment, Survey Study on Improving the Accuracy of Emission Factors for Greenhouse Gas Emissions from the Waste Sector, 2010*" (hereinafter referred to as Reference #15) and Reference #7 as indicated in Table 8-3.

Table 8 - 3 Carbon content of waste disposed of in managed landfill sites (dry base)

Item	Carbon Content (%)	Data source
Kitchen garbage	43.4	MSW: Calculated by taking the averages of carbon contents of MSW provided by Tokyo, Yokohama, Kawasaki, Kobe, and Fukuoka (FY 1990-2004) ISW: Substituted the carbon content for the MSW for ISW because its properties are similar to those of MSW (Reference #15)
Waste paper	40.9	
Waste wood	45.2	
Waste natural fiber textiles	45.0	Calculated by taking a weighted average of carbon content estimated based on the constituent of each natural fiber type (cotton, wool, silk, linen, and recycled textiles) by the domestic demand of natural fibers (FY1990-2004) (Reference #7)
Digested sewage sludge	30.0	Expert judgment based on Reference #48, 49, 57, 61
Other sewage sludge	40.0	GPG2000
Human waste treatment, Septic tank sludge	40.0	Substituted the value for "Other sewage sludge" from GPG2000
Waterworks sludge	6.0	Average values of survey results conducted at 23 water purification plants (Reference #15)
Organic sludge from manufacturing	45.0	Value for papermaking industry was substituted because it generates the largest amount of organic sludge finally disposed of. Estimated based on the carbon content of cellulose because the main constituent of organic sludge generated is paper sludge (Reference #7)
Livestock waste	40.0	Substituted the value for "Other sewage sludge" from GPG2000

➢ *Gas conversion rate*

Gas conversion rate for the biodegradable waste was set at 50% based on Ito (1992).

➢ *Methane correction factor*

Default values given in the 2006 IPCC Guidelines were used: 1.0 for anaerobic landfill sites and 0.5 for semi-aerobic landfill sites.

➢ *Proportions of CH_4 in generated gas*

Default value (50%) given in the Revised 1996 IPCC Guidelines was used.

Table 8 - 4 Emission factors by type of biodegradable waste and by treatment

Item	Anaerobic landfill （kg CH_4/t）	Semi-aerobic landfill （kg CH_4/t）
Kitchen garbage	145	72
Waste paper	136	68
Waste textiles	150	75
Waste wood	151	75
Digested sewage sludge	100	50*
Other sewage sludge	133	67*
Human waste treatment, Septic tank sludge	133	67
Waterworks sludge	20	10*
Organic sludge from manufacturing	150	75*
Livestock waste	133	67*

* Currently its activity data are not identified.

● *Activity Data*

Out of the amount of waste landfilled without incineration (dry basis), the amount of waste degraded within the reporting year was calculated by multiplying the amount of waste remaining in landfills at the end of the previous reporting year by the decomposition rate for waste landfilled. The amount of biodegradable MSW and ISW were determined by type of waste and landfill site.

The amount of waste landfilled in each fiscal year was calculated by multiplying the amount of biodegradable waste landfilled (wet basis) by the percentage of landfill site by the type of site (wet basis), and subtracting the water content by each type of waste. Activity data were estimated going back as far as FY1954, when the Public Cleansing Law (now the Waste Disposal and Public Cleansing Law) was enforced.

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

Where:

$A_i(T)$: Amount of waste i degraded in the calculated year (year T) (activity data: dry basis)
$W_i(T)$: Amount of waste i remaining in a landfill in year T
$w_i(T)$: Amount of waste i landfilled in year T
k : Decomposition rate constant (1/year), and
H : Decomposition half-life of waste i (the time taken by landfilled waste i to reduce in amount by half)

The amount of waste i landfilled in year T
= (Amount of biodegraded waste i landfilled in year T)
× （percentages of landfill sites of each site type） × （1 - percentage of water content in waste i）

➢ *Amount of biodegradable waste disposed of in landfills*

Table 8-5 shows the annual amount of biodegradable waste disposed of in landfills (dry basis) in Japan.

Table 8 - 5 Annual amount of biodegradable waste disposed of in landfills

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Kitchen garbage	kt / year (dry)	501	483	297	110	50	64	60
Waste paper	kt / year (dry)	1,179	868	611	290	81	71	131
Waste textiles (natural fiber)	kt / year (dry)	59	48	31	20	7	5	8
Waste wood	kt / year (dry)	652	476	221	152	76	90	43
Digested sewage sludge	kt / year (dry)	59	50	31	11	5	4	3
Other sewage sludge	kt / year (dry)	219	185	114	42	20	17	16
Human waste treatment, Septic tank sludge	kt / year (dry)	78	51	46	47	10	11	15
Waterworks sludge	kt / year (dry)	199	166	146	66	67	67	67
Organic sludge from manufacturing industries	kt / year (dry)	346	156	69	48	34	23	22
Livestock waste	kt / year (dry)	12	12	11	11	11	12	11
Total	kt / year (dry)	3,303	2,495	1,577	796	362	365	376

As indicated in Table 8-6, for the data sources for the amount of biodegradable waste disposed of in landfills, the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (Volume on Cyclical Use), Waste Management and Recycling Department of the Ministry of the Environment* (hereinafter referred to as the *Cyclical Use of Waste Report*), and the *annual editions of Sewage Statistics (Admin. Ed.)*, Japan Sewage Works Association (hereinafter referred to as the *Sewage Statistics*) were used.

Table 8 - 6 Data overview for the amount of biodegradable waste disposed of in landfills

Item		Data source	MSW	ISW	Remarks
Kitchen garbage		*Research on the State of Wide-range Movement and Cyclical Use of Wastes* (MoEJ)	Calculated by multiplying total amount of corresponding landfilled waste by the composition ratio of each waste type	- Amount of animal and plant residues directly landfilled and after intermediate processing. - Amount of livestock carcasses directly landfilled	- Estimated by interpolation for some fiscal years, - Substituted FY 1980 value for the years prior to FY 1980
Waste paper				Amount of waste paper directly landfilled	
Waste wood				Amount of waste wood directly landfilled	
Waste natural fiber textiles			Calculated by multiplying by the ratio of natural fiber textiles in textile products each year from "*Annual Textile Statistics Report*"	Amount of waste natural fiber textiles directly landfilled (considereing all the amount as waste natural fiber textiles due to the Waste Disposal and Pubic Cleansing Law	
Digested sewage sludge		*Annual editions of Sewage Statistics (Admin. Ed.)*		Compiled and provided by MLITT	- For some fiscal years, estimated by interpolation - Substituted FY 1985 value for the years prior to FY 1985
Other sewage sludge				Total amount of sewage sludge excluding the amount of digested sewage sludge	
Human waste treatment, Septic tank sludge		*Research on the State of Wide-range Movement and Cyclical Use of Wastes* (MoEJ)	"Direct final disposal & final disposal after treatment" of "Human waste treatment and septic tank sludge" (estimated by subtracting the amount of final disposal from those incinerated within the incineration facilities or sewage sludge treatment facilities)		For the years prior to FY 1998, multiplying the amount of human waste sludge in landfill (volume basis) by the weight-conversion factor (1.0 kg/L)
Waterworks sludge		*Waterworks Statistics* (Japan Water Works Association)		Estimated by "Total amount of soil disposed" and "landfilled percentage" of each purification plant	Substituted FY 1980 value for the years prior to FY1980
Organic sludge from manufacturing	Papermaking industry	Data provided by Japan Paper Association, Japan Technical Association of the Pulp and Paper Industry		Total amount of organic sludge landfilled for papermaking industry	Substituted FY 1989 value for the years prior to FY 1989
	Chemicals industry	*Report on Results of Trend and Industry-Specific Studies on Industrial Wastes (Mining Industry Waste) and Recyclable Waste*		Total amount of organic sludge landfilled for chemicals industry and food manufacturing industry	- For some fiscal years, estimated by interpolation - For the years prior to FY 1998, estimated with the data from the *Voluntary Action Plan on Environmen), Follow-up Action Result* (Japan Federation of Economic Organizations) - Substituted FY 1990 value for the years prior to FY 1990
	Food manufacturing industry				
Livestock waste		Survey conducted by MoEJ			Substituted FY 1980 value for the years prior to FY 1980

➢ *Percentage of water content in waste*

In Japan, activity data are estimated on a dry basis which can identify the carbon content of waste more precisely. The percentages of water content by each type of waste to estimate activity data on a dry basis and its sources are given in Table 8-7. In order to estimate the CO_2 emissions for the category "8.4. Waste Incineration (6C)" as well as this source category, dry basis activity were used for the same reason.

Table 8 - 7 Percentage of water content in waste disposed of in controlled landfill sites

Category		Water content (%)	Source
Kitchen garbage, animal and plant residues		75 (direct final disposal)	Water percentage of kitchen garbage in *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*
		70 (final disposal after treatment)	
Waste paper		20 (MSW) 15 (ISW)	Expert judgment
Waste wood		45	Expert judgment
Waste natural fiber textiles		20 (MSW) 15 (ISW)	Expert judgment
Sewage sludge	Digested sewage sludge	Specific to each disposal site	Average moisture content of "delivered or final disposal sludge" in *Sewage Statistics (Admin. Ed.)*
	Other sewage sludge		
Sludge from human waste treatment and septic tanks		85 (direct final disposal)	Moisture content standard of landfill standard (sludge) specified by enforcement ordinance of Wastes Disposal and Public Cleansing Law
		70 (final disposal after treatment)	Determined by specialists
Waterworks Sludge		- *	—
Organic sludge from manufacturing industries		23 (food manufacturing) 43 (chemical industries) - (paper industries) *	Reference of Clean Japan Center Survey
Livestock waste		83.1 (direct final disposal)	Organic percentage in "*Controlling the Generation of Greenhouse Gases in the Livestock Industry*"
		70 (final disposal after treatment)	Expert judgment

*The water content of waterworks sludge and organic sludge from paper industries are not included in this table because activity data on a dry basis were provided by the data sources.

➢ *Percentages of landfill sites of each site structure type*

The percentages of MSW landfill sites with respect to the land fill sites by their structure of each site structure type were determined by referring to annual editions of Results of Study on Municipal Solid Waste Disposal,Waste Management and Recycling Department, Ministry of the Environment (hereinafter referred to as *Results of Study on MSW Disposal*), which lists Japan's MSW disposal sites in the section "Facility by Type (Final Disposal Sites)", regarding as semi-aerobic those sites which have leachate treatment facilities and subsurface containment structures, and regarding the percentage of semi-aerobic landfill disposal volume to be the percentage of their total landfill capacity (m^3).

However, disposal sites, where landfilling started before the 1977 joint order, and all coastal and inland water landfills are treated as anaerobic disposal sites. Additionally, because sites, where landfilling started in FY 1978-1989 likely include both anaerobic and semi-aerobic sites, the percentages of semi-aerobic sites were determined based on the expert judgment, and then the estimation was carried out. All industrial waste disposal sites are considered to be anaerobic.

Table 8 - 8 Landfill percentages of municipal solid waste disposal sites by site structure

Item	Unit	1977	1980	1990	1995	2000	2005	2007	2008	2009
Anaerobic landfill percentage	%	100.0	94.0	74.2	64.2	54.4	43.5	40.5	41.5	36.5
Semi-aerobic landfill percentage	%	0.0	6.0	25.8	35.8	45.6	56.5	59.5	58.5	63.5

➢ *Decomposition half-life*

Decomposition half-life is the time taken for 50% of waste landfilled in a certain year to be degraded from its initial mass. According to Ito (1992) (Reference #51), the half-lives for kitchen waste, waste paper, waste natural fiber textiles, and waste wood are respectively 3, 7, 7, and 36 years. Because no relevant research have been obtained to identify a country specific half life for the sludge, the default value of 3.7 years provided in the spreadsheets attached to the 2006 IPCC Guidelines was applied.

➢ *Delay time*

Delay time is the time lag since the waste is landfilled until the decomposition actually occurs. As no research is found for making it possible to set a delay time specific to Japan, the default value (6 months) given in the *2006 IPCC Guidelines* was used.

Table 8 - 9 Amount of biodegraded waste decomposed in each year (Activity data)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Kitchen garbage	kt / year (dry)	517	511	444	304	230	193	166
Waste paper	kt / year (dry)	1,246	1,175	995	803	706	647	593
Waste textiles (natural fiber)	kt / year (dry)	73	65	56	45	40	37	34
Waste wood	kt / year (dry)	344	377	373	357	349	343	339
Digested sewage sludge	kt / year (dry)	63	58	47	31	24	21	18
Other sewage sludge	kt / year (dry)	234	219	176	114	90	78	68
Human waste treatment, Septic tank sludge	kt / year (dry)	111	84	64	51	47	41	36
Waterworks sludge	kt / year (dry)	192	185	157	120	103	97	92
Organic sludge from manufacturing industries	kt / year (dry)	363	292	182	118	95	85	74
Livestock waste	kt / year (dry)	12	12	12	11	11	11	11
Total	kt / year (dry)	3,156	2,979	2,506	1,954	1,694	1,552	1,430

The declining trend in the amount of biodegraded waste is affected by the improvement of waste reduction that causes the decrease of landfilled waste.

➢ *Amount of CH_4 recovered from landfills*

In order to reduce the amount of organic matter content and CH_4 emissions at landfill sites, certain intermediate treatments and landfill methods have been conducted; CH_4 recovery from landfills is not very common practice in Japan. CH_4 recovery from landfilled MSW for the purpose of electric power generation implemented at the Tokyo Metropolitan Inner Landfill Site for the Central Breakwater ”Uchigawa-Shobunjo” is the sole practice example in Japan. For ISW, there is no practice of CH_4 recovery from landfills implemented in Japan. Because CO_2 emitted from the combustion of recovered CH_4 is of biogenic-origin, it is not included in the total emissions.

$$R = r \times f \times 16/ 24.4 / 1,000$$

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

- *The amount of recovered landfill gas used for electric power generation in "Uchigawa-Shobunjo" landfill*

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

- *Fraction of CH_4 to the recovered gas*

The fraction of CH_4 to recovered landfill gas in the *Uchigawa-Shobunjo* has been annually provided since FY 2005 by the Waste Disposal Management Office of Tokyo. The fraction for the years prior to FY 2005 were determined based on the hearing conducted with the Waste Disposal Management Office of Tokyo: 60% for FY 1987, when the recovery of landfill gas was started; 40% for FY 1996; interpolated for FY 1988 through FY 1995; The FY 1996 value was used for FY 1997 through FY 2004.

Table 8 - 10 Amount of CH_4 recovered at landfill sites in Japan

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Amount of gaseous use	km^3N	1,985	2,375	2,372	140	1,157	1,161	1,154
CH_4 ratio	%	53.3	42.2	40.0	48.5	37.4	37.1	40.0
Amount of CH_4 use	km^3N	1,059	1,003	949	68	433	431	462
CH_4 unit conversion	Gg CH_4	0.76	0.72	0.68	0.05	0.31	0.31	0.33

The consumption of gas used for electric power generation during 1991-1994 had decreased compared to the preceding year and the following year because recovered gas was used for the purposes other than electric power generation. The consumption of recovered gas used for electric power generation had decreased compared to 1996 because no electric power generation using recovered gas was conducted between late 1994 and early 1995 due to the relocation of electric power generation facilities. Amount of gas used in 2005 has dropped to less than 10 percent over the previous year because the electric power generating equipment had been halted from April, 2005 to Mid-February, 2006. After resumption, methane concentration was high through to the end of the fiscal year.

➢ *CH_4 oxidation rate related by landfill cover soil*

Based on law enforcement ordinances and local government ordinances, daily, intermediate and final soil coverings are practiced in the managed final disposal sites for MSW and ISW in Japan. Therefore, the default oxidation factor for managed landfill sites (0.1) was used in accordance with the *2006 IPCC Guidelines*.

c） Uncertainties and Time-series Consistency

● Uncertainties

The uncertainty in emission factors was evaluated by integrating the uncertainties for carbon content, gas conversion rate, CH_4 correction factor, and percentage of CH_4 in generated gas, and estimated to be in the range of 42.4-108.6%. The uncertainty in activity data was evaluated by integrating the uncertainties for the residual amount of biodegradable waste (landfilled amount and percentage of water content in waste) at the end of the year before the reporting year and the decomposition rate for the reporting year, and estimated to be in the range of 31.7-56.6%. As a result, the uncertainty in the emissions from solid waste disposal sites was estimated to be in the range of 53-113%.

The methods for evaluation of the uncertainty levels for each component are:

- Use of 95% confidence interval of actual measurement data: carbon content (kitchen garbage, waste paper and waste wood)

- Use of the statistical uncertainties: domestic demand for textile and landfilled amount of biodegradable waste
- Based on expert judgment: carbon content (sewage sludge, human waste treatment sludge and organic sludge from manufacturing industries), gas conversion rate, percentage of CH_4 in landfill gas and percentage of water content in biodegradable waste
- Use of the default values in the IPCC Guidelines: carbon content (livestock waste) and CH_4 correction factor
- Use of the values set by the Committee for GHGs Emissions Estimation Methods: carbon content (waterworks sludge)
- Use of the differences between the adopted values and default ones: residual amount of biodegradable waste.

For more details about basic methods for uncertainty assessment in Japan, refer to the Annex 7.

- ***Time-series consistency***

Although some activity data in FY 1990 and thereafter are not available, they are estimated by using the methods described in “Activity data” to develop consistent time-series data. The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） Source-specific Recalculations

The emission estimates for the period FY 1990 - FY 2008 were recalculated because of the data update on the amount of waste landfilled sludge from human waste treatment, and septic tanks and Organic sludge from manufacturing industries.

f） Source-specific Planned Improvements

Further improvements are planned owing to a lack of sufficient current information. Major issues are:

- Determining the value of methane correction factor taking into account the conditions of the management of landfill sites
- Gas conversion rate for each type of biodegradable waste
- Country-specific half-life for sludge at final disposal sites
- Percentage of anaerobic and semi-aerobic landfills for ISW

8.2.2. Emissions from Unmanaged Waste Disposal Sites (6.A.2.)

Because landfill sites in Japan are appropriately managed pursuant to the Waste Disposal and Public Cleansing Law, there are no unmanaged waste disposal sites in Japan. Therefore, the emissions from this source category are reported as NA.

8.2.3. Emissions from Other Managed Landfill Sites (6.A.3.)

8.2.3.1. Emissions from Inappropriate Disposal (6.A.3.a)

a） Source/Sink Category Description

In Japan, waste is disposed in landfill sites pursuant to the Wastes Disposal and Public Cleansing Law; however, part of it is disposed inappropriately. Although these inappropriate disposal sites generally satisfy the conditions of managed disposal sites defined in the *Revised 1996 IPCC Guidelines*, CH_4 emissions from inappropriate disposal are reported under “Other (6.A.3.)”, because it is not appropriate management under the law. Fires are occasionally observed in inappropriate landfill sites, and they may be emitting fossil-fuel derived CO_2. However, since actual data are not available, the emissions from the fires at inappropriate landfill sites are reported as NE.

b） Methodological Issues

- ***Estimation Method***

Waste wood and waste paper are the wastes containing biodegradable carbon and being inappropriately disposed without incineration; however, only waste wood is the subject for the estimation, because the residual amount of waste paper should be very small.

In a similar manner for the “Emissions from Controlled Disposal Sites (6.A.1.)”, a FOD method with Japan’s country-specific parameters is used for the estimation. Emissions are estimated by multiplying the amount of waste wood (dry basis) degraded in a reporting year by an emission factor.

- ***Emission Factor***

Since inappropriately disposed wastes are generally covered with soil in Japan, the mechanism for CH_4 emissions from inappropriate disposal is regarded as almost same as for the anaerobic landfill. Therefore the same emission factor is used for the anaerobic disposal sites for “waste wood emissions from managed disposal sites”.

- ***Activity Data***

Activity data (dry basis) was obtained by subtracting the water content from the residual amount of inappropriately disposed waste wood (wet basis) and multiplied by decomposition rate. The amount of inappropriately disposed waste wood is provided by “Waste Wood (Construction and Demolition)” in *Study on Residual Amounts of Industrial Waste from Illegal Dumping and other Sources* (Waste Management and Recycling Department, Ministry of the Environment). The percentage of water content and the decomposition rate used for estimating emissions from waste wood in managed disposal sites were also used for this source.

Table 8 - 11 Activity data of inappropriately disposed waste wood (dry basis)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Activity data	kt (dry)	2.3	5.5	15.9	15.7	15.1	13.8	12.2

c） Uncertainties and Time-series Consistency

● Uncertainties

The uncertainties in emission factor and activity data were evaluated by using the same methods that were used for “Emissions from Controlled Landfill Sites” (6.A.1). The uncertainty in the CH_4 emissions from inappropriate disposal was estimated to be 79%. For more details, refer to the Annex 7.

● Time series consistency

Because data on inappropriate disposal are available only since FY 2002, activity data prior to FY 2002 are estimated. The emissions are calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials. Also,

e） Source-specific Recalculations

Due to the changes in the amount of inappropriate disposal, emission estimates were recalculated.

f） Source-specific Planned Improvements

For future inventories, long-term efforts on further scientific investigations will be made to identify country-specific parameters.

8.3. Wastewater Handling (6.B.)

The CH_4 and N_2O emissions from wastewater handling are estimated in the “Wastewater Handling (6.B.)”. The target categories are shown in Table 8-12. Since an emission factor that takes into account emissions from wastewater and sludge treatment processes is used in Japan, emissions from these processes are reported altogether. Therefore, total emission amount is reported in the subcategory “Wastewater” in CRF, 6.B.; while IE is reported in the subcategory “Sludge”.

Table 8 - 12 Categories overview for wastewater handling (6.B.)

Category	Type Estimated	Forms of Treatment		CH_4	N_2O
6.B.1. (8.3.1)	Industrial wastewater	(Sewage treatment plants)		○	○
6.B.2. (8.3.2)	Domestic/commercial wastewater	Sewage treatment plants (8.3.2.1)		○	○
		Domestic wastewater treatment facilities (mainly septic tanks) (8.3.2.2)	Community plant	○	○
			Gappei-shori johkasou	○	○
			Tandoku-shori johkasou	○	○
			Vault toilet	○	○
		Human waste treatment facilities (8.3.2.3)	High-load denitrification treatment	○	○
			Membrane separation	○	○
			Anaerobic treatment	○	○
			Aerobic treatment	○	
			Standard denitrification treatment	○	
			Other	○	
	Degradation of domestic wastewater in nature (8.3.2.4)	Discharge of untreated domestic wastewater	*Tandoku-shori johkasou*	○	○
			Vault toilet	○	○
			On-site treatment	○	○
		Sludge disposal at sea	Human waste sludge	○	○
			Sewage sludge	○	○

Estimated greenhouse gas emissions from wastewater handling are shown in Table 8-13. In FY 2008, emissions from this source category were 2,335 Gg-CO_2 eq. and accounted for 0.2% of the national total emissions (excluding LULUCF). The emissions from this source category decreased by 31.4% compared to those in FY 1990. This emission decrease is the result of decrease in the amount of CH_4 emissions from "Degradation of Domestic Wastewater in Nature" because the practice of wastewater treatment at wastewater treatment plants increased in Japan. Due to the same reason, the N_2O emissions from the subcategory of "Sewage Treatment Plants (6.B.2.a)" for FY1995 through FY1998 increased.

Table 8 - 13 GHG emissions from wastewater handling (6.B.)

Gas	Category	Item	Unit	1990	1995	2000	2005	2007	2008	2009
CH_4	6.B.1. Industrial waste water	(Sewage treatment plants)	Gg CH_4	5.2	5.1	5.0	4.9	4.9	4.9	4.9
	6.B.2. Domestic/commercial wastewater	Sewage treatment plants	Gg CH_4	8.6	9.1	11.0	11.8	11.9	12.2	11.2
		Domestic waste water treatment facilities (mainly septic tank)	Gg CH_4	21.5	20.4	20.6	20.5	21.0	20.6	20.3
		Humanwaste treatment facilities	Gg CH_4	5.2	3.2	1.8	1.0	0.8	0.7	0.7
		Degradation of domestic wastewater in nature	Gg CH_4	60.2	50.8	39.5	28.7	24.7	23.9	22.4
	Total		Gg CH_4	100.9	88.5	77.9	66.8	63.2	62.4	59.4
			Gg CO_2 eq	2,118	1,859	1,635	1,403	1,327	1,310	1,247
N_2O	6.B.1. Industrial waste water	(Sewage treatment plants)	Gg N_2O	0.39	0.38	0.33	0.39	0.39	0.41	0.41
	6.B.2. Domestic/commercial wastewater	Sewage treatment plants	Gg N_2O	1.59	1.67	2.01	2.16	2.18	2.25	2.06
		Domestic waste water treatment facilities (mainly septic tank)	Gg N_2O	1.51	1.35	1.17	0.99	0.93	0.90	0.87
		Humanwaste treatment facilities	Gg N_2O	0.22	0.26	0.12	0.02	0.02	0.02	0.02
		Degradation of domestic wastewater in nature	Gg N_2O	0.44	0.35	0.27	0.19	0.16	0.16	0.15
	Total		Gg N_2O	4.15	4.01	3.90	3.74	3.68	3.73	3.51
			Gg CO_2 eq	1,287	1,244	1,209	1,160	1,140	1,157	1,087
Total of all gases			Gg CO_2 eq	3,405	3,103	2,844	2,563	2,467	2,466	2,335

8.3.1. Industrial Wastewater (6.B.1.)

a） Source/Sink Category Description

CH_4 and N_2O emissions from industrial effluent, which is treated by factories and other facilities in accordance with the regulations based on the Water Pollution Prevention Law and the Sewerage Law, are allocated to “Emissions from industrial wastewater treatment (6.B.1.)”.

b） Methodological Issues

- ***Estimation Method***

In accordance with the *GPG (2000)* decision tree, CH_4 and N_2O emissions were estimated for the industries that release organic-rich wastewater. Since default values given in the *Revised 1996 IPCC Guidelines* are considered to be unsuited to Japan’s circumstances, CH_4 emissions were estimated based on Japan’s country-specific methodology, namely, by multiplying the annual amount of organic matter in industrial wastewater subject to report (BOD basis) by the CH_4 emission factor per unit BOD that is based on Japan’s country-specific wastewater handling. Because CH_4 is emitted in wastewater biological treatment processes, BOD-based activity data (amount of organic matter in wastewater degraded through biological treatment) is thought to be preferable to COD-based data. For this reason, CH_4 emissions are calculated using BOD in Japan. With regard to N_2O emissions, no estimation methodologies are given in the IPCC guidelines. Therefore, in the same manner for estimating CH_4 emissions, N_2O emissions were estimated by multiplying the amount of nitrogen in industrial wastewater by Japan’s country-specific N_2O emission factor.

$$E = EF \times A$$

E : Amount of CH_4 or N_2O emissions generated when treating industrial wastewater (kg CH_4, kg N_2O)
EF : Emission factor（kg CH_4/kg BOD, kg N_2O/kg N）
A : Annual amount of industrial wastewater treated at wastewater treatment facilities (m^3)

- ***Emission Factor***

No research applicable to the circumstances in Japan has been found for the amounts of CH_4 and N_2O generated from the industrial wastewater treatments; therefore, emission factors were established by using with the ones used for the “Emissions from Treatment of Domestic and Commercial Wastewater (at sewage treatment plants) (6.B.2.a)”, which were believed to be relatively similar to the CH_4 and N_2O generation processes in wastewater treatment.

Since the ones used in “6.B.2.a” are expressed in units of volume of wastewater treated (m^3), these emission factors were converted to units per amount of organic matter (BOD basis) and nitrogen by dividing the emission factor by the following concentrations of organic matter (BOD basis) and nitrogen in the wastewater intake at sewage treatment plants.

For the BOD concentration of runoff water, the “Planned Runoff Water Quality of Municipal Solid Domestic Wastewater” (180 mgBOD/l) given in *Guidelines and Explanation of Sewerage Facility Design* (Japan Sewage Works Association, 2001) was used.

For the nitrogen concentration of runoff water, 37.2 mg N/L was used, which was the simple average of total nitrogen concentrations of runoff water of sewage treatment plants obtained from the *Sewage Statistics 2003 (Admin. Ed.)*.

CH_4 emission factor
＝(CH$_4$ emission factor for emissions from domestic and commercial wastewater treatment & Sewage treatment plant)) / (BOD concentration in influent water)
＝8.8×10^{-4} (kg CH$_4$/m^3) / 180 (mg BOD/L)×1000
＝0.00489 ≒0.0049 (kg CH$_4$/kg BOD)

N_2O emission factor
＝(N$_2$O emission factor for emissions from domestic and commercial wastewater treatment & Sewage treatment plant)) / (N concentration in influent water)
＝1.6×10^{-4} (kg N$_2$O/m^3) / 37.2 (mg N/L)×1000
＝0.0043 (kg N$_2$O/kg N)

In Japan, CH_4 emissions generated by anaerobic wastewater treatment are entirely recovered. For a small amount of CH_4 emissions generated under partially anaerobic conditions created during aerobic treatment, a country-specific emission factor was applied for emission estimates because the condition for this particular CH_4 emissions differs from that for the use of default value for the CH_4 emissions generated from anaerobic treatment defined in *the 2006 IPCC Guidelines*.

- ***Activity Data***

The activity data for CH_4 emission were estimated based on the amount of organic matter contained in wastewater using BOD concentrations. The emission estimates were conducted for the industries which generate large amount of CH_4 emissions with high BOD concentrations from the treatment of wastewater referring to the industry types provided in the *Revised 1996 IPCC Guidelines* (Table 8-14). The amount of organic matter was obtained by sorting and aggregating by industry type according to the middle industrial classification provided by the *Guidelines and Explanation of Sewage Facility Design* (Japan Sewage Works Assosiation,2001).

The use of COD concentrations is required to report activity data on CRF; however, activity data are reported as "NE" because country-specific methodology was used for this source.

CH_4 emission activity
= ∑[(Amount of industrial wastewater flowing into wastewater treatment facilities) × (Percentage of industrial wastewater treated at treatment facilities emitting CH$_4$) × (Percentage of industrial wastewater treated on-site) × (BOD concentration of runoff water)]

The activity data for N_2O emissions were obtained based on the amount of nitrogen contained in industrial wastewater and aggregated by the same industrial sub-category as that applied to the estimation of CH_4 emissions.

N_2O emission activity
= ∑[(Amount of industrial wastewater flowing into wastewater treatment facilities) × (Percentage of industrial wastewater treated at treatment facilities emitting N$_2$O) × (Percentage of industrial wastewater treated on-site) × (Nitrogen concentration of runoff water)]

- ***Amount of industrial wastewater inflowed into wastewater treatment facilities***

The amount of water used for the treatment of products by industrial sub-category and the volume of water used for washing given in the *Table of Industrial Statistics - Land and Water* (Ministry of Economy, Trade and Industry) were used for the amount of industrial wastewater treated at wastewater treatment facilities.

➢ *Percentage of industrial wastewater treated at facilities generating CH_4*

Emissions of CH_4 from industrial wastewater treatment are believed to be generated from the treatment of wastewater with the activated sludge method and from the anaerobic treatment. Industrial wastewater treatment percentages for each industry code were set from the percentages of reported wastewater amounts in total wastewater, as given under “active sludge”, “other biological treatment”, “membrane treatment”, “nitrification and denitrification” and “other advanced treatment” in the *Study on the Control of Burdens Generated* (Water and Air Environment Bureau, Ministry of the Environment).

➢ *Percentage of industrial wastewater treated at facilities generating N_2O*

Emissions of N_2O from industrial wastewater treatment are believed to be generated mainly from biological treatment processes such as denitrification. Data on the fraction of industrial wastewater treated at facilities generating CH_4 was also used for N_2O emission estimates.

➢ *Percentage of industrial wastewater treated on-site*

Percentage of industrial wastewater treated on-site is set at 1.0 in all industrial sub-categories because there is no statistical information available making it possible to ascertain this percentage.

➢ *BOD and nitrogen concentrations in runoff wastewater*

For the BOD concentrations for industrial sub-categories, the BOD raw water quality for industrial sub-categories given in the *Guidelines and Analysis of Comprehensive Planning Surveys for the Provision of Water Mains, by Catchment Area 1999 Edition* (Japan Sewage Works Association) was used. For the nitrogen concentrations for industrial sub-categories, emission intensities (TN: Total Nitrogen) provided by the same survey for industrial sub-categories were used.

Table 8 - 14 BOD and nitrogen concentrations by industry type used for emission estimates

Industry code	Category of Manufacturing	mg BOD/l	mgN/l
9	Food manufacturing	1,467	62
10	Beverage, tobacco and feeding stuff manufacturing	1,138	77
11	Textile manufacturing	386	36
14	Pulp, paper and other paper manufacturing	556	37
16	Chemical industries	1,093	191
17	Petroleum products and coal product manufacturing	975	289
18	Plastic products manufacturing	268	11
19	Rubber products manufacturing	112	32
20	Chamois, chamois products and fur skin manufacturing	1,810	60

Table 8 - 15 BOD loading (kt BOD) and nitrogen amount (kt N) for industrial wastewater

Item	Unit	1990	1995	2000	2005	2007	2008	2009
BOD load	kt BOD	1,075	1,046	1,032	1,000	1,004	1,004	1,004
TN load	kt N	89	87	76	89	89	94	94

c） *Uncertainties and Time-series Consistency*

- ***Uncertainties***

The level of uncertainty in the CH_4 emission factor was evaluated on the basis of expert judgment. The uncertainty in activity data was estimated to be 37.4% on the basis of the uncertainties in the amount of wastewater used, percentage of industrial wastewater treated at CH_4-generating facilities, percentage of wastewater treated on-site, and BOD concentration in runoff water provided by each middle classification industry. The uncertainties in the amount of wastewater used, percentage of industrial wastewater treated at facilities generating CH_4, and BOD concentration in runoff water were estimated by using statistical uncertainty. The uncertainty in the percentage of wastewater treated on-site was determined by expert judgment. The uncertainty level for N_2O is evaluated by the same method as was used for the CH_4 and estimated to be 300% and 51.1% for emission factor and activity data, respectively. The uncertainties in CH_4 and N_2O emissions from industrial wastewater handling were estimated to be 71% and 304%, respectively. For details, refer to the Annex 7.

- ***Time-series consistency***

Data on the percentage of industrial wastewater treated at CH_4- and N_2O-generating facilities since FY 2001 are available only for FY 2004. Therefore, data were interpolated and extrapolated for the remaining years. The emissions were calculated in a consistent manner.

d） *Source-specific QA/QC and Verification*

Tier 1 QC activities are implemented in accordance with the GPG (2000). The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） *Source-specific Recalculations*

Activity data for all the reporitng years were recalculated in order to ensure its time-series consistency because the industrial sub-category (Rev.12) was revised according to the revision of the *Japan Standard Industrial Clasification* in 2007.

f） *Source-specific Planned Improvements*

For future inventories, long-term efforts on further scientific investigations will be made to the following items:

- Improving the emission factors for emissions from industrial wastewater treatment for which currently the emission factors used for sewage treatment plants are substituted.
- Identifying the methodology for estimating emissions from landfill leachate treatment
- Determining the amount of CH_4 recovery from industrial wastewater treatment

8.3.2. Domestic and Commercial Wastewater (6.B.2.)

Domestic and commercial wastewater generated in Japan is treated at various wastewater treatment facilities (e.g., sewage treatment plants, septic tanks, human-waste treatment plants) and greenhouse gas emissions from these sources are reported under “Domestic and Commercial Wastewater (6.B.2.)”. Because the CH_4 and N_2O emission characteristics differ from one wastewater treatment facility to another, a different emission estimation method is established for each facility.

The characteristics, effectiveness, and economic efficiency of wastewater treatment systems were thoroughly reviewed, and the most suitable systems were selected for each area in Japan with care also being taken to avoid excessive expenditure. Public sewerage system is spreading from large cities to smaller municipalities and used by 67.5% of the population at the end of FY 2008.

Domestic wastewater treatment systems (e.g. *gappei shori jokasou*) are being promoted as an effective means of supplementing sewerage systems in smaller municipalities with low population densities and little flat land. In FY 2008, septic tanks (*jokasou*) were used by 22.9% of the population, with the remainder being treated after collection or on-site.

In CRF (6.B.2.), N_2O emissions from human waste treatment plants are reported in the subcategory “Human sewage (6.B.2.2)”, and other emissions are reported in “Domestic and Commercial (w/o human sludge) (6.B.2.1)”.

“NE” is reported on the CRF table for activity data instead of reporting the amount of organic carbon based on BOD values because the activity data for this source are estimated using a country-specific method by each gas and each wastewater treatment facility.

8.3.2.1. Sewage Treatment Plant (6.B.2.a)

a） *Source/Sink Category Description*

This category covers CH_4 and N_2O emissions from treatment of wastewater at sewage treatment plants.

b） *Methodological Issues*

- ***Estimation Method***

Emissions of CH_4 and N_2O from this source were calculated using Japan’s country-specific method in accordance with the decision tree of the *GPG (2000)* (Page 5.14, Fig. 5.2). Emissions were calculated by multiplying the volume of sewage treated at sewage treatment plants by the emission factor.

$$E = EF \times A$$

E :Amount of CH_4 or N_2O emitted from sewage treatment plants in conjunction with domestic/commercial wastewater treatment (kg CH_4, kg N_2O)
EF : Emission factor (kg CH_4/m^3, kg N_2O/m^3)
A : Yearly amount of sewage treated at a sewage treatment plant (m^3)

- ***Emission Factors***

Emission factors were established by adding the simple averages for each treatment process, having taken the actual volume of CH_4 and N_2O released from sludge treatment and water treatment processes measured at sewage treatment plants from research studies conducted in Japan (Refer to Reference #7).

CH_4 emission factor
= Average of emission factor for water treatment processes + 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]

<u>*N_2O emission factor*</u>
= Average of emission factor for water treatment processes + 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]

- ***Activity Data***

Activity data for CH_4 and N_2O 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 *Sewage Statistics (Admin. Ed.)* (Japan Sewage Works Association).

In order to avoid overestimates of activity data, volumes subject to primary processing was subtracted from the annual volume of water treated because CH_4 and N_2O emitted from this source are primarily emitted from biological reaction tanks although the annual volume of water treated as given in the *Sewage Statistics (Admin. Ed.)* (Japan Sewage Works Association) includes primary treatment volumes that are only subject to settling.

<u>Activity data</u>
= (Annual volume of water treated at sewage treatment plants) – (Annual input volume for primary processing at sewage treatment plants)

Table 8 - 16 Activity data for wastewater treated at sewage treatment plant

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Annual amount of wastewater treated	10^6m^3	9,857	10,392	12,519	13,407	13,534	13,963	12,813

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

The uncertainties in CH_4 and N_2O emission factors were estimated by using the 95% confidence interval of actual measurement data. The uncertainty in activity data was evaluated based on the annual throughput and annual primary treatment amount and estimated by using the statistical uncertainties. The uncertainties in CH_4 and N_2O emissions from sewage treatment plants were estimated to be 33% and 146%, respectively. For details, refer to the Annex 7.

- ***Time series consistency***

The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） Source-specific Recalculations

No recalculations were conducted.

f） Source-specific Planned Improvements

A revision of the emission factor for sewage treatment plants is planned owing to the high uncertainty.

8.3.2.2. Domestic Sewage Treatment Plant (mainly septic tanks) (6.B.2.b)

a） Source/Sink Category Description

A part of domestic and commercial wastewater not processed in the public sewerage in Japan is processed in *community plants*, *gappei-shori johkasou*, the *tandoku-shori johkasou*, and vaults. The *gappei-shori* and *tandoku-shori* are decentralized wastewater treatment facilities installed at an individual home. The *gappei-shori* processes feces and urine and miscellaneous wastewater, whereas *tandoku-shori* processes only feces and urine. A community plant is small-scale sewage facility, where urine and the miscellaneous wastewater of each region are processed.

Table 8 - 17 Type of sewage and sewage treatment

Sewage treatment type		Sewage type
Community plants	Small-scale wastewater treatment facility regionally established	Human waste and miscellaneous wastewater
Gappei-shori johkasou	Wastewater treatment unit installed at an individual household	Human waste and miscellaneous wastewater
Tandoku-shori johkasou	Wastewater treatment unit installed at an individual household	Human waste
Vaults	Installed at an individual household	Human waste

This category covers CH_4 and N_2O emissions from domestic sewage treatment plants. Emissions from human waste within its residence time in vault toilets were accounted for under this category, whereas the emissions that occur after the waste is collected from vault toilets were accounted for under "Human waste treatment facilities (6.B.2.c)".

b） Methodological Issues

● Estimation Method

Emissions of CH_4 and N_2O from this source were calculated using Japan's country-specific method, in accordance with decision tree the *GPG (2000)* (Page 5.14, Fig. 5.2). Emissions were calculated by multiplying the annual population of treatment for each type of domestic sewage treatment plant by the emission factor.

$$E = \sum \left(EF_i \times A_i \right)$$

E : Emissions of methane and nitrous oxide from the processing of domestic and commercial wastewater at domestic sewage treatment plants (i.e. household septic tanks) (kg CH_4, kg N_2O)

EF_i : Emission factor for domestic sewage treatment plant *i* (kg CH_4/person, kg N_2O/person)

A : Population (persons) requiring waste processing at domestic sewage treatment plant *i* per year

● Emission Factors

The CH_4 and N_2O emission factors for this source were determined as described below:

- For the CH_4 emission factor for community plants by FY1995, the values indicated in Tanaka, (1998) were used. For the values from FY2005 onwards, the values indicated in Souda (2010) were used taking into account the performance improvement in the plants. The values for FY1996 through FY2004 were interpolated.

- For the N_2O emission factor for community plants by FY1995, the mean values of the upper limit and the lower limit of actual measured values indicated in Tanaka (1997) were used. For the values from FY2005 onwards, the values indicated in Ike and Souda (2010) were used taking into account the performance improvement of the plants. The values for FY1996 through FY2004 were interpolated.

- For the CH_4 and N_2O emission factors for gappei-shori johkasou, the mean values of the upper limit and the lower limit of actual measured values indicated in Tanaka et al. (1998) were used.

- For the CH_4 and N_2O emission factors for tandoku-shori johkasou, the mean value of the upper limit and the lower limit of actual measured values indicated in Takeishi et al., (1993), and Takeishi et al., (1994) were used.

- For the CH_4 and N_2O emission factors for vault toilets, the same values as that used for tandoku-shori johkasou were applied because the detention period of human waste is very similar.

Table 8 - 18 CH_4 Emission factors for domestic sewage treatment plants

Item	CH_4 Emission factor [kg CH_4 /person-year]		
	FY 1990-1995	FY 1996-2004	FY2005-
Community plants	0.195	Calculated by interpolation using the values of FY1995 and FY 2005	0.062
Gappei-shori johkasou	1.106		
Tandoku-shori johkasou	0.197		
Vault toilets	0.197		

Table 8 - 19 N_2O emission factor for domestic sewage treatment plants

Item	N_2O Emission factor [kg N_2O-N// person-year]		
	FY 1990-1995	FY 1996-2004	FY2005-
Community plants	0.0394	Calculated by interpolation using the values of FY1995 and FY 2005	0.0048
Gappei-shori johkasou	0.0264		
Tandoku-shori johkasou	0.0200		
Vault toilets	0.0200		

● *Activity Data*

Annual treatment population by type of domestic sewage treatment plant for community plants, *gappei-shori johkasou, tandoku-shori johkasou*, and vault toilets given in the *Waste Treatment in Japan* was used as the activity data for CH_4 and N_2O emitted in association with domestic wastewater treatment facilities.

Table 8 - 20 Annual treatment population by type of domestic sewage treatment plant (1,000 persons)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Community plant	1000 person	493	398	414	554	336	416	297
Gappei-shori johkasou	1000 person	7,983	8,515	10,806	12,770	13,939	13,854	13,792
Tandoku-shori johkasou	1000 person	25,119	26,105	23,289	18,303	15,923	15,413	14,712
Vault toilet	1000 person	38,920	29,409	20,358	13,920	12,121	11,301	10,671
Total	1000 person	72,515	64,427	54,867	45,547	42,319	40,984	39,472

c） Uncertainties and Time-series Consistency

● Uncertainties

The level of uncertainty in the emission factor was evaluated for each treatment facility taking into account the actual measurement data and setting methods. The following data were used:

- The 95% confidence interval of actual measurement data: gappei-shori (N_2O) and tandoku-shori (CH_4 and $_2O$)
- The upper and lower limits of actual measurement data: community plants (CH_4) and gappei-shori (CH_4)
- The values set by the Committee for GHGs Emissions Estimation Methods: community plants (N_2O) and vault toilets (CH_4 and N_2O)

The uncertainty in activity data was evaluated based on the uncertainties in treatment population for each type of treatment facilities by using the statistical uncertainty (10%). The uncertainties in CH_4 and N_2O emissions from domestic wastewater treatment (mainly septic tanks) were estimated to be 87% and 72%, respectively. For details, refer to the Annex 7.

● Time series consistency

The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） Source-specific Recalculations

Because of the update on the activity data for FY 2008, emission estimates were recalculated.

f） Source-specific Planned Improvements

No improvements are planned.

8.3.2.3. Human-Waste Treatment Plant (6.B.2.c)

a） Source/Sink Category Description

This category covers emissions of CH_4 and N_2O emissions from treatment of vault toilet human waste and septic tank sludge collected at human waste treatment plants.

b） Methodological Issues

1） CH_4

Estimation Method

Emissions of CH_4 from this source were calculated using Japan’s country-specific methodology in accordance with decision tree of the *GPG (2000)* (Page 5.14, Fig. 5.2). Emissions were calculated by multiplying the volume of domestic wastewater treated at human waste treatment plants by the emission factor.

$$E = \sum \left(EF_i \times A_i \right)$$

E : Emission of methane from the processing of domestic and commercial wastewater at human waste treatment plants (kg CH_4)
EF_i : Emission factor for human waste treatment plants (for treatment process i) (kg CH_4/m^3)
A_i : Input volume of human waste and septic tank sludge at human waste treatment plants (for treatment process i) (m^3)

Emission factors

Emission factors for CH_4 were determined by treatment processes type, including anaerobic, aerobic, standard denitrification and high-load denitrification treatments as well as membrane separation systems, for each of the human waste treatment plants (Refer to Reference #7).

Table 8 - 21 CH_4 emission factors by each treatment process

Treatment method	CH_4 emission factor [kg CH_4/m^3]	Data source
Anaerobic treatment	0.543	Estimated by multiplying the actual methane emissions given in Reference #35 by the value of 1 – CH_4 recovery rate (90%).
Aerobic treatment	0.00545	Simple average value of standard de-nitrification and high-load de-nitrification since actual data on emissions is not available.
Standard de-nitrification treatment	0.0059	Reference #62
High load de-nitrification treatment	0.005	Reference #62
Membrane separation	0.00545	Because the current status of its emissions is not identified, substituted the emission factor for aerobic treatment.
Other	0.00545	Because the current status of its emissions is not identified, substituted the emission factor for aerobic treatment.

Activity Data

Activity data for CH_4 emissions associated with the processing of wastewater at human waste treatment plants was determined from the calculated throughput volume for each of the treatment processes (Table 8-22), by multiplying the total volume of human waste and septic tank sludge processed at human waste treatment plants that were indicated in *Waste Treatment in Japan* (Table 8-23) by the capacity of each treatment process (Table 8-24).

Activity data for human waste treatment method i
= (Total amount of human waste and septic tank sludge by treatment method i) ×
(Capacity of waste treatment method i) / (Total capacity of all waste treatment methods)

Table 8 - 22 Volume of human waste and septic tank sludge treated at their treatment plants

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Vault toilet	1000 kl/year	20,406	18,049	14,673	10,400	9,261	8,894	8,353
ST sludge	1000 kl/year	9,224	11,545	13,234	13,790	13,987	14,064	13,989
Total	1000 kl/year	29,630	29,594	27,907	24,190	23,248	22,958	22,342

Source: *Waste Treatment in Japan*

Table 8 - 23 Trends in treatment capacity by treatment process

Unit	Unit	1990	1995	2000	2005	2007	2008	2009
Anaerobic treatment	kl/day	34,580	19,869	10,996	6,476	4,801	4,444	4,144
Aerobic treatment	kl/day	26,654	19,716	12,166	8,465	7,892	7,535	6,961
Standard denitrification	kl/day	25,196	30,157	31,908	29,655	28,102	27,737	27,748
High-intensity denitrification	kl/day	8,158	13,817	16,498	17,493	15,784	14,938	16,285
Membrane separation	kl/day	0	1,616	2,375	3,055	3,861	3,650	3,573
Other	kl/day	13,777	20,028	25,917	30,277	33,115	35,441	34,654

Table 8 - 24 Activity Data for human waste by treatment type

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Anaerobic treatment	1000 kl/year	9,455	5,589	3,073	1,642	1,193	1,088	992
Aerobic treatment	1000 kl/year	7,288	5,546	3,400	2,146	1,961	1,845	1,666
Standard denitrification	1000 kl/year	6,889	8,483	8,917	7,518	6,983	6,793	6,640
High-intensity denitrification	1000 kl/year	2,231	3,887	4,611	4,435	3,922	3,658	3,897
Membrane separation	1000 kl/year	0	455	664	774	959	894	855
Other	1000 kl/year	3,767	5,634	7,243	7,676	8,229	8,679	8,293
Total	1000 kl/year	29,630	29,594	27,907	24,190	23,248	22,958	22,343

2） N_2O

- ***Estimation Method***

Emissions of N_2O from this source were calculated using Japan’s country-specific methodology, in accordance with decision tree of the *GPG (2000)* (Page 5.14, Fig. 5.2). Emissions were calculated by multiplying the volume of nitrogen treated at human waste treatment plants, by the emission factor.

$$E = \sum \left(EF_i \times A_i \right)$$

E Emission of nitrous oxide from the processing of domestic and commercial wastewater at human waste treatment plants (kg N_2O)
EF_i : Emission factor for human waste treatment plants (by treatment process *i*) (kg N_2O/kg N)
A_i Amount of nitrous oxide in human waste and septic tank sludge input at human waste treatment plants (by treatment process *i*) (kg N)

- ***Emission factors***

The emission factors for N_2O were determined for each treatment process including high-load denitrification treatment and membrane separation systems using the results of actual case studies in

Japan (Refer to Reference #7).

According to the survey study on the emission factors for human waste treatment facilities conducted in FY1994 (Tanaka et al., 1997) and FY2003 (Ohmura et al., 2004) in Japan, because of the advancement of the structure of human waste treatment facilities and the technology of operation and maintenance, actual measurement results show the improvement in the emission factors for high load de-nitrification treatment and membrane separation; therefore, different emission factors were used for FY1994 or before and from FY2003 onwards.

Table 8 - 25 Nitrous oxide emission factors by each treatment process

Treatment method	N_2O emission factors [kg N_2O-N/kg-N]		
	FY1990-1994	FY1995-2002	FY2003 -
High load de-nitrification treatment	0.033[a]	Calculated by interpolation using the values of FY1994 and FY 2003	0.0029[b]
Membrane separation	0.033[a]	Calculated by interpolation using the values of FY1994 and FY 2003	0.0024[b]
Other (including anaerobic treatment, aerobic treatment, standard de-nitrification treatment)	0.0000045[c]		

a) Use median value of actual measurements at 13 plants given in Reference #63

b) Use median value of actual measurements at 13 plants given in Reference #56

c) Referred to Reference #62

Note: Calculated by dividing upper limit value for standard de-nitrification treatment (0.00001kg N2O/m^3) by treated nitrogen concentration in FY1994 (2,211mg/L).

● *Activity Data*

The volume of nitrogen treated at human waste treatment plants was calculated by multiplying treated nitrogen concentration by the volume of human waste treated at these facilities (the sum of collected human waste and sewage in sewerage tank), given in the *Waste Treatment in Japan*. The treated nitrogen concentration is based on weighted average of the volume of nitrogen contained in collected human waste and sewage in sewerage tank derived using the volume of collected human waste and sewage in sewerage tank treated at human waste treatment plants.

Activity data
= [(Input volume of human waste at human waste treatment plants) × (Nitrogen concentration in human waste) + (Input volume of septic tank sludge at human waste treatment plants) × (Nitrogen concentration in septic tank sludge)] × (percentage throughput of treatment process *i*)

➢ *Input volume of human waste and septic tank sludge at human waste treatment plants:*

Refer to the data used for the calculation of CH_4 emissions from human waste treatment plants (Table 8-22).

➢ *Percentage throughput of the human waste treatment processes:*

Refer to the data used for the calculation of CH_4 emission from human waste treatment plants (Table8-23).

➢ *Nitrogen concentration in human waste and septic tank sludge input at treatment plants:*

For the nitrogen concentration in human waste and septic tank sludge input at treatment plants, the values analyzed for the period FY 1989 - FY 1991, FY 1992 - FY 1994, FY1995 – FY1997. and FY

1998 - FY 2000, respectively, were used based on the research conducted by Okazaki (2001). The value of FY 2000 was substituted for the values from FY 2001 onward. (See Table 8-26).

Table 8 - 26 Concentration of nitrogen contained in collected human waste and sewage in sewerage tank

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Vault toilet	mg N/l	3,940	3,100	2,700	2,700	2,700	2,700	2,700
ST sludge	mg N/l	1,060	300	580	580	580	580	580
Weighted average	mg N/l	3,043	2,008	1,695	1,491	1,425	1,401	1,373

Table 8 - 27Activity data:
Amount of nitrogen in human waste processed at human waste treatment plants and septic tank sludge

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Anaerobic treatment	kt N	28.8	11.2	5.2	2.4	1.7	1.5	1.4
Aerobic treatment	kt N	22.2	11.1	5.8	3.2	2.8	2.6	2.3
Standard denitrification	kt N	21.0	17.0	15.1	11.2	9.9	9.5	9.1
High-intensity denitrification	kt N	6.8	7.8	7.8	6.6	5.6	5.1	5.3
Membrane separation	kt N	0	0.9	1.1	1.2	1.4	1.3	1.2
Other	kt N	11.5	11.3	12.3	11.4	11.7	12.2	11.4
Total	kt N	90.2	59.4	47.3	36.1	33.1	32.2	30.7

c） Uncertainties and Time-series Consistency

● *Uncertainties*

The level of uncertainty in the CH_4 emission factor was evaluated by using the default values set by the Committee for GHGs Emissions Estimation Methods for each type of human waste treatment method (anaerobic treatment, aerobic treatment, standard denitrification, high-intensity denitrification, membrane separation, and other). The uncertainty in the activity data for CH_4 is associated with uncertainties in the amount of human waste and septic tank sludge that entered human waste treatment facilities and the throughput capacity rate by type of human waste treatment. The uncertainties for each component were estimated by using the statistical uncertainties. The uncertainty level in N_2O emission factors was also evaluated by treatment type. For high-intensity denitrification and membrane separation, the 95% confidence interval of actual measurement data on emission factors was used. For other treatments, the default values set by the Committee for GHGs Emissions Estimation Methods were used. The uncertainty in activity data for N_2O was estimated by using the uncertainties in nitrogen concentration in human waste and septic tank sludge that determined from the standard deviations in actual measurement data, in addition to the components of uncertainty for CH_4. The uncertainties in CH_4 and N_2O emissions from human waste treatment were estimated to be 101% and 106%, respectively. For details, refer to the Annex 7.

● *Time series consistency*

For N_2O emission factor, consistent data over the time series were constructed based on the actual measurement data by using the methods described in Table 8-25. For other parameters, data were constructed consistently for the entire time series. The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the GPG (2000). The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） Source-specific Planned Improvements

Because of the revision on the activity data for FY2005 and the update on the activity data for FY2008, the emission estimates for the said years were recalculated.

f） Source-specific Planned Improvements

No improvements are planned.

8.3.2.4. Emission from the Natural Decomposition of Domestic Wastewater (6.B.2.d)

a） Source/Sink Category Description

Although most of the domestic wastewater generated by Japanese households is processed at wastewater treatment plants, some is discharged untreated into public waters. The amounts of CH_4 and N_2O decomposes and emitted from this source are reported under this category.

b） Methodological Issues

- ***Estimation Method***

Estimation method was established in accordance with the method described in the 2006 IPCC Guidelines. In the natural decomposition of wastewater, both the volume of organic matter extracted as sludge and recovered CH_4 were zero. Accordingly, CH_4 emissions were calculated by multiplying the volume of organic matter contained in the untreated domestic wastewater that was discharged into public waters by the emission factor. The N_2O emission was calculated by multiplying the volume of nitrogen contained in the wastewater by the emission factor.

$$E = EF \times A$$

E : Emission of methane or nitrous oxide from the natural decomposition of domestic wastewater (kg CH_4; kg N_2O)

EF : Emission factor (kg CH_4/kg BOD; kg N_2O/kg N)

A : Volume of organic matter (kg BOD) or nitrogen (kg N) in domestic wastewater

- ***Emission factors***

Emission factors were determined in accordance with the *2006 IPCC Guidelines*. The emission factor for CH_4 was established by multiplying the maximum CH_4 generation potential (B_0) by a CH_4 conversion factor (MCF). The maximum CH_4 generation potential was set to 0.6 kg CH_4/kg BOD, given in the *2006 IPCC Guidelines*, and the MCF was set to 0.1, a default value for “Sea, river and lake discharge” of “Untreated systems”.

$$\begin{aligned} EF_{\mathrm{CH4}} &= B_0 \times MCF \\ &= 0.6\ (\mathrm{kg\ CH_4/kg\ BOD}) \times 0.1 \\ &= 0.06\ (\mathrm{kg\ CH_4/kg\ BOD}) \end{aligned}$$

The emission factor for N_2O was calculated from the value of 0.005 kg N_2O-N/kg N after conversion of the units.

$$EF_{N2O} = 0.005\ (\text{kg } N_2O\text{-N/kg N}) \times 44/28$$
$$= 0.0079\ (\text{kg } N_2O\text{/kg N})$$

- ***Activity Data***

Activity data to be calculated are the following sources:

- Domestic wastewater from households using tandoku-shori johkasou
- Domestic wastewater from households using Vault toilets
- Domestic wastewater from households using on-site disposal systems
- Human waste and septic tank sludge dumped into the ocean
- Sewage sludge dumped into the ocean

Definition for each activity data is provided as in Table 8-28. Estimated activity data are shown in Table 8-29

Table 8 - 28 Calculation method for activity data used for the calculation of GHG emissions from the natural decomposition of domestic wastewater

Item	Methane emission activity data	Nitrous oxide emission activity data
Tandoku-shori johkasou	User population (persons) × Unit BOD from domestic wastewater (g BOD/person·day）	User population (persons) × Unit nitrogen from domestic wastewater (g N/person·day）
Vault toilet		
On-site disposal [*]	Population using on-site disposal system (person) × Unit BOD from domestic wastewater (g BOD/person·day）	Population using on-site disposal system (person) × Unit nitrogen from domestic wastewater (g N/person·day)
Ocean dumping (Human waste)	Human waste dumped in ocean (kL) × BOD concentration in human waste (mg BOD/L) + septic tank sludge dumped in ocean (kL) × BOD concentration in septic tank sludge (mg BOD/L)	Human waste dumped in ocean (kL) × nitrogen concentration in septic tank sludge (mg N/L) + septic tank sludge dumped in ocean (kL) × nitrogen concentration in septic tank sludge (mg N/L)
Ocean dumping (Sewage sludge)	Sewage sludge dumped in ocean (kL) × BOD concentration in sewage sludge (mg BOD/L)	Sewage sludge dumped in ocean (kL) × nitrogen concentration in sewage sludge (mg N/L)

Source:
- Volumes for *tandoku-shori johkasou*, vault toilets, on-site disposal systems and ocean dumping: Reference #8
- Unit BOD and unit nitrogen from domestic wastewater: Reference #42
- BOD concentration and nitrogen concentration in human waste and septic tank sludge: Reference #55

* A portion of the human waste in on-site disposal systems is utilized as fertilizer on farmlands in Japan. The nitrous oxide emission from this portion of human waste is already included in the "Direct emission from soil (4.D.)" category in the Agriculture section, and therefore, not included in the calculation for this source.

Table 8 - 29 Activity data:
Amount of organic material and nitrogen in domestic wastewater untreated
and discharged into public water body

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Tandoku-shori	kt BOD	366.7	381.1	341.0	267.2	232.5	225.6	214.8
Vault toilet	kt BOD	568.2	429.4	298.0	203.2	177.0	165.4	155.8
On-site disposal	kt BOD	46.2	21.0	9.4	3.9	2.7	7.6	2.0
Ocean dumping (Human waste)	kt BOD	21.7	13.5	9.3	3.5	0	0	0
Ocean dumping (sewege sludge)	kt BOD	0.8	0.9	0.0	0	0	0	0
Total	kt BOD	1,002.9	845.1	657.7	477.8	412.1	398.7	372.6

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Tandoku-shori	kt N	18.3	19.1	17.0	13.4	11.6	11.3	10.7
Vault toilet	kt N	28.4	21.5	14.9	10.2	8.8	8.3	7.8
On-site disposal	kt N	2.3	1.1	0.5	0.2	0.1	0.4	0.1
Ocean dumping (Human waste)	kt N	7.2	3.2	2.2	0.8	0	0	0
Ocean dumping (sewege sludge)	kt N	0.1	0.1	0.0	0	0	0	0
Total	kt N	56.3	44.7	34.6	24.5	20.6	19.9	18.6

c） Uncertainties and Time-series Consistency

● *Uncertainties*

The level of uncertainty in the CH_4 emission factor was estimated by using the uncertainties in the maximum CH_4 generation potential and the CH_4 correction factor. The default value in the *2006 IPCC Guidelines* was used for uncertainty in the N_2O emission factor. The uncertainties in activity data were evaluated for *tandoku-shori*, vault toilets, on-site disposal (determined from the wastewater treatment population and unit BOD or nitrogen in domestic wastewater) and ocean dumping (amount of human waste and septic tank sludge dumped into ocean, and concentration of organic matter or nitrogen in human waste and septic tank sludge). The methods of evaluation of the uncertainty levels for each component are:

- Use of the default values in the 2006 IPCC Guidelines: maximum CH4 generation potential and CH_4 correction factor

- Based on expert judgment: unit BOD and nitrogen in domestic wastewater

- Use of 95% confidence interval of actual measurement data: concentrations of organic matter and nitrogen in human waste and septic tank sludge

- Use of the statistical uncertainties: wastewater treatment population, amount of human waste and septic tank sludge dumped into ocean

The uncertainties in CH_4 and N_2O emissions from natural decomposition of domestic wastewater were estimated to be 76%. For more details, refer to the Annex 7.

● *Time series consistency*

The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） Source-specific Recalculations

Because of the update on the activity data for FY 2008, the emission estimates for FY 2008 were recalculated.

f） Source-specific Planned Improvements

No improvements are planned.

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

a） Source/Sink Category Description

In Japan, CH_4 emissions generated from sludge digestion at sewage treatment plants and human waste treatment facilities are recovered.

CH_4 emissions generated by anaerobic wastewater treatment are entirely recovered. A small amount of CH_4 emission generated under aerobic conditions is estimated with a country-specific emission factor. These recovered CH_4 emissions treating domestic and commercial wastewater explained in this section are not estimated by the methodology indicated in the *GPG (2000)* and not included in emission estimates.

Therefore, for reference purpose only, the amount of CH_4 recovered treating domestic and commercial wastewater at sewage treatment plants and human waste treatment facilities are reported in this section.

b） Methodological Issues

1） Methane Recovery at Sewage Treatment Plants

- **Estimation Method**

The amount of CH_4 recovered from sludge digesters at sewage treatment plants is calculated by multiplying the amount of digester gas (volumetric basis) recovered from digesters by an emission factor that takes into account the concentration of CH_4 in digester gas.

$$R = A \times EF$$

R : Amount of recovered CH_4 at final disposal site (Gg CH_4)
A : Amount of generated digester gas (m^3)
EF : Emission factor (Gg CH_4 /m^3)

- **Emission factors**

Emission factor is set by finding the weight equivalent of the average CH4 concentration in digester gas.

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

EF : Emission factor (Gg CH_4 /m^3)

F_{CH4} : Concentration of methane in digester gas (volumetric basis)

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

- ***Activity Data***

The amount of digester gas recovered from sludge digesters at sewage treatment plants is provided by “amount of digester gas generated by sludge treatment facilities” in the *Sewage Statistics (Admin. Ed.)* (Japan Sewage Works Association). Because entire digester gas generated at sewage treatment plants in Japan is recovered, the total amount of generated digester gas is treated as the amount of digester gas recovered. The amount of digester gas used for energy to be included in the energy category is determined from the amount of digester gas listed in “amount of digester gas used in sludge digester facilities” of the *Sewerage Statistics*.

Table 8 - 30 Amount of CH_4 recovered from sewage treatment plant sludge digesters (Gg- CH_4)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Recovered CH_4 amount	Gg CH_4	88.7	110.5	113.3	122.0	134.1	130.3	130.9
Portion used as energy	Gg CH_4	65.3	73.9	75.3	85.0	93.0	93.2	92.4

2） Methane Recovery from Human Waste Treatment Facilities

- ***Estimation Method***

The amount of CH_4 recovery at human waste treatment facilities was obtained by multiplying the amount of recycled biogas at human waste treatment facilities on a volumetric basis by the emission factor taking into account CH_4 concentration in biogas.

$$R = A \times EF$$

R : Amount of CH_4 recovered at human waste treatment facilities（Gg CH_4）

A : Amount of Recycled Biogas（m^3）

EF : Emission Factor（Gg CH_4 /m^3）

- ***Emission Factors***

Emission factor was determined by taking into account CH_4 concentration in biogas and molecular weight conversion. CH_4 concentration in biogas was determined to be 60% referring to the *JARUS Reference System for Information of Biomass Recycling Technology* (The Japan Association of Rural Resource Recycling Solutions). Because statistical data are aggregated on a volumetric basis, they are converted into molecular weight given the average temperature at the facilities is 18℃.

$$EF = F_{CH4} \times 16 / 22.4 \times 273 / (273 + 18)$$

EF : Emission factor（Gg CH_4 /m^3）

F_{CH4} : CH_4 concentration in biogas（volumetric basis）

- ***Activity Data***

For the activity data on CH_4 recovery at human waste treatment facilities, the aggregated amount of recycled biogas at human waste treatment facilities (volumetric basis) provided by *the State of Municipal Waste Treatment Survey*, Ministry of the Environment, Waste Management and Recycling Department was used. The statistical data before FY2005 are not obtained. Therefore, the emissions for FY2004 and before were estimated by applying the amount of CH_4 actually recovered in FY 2005 and in the year that facilities started their operation provided by this survey and in FY 2005, and also using the amount of human waste (vault toilet) and septic tank sludge treated at the facilities for FY 2004 and before.

Table 8 - 31 Amount of CH_4 recovered at human waste treatment facilities

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Recovered CH_4 amount	Gg CH_4	0.3	0.5	0.8	0.9	1.4	1.6	1.7

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

The assessment was not conducted, as the amount of CH_4 recovered is reported as a reference value.

- ***Time series consistency***

The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） Source-specific Recalculations

No recalculations were made.

f） Source-specific Planned Improvements

No improvements are planned.

8.4. Waste Incineration (6.C.)

In Japan, waste disposed of has been reduced in volume primarily by incineration. Emissions from waste incineration are categorized as shown in Table 8-32. CO_2, CH_4, N_2O emissions without energy recovery are allocated to this category. Also, waste incineration includes the following practices of waste used as raw material or fuel:

- Energy recovery from waste incineration
- Waste material is used directly as fuel
- Waste material is converted into fuel

Estimated emissions from the sources listed above are allocated to the “Fuel Combustion (Category

1.A.)" in accordance with the *Revised 1996 IPCC Guidelines* and the *GPG (2000)*.

In order to avoid double-counting or any other confusion, emissions from the categories indicated in Table 8-32 with or without energy use were estimated collectively under the waste sector, thus the estimation methodology for these categories are provided in this section.

Table 8 - 32 Categories for the calculation of emissions from waste incineration (6.C.)

Incineration	Waste category	Estimation classification	Category to be allocated to	CO_2	CH_4	N_2O
Waste incineration (without energy recovery)	Municipal solid waste	Plastic	6.C.1	○	○ Estimated in bulk	○ Estimated in bulk
		Synthetic textile	6.C.1	○		
		Other (biogenic)	6.C.1			
	Industrial solid waste	Waste oil	6.C.2	○	○	○
		Waste plastic	6.C.2	○	○	○
		Other (biogenic)	6.C.2		○	○
	Specially controlled industrial waste	Waste oil	6.C.3	○	○	○
		Infectious waste (plastic)	6.C.3	○	○	○
		Infectious waste except plastic (biogenic)	6.C.3		○	○
Waste incineration with energy recovery	Municipal solid waste	Plastic	1.A.1	○	○ Estimated in bulk	○ Estimated in bulk
		Synthetic textile	1.A.1	○		
		Other (biogenic)	1.A.1			
	Industrial solid waste	Waste oil	1.A.1	○	○	○
		Waste plastic	1.A.1	○	○	○
		Other (biogenic)	1.A.1		○	○
Direct use of waste as fuel	Municipal solid waste	Plastic	1.A.1/2	○	○	○
	Industrial solid waste	Waste oil	1.A.2	○	○	○
		Waste plastic	1.A.2	○	○	○
		Waste wood	1.A.2		○	○
	Waste tire	Fossil origin	1.A.1/2	○	○	○
		Biogenic origin	1.A.1/2			
Use of waste processed as fuel	Refuse derived fuel (RDF・RPF)	Fossil origin	1.A.1/2	○	○	○
		Biogenic origin	1.A.1/2			

* CO2 emissions from the incineration of biomass-derived waste (including biomass-based plastics and waste animal and vegetable oil) is not included in the total emissions in accordance with the Revised 1996 IPCC Guidelines; instead it is estimated as a reference value and reported under " Biogenic" in Table 6.A,C of the CRF.

Estimated greenhouse gas emissions from waste incineration (category 6.C.) are shown in Table 8-33. In FY 2009, emissions from waste incineration were 15,632 Gg-CO2 eq. and accounted for 1.3% of the national total emissions (excluding LULUCF). The emissions from this source category decreased by 13.3% compared to those in FY 1990. For the period FY1990-FY1997, CO2 emissions increased as the practice of intermediate treatment by waste incineration increased in order to decrease the total volume of waste landfilled. From FY2001 onwards, as the use of waste as raw material or fuel has been replacing the incineration of fossil-origin waste for intermediate treatments, and these CO2emissons which used to be allocated to the waste sector is now allocated to the Energy sector, CO2 emission estimates from the waste sector decreased.

On the other hand, N_2O emissions increased compared to FY1990 level due to the increase in sewage sludge incineration practice for the period FY 1990 - FY1997. From FY2005 onward, N_2O emissions from this source decreased because the practice of high temperature incineration of sewage sludge increased.

Table 8 - 33 GHG emissions from waste incineration (6.C.)

Gas	Waste category	Estimation Category	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	Municipal solid waste	Plastics	Gg CO_2	5,041	5,031	5,222	3,060	2,418	2,306	2,913
		Synthetic textiles	Gg CO_2	503	539	421	428	447	421	571
		Other (biogenic)	Gg CO_2							
	Industrial solid waste	Waste oil	Gg CO_2	3,652	4,344	4,775	4,249	4,112	4,616	3,969
		Waste plastics	Gg CO_2	2,120	4,516	4,358	4,311	4,549	4,874	4,646
		Other (biogenic)	Gg CO_2							
	Specially controlled waste	Waste oil	Gg CO_2	748	1,110	1,636	1,504	1,463	1,647	1,416
		Infectious plastics	Gg CO_2	198	327	426	433	459	492	469
		Infectious waste (except plastics; biogenic)	Gg CO_2							
	Total		Gg CO_2	12,263	15,867	16,838	13,984	13,448	14,356	13,984
CH_4	Municipal solid waste		Gg CH_4	0.464	0.431	0.381	0.064	0.063	0.059	0.060
	Industrial solid waste	Waste oil	Gg CH_4	0.006	0.007	0.008	0.006	0.006	0.007	0.006
		Waste plastics	Gg CH_4	0.025	0.053	0.051	0.014	0.014	0.015	0.015
		Other (biogenic)	Gg CH_4	0.140	0.207	0.181	0.541	0.449	0.427	0.402
	Specially controlled waste	Waste oil	Gg CH_4	0.001	0.002	0.003	0.002	0.002	0.002	0.002
		Infectious plastics	Gg CH_4	0.002	0.004	0.005	0.001	0.001	0.002	0.001
		Infectious waste (except plastics; biogenic)	Gg CH_4	0.002	0.004	0.005	0.051	0.054	0.058	0.056
	Total		Gg CH_4	0.642	0.708	0.635	0.679	0.591	0.570	0.542
			Gg CO_2 eq	13.481	14.868	13.333	14.267	12.404	11.977	11.383
N_2O	Municipal solid waste		Gg N_2O	1.025	1.049	0.979	0.525	0.511	0.472	0.485
	Industrial solid waste	Waste oil	Gg N_2O	0.015	0.018	0.021	0.098	0.095	0.107	0.092
		Waste plastics	Gg N_2O	0.149	0.318	0.307	0.025	0.026	0.028	0.027
		Other (biogenic)	Gg N_2O	3.692	5.074	5.943	6.062	5.152	4.943	4.627
	Specially controlled waste	Waste oil	Gg N_2O	0.003	0.005	0.007	0.032	0.031	0.035	0.030
		Infectious plastics	Gg N_2O	0.014	0.023	0.030	0.003	0.003	0.003	0.003
		Infectious waste (except plastics; biogenic)	Gg N_2O	0.002	0.004	0.005	0.018	0.019	0.020	0.019
	Total		Gg N_2O	4.901	6.491	7.290	6.762	5.836	5.608	5.282
			Gg CO_2 eq	1,519	2,012	2,260	2,096	1,809	1,738	1,637
Total of all gases			Gg CO_2 eq	13,796	17,894	19,111	16,095	15,269	16,106	15,632

* CO2 emissions from the incineration of biomass-derived waste (including biomass-based plastics and waste animal and vegetable oil) is not included in the total emissions in accordance with the Revised 1996 IPCC Guidelines; instead it is estimated as a reference value and reported under " Biogenic" in Table 6.A,C of the CRF.

For reference, the greenhouse gas emissions from waste incineration for energy purpose and with energy recovery are shown in Table 8-34. In FY 2009, the emissions from waste incineration including these sources were 30,455 Gg-CO_2, and it accounts for 2.5% of Japan's total greenhouse gas emissions (excluding LULUCF). The emissions from this sources category had increased by 30.4% compared to those in FY 1990.

Table 8 - 34

Total GHG emissions from incineration of waste (reference value) including emissions from waste incineration for energy use and energy recovery

Gas	Waste category	Estimation Category	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	Waste incineration without energy recovery (simple incineration)		Gg CO_2	12,263	15,867	16,838	13,984	13,448	14,356	13,984
	Municipal solid waste	Plastics	Gg CO_2	5,857	6,309	8,188	6,611	5,007	4,989	5,692
		Synthetic textiles	Gg CO_2	585	676	660	925	925	912	1,115
		Other (biogenic)	Gg CO_2							
	Industrial solid waste	Waste oil	Gg CO_2	21	30	28	108	104	117	101
		Waste plastics	Gg CO_2	31	65	187	306	353	378	360
		Other (biogenic)	Gg CO_2							
	Municipal solid waste	Plastics	Gg CO_2	0	0	91	507	439	368	411
	Industrial solid waste	Waste oil	Gg CO_2	2,019	2,504	2,345	3,602	3,858	3,677	2,955
		Waste plastics	Gg CO_2	54	36	446	1,203	1,368	1,325	1,418
		Waste wood	Gg CO_2							
	Waste tire	Fossil origin	Gg CO_2	524	841	1,039	865	993	1,023	946
		Biogenic origin	Gg CO_2							
	Refuse derived fuel (RDF, RPF)	Fossil origin	Gg CO_2	26	41	159	996	1,372	1,361	1,392
		Biogenic origin	Gg CO_2							
	Total		Gg CO_2	21,379	26,369	29,980	29,107	27,867	28,504	28,374
CH_4	Waste incineration without energy recovery (simple incineration)		Gg CH_4	0.64196	0.70800	0.63491	0.67938	0.59067	0.57035	0.54206
	Municipal solid waste		Gg CH_4	0.53965	0.54072	0.59747	0.13829	0.13138	0.12779	0.11812
	Industrial solid waste	Waste oil	Gg CH_4	0.00004	0.00005	0.00005	0.00016	0.00016	0.00017	0.00015
		Waste plastics	Gg CH_4	0.00036	0.00077	0.00221	0.00096	0.00110	0.00118	0.00113
		Other (biogenic)	Gg CH_4	0.00039	0.00118	0.00130	0.00828	0.00819	0.00779	0.00733
	Municipal solid waste	Plastics	Gg CH_4	0	0	0.00003	0.00005	0.00003	0.00002	0.00005
	Industrial solid waste	Waste oil	Gg CH_4	0.01183	0.01626	0.01895	0.02657	0.02853	0.02597	0.02262
		Waste plastics	Gg CH_4	0.00025	0.00016	0.03922	0.11568	0.15632	0.16363	0.16861
		Waste wood	Gg CH_4	1.75918	1.75918	2.21808	2.88749	3.27682	3.67697	4.00891
	Waste tire	Fossil origin	Gg CH_4	0.03095	0.07576	0.09914	0.08004	0.06641	0.06352	0.05091
	Refuse derived fuel (RDF, RPF)	Fossil origin	Gg CH_4	0.00008	0.00012	0.00056	0.00595	0.00651	0.01004	0.01193
	Total		Gg CH_4	2.98468	3.10221	3.61191	3.94285	4.26612	4.64742	4.93181
			Gg CO_2 eq	63	65	76	83	90	98	104
N_2O	Waste incineration without energy recovery (simple incineration)		Gg N_2O	4.90142	6.49081	7.29001	6.76181	5.83638	5.60777	5.28206
	Municipal solid waste		Gg N_2O	1.19113	1.31566	1.53434	1.13358	1.05811	1.02089	0.94718
	Industrial solid waste	Waste oil	Gg N_2O	0.00009	0.00013	0.00012	0.00248	0.00241	0.00271	0.00233
		Waste plastics	Gg N_2O	0.00217	0.00460	0.01318	0.00177	0.00204	0.00219	0.00209
		Other (biogenic)	Gg N_2O	0.00838	0.00853	0.01017	0.00540	0.00648	0.00603	0.00567
	Municipal solid waste	Plastics	Gg N_2O	0	0	0.00002	0.00004	0.00002	0.00001	0.00004
	Industrial solid waste	Waste oil	Gg N_2O	0.01581	0.02376	0.03221	0.04225	0.04531	0.03980	0.03677
		Waste plastics	Gg N_2O	0.00018	0.00012	0.00356	0.01023	0.01385	0.01451	0.01495
		Waste wood	Gg N_2O	0.01993	0.01993	0.02513	0.03271	0.03712	0.04165	0.04541
	Waste tire	Fossil origin	Gg N_2O	0.00501	0.00999	0.01166	0.01484	0.01717	0.01773	0.01643
	Refuse derived fuel (RDF, RPF)	Fossil origin	Gg N_2O	0.00051	0.00079	0.00309	0.01865	0.02540	0.02524	0.02582
	Total		Gg N_2O	6.14462	7.87432	8.92348	8.02375	7.04431	6.77854	6.37875
			Gg CO_2 eq	1,905	2,441	2,766	2,487	2,184	2,101	1,977
Total of all gases			Gg CO_2 eq	23,346	28,875	32,822	31,677	30,140	30,703	30,455

* CO_2 emissions from the incineration of biomass-derived waste (including biomass-based plastics and waste animal and vegetable oil) is not included in the total emissions in accordance with the Revised 1996 IPCC Guidelines

8.4.1. Waste Incineration without Energy Recovery (6.C.)

8.4.1.1. Municipal Solid Waste Incineration (6.C.1)

a） Source/Sink Category Description

This category covers the emissions from incineration of MSW without energy recovery. Emissions of CO_2 are reported under either “biogenic” or “plastics and other non-biogenic waste” in accordance with the waste type. Emissions of CH_4 and N_2O are estimated for each type of furnace. The data used for MSW incineration can not distinguish wastes that are either biogenic-origin or non-biogenic origin. Therefore, total emissions including biogenic-origin ones are reported altogether under “plastics and other non-biogenic waste”.

Methodological Issues

1） CO_2

- ***Estimation Method***

Emissions of CO_2 from this emission source was calculated based on Japan’s country-specific emission factors, the volume of waste incinerated (dry basis) and the percentage of municipal waste incinerated at the municipal incineration facilities that is accompanied by energy recovery, in accordance with the decision tree in the GPG (2000) (Page 5.26, Fig. 5.5). In order to estimate CO_2 emissions from the incineration of fossil-fuel derived waste[2], emissions from plastics and synthetic textile wastes in municipal waste were calculated.

$E = EF \times A \times (1\text{-}R)$

E : Emission of carbon dioxide from the incineration of various types of waste (kg CO_2)
EF : Emission factor for the incineration of various types of waste (dry basis) (kg CO_2/t)
A : Volume of each type of waste incinerated (dry basis) (t)
R : Percentage of municipal solid waste incinerated at facilities with energy recovery

- ***Emission factor***

In accordance with the *Revised 1996 IPCC Guidelines*, the emission factor was calculated by multiplying the carbon content of each type of waste by the incineration rate at each incinerator.

CO_2 emission factor (dry basis)
= 1000 [kg] × Carbon content × efficiency of combustion × 44/12

➢ ***Carbon content***

The carbon content of waste plastics (fossi-fuel derived and biomass-derived waste) in MSW was estimated based on the averaged value of actual measured data for the period FY1990 - FY2008 provided by four municipalities (Akita city, Kawasaki city, Kobe city and Osaka pref.) and applying it for the entire time-series, according to the *Survey Study on Improving the Accuracy of Emission Factors for Greenhouse Gas Emissions from the Waste Sector, 2010*, Ministry of the Environment

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[2] Emissions from the incineration of kitchen garbage, waste paper, waste natural fiber textiles and waste wood, and biomass-based plastics were accounted for as the reference figures of biogenic waste. Estimation methods for their emissions are the same as those for emissions from the incineration of fossil-fuel derived plastics and synthetic textile scraps.

(Reference #15).

For the carbon content of synthetic textile wastes in MSW, the carbon content of the synthetic fibers in the textile products was used. It was set by taking a weighted average of carbon contents determined by the molecular formula of polymer for each type of synthetic textile based on the volume of synthetic textile consumption.

Table 8 - 35 Carbon content of plastics and synthetic textile scrap in MSW

Item	Carbon content	Remarks
Plastics	75.1 %	Averaged value of the data provided by four municipalities
Synthetic textile	63.0 %	Weighted average of carbon content by each type of synthetic textile

➢ *Efficiency of Combustion*

Taking into account Japan’s circumstances, the default value of 99% indicated in the *GPG (2000)* was used.

● *Activity data*

The activity data for CO_2 emissions from the incineration of fossi-fuel derived waste plastics in MSW on a dry basis were calculated by subtracting water content from the amount of plastics incinerated (wet basis) and also subtracting the amount of biomass-based plastics incinerated (dry basis) in MSW which were estimated separately.

Activity data for plastics (MSW) incinerated (dry basis)
= Volume of plastics incinerated (wet basis) × (1 - Percentage of water content in waste plastics) – Amount of biomass-based plastics incinerated (dry basis)

The amount of biomass-based plastics incinerated (dry basis) is estimated as indicated below:

Amount of biomass-based plastics incinerated (dry basis)
= Amount of biomass-based plastics products consumed (dry basis) × Fraction of biogenic component of biomass-based plastics products × Fraction of biomass-based plastics disposed of as MSW × Fraction of biomass-based plastics incinerated

The activity data of waste synthetic textile in MSW was estimated by multiplyting the amount of waste textile in MSW incinerated (wet basis) by the fraction of waste synthetic textile content in waste texitile, and subtracing the water content in waste textile.

Activity data for incineration of synthetic textile scraps (MSW) (dry basis)
= Volume of textile scraps incinerated (wet basis) × (1 - Percentage of water content in waste textile) × Percentage of synthetic fiber content in textile scraps

Table 8 - 36 Amount of incineration of plastics and synthetic textile scraps in MSW (dry basis)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Plastics	kt / year (dry)	3,998	4,160	4,919	3,548	2,725	2,677	3,158
Synthetic textile	kt / year (dry)	476	531	473	592	600	583	737

➢ *Incineration volume by type of municipal solid waste*

The amount of waste plastics inclding biomass-based plastics and waste textile incinerated were obtained from the *Cyclical Use of Wastes Report*.

- ***Amount of biomass-based plastics products consumed***

Because of the fact that most of biomass-based plastics products comsumed in Japan are produced abroad, the amount of import of biomass-based plastics products are substituted for the amount of biomass-based plastics products consumed, which was compiled by the Japan Society of Biomass Industries. Currently, available values, the amount of biomass-based plastics products consumed by type and use, are limited to the products from polylactic acid (PLA), chemically modified, and partially biomass-based (Table 8-37).

Table 8 - 37 Amount of biomass-based plastics products consumed

Product type	Unit	1990	1995	2000	2005	2007	2008	2009
Containers and Packaging (Polylactic acid (PLA))	kt / year (dry)	0	0	0	0	1.18	1.18	1.18
Plastic bags (Chemically modified & Partially biomass-based)	kt / year (dry)	0	0	0	0	0.43	0.43	0.43
Molded consumer goods (Chemically modified & Partially biomass-based)	kt / year (dry)	0	0	0	0	0.29	0.29	0.29

- ***Fraction of biogenic component of biomass-based plastics products***

Because of the fact that some types of biomass-based plastics products include substances other than biogenic component, the net amount of biomass-based plastics incinerted by product type was estimated with the fraction of biogenic component (Table 8-38) obtained by the inquiry results from the Japan Society of Biomass Industries.

Table 8 - 38 Fraction of biogenic component of biomass-based plastics products

Product type	Product use	Unit	Fraction of biogenic property
Polylactic acid (PLA)	Containers and packaging	%	100
Chemically modified & partially biomass-based	Plastic bags	%	25
	Molded consumer goods	%	55

- ***Fraction of biomass-based plastics disposed of as MSW***

The fraction of biomass-based plastics disposed of as MSW was considered to be 100% for the each product use of containers and packaging, plastic bags, and molded household consumer goods based on the inquiry results from the Japan Society of Biomass Industries including the fact that all of these products were disposed of as MSW within a relatively short period of time after the their production.

- ***Fraction of biomass-based plastics incinerated, used as raw materials or fuels, and used as RDF***

Biomass-based plastics are disposed of as MSW and utilized in a few different ways. The fraction of biomass-based plastics incinerated, biomass-based plastics used as raw materials or fuels, and used as RDF were estimated by dividing the amount of biomass-based plastics incinerated, used as raw materials or fuels, and plastic-derived component of RDF by the amount of plastics disposed of as MSW (Table 8-39).

Table 8 - 39

Fraction of biomass-based plastics incinerated, used as raw materials and fuels, and used as RDF

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Incineration rate including energy recovery	%	74.9	79.5	86.7	79.4	73.0	73.9	87.2
Fraction of biomass-based plastics used as raw material or fuel (excluding the use of recycable materials)	%	0	0	0.6	5.3	5.5	5.1	5.0
Fraction of biomass-based plastics used as RDF	%	0.2	0.2	0.8	2.8	3.2	3.3	2.9

➢ *Percentage of water content*

The percentage of water content in plastics in MSW was determined to be 20% provided by the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*. The percentage of water content in the waste textile contained in MSW was determined to be 20% based on expert judgment and their review of case studies in Japan.

➢ *Percentage of synthetic textile in waste textile*

Percentage of synthetic textile content in waste textiles contained in the MSW was calculated using the percentage of synthetic textile products in textile products, which was determined by taking the ratio of the annual domestic demand for synthetic textile to the one for all textiles indicated in the *Textile Handbook* and the *Yearbook of Textiles and Consumer Goods Statistics*.

Table 8 - 40 Percentage of synthetic textile in waste textile

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Fraction of Synthetic fabric	%	49.1	50.7	53.5	52.8	55.3	55.9	56.6

- Percentage of municipal waste incinerated at municipal incineration facilities for energy recovery

Percentage of municipal waste that is incinerated at municipal incineration facilities with energy recovery stands for the one being incinerated at the facilities actually supply electricity or heat outside of them. These values were obtained from the *State of Municipal Waste Treatment Survey* (Ministry of the Environment).

Table 8 - 41 Percentage of municipal solid waste incinerated at incineration facilities with energy recovery

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Without off-field power generation or heat utilization	%	46.3	44.4	38.9	31.6	32.6	31.6	33.9
With off-field power generation or heat utilization	%	53.7	55.6	61.1	68.4	67.4	68.4	66.1

2） CH_4

● *Estimation Method*

CH_4 emissions from incinerator were estimated by multiplying the amount of MSW (wet basis) by incinerator method by each emission factor. CH_4 emissions from gasification melting furnace were estimated by multiplying the amount of MSW (wet basis) incinerated in gasification melting furnace by emission factors. Emissions from MSW with energy recovery were subtracted from the total emissions from this source and allocated to the waste sector.

$$E = \sum \left(EF_i \times A_i \right) \times \left(1 - R \right)$$

E : CH_4 emission from the incineration of MSW (kg CH_4)
EF_i : Emission factor for incineration method i (or furnace type i) (wet basis) (kg CH_4/t)
A_i : Amount of incinerated MSW by incineration method i (or furnace type i) (wet basis) (t)
R : Percentage of MSW incinerated at facilities with energy recovery

- ***Emission factor***

- ***Incinerator***

In order to implement countermeasures against dioxins, the renovations, repairs, or rebuilding of incineration facilities took place in the latter half of 1990 through the first half of 2000 in Japan. There have been some improvements made in CH_4 emission factors from the facilities renovated or rebuilt in FY 2000 and later, compared to the values obtained before then (Reference # 15). Therefore, based on the survey (Reference #15) and expert judgment, for the CH_4 emission factors for incinerator by incinerator type (stoker furnace and fluidized bed incinerator) and incineration method (continuous incinerator, semi-continuous incinerator, and batch type incinerator) for the period FY 2001 and before (Reference #7), and from FY 2002 onward (Reference #15), respectively, different values were used. All the emission factors were established based on actual measurement survey.

In order to apply activity data based on the amount of incineration by incineration method, emission factors were established by incineration method (continuous incinerator, semi-continuous incinerator, and batch type incinerator) using the weighted average of fraction of the amount of incineration by incinerator type for each fiscal year. The Correction taking into account CH_4 concentrations in the atmosphere was not made to these emission factors.

Table 8 - 42 CH_4 emission factors by incineration method of incinerator (MSW)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Continuous incinerator	g CH_4/t	8.2	8.2	8.3	2.6	2.6	2.6	2.6
Semi-continuous incinerator	g CH_4/t	69.6	69.6	75.1	19.9	20.9	21.0	20.6
Batch type incinerator	g CH_4/t	80.5	80.5	84.1	13.2	13.3	13.2	13.4

Source: Reference # 6, 8, 15, 23, 47, 52

- ***Gasification Melting Furnace***

Different emission factor was used for each furnace type (shaft furnace, fluidized bed, and rotary kiln) (Reference #15). Also, in order to apply activity data based on the total amount of incineration, emission factors were determined by taking the weighted average of the amount of incineration by gasification melting furnace type for each year.

Table 8 - 43 CH_4 emission factors by type of gasification melting furnace (MSW)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Gasification melting furnace	g CH_4 / t	-	-	5.6	6.9	7.0	7.1	7.0

- ***Activity Data***

The activity data for CH_4 emissions for incinerator and gasification melting furnace were estimated by multiplying the amount of MSW incinerated (wet basis) provided in the *Report of the Research on the state of wide-range Movement and Cyclical Use of Wastes*(publicized reports and the most current data from the reports prior to publication) by the fraction of incineration by incineration method of incinerator or gasification meting furnace provided by the *Waste Treatment in Japan*.

Table 8 - 44 Amount of incineration of MSW by type of incinerator

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Continuous incinerator	kt /year (wet)	26,215	29,716	32,749	32,246	30,840	29,349	28,444
Semi-Continuous Incinerator	kt /year (wet)	4,810	5,455	5,882	4,047	3,609	3,330	3,155
Batch type Incinerator	kt /year (wet)	5,643	4,328	3,131	1,562	1,369	1,342	1,144

Table 8 - 45 Amount of incineration of MSW from gasification melting furnace

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Gasification melting furnace	kt /year (wet)	0	0	370	2,397	2,954	3,114	3,245

3） N_2O

- **_Estimation Method_**

N_2O emissions from incinerator were estimated by multiplying the amount of MSW (wet basis) by incinerator method by each emission factor. N_2O emissions from gasification melting furnace were estimated by multiplying the amount of MSW (wet basis) incinerated in gasification melting furnace by emission factors. Emissions from MSW with energy recovery were subtracted from the total emissions from this source and allocated to the waste sector.

$$E = \sum (EF_i \times A_i) \times (1 - R)$$

E : N_2O emission from the incineration of MSW (kg N_2O)
EF_i : Emission factor for incineration method *i* (or furnace type *i*) (wet basis) (kg N_2O /t)
A_i : Amount of incinerated MSW by incineration method *i* (or furnace type *i*) (wet basis) (t)
R : Percentage of MSW incinerated at facilities with energy recovery

- **_Emission factor_**

➢ **_Incinerator_**

Same as for CH_4 emissions estimation, for the N_2O emission factors for incinerator by type and by incineration method, different values were used for the period FY 2001 and before (Reference #7), and from FY 2002 onward (Reference #15), respectively. In order to apply activity data based on the amount of incineration by incineration method, emission factors were established by incineration method (continuous incinerator, semi-continuous incinerator, and batch type incinerator) using the weighted average of fraction of the amount of incineration by incinerator type for each fiscal year calculated based on the *Waste Treatment in Japan*.

Table 8 - 46 N_2O emission factors for incinerator by incineration method (MSW)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Continuous incinerator	g N_2O/t	58.8	58.8	59.1	37.9	37.9	37.9	37.9
Semi-continuous incinerator	g N_2O/t	56.8	56.8	57.3	71.5	73.1	73.3	72.7
Batch type Incinerator	g N_2O/t	71.4	71.4	74.8	76.0	76.0	76.0	76.0

Source: Reference # 7, 8, 15 23, 47, 52

➢ **_Gasification Melting Furnace_**

Different emission factor was used for each furnace type (shaft furnace, fluidized bed, and rotary kiln) (Reference #15). In order to apply the activity data based on the total amount of incineration, emission factors were established by taking the weighted average of the amount of incineration by gasification melting furnace type for each year calculated based on the *Waste Treatment in Japan.*

Table 8 - 47 N_2O emission factors for gasification meting furnace (MSW)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Gasification melting furnace	g N_2O / t	-	-	16.9	12.0	11.5	11.1	11.2

- ***Activity Data***

The activity data for estimating CH_4 emissions from incinerator and gasification melting furnace were also applied for the activity data for N_2O emisson estimates from incinerator and gasification melting furnace.

b） Uncertainties and Time-series Consistency

- ***Uncertainties***

The level of uncertainty in the CO_2 emission factor was estimated by using the uncertainties in the carbon content of MSW (plastic and synthetic textile) and the incineration rate of MSW incineration facilities. The uncertainty in activity data for CO_2 emissions was estimated from the uncertainties in the amount of MSW incinerated, the percentage of water content and the percentage of synthetic textile (for synthetic textile in MSW).

The uncertainties in the CH_4 and N_2O emission factors were evaluated by type of incineration facilities and determined from the uncertainties in the emission factors for each type of incineration facilities and the ratio of the incinerated amount by type of incineration facilities. The uncertainties in the activity data were estimated based on the uncertainties in the amount of waste incinerated and the ratio of incinerated amount by type of incineration facilities. The methods of evaluation of the uncertainty levels for each component are:

- Use of 95% confidence interval: carbon content, fraction of synthetic textile, emission factors for CH_4 and N_2O by type of incineration facility
- Use of the default value in the 2006 IPCC Guidelines: combustion rate
- Based on expert judgment: percentage of water content
- Use of the statistical uncertainties: incinerated amount of waste and incineration rate by incinerator type

The uncertainties in the CO_2 emissions from incineration of plastics and synthetic textiles of MSW were estimated to be 17% and 23%, respectively. The uncertainties in the CH_4 and N_2O emissions from incineration of MSW were estimated to be 101% and 42%, respectively. For more details, refer to the Annex 7.

- ***Time-series consistency***

Because data on the amount of waste incinerated by type of waste were not available for years prior to FY 1997, the data were estimated by using the total incinerated amount of MSW for each year and the ratio of amount of waste incinerated by waste type for FY 1998. The emissions were calculated in a consistent manner.

c） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

d） Source-specific Recalculations

- The emission estimates for FY 2008 were recalculated because of the revision on the activity data for the amount of incineration.

- CO_2 emissions for the period FY 2007 - FY2008 were recalculated because the amount of biomass-based plastics incinerated became available.

e） Source-specific Planned Improvements

No improvements are planned.

8.4.1.2. Industrial Waste Incineration (6.C.2)

a） Source/Sink Category Description

This category covers CO_2, CH_4 and N_2O emissions from incineration of ISW without energy recovery by each waste type and the emissions are reported in the corresponding category either “biogenic” or “plastics and other non-biogenic waste”.

b） Methodological Issues

1） CO_2

● Estimation Method

Emissions of CO_2 from this source were calculated by using the volume of waste mineral oil and waste plastics incinerated, Japan’s country-specific emission factors, and the percentage of incinerated industrial solid waste with energy recovery at industrial waste incineration facilities in accordance with the decision tree of the *GPG (2000)* (Page 5.26, Fig. 5.5). Since industrial waste textile does not include synthetic texitleunder the regulation of the Waste Disposal and Public Cleansing Law, the industrial waste textile is regarded as waste natural fiber. Thus the CO_2 emissions from incineration of industrial waste textile were not included in national total because these emissions are biogenic-origin.

$$E = EF \times A \times (1-R)$$

E : Emission of carbon dioxide from incineration of waste（kg CO_2）
EF : Emission factor for waste incineration (wet basis)（kg CO_2/t）
A : Amount of waste incinerated (wet basis) (t)
R : Percentage of industrial solid waste incinerated at facilities with energy recovery (by type of waste)

● Emission factor

In accordance with the approach taken by the *Revised 1996 IPCC Guidelines*, emission factor was calculated by multiplying the carbon content of each type of waste by the incineration rate for incineration facilities.

Carbon dioxide emission factor (wet basis)
= 1000 [kg] × Carbon content × Efficiency of combustion × 44/12

➢ Carbon content

Carbon content in waste oil was deemed to be 80% based on the factor of 0.8 (t C/t) given in the *Environmental Agency's Report on a Survey of Carbon Dioxide Emissions (1992)*.

Carbon content in waste plastics was deemed to be 70% based on the factor of 0.7 (t C/t) given in the said report .

➢ Efficiency of combustion

Considering Japan's circumstances, the default value for hazardous wastes of 99.5% given in the *GPG (2000)* was used.

● Activity Data

For the activity data for CO_2 emissions from the incineration of waste oil and waste plastics in industrial waste, the amount of incineration provided by *the Report of the Research on the State of Wide-range Movement and Cyclic Use of Wastes* was used. However, the amount of incineration provided in this report includes the amount of incineration of specially controlled industrial waste which is separately reported under "Incineration of Specially Controlled Industrial Waste (6.C.3)", thus it was subtracted from the activity data from this source. The activity data for waste mineral oil was obtained by using the fraction of animal and vegetable waste oil (biogenic-origin waste oil) provided by the survey study conducted by the Ministry of the Environment from the total amount of waste oil (see the methodological equation indicated below). All of the plastics in ISW was considered to be fossil-fuel derived.

Activity data for the incineration of waste mineral oil (wet basis)
= Amount of waste oil incinerated in industrial waste × (1 – Fraction of waste oil from animal and vegetable origin) – Amount of waste oil incinerated in specially controlled industrial waste*

*All the waste oil in specially controlled industrial waste to be estimated for emissions are waste mineral oil.

Activity data for the incineration of waste oil and plastics (ISW) (wet basis)
= Amount of waste plastics incinerated in industrial waste – Amount of waste plastics incinerated in specially controlled industrial waste

Table 8 - 48 Incinerated ISW (waste oil and waste plastics)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Waste mineral oil	kt / year (wet)	1,258	1,498	1,646	1,493	1,445	1,622	1,394
Waste plastics	kt / year (wet)	842	1,794	1,780	1,808	1,919	2,056	1,960

Table 8 - 49 Fraction of waste animal and vegetable oil

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Fraction of waste animal and vegetable oil	%	2.6	3.5	4.5	5.4	5.8	6.0	6.0

- Percentage of industrial waste incinerated at industrial incineration facilities for energy recovery (by type)

Percentage of industrial waste that is incinerated at industrial incineration facilities with energy recovery stands for the one being incinerated at the facilities actually supply electricity or heat outside of them. The values were obtained from the *FY 2007 Survey of Industrial Waste Treatment Facilities* (Ministry of the Environment).

In Japan, industrial incineration facilities are installed mainly by private sector waste disposal enterprises. In comparison with the municipal waste incinerators installed primarily by municipal governments, energy recovery (for use in power generation and as a heat source) has not yet been so popular. The percentage for the industrial waste category is therefore smaller.

Table 8 - 50 Percentage of ISW incinerated at incineration facilities with energy recovery

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Waste oil [a)]	%	0.6	0.7	0.6	2.5	2.5	2.5	2.5
Waste plastics	%	1.4	1.4	4.1	6.6	7.2	7.2	7.2
Waste wood [b)]	%	0.2	0.8	1.1	1.5	1.8	1.8	1.8
Sludge	%	0.9	0.8	1.0	1.1	1.6	1.6	1.6
Other [c)]	%	0.2	0.8	1.1	1.5	1.8	1.8	1.8

a): “Waste oil” includes waste mineral/animal and vegetable oil.

b): “Waste wood” includes waste paper or waste wood.

c): “Other” includes waste textile, animal and vegetable residues, and animal carcasses.

2） CH_4

- ***Estimation Method***

Emissions of methane from this source have been calculated by multiplying the volume of industrial waste incinerated by Japan’s country specific emission factor and by percentage of industrial solid waste incinerated at incineration facilities with energy recovery.

$$E = \sum \left\{ EF_j \times A_j \times \left(1 - R_j\right) \right\}$$

E : Emission of methane from the incineration of industrial waste (kg CH_4)
EF_j : Emission factor for waste type j (wet basis) (kg CH_4/t)
A_j : Incinerated amount of waste type j (wet basis) (t)
Rj : Percentage of industrial solid waste j incinerated at facilities with energy recovery

- ***Emission factor***

Based on expert judgement which takes into account the countermeasures against dioxin emissions from incinerators, for the emission factors by waste type for the period FY1990 - FY2001 (Reference #7) and from FY 2002 onward (Reference #15), respectively, different values were used. These emission factors were established based on actual measurement survey. The correction taking into account CH_4 concentrations in the atmosphere was not made to these emission factors. The emission factor for waste paper or waste wood was substitued for the emission factor for waste textile, animal and vegetable residues, and animal carcasses.

Table 8 - 51 CH_4 emission factors for industrial waste by type

Item	Unit	FY 1990-2001	FY 2002 onward
Waste oil（mineral/animal and vegetable）	g CH_4 /t	4.8	4.0
Waste plastics	g CH_4 /t	30	8.0
Waste paper or Waste wood	g CH_4 /t	22	225
Waste textile	g CH_4 /t	22	225
Animal and vegetable residues/animal carcasses	g CH_4 /t	22	225
Sludge	g CH_4 /t	14	1.5

Reference # 6, 24, 47

- ***Activity Data***

The volume of waste incinerated (wet basis) by waste type was used as the activity data for CH_4 emissions from the incineration of industrial waste.

➢ ***Paper and wood scraps, waste oil, textile scraps, animal and plant residues or animal carcasses:***

The volume of waste incinerated for each type was obtained from the Report of the Research on the State of Wide-range Movement and Cyclical Use of Waste.

➢ ***Sludge***

Activity data was taken as the aggregate of the values obtained from the “Volume of Other Incinerated Organic Sludge” section in the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*, and the “Volume of Incinerated Sewage Sludge” reported in a survey by the Ministry of Lands, Infrastructure, Transport and Tourism.

➢ ***Waste oil (mineral/animal and vegetable) and waste plastics***

The activity data for waste oil and waste plastics were provided by the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Waste*. Because the values provided by this report include the amount of specially controlled industrial waste which is allocated to the category of Specially Controlled Industrial Waste (6.C.3), it was subtracted from the total amount to avoid double counting. Unlike the activity data for CO_2 emissions, waste mineral oil and also waste animal and vegetable oil are included for the estimation of activity data from this source.

Table 8 - 52 Incinerated ISW by waste types

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Waste animal and vetable oil	kt / year (wet)	40	69	103	115	120	139	120
Waste paper, waste wood	kt / year (wet)	3,014	5,455	3,832	2,188	1,800	1,638	1,539
Waste textile	kt / year (wet)	31	49	50	43	36	33	31
Animal and vegetable remnants, animal carcasses	kt / year (wet)	77	125	272	167	154	220	209
Sludge	kt / year (wet)	5,032	5,850	6,371	7,275	7,094	6,820	6,660

For the amount of waste oil and waste tires incinerated, refer to Table 8-48.

3） N_2O

- ***Estimation Method***

Emissions of N_2O from this source were calculated separately for the major emission source, sewage sludge, and the waste other than sewage sludge. With respect to sewage sludge, emission factors were set by type of flocculants and furnaces; and the ones for “high-molecular-weight, flocculant fluidized bed incinerator" were further determined by the incineration temperatures. Emissions from the industrial waste other than sewage sludge were estimated by multiplying the volume of waste incinerated by Japan's country-specific emission factor. Among those emissions, the ones to be reported in the waste sector were calculated by multiplying the percentage of industrial waste incinerated at the industrial waste incineration facilities with energy recovery.

$$E = \sum \left\{ EF_j \times A_j \times \left(1 - R_j\right) \right\}$$

E : Emission of nitrous oxide from the incineration of industrial waste (kg N_2O)
EF_j : Emission factor for waste type j (wet basis) (kg N_2O /t)
A_j : Incinerated amount of waste type j (wet basis) (t)
R_j : Percentage of industrial solid waste j incinerated at facilities with energy recovery

● *Emission factor*

➢ *Sewage sludge*

Emission factor for N_2O emissions from sewage sludge incineration were determined by taking a weighted average of actually measured emission factors of N_2O at each incineration facility based on the volume of sewage sludge incinerated at the facilities. Since emission factors are different depending on the types of flocculants, incinerators, and furnace temperatures, they were established for each category as given in Table 8-53 (Reference #7).

Table 8 - 53 N_2O emission factors for sewage sludge incineration (wet basis)

Type of flocculant	Type of incinerator	Combustion Temperature	Emission Factor (g N_2O/t)
High-molecular weight flocculant	Fluidized Bed Incinerator	Normal temperature combustion（around 800˚C）	1,508
	Fluidized Bed Incinerator	High temperature combustion（around 850˚C）	645
	Multiple Hearth	―	882
Other	―	―	
Lime Sludge	―	―	294

- Source: Reference #25, 26, 27, 28, 29, 30, 47, 53, 54
- Assume that emission factors for FY1990-2002 are constant.

➢ *Waste other than sewage sludge*

Based on expert judgement which takes into account the countermeasures against dioxin emissions from incinerators, for the emission factors by waste type for the period FY1990-FY 2001 (Reference #7) and from FY2002 onwared (Reference #15), respecively, different values were used. These emission factors were established based on actual measurement survey. The correction taking into account CH_4 concentrations in the atmosphere was not made to these emission factors. The emission factor applied for waste paper or waste wood was also used for waste textile, animal and vegetable residues, and animal carcasses.

Table 8 - 54 N_2O Emission factors for industrial waste by type (wet basis)

Item	Unit	FY 1990-2001	From FY 2002 onward
Waste oil（mineral/animal and vegetable）	g N_2O /t	12	62
Waste plastics	g N_2O /t	180	15
Waste paper or Waste wood	g N_2O /t	21	77
Waste textile	g N_2O /t	21	77
Animal and vegetable residues/animal carcasses	g N_2O /t	21	77
Sludge (excluding sewage sludge)	g N_2O /t	457	99

Souce: Reference # 6, 15, 24, 27, 53, 54, 58, 59, 60, 64, 65

● *Activity Data*

➢ *Sewage sludge*

Data in the “volume of incinerated sewage sludge, by flocculants and by incinerator types” reported in a survey by the Ministry of Lands, Infrastructure, Transport and Tourism were used as activity data (wet basis).

Table 8 - 55 Amount of sewage sludge incinerated

Item	Unit	1990	1995	2000	2005	2007	2008	2009
High-molecular weight flocculant Fluidized bed incinerator (nomal temp.)	kt / year (wet)	1,112	1,869	2,397	2,839	1,935	1,785	1,445
High-molecular weight flocculant Fluidized bed incinerator (high temp.)	kt / year (wet)	128	219	723	1,469	2,355	2,470	2,809
High-molecular-weight flocculant multiple hearth	kt / year (wet)	560	656	572	102	69	56	64
Lime sludge	kt / year (wet)	1,070	767	341	289	211	193	142
Other	kt / year (wet)	190	316	267	289	249	233	241

➢ *Industrial waste other than sewage sludge*

Activity data (wet basis) was determined in the same manner as for the CH_4 emissions from industrial waste, with the exception that the “volume of other incinerated organic sludge” was used as activity data for the sludge (excluding sewage sludge).

c） Uncertainties and Time-series Consistency

● *Uncertainties*

The uncertainties in the CO_2 emission factor and activity data for waste oil and waste plastics were evaluated by the same method as was used for incineration of MSW. The uncertainties in CH_4 and N_2O emission factors were estimated by using the 95% confidence interval of actual measurement data of the emission factors by type of ISW and by type of incineration facility. The uncertainties in the CH_4 and N_2O activity data were estimated by using the statistical uncertainties for incinerated amount of industrial waste by type of waste.

The uncertainties in the CH_4 and N_2O emissions from incineration of industrial waste were estimated to be 150% and 116%, respectively. The uncertainties in the CO_2 emissions from incineration of waste oil and waste plastics were 105% and 100%, respectively. For more details, refer to the Annex 7.

- ***Time series consistency***

Emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials. Also,

e） Source-specific Recalculations

- Because the fraction of sewage sludge incinerated at ISW incineration facility with energy recovery was reviewed, the reallocation of the CH_4 emissons for the period FY1990 **-** FY 2008 to the Energy sector was implemented.

f） Source-specific Planned Improvements

No improvements are planned.

8.4.1.3. Incineration of Specially controlled Industrial Waste (6.C.3)

a） Source/Sink Category Description

The specially controlled industrial waste includes wastes with properties that may be harmful to human health and living environment such as explosiveness, toxicity and infectivity. This category covers CO_2, CH_4, and N_2O emissions from incineration of specially controlled industrial waste were estimated by each waste type and reported in the corresponding category either “biogenic” or “plastics and other non-biogenic waste”.

Because the actual state of energy recovery from the incineration of specially controlled industrial waste is not sufficiently understood, the emissions from specially controlled industrial waste are reported entirely in “Waste Incineration (Category 6.C.)”.

b） Methodological Issues

1） CO_2

- ***Estimation Method***

Emissions of CO_2 from the incineration of waste oil and infectious plastic waste contained in specially controlled industrial waste were calculated in accordance with the decision tree given in the *GPG (2000)* (Page 5.26, Fig 5.5) by using Japan’s country-specific emission factors and the volume of waste incinerated.

- ***Emission factor***

Emission factors for waste oil and waste plastics in industrial waste were used as the ones for waste oil and waste plastics in specially controlled industrial waste, since their differences in terms of carbon contents and rates of combustion were considered to be small.

- ***Activity Data***

On the assumption that the entire volume of waste oil and infectious plastic waste contained in specially controlled industrial waste was incinerated, output volume of waste oil indicated in the *Report on Survey of Organizations in Industrial Waste Administration* (Water Supply Division, Health Service Bureau, the Ministry of Health and Welfare) was used as activity data for the waste mineral oil; while for the plastics in infectious waste, the activity data was calculated by multiplying the output volume of infectious waste reported by the same survey by the percentage of plastic content in infectious waste indicated in the *Waste Handbook* as the result of a composition analysis of infectious waste. All the waste oil in specially controlled industrial waste to be estimated for emissions is waste mineral oil. All of plastics in infectious waste was considered to be fossil-fuel derived.

Activity data for incineration of waste mineral oil (specially controlled ISW) (wet basis)
= Output volume of waste oil

Activity data for incineration of plastics in infectious waste (specially controlled ISW)(wet basis)
= Output volume of infectious waste × percentage of plastic content in infectious waste

2） CH_4

● Estimation Method

Emissions of CH_4 from the incineration of waste oil and infectious waste included in the specially controlled industrial waste were calculated by multiplying the volume of incinerated waste by type (wet basis) by Japan’s country-specific emission factor.

● Emission factor

Because actual measurement data were not available, the emission factors for the incineration of industrial waste were used as substitutes for the emission factor for the specially controlled industrial waste by type. Specifically, the substitute emission factors used were: the waste mineral oil in industrial waste for the waste mineral oil; the waste plastics in industrial waste for the infectious waste plastics; and the waste paper and waste wood in industrial waste for the waste other than infectious plastics.

● Activity Data

Activity data for the waste oil and infectious waste plastics were the same as those used for CO_2 emission. The volume of non-infectious waste plastics incinerated was deemed to be the same as the output volume, and calculated by multiplying the output volume of infectious waste by the percentage of non-plastic content in infectious waste.

3） N_2O

● Estimation Method

Emissions of N_2O from the incineration of waste oil and infectious waste in specially controlled industrial waste were calculated by multiplying the incinerated volume of each type of waste (wet basis) by Japan’s country-specific emission factor.

● Emission factor

Because actual measurement data were not available, the N_2O emission factors for the incineration of industrial waste were used as substitutes for determining the emission factor for each type of specially controlled industrial waste. Specifically, the substitute emission factors used were: the waste oil in industrial waste for the waste oil; the waste plastics in industrial waste for the infectious waste plastics; and the waste paper and waste wood in industrial waste for the waste other than infectious plastics.

- ***Activity Data***

The same activity data used for CH_4 emissions was used.

Table 8 - 56 Amount of incineration of specially controlled industrial waste

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Waste mineral oil	kt (wet)	256	380	560	515	501	564	485
Infections Waste (plastic)	kt (wet)	78	128	167	169	180	193	184
Infections Waste (non-plastic)	kt (wet)	105	172	225	228	242	260	248

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

Since the same CO_2, $CH_{4,}$ and N_2O emission factors used for the industrial waste were used; their uncertainties were also applied. The uncertainties in activity data were set out separately for waste oil and waste plastics. To the incinerated amount of waste oil and infectious waste, twice the statistical uncertainties were applied by taking into account the fact that the data were recently obtained based on the estimation. For waste plastics, the uncertainties in the percentage of plastics in infectious waste were determined based on the expert judgment, and then their uncertainties were combined with the ones in the amount of waste incinerated. The uncertainties in the CO_2, $CH_{4,}$ and N_2O emissions from incineration of specially controlled industrial waste were estimated to be 167%, 142% and 159%, respectively. For details, refer to the Annex 7.

- ***Time series consistency***

Since some basic data used for calculating activity data were available only for part of time series, consistent data over the time series were developed based on the estimation. The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） Source-specific Recalculations

- Because of the update on the data used FY 2008, emission estimates were recalculated.

f） Source-specific Planned Improvements

No improvements are planned.

8.4.2. Emissions from waste incineration with energy recovery (1.A.)

a） Source Category Description

In this category, CO_2, CH_4, and N_2O emissions from the incineration of municipal and industrial waste with energy recovery are estimated and reported. The reporting category for the emissions is

"Power Generation/Heat Supply (Category 1.A.1.a)" and the fuel type is classified as "Other fuels".

b） Methodological Issues

Methodologies similar to that used in "8.4.1.1 Municipal Solid Waste Incineration (6.C.1)" and "8.4.1.2. Industrial Waste Incineration (6.C.2)" were used. Emissions are calculated using the following equation:

1） CO_2

● Estimation Method

➢ Municipal Solid Waste

$$E = EF \times A \times R$$

E : Emission of CO_2 from waste incineration (kg CO_2)
EF : Emission factor for incineration (dry basis) (kg CO_2/t)
A : Amount of waste incinerated (dry basis) (t)
R : Percentage of municipal solid waste incinerated at incineration facilities with energy recovery

➢ Industrial Solid Waste

$$E = EF \times A \times R$$

E : Emission of CO_2 from waste incineration (kg CO_2)
EF : Emission factor for waste incineration (wet basis) (kg CO_2/t)
A : Amount of waste incinerated (wet basis) (t)
R : Fraction of industrial solid waste incinerated at ISW incineration facilities with energy recovery (by waste type)

2） CH_4 , N_2O

● Estimation Method

➢ Municipal Solid Waste

$$E = \sum \left(EF_i \times A_i \right) \times R$$

E : Emissions of CH_4 or N_2O from incineration of municipal solid waste (kgCH_4) (kg N_2O)
EF_i : Emission factor for municipal solid waste incinerator type i (wet basis) (kgCH_4/t) (kg N
A_i : Amount of municipal solid waste incinerated for incinerator type i (wet basis) (t)
R : Percentage of municipal solid waste incinerated at facilities with energy recovery

➢ Industrial Solid Waste

$$E = \sum \left(EF_j \times A_j \times R_j \right)$$

E : Emissions of CH_4 or N_2O from incineration of industrial solid waste (kgCH_4) (kg N_2O)
EF_j : Emission factor for industrial solid waste type j (wet basis) (kgCH_4/t) (kg N_2O/t)
A_j : Amount of industrial solid waste type j incinerated (wet basis) (t)
R : Fraction of industrial solid waste type j incinerated at ISW incineration facilities with energy recovery

- ***Activity Data converted into energy units (reference value)***

Activity data converted into energy units to be reported in CRF was estimated as indicated below.

➢ ***Municipal Solid Waste***

$$A_E = A \times GCV \times R/10^6$$

A_E : Calorific value of activity data of MSW (TJ)
A : Total amount of MSW incinerated (kg[wet])
GCV : Gross calorific value of MSW (MJ/kg)
R : Fraction of MSW incinerated at MSW incineration facility with energy recovery

Based on the actual measurement results obtained at municipality, the calorific value of MSW is 9.9 (MJ/kg).

➢ ***Industrial Solid Waste***

$$A_E = \sum A_j \times GCV_j \times R \big/ 10^6$$

A_E : Calorific value of activity data of ISW（TJ）
A_j : Amount of ISW type j incinerated (kg[wet])
GCV_j : Gross calorific value of ISW type j（MJ/kg）
R : Fraction of ISW type j incinerated at ISW incineration facility with energy recovery

Calorific value of ISW is indicated in Table 8-63 (as referred to hereinafter).

c） Uncertainties and Time-series Consistency

Methodologies similar to that used in “8.4.1.1 Municipal Solid Waste Incineration (6.C.1)” and “8.4.1.2. Industrial Waste Incineration of (6.C.2)” were used.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials. Also, QA activity was implemented for the waste sector by the GHG Inventory Quality Assurance Working Group in FY 2009. For more details of QA/QC activities, refer to the Annex 6.

e） Source-specific Recalculations

- The CO_2 emissions for the period FY 2007 - FY 2008 were recalculated because the amount of biomass-based plastics in MSW incinerated became available.

- Because the fraction of sewage sludge incinerated at ISW incineration facility with energy recovery was reviewed, the realocation of CH_4 emissons for the period FY1990 - FY 2008 to the Energy sector was implemented.

f） Source-specific Planned Improvements

No improvements are planned.

8.4.3. Emissions from direct use of waste as fuel (1.A.)

a） Source/Sink Category Description

In this category, CO_2, CH_4, and N_2O emissions from waste directly used as fuel are estimated and reported. The reporting category for the emissions for each type of waste is, according to its use as fuel or raw material, either “Energy Industry (Category 1.A.1.)” or “Manufacturing and Construction (1.A.2)”. The fuel type is classified as “Other fuels”.

Greenhouse gas emissions during the direct use of waste as a raw material, such as plastics used as reducing agents in blast furnaces or as a chemical material in coking furnaces, or use of intermediate products manufactured using the waste as a raw material, are estimated in this category. The waste used as raw material and that used as fuel are combined and expressed as “Raw Material/Fuel Use” in this section.

Table 8 - 57 Estimation category for emissions from the direct use of waste as fuel

Emission source	Application breakdown	Major application	Reporting category of Energy sector	
Use of municipal solid waste (plastics) as alternative fuel or rawmaterial	Petrochemical	Fuel	1A2f	Other
	Blast furnace reducing agent	Reducing agent in blast furnace	1A2a	Iron & Steel
	Coke oven chemical feedstock	Alternative fuel or raw material in coke oven	1A1c	Manufacture of solid fuels
	Gasification	Fuel	1A2f	Other
Use of waste oil as alternative fuel or raw material	Cement burning	Cement burning	1A2f	Cement & Ceramics
	Other	Fuel	1A2f	Other
Use of industrial solid waste (waste plastics) as alternative fuel or raw material	Blast furnace reducing agent	Blast furnace reducing agent	1A2a	Iron & Steel
	Boiler	Fuel	1A2b	Chemicals
	Boiler	Fuel	1A2d	Pulp, paper and print
	Cement burning	Cement burning	1A2f:	Cement & Ceramics
	Boiler	Fuel	1A2f	Machinery
Use of industrial solid waste (waste wood) as alternative fuel or material	-	Fuel	1A2f	Other
Use of waste tire as alternative fuel or raw material	Cement burning	Cement burning	1A2f	Cement & Ceramics
	Boiler	Fuel	1A2f	Other
	Iron manufacture	Alternative fuel or raw materials in iron manufacturing	1A2a	Iron & Steel
	Gasification	Fuel in iron manufacturing	1A2a	Iron & Steel
	Metal refining	Fuel in metal refining	1A2b	Non-ferrous metals
	Tire manufacture	Fuel in tire manufacturing	1A2c	Chemicals
	Papermanufacture	Fuel in paper manufacturing	1A2d	Pulp, paper and print
	Power generation	Power generation	1A1a	Public electricity and heat production[※]

*Since the industry category for the use of it is not identified, “1A1a” is applied.

b） Methodological Issues

1） CO_2

- ***Estimation Method***

Emissions were estimated by multiplying the incinerated volume of each type of waste used as raw material or fuel by Japan’s country-specific emission factor. The wastes included in the estimation are the portions used as raw material or fuel of: plastics in MSW; waste plastics and waste mineral oil in industrial waste; and waste tires.

- ***Emission factor***

Emission factors were established for the plastics from MSW that were used as chemical raw material in coke ovens and waste tires. The remaining emission sources used the emission factors for "Waste Incineration without Energy Recovery (Chapter 8.4.1.)".

Emission factors for this category	Plastics from municipal solid waste (as chemical raw material in coke ovens) and waste tires
Emission factors for incineration without energy recovery	Plastics from municipal solid waste (other than those used as chemical material in coke ovens) and industrial waste

Table 8 - 58 Country-specific CO_2 emission factors for this category

Item	Unit	1990	1995	2000	2005	2007	2008	2009
MSW-coke oven	kg CO_2/t(dry)	1,420	1,420	1,420	1,420	1,420	1,420	1,420
Waste tire	kg CO_2/t(dry)	1,858	1,785	1,790	1,737	1,722	1,725	1,729

- ***Activity Data***

Details of the amount of waste used as raw material or alternative fuels, refer to the 8.4.3.1. - 8.4.3.3.

Table 8 - 59 Use of waste as raw materials or fuels for CO_2 emissions

Item	Unit	1990	1995	2000	2005	2007	2008	2009
MSW-plastics-oilification	kt (dry)	0	0	3	7	4	3	6
MSW-plastics-reducer in blast furnace	kt (dry)	0	0	24	35	32	17	26
MSW-plastics-chemical material in coke-oven	kt (dry)	0	0	10	168	137	136	144
MSW-plastics-gasification	kt (dry)	0	0	1	56	54	45	43
ISW-waste plastics (iron and steel)	kt (wet)	0	0	57	160	112	74	97
ISW-waste plastics (cement)	kt (wet)	0	0	102	302	408	427	440
ISW-waste plastics (boiler)	kt (wet)	21	14	16	9	15	18	19
ISW-waste mineral oil (cement baking furnace)	kt (wet)	137	225	343	423	451	384	372
ISW-waste mineral oil (boiler)	kt (wet)	554	633	460	811	871	876	640
Waste tire	kt (dry)	282	471	580	498	577	593	547

* The amount of biomass-based plastics and waste animal and vegetable oil are not included in any of the items in the table.

2） CH_4, N_2O

- ***Estimation Method***

Emissions were estimated by multiplying the amount of each type of waste used as raw material or fuel by the country-specific emission factor. It should be noted that emissions from some of the emission sources are not estimated. They are summarized below.

Table 8 - 60
CH_4 and N_2O emissions sources not included in emission estimates or allocations

Emission source	Emission source (not calculated)
Use of municipal solid waste as alternative fuel or raw materials	Blast furnace redusing agent (NO), Coke-oven chemical feedstock (IE), Gasification (NE)
Use of industrial solid waste as alternative fuel or raw materials	Balst furnace reducing agent (NO), Petrochemical (NE), Gasification (NE)
Use of waste tire as alternative fuel or raw material	Iron manufacturing（NO）

- ***Emission factor***

Emission factors for waste used as raw material and fuel were determined by multiplying the emission factor for applicable types of furnaces by the calorific value of each waste type, and converting the result to the weight-based values. Table 8-61 shows the data used in the estimation.

Calculation of emission factor (wet basis)
= (Emission factor for each type of furnace (kg-CH_4/TJ, kg-N_2O/TJ)) × (Calorific value of each waste type (MJ/kg)) / 1000

Table 8 - 61
Data used for the calculation of CH_4 and N_2O emission factors for wastes used as raw material and fuel

Item			Emission factor for furnaces and ovens (Energy sector)	Calorific value
Plastics from municipal solid waste		Plastic oil	Boilers (Heavy fuel oil A, gas oil, kerosene, naphtha, other liquid fuels)	Calorific value of waste plastics
Industrial waste	Waste plastics	Cement kilns	Other industrial furnaces (solid fuel)	Calorific value of waste plastics
		Boilers	CH_4: Boilers (wood, charcoal, and other solid fuel) N_2O: Boilers (other than fluidized-bed) (solid fuel)	
	Waste oil (mineral/animal and vegetable)	Cement kilns, boilers	Other industrial furnaces (solid fuel)	Specific gravity of reclaimed oil/waste oil [a)]
		Boilers	Boilers (Heavy fuel oil A, gas oil, kerosene, naphtha, other liquid fuels)	
	Wood scraps	Boilers	CH_4: Boilers (wood, charcoal) N_2O: Boilers (other than fluidized-bed) (solid fuel)	Calorific value of wood [b)]
Waste tires		Cement kilns	Other industrial furnaces (solid fuel)	Calorific value of waste tires
		Boilers	CH_4: Boilers (Steam coal, coke, other solid fuels) N_2O: Boilers (other than fluidized-bed) (solid fuel)	
		Carbonization	Boilers (gas fuels)	
		Gasification	Other industrial furnaces (gas fuels) and other industrial furnaces (liquid fuels) [c)]	

a) Calorific value per unit volume was determined by dividing by the specific gravity of waste oil (0.9 kg/L) obtained from the Waste Handbook (1997).

b) Source: 1997 General Survey of Emissions of Air Pollutants

c) The percentage of substances recovered during the gasification of waste tires. A weighted average was calculated using the proportions of gas and oil (22% and 43%) reported in the Hyogo Eco-town documents.

Table 8 - 62
CH_4 and N_2O emission factors for the use of waste as raw material or fuel used in the Energy sector

Furnace type/Fuel type	CH_4 Emission factor (kg-CH_4/TJ)	N_2O Emission factor (kg-N_2O/TJ)
Boilers (Heavy fuel oil A, gas oil, kerosene, naphtha, other liquid fuels)	0.26	0.19
Boilers (gas fuels)	0.23	0.17
Boilers (steam coal, coke, other solid fuels)	0.13	
Boilers (wood, charcoal)	74.9	
Boilers (other than fluidized-bed) (solid fuels)		0.85
Other industrial furnaces (liquid fuel)	0.83	1.8
Other industrial furnaces (solid fuel)	13.1	1.1
Other industrial furnaces (gas fuel)	2.3	1.2

Emission factors are from Chapter 3, Energy.

Table 8 - 63 Calorific Value of waste incinerated and used as raw material or fuel

Item		Unit	GCV	Source of calorific value
Waste oil (including reclaimed oil)		TJ/l	40.2	Reference # 21; estimated with 0.9(kg/l) from Reference # 46
Waste plastics		MJ/kg	29.3	Reference # 21
Waste paper		MJ/kg	15.1	Reference # 46 (dry basis); value was obtained by subtracting water content
Waste wood		MJ/kg	14.4	Reference # 21
Waste textile		MJ/kg	17.9	Reference # 46 (dry basis) ; value was obtained by subtracting water content
Animal & vegetable residues/animal carcasses		MJ/kg	4.4	Reference # 46 (dry basis) ; value was obtained by subtracting water content
Sludge (including sewage sludge)		MJ/kg	4.7	Reference # 21 (dry basis) ; value was obtained by subtracting water content
Waste tires	2004 and before	MJ/kg	20.9	Reference # 21
	2005 and later	MJ/kg	33.2	Reference # 21
RDF		MJ/kg	18	Reference # 21
RPF		MJ/kg	29.3	Reference # 21

- ***Activity Data***

➢ ***Waste used as raw material and fuel***

Activity data were determined for each category using the wet-basis values (Table 8-64). For more details, refer to each section.

Table 8 - 64 Amount of waste used as raw material or fuel for CH_4 and N_2O emissions

Item	Unit	1990	1995	2000	2005	2007	2008	2009
MSW-oilification	kt (wet)	0	0	3	7	4	3	7
ISW-waste wood	kt (wet)	1,635	1,635	2,061	2,683	3,045	3,417	3,725
ISW-waste mineral/animal & vegetable oil (cement baking furnace)	kt (wet)	141	233	359	447	479	408	396
ISW-waste mineral/animal & vegetable oil (boiler)	kt (wet)	569	657	482	858	924	932	681
Waste tire-cement baking furnace	kt (wet)	111	275	361	181	148	141	112
Waste tire-boiler	kt (wet)	119	184	163	255	369	394	387
Waste tire-pyrolysis furnace	kt (wet)	67	37	30	10	8	2	1
Waste tire-gasification	kt (wet)	0	0	0	27	42	48	48

Refer to Table 8-59 for the activity data for ISW-waste plastics (cement manufacurer) and ISW-waste plastics (boiler).

➢ ***Activity Data converted into energy units (reference value)***

Activity data converted into energy units to be reported in CRF are calculated as indicated below.

Activity data converted into energy units

= (Amount of waste used as raw material or fuel (kg [wet])) × Corresponding calorific value of waste (MJ/kg)) / 10^6

c） *Uncertainties and Time-series Consistency*

Refer to the respective section.

d） Source-specific QA/QC and Verification

Refer to the respective section.

e） Source-specific Recalculations

Refer to the respective section.

f） Source-specific Planned Improvements

Refer to the respective section.

8.4.3.1. Emissions from municipal waste (waste plastics) used as alternative fuel (1.A.1 and 1.A.2)

a） Source/Sink Category Description

This category covers the emissions from municipal waste (waste plastics) used as raw materials or alternative fuels. Plastics in MSW collected under the Containers and Packaging Recycling Law are processed into petrochemical, blast furnace reducing agent, chemical raw material in coke-oven, and gasification to be used as alternative fuel or raw material.

b） Methodological Issues

1） CO_2

- ***Estimation Method***

Emission estimates were calculated by multiplying the amount of fossil-fuel derived plastics in MSW by each usage (petrochemical, blast furnace reducing agent, chemical raw material in coke-oven, and gasification) by Japan’s country-specific emission factor.

- ***Emission factor***

For the emission factors for plastics in MSW in the usage of petrochemical, blast furnace reducing agent, and gasification, the same values applied in “8.4.1.1. Municipal Solid Waste Incineration (6.C.1)” were applied. The emission factor for plastics used as chemical raw material in coke ovens was set as the volume of hydrocarbon that is used as chemical raw material and from which no CO_2 is emitted into the air by subtracting the percentage of carbon in the plastics that migrates to hydrocarbon oil in the coke oven (47.9%) from emission factor for plastics (MSW).

Calculation of the emission factor for plastics used as raw material in coke ovens (dry basis)
= (Emission factor for the incineration of plastics in municipal solid waste) × [1 − (Fraction of carbon in plastics used as chemical raw material for coke ovens that migrates to hydrocarbon)]

- ***Activity Data***

The amount of plastics in MSW used as raw material or fuel by usage (wet basis) was estimated by the total amount collected by designated legal bodies and municipalities to be processed as raw material or fuel by usage (wet basis). The amount of waste plastics (dry basis) was estimated by subtracting water content from the amount of waste plastics (wet basis). The amount of fossil-fuel derived plastics in MSW used as raw material or fuel (dry basis) was obtained by subtracting the amount of biomass-based plastics in MSW used as raw material or fuel assuming that all of the biomass-based plastics content in each usage is the same.

Amount of fossil-fuel derived waste plastics used as raw material or fuel by usage (dry basis)
= Amount of waste plastics used as raw material or fuel by usage (wet basis) × (1 – Water content in waste plastics) – Amount of biomass-based plastics in MSW used as raw material or fuel (dry basis) × Amount of MSW used as raw material or fuel by usage / amount of waste plastics in MSW used as raw material or fuel

As in the CO_2 emission estimates in "Municipal Solid Waste Incineration (6.C.1)", the amount of biomass-based plastics in MSW used as raw material or fuel was estimated as indicated below.

Amount of biomass-based plastics in MSW used as raw material or fuel (dry basis))
= Amount of biomass-based plastic products consumed (dry basis) × Fraction of biogenic component × Fraction of biomass-based plastics disposed of as MSW × Fraction of biomass-based plastics used as raw material or fuel

➢ *Processing of plastics collected by designated legal bodies*

The amount of the plastics in MSW collected by designated legal bodies into raw material and fuel was determined from the amount reported (pyrolytic oil: petrochemical, blast furnace reducing agent, chemical raw material in coke-oven, syngas, and gasification) in the "Plastic Containers and Packaging (Other Plastics, Food Trays)" section of the *Statistics of Commercial Recycling of Plastics (Recycling)* compiled by the Japan Containers and Packaging Recycling Association. Usage in products that do not emit CO_2 was deducted.

➢ *Processing of plastics collected by municipalities*

The amount of plastics in MSW collected by municipalities and processed into raw material or fuel was calculated by first subtracting the amount of plastics (wet basis) that was commercially recycled through designated legal bodies from the amount of all plastics that were commercially recycled under the Plastic Containers and Packaging Recycling Law (wet basis). The amount of waste plastics used as raw material or fuel by usage was estimated by multiplying the amount of plastics in MSW collected by municipalities to be processed into raw material and fuel by the fraction of plastic content by usage and the fraction of amount of commercially recycled products.

- Amount of plastics commercially recycled under the Plastic Containers and Packaging Recycling Law (wet basis)

  The results of the selective collections by municipalities and commercial recycling under the Plastic Containers and Packaging Recycling Law were determined from *Annual Recycling Statistics* by the Waste Management and Recycling Department of the Ministry of the Environment.

- Amount of plastics commercially recycled through designated legal body channels (wet basis)

  The amount was determined from the "Actual Collection of Plastic Containers and Packages" section of the *Statistics of Commercial Recycling of Plastics (Recycling).*

- Percentage of commercially recycled plastics by recycling method

  The rates were obtained from the percentages for various methods of commercial recycling of the plastics collected through municipal channels in the *Results of the 2001 Questionnaire to Municipalities on Waste Plastics Processing* compiled by the Plastic Waste Management Institute.

- Percentage of commercially recycled plastic products by recycling method

  The values for the commercial recycling of the plastics collected through the municipal channels were substituted for the percentage of commercially recycled plastic products collected through designated legal body channels. The percentages were calculated by dividing the amounts of commercially recycled plastic products by various recycling methods, which were established in the activity data for recycling through designated legal body channels, by the amount of commercially recycled plastics. The amount of commercially recycled plastics by each of the recycling methods was calculated by multiplying the amount of plastics commercially recycled through designated legal body channels, by the percentage of commercially recycled plastics by recycling method obtained from the *Assessment and Deliberation of the Plastic Containers and Packaging Recycling Law*, the Japan Containers and Packaging Recycling Association.

➢ Water content ratio

Water content ratio of 4% was determined based on the data provided by the *Japan Containers and Packaging Recycling Association*.

➢ Amount of biomass plastics products consumed

Refer to the section “Municipal Solid Waste Incineration (6.C.1).”

➢ Fraction of biogenic component in biomass-based plastics disposed of as MSW

Refer to the section “Municipal Solid Waste Incineration (6.C.1).”

➢ Fraction of waste plastics used as raw material or fuel

Refer to the section “Municipal Solid Waste Incineration (6.C.1).”

2） CH_4, N_2O

For estimation method and emission factors, refer to the section “Emissions from Direct Use of Waste as Fuel (8.4.3)”. The amount of waste plastics used as raw material or fuel by usage (wet basis) was determined by the total amount collected by designated legal bodies and municipalities to be processed as raw material and fuel by usage (wet basis); this value includes the amount of biomass-based plastics consumed.

c） Uncertainties and Time-series Consistency

● Uncertainties

The same value of uncertainty in “CO_2 emissions from incineration of MSW (6.C.1.a)” was used for the uncertainty in the CO_2 emission factor. The uncertainty in activity data for CO_2 emissions was estimated by using the uncertainties in the amount of plastics used as raw materials or alternative fuels (statistical uncertainty) and the percentage of water content (same value that was used for the MSW incineration).

The uncertainty in the CH_4 emission factor was estimated by using the uncertainties in emission factors and the calorific value of plastics. For uncertainty in CH_4 and N_2O activity data, the uncertainties in the amount of MSW plastics used as raw materials or alternative fuels were used. The uncertainties in the CO_2, CH_4 and N_2O emissions from MSW plastics used as raw materials or alternative fuels were estimated to be 17%, 180% and 112%, respectively. For details, refer to the Annex 7.

- ***Time series consistency***

Time series consistency in emission estimates has been ensured. However, the statistical data for activity data have been available since FY 2000 because the use of waste as alternative fuel or raw material was not a common practice prior to FY 2000 in Japan.

d）Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials. Also, QA activity was implemented for the waste sector by the GHG Inventory Quality Assurance Working Group in FY 2009. For more details of QA/QC activities, refer to the Annex 6.

e）Source-specific Recalculations

The CO_2 Emission estimates for the period FY 2007 – FY 2008 were recalculated because the amount of biomass-based plastics in MSW used as raw material or fuel became available.

f）Source-specific Planned Improvements

No improvements are planned.

8.4.3.2. Emissions from industrial waste (waste plastics, waste oil, and waste wood) used as raw material or alternative fuels (1.A.2.))

a）Source/Sink Category Description

This category covers greenhouse gas emissions from industrial waste (waste plastics, waste oil, and waste wood) used as raw material or alternative fuels.

b）Methodological Issues

1）CO_2

- ***Estimation Method and Emission factor***

Emissions were estimated by multiplying the incinerated amount of waste plastics and waste mineral oil used as raw material or alternative fuels by emission factor used for incineration of ISW.

- ***Activity Data***

➢ ***Industrial waste plastics***

Estimated activity data were the amounts of waste plastics (wet basis) in industrial waste used as raw material or fuel in steel industry, chemical industry, paper industry, cement Manufacturer, and automobile manufacturer. The amount of waste plastics in industrial waste used as raw material or fuel in each industry was provided by the following data sources: for steel industry, the *Current State of Plastic Waste Recycling and Future Tasks* published by the Japan Iron and Steel Federation; for cement manufacturing industry, from the *Cement Handbook* published by the Japan Cement Association; for chemical industry, paper industry, and automobile manufacturer, the amount of waste plastics used for fluid bed boiler provided by the Japan Chemical Industry Association, the Japan

Paper Association, the Japan Automobile Manufacturers Association. All of the waste plastics in ISW was considered to be fossil-fuel derived.

➢ *Waste mineral oil*

Activity data were estimated by subtracting the amount of biogenic-origin waste oil indicated as "Fraction of Animal and Vegetable Origin Waste Oil" provided by the survey conducted by the Ministry of the Environment from the amount of waste oil indicated as "Fuel Usage" of "Direct Recycle Usage" and "Recycle Usage after Treatment" of ISW provided by the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes*. The activity data for FY1997 and before were estimated by using the trend of the amount of incinerated industrial waste oil.

2） CH_4, N_2O

● *Estimation Method and Emission factor*

Refer to the section "Emissions from Direct Use of Waste as Fuel (8.4.3)"

● *Activity Data*

➢ *Waste plastics*

Estimated activity data were the amounts of waste plastics used for cement kilns and boilers. Out of the activity data used for CO_2 emission estimates from this source, the amount used as raw materials and fuels in chemical industry, paper industry, cement manufacturer, and automobile manufacturer were used for CH_4 and N_2O emission estimates. Because blast furnace gas generated from steel industry is entirely recovered and not included in the activity data.

➢ *Waste oil (Mineral / Animal and Vegetable)*

The amount of waste oil used as raw material or fuel is calculated separately for cement kilns and boilers. The amount of waste oil and reclaimed oil, which was produced from the waste oil contained in industrial waste and other waste oil, used as fuel for cement kilns was determined from the annual data in the *Cement Handbook*. The amount used as fuel for boilers was determined by subtracting the amount used as fuel for cement kilns from the amount of waste oil indicated as "Fuel Usage" of "Direct Recycle Usage" and "Recycle Usage after Treatment" of ISW provided by the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes.*

Unlike the activity data for CO_2 emissions, waste mineral oil and also waste animal and vegetable oil are included for the estimation of activity data from this source.

➢ *Waste wood*

The amount of usage of waste wood as raw material or fuel was obtaineded from the "fuel usage" in the "direct recycle usage" and the "fuel usage" in the "recycle usage after treatment" in the *Report of the Research on the State of Wide-range Movement (the volume on Cyclical Use)*. The values before FY 1997 are estimated by using the average value in the period of FY 1998-2002.

c） *Uncertainties and Time-series Consistency*

● *Uncertainties*

The same value of uncertainty as was used for "CO_2 emissions from incineration of industrial waste (6.C.1.b)" was applied to uncertainty in CO_2 emission factor. The uncertainties in emission factors for

CH_4 and N_2O were evaluated by the same method that was used for municipal waste used as raw materials or alternative fuels. The uncertainty in activity data were evaluated separately for waste plastics, waste oil, and waste wood. For waste plastics, the uncertainty was calculated by combining of the uncertainties in the amount of waste plastics used as raw materials or alternative fuels in the iron and steel industry and in the cement industry. The uncertainty levels for each component were evaluated by using the statistical uncertainties. For waste oil, the values for cement kilns (statistical uncertainty) and boilers (a value for CO_2) were combined. For waste wood, statistical uncertainties for the amount of waste wood used as raw materials or alternative fuels were used.

The uncertainties in CO_2, CH_4 and N_2O emissions from the incineration of industrial waste used as raw material or alternative fuels were estimated to be in the range of 13-105%, 74-128% and 31-110%, respectively. For details, refer to the Annex 7.

- ***Time series consistency***

Data on the amount of waste oil and waste wood used as alternative fuels have been available since FY 1998. For waste oil, consistent data over the time series were developed by using the total amount of waste oil incinerated without the use of waste oil as alternative fuel. For waste wood, the average of FY 1998–2002 data was used to estimate the amount of waste wood for the past years. The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials. Also, QA activity was implemented for the waste sector by the GHG Inventory Quality Assurance Working Group in FY 2009. For more details of QA/QC activities, refer to the Annex 6.

e） Source-specific Recalculations

The emission estimates for the period FY 1990 – FY 2008 were recalculated because of the update of the amount of waste plastics used as raw material or fuel.

f） Source-specific Planned Improvements

No improvements are planned.

8.4.3.3. Emissions from waste tires used as raw materials and alternative fuels (1.A.1 and 1.A.2)

a） Source/Sink Category Description

This category includes the emissions from the use of waste tires as raw materials or alternative fuels.

b） Methodological Issues

1） CO_2

- ***Estimation Method***

The emissions were calculated by multiplying the incinerated amount of waste tires used as raw materials or fuels by Japan’s country-specific emission factor.

- ***Emission factor***

The emission factor for waste tires was calculated by multiplying the fossil fuel-derived carbon content of the waste tires by the efficiency of combustion of the waste tires at the facilities that use waste tires as fuel. The volume of the fossil fuel-derived carbon in the waste tires was calculated by the material contents of new tires. The efficiency of combustion for waste tires was set to 99.5% based on the maximum default value for hazardous waste in the *GPG (2000)*.

Calculation of emission factor for the incineration of waste tires (dry basis)
= (Fossil fuel-derived carbon content in waste tires) × (Efficiency of combustion of waste tires) × 1000 × 44 / 12

- ***Activity Data***

Activity data (dry basis) was calculated by subtracting the water content in the waste tires determined from analyses of three constituents of divided tires reported in *the Basic Waste Date Fact Book (2000)* published by Japan Environmental Sanitation Center from the amount of waste tires used as raw material or fuel (wet basis) in the *Tire Industry of Japan (32),* published by the Japan Automobile Tire Manufacturers Association, Inc.

2） CH_4, N_2O

- ***Estimation Method and Emission factor***

Refer to the section 8.4.3.

- ***Activity Data***

The volume of waste tires used as raw material or fuel by usage that was determined during the calculation of the CO_2 emissions from this source was used. For the activity data, the volume of waste tires recorded in the following categories were used: “Cement kilns” for use in cement kilns; “Medium to small boilers”, “Use by tire factories”, “Use by paper manufacturers”, and “Power generation” for use in boilers; “metal refining” for use in carbonization; and “Gasification” for use in gasification processes.

c） Uncertainties and Time-series Consistency

- ***Uncertainties***

The level of uncertainty in CO_2 emission was estimated by using the carbon content of waste tires and the combustion rate of the furnace using waste tires as alternative fuels. For activity data, the uncertainty was estimated by using the uncertainties in the amount of waste tires used as raw materials or alternative fuels and the percentage of water contents in waste tires. The uncertainties in the emission factors for CH_4 and N_2O were evaluated by the same method that was applied to MSW used as raw materials or alternative fuels and were estimated by combining the uncertainties in emission factors (CH_4, N_2O of the Energy sector) using waste tires as raw materials or alternative fuels and in the calorific value of waste tires. For activity data, the uncertainties in the amount of waste tires used as raw materials or alternative fuels were used. The methods of evaluation of the uncertainty levels for each component are:

- Use of the values for industrial waste (waste plastics) incineration: carbon content and combustion rate

- Based on expert judgment: percentage of water contents

- Use of the uncertainties set by each statistics: amount of waste tires used as raw materials or alternative fuels

The uncertainties in CO_2, CH_4 and N_2O emissions from the use of waste tires as raw materials or alternative fuels were estimated to be 15%, 91% and 26%, respectively. For details, refer to the Annex 7.

- ***Time series consistency***

The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials. Also, QA activity was implemented for the waste sector by the GHG Inventory Quality Assurance Working Group in FY 2009. For more details of QA/QC activities, refer to the Annex 6.

e） Source-specific Recalculations

No recalculations were conducted.

f） Source-specific Planned Improvements

No improvements are planned.

8.4.4. Emissions from incineration of waste processed as fuel (1.A.)

8.4.4.1. Incineration of refuse-based solid fuels (RDF and RPF) (1.A.1 and 1.A.2)

a） Source/Sink Category Description

In this category, CO_2, CH_4, and N_2O emissions from waste that is processed and used as fuel are estimated and reported. Refuse-derived solid fuels (RDF as Refuse Derived Fuel and RPF as Refuse Paper and Plastic Fuel) are used for the estimation of emissions from fuels produced from waste. The reporting categories for the above emissions are included in “Energy Industry (1.A.1) ” and “Manufacturing/Construction (1.A.2)” according to the use of waste as fuels. The fuel type is classified as “Other fuels”.

Table 8 - 65 Estimation category for emissions from the use of waste processed as fuel

Emission source	Application breakdown	Major application	Reporting category of Energy sector
Use of refuse-derived fuel （RDF・RPF）	RDF	Fuel use (including power generation)	1A2f Other*
	RPF (petroleum products)	boiler fuel	1A1b Petroleum refining
	RPF (chemical industry)	boiler fuel	1A2c Chemicals
	RPF (paper manufacture)	Fuel use in paper manufacturing	1A2d Pulp, paper and print
	RPF (cement burning)	Cement burning	1A2f Cement & ceramics

* : Emissions from power generation and heat supply excluding in-house use should be included in the category 1A1a. However, they are reported in the category 1A2f, because the actual circumstances are not understood at the moment.

b） Methodological Issues

1） CO_2

- **Estimation Method**

Emissions were estimated by multiplying the incinerated amount of RDF and RPF by Japan's country-specific emission factor.

- **Emission factor**

Emission factor associated with the use of the refuse-derived solid fuels (RDF and RPF) was calculated separately for RDF and RPF by the equation shown below. For the RPF (refuse paper and plastic fuel), the emission factors were calculated separately for the coal-equivalent and coke-equivalent fuels, and also calculated their average weighted by the percentage used as fuel.

Calculation of emission factor for the use of RDF and RPF as fuel (dry basis)
= 1000 × (1 - Average percentage of water content) × (Percentage of plastic-derived constituents, dry basis) × (Carbon content of plastics, dry basis) × (Efficiency of combustion) × 44 / 12

➢ ***Average percentage of water content***

Percentage of water contents in the RDF was set to 5.5%, based on the simple average of water content in the RDF manufactured by the facilities listed in the *Proper Management of Refuse-derived Fuels* compiled by the Study Group for Proper Management of RDF.

Percentage of water contents in the RPF was set to 2.6%, based on the water contents of coal-equivalent and coke-equivalent products indicated by the RPF quality standards set by the Japan RPF Industry Association with their average weighted by the manufacturing ratio of these products.

➢ ***Percentage of plastic-derived content***

Calculation of the percentage of the plastics-derived constituents (dry basis) used the wet-based moisture content of the constituents of MSW determined in the "Emission from Controlled Disposal Sites (6.A.1.)" section, which was converted to a dry-based value. The results of the content analysis of the wet-based refuse were obtained from the *Results of Content Analysis of Refuse* for each facility listed in the "Proper Management of Refuse-derived Fuels". The percentage of plastics-derived constituents in the RPF (dry basis) was set at 50% for the coal-equivalent product and 90% for the coke-equivalent product based on the results of a fact-finding survey by the Japan RPF Industry Association.

➢ ***Carbon content in plastics***

Average carbon content used in the "Incineration of Municipal Solid Waste (Plastics)" (Table 8 - 35)" was applied to the carbon content in plastics contained in the RDF (dry basis). The carbon content (73.7%) of plastics contained in the RPF (dry basis) was determined from the carbon content value (70%) used in the "Incineration of Industrial Waste (Waste Plastics)" (95%), which was converted to a dry basis using the moisture content in waste plastics in industrial waste.

➢ ***Efficiency of combustion***

Rate of combustion of the RDF was set to 99%, applying the default value in the *GPG (2000)* in the same manner as for MSW (plastics). The rate for the RPF was set to 99.5%, using the default value in the *GPG (2000)* in the same manner as for industrial waste (waste plastics).

Table 8 - 66 CO_2 emission factors for the emissions from the use of refused-derived fuel (RDF) or refuse paper & plastic fuel (RPF)

Item	Emission Factor [kg CO_2/t (dry)]
RDF	808
RPF (coal-equivalent products)	1,419
RPF (coke-equivalent products)	2,445
RPF (weighted average values)	1,627

- ***Activity Data***

➢ *RDF*

The amount of RDF production was used as the substitute for the amount of use of RDF. Activity data (dry basis) was calculated by subtracting the water content of RDF from the amount of RDF production at RDF production facilities (wet basis) provided by the *Report on Survey of State of Treatment of Municipal Solid Waste* and also subtracting the amount of biomass-based plastics used as RDF. For the fiscal years that the data were unavailable, emission estimates were conducted substituting the values of the refuse processing capacity.

Activity data for the use of RDF (dry basis)
= Amount of use of RDF (wet basis) × (1 – water content of RDF) - Amount of biomass-based plastics used as RDF (dry basis)

As in the activity data for CO_2 emission estimates in "Municipal Solid Waste Incineration (6.C.1)", the amount of biomass-based plastics used as RDF was estimated as indicated below

Amount of biomass-based plastics used as RDF (dry basis)
= Amount of import of biomass plastics (dry basis) × Fraction of biogenic component
× Fraction of biomass-based plastics disposed of as MSW × Fraction of use of RDF

➢ *Amount of biomass-based plastics products consumed*

Refer to the section "Municipal Solid Waste Incineration (6.C.1)."

➢ *Fraction of biogenic component and biomas-baseds plastics disposed of as MSW*

Refer to the section "Municipal Solid Waste Incineration (6.C.1)."

➢ *Fraction of use of RDF*

Refer to the section "Municipal Solid Waste Incineration (6.C.1)."

➢ *RPF*

The amounts of RPF used in chemical industry, paper industry, cement manufacturer, and petroleum product manufacturer were estimated. The amount of RPF (dry basis) for paper industry was obtained from the survey results conducted by the Japan Paper Association. The amounts of RPF (dry basis) for chemical industry, cement manufacturer, and petroleum product manufacturer were obtained by using the average water content of RPF and also the survey results (wet basis) conducted by the Japan Cement Association and the Japan Automobile Manufacturers Association. All of the plastices included in RPF was conisdered to be fossil-fuel derived.

Table 8 - 67 Amount of use of refuse-derived fuel (RDF) or refuse paper & plastic fuel (RPF) (wet basis)

Item	Unit	1990	1995	2000	2005	2007	2008	2009
RDF	kt (dry)	32	37	140	392	375	365	355
RPF	kt (dry)	0	8	32	478	752	749	776

2） CH_4, N_2O

● *Estimation Method and Emission factor*

For the estimation method and the emission factors used, refer to “Emissions from Direct Use of Waste as Fuel (8.4.3)”.

Table 8 - 68 Data used for the calculation of the methane and nitrous oxide emission factors for wastes used as raw material and fuel

Item		Emission factor for furnaces and ovens (Energy sector)	Calorific value
RDF	Boilers	CH_4: Boilers (Steam coal, coke, other solid fuels) N_2O: Boilers (other than fluidized-bed) (solid fuel)	Calorific value of RDF
RPF	Cement kilns, boilers	Other industrial furnaces (solid fuel)	Calorific value of RPF ※
	Boilers	CH_4: Boilers (Steam coal, coke, other solid fuels) N_2O: Boilers (other than fluidized-bed) (solid fuel)	

*Weighted average of calorific values calculated based on the manufacturing ratio of Coal substitution RPF and Coke substitution RPF given by the Japan RPF Industry Association

● *Activity Data*

➢ *RDF*

The entire amount of RDF production (wet basis) used for CO_2 emission estimates was also used for the amount of use of RDF for boiler. The said amount includes the amount of biomass-based plastics.

➢ *RPF*

Out of the amount of RPF used for CO_2 emission estimates, the amounts of RPF used in chemical industry, paper industry, and petroleum products manufacturer were applied to the amount of PRF used for boiler (wet basis). The amount of PRF used in cement industry was applied to the amount of RPF used for cement kiln (wet basis). Because the amount of RPF used in paper industry is on a dry basis, the average water content of RPF was added to obtain the value on a wet basis.

➢ *Activity data converted into energy units (reference value)*

Activity data converted into energy units to be reported in CRF is calculated as indicated below.

Activity data converted into energy units

= (Amount of RDF & RPF consumed (kg [wet basis]))×calorific value of corresponding fuel (MJ/kg)） / 10^6

c） *Uncertainties and Time-series Consistency*

● *Uncertainties*

The level of uncertainty in the CO_2 emission factor for RDF used as fuels was estimated by using the uncertainties in the percentage of plastic-derived constituents in RDF, carbon content in the plastics, and combustion rate of the facilities using RDF as fuels. For RPF, the uncertainty in emission factor for coal-equivalent RPF was used. The uncertainty in activity data was estimated by combining the uncertainty for each element because the activity data were estimated by subtracting water content from the amount of RDF and RPF used as fuels (wet basis) to obtain the values on a dry basis.

The uncertainties in the CH_4 and N_2O emission factors were estimated by using the uncertainties in emission factors by usage of RDF and RPF and the calorific values of the RDF and RPF. For activity data, the uncertainties in the amount of RDF and RPF were used.

The methods of evaluation of the uncertainty levels for each component are:

- Use of 95% confidence interval of data: percentage of plastic-derived constituents of RDF, percentage of water content in RDF
- Use of the values for MSW (plastics) incineration: carbon content of RDF and combustion rate for RDF
- Use of the values for ISW (waste plastics) incineration: carbon content of RPF and combustion rate for RPF
- Expert judgment: percentage of plastic-derived constituents of RPF
- Use of the uncertainties set by each statistics: amount of RDF and RPF used as alternative fuels

The uncertainties in CO_2, CH_4, and N_2O emissions from the use of RDF and RPF as raw materials or alternative fuels were estimated to be 44%, 49%, and 33%, respectively. For details, refer to the Annex 7.

● *Time-series consistency*

Because data on the amount of RDF produced were not available for the years prior to FY 1997, these data were estimated by using the trend on capacity of refuse-based fuel-producing facilities. The emissions were calculated in a consistent manner.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials. Also, QA activity was implemented for the waste sector by the GHG Inventory Quality Assurance Working Group in FY 2009. For more details of QA/QC activities, refer to the Annex 6.

e） Source-specific Recalculations

- The CO_2 emission estimates for the period FY 2007 - FY 2008 were recalculated because the amount of biomass-based plastics in MSW consumed contained in RDF became available.

- The Emissions estimates for the period FY 2002 - FY 2008 were recalculated because of the update of the amount of use of RPF.

f） Source-specific Planned Improvements

No improvements are planned.

8.5. Other (6.D.)

In this category, CO_2 emissions as a result of the decomposition of petroleum-derived surfactants and CH_4 and N_2O emissions from the composting of organic waste are calculated. Estimated greenhouse gas emissions from category ‘Other’ are shown in Table 8-69. In FY 2008, emissions from this source category were 560 Gg-CO_2 eq. and accounted for 0.05% of the national total emissions (excluding LULUCF). The emissions from this source category had decreased by 23.3% compared to those in FY 1990. This emission decrease is primarily due to the decrease in CO_2 emissions for FY2001 through FY2004 from the use of alkylbenzenes by introduction of the Pollutant Release and Transfer Register (PRTR).

Table 8 - 69 GHG emissions from category ‘Other’ (6.D.)

Gas	Category	Unit	1990	1995	2000	2005	2007	2008	2009
CO_2	6.D.2. Decomposition of petroleum-derived surfactants	Gg CO_2	703	668	656	507	561	530	514
CH_4	6.D.1. Composting of organic waste	Gg CH_4	0.7	0.5	0.6	0.8	1.0	1.0	1.2
		Gg CO_2 eq	14	11	13	16	21	21	25
N_2O		Gg N_2O	0.04	0.03	0.04	0.05	0.06	0.06	0.07
		Gg CO_2 eq	13	10	12	14	18	18	22
Total of all gases		Gg CO_2 eq	730	689	681	537	600	570	560

8.5.1. Emissions from Composting of Organic Waste (6.D.1)

a） Source/Sink Category Description

Part of the MSW and industrial waste generated in Japan is composted, and CH_4 and N_2O generated in that process are emitted from composting facilities. Emissions from composting of livestock waste are accounted for under “Emissions from manure treatment (4.B)” in the agriculture sector.

b） Methodological Issues

- ***Estimation Method***

Emissions were calculated by taking the amount of organic waste composted, which was obtaineded from the statistical information available in Japan, and multiplying it by the default emission factor provided in the *IPCC 2006 Guidelines*. The calculation method is the same for both CH_4 and N_2O emissions.

$$E = EF \times A$$

E : Amount of CH_4 (N_2O) emissions generated by composting organic waste (kg CH_4 or kgN_2O)
EF : Emission factor for (dry basis) (kg CH_4/t, （kg N_2O/t）
A_{dry} : Amount of composted organic waste (dry basis)

- ***Emission factor***

In accordance with the *2006 IPCC Guidelines*, emission factors (dry basis) are set as 10.0 (kg CH_4/t) for $CH_4$and 0.6 (kg N_2O/t) for N_2O, respectively, for all fiscal years.

● *Activity data*

Activity data (amount composted on a dry basis) was obtained by subtracting the water content appropriate to the properties of composted waste from the amount of composted waste (wet basis) listed below:

➢ *Municipal Solid Waste*

- Amount of composted waste by waste types calculated by multiplying the amount of MSW treated at waste composting facilities indicated in the *Waste Treatment in Japan* by the fraction of waste types in MSW treated at high-rate composting facilities provided in the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes.*

- Amount of human waste composted at waste composting facilities indicated in the Ministry of the Environment, Waste Management and Recycling Department, *The state of municipal waste treatment survey*.

➢ *Industrial Solid Waste*

- Amount of sludge treated at composting facilities provided by the *Sewage Statistics*

Percentage of water content in composted waste, as indicated in the "Emissions from Controlled Disposal Sites (6.A.1)" section, are; 20% in waste paper, 75% in kitchen waste, 20% in textile waste, 45% in waste wood, and 70% in sewage sludge.

Table 8 - 70 Amounts of composted waste

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Municipal solid waste	kt (dry)	38	22	29	36	46	53	68
Industrial solid waste	kt (dry)	31	33	34	39	52	46	50

c） *Uncertainties and Time-series Consistency*

● *Uncertainties*

The uncertainty in emission factor was estimated by using the upper and lower limits for the uncertainty range provided in the *2006 IPCC Guidelines*. For activity data, uncertainty was evaluated on the basis of the statistical uncertainties. The uncertainties in CH_4 and N_2O emissions from composting of organic wastes were estimated to be 74% and 86.3%, respectively. For more details, refer to the Annex 7.

● *Time series consistency*

With respect to the input of municipal waste at composting facilities, due to changes in the statistical classification, the data used for FY 2005 and subsequent years covered a wider scope than those used in the FY 2004 and years prior. Consequently, the continuity of values between FY 2004 and FY 2005 is not maintained. Re-tabulation of the FY 1990–2004 data according to the current classification is now in progress, and the activity data will be updated as soon as the new data become available. The estimation methodology itself, however, remains consistent.

d） *Source-specific QA/QC and Verification*

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials.

e） Source-specific Recalculations

The Emission estimates for the period FY 2005 – FY 2008 were recalculated because of the update of the amount of MSW treated at waste composting facilities.

f） Source-specific Planned Improvements

- For future inventories, detailing of emission estimates will be conducted upon new scientific findings because the necessity of establishing country-specific emission factor from this source has been well recognized.

- The implementation of emission estimates from domestic and commercial composting machine will be further considered because this kind of research could not be completed in a short period of time, and a long-term efforts on scientific investigations will be necessary.

8.5.2. Emissions from the Decomposition of Petroleum-Derived Surfactants (6.D.2)

a） Source/Sink Category Description

Surfactants are used for various cleaning activities at home and factories in Japan. Petroleum-derived surfactants discharged into wastewater treatment facilities and into the environment, and emit CO_2. As this emission source did not correspond to any of the existing waste categories (6.A. to 6.C.), it was included in the “Other (6.D.)” section. Because “CH_4 and N_2O emissions from wastewater treatment” and “CO_2 emissions from the decomposition of petroleum-derived surfactants” concern different types of gas, they are unrelated to each other and pose no duplicate inventory issues.

b） Methodological Issues

● Estimation Method

As neither the *Revised 1996 IPCC Guidelines* nor the *GPG (2000)* specified a method for determining CO_2 emissions, a method specifically established in Japan was applied to the calculation. Because carbon contained in surfactants that emitted into wastewater treatment facilities and into the environment is eventually oxidized to CO_2 and emitted into the atmosphere as a result of surfactants decomposition, CO_2 emissions were estimated based on the amount of carbon contained in surfactants that emitted into wastewater treatment facilities and into the environment.

Based on the facts stated above, the CO_2 emissions were calculated by multiplying the volume of the petroleum-derived surfactant for each type of raw material by the carbon content of each of the materials. The calculation covered synthetic alcohols, alkylbenzenes, alkylphenols, and ethylene oxide. Some of the carbon contained in surfactants discharged into wastewater treatment facilities are adsorbed and assimilated by sludge. However, this portion of carbon is not decomposed biologically. It is released into the atmosphere as CO_2 through incineration and landfilling of sludge. Therefore, the emission is included in CO_2 emission estimates.

● Emission factor

Emission factor was determined for each type of material by calculating the amount of CO_2, expressed in kg that was emitted from the decomposition of 1 t of a surfactant using the average carbon content in the molecules.

$$EF_i = C_i \times 1{,}000 \times 44/12$$

EF_i : Emission factor of petroleum-derived raw material *i* used in a surfactant

C_i: Average carbon content of petroleum-derived raw material *i* used in a surfactant

Table 8 - 71 Average carbon content of surfactants, by petroleum-derived raw material

Raw material	Carbon number	Molecular weight	Carbon content	Basis for determination
Synthetic alcohol	12	186	77.4%	C12-alcohol as the main constituent.
Alkylbenzene	18	250	86.4%	C12-alkylbenzene as the main constituent.
Alkylphenol	15	210	85.7%	C9-alkylphenol as the main constituent.
Ethylene oxide	2	44	54.5%	Based on ethylene oxide molecules (C_2H_4O)

- ***Activity Data***

Activity data is the amount of raw materials consumed for petroleum-derived surfactants. As some of the surfactants produced in Japan are exported, the activity data were determined by multiplying the volume of raw materials used in the surfactants obtained from the statistical data for surfactant use by an import/export adjustment factor.

➢ ***Volume of surfactants used***

The volumes of the use of surfactant by material were obtaineded from the consumption of raw materials for surfactants indicated in the *Chemical Industry Statistical Yearbook*. As there was no compilation of usage since FY 2002, the volume of use was estimated using the simple averages (k value) of ratio of consumption and production in the period from FY 1990 to FY 2001.

➢ ***Export/import correction factor***

Correction factor was calculated from the export/import statistics in *International Trade Statistics* by the Customs Bureau of the Ministry of Finance for categories of anionic surfactants, cationic surfactants, non-ionic surfactants, and other organic surfactants and the volume of surfactants used. As some of the materials for surfactants were used in several types of surfactants, an average of the export/import correction factor was weighted by surfactant production volume as necessary to calculate the correction factor for each classification of surfactant.

Export/Import correction factor
= (Surfactant production + Surfactants imported – surfactants exported) / surfactant production

Table 8 - 72 Activity data associated with decomposition of petroleum-based surfactants

Item	Unit	1990	1995	2000	2005	2007	2008	2009
Synthetic alcohol	t	29,239	16,253	28,285	31,609	36,896	32,988	32,879
Alkyl benzene	t	105,432	102,794	80,832	47,349	51,251	55,442	50,206
Alkyl phenol	t	10,141	8,798	7,454	3,448	3,084	2,338	2,045
Ethylene oxide	t	124,984	132,175	146,509	127,150	141,104	125,628	126,298

c） Uncertainties and Time-series Consistency

● Uncertainty

The level of uncertainty associated with emission factor was evaluated by using the differences in carbon content in the major constituents of raw materials for surfactants and was found to be 19% (calculated by using standard deviation). With respect to uncertainties in activity data, twice of the statistical uncertainties set out for the statistics (Survey of total population (rounding) and Other statistics) was used and evaluated to be 40%.

● Time-series consistency

Consistent methodology was used in the estimation. However, data on the amount of raw materials consumed for surfactants have became not available since FY 2002 and activity data were estimated from the production amount of the surfactants.

d） Source-specific QA/QC and Verification

Tier 1 QC activities are implemented in accordance with the *GPG (2000)*. The Tier 1 QC activities include the verification of parameters such as activity data and emission factors, and the archive of reference materials. Also,

e） Source-specific Recalculations

No recalculations were conducted.

f） Source-specific Planned Improvements

No improvements are planned.

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Chapter 9. Other (CRF sector 7)

9.1. Overview of Sector

UNFCCC Reporting Guidelines (FCCC/SBSTA/2006/9) para.29 indicates that Annex I Parties should report and explicitly describe the details of emissions from each country-specific source of gases which are not included in the IPCC Guidelines. According to this requirement, emissions from other category (CRF sector7) are indicated below.

9.2. CO_2, CH_4, N_2O, HFCs, PFCs and SF_6

The national inventory submitted this year does not include the emissions and removals of gases targeted under the Kyoto Protocol (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) from the sources which are not included in the IPCC Guideline.

9.3. NOx, CO, NMVOC and SO_2

The inventory submitted this year includes CO emissions from smoking as the emissions of indirect greenhouse gases (NOx, CO, NMVOC) and SO_2 from the sources which are not included in the IPCC Guideline.

Chapter 10. Recalculation and Improvements

10.1. Explanation and Justification for Recalculations

This section explains improvements on estimation of emissions and removals in the inventory submitted in 2011.

In accordance with the *Good Practice and Uncertainty Management in National Greenhouse Gas Inventories (2000)* and the *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry*, recalculations of previously reported emissions and removals are recommended in the cases of 1) application of new estimation methods, 2) addition of new categories for emissions and removals and 3) data refinement. Major changes in the inventory submitted last year are indicated below.

10.1.1. General Issues

In general, activity data for the latest year available at the time when the inventory is compiled are often revised in the year following the submission year because of such as the publication of data in the fiscal year basis. In the national inventory submitted this year, activity data in many sources for 2008 have been changed and as a result, the emissions from those sources for the inventory year have been recalculated.

10.1.2. Recalculations in Each Sector

The information of recalculation for sectors (energy; industrial processes; solvent and other product use; agriculture; land use, land-use change and forestry; and waste) is described separately at sections named as “Source/Sink-specific Recalculations” in Chapters 3 to 8.

10.2. Implications for Emission Levels

Table 10-1 shows the changes made to the overall emission estimates due to the recalculations indicated in “Section 10.1. Explanation and Justification for Recalculations”.

Compared to the values reported in the previous year’s inventory, total emissions excluding LULUCF sector in the base year (1990) under the UNFCCC decreased by 0.18%, and the total emissions in year 2008 decreased by 0.10% compared to the data reported in last year (Table 10-1).

Table 10-1 Comparison of emissions and removals in the inventories submitted in 2010and 2011

[Mt CO_2eq.]

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
CO_2	JNGI2010	1,080.0	1,082.1	1,090.9	1,081.0	1,139.5	1,152.5	1,160.3	1,155.7	1,119.7	1,154.2	1,174.0	1,157.7	1,194.1	1,189.8	1,189.6	1,199.8	1,184.8	1,218.8	1,135.6
with LULUCF[3)]	JNGI2011	1,071.5	1,073.2	1,082.0	1,071.4	1,129.5	1,142.1	1,150.3	1,144.9	1,109.5	1,144.2	1,164.2	1,149.0	1,184.9	1,180.9	1,180.7	1,192.0	1,178.5	1,212.5	1,134.9
	difference	*-0.78%*	*-0.82%*	*-0.82%*	*-0.89%*	*-0.88%*	*-0.90%*	*-0.86%*	*-0.93%*	*-0.91%*	*-0.86%*	*-0.83%*	*-0.75%*	*-0.77%*	*-0.75%*	*-0.74%*	*-0.66%*	*-0.53%*	*-0.51%*	*-0.06%*
CO_2	JNGI2010	1,143.4	1,152.8	1,160.9	1,153.6	1,213.4	1,226.5	1,238.8	1,234.6	1,198.6	1,233.6	1,254.3	1,238.3	1,276.0	1,281.6	1,281.5	1,286.0	1,266.7	1,300.6	1,214.4
without LULUCF	JNGI2011	1,141.2	1,150.1	1,158.6	1,150.9	1,210.7	1,223.7	1,236.6	1,231.5	1,195.9	1,230.9	1,251.6	1,236.4	1,273.5	1,278.6	1,278.0	1,282.3	1,263.1	1,296.3	1,213.3
	difference	*-0.20%*	*-0.23%*	*-0.20%*	*-0.23%*	*-0.22%*	*-0.23%*	*-0.18%*	*-0.25%*	*-0.23%*	*-0.22%*	*-0.22%*	*-0.15%*	*-0.20%*	*-0.23%*	*-0.27%*	*-0.29%*	*-0.29%*	*-0.33%*	*-0.10%*
CH_4	JNGI2010	31.9	31.7	31.4	31.2	30.5	29.5	28.9	27.8	27.0	26.4	25.8	25.0	24.1	23.5	23.1	22.7	22.3	21.8	21.3
with LULUCF	JNGI2011	31.9	31.7	31.4	31.2	30.5	29.6	28.9	27.8	27.0	26.4	25.8	25.0	24.1	23.5	23.1	22.7	22.3	21.8	21.2
	difference	*0.00%*	*0.01%*	*0.01%*	*0.01%*	*0.01%*	*0.26%*	*0.00%*	*0.00%*	*-0.01%*	*-0.01%*	*-0.01%*	*-0.01%*	*-0.02%*	*-0.02%*	*-0.02%*	*-0.02%*	*-0.02%*	*-0.01%*	*-0.43%*
CH_4	JNGI2010	31.9	31.7	31.4	31.1	30.5	29.5	28.9	27.8	27.0	26.4	25.8	25.0	24.1	23.5	23.1	22.7	22.3	21.8	21.3
without LULUCF	JNGI2011	31.9	31.7	31.4	31.1	30.5	29.6	28.9	27.8	27.0	26.4	25.8	25.0	24.0	23.5	23.1	22.7	22.3	21.8	21.2
	difference	*0.00%*	*0.01%*	*0.01%*	*0.01%*	*0.01%*	*0.26%*	*-0.09%*	*-0.13%*	*-0.05%*	*-0.03%*	*-0.04%*	*-0.06%*	*-0.10%*	*-0.03%*	*-0.07%*	*-0.06%*	*-0.03%*	*-0.02%*	*-0.53%*
N_2O	JNGI2010	31.6	31.1	31.2	30.8	32.0	32.4	33.4	34.1	32.6	26.1	28.7	25.3	24.5	24.2	24.3	23.9	23.9	22.6	22.5
with LULUCF	JNGI2011	31.7	31.2	31.3	31.1	32.3	32.7	33.7	34.4	32.8	26.4	29.0	25.5	24.8	24.5	24.5	24.0	24.0	22.7	22.5
	difference	*0.35%*	*0.41%*	*0.48%*	*0.81%*	*0.74%*	*0.99%*	*0.90%*	*0.85%*	*0.82%*	*1.00%*	*0.85%*	*1.00%*	*1.05%*	*0.95%*	*0.76%*	*0.67%*	*0.47%*	*0.38%*	*-0.24%*
N_2O	JNGI2010	31.5	31.0	31.1	30.8	32.0	32.3	33.4	34.1	32.6	26.1	28.7	25.3	24.5	24.2	24.3	23.9	23.9	22.6	22.5
without LULUCF	JNGI2011	31.6	31.1	31.3	31.0	32.2	32.7	33.7	34.3	32.8	26.4	28.9	25.5	24.8	24.5	24.5	24.0	24.0	22.7	22.4
	difference	*0.36%*	*0.42%*	*0.49%*	*0.82%*	*0.73%*	*0.98%*	*0.74%*	*0.71%*	*0.69%*	*0.86%*	*0.74%*	*0.88%*	*0.94%*	*0.86%*	*0.68%*	*0.60%*	*0.42%*	*0.33%*	*-0.29%*
HFCs	JNGI2010	NE	NE	NE	NE	NE	20.3	19.9	19.9	19.4	19.9	18.8	16.2	13.7	13.8	10.6	10.6	11.7	13.3	15.3
	JNGI2011	NE	NE	NE	NE	NE	20.3	19.9	19.9	19.4	19.9	18.8	16.2	13.7	13.8	10.6	10.6	11.7	13.3	15.3
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.01%*	*0.02%*	*0.03%*	*0.04%*	*0.05%*	*0.22%*
PFCs	JNGI2010	NE	NE	NE	NE	NE	14.2	14.8	16.2	13.4	10.4	9.5	7.9	7.4	7.2	7.5	7.0	7.3	6.4	4.6
	JNGI2011	NE	NE	NE	NE	NE	14.2	14.8	16.2	13.4	10.4	9.5	7.9	7.4	7.2	7.5	7.0	7.3	6.4	4.6
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*
SF_6	JNGI2010	NE	NE	NE	NE	NE	17.0	17.5	15.0	13.6	9.3	7.2	6.0	5.6	5.3	5.1	4.5	4.9	4.4	3.8
	JNGI2011	NE	NE	NE	NE	NE	17.0	17.5	15.0	13.6	9.3	7.2	6.0	5.6	5.3	5.1	4.8	4.9	4.4	3.8
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*7.36%*	*0.00%*	*0.00%*	*0.90%*
Total	JNGI2010	1,143.5	1,144.8	1,153.5	1,143.0	1,202.0	1,265.9	1,274.8	1,268.7	1,225.7	1,246.4	1,264.0	1,238.0	1,269.4	1,263.7	1,260.1	1,268.4	1,255.0	1,287.2	1,203.1
with LULUCF	JNGI2011	1,135.1	1,136.1	1,144.7	1,133.7	1,192.2	1,255.9	1,265.1	1,258.2	1,215.8	1,236.7	1,254.5	1,229.5	1,260.4	1,255.1	1,251.5	1,261.1	1,248.8	1,281.1	1,202.3
	difference	*-0.73%*	*-0.77%*	*-0.77%*	*-0.82%*	*-0.81%*	*-0.79%*	*-0.76%*	*-0.83%*	*-0.81%*	*-0.78%*	*-0.75%*	*-0.68%*	*-0.71%*	*-0.69%*	*-0.69%*	*-0.58%*	*-0.49%*	*-0.48%*	*-0.06%*
Total	JNGI2010	1,206.8	1,215.5	1,223.5	1,215.5	1,275.8	1,339.8	1,353.3	1,347.6	1,304.7	1,325.7	1,344.3	1,318.6	1,351.3	1,355.6	1,352.0	1,354.6	1,336.8	1,369.0	1,281.9
without LULUCF	JNGI2011	1,204.7	1,212.9	1,221.2	1,213.1	1,273.3	1,337.4	1,351.3	1,344.7	1,302.2	1,323.3	1,341.8	1,317.0	1,349.0	1,352.8	1,348.7	1,351.3	1,333.3	1,364.9	1,280.6
	difference	*-0.18%*	*-0.21%*	*-0.18%*	*-0.20%*	*-0.19%*	*-0.18%*	*-0.15%*	*-0.22%*	*-0.19%*	*-0.19%*	*-0.19%*	*-0.13%*	*-0.17%*	*-0.21%*	*-0.25%*	*-0.24%*	*-0.26%*	*-0.31%*	*-0.10%*

10.3. Implication for Emission Trends, including Time Series Consistency

Table 10-2 shows the changes made to the emission trends due to the recalculations indicated in “Section 10.1. Explanation and Justification for Recalculations”. The comparison between the 2010 submission (JNGI 2010) and the 2011 submission (JNGI 2011) applies the comparison values between the base year and FY2008.

The actual emissions of HFCs, PFCs, and SF_6 prior to CY1995 are not reported; hence, the comparison between JNGI 2010 and JNGI 2011 of these emissions applies the comparison values between CY1995 and CY2008.

Total emissions excluding LULUCF sector in the 2011 submission increased by approximately 0.8 million tons (in CO_2 equivalents) and increased by 0.1 percentage points, compared to the data reported in the previous submission.

Table 10-2 Comparison of increase and decrease from the base year, between the inventories submitted in 2010 and 2011 excluding LULUCF sector

		Trend [Mt CO_2eq.]			Trend (%)		
		JNGI2010	JNGI2011	Difference	JNGI2010	JNGI2011	Difference
CO_2	1)	71.0	72.1	1.1	6.2%	6.3%	0.1%
CH_4	1)	-10.6	-10.7	-0.1	-33.1%	-33.5%	-0.4%
N_2O	1)	-9.0	-9.2	-0.2	-28.5%	-29.0%	-0.5%
HFCs	2)	-5.0	-5.0	0.0	-24.7%	-24.5%	0.2%
PFCs	2)	-9.6	-9.6	0.0	-67.6%	-67.6%	0.0%
SF_6	2)	-13.2	-13.2	0.0	-77.8%	-77.6%	0.2%
Total	3)	23.6	24.4	0.8	1.9%	1.9%	0.1%

1) Comparison of emissions between FY1990 and FY2008

2) Comparison of emissions between CY1995 and CY2008

3) Comparison of emissions between the base year of the Kyoto Protocol (CO_2, CH_4, N_2O: FY1990, HFCs, PFCs, SF_6: CY1995) and 2008

10.4. Recalculations and improvement plan, including response to the review process

10.4.1. Improvements after submission of inventory in 2010

The major improvements carried out since submission of the2010 inventory are listed below.

10.4.1.1. Methodology for estimating emissions and removals of GHGs

Changed calculation methods are as follows. See each category for details.

1. For “1.A.1.a（Public electricity and heat production）”, CH_4 and N_2O emissions from biomass were recalculated, because of changed activity data for biomass consumption to statistical value from notation key ‘NO’.
2. For “1.A.2.d (Pulp, Paper and Print) ”, ”1.A.2.f (Machinery)” and “1.A.2.f (Duplication Adjustment)”, CH_4 and N_2O emissions from biomass were recalculated, because of changed activity data for biomass consumption to statistical value from notation key ‘NO’.
3. For “2.A.1.Cement Production,” the emission factor was re-established based on the data of 13 types of waste origin materials.
4. For “2.A. 2. Lime Production,” “2.A.3. Limestone and Dolomite Use,” “2.A.4. Soda Ash Production and Use,” and “2.B.4. Calcium Carbide,” a full re-examination was conducted through the use of the Adjusted Price Transaction Table and omission/double-counting of limestone related emissions has been resolved.
5. For “4.D.1. Crop Residue”, New Nitrogen content and Residue ratio were adopted.
6. For “4.F. Field Burning of Agricultural Residues”, nitrogen content and residue ratio were changed in accordance with the newly adopted data in “4.D.1. Crop Residue”.
7. For "5.A. Forest land", carbon stock change in living biomass of "5.A.2. Land converted to Forest land" was separated from "5.A.1. Forest land remaining Forest land" and reported individually, which had been combined to 5.A.1. and reported as "IE".
8. For "5.A.1. Forest land remaining Forest land", carbon stock changes in dead organic matters and soils before FY 2004 had been reported as "NE" due to lack of data, however, they were reported from the 2011 submission. In addition, carbon stock changes in organic soils before FY 2004 were reported as "IE", as had been reported for FY 2005 and after.
9. For "5.B.1. Cropland remaining Cropland", areas were recalculated due to change of estimation method.
10. For "5.B.2. Land converted to Cropland", areas were recalculated due to change of estimation method.
11. For "5.B.2. Land converted to Cropland", carbon stock changes in dead organic matters of the land converted from Grassland and Wetlands were changed from "NE" to "NA"; while those of the land converted from Settlements were changed from "IE" to "NA".
12. For "5.C.1. Grassland remaining Grassland", areas were recalculated due to change of estimation method.
13. For "5.C.2. Land converted to Grassland", areas were recalculated due to change of estimation method.
14. For "5.C.2. Land converted to Grassland", carbon stock changes in dead organic matters of the land converted from Settlements were changed from "IE" to "NA", while the land converted from Cropland and Wetlands were changed from "NE" to "NA".
15. For "5.D.2. Land converted to Wetlands", areas of the land converted from Forest land were recalculated due to change of estimation method.

16. For "5.D.2. Land converted to Wetlands", carbon stock changes in dead organic matters of the land converted from Cropland, Grassland and Settlements were changed from "NE" to "NA".
17. Area of Urban Green Facilities in “5.E.1. Settlements remaining Settlements” was recalculated due to change of estimation method.
18. Area of Settlements converted from Forest land in “5.E.2 Land converted to Settlements” was recalculated due to change of estimation method.
19. Area of Cropland converted from Wetlands and Settlements in “5.E.2 Land converted to Settlements”, which used to be reported as “IE”, was reported as “NO”.
20. For “5.F.2 Land converted to Other land”, areas were recalculated due to change of estimation method.
21. For “6.C Waste Incineration” and “1.A.Fuel combustion”, CO_2 from incineration of biomass-plastics was cancelled.
22. For “6.D.1. Emissions from Composting of Organic Waste”, composting from not high-rate composting facilities was newly added to the activity.

10.4.1.2. National Greenhouse Gas Inventory Report

Prior to sections describing detailed methods for each land-use category where basic parameters for estimating carbon stock changes were shown , a section to tabulate the parameters is established, since land conversions are cross-cutting activity between land-use categories.

10.4.1.3. Improvements by following UNFCCC-ERT recommendations

Actions taken by following UNFCCC-ERT recommendations are summarized below. See relating sections for details.

Table 10-3 Improvements to the NIR and the CRF in response to UNFCCC review

Sector/Category	recommendations by ERT	Taken Actions	NIR/CRF
Energy/ Fuel combustion (1.A)	The ERT recommends that Japan report AD in CRF table for “other fuels”. (paragraph 32 in ARR 2010)	The activity data for “other fuels” are reported in the CRF table.	CRF Table1.A(a)s1 Table1.A(a)s2
Energy/ Fuel combustion (1.A)	The ERT recommends that all non-CO_2 combustion emissions are reported in the inventory submission. (paragraph31 in ARR 2010)	CH_4 and N_2O emissions from biomass in 1.A.1.a, 1.A.2.d. and 1.A.2.f were recalculated, because of changed activity data for biomass consumption to statistical value from notation key ‘NO’.	CRF Table1.A(a)s1 Table1.A(a)s2
Industrial Processes (2.A.2., 2.A.3, 2.A.4., 2.B.4)	The ERT recommends that Japan provide information in the next NIR on how it ensures that all limestone and dolomite use in Japan has been covered in the inventory. (paragraph 44 in ARR 2008)	A full re-examination was conducted through the use of the Adjusted Price Transaction Table and omission/double-counting has been resolved in this Inventory submission.	NIR p. 4-6 and others
Agriculture/ Enteric fermentation/ Cattle (4.A.1.)	To provide details of the additional parameters (i.e. weight of animals, weight gain, milk fat content) used in the emissions estimation of enteric fermentation of cattle. (paragraph 56 in ARR 2010)	Parameters used for estimation of enteric fermentation for cattle was indicated in Chapter 6 of NIR.	NIRp.6-3
Agriculture/ Enteric fermentation/ Cattle (4.A.1.)	To report in the CRF table in regarding to the point that cattle which are less than five months old are not included. (paragraph 50 in ARR 2010)	Described in 4A documentation box of CRF.	CRF Table 4.A. Documentation Box
Agriculture/ Manure Management (4.B.)	To revise errors in the reporting of N-ex under manure management for swine and poulty (CRF 4.B(b)). (paragraph 55 in ARR 2010)	Error included in estimation files was revised. Furthermore, minor discrepancies between total values and integrated values from detail level were resolved. These reflect These are reflected in the data of 4B of CRF.	CRF Table 4.B.
LULUCF	Japan did not indicate the destinations of “IE” data, accompanying the land conversion matrix tables. (paragraph 60 in ARR 2010)	The relevant information is now given in the NIR together with the land use conversion matrix tables.	NIR p.7-2
LULUCF/ Forest land remaining forest land (5.A.1)	Japan did not provide time-series data of carbon stock changes in dead organic matter for 1990-2004. (paragraph 64 in ARR 2010)	The data are now reported in the CRF and the recalculation is described in the NIR.	NIR p.7-18
LULUCF/ Forest land (5.A)	Japan could improve the documentation in regards to why the carbon stock change in living biomass in forest land cannot be reported separately. (paragraph 65 in ARR 2010)	Carbon stock changes in living biomass in Land converted to Forest land are not estimated and reported separately according to whether or not the land use conversion and the results are reported in the CRF and NIR.	NIR p.7-18, 7-19

10.4.2. Planned Improvements

The main planned improvements are as follows.

1. Review of estimation methods, activity data, emission factors and other elements

   Japan will hold meetings of a Committee for Greenhouse Gas Emission Estimation Methods and will consider improvements of estimation methods, activity data, emission factors and other elements used in the current inventory. In case of implementation, Japan will prioritize highly important issues such as those relevant to key-categories and those pointed out in the past review reports.

2. Improvement of transparency

   Japan will further improve transparency of the inventory by examining descriptions of methodologies, assumptions, data, and other elements in NIR, and by adding necessary information to NIR.

Annex 1. Key Categories

A1.1. Outline of Key Category Analysis

The *UNFCCC Inventory Reporting Guidelines*[1] require the application of the *Good Practice Guidance (2000)*, and the key category analysis[2] given in the Guidance. The guidelines for national system under Article 5 of the Kyoto Protocol also require countries, in compiling their inventories, to follow the method given in Chapter 7 of the *GPG* and identify the key categories.

The key category analyses were done for both data of FY 2009 and of FY 1990, the base year for the UNFCCC[3]. Their results are presented here.

A1.2. Results of Key Category Analysis

A1.2.1. Key Categories

Key categories were assessed in accordance with the *GPG* assessment methods (Tier 1 level assessment, Tier 1 trend assessment, Tier 2 level assessment and Tier 2 trend assessment).

The key category for Land use, land use change and forestry (LULUCF) sector were assessed in accordance with *GPG-LULUCF*. The key categories were identified for the inventory excluding LULUCF first, and then the key category analysis was repeated for the full inventory including the LULUCF categories.

As a result, 35 and 32 sources and sinks were detected as the key source categories for FY 2009 and FY 1990, respectively (Table A1-1 and A1-2).

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[1] Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (following incorporation of the provisions of decision 14/CP.11) (FCCC/SBSTA/2006/9)

[2] The *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (2003), which was welcomed in COP9, extends the key source analysis to LULUCF categories. In the latest UNFCCC reporting guidelines (FCCC/SBSTA/2004/8), the term “key source category” was revised to “key category”.

[3] With respect to HFCs、PFCs、SF_6, the data used for this analysis were the FY 1995 values.

Table A1-1 Japan’s Key Categories (FY2009)

	A IPCC Category		B Direct GHGs	L1	T1	L2	T2
#1	1A Stationary Combustion	Solid Fuels	CO2	#1	#2	#3	#8
#2	1A Stationary Combustion	Liquid Fuels	CO2	#2	#1	#9	#7
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	#3	#4	#4	#17
#4	1A Stationary Combustion	Gaseous Fuels	CO2	#4	#3		
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO2	#5		#5	
#6	2A Mineral Product	1. Cement Production	CO2	#6	#7	#8	#10
#7	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	1. Refrigeration and Air Conditioning Equipment	HFCs	#7	#6	#2	#1
#8	1A Stationary Combustion	Other Fuels	CO2	#8	#11	#6	#9
#9	6C Waste Incineration		CO2	#9			
#10	1A3 Mobile Combustion	d. Navigation	CO2	#10			
#11	1A3 Mobile Combustion	a. Civil Aviation	CO2	#11	#15		
#12	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#12	#17	#17	#21
#13	4A Enteric Fermentation		CH4			#21	
#14	4C Rice Cultivation		CH4			#15	
#15	2A Mineral Product	2. Lime Production	CO2			#19	
#16	4B Manure Management		N2O			#10	
#17	1A Stationary Combustion		N2O			#14	#15
#18	6A Solid Waste Disposal on Land		CH4		#13		
#19	4D Agricultural Soils	1. Direct Soil Emissions	N2O			#7	#12
#20	4D Agricultural Soils	3. Indirect Emissions	N2O			#11	#18
#21	1A3 Mobile Combustion	b. Road Transportation	N2O			#12	#11
#22	4B Manure Management		CH4			#13	#20
#23	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	PFCs			#16	#14
#24	5E Settlements	2. Land converted to Settlements	CO2		#14		
#25	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs		#9		#4
#26	2B Chemical Industry	3. Adipic Acid	N2O		#10		#16
#27	5E Settlements	1. Settlements remaining Settlements	CO2			#22	
#28	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF6		#8		#2
#29	6D Other		CO2			#20	
#30	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#12		#3
#31	5B Cropland	2. Land converted to Cropland	CO2				#19
#32	1A3 Mobile Combustion	a. Civil Aviation	N2O			#1	#5
#33	1A3 Mobile Combustion	d. Navigation	N2O			#18	
#34	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs		#5		#13
#35	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#16		#6

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

Table A1-2 Japan's Key Categories (FY 1990)

	A **IPCC Category**		**B** **Direct GHGs**	**L1**	**L2**
#1	1A Stationary Combustion	Liquid Fuels	CO2	#1	#5
#2	1A Stationary Combustion	Solid Fuels	CO2	#2	#4
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	#3	#6
#4	1A Stationary Combustion	Gaseous Fuels	CO2	#4	
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO2	#5	#9
#6	2A Mineral Product	1. Cement Production	CO2	#6	#8
#7	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	#7	#23
#8	1A3 Mobile Combustion	d. Navigation	CO2	#8	
#9	6C Waste Incineration		CO2	#9	
#10	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#10	#19
#11	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF6	#11	#2
#12	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs	#12	#7
#13	1A Stationary Combustion	Other Fuels	CO2	#13	#15
#14	4A Enteric Fermentation		CH4	#14	#24
#15	6A Solid Waste Disposal on Land		CH4	#15	
#16	2B Chemical Industry	3. Adipic Acid	N2O	#16	
#17	2A Mineral Product	2. Lime Production	CO2	#17	#22
#18	1A3 Mobile Combustion	a. Civil Aviation	CO2	#18	
#19	4C Rice Cultivation		CH4		#18
#20	4B Manure Management		N2O		#13
#21	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#3
#22	4D Agricultural Soils	1. Direct Soil Emissions	N2O		#10
#23	1A3 Mobile Combustion	b. Road Transportation	N2O		#12
#24	4D Agricultural Soils	3. Indirect Emissions	N2O		#14
#25	2B Chemical Industry	1. Ammonia Production	CO2		#25
#26	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	PFCs		#16
#27	4B Manure Management		CH4		#17
#28	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#11
#29	2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs		#26
#30	6D Other		CO2		#21
#31	1A3 Mobile Combustion	d. Navigation	N2O		#20
#32	1A3 Mobile Combustion	a. Civil Aviation	N2O		#1

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

The data of HFCs, PFCs and SF_6 utilized for this analysis are the 1995 values.

A1.2.2. Level Assessment

Level assessment involves an identification of categories as a key by calculating the proportion of emissions and removals in each category to the total emissions and removals. The calculated values of proportion are added from the category that accounts for the largest proportion, until the sum reaches 95% for Tier 1, 90% for Tier 2. Tier 1 level assessment uses emissions and removals from each category directly and Tier 2 level assessment analyzes the emissions and removals of each category, multiplied by the uncertainty of each category.

The key category analysis was first conducted for the inventory excluding LULUCF and the key categories for source sectors were identified (1). Then the key category analysis was repeated again for the full inventory including the LULUCF categories and key categories for LULUCF sector were identified (2). In accordance with the *GPG-LULUCF*, a source category, which was identified as key in (1) but not in (2), was still regarded as key; while a source category, which was not identified as key in (1) but was done in (2), was not regarded as key (gray rows in tables below).

Tier 1 level assessment of the latest emissions and removals (FY 2009) gives the following 12 sub-categories as the key categories (Table A1-3). Tier 2 level assessment of the latest emissions and removals (FY 2009) gives the following 22 sub-categories as the key categories (Table A1-4).

Table A1-3 Results of Tier 1 Level Assessment (FY 2009)

	A **IPCC Category**		**B** **Direct GHGs**	**D** **Current Year Estimate [Gg-CO_2eq.]**	**E** **Level Assessment**	**F** **% Contribution to Level**	**Cumulative**
#1	1A Stationary Combustion	Solid Fuels	CO2	401,542.04	0.312	31.2%	31.2%
#2	1A Stationary Combustion	Liquid Fuels	CO2	252,192.89	0.196	19.6%	50.8%
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	201,942.98	0.157	15.7%	66.5%
#4	1A Stationary Combustion	Gaseous Fuels	CO2	198,688.68	0.154	15.4%	81.9%
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO2	73,331.60	0.057	5.7%	87.6%
#6	2A Mineral Product	1. Cement Production	CO2	24,755.14	0.019	1.9%	89.5%
#7	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	1. Refrigeration and Air Conditioning Equipment	HFCs	15,251.25	0.012	1.2%	90.7%
#8	1A Stationary Combustion	Other Fuels	CO2	14,390.14	0.011	1.1%	91.8%
#9	6C Waste Incineration		CO2	13,983.52	0.011	1.1%	92.9%
#10	1A3 Mobile Combustion	d. Navigation	CO2	10,590.44	0.008	0.8%	93.7%
#11	1A3 Mobile Combustion	a. Civil Aviation	CO2	9,781.30	0.008	0.8%	94.5%
#12	2A Mineral Product	3. Limestone and Dolomite Use	CO2	7,444.54	0.006	0.6%	95.1%

Table A1-4 Results of Tier 2 Level Assessment (FY 2009)

	A **IPCC Category**		**B** **Direct GHGs**	**C** **Base Year Estimate [Gg-CO_2eq.]**	**I** **Source/Sink Uncertinty**	**K** **Contribution to Total L2**	**Cumulative**
#1	1A3 Mobile Combustion	a. Civil Aviation	N2O	98.32	10000%	15.2%	15.2%
#2	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning	HFCs	15,251.25	44%	10.3%	25.6%
#3	1A Stationary Combustion	Solid Fuels	CO2	401,542.04	2%	9.4%	35.0%
#4	1A3 Mobile Combustion	b. Road Transportation	CO2	201,942.98	2%	7.2%	42.2%
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO2	73,331.60	5%	5.6%	47.8%
#6	1A Stationary Combustion	Other Fuels	CO2	14,390.14	23%	5.2%	52.9%
#7	4D Agricultural Soils	1. Direct Soil Emissions	N2O	3,002.48	91%	4.2%	57.1%
#8	2A Mineral Product	1. Cement Production	CO2	24,755.14	10%	4.0%	61.1%
#9	1A Stationary Combustion	Liquid Fuels	CO2	252,192.89	1%	4.0%	65.1%
#10	4B Manure Management		N2O	4,761.36	48%	3.6%	68.7%
#11	4D Agricultural Soils	3. Indirect Emissions	N2O	2,826.92	63%	2.8%	71.5%
#12	1A3 Mobile Combustion	b. Road Transportation	N2O	2,404.93	71%	2.6%	74.1%
#13	4B Manure Management		CH4	2,299.73	64%	2.3%	76.4%
#14	1A Stationary Combustion		N2O	4,083.29	33%	2.1%	78.4%
#15	4C Rice Cultivation		CH4	5,566.50	23%	2.0%	80.4%
#16	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	1,715.19	64%	1.7%	82.1%
#17	2A Mineral Product	3. Limestone and Dolomite Use	CO2	7,444.54	14%	1.6%	83.8%
#18	1A3 Mobile Combustion	d. Navigation	N2O	87.35	1000%	1.4%	85.1%
#19	2A Mineral Product	2. Lime Production	CO2	5,370.58	16%	1.3%	86.4%
#20	6D Other		CO2	513.71	159%	1.3%	87.7%
#21	4A Enteric Fermentation		CH4	6,849.21	12%	1.2%	88.9%
#22	5E Settlements	1. Settlements remaining Settlements	CO2	765.22	78%	0.9%	89.9%
#23	1A Stationary Combustion	Gaseous Fuels	CO2	198,688.68	0%	0.9%	90.8%

Tier 1 level assessment of the latest emissions and removals (FY 1990) gives the following 18 sub-categories as the key categories (Table A1-5). Tier 2 level assessment of the latest emissions and removals (FY 1990) gives the following 26 sub-categories as the key categories (Table A1-6).

Table A1-5 Results of Tier 1 Level Assessment (FY 1990)

	A IPCC Category		B Direct GHGs	C Base Year Estimate [Gg-CO_2eq.]	E level Assessment	F % Contribution to Level	Cumulative
#1	1A Stationary Combustion	Liquid Fuels	CO2	435,168.99	0.323	32.3%	32.3%
#2	1A Stationary Combustion	Solid Fuels	CO2	308,620.23	0.229	22.9%	55.3%
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	189,227.88	0.141	14.1%	69.3%
#4	1A Stationary Combustion	Gaseous Fuels	CO2	104,300.83	0.077	7.7%	77.1%
#5	5A Forest Land	1. Forest Land remaining Forest Land	CO2	76,762.09	0.057	5.7%	82.8%
#6	2A Mineral Product	1. Cement Production	CO2	37,904.87	0.028	2.8%	85.6%
#7	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	0.013	1.3%	86.8%
#8	1A3 Mobile Combustion	d. Navigation	CO2	13,730.95	0.010	1.0%	87.9%
#9	6C Waste Incineration		CO2	12,262.95	0.009	0.9%	88.8%
#10	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF6	11,004.99	0.008	0.8%	89.6%
#11	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,522.25	0.008	0.8%	90.4%
#12	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs	10,263.55	0.008	0.8%	91.1%
#13	1A Stationary Combustion	Other Fuels	CO2	9,115.90	0.007	0.7%	91.8%
#14	4A Enteric Fermentation		CH4	7,676.61	0.006	0.6%	92.4%
#15	6A Solid Waste Disposal on Land		CH4	7,639.75	0.006	0.6%	93.0%
#16	2B Chemical Industry	3. Adipic Acid	N2O	7,501.25	0.006	0.6%	93.5%
#17	1A3 Mobile Combustion	a. Civil Aviation	CO2	7,162.41	0.005	0.5%	94.0%
#18	4C Rice Cultivation		CH4	6,959.68	0.005	0.5%	94.6%
#19	2A Mineral Product	2. Lime Production	CO2	6,674.45	0.005	0.5%	95.1%

Table A1-6 Results of Tier 2 Level Assessment (FY 1990)

	A IPCC Category		B Direct GHGs	C Base Year Estimate [Gg-CO_2eq.]	I Source/Sink Uncertinty	K Contribution to Total L2	Cumulative
#1	1A3 Mobile Combustion	a. Civil Aviation	N2O	69.75	10000%	8.5%	8.5%
#2	2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF6	11,004.99	45%	6.0%	14.6%
#3	2E Production of Halocarbons	2. Fugitive Emissions	SF6	4,708.30	100%	5.8%	20.3%
#4	1A Stationary Combustion	Solid Fuels	CO2	308,620.23	2%	5.7%	26.0%
#5	1A Stationary Combustion	Liquid Fuels	CO2	435,168.99	1%	5.4%	31.4%
#6	1A3 Mobile Combustion	b. Road Transportation	CO2	189,227.88	2%	5.3%	36.7%
#7	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	10,263.55	40%	5.0%	41.7%
#8	2A Mineral Product	1. Cement Production	CO2	37,904.87	10%	4.8%	46.6%
#9	5A Forest Land	1. Forest Land remaining Forest Land	CO2	76,762.09	5%	4.6%	51.2%
#10	4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,155.47	91%	4.6%	55.8%
#11	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2,785.23	113%	3.8%	59.6%
#12	1A3 Mobile Combustion	b. Road Transportation	N2O	3,901.71	71%	3.4%	63.0%
#13	4B Manure Management		N2O	5,533.01	48%	3.3%	66.2%
#14	4D Agricultural Soils	3. Indirect Emissions	N2O	3,730.52	63%	2.9%	69.1%
#15	1A Stationary Combustion	Other Fuels	CO2	9,115.90	23%	2.6%	71.7%
#16	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	3,144.23	64%	2.5%	74.1%
#17	4B Manure Management		CH4	3,094.12	64%	2.4%	76.5%
#18	4C Rice Cultivation		CH4	6,959.68	23%	2.0%	78.5%
#19	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,522.25	14%	1.8%	80.3%
#20	1A3 Mobile Combustion	d. Navigation	N2O	111.58	1000%	1.4%	81.7%
#21	6D Other		CO2	702.83	159%	1.4%	83.0%
#22	2A Mineral Product	2. Lime Production	CO2	6,674.45	16%	1.3%	84.3%
#23	2E Production of Halocarbons	1. By-product Emissions	HFCs	16,965.00	5%	1.1%	85.4%
#24	4A Enteric Fermentation		CH4	7,676.61	12%	1.1%	86.5%
#25	2B Chemical Industry	1. Ammonia Production	CO2	3,384.68	23%	1.0%	87.5%
#26	2E Production of Halocarbons	2. Fugitive Emissions	PFCs	762.85	100%	0.9%	88.4%
#27	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF6	1,128.66	64%	0.9%	89.3%
#28	1A Stationary Combustion		N2O	2,188.60	33%	0.9%	90.2%
#29	2B Chemical Industry	3. Adipic Acid	N2O	7,501.25	9%	0.8%	91.0%

A1.2.3. Trend Assessment

The difference between the rate of change in emissions and removals in a category and the rate of change in total emissions and removals is calculated. The trend assessment is calculated by multiplying this value by the ratio of contribution of the relevant category to total emissions and removals. The calculated results, regarded as trend assessment values, are added from the category of which the proportion to the total of trend assessment values is the largest, until the total reaches 95% for Tier 1, 90% for Tier 2. At this point, these categories are defined as the key categories. Tier 1 level assessment uses emissions and removals from each category directly and Tier 2 level assessment analyzes the emissions and removals of each category, multiplied by the uncertainty of each category.

The key category analysis was first conducted for the inventory excluding LULUCF and the key categories for source sectors were identified (1). Then the key category analysis was repeated again for the full inventory including the LULUCF categories and key categories for LULUCF sector were identified (2). In accordance with the *GPG-LULUCF*, a source category, which was identified as key in (1) but not in (2), was still regarded as key; while a source category, which was not identified as key in (1) but was done in (2), was not regarded as key (gray rows in tables below).

Tier 1 trend assessment of the latest emissions and removals (FY 2009) gives the following 17 sub-categories as the key categories (Table A1-7). Tier 2 trend assessment of the latest emissions and removals (FY 2009) gives the following 21 sub-categories as the key categories (Table A1-8).

Table A1-7 Results of Tier 1 Trend Assessment (FY 2009)

	A IPCC Category		**B Direct GHGs**	**C Base Year Estimate [Gg-CO_2eq.]**	**D Current Year Estimate [Gg-CO_2eq.]**	**H % Contribution to Trend**	**Cumulative**
#1	1A Stationary Combustion	Liquid Fuels	CO2	435169	252193	32.2%	32.2%
#2	1A Stationary Combustion	Solid Fuels	CO2	308620	401542	20.9%	53.1%
#3	1A Stationary Combustion	Gaseous Fuels	CO2	104301	198689	19.4%	72.6%
#4	1A3 Mobile Combustion	b. Road Transportation	CO2	189228	201943	4.1%	76.7%
#5	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16965	40	3.2%	79.9%
#6	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	1. Refrigeration and Air Conditioning Equipment	HFCs	840	15251	2.8%	82.7%
#7	2A Mineral Product	1. Cement Production	CO2	37905	24755	2.3%	85.0%
#8	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF6	11005	745	1.9%	86.9%
#9	2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs	10264	1142	1.7%	88.6%
#10	2B Chemical Industry	3. Adipic Acid	N2O	7501	1083	1.2%	89.8%
#11	1A Stationary Combustion	Other Fuels	CO2	9116	14390	1.1%	90.9%
#12	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4708	261	0.8%	91.8%
#13	6A Solid Waste Disposal on Land		CH4	7640	3303	0.8%	92.5%
#14	5E Settlements	2. Land converted to Settlements	CO2	5287	1581	0.7%	93.2%
#15	1A3 Mobile Combustion	a. Civil Aviation	CO2	7162	9781	0.6%	93.8%
#16	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2785	35	0.5%	94.3%
#17	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10522	7445	0.5%	94.8%
#18	1A3 Mobile Combustion	d. Navigation	CO2	13731	10590	0.5%	95.3%

Table A1-8 Results of Tier 2 Trend Assessment (FY 2009)

	A IPCC Category		**B Direct GHGs**	**C Base Year Estimate [Gg CO_2eq.]**	**D Current Year Estimate [Gg-CO_2eq.]**	**I Source/Sink Uncertinty**	**M Contribution to Total T2**	**Cumulative**
#1	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning	HFCs	840.40	15,251.25	44%	15.0%	15.0%
#2	2F(a) Consumption of Halocarbons	8. Electrical Equipment	SF6	11,004.99	745.46	45%	10.4%	25.4%
#3	2E Production of Halocarbons	2. Fugitive Emissions	SF6	4,708.30	260.51	100%	10.1%	35.5%
#4	2F(a) Consumption of Halocarbons	5. Solvents	PFCs	10,263.55	1,142.15	40%	8.2%	43.7%
#5	1A3 Mobile Combustion	a. Civil Aviation	N2O	69.75	98.32	10000%	7.5%	51.2%
#6	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2,785.23	35.14	113%	7.0%	58.3%
#7	1A Stationary Combustion	Liquid Fuels	CO2	435,168.99	252,192.89	1%	4.0%	62.2%
#8	1A Stationary Combustion	Solid Fuels	CO2	308,620.23	401,542.04	2%	3.8%	66.1%
#9	1A Stationary Combustion	Other Fuels	CO2	9,115.90	14,390.14	23%	3.1%	69.2%
#10	2A Mineral Product	1. Cement Production	CO2	37,904.87	24,755.14	10%	2.8%	72.0%
#11	1A3 Mobile Combustion	b. Road Transportation	N2O	3,901.71	2,404.93	71%	2.2%	74.2%
#12	4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,155.47	3,002.48	91%	2.1%	76.3%
#13	2E Production of Halocarbons	1. By-product Emissions	HFCs	16,965.00	39.78	5%	2.1%	78.4%
#14	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	PFCs	3,144.23	1,715.19	64%	2.0%	80.3%
#15	1A Stationary Combustion		N2O	2,188.60	4,083.29	33%	1.6%	81.9%
#16	2B Chemical Industry	3. Adipic Acid	N2O	7,501.25	1,082.59	9%	1.3%	83.2%
#17	1A3 Mobile Combustion	b. Road Transportation	CO2	189,227.88	201,942.98	2%	1.1%	84.4%
#18	4D Agricultural Soils	3. Indirect Emissions	N2O	3,730.52	2,826.92	63%	1.1%	85.5%
#19	5B Cropland	2. Land converted to Cropland	CO2	2,532.77	257.51	20%	1.0%	86.5%
#20	4B Manure Management		CH4	3,094.12	2,299.73	64%	1.0%	87.5%
#21	2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,522.25	7,444.54	14%	0.9%	88.4%
#22	2E Production of Halocarbons	2. Fugitive Emissions	PFCs	762.85	399.48	100%	0.8%	89.1%
#23	2B Chemical Industry	1. Ammonia Production	CO2	3,384.68	1,908.78	23%	0.7%	89.9%
#24	2F(a) Consumption of Halocarbons	7. Semiconductor Manufacture	SF6	1,128.66	606.31	64%	0.7%	90.6%

Data utilized for the key category analysis are shown in Table A1-9 and A1-10 as references.

Table A1-9 Data used for the key category analysis (FY 2009)

A IPCC Category		B Direct GHGs	C Base Year Estimate [Gg-CO_2eq.]	D Current Year Estimate [Gg-CO_2eq.]	E Level Assessment	F % Contribution to Level	G Trend Assessment	H % Contribution to Trend	I Source/Sink Uncertinty	J Level Uncertainty (x 1000)	K Contribution to Total L2	L Trend Uncertainty (x 1000)	M Contribution to Total T2
1A Stationary Combustion	Liquid Fuels	CO2	435,168.99	252,192.89	0.196	19.6%	0.1332	32.2%	1%	1.99	0.04	1.36	0.04
1A Stationary Combustion	Solid Fuels	CO2	308,620.23	401,542.04	0.312	31.2%	0.0865	20.9%	2%	4.73	0.09	1.31	0.04
1A Stationary Combustion	Gaseous Fuels	CO2	104,300.83	198,688.68	0.154	15.4%	0.0804	19.4%	0%	0.46	0.01	0.24	0.01
1A Stationary Combustion	Other Fuels	CO2	9,115.90	14,390.14	0.011	1.1%	0.0046	1.1%	23%	2.58	0.05	1.07	0.03
1A Stationary Combustion		CH4	543.43	561.62	0.000	0.0%	0.0000	0.0%	47%	0.21	0.00	0.02	0.00
1A Stationary Combustion		N2O	2,188.60	4,083.29	0.003	0.3%	0.0016	0.4%	33%	1.05	0.02	0.53	0.02
1A Stationary Combustion		CH4	49.20	92.18	0.000	0.0%	0.0000	0.0%	117%	0.08	0.00	0.04	0.00
1A Stationary Combustion		N2O	385.39	339.97	0.000	0.0%	0.0000	0.0%	36%	0.10	0.00	0.01	0.00
1A3 Mobile Combustion	a. Civil Aviation	CO2	7,162.41	9,781.30	0.008	0.8%	0.0024	0.6%	3%	0.19	0.00	0.06	0.00
1A3 Mobile Combustion	b. Road Transportation	CO2	189,227.88	201,942.98	0.157	15.7%	0.0171	4.1%	2%	3.61	0.07	0.39	0.01
1A3 Mobile Combustion	c. Railways	CO2	932.45	599.93	0.000	0.0%	0.0002	0.1%	2%	0.01	0.00	0.01	0.00
1A3 Mobile Combustion	d. Navigation	CO2	13,730.95	10,590.44	0.008	0.8%	0.0021	0.5%	2%	0.20	0.00	0.05	0.00
1A3 Mobile Combustion	a. Civil Aviation	CH4	2.94	4.61	0.000	0.0%	0.0000	0.0%	200%	0.01	0.00	0.00	0.00
1A3 Mobile Combustion	b. Road Transportation	CH4	266.66	159.46	0.000	0.0%	0.0001	0.0%	64%	0.08	0.00	0.05	0.00
1A3 Mobile Combustion	c. Railways	CH4	1.18	0.73	0.000	0.0%	0.0000	0.0%	14%	0.00	0.00	0.00	0.00
1A3 Mobile Combustion	d. Navigation	CH4	26.45	20.71	0.000	0.0%	0.0000	0.0%	200%	0.03	0.00	0.01	0.00
1A3 Mobile Combustion	a. Civil Aviation	N2O	69.75	98.32	0.000	0.0%	0.0000	0.0%	10000%	7.64	0.15	2.57	0.07
1A3 Mobile Combustion	b. Road Transportation	N2O	3,901.71	2,404.93	0.002	0.2%	0.0011	0.3%	71%	1.32	0.03	0.76	0.02
1A3 Mobile Combustion	c. Railways	N2O	121.38	76.81	0.000	0.0%	0.0000	0.0%	11%	0.01	0.00	0.00	0.00
1A3 Mobile Combustion	d. Navigation	N2O	111.58	87.35	0.000	0.0%	0.0000	0.0%	1000%	0.68	0.01	0.16	0.00
1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2,785.23	35.14	0.000	0.0%	0.0021	0.5%	113%	0.03	0.00	2.41	0.07
1B Fugitive Emission	1a ii. Coal Mining and Handling (surface)	CH4	21.20	11.11	0.000	0.0%	0.0000	0.0%	185%	0.02	0.00	0.01	0.00
1B Fugitive Emission	2a. Oil	CO2	0.14	0.11	0.000	0.0%	0.0000	0.0%	20%	0.00	0.00	0.00	0.00
1B Fugitive Emission	2a. Oil	CH4	28.32	25.38	0.000	0.0%	0.0000	0.0%	17%	0.00	0.00	0.00	0.00
1B Fugitive Emission	2a. Oil	N2O	0.00	0.00	0.000	0.0%	0.0000	0.0%	27%	0.00	0.00	0.00	0.00
1B Fugitive Emission	2b. Natural Gas	CO2	0.25	0.43	0.000	0.0%	0.0000	0.0%	25%	0.00	0.00	0.00	0.00
1B Fugitive Emission	2b. Natural Gas	CH4	187.94	310.90	0.000	0.0%	0.0001	0.0%	22%	0.05	0.00	0.02	0.00
1B Fugitive Emission	2c. Venting & Flaring	CO2	36.23	34.61	0.000	0.0%	0.0000	0.0%	18%	0.00	0.00	0.00	0.00
1B Fugitive Emission	2c. Venting & Flaring	CH4	14.45	11.67	0.000	0.0%	0.0000	0.0%	20%	0.00	0.00	0.00	0.00
1B Fugitive Emission	2c. Venting & Flaring	N2O	0.11	0.11	0.000	0.0%	0.0000	0.0%	18%	0.00	0.00	0.00	0.00
2A Mineral Product	1. Cement Production	CO2	37,904.87	24,755.14	0.019	1.9%	0.0093	2.3%	10%	2.01	0.04	0.97	0.03
2A Mineral Product	2. Lime Production	CO2	6,674.45	5,370.58	0.004	0.4%	0.0008	0.2%	16%	0.66	0.01	0.13	0.00
2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,522.25	7,444.54	0.006	0.6%	0.0021	0.5%	14%	0.81	0.02	0.30	0.01
2A Mineral Product	4. Soda Ash Production and Use	CO2	267.28	138.19	0.000	0.0%	0.0001	0.0%	16%	0.02	0.00	0.02	0.00
2B Chemical Industry	1. Ammonia Production	CO2	3,384.68	1,908.78	0.001	0.1%	0.0011	0.3%	23%	0.34	0.01	0.25	0.01
2B Chemical Industry	other products except Anmonia	CO2	824.39	579.42	0.000	0.0%	0.0002	0.0%	77%	0.35	0.01	0.13	0.00
2B Chemical Industry	2. Nitric Acid	N2O	765.70	476.91	0.000	0.0%	0.0002	0.1%	46%	0.17	0.00	0.10	0.00
2B Chemical Industry	3. Adipic Acid	N2O	7,501.25	1,082.59	0.001	0.1%	0.0049	1.2%	9%	0.08	0.00	0.46	0.01
2B Chemical Industry	4. Carbide Production	CH4	0.42	0.66	0.000	0.0%	0.0000	0.0%	100%	0.00	0.00	0.00	0.00
2B Chemical Industry	5. Carbon Black, Ethylene, Ethylene Dichloride, Styrene, Methanol, Coke	CH4	337.80	95.98	0.000	0.0%	0.0002	0.0%	89%	0.07	0.00	0.16	0.00
2C Metal Production	1 Iron and Steel Production	CO2	356.09	111.99	0.000	0.0%	0.0002	0.0%	5%	0.00	0.00	0.01	0.00
2C Metal Production	1 Iron and Steel Production	CH4	15.47	10.67	0.000	0.0%	0.0000	0.0%	163%	0.01	0.00	0.01	0.00
2C Metal Production	2. Ferroalloys Production	CH4	3.89	2.27	0.000	0.0%	0.0000	0.0%	163%	0.00	0.00	0.00	0.00
2C Metal Production	3. Aluminium Production	PFCs	69.74	11.02	0.000	0.0%	0.0000	0.0%	33%	0.00	0.00	0.02	0.00
2C Metal Production	4. SF6 Used in Aluminium and Magnesium oundries	SF6	119.50	239.00	0.000	0.0%	0.0001	0.0%	5%	0.01	0.00	0.01	0.00
2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	39.78	0.000	0.0%	0.0131	3.2%	5%	0.00	0.00	0.71	0.02
2E Production of Halocarbons and SF6	2. Fugitive Emissions	HFCs	480.12	182.36	0.000	0.0%	0.0002	0.1%	100%	0.14	0.00	0.23	0.01
2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	762.85	399.48	0.000	0.0%	0.0003	0.1%	100%	0.31	0.01	0.27	0.01
2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4,708.30	260.51	0.000	0.0%	0.0034	0.8%	100%	0.20	0.00	3.46	0.10
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	1. Refrigeration and Air Conditioning Equipment	HFCs	840.40	15,251.25	0.012	1.2%	0.0117	2.8%	44%	5.19	0.10	5.14	0.15
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	2. Foam Blowing	HFCs	451.76	290.18	0.000	0.0%	0.0001	0.0%	50%	0.11	0.00	0.06	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	3. Fire Extinguishers	HFCs	0.00	6.55	0.000	0.0%	0.0000	0.0%	64%	0.00	0.00	0.00	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	4. Aerosols/ Metered Dose Inhalers	HFCs	1,365.00	809.25	0.001	0.1%	0.0004	0.1%	28%	0.18	0.00	0.11	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs	10,263.55	1,142.15	0.001	0.1%	0.0070	1.7%	40%	0.35	0.01	2.82	0.08
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	HFCs	157.89	92.36	0.000	0.0%	0.0000	0.0%	64%	0.05	0.00	0.03	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	PFCs	3,144.23	1,715.19	0.001	0.1%	0.0010	0.3%	64%	0.85	0.02	0.67	0.02
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	SF6	1,128.66	606.31	0.000	0.0%	0.0004	0.1%	64%	0.30	0.01	0.25	0.01
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF6	11,004.99	745.46	0.001	0.1%	0.0079	1.9%	45%	0.26	0.01	3.58	0.10
2F(a) Consumption of Halocarbons	9. Other - Railway Silicon Rectifiers	PFCs	0.00	3.63	0.000	0.0%	0.0000	0.0%	45%	0.00	0.00	0.00	0.00
3 Solvent & Other Product Use	Using Laughing Gas in Hospital	N2O	287.07	120.50	0.000	0.0%	0.0001	0.0%	5%	0.00	0.00	0.01	0.00
4A Enteric Fermentation		CH4	7,676.61	6,849.21	0.005	0.5%	0.0004	0.1%	12%	0.62	0.01	0.05	0.00
4B Manure Management		CH4	3,094.12	2,299.73	0.002	0.2%	0.0005	0.1%	64%	1.14	0.02	0.34	0.01
4B Manure Management		N2O	5,533.01	4,761.36	0.004	0.4%	0.0004	0.1%	48%	1.79	0.04	0.21	0.01
4C Rice Cultivation		CH4	6,959.68	5,566.50	0.004	0.4%	0.0009	0.2%	23%	1.00	0.02	0.20	0.01
4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,155.47	3,002.48	0.002	0.2%	0.0008	0.2%	91%	2.11	0.04	0.71	0.02
4D Agricultural Soils	2. Pasture, Range and Paddock Manure	N2O	11.91	12.62	0.000	0.0%	0.0000	0.0%	133%	0.01	0.00	0.00	0.00
4D Agricultural Soils	3. Indirect Emissions	N2O	3,730.52	2,826.92	0.002	0.2%	0.0006	0.1%	63%	1.38	0.03	0.38	0.01
4F Field Burning of Agricultural Residues		CH4	100.68	63.15	0.000	0.0%	0.0000	0.0%	204%	0.10	0.00	0.05	0.00
4F Field Burning of Agricultural Residues		N2O	32.65	20.13	0.000	0.0%	0.0000	0.0%	153%	0.02	0.00	0.01	0.00
5A Forest Land	1. Forest Land remaining Forest Land	CO2	76,762.09	73,331.60	0.057	5.7%	0.0001	0.0%	5%	2.81	0.06	0.00	0.00
5A Forest Land	2. Land converted to Forest Land	CO2	1,874.11	346.33	0.000	0.0%	0.0012	0.3%	16%	0.04	0.00	0.19	0.01
5A Forest Land		CH4	8.31	8.73	0.000	0.0%	0.0000	0.0%	88%	0.01	0.00	0.00	0.00
5A Forest Land		N2O	0.84	0.89	0.000	0.0%	0.0000	0.0%	114%	0.00	0.00	0.00	0.00
5B Cropland	1. Cropland remaining Cropland	CO2	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5B Cropland	2. Land converted to Cropland	CO2	2,532.77	257.51	0.000	0.0%	0.0018	0.4%	20%	0.04	0.00	0.35	0.01
5B Cropland		CH4	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5B Cropland		N2O	90.02	7.60	0.000	0.0%	0.0001	0.0%	86%	0.01	0.00	0.05	0.00
5C Grassland	1. Grassland remaining Grassland	CO2	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5C Grassland	2. Land converted to Grassland	CO2	441.28	276.24	0.000	0.0%	0.0001	0.0%	37%	0.08	0.00	0.04	0.00
5C Grassland		CH4	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5C Grassland		N2O	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5D Wetlands	1. Wetlands remaining Wetlands	CO2	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5D Wetlands	2. Land converted to Wetlands	CO2	86.72	22.72	0.000	0.0%	0.0000	0.0%	38%	0.01	0.00	0.02	0.00
5D Wetlands		CH4	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5D Wetlands		N2O	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5E Settlements	1. Settlements remaining Settlements	CO2	621.88	765.22	0.001	0.1%	0.0001	0.0%	78%	0.46	0.01	0.11	0.00
5E Settlements	2. Land converted to Settlements	CO2	5,286.52	1,581.21	0.001	0.1%	0.0028	0.7%	8%	0.10	0.00	0.23	0.01
5E Settlements		CH4	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5E Settlements		N2O	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5F Other Land	1. Other Land remaining Other Land	CO2	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5F Other Land	2. Land converted to Other Land	CO2	1,567.30	1,049.01	0.001	0.1%	0.0004	0.1%	12%	0.10	0.00	0.04	0.00
5F Other Land		CH4	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5F Other Land		N2O	0.00	0.00	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
5G Other	CO2 emissions from agricultural lime application	CO2	550.22	268.25	0.000	0.0%	0.0002	0.1%	51%	0.11	0.00	0.11	0.00
6A Solid Waste Disposal on Land		CH4	7,639.75	3,303.02	0.003	0.3%	0.0033	0.8%	0%	0.00	0.00	0.00	0.00
6B Wastewater Handling		CH4	2,117.96	1,247.42	0.001	0.1%	0.0006	0.2%	0%	0.00	0.00	0.00	0.00
6B Wastewater Handling		N2O	1,286.81	1,087.40	0.001	0.1%	0.0001	0.0%	0%	0.00	0.00	0.00	0.00
6C Waste Incineration		CO2	12,262.95	13,983.52	0.011	1.1%	0.0018	0.4%	0%	0.00	0.00	0.00	0.00
6C Waste Incineration		CH4	13.48	11.38	0.000	0.0%	0.0000	0.0%	0%	0.00	0.00	0.00	0.00
6C Waste Incineration		N2O	1,519.44	1,637.44	0.001	0.1%	0.0001	0.0%	0%	0.00	0.00	0.00	0.00
6D Other		CO2	702.83	513.71	0.000	0.0%	0.0001	0.0%	159%	0.63	0.01	0.20	0.01
6D Other		CH4	14.48	24.74	0.000	0.0%	0.0000	0.0%	25%	0.00	0.00	0.00	0.00
6D Other		N2O	12.83	21.91	0.000	0.0%	0.0000	0.0%	74%	0.01	0.00	0.01	0.00
TOTAL			1,345,996.63	1,287,124.83	1.00	100.0%	0.41	100.0%		50.17	1.00	34.28	1.00

Table A1-10 Data used for the key category analysis (FY 1990)

A IPCC Category		B Direct GHGs	C Base Year Estimate [Gg-CO_2eq.]	E Level Assesslent	F % Contribution to Level	I Source/Sink Uncertinty	J Level Uncertainty (x 1000)	K Contribution to Total L2
1A Stationary Combustion	Liquid Fuels	CO2	435,168.99	0.323	32.3%	1%	3.29	0.05
1A Stationary Combustion	Solid Fuels	CO2	308,620.23	0.229	22.9%	2%	3.48	0.06
1A Stationary Combustion	Gaseous Fuels	CO2	104,300.83	0.077	7.7%	0%	0.23	0.00
1A Stationary Combustion	Other Fuels	CO2	9,115.90	0.007	0.7%	23%	1.57	0.03
1A Stationary Combustion		CH4	543.43	0.000	0.0%	47%	0.19	0.00
1A Stationary Combustion		N2O	2,188.60	0.002	0.2%	33%	0.54	0.01
1A Stationary Combustion		CH4	49.20	0.000	0.0%	117%	0.04	0.00
1A Stationary Combustion		N2O	385.39	0.000	0.0%	36%	0.10	0.00
1A3 Mobile Combustion	a. Civil Aviation	CO2	7,162.41	0.005	0.5%	3%	0.13	0.00
1A3 Mobile Combustion	b. Road Transportation	CO2	189,227.88	0.141	14.1%	2%	3.23	0.05
1A3 Mobile Combustion	c. Railways	CO2	932.45	0.001	0.1%	2%	0.02	0.00
1A3 Mobile Combustion	d. Navigation	CO2	13,730.95	0.010	1.0%	2%	0.24	0.00
1A3 Mobile Combustion	a. Civil Aviation	CH4	2.94	0.000	0.0%	200%	0.00	0.00
1A3 Mobile Combustion	b. Road Transportation	CH4	266.66	0.000	0.0%	64%	0.13	0.00
1A3 Mobile Combustion	c. Railways	CH4	1.18	0.000	0.0%	14%	0.00	0.00
1A3 Mobile Combustion	d. Navigation	CH4	26.45	0.000	0.0%	200%	0.04	0.00
1A3 Mobile Combustion	a. Civil Aviation	N2O	69.75	0.000	0.0%	10000%	5.18	0.09
1A3 Mobile Combustion	b. Road Transportation	N2O	3,901.71	0.003	0.3%	71%	2.05	0.03
1A3 Mobile Combustion	c. Railways	N2O	121.38	0.000	0.0%	11%	0.01	0.00
1A3 Mobile Combustion	d. Navigation	N2O	111.58	0.000	0.0%	1000%	0.83	0.01
1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4	2,785.23	0.002	0.2%	113%	2.34	0.04
1B Fugitive Emission	1a ii. Coal Mining and Handling (surface)	CH4	21.20	0.000	0.0%	185%	0.03	0.00
1B Fugitive Emission	2a. Oil	CO2	0.14	0.000	0.0%	20%	0.00	0.00
1B Fugitive Emission	2a. Oil	CH4	28.32	0.000	0.0%	17%	0.00	0.00
1B Fugitive Emission	2a. Oil	N2O	0.00	0.000	0.0%	27%	0.00	0.00
1B Fugitive Emission	2b. Natural Gas	CO2	0.25	0.000	0.0%	25%	0.00	0.00
1B Fugitive Emission	2b. Natural Gas	CH4	187.94	0.000	0.0%	22%	0.03	0.00
1B Fugitive Emission	2c. Venting & Flaring	CO2	36.23	0.000	0.0%	18%	0.00	0.00
1B Fugitive Emission	2c. Venting & Flaring	CH4	14.45	0.000	0.0%	20%	0.00	0.00
1B Fugitive Emission	2c. Venting & Flaring	N2O	0.11	0.000	0.0%	18%	0.00	0.00
2A Mineral Product	1. Cement Production	CO2	37,904.87	0.028	2.8%	10%	2.94	0.05
2A Mineral Product	2. Lime Production	CO2	6,674.45	0.005	0.5%	16%	0.78	0.01
2A Mineral Product	3. Limestone and Dolomite Use	CO2	10,522.25	0.008	0.8%	14%	1.10	0.02
2A Mineral Product	4. Soda Ash Production and Use	CO2	267.28	0.000	0.0%	16%	0.03	0.00
2B Chemical Industry	1. Ammonia Production	CO2	3,384.68	0.003	0.3%	23%	0.58	0.01
2B Chemical Industry	other products except Anmonia	CO2	824.39	0.001	0.1%	77%	0.47	0.01
2B Chemical Industry	2. Nitric Acid	N2O	765.70	0.001	0.1%	46%	0.26	0.00
2B Chemical Industry	3. Adipic Acid	N2O	7,501.25	0.006	0.6%	9%	0.51	0.01
2B Chemical Industry	4. Carbide Production	CH4	0.42	0.000	0.0%	100%	0.00	0.00
2B Chemical Industry	5. Carbon Black, Ethylene, Ethylene Dichloride, Styrene, Methanol, Coke	CH4	337.80	0.000	0.0%	89%	0.22	0.00
2C Metal Production	1 Iron and Steel Production	CO2	356.09	0.000	0.0%	5%	0.01	0.00
2C Metal Production	1 Iron and Steel Production	CH4	15.47	0.000	0.0%	163%	0.02	0.00
2C Metal Production	2. Ferroalloys Production	CH4	3.89	0.000	0.0%	163%	0.00	0.00
2C Metal Production	3. Aluminium Production	PFCs	69.74	0.000	0.0%	33%	0.02	0.00
2C Metal Production	4. SF6 Used in Aluminium and Magnesium oundries	SF6	119.50	0.000	0.0%	5%	0.00	0.00
2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs	16,965.00	0.013	1.3%	5%	0.68	0.01
2E Production of Halocarbons and SF6	2. Fugitive Emissions	HFCs	480.12	0.000	0.0%	100%	0.36	0.01
2E Production of Halocarbons and SF6	2. Fugitive Emissions	PFCs	762.85	0.001	0.1%	100%	0.57	0.01
2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6	4,708.30	0.003	0.3%	100%	3.52	0.06
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	1. Refrigeration and Air Conditioning Equipment	HFCs	840.40	0.001	0.1%	44%	0.27	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	2. Foam Blowing	HFCs	451.76	0.000	0.0%	50%	0.17	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	3. Fire Extinguishers	HFCs	0.00	0.000	0.0%	64%	0.00	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	4. Aerosols/ Metered Dose Inhalers	HFCs	1,365.00	0.001	0.1%	28%	0.28	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	5. Solvents	PFCs	10,263.55	0.008	0.8%	40%	3.05	0.05
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	HFCs	157.89	0.000	0.0%	64%	0.08	0.00
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	PFCs	3,144.23	0.002	0.2%	64%	1.50	0.02
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	7. Semiconductor Manufacture	SF6	1,128.66	0.001	0.1%	64%	0.54	0.01
2F(a) Consumption of Halocarbons and SF6 (actual emissions - Tier 2)	8. Electrical Equipment	SF6	11,004.99	0.008	0.8%	45%	3.68	0.06
2F(a) Consumption of Halocarbons	9. Other - Railway Silicon Rectifiers	PFCs	0.00	0.000	0.0%	45%	0.00	0.00
3 Solvent & Other Product Use	Using Laughing Gas in Hospital	N2O	287.07	0.000	0.0%	5%	0.01	0.00
4A Enteric Fermentation		CH4	7,676.61	0.006	0.6%	12%	0.67	0.01
4B Manure Management		CH4	3,094.12	0.002	0.2%	64%	1.47	0.02
4B Manure Management		N2O	5,533.01	0.004	0.4%	48%	1.99	0.03
4C Rice Cultivation		CH4	6,959.68	0.005	0.5%	23%	1.19	0.02
4D Agricultural Soils	1. Direct Soil Emissions	N2O	4,155.47	0.003	0.3%	91%	2.80	0.05
4D Agricultural Soils	2. Pasture, Range and Paddock Manure	N2O	11.91	0.000	0.0%	133%	0.01	0.00
4D Agricultural Soils	3. Indirect Emissions	N2O	3,730.52	0.003	0.3%	63%	1.75	0.03
4F Field Burning of Agricultural Residues		CH4	100.68	0.000	0.0%	204%	0.15	0.00
4F Field Burning of Agricultural Residues		N2O	32.65	0.000	0.0%	153%	0.04	0.00
5A Forest Land	1. Forest Land remaining Forest Land	CO2	76,762.09	0.057	5.7%	5%	2.81	0.05
5A Forest Land	2. Land converted to Forest Land	CO2	1,874.11	0.001	0.1%	16%	0.22	0.00
5A Forest Land		CH4	8.31	0.000	0.0%	88%	0.01	0.00
5A Forest Land		N2O	0.84	0.000	0.0%	114%	0.00	0.00
5B Cropland	1. Cropland remaining Cropland	CO2	0.00	0.000	0.0%	0%	0.00	0.00
5B Cropland	2. Land converted to Cropland	CO2	2,532.77	0.002	0.2%	20%	0.37	0.01
5B Cropland		CH4	0.00	0.000	0.0%	0%	0.00	0.00
5B Cropland		N2O	90.02	0.000	0.0%	86%	0.06	0.00
5C Grassland	1. Grassland remaining Grassland	CO2	0.00	0.000	0.0%	0%	0.00	0.00
5C Grassland	2. Land converted to Grassland	CO2	441.28	0.000	0.0%	37%	0.12	0.00
5C Grassland		CH4	0.00	0.000	0.0%	0%	0.00	0.00
5C Grassland		N2O	0.00	0.000	0.0%	0%	0.00	0.00
5D Wetlands	1. Wetlands remaining Wetlands	CO2	0.00	0.000	0.0%	0%	0.00	0.00
5D Wetlands	2. Land converted to Wetlands	CO2	86.72	0.000	0.0%	38%	0.02	0.00
5D Wetlands		CH4	0.00	0.000	0.0%	0%	0.00	0.00
5D Wetlands		N2O	0.00	0.000	0.0%	0%	0.00	0.00
5E Settlements	1. Settlements remaining Settlements	CO2	621.88	0.000	0.0%	78%	0.36	0.01
5E Settlements	2. Land converted to Settlements	CO2	5,286.52	0.004	0.4%	8%	0.32	0.01
5E Settlements		CH4	0.00	0.000	0.0%	0%	0.00	0.00
5E Settlements		N2O	0.00	0.000	0.0%	0%	0.00	0.00
5F Other Land	1. Other Land remaining Other Land	CO2	0.00	0.000	0.0%	0%	0.00	0.00
5F Other Land	2. Land converted to Other Land	CO2	1,567.30	0.001	0.1%	12%	0.14	0.00
5F Other Land		CH4	0.00	0.000	0.0%	0%	0.00	0.00
5F Other Land		N2O	0.00	0.000	0.0%	0%	0.00	0.00
5G Other	CO2 emissions from agricultural lime application	CO2	550.22	0.000	0.0%	51%	0.21	0.00
6A Solid Waste Disposal on Land		CH4	7,639.75	0.006	0.6%	0%	0.00	0.00
6B Wastewater Handling		CH4	2,117.96	0.002	0.2%	0%	0.00	0.00
6B Wastewater Handling		N2O	1,286.81	0.001	0.1%	0%	0.00	0.00
6C Waste Incineration		CO2	12,262.95	0.009	0.9%	0%	0.00	0.00
6C Waste Incineration		CH4	13.48	0.000	0.0%	0%	0.00	0.00
6C Waste Incineration		N2O	1,519.44	0.001	0.1%	0%	0.00	0.00
6D Other		CO2	702.83	0.001	0.1%	159%	0.83	0.01
6D Other		CH4	14.48	0.000	0.0%	25%	0.00	0.00
6D Other		N2O	12.83	0.000	0.0%	74%	0.01	0.00
TOTAL			1,345,996.63	1.00	100.0%		60.92	1.00

A1.2.4. Qualitative Analysis

Key categories identified in the qualitative analysis include the categories in which: mitigation techniques have been employed, significant variance of emissions and removals has been confirmed, a high uncertainty exists due to the solo implementation of the Tier 1 analysis of key categories, and unexpectedly high or low estimates are identified.

In Japan, the categories in which mitigation techniques have been employed, emissions and removals have been newly estimated, and estimation methods have been changed, were identified as key in terms of the qualitative analysis. In this year, the key categories were identified only based on the quantitative results of the level and trend assessments, including both Tier 1 and Tier 2.

Annex 2. Detailed Discussion on Methodology and Data for Estimating CO_2 Emissions from Fossil Fuel Combustion

A2.1. Discrepancies between the figures reported in the CRF tables and the IEA statistics

In the report of the individual review of the greenhouse gas inventory of Japan submitted in 2006 (FCCC/ARR/2006/JPN), which was conducted from January to February 2007, the ERT (Expert Review Team) recommended that in the next NIR submission Japan provide a clear explanation for the discrepancies found between the data in the CRF tables and the IEA statistics.

In summary, these discrepancies occurred because (a) Japan and the IEA treat international aviation and marine bunker fuels differently in their respective energy balances and (b) because of the different classifications of fuel oil A. The IEA energy balances include fuel consumption by international flights and international marine; whereas the energy balances of Japan do not include them as these are not regarded as domestic consumption. Consequently, the data for the bonded exports and imports of jet kerosene and fuel oil C are differently accounted for. With respect to fuel oil A, Japan includes it under Residual Fuel Oil in its energy balances but reports it to the IEA under Gas/Diesel Oil according to the classifications used in Europe and the United States. The changes in the stock data were caused by the difference in the classification of fuel oil A as well as by circumstances specific to individual items.

According to Japanese definition, fuel oil A has a flash point of more than 60 °C, kinematic viscosity of 20 mm^2/s below, carbon residue content of 4% below and sulfur content of 2.0 % below. Fuel oil B has a flash point of more than 60 °C, kinematic viscosity of 50 mm^2/s below, carbon residue content of 8% below and sulfur content of 3.0 % below. Fuel oil B is rarely used nowadays in Japan, for this reason, fuel oil B is treated as fuel oil B/C in Japanese statistics. Fuel oil C has a flash point of more than 70 °C, kinematic viscosity of less than 1000 mm^2/s and sulfur content of less than 3.5%.

Further explanations are provided below for each of the discrepancies noted by the ERT.

The IEA statistical data used in the Reference tables below were extracted from the Energy Statistics of OECD Countries 2004–2005 (CD-ROM version), 2007 Edition, OECD/IEA.

a）Differences in exports of jet kerosene and residual fuel oil

<ERT findings>

Exports of liquid fuels are between 40 and 70 per cent lower in the IEA data; the differences are due in particular to differences in the figures for jet kerosene and residual fuel oil, with the largest errors occurring in recent years.

<Explanation 1: Exports of jet kerosene>

The figures for jet kerosene exports reported in the CRF tables are different from those in the IEA statistics because the CRF figures include bonded exports whereas the export figures in the IEA statistics do not. The IEA statistics accounted the final consumption of jet kerosene by international aviation as an aggregate of the bonded exports and imports. (See Chapter 3, for bonded exports and imports.)

<Reference: Exports of jet kerosene in 2005>

CRF Table 1.A(b)	IEA Statistics
Exports: $6,688.96\times 10^3$ kl <Breakdown> Exports excluding bonded exports: 851.28×10^3 kl Bonded exports: $5,837.68\times 10^3$ kl	Exports: 667×10^3 t [851.28×10^3 kl (exports excluding bonded exports) × 0.7834 (specific gravity) = 667×10^3 t]
	<Remarks> International aviation: $6,825\times 10^3$ t [$5,837.68\times 10^3$ kl (bonded exports) + $2,874.92\times 10^3$ kl (bonded imports)* = $8,712.60\times 10^3$ kl; $8,712.60\times 10^3$ kl × 0.7834 (specific gravity) = $6,825\times 10^3$ t] * The bonded imports in the 2005 statistics were revised to $2,821.84\times 10^3$ kl in the 2006 statistics.

<Explanation 2: Exports of residual fuel oil>

The figures for exports of residual fuel oil reported in the CRF tables are different from those in the IEA statistics because the CRF figures for residual fuel oil include the bonded exports, whereas the export figures for heavy fuel oil in the IEA statistics do not. The bonded exports portion of the heavy fuel oil was reported in the IEA statistics as an aggregate of the bonded exports and imports of heavy fuel oil under International Marine Bunkers. (See Chapter 3, for bonded exports and imports.)

Further, the figures for exports of residual fuel oil reported in the CRF include fuel oil A, whereas the figures reported under Heavy Fuel Oil in the IEA statistics do not. The IEA reports fuel oil A together with gas oil under Gas/Diesel Oil in its statistics. Because fuel oil A, which is treated as a fuel oil that is distinguished from diesel oil in Japan, is grouped together with diesel oil in Europe and the United States, the fuel oil A data have been included in the diesel oil data in Japan’s report to the IEA.

<Reference: Exports of residual fuel oil in 2005>

CRF Table 1.A(b)	IEA Statistics/Heavy Fuel oil
Exports: $10,035.13\times 10^3$ kl [167.98×10^3 kl (fuel oil A) + $9,867.15\times 10^3$ kl (fuel oils B and C) = $10,035.13\times 10^3$ kl]	Exports: $3,018\times 10^3$ t [$3,352.98\times 10^3$ kl (exports of fuel oils B and C excluding bonded exports) × 0.9 (specific gravity) = $3,018\times 10^3$ t]

<Breakdown>	<Remarks>
Exports of fuel oil A: 167.98× 10^3 kl Exports excluding bonded exports: 0 Bonded exports: 167.98× 10^3 kl Exports of fuel oils B and C: 9,867.15× 10^3 kl Exports excluding bonded exports: 3,352.98× 10^3 kl Bonded exports: 6,514.17× 10^3 kl	International marine bunkers: 5,889× 10^3 t [6,514.17× 10^3 kl (bonded exports of fuel oils B and C) + 29.48× 10^3 kl (bonded imports of fuel oils B and C) = 6,543.65× 10^3 kl; 6,543.65× 10^3 kl × 0.9 (specific gravity) = 5,889× 10^3 t]

b）Differences in imports of jet kerosene and gas/diesel oil

<ERT findings>

Imports of jet kerosene have been reported to the IEA, but are shown as zero in the CRFs for the years 1990–1997, while imports of gas/diesel oil are systematically about 80 per cent lower in the CRF tables than in the IEA figures.

<Explanation 1: Imports of jet kerosene>

The figures for jet kerosene imports reported in the CRF tables are different from those in the IEA statistics because the CRF figures do not include bonded imports while the IEA statistics do. (See Chapter 3, for bonded exports and imports.)

<Reference: Jet kerosene imports in 1990>

CRF Table 1.A(b)	IEA Statistics
Imports: NO <Jet kerosene imports> Imports excluding bonded imports: 0 Bonded imports: 4,446.44× 10^3 kl	Imports: 3,483× 10^3 t [4,446.44× 10^3 kl (imports including bonded imports) × 0.7834 (specific gravity) = 3,483× 10^3 t]

<Explanation 2: Imports of gas/diesel oil>

The figures for imports of gas/diesel oil reported in the CRF tables are different from those in the IEA statistics because the CRF figures (excluding bonded imports) do not include fuel oil A while the figures for imports of gas/diesel oil in the IEA statistics are the aggregate of imports of diesel oil and fuel oil A, both of which included the bonded imports. (See a) above.)

<Reference: Imports of gas/diesel oil in 1990>

CRF Table 1.A(b)	IEA Statistics
Imports: 4,953.85× 10^3 kl <Imports of gas oil> Imports excluding bonded imports: 4,953.85× 10^3 kl Bonded imports: 32.90× 10^3 kl	Imports: 5,450× 10^3 t [4,986.75× 10^3 kl (imports of gas oil including bonded imports) + 1,663.52× 10^3 kl (imports of fuel oil A including bonded imports) = 6,650.27× 10^3 kl; 6,650.27× 10^3 kl × 0.843 (specific gravity) = 5,606× 10^3 t]
	<Remarks> The imports calculated by the formula in the brackets above differ from the imports reported in the IEA statistics due to an omission of bonded imports from the imports of fuel oil A. The correction (to 5,606 kt) was reported to the IEA in April 2008.

c) Differences in imports of coking coal

<ERT findings>

Furthermore, the figures for imports of coking coal are systematically lower in the CRF tables than those in the IEA statistics, with the largest discrepancy occurring in 1999.

<Explanation: Imports of coking coal>

The figures for imports of coking coal reported in the CRF tables are the same as the figures reported in the IEA statistics.

<Reference: Imports of coking coal in 1999>

CRF Table 1.A(b)	IEA Statistics
Imports: 54,880.04× 10^3 t	Imports: 54,880× 10^3 t

d) Differences in stock changes in liquid and gaseous fuels

<ERT findings>

In addition, the data on stock changes are not consistent for liquid and gaseous fuels.

<Explanation 1: Changes in crude oil stock>

The difference between the CRF table and the IEA statistics with respect to changes in crude oil stock occurred because the figures reported in the CRF were calculated using the stock of crude oil after customs clearance (or more precisely, after inspection in the presence of customs officers). The stock changes reported in the IEA statistics were calculated based on stock that included crude oil carried by oil tankers in Japanese territorial waters but which was yet to clear customs as well as the crude oil in the national stockpile. This discrepancy arose because the UNFCCC and the IEA had different objectives.

<Reference: Changes of crude oil stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: - 673× 10^3 kl	Stock changes: 276× 10^3 t

<Explanation 2: Changes in NGL stock>

Stock changes concerning NGL were reported in the CRF. The NGL stock changes reported in the IEA statistics were zero because the NGL stock figure in the Monthly Oil Statistics (MOS) of the IEA was zero. This discrepancy resulted from the direction given by the IEA that the figures in the IEA statistics must be consistent with the MOS figures.

Furthermore, the figures for “stock changes” required by the CRF tables are not included in the MOS. On the other hand, the MOS requires figures for Opening Stock and Closing Stock, but Japan does not collect such statistical data for NGL. As a result, Japan reported zero values to the IEA for both Opening Stock and Closing Stock data for the MOS. In light of the fact that no statistical data exists for stock changes in NGL, even though the stock actually existed, with respect to the CRF tables changes in NGL stock were estimated by a method developed for the calculation of estimates from the production, imports, and shipment data, etc, for NGL in order to minimize error in the energy and carbon balances with respect to oil refining for the years 1990 to 2003.

<Reference: Changes in NGL stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: 3,430.63× 10^3 kl	Stock changes: 0

<Explanation 3: Changes in gasoline stock>

The figures for changes in gasoline stock reported in the CRF tables are the same as the figures in the IEA statistics.

<Reference: Changes in gasoline stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: 76.92× 10^3 kl	Stock changes in motor gasoline: 57× 10^3 t [76.92× 10^3 kl × 0.737 (specific gravity) = = 57× 10^3 t] Stock changes in white spirit: 0

<Explanation 4: Changes in jet kerosene stock>

The figures for changes in jet kerosene stock reported in the CRF tables are the same as the figures in the IEA statistics.

<Reference: Changes in jet kerosene stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: 97.17× 10^3 kl	Stock changes: 76× 10^3 t [97.17× 10^3 kl (0.7834 (specific gravity) = 76× 10^3 t]

<Explanation 5: Changes in kerosene stock>

The figures for changes in kerosene stock reported in the CRF tables are the same as the figures in the IEA statistics.

<Reference: Changes in kerosene stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: 537.28× 10^3 kl	Stock changes: 437× 10^3 t [537.28× 10^3 kl × 0.814 (specific gravity) = 437× 10^3 t]

<Explanation 6: Changes in gas/diesel oil stock>

The figures for gas/diesel stock reported in the CRF tables were different from those in the IEA statistics because the CRF figures did not include stock changes in fuel oil A while the IEA statistics did.

<Reference: Changes in gas/diesel oil stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: 321.21× 10^3 kl	Stock changes: 402× 10^3 t [321.21× 10^3 kl × 0.843 (specific gravity) = 270.78× 10^3 t (stock changes in gas oil); 155.30× 10^3 kl × 0.843 (specific gravity) = 130.92× 10^3 t (stock changes in fuel oil A); 270.78 + 130.92 = 402× 10^3 t]

<Explanation 7: Changes in residual fuel oil stock>

The figures for residual fuel oil stock reported in the CRF tables were different from those in the IEA statistics because the CRF figures included changes in fuel oil A stock, whereas stock change data under Heavy Fuel Oil in the IEA statistics did not include fuel oil A. (See the explanation for the gas/diesel oil data above.)

<Reference: Changes in residual fuel oil stock in 2005>

CRF Table 1.A(b)	IEA Statistics/Heavy Fuel oil
Stock changes: 74.59× 10^3 kl <Breakdown> Stock changes in fuel oil A: 155.30× 10^3 kl Stock changes in fuel oil C: - 80.71× 10^3 kl	Stock changes: - 72× 10^3 t [- 80.71× 10^3 kl (stock changes in fuel oil C) × 0.900 (specific gravity) = - 72.64× 10^3 t]

<Explanation 8: Changes in LPG stock>

The figures for changes in LPG stock reported in the CRF tables are the same as the figures in the IEA statistics.

<Reference: Changes in LPG stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: 310.88× 10^3 t	Stock changes: 310× 10^3 t

<Explanation 9: Changes in naphtha stock>

The figures for changes in naphtha stock reported in the CRF tables are the same as the figures in the IEA statistics.

<Reference: Changes in naphtha stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: - 53.55× 10^3 kl	Stock changes: - 39× 10^3 t [- 53.55× 10^3 kl × 0.737 (specific gravity) = -39× 10^3 t]

<Explanation 10: Changes in bitumen stock>

The figures for changes in bitumen stock reported in the CRF tables were slightly different from the figures reported under Bitumen in the IEA statistics because the Bitumen data in the CRF tables included asphalt and other heavy oil and paraffin products. The IEA statistics reported figures for only asphalt under Bitumen, and the figures for other heavy oil and paraffin products reported in the CRF tables under Bitumen were included in the figures reported under Paraffin Waxes in the IEA statistics.

<Reference: Changes in bitumen stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: -20.03× 10^3 t <Breakdown> Asphalt: -19.37× 10^3 t Other heavy oils and paraffin products: -0.66× 10^3 t	Stock changes in bitumen: -19× 10^3 t <Remarks> In the IEA statistics, the figures for other heavy oil and paraffin products (which were reported under Bitumen in the CRF tables) are reported under Paraffin Waxes.

<Explanation 11: Changes in lubricants stock>

The figures for changes in lubricants stock reported in the CRF tables are the same as the figures in the IEA statistics.

<Reference: Changes in lubricating oil stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: -7.94× 10^3 kl	Stock changes: -7× 10^3 t [-7.94× 10^3 kl × 0.891 (specific gravity) = -7× 10^3 t]

<Explanation 12: Changes in oil coke stock>

The figures for changes in oil coke stock reported in the CRF tables are the same as the figures in the IEA statistics.

<Reference: Changes in oil coke stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Stock changes: 5× 10^3 t	Stock changes: 5× 10^3 t

<Explanation 13: Changes in refinery feedstock stock>

The figures for changes in refinery feedstock stock reported in the CRF were different from those in the IEA statistics because the IEA statistics included the figures for stock changes in slack wax and slack coke in addition to the semi-refined products reported in the CRF tables.

The changes in slack wax and coke stocks were not reported in the CRF tables because the both items were solids used as raw materials for the production of paraffin and oil coke, and unlikely to be returned to oil refining processes. In addition, shipments of paraffin and oil coke produced using slack wax and slack coke were separately accounted for.

<Reference: Changes in refinery feedstock stock in 2005>

<table>
<tr><th>CRF Table 1.A(b)</th><th>IEA Statistics</th></tr>
<tr><td>Stock changes: 502.16× 10^3 kl

<Breakdown>
Slack gasoline: -35.29× 10^3 kl
Slack kerosene: 78.26× 10^3 kl
Slack diesel oil or gas oil: 359.83× 10^3 kl
Slack fuel oil: 99.35× 10^3 kl
(Slack fuel oil is the aggregate of 139.32× 10^3 kl for slack fuel oil and -39.97× 10^3 kl for slack luburicant)</td><td>Stock changes: 416× 10^3 t

<Breakdown>
Slack gasoline: -42.74× 10^3 kl
Slack kerosene: 78.26× 10^3 kl
Slack diesel oil or gas oil: 359.83× 10^3 kl
Slack fuel oil: 139.32× 10^3 kl
Slack lubricant: -39.97× 10^3 kl
Slack wax: -4.53× 10^3 kl
Slack coke: -5.04× 10^3 kl

Each of the above figures is multiplied by its specific gravity for conversion to weight for reporting purposes.</td></tr>
<tr><td colspan="2"><Remarks>
The differences between monthly statistics and yearly statistics caused the difference in the changes of stock of slack gasoline between the CRF tables and the IEA statistics. The figures for the supply and stock of oil in the IEA statistics use the figures in the Monthly Oil Statistics compiled by the IEA. The report to the IEA for the MOS is submitted on a monthly basis. The monthly data may be adjusted for the yearly statistics. The CRF tables reported annual data.</td></tr>
</table>

<Explanation 14: Changes in natural gas stock>

The figures for changes in natural gas stock (imported LNG and domestic natural gas) reported in the CRF tables were different from those in the IEA statistics because of the differences in the methods used for estimation of changes in the imported LNG stock. Although the same figure for the domestic natural gas stock was reported in the CRF and the IEA statistics because the statistical data existed in Japan, data were estimated for the imported LNG due to the lack of stock statistics.

The figures for changes in LNG stock reported in the CRF tables were estimated as the difference between the LNG imports and the consumption. The figures for stock changes reported to the IEA were the difference between the stock of imported LNG at the end of the previous year and the stock at the end of the current year, with the former calculated as one-half of the LNG import in March of the previous year, and the latter as one-half of the LNG import in March of the current year.

<Reference: Changes in natural gas stock in 2005>

CRF Table 1.A(b)	IEA Statistics
Changes in LNG stock: -1,933.17× 10^3 t Changes in domestic natural gas stock: 3.23× $10^6 m^3$	Stock changes: -4,846 TJ-gross <Remarks> The figures for LNG and natural gas were combined under Natural Gas as the IEA statistics do not separate them.

A2.2. General Energy Statistics

A2.2.1. General Energy Statistics Overview

The data given in the *General Energy Statistics* compiled by the Agency for Natural Resources and Energy were used for the activity data of fuel combustion in energy sector.
The *General Energy Statistics* (Energy Balance Table) provides a comprehensive overview of domestic energy supply and demand to grasp what are converted from energy sources, such as coal, oil, natural gas and others, provided in Japan and what are consumed in what sectors. The supply/conversion and consumption data in *General Energy Statistics* use official statistics and are structured with the minimum of estimation and adjustment.

General Energy Statistics (Energy Balance Table) indicates an overview of domestic energy supply and demand, shows the main energy sources used in Japan as “Columns” and the supply, conversion and consumption sectors as “Rows”, in a matrix. Specifically, columns comprise 11 major categories (coal [code $100], coal products [code $150], oil [code $200], oil products [code $250], natural gas [code $400], town gas [code $450], new and renewable energy [code $500], large-scale hydropower [code $550], nuclear power [code $600], electricity [code $700], and heat [code $800]) and the necessary sub-categories and a more detailed breakdown of the sub-categories. The *General Energy Statistics* supply and demand sectors (rows) comprise 3 major sectors — primary energy supply (primary supply) [code #1000], energy conversion (conversion) [code #2000], and final energy consumption (final consumption) [code #5000] — plus the necessary sub-categories and a more detailed breakdown of the sub-categories. (Refer to the following General Energy Statistics simplified table.)

The *General Energy Statistics* (complete Energy Balance Tables) for the years since FY 1990 are available on the following internet site:
http://www.enecho.meti.go.jp/info/statistics/jukyu/result-2.htm

The following is the energy balance simplified table (Table A 2-1 - Table A 2-5).

Table A 2-1 Energy balance simplified table (General Energy Statistics, FY1990)

1990FY		Code	100	150	200	250	400	450	500	550	600	700	800		900	910	920
		〈Energy balance simplified table〉	Coal	Coal Product	Oil	Oil Products	Natural Gas	Town Gas	Renewable E	Hydraulic	Nuclear Ener	Electricity	Heat		Total	Energy Total	Non-Energy
		〈〈Energy units〉〉	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ		TJ	TJ	TJ
Code																	
1000	Primary Energy Supply		3345244	15352	9164033	2354044	2059168	0	524099	833304	1887390	0	0		20182635	18632722	1549913
1100		Indigenous Production	187036	0	24484	0	89203	0	524099	833304	1887390	0	0		3545517	0	0
1200		Import	3158208	15352	9139549	2354044	1969965	0	0	0	0	0	0		16637118	0	0
1500	TPES	Total Primary Energy Supply	3345244	15352	9164033	2354044	2059168	0	524099	833304	1887390	0	0		20182635	18632722	1549913
1600		Export	-53	-56644	0	-302130	0	0	0	0	0	0	0		-358828	0	
1700		Stockpile Change	1669	1951	-190171	-22710	42651	0	0	0	0	0	0		-166610	0	0
1900	DPES	Domestic Primary Energy Supply	3346859	-39341	8973862	2029203	2101819	0	524099	833304	1887390	0	0	supply side	19657197	18107284	1549913
														consumption side	19785779	18235866	1549913
2000	Energy Transformation & Own use		-3039243	1595040	-9032036	5785908	-2039503	629852	-470769	-833304	-1887390	2698536	696058		-5896853	-5865031	-31822
2100		Power Genertion	-673045	-204274	-874209	-1055765	-1531630	0	-19259	-767173	-1879280	2691329	0		-4313307	-4313307	0
2200		Auto Power Generation	-116820	-96004	0	-399646	-5054	-12280	-170874	-66131	-8110	304022	0		-570897	-570897	0
2300		Industrial Steam Generation	-123177	-69991	0	-444065	-2693	-15028	-278052	0	0	0	784558		-148448	-148448	0
2350		District Heat Supply	-824	0	0	-2633	0	-6169	-2028	0	0	-1229	8464		-4419	-4419	0
2400		Town Gas Production	0	-19178	0	-142210	-503865	664661	-546	0	0	0	0		-1139	-1139	0
2500		Coal Products	-2142396	2081208	0	-38206	0	0	0	0	0	0	0		-99394	-99394	0
2600		Oil Products	0	0	-8143167	8175984	5121	0	0	0	0	0	-94149		-56212	0	-56212
2700		Other Conversions & Blending	30171	2880	0	-18897	0	18897	0	0	0	0	0		33051	0	33051
2800	TC	Total Conversion	-3026090	1694639	-9017376	6074562	-2038122	650081	-470758	-833304	-1887390	2994122	698872		-5160764	-5137603	-23161
2900		Own Use & Loss	-3015	-101777	-1017	-301251	-1738	-20230	0	0	0	-295586	-2814		-727428	-727428	0
3000	OI	Other Imput/Output	0	0	0	12924	0	0	0	0	0	0	0		12924	0	12924
3500	FS	Stock Change	-10138	2177	-13642	-327	357	0	-10	0	0	0	0		-21584	0	-21584
4000	DC	Stastical Discrepancy	-75007	0	-58202	3856	769	0	0	0	0	2	0		-128582	-128582	0
5000	Final Energy Consumption		382623	1555699	28	7811256	61547	629852	53330	0	0	2698534	696058		13888926	12370836	1518091
6000	Industry		365162	1532019	28	3019423	57690	110593	0	0	0	1220265	687697		6992876	5516717	1476159
6100	NMFC	Non-Manufacturing	263	1141	28	759211	3757	20677	0	0	0	21251	0		806329	553571	252758
6500	MFC	Manufacturing	364899	1530877	0	2260212	53933	89916	0	0	0	1199013	687697		6186547	4963145	1223401
6520		Pulp & Paper	126	0	0	27726	2	1272	0	0	0	121360	249523		400009	400009	0
6550		Chemical	5443	46803	0	1356286	26599	1028	0	0	0	186050	185545		1807754	670574	1137180
6570		Cement & Ceramics	235223	40381	0	104386	20	743	0	0	0	79708	6706		467168	456544	10624
6580		Iron & Steel	143931	1103634	0	119268	25030	8746	0	0	0	265486	92916		1759011	1758326	685
6600		Machinery	15	16700	0	85879	2132	22135	0	0	0	212915	0		339776	339776	0
6700		Duplication Adjustment	-36513	-8421	0	-56803	-3000	-2137	0	0	0	-49573	-22295		-178742	-169225	-9517
6900		Other Industries & SMEs	1164	320931	0	354525	2014	31396	0	0	0	235503	121650		1067184	982755	84429
7000	ResCom		17461	23680	0	1634972	3857	519258	53330	0	0	1417755	8361		3678676	3677496	1180
7100	RES	Residential	0	2880	0	594332	0	342157	51488	0	0	662933	1284		1655075	1655075	0
7150		HokkaidoTohoku,Hokuriku	0	0	0	214484	0	41416	0	0	0	104048	0		359948	359948	0
7160		Kantou, Toukai, Kansai	0	0	0	285397	0	337114	0	0	0	416516	0		1039026	1039026	0
7170		Chuugoku,Shikoku,Kyushu,Okinawa	0	0	0	119753	0	48044	0	0	0	143216	0		311012	311012	0
7500	COM	Commercial & Others	17461	20801	0	1040640	3857	177101	1842	0	0	754822	7077		2023601	2022421	1180
7510		Water supply, Sewage & Waste Dis	262	0	0	73615	0	3295	0	0	0	67696	4		144872	144872	0
7540		Telecommunication & Broadcasting	0	0	0	9009	0	2257	0	0	0	19005	395		30666	30666	0
7600		Trade & Finance Service	0	0	0	259263	0	25973	0	0	0	188251	2656		476143	476143	0
7700		Public Service	12038	0	0	274167	0	49255	0	0	0	214702	1346		551508	551508	0
7810		Commercial Service	235	261	0	97285	0	4358	0	0	0	55712	413		158265	158265	0
7850		Retail Service	2406	1906	0	219818	0	67360	0	0	0	135481	1576		428547	428547	0
8000	Transportation		0	0	0	3156861	0	0	0	0	0	60514	0		3217375	3176623	40752
8100	PAS	Passenger	0	0	0	1614051	0	0	0	0	0	56610	0		1670661	1638859	31802
8110		Car	0	0	0	1375786	0	0	0	0	0	0	0		1375786	1344140	31646
8120		Rail	0	0	0	11264	0	0	0	0	0	56610	0		67874	67718	156
8130		Ship	0	0	0	67628	0	0	0	0	0	0	0		67628	67628	0
8140		Air	0	0	0	88429	0	0	0	0	0	0	0		88429	88429	0
8500	FRT	Freight	0	0	0	1542810	0	0	0	0	0	3905	0		1546714	1537764	8950
8510		Truck & Lorry	0	0	0	1391105	0	0	0	0	0	0	0		1391105	1386473	4632
8520		Rail	0	0	0	2638	0	0	0	0	0	3905	0		6543	6374	169
8530		Ship	0	0	0	130812	0	0	0	0	0	0	0		130812	126662	4149
8540		Air	0	0	0	18256	0	0	0	0	0	0	0		18256	18256	0
9000	FEEC	Final Energy Consumption	382112	1538556	28	6324859	47544	629814	53330	0	0	2698534	696058		12370836	12370836	0
9500	Non-Energy		511	17143	0	1486397	14003	38	0	0	0	0	0		1518091	0	1518091
9600		Industry	511	17143	0	1444465	14003	38	0	0	0	0	0		1476159	0	1476159
9800		ResCom & others	0	0	0	1180	0	0	0	0	0	0	0		1180	0	1180
9850		Transport	0	0	0	40752	0	0	0	0	0	0	0		40752	0	40752

Table A 2-2 Energy balance simplified table (General Energy Statistics, FY1995)

1995FY		Code	100	150	200	250	400	450	500	550	600	700	800		900	910	920
	〈Energy balance simplified table〉		Coal	Coal Product	Oil	Oil Products	Natural Gas	Town Gas	Renewable E	Hydraulic	Nuclear Ener	Electricity	Heat		Total	Energy Total	Non-Energy
	《Energy units》		TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ		TJ	TJ	TJ
Code																	
1000	Primary Energy Supply		3732254	18016	10204290	2225292	2479453	0	564207	761329	2700257	0	0		22685097	20955245	1729852
1100		Indigenous Production	149495	0	32455	0	95250	0	564207	761329	2700257	0	0		4302993	0	0
1200		Import	3582759	18016	10171835	2225292	2384203	0	0	0	0	0	0		18382105	0	0
1500	TPES	Total Primary Energy Supply	3732254	18016	10204290	2225292	2479453	0	564207	761329	2700257	0	0		22685097	20955245	1729852
1600		Export	-75	-103811	0	-733696	0	0	0	0	0	0	0		-837582	0	
1700		Stockpile Change	-2710	-6113	-30486	134344	58576	0	0	0	0	0	0		153611	0	0
1900	DPES	Domestic Primary Energy Supply	3729468	-91908	10173804	1625939	2538029	0	564207	761329	2700257	0	0	supply side	22001126	20271274	1729852
														consumption side	21947773	20217921	1729852
2000	Energy Transformation & Own use		-3286798	1395073	-10108952	7217919	-2474669	823061	-518878	-761329	-2700257	3090955	694292		-6629583	-6626513	-3070
2100		Power Genertion	-1072304	-210723	-669401	-838649	-1750818	0	-36870	-700065	-2687729	3071160	0		-4895399	-4895399	0
2200		Auto Power Generation	-150687	-115758	-880	-459430	-5691	-32050	-199357	-61264	-12528	364710	0		-672935	-672935	0
2300		Industrial Steam Generation	-133278	-60234	-328	-446810	-2879	-30180	-278056	0	0	0	784719		-167044	-167044	0
2350		District Heat Supply	-638	0	0	-1638	0	-11101	-4577	0	0	-2548	16423		-4079	-4079	0
2400		Town Gas Production	0	-12205	0	-157821	-723643	892307	-37	0	0	0	0		-1400	-1400	0
2500		Coal Products	-1963775	1893360	0	-30083	0	0	0	0	0	0	0		-100498	-100498	0
2600		Oil Products	0	0	-9421404	9490043	5773	0	0	0	0	0	-103260		-28847	-0	-28847
2700		Other Conversions & Blending	36411	1637	0	-22539	0	22539	0	0	0	0	0		38047	0	38047
2800	TC	Total Conversion	-3284272	1496077	-10092012	7533073	-2477258	841515	-518897	-761329	-2700257	3433322	697882		-5832154	-5841355	9200
2900		Own Use & Loss	-2978	-93780	-1058	-321669	-1261	-18454	0	0	0	-342367	-3590		-785158	-785158	0
3000	OI	Other Imput/Output	0	0	0	9078	0	0	0	0	0	0	0		9078	0	9078
3500	FS	Stock Change	452	-7224	-15882	-2563	3850	0	19	0	0	0	0		-21348	0	-21348
4000	DC	Stastical Discrepancy	-7652	0	64852	-8469	4622	0	-0	0	0	0	0		53353	53353	0
5000	Final Energy Consumption		450322	1303165	0	8852328	58738	823061	45329	0	0	3090955	694292		15318190	13591408	1726782
6000	Industry		428876	1299570	0	3267149	56329	163883	36	0	0	1269782	678469		7164096	5471642	1692454
6100	NMFC	Non-Manufacturing	191	528	0	735650	1776	26151	0	0	0	20464	0		784760	557911	226848
6500	MFC	Manufacturing	428685	1299042	0	2531499	54553	137733	36	0	0	1249318	678469		6379336	4913731	1465605
6520		Pulp & Paper	0	0	0	30072	5	5747	36	0	0	126598	246261		408718	408718	0
6550		Chemical	6176	34647	0	1705864	21627	6650	0	0	0	199040	193896		2167901	799104	1368797
6570		Cement & Ceramics	235274	37704	0	118517	341	628	0	0	0	84884	8266		485615	475539	10076
6580		Iron & Steel	201778	958301	0	114033	26245	20866	0	0	0	255475	94083		1670781	1670574	208
6600		Machinery	4	14083	0	89461	3476	32517	0	0	0	236790	0		376331	376331	0
6700		Duplication Adjustment	-26421	-5593	0	-81902	-1529	-3384	0	0	0	-49200	-20224		-188251	-182224	-6028
6900		Other Industries & SMEs	1841	250502	0	261747	2608	40947	0	0	0	244492	104443		906581	814028	92553
7000	ResCom		21446	3594	0	1846240	2409	659177	45293	0	0	1753655	15823		4347637	4345809	1828
7100	RES	Residential	0	1637	0	700079	0	398516	43786	0	0	827334	1368		1972720	1972720	0
7150		HokkaidoTohoku,Hokuriku	0	0	0	245943	0	46561	0	0	0	135963	0		428467	428467	0
7160		Kantou, Toukai, Kansai	0	0	0	330756	0	367163	0	0	0	541005	0		1238924	1238924	0
7170		Chuugoku,Shikoku,Kyushu,Okinawa	0	0	0	145241	0	50323	0	0	0	187224	0		382789	382789	0
7500	COM	Commercial & Others	21446	1958	0	1146160	2409	260662	1507	0	0	926321	14455		2374918	2373090	1828
7510		Water supply, Sewage & Waste Dis	426	0	0	113365	0	4750	0	0	0	63661	8		182210	182210	0
7540		Telecommunication & Broadcasting	0	0	0	10732	0	2438	0	0	0	22209	384		35764	35764	0
7600		Trade & Finance Service	0	0	0	269831	0	40343	0	0	0	201589	6828		518593	518593	0
7700		Public Service	16599	0	0	364499	0	75063	0	0	0	277487	1960		735608	735608	0
7810		Commercial Service	330	254	0	98680	0	5580	0	0	0	66005	587		171435	171435	0
7850		Retail Service	3820	1682	0	261577	0	154955	0	0	0	160825	3268		586127	586127	0
8000	Transportation		0	0	0	3738939	0	0	0	0	0	67518	0		3806457	3773957	32500
8100	PAS	Passenger	0	0	0	2044897	0	0	0	0	0	63676	0		2108573	2083686	24887
8110		Car	0	0	0	1787686	0	0	0	0	0	0	0		1787686	1762915	24771
8120		Rail	0	0	0	9759	0	0	0	0	0	63676	0		73435	73319	116
8130		Ship	0	0	0	79258	0	0	0	0	0	0	0		79258	79258	0
8140		Air	0	0	0	128698	0	0	0	0	0	0	0		128698	128698	0
8500	FRT	Freight	0	0	0	1694042	0	0	0	0	0	3842	0		1697884	1690271	7613
8510		Truck & Lorry	0	0	0	1566432	0	0	0	0	0	0	0		1566432	1562452	3980
8520		Rail	0	0	0	2400	0	0	0	0	0	3842	0		6242	6130	112
8530		Ship	0	0	0	131840	0	0	0	0	0	0	0		131840	128319	3521
8540		Air	0	0	0	24397	0	0	0	0	0	0	0		24397	24397	0
9000	FEEC	Final Energy Consumption	449885	1291322	0	7149862	46702	823061	45329	0	0	3090955	694292		13591408	13591408	0
9500	Non-Energy		437	11843	0	1702466	12036	0	0	0	0	0	0		1726782	0	1726782
9600		Industry	437	11843	0	1668138	12036	0	0	0	0	0	0		1692454	0	1692454
9800		ResCom & others	0	0	0	1828	0	0	0	0	0	0	0		1828	0	1828
9850		Transport	0	0	0	32500	0	0	0	0	0	0	0		32500	0	32500

Table A 2-3 Energy balance simplified table (General Energy Statistics, FY2000)

2000FY		Code	100	150	200	250	400	450	500	550	600	700	800		900	910	920
		〈Energy balance simplified table〉	Coal	Coal Product	Oil	Oil Products	Natural Gas	Town Gas	Renewable E	Hydraulic	Nuclear Ener	Electricity	Heat		Total	Energy Total	Non-Energy
		〈〈Energy units〉〉	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ		TJ	TJ	TJ
Code																	
1000	Primary Energy Supply		4210040	76219	9761365	2246246	3060666	0	616335	778417	2873130	0	0		23622418	21719570	1902848
1100		Indigenous Production	66013	0	28034	0	106340	0	616335	778417	2873130	0	0		4468269	0	0
1200		Import	4144027	76219	9733330	2246246	2954327	0	0	0	0	0	0		19154149	0	0
1500	TPES	Total Primary Energy Supply	4210040	76219	9761365	2246246	3060666	0	616335	778417	2873130	0	0		23622418	21719570	1902848
1600		Export	-112	-78077	0	-627862	0	0	0	0	0	0	0		-706051	0	
1700		Stockpile Change	-2958	-1963	-116285	-106335	72387	0	0	0	0	0	0		-155155	0	0
1900	DPES	Domestic Primary Energy Supply	4206970	-3821	9645079	1512049	3133054	0	616335	778417	2873130	0	0	supply side	22761213	20858365	1902848
														consumption side	22790985	20888136	1902848
2000	Energy Transformation & Own use		-3736666	1287540	-9721175	7518258	-3072804	986782	-562115	-778417	-2873130	3396151	739685		-6815890	-6685083	-130807
2100		Power Genertion	-1515218	-212244	-301245	-548677	-2131672	-1447	-46226	-711603	-2866777	3333294	0		-5001815	-5001815	0
2200		Auto Power Generation	-199734	-148205	-99	-425144	-9644	-38900	-211258	-66814	-6353	423092	0		-683058	-683058	0
2300		Industrial Steam Generation	-191460	-34306	-119	-428955	-6984	-30434	-298304	0	0	0	857666		-132897	-132897	0
2350		District Heat Supply	-708	0	0	-1725	0	-14515	-6275	0	0	-3940	23428		-3735	-3735	0
2400		Town Gas Production	0	-9573	0	-126581	-925315	1061122	-31	0	0	0	0		-377	-377	0
2500		Coal Products	-1816696	1790538	0	-39481	0	0	0	0	0	0	0		-65640	-65640	0
2600		Oil Products	0	0	-9431042	9467009	6972	0	0	0	0	0	-137327		-94389	0	-94389
2700		Other Conversions & Blending	17846	0	0	-23232	0	23232	0	0	0	0	0		17846	0	17846
2800	TC	Total Conversion	-3705970	1386210	-9732505	7873214	-3066643	999058	-562094	-778417	-2873130	3752445	743767		-5964065	-5887523	-76543
2900		Own Use & Loss	-4240	-93659	-518	-325749	-743	-12276	0	0	0	-356294	-4082		-797561	-797561	0
3000	OI	Other Imput/Output	0	0	0	-32610	0	0	0	0	0	0	0		-32610	0	-32610
3500	FS	Stock Change	-26456	-5012	11849	3404	-5418	0	-21	0	0	0	0		-21654	0	-21654
4000	DC	Stastical Discrepancy	43208	0	-76095	-6521	9637	0	0	0	0	0	0		-29772	-29772	0
5000	Final Energy Consumption		427096	1283719	0	9036828	50613	986782	54220	0	0	3396151	739685		15975094	14203053	1772041
6000	Industry		402587	1281740	0	3284658	49960	159109	18388	0	0	1307620	717036		7221098	5490897	1730201
6100	NMFC	Non-Manufacturing	178	603	0	608480	1930	25527	0	0	0	17223	0		653942	474431	179511
6500	MFC	Manufacturing	402409	1281136	0	2676177	48030	133583	18388	0	0	1290397	717036		6567156	5016466	1550690
6520		Pulp & Paper	0	0	0	20792	70	563	12142	0	0	132838	253277		419682	419682	0
6550		Chemical	19	37438	0	1809648	23095	3181	0	0	0	179582	256781		2309744	843806	1465939
6570		Cement & Ceramics	184710	23143	0	85120	175	489	6235	0	0	79974	10800		390646	390154	492
6580		Iron & Steel	223836	977757	0	100256	22175	31628	0	0	0	253494	105469		1714614	1714463	152
6600		Machinery	0	6359	0	37273	945	18502	2	0	0	262650	0		325731	325731	0
6700		Duplication Adjustment	-12253	-1231	0	-27736	-176	-676	-10	0	0	-40768	-88966		-171817	-171817	-0
6900		Other Industries & SMEs	1927	227946	0	423747	0	46382	0	0	0	266689	124234		1090926	1006819	84107
7000	ResCom		24509	1979	0	1891287	653	827673	35833	0	0	2021667	22648		4826249	4818571	7678
7100	RES	Residential	0	0	0	731171	0	418454	34912	0	0	928274	1306		2114117	2114117	0
7150		HokkaidoTohoku,Hokuriku	0	0	0	258987	0	52403	0	0	0	166607	0		477997	477997	0
7160		Kantou, Toukai, Kansai	0	0	0	339898	0	417463	0	0	0	624718	0		1382078	1382078	0
7170		Chuugoku,Shikoku,Kyushu,Okinawa	0	0	0	147430	0	50550	0	0	0	210400	0		408379	408379	0
7500	COM	Commercial & Others	24509	1979	0	1160116	653	409219	921	0	0	1093394	21342		2712132	2704454	7678
7510		Water supply, Sewage & Waste Dis	521	0	0	100189	0	7316	0	0	0	76046	12		184085	184085	0
7540		Telecommunication & Broadcasting	0	0	0	18618	0	5698	0	0	0	36920	605		61841	61841	0
7600		Trade & Finance Service	0	0	0	258854	0	54325	0	0	0	230281	9039		552499	552499	0
7700		Public Service	17507	0	0	419901	0	124201	0	0	0	363562	3024		928195	928195	0
7810		Commercial Service	464	334	0	106094	0	8911	0	0	0	88762	1066		205631	205631	0
7850		Retail Service	4658	1567	0	280109	0	205098	0	0	0	196235	4745		692411	692411	0
8000	Transportation		0	0	0	3860884	0	0	0	0	0	66864	0		3927748	3893585	34162
8100	PAS	Passenger	0	0	0	2283876	0	0	0	0	0	63385	0		2347261	2321514	25746
8110		Car	0	0	0	2086803	0	0	0	0	0	0	0		2086803	2061151	25652
8120		Rail	0	0	0	8598	0	0	0	0	0	63385	0		71983	71889	94
8130		Ship	0	0	0	78498	0	0	0	0	0	0	0		78498	78498	0
8140		Air	0	0	0	134790	0	0	0	0	0	0	0		134790	134790	0
8500	FRT	Freight	0	0	0	1577008	0	0	0	0	0	3479	0		1580487	1572071	8416
8510		Truck & Lorry	0	0	0	1558126	0	0	0	0	0	0	0		1558126	1555516	2610
8520		Rail	0	0	0	1878	0	0	0	0	0	3479	0		5357	5274	83
8530		Ship	0	0	0	137346	0	0	0	0	0	0	0		137346	131623	5722
8540		Air	0	0	0	24246	0	0	0	0	0	0	0		24246	24246	0
9000	FEEC	Final Energy Consumption	427096	1268259	0	7288772	42088	986782	54220	0	0	3396151	739685		14203053	14203053	0
9500	Non-Energy		0	15460	0	1748057	8525	0	0	0	0	0	0		1772041	0	1772041
9600		Industry	0	15460	0	1706216	8525	0	0	0	0	0	0		1730201	0	1730201
9800		ResCom & others	0	0	0	7678	0	0	0	0	0	0	0		7678	0	7678
9850		Transport	0	0	0	34162	0	0	0	0	0	0	0		34162	0	34162

Table A 2-4 Energy balance simplified table (General Energy Statistics, FY2005)

2005FY		Code	100	150	200	250	400	450	500	550	600	700	800		900	910	920
		〈Energy balance simplified table〉	Coal	Coal Product	Oil	Oil Products	Natural Gas	Town Gas	Renewable E	Hydraulic	Nuclear Ener	Electricity	Heat		Total	Energy Total	Non-Energy
		〈〈Energy units〉〉	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ		TJ	TJ	TJ
Code																	
1000	Primary Energy Supply		4747650	81314	9506203	2135196	3288496	0	676443	671713	2676958	0	0		23783974	21767429	2016545
1100		Indigenous Production	0	0	33051	0	134612	0	676443	671713	2676958	0	0		4192776	0	0
1200		Import	4747650	81314	9473152	2135196	3153885	0	0	0	0	0	0		19591198	0	0
1500	TPES	Total Primary Energy Supply	4747650	81314	9506203	2135196	3288496	0	676443	671713	2676958	0	0		23783974	21767429	2016545
1600		Export	-85	-49279	0	-897381	0	0	0	0	0	0	0		-946745	0	
1700		Stockpile Change	0	-16228	-96075	-73435	105352	0	0	0	0	0	0		-80386	0	0
1900	DPES	Domestic Primary Energy Supply	4747565	15807	9410128	1164381	3393848	0	676443	671713	2676958	0	0	supply side	22756843	20740297	2016545
														consumption side	23025347	21001485	2016545
2000	Energy Transformation & Own use		-4380236	1328905	-9637342	7534806	-3318058	1206465	-645344	-671713	-2676958	3515694	714918		-7028862	-6832682	-188862
2100		Power Genertion	-2146038	-186507	-301537	-546923	-1912210	-58869	-76110	-613992	-2676958	3440416	0		-5071412	-5071412	0
2200		Auto Power Generation	-225239	-138544	-24	-396248	-18506	-67598	-247349	-57720	0	464983	0		-686246	-686246	0
2300		Industrial Steam Generation	-201817	-33452	-33	-364073	-10580	-53178	-314989	0	0	0	832833		-145289	-145289	0
2350		District Heat Supply	-633	0	0	-1058	0	-18102	-6739	0	0	-4129	25984		-4677	-4677	0
2400		Town Gas Production	0	-1994	0	-76818	-1315225	1391962	-46	0	0	0	0		-2121	-2121	0
2500		Coal Products	-1852761	1802622	0	-19827	0	0	0	0	0	0	0		-69966	-69966	0
2600		Oil Products	0	0	-9331018	9324886	8203	0	0	0	0	0	-139784		-137714	0	-137714
2700		Other Conversions & Blending	18933	0	0	-22505	0	22505	0	0	0	0	0		18933	0	18933
2800	TC	Total Conversion	-4407555	1442124	-9632613	7897434	-3248318	1216719	-645232	-671713	-2676958	3901270	719033		-6105809	-5979711	-118781
2900		Own Use & Loss	-6994	-94841	-85	-309370	-41736	-10254	0	0	0	-385576	-4115		-852972	-852972	0
3000	OI	Other Imput/Output	0	0	0	-53184	0	0	0	0	0	0	0		-53184	0	-53184
3500	FS	Stock Change	34314	-18378	-4644	-73	-28004	0	-112	0	0	0	0		-16897	0	-16897
4000	DC	Stastical Discrepancy	-48131	0	-227214	-2538	9378	0	-0	0	0	0	0		-268505	-261187	0
5000	Final Energy Consumption		415460	1344712	0	8701725	66413	1206465	31099	0	0	3515694	714918		15996485	14168802	1827683
6000	Industry		394168	1342658	0	3142673	65661	191539	6329	0	0	1231595	689846		7064470	5273144	1791326
6100	NMFC	Non-Manufacturing	100	191	0	503751	2758	30491	0	0	0	10887	0		548178	423510	124667
6500	MFC	Manufacturing	394067	1342467	0	2638922	62903	161049	6329	0	0	1220708	689846		6516292	4849634	1666658
6520		Pulp & Paper	0	0	0	18699	119	762	25	0	0	127812	242031		389447	389447	0
6550		Chemical	4351	37042	0	1880133	31475	5702	0	0	0	171601	242225		2372528	789974	1582554
6570		Cement & Ceramics	161134	20463	0	75555	185	842	6300	0	0	78074	9075		351627	348954	2673
6580		Iron & Steel	248848	971128	0	84755	25945	47754	0	0	0	253662	97734		1729825	1729695	130
6600		Machinery	1	5255	0	36649	3007	25317	5	0	0	285518	0		355752	355752	0
6700		Duplication Adjustment	-24479	0	0	-20151	-500	-754	0	0	0	-33744	-77425		-157052	-154564	-2488
6900		Other Industries & SMEs	1409	299506	0	386675	0	28603	0	0	0	191277	129120		1036590	952801	83789
7000	ResCom		21292	2054	0	1872067	751	1014925	24769	0	0	2215492	25072		5176423	5174228	2195
7100	RES	Residential	0	0	0	701600	0	435817	24033	0	0	1019088	1326		2181864	2181864	0
7150		HokkaidoTohoku,Hokuriku	0	0	0	252024	0	57970	0	0	0	182318	0		492311	492311	0
7160		Kantou, Toukai, Kansai	0	0	0	329849	0	472168	0	0	0	705199	0		1507215	1507215	0
7170		Chuugoku,Shikoku,Kyushu,Okinawa	0	0	0	151797	0	55495	0	0	0	243104	0		450396	450396	0
7500	COM	Commercial & Others	21292	2054	0	1170467	751	579108	736	0	0	1196404	23746		2994559	2992364	2195
7510		Water supply, Sewage & Waste Dis	707	0	0	97018	0	10275	0	0	0	77680	10		185689	185689	0
7540		Telecommunication & Broadcasting	0	0	0	16400	0	7767	0	0	0	33240	687		58094	58094	0
7600		Trade & Finance Service	0	0	0	228066	0	184556	0	0	0	369264	7442		789329	789329	0
7700		Public Service	15580	0	0	396400	0	165795	0	0	0	345691	2515		925981	925981	0
7810		Commercial Service	785	220	0	83668	0	8214	0	0	0	87825	947		181659	181659	0
7850		Retail Service	2159	1798	0	264254	0	238811	0	0	0	193168	2954		703145	703145	0
8000	Transportation		0	0	0	3686985	0	0	0	0	0	68607	0		3755592	3721430	34162
8100	PAS	Passenger	0	0	0	2242955	0	0	0	0	0	65029	0		2307984	2282238	25746
8110		Car	0	0	0	1968839	0	0	0	0	0	0	0		1968839	1943187	25652
8120		Rail	0	0	0	7833	0	0	0	0	0	65029	0		72862	72768	94
8130		Ship	0	0	0	70204	0	0	0	0	0	0	0		70204	70204	0
8140		Air	0	0	0	137208	0	0	0	0	0	0	0		137208	137208	0
8500	FRT	Freight	0	0	0	1444030	0	0	0	0	0	3578	0		1447608	1439192	8417
8510		Truck & Lorry	0	0	0	1333297	0	0	0	0	0	0	0		1333297	1330687	2610
8520		Rail	0	0	0	1718	0	0	0	0	0	3578	0		5296	5212	84
8530		Ship	0	0	0	117819	0	0	0	0	0	0	0		117819	112097	5722
8540		Air	0	0	0	23641	0	0	0	0	0	0	0		23641	23641	0
9000	FEEC	Final Energy Consumption	415460	1329123	0	6905897	50146	1206465	31099	0	0	3515694	714918		14168802	14168802	0
9500	Non-Energy		0	15589	0	1795828	16266	0	0	0	0	0	0		1827683	0	1827683
9600		Industry	0	15589	0	1759470	16266	0	0	0	0	0	0		1791326	0	1791326
9800		ResCom & others	0	0	0	2195	0	0	0	0	0	0	0		2195	0	2195
9850		Transport	0	0	0	34162	0	0	0	0	0	0	0		34162	0	34162

Table A 2-5　Energy balance simplified table (General Energy Statistics, FY2009)

2009FY		Code	100	150	200	250	400	450	500	550	600	700	800		900	910	920
	⟨Energy balance simplified table⟩		Coal	Coal Product	Oil	Oil Products	Natural Gas	Town Gas	Renewable E	Hydraulic	Nuclear Ener	Electricity	Heat		Total	Energy Total	Non-Energy
	⟨⟨Energy units⟩⟩		TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ		TJ	TJ	TJ
Code																	
1000	Primary Energy Supply		4395186	12588	8064639	1769594	3781300	0	654700	662778	2411197	0	0		21751982	20057194	1694789
1100		Indigenous Production	0	0	32968	0	159411	0	654700	662778	2411197	0	0		3921054	0	0
1200		Import	4395186	12588	8031671	1769594	3621889	0	0	0	0	0	0		17830928	0	0
1500	TPES	Total Primary Energy Supply	4395186	12588	8064639	1769594	3781300	0	654700	662778	2411197	0	0		21751982	20057194	1694789
1600		Export	-59	-31515	0	-1196659	0	0	0	0	0	0	0		-1228233	0	
1700		Stockpile Change	0	11757	57229	102371	197864	0	0	0	0	0	0		369221	0	0
1900	DPES	Domestic Primary Energy Supply	4395128	-7170	8121868	675307	3979163	0	654700	662778	2411197	0	0	supply side	20892971	19198182	1694789
														consumption side	20838519	19140984	1694789
2000	Energy Transformation & Own use		-4012200	1194498	-8097982	6766104	-3929452	1355004	-631831	-662778	-2411197	3359397	626238		-6444199	-6495653	54201
2100		Power Genertion	-1990383	-158292	-145878	-347191	-2252943	-56124	-68759	-582680	-2411197	3304330	0		-4706371	-4706371	0
2200		Auto Power Generation	-228998	-118966	-65	-289099	-24750	-74827	-241288	-80098	0	439751	0		-618340	-618340	0
2300		Industrial Steam Generation	-205312	-34235	-86	-265939	-17664	-65646	-315449	0	0	0	752681		-151650	-151650	0
2350		District Heat Supply	0	0	0	-320	0	-16280	-5904	0	0	-3903	24018		-2389	-2389	0
2400		Town Gas Production	0	0	0	-44360	-1551190	1593032	0	0	0	0	0		-2518	-2518	0
2500		Coal Products	-1662080	1599261	0	-16091	0	0	0	0	0	0	0		-78910	-78910	0
2600		Oil Products	0	0	-7956668	8047039	4955	0	0	0	0	0	-144832		-49506	0	-49506
2700		Other Conversions & Blending	15831	0	0	-19833	0	19833	0	0	0	0	0		15831	0	15831
2800	TC	Total Conversion	-4070943	1287767	-8102697	7064206	-3841592	1399987	-631399	-662778	-2411197	3740178	631867		-5596600	-5560179	-33675
2900		Own Use & Loss	-20407	-106457	-58	-277107	-100051	-44983	0	0	0	-380781	-5629		-935474	-935474	0
3000	OI	Other Imput/Output	0	0	0	-25673	0	0	0	0	0	0	0		-25673	0	-25673
3500	FS	Stock Change	79150	13188	4773	4678	12192	0	-432	0	0	0	0		113549	0	113549
4000	DC	Stastical Discrepancy	55616	0	23886	-12830	-12238	0	-0	0	0	19	0		54452	57198	0
5000	Final Energy Consumption		327312	1187328	0	7454241	61950	1355004	22869	0	0	3359378	626238		14394320	12645331	1748990
6000	Industry		306788	1185213	0	2735646	61291	211497	3400	0	0	1046911	603241		6153988	4439161	1714827
6100	NMFC	Non-Manufacturing	75	191	0	390020	3990	32595	0	0	0	8990	0		435860	338176	97684
6500	MFC	Manufacturing	306714	1185022	0	2345626	57302	178903	3400	0	0	1037921	603241		5718128	4100985	1617144
6520		Pulp & Paper	0	0	0	14472	353	1800	46	0	0	112928	204024		333623	333623	0
6550		Chemical	13	36515	0	1811970	30189	8240	0	0	0	152728	219179		2258834	722793	1536042
6570		Cement & Ceramics	126871	16983	0	67482	408	987	3354	0	0	73523	10556		300165	297964	2201
6580		Iron & Steel	192772	879028	0	58192	18860	60735	0	0	0	218677	89827		1518091	1517924	167
6600		Machinery	0	4144	0	28840	3067	24784	0	0	0	264513	0		325349	325349	0
6700		Duplication Adjustment	-15451	0	0	-10656	-34	-2493	0	0	0	-34024	-71990		-134647	-132495	-2153
6900		Other Industries & SMEs	1045	239873	0	264509	0	14163	0	0	0	91949	114962		726501	645614	80887
7000	ResCom		20524	2115	0	1385198	659	1143507	19469	0	0	2242896	22997		4837365	4837365	0
7100	RES	Residential	0	0	0	566883	0	420673	18810	0	0	1029656	1318		2037340	2037340	0
7150		HokkaidoTohoku,Hokuriku	0	0	0	212867	0	45291	0	0	0	217901	0		476059	476059	0
7160		Kantou, Toukai, Kansai	0	0	0	265733	0	427880	0	0	0	807999	0		1501612	1501612	0
7170		Chuugoku,Shikoku,Kyushu,Okinawa	0	0	0	108196	0	56023	0	0	0	274469	0		438687	438687	0
7500	COM	Commercial & Others	20524	2115	0	818315	659	722834	659	0	0	1213240	21679		2800025	2800025	0
7510		Water supply, Sewage & Waste Dis	898	0	0	71927	0	12475	0	0	0	80662	8		165970	165970	0
7540		Telecommunication & Broadcasting	0	0	0	10785	0	9125	0	0	0	31169	765		51844	51844	0
7600		Trade & Finance Service	0	0	0	145010	0	244648	0	0	0	417401	5085		812144	812144	0
7700		Public Service	13756	0	0	290092	0	191856	0	0	0	317172	1921		814796	814796	0
7810		Commercial Service	1046	123	0	53048	0	6693	0	0	0	84324	817		146051	146051	0
7850		Retail Service	2186	1956	0	204395	0	244118	0	0	0	185590	1494		639738	639738	0
8000	Transportation		0	0	0	3333396	0	0	0	0	0	69571	0		3402967	3368805	34162
8100	PAS	Passenger	0	0	0	2059012	0	0	0	0	0	66068	0		2125080	2099328	25752
8110		Car	0	0	0	1905822	0	0	0	0	0	0	0		1905822	1880170	25652
8120		Rail	0	0	0	7352	0	0	0	0	0	66068	0		73420	73320	100
8130		Ship	0	0	0	55993	0	0	0	0	0	0	0		55993	55993	0
8140		Air	0	0	0	122954	0	0	0	0	0	0	0		122954	122954	0
8500	FRT	Freight	0	0	0	1274384	0	0	0	0	0	3503	0		1277887	1269476	8411
8510		Truck & Lorry	0	0	0	1239049	0	0	0	0	0	0	0		1239049	1236439	2610
8520		Rail	0	0	0	1561	0	0	0	0	0	3503	0		5064	4986	78
8530		Ship	0	0	0	99116	0	0	0	0	0	0	0		99116	93394	5722
8540		Air	0	0	0	22738	0	0	0	0	0	0	0		22738	22738	0
9000	FEEC	Final Energy Consumption	327312	1172889	0	5733916	47724	1355004	22869	0	0	3359378	626238		12645331	12645331	0
9500	Non-Energy		0	14439	0	1720325	14226	0	0	0	0	0	0		1748990	0	1748990
9600		Industry	0	14439	0	1686162	14226	0	0	0	0	0	0		1714827	0	1714827
9800		ResCom & others	0	0	0	0	0	0	0	0	0	0	0		0	0	0
9850		Transport	0	0	0	34162	0	0	0	0	0	0	0		34162	0	34162

A2.2.2. General Energy Statistics and CRF

In order to report CO_2 emissions in CRF, emissions reported under the sectors in *General Energy Statistics* (Energy Balance Table) were reported under each sector in CRF as indicated in Table A 2-6 and Table A 2-7.

Values subtracting energy consumption reported under ‘Non-energy’ [#9500] from energy consumption reported under ‘Energy Conversion & Own use’ [#2000], ‘Industry’ [#6000], ‘Residential’ [#7100], ‘Commercial & Others’ [#7500], and ‘Transportation’ [#8000] in *General Energy Statistics* (Energy Balance Table) are used for activity data. Because energy consumption reported under ‘Non-energy’ [#9500] was used for the purposes other than combustion and was considered not emitting CO_2, these values were deducted. However, out of this amount deducted as feedstocks and non-energy use, the emissions from what is used or collected as energy during waste incineration are separately estimated and reported.

The *Revised 1996 IPCC Guidelines* requires carbon dioxide emitted from auto power generation, etc., to be counted in the corresponding sector. In Japan’s Energy Balance Table (*General Energy Statistics*), fuel consumption used for auto power generation and industrial steam generation are presented under ‘Auto Power Generation’ [#2200], ‘Industrial Steam Generation’ [#2300] in the Energy Conversion Sector. However, auto power generation and industrial steam generation actually belong to industrial sector. Hence, carbon dioxide emissions from “Auto Power Generation” and “Industrial Steam Generation” are allocated to each section of ‘1.A.2 Manufacturing Industries and Construction’.

Table A 2-6 Correspondence between sectors of General Energy Statistics (Miner Sector) and of the CRF

CRF			Japan's Energy Balance Table	
1A1		Energy Industries		
	1A1a	Public Electricity and Heat Production	Power Generation, General Electric Utilities	#2110
			Own use, General Electric Utilities	#2911
			Power Generation, Independent Power Producing	#2150
			Own use, Independent Power Producing	#2912
			District Heat Supply	#2350
			Own use, District Heat Supply	#2913
	1A1b	Petroleum Refining	Own use, Oil Refinary	#2916
	1A1c	Manufacture of Solid Fuels and Other Energy Industries	Own use, Coal Products	#2500
			Own use, Town Gas	#2914
			Own use, Steel Coke	#2915
			Own use, Other Conversion	#2917
1A2		Manufacturing Industries and Construction		
	1A2a	Iron and Steel	Auto: Iron & Steel	#2217
			Steam Generation: Iron & Steel	#2307
			Final Energy Consumption, Iron & Steel	#6580
			Non-Energy, Iron & Steel	#9680
	1A2b	Non-Ferrous Metals	Auto: Non-Ferrous Metal	#2218
			Steam Generation: Non-Ferrous Metal	#2308
			Final Energy Consumption, Non-Ferrous Metal	#6590
			Non-Energy, Non-Ferrous Metal	#9690
	1A2c	Chemicals	Auto: Chemical Textiles	#2212
			Steam Generation: Chemical Textiles	#2302
			Final Energy Consumption, Chemical Textiles	#6530
			Non-Energy, Chemical Textiles	#9630
			Auto: Chemical	#2214
			Steam Generation: Chemical	#2304
			Final Energy Consumption, Chemical	#6550
			Non-Energy, Chemical	#9650
	1A2d	Pulp, Paper and Print	Auto: Pulp & Paper	#2211
			Steam Generation: Pulp & Paper	#2301
			Final Energy Consumption, Pulp & Paper	#6520
			Non-Energy, Pulp & Paper	#9620
	1A2e	Food Processing, Beverages and Tobacco	Final Energy Consumption, Food	#6510
			Non-Energy, Non-Manufacturing Industry (Food)	#9610
	1A2f	Other		
		Mining	Final Energy Consumption, Mining	#6120
			Non-Energy, Non-Manufacturing Industry (Mining)	#9610
		Construction	Final Energy Consumption, Construction	#6150
			Non-Energy, Non-Manufacturing Industry (Construction)	#9610
		Oil Products	Auto: Oil products	#2213
			Steam Generation: Oil products	#2303
			Final Energy Consumption, Oil products	#6540
			Non-Energy, Oil products	#9640
		Glass Wares	Auto: Glass Wares	#2215
			Steam Generation: Glass Wares	#2305
			Final Energy Consumption, Glass Wares	#6560
			Non-Energy, Glass Wares	#9660
		Cement & Ceramics	Auto: Cement & Ceramics	#2216
			Steam Generation: Cement & Ceramics	#2306
			Final Energy Consumption, Cement & Ceramics	#6570
			Non-Energy, Cement & Ceramics	#9670
		Machinery	Auto: Machinery & Others	#2219
			Steam Generation: Machinery & Others	#2309
			Final Energy Consumption, Machinery	#6600
			Non-Energy, Machinery	#9700
		Duplication Adjustment	Auto: Duplication Adjustment	#2220
			Steam Generation: Duplication Adjustment	#2310
			Final Energy Consumption, Duplication Adjustment	#6700
			Non-Energy, Duplication Adjustment	#9710
		Other Industries & Small and Medium Enterprises	Auto: Others	#2250
			Final Energy Consumption, Other Industries & Small and Medium Enterprises	#6900
			Non-Energy, Other Industries & Small and Medium Enterprises	#9720

Table A 2-7 Correspondence between sectors of General Energy Statistics (Miner Sector) and of the CRF (cont.)

CRF			Japan's Energy Balance Table	
1A3		Transport		
	1A3a	Civil Aviation	Final Energy Consumption, Passenger Air	#8140
			Final Energy Consumption, Freight Air	#8540
			Non-Energy, Transportation (Air)	#9850
	1A3b	Road Transportation	Final Energy Consumption, Passenger Car	#8110
			Final Energy Consumption, Freight, Freight Truck & Lorry	#8510
			Final Energy Consumption, Passenger Bus	#8115
			Final Energy Consumption, Passenger, Transportation fraction estimation error	#8190
			Final Energy Consumption, Freight, Transportation fraction estimation error.	#8590
			Non-Energy, Transportation (Car, Truck & Lorry, Bus)	#9850
	1A3c	Railways	Final Energy Consumption, Passenger Rail	#8120
			Final Energy Consumption, Freight Rail	#8520
			Non-Energy, Transportation (Rail)	#9850
	1A3d	Navigation	Final Energy Consumption, Passenger Ship	#8130
			Final Energy Consumption, Freight Ship	#8530
			Non-Energy, Transportation (Ship)	#9850
	1A3e	Other Transportation	-	-
1A4		Other Sectors		
	1A4a	Commercial/Institutional	Final Energy Consumption, Commercial & Others	#7500
			Non-Energy, ResCom & others (Commercial & Others)	#9800
	1A4b	Residential	Final Energy Consumption, Residential	#7100
			Non-Energy, ResCom & others (Residential)	#9800
	1A4c	Agriculture/Forestry/Fisheries	Final Energy Consumption, Agruculture, Forestry & Fishery	#6110
			Non-Energy, Non-Manufacturing Industry (Agruculture, Forestry & Fishery)	#9610
1A5		Other		
	1A5a	Stationary	-	-
			-	-
	1A5b	Mobile	-	-

・Auto: Non-utility power generation

・#9xxx items are not energy use activity.

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

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

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

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

A2.2.3. Duplication adjustment for Energy Balance Table

The data set of the manufacturing sector indicated in Japan’s Energy Balance Table (*General Energy Statistics*) and used as the reference of activity data are based on the Ministry of Economy, Trade and Industry’s *Yearbook of the Current Survey of Energy Consumption. The Yearbook of the Current Survey of Energy Consumption* is a statistical survey on factories and business institutions of key manufacturing. Factories and business institutions which produce items indicated in Table A 2-8 are surveyed.

In Japan, it is rare that single factory or business institution produces single item. Most factories and business institutions produce various items extending across categories of industry utilizing by-products and surplus business resources. For example, most integrated steelworks produce not only steel products falling into iron & steel industry but also coke and slag cement falling into cement & ceramics industry and chemical products delivered from coal tar and industrial gas falling into chemical industry; i.e. one factory can conduct three different categories of industries and produces many kinds of items at the same time.

Because single factory may report duplicated energy consumption data which can not be classified to certain sector or item, total energy consumption summed up by sector or by item can be larger than actual total energy consumption when totalizing by sector or by item is conducted under the *Yearbook of the Current Survey of Energy Consumption.*

Hence, to avoid duplication adjustment and to adjust the data in the *Yearbook of the Current Survey of Energy Consumption,* the following steps were taken: (1) to calculate total energy consumption by factory and business institution, (2) to calculate total energy consumption by sector and by item including duplication among sectors and items, (3) to express the difference between total energy consumption by sector and item and total energy consumption by factory and business as negative values as “duplication adjustment”.

In the *Yearbook of the Current Survey of Energy Consumption,* the adjustment stated above is applied indicating values for “duplication adjustment” when total energy consumption is calculated by sector or by item for Auto Power Generation, Industrial Steam Generation, and Manufacturing.

Calculation method for duplication adjustment

Values of duplication adjustment $= E_p - E_t$

E_p : Total energy consumption of designated sectors and items by factories and business institutions

E_t : Total energy consumption by factories and business institutions

Subjects to be surveyed to obtain the data for the *Yearbook of the Current Survey of Energy Consumption* were changed in December, 1997. As shown in Table A 2-8, the survey for the industries of Dyeing, Rubber Product, and Non-ferrous Metals has been discontinued since 1998. Also, since 1998, business institutions or designated items to be surveyed for the industries of Chemical Ceramics, Clay and Stone Products, Glass Products, Iron and Steel, Non-ferrous Metals, and Machinery has been changed. Therefore, energy consumption for the said industries during 1990-1997 is chronologically inconsistent comparing to that from 1998 and onward. Also, the classification of industries was revised during this period. Because of these changes, energy consumption for duplication adjustment, other industries, and small-to-medium-sized manufacturing significantly fluctuates.

Table A 2-8 Surveyed industries and products in *Yearbook of the Current Survey of Energy Consumption*

Surveyed industry	from 1990 to 1997		after 1997	
	Products	Scope of survey	Products	Scope of survey
Pulp and paper industry	* Pulp * Paper * Sheet paper	All Establishments with 50 or more employees Establishments with 50 or more employees	* Pulp * Paper * Sheet paper	All Establishments with 50 or more employees Establishments with 50 or more employees
Chemical industry (except chemical fiber industry)	* Petrochemical products * Ammonia and amonia-derived products * Soda industries chemicals * High pressure gas (O_2, N_2, Ar) * Inorganic chemicals and colorant (titanic oxide, active char, chinese white, iron oxide) * Oil and fat products and surfactant	All All All All (except high pressure gas products by air fraction method(gas container)) All Establishments with 30 or more employees	* Petrochemical products * Ammonia and amonia-derived products * Soda industries chemicals	All
Chemical fiber industry	* Chemical fibers	Establishments with 30 or more employees	* Chemical fibers	Establishments with 30 or more employees
Petroleum products industry	* Petroleum products (except grease)	All	* Petroleum products (except grease)	All
Ceramics, clay and stone products industry (except glass product industry, with the exception of sheet glass industry)	* Cement * Sheet glass * Lime * Fire brick * Carbon products	All All Establishments with 30 or more employees Establishments with 30 or more employees All	* Cement * Sheet glass * Lime	All All Establishments with 30 or more employees
Glass product industry (except sheet glass industry)	* Glass products	Establishments with 10 or more employees	* Glass products	Establishments with 100 or more employees
Iron and steel industry	Manufacturers of pig iron, ferroalloys, crude steel, semi-finished steel products, forged steel products, cast steel products, general steel and hot-rolled steel materials, cold-rolled wide steel strips, cold-rolled electrical steel strips, plated steel materials, special steel hot-rolled steel materials, steel pipes (except cold working steel pipes), or cast iron tubes. Iron and steel.	All	Manufacturers of pig iron, ferroalloys, crude steel, semi-finished steel products, forged steel products, cast steel products, general steel and hot-rolled steel materials, cold-rolled wide steel strips, cold-rolled electrical steel strips, plated steel materials, special steel hot-rolled steel materials, steel pipes (except cold working steel pipes), or cast iron tubes. Iron and steel.	All
Non-ferrous metal industry	* Non-ferrous metals	All	* Copper * Lead * Zinc * Aluminum * Alminum secondary ground metal	All All All All Establishments with 30 or more employees
Machinery industry	* Machinery and appliances * cast and forged products	Establishments with 500 or more employees Establishments with 100 or more employees	* Civil engineering machinery, tractors, metal working and metal processing machinery, parts and accessories for communication and electrictronics equipment, electron tubes, semiconductors, ICs, electronics applied equipment, automobiles and parts (including motorcycles)	Establishments with 500 or more employees which are designated by the Minister of International Trade and Industry
Dyeing	* Dyeing wool * Dyeing fablic	Establishments with 20 or more employees	demise	
Rubber product	* Tires and tube	Establishments with 30 or more employees	demise	
Non-ferrous metal product	* Copper and brass * Flat-rolled aluminum * Electric cable * Alminum secondary bare metal	All All Establishments with 30 or more employees Establishments with 30 or more employees	demise	

References

1. Environmental Agency , *The Estimation of CO_2 Emissions in Japan*, 1992
2. Research Institute of Economy, Trade & Industry, Kazunari Kaino, *Interpretation of General Energy Statistics*, 2009

Annex 3. Other Detailed Methodological Descriptions for Individual Source or Sink Categories

A3.1. Methodology for Estimating Emissions of Precursors

In addition to the greenhouse gases (e.g., CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) reported under the Kyoto Protocol, Japan reports on the emissions of precursors (NOx, CO, NMVOC, SO_2) calculated by established methods. This section explains the source categories for which methodologies for estimating emissions have been provided.

Emissions from the source categories for which estimation methods have not been established are considered to be minimal, and accordingly reported as either “NO” or “NE” (or as “IE” as the case may be) based on the results of historical investigations.

A3.1.1. Energy Sector

A3.1.1.1. Stationary Combustion (1.A.1., 1.A.2., 1.A.4.: NO_x, CO, NMVOC, SO_2)

A3.1.1.1.a. Facilities emitting soot and smokes

1） NO_x and SO_2

● ***Methodology for Estimating Emissions***

General Survey of the Emissions of Air Pollutants by the Ministry of the Environment (MoE) was used as the basis for estimation of NO_x and SO_2 emitted from fixed sources (see Page 3.12 for details of the survey). So as to ensure consistency with the *Revised 1996 IPCC Guidelines* and the *IPCC Good Practice Guidance (2000)*, the following operation isolated the emissions from the energy sector from the emissions listed in the *General Survey of the Emissions of Air Pollutants*:

1. All emissions from the following facilities and operations are reported under Energy:

   Facility: [0101–0103: Boilers]; [0601–0618: Metal rolling furnaces, metal furnaces, and metal forge furnaces]; [1101–1106: Drying ovens]; [2901–3202: Gas turbines, diesel engines, gas engines, and gasoline engines]

   Operation: [A–D: Accommodation/eating establishments, health care/educational and academic institutions, pubic bathhouses, laundry services]; [F–L: Agriculture/fisheries, mining, construction, electricity, gas, heat distribution, building heating/other operations]

2. Emissions from the facilities and operations other than the above and [1301–1304: Waste incinerators], are reported under the Industrial Processes sector. Accordingly, the emissions from the specified sources, calculated by the following methods, are subtracted from the emissions listed in the *General Survey of the Emissions of Air Pollutants* to determine the emissions from the Energy sector.

➢ ***NO_x***

If raw material falls under either [44: Metallurgical coal] or [45: Metallurgical coke], the following equation is used:

Calculation of NO_x emissions from metallurgical coal or coke (to be included in the Industrial Processes sector)

NOx emissions from metallurgical coal or coke [t-NOx]

= NOx emission factor per material [t-NOx/kcal] × energy consumed per material [kcal] × (1 – denitrification rate [%])

If raw material falls under either [41: Iron/ironstone] or [46: Other], the following equation is used:

Calculation of NOx emissions from iron/ironstone or other material (to be included in the Industrial Processes sector)

NOx emissions from iron/ironstone or other material [t-NOx]

= Nitrogen content per material [t-NOx] × (1 – denitrification rate [%])

If, however, the emissions from the Industrial Processes sector calculated by the above equations exceed the emission volume listed in the *General Survey of the Emissions of Air Pollutants*, the total emissions listed in the Survey are considered to be the emissions from the Industrial Processes sector. Materials listed in the categories [42: Sulfide minerals] and [43: Non-ferrous metal ores] are excluded from the calculation due to the lack of data.

- ***SO_2***

Emissions from the Industrial Processes sector is calculated from the consumption and sulfur contents of the materials in categories from [41: Iron/ironstone] to [46: Other materials], and subtracted from the emissions listed in the *General Survey of the Emissions of Air Pollutants* to determine SO_2 emissions in the energy sector.

Calculation of SO_2 emissions (in the Industrial Processes sector)

SO_2 emissions [t-SO_2] = Sulfur content per material [t-SO_2] × (1 – desulphurization rate [%])

Emission factors

- ***NO_x emission factors for metallurgical coal and coke***

NO_x emission factors for the materials used in the calculation of NO_x emissions from metallurgical coal and coke (in the Industrial Processes sector) were established for each facility and material type based on the *General Survey of the Emissions of Air Pollutants*.

- ***Denitrification rate***

The denitrification rate was calculated by the following equation:

Calculation of denitrification rate

Denitrification rate [%]

= Denitrification efficiency [%] × (Hours of operation of denitrification unit [h/yr] /

Hours of operation of furnace [h/yr]) × (Processing capacity of denitrification unit [m^3/yr] /

max exhaust gas emission [m^3/yr])

The General Survey of the Emissions of Air Pollutants data were used for all items.

Denitrification efficiency: (NO_x volume before treatment – NO_x volume after treatment) / volume of smoke and soot

- ***Desulphurization rate***

Desulphurization rate was calculated by the following equation:

Calculation of desulphurization rate

Desulphurization rate [%]

= Desulphurization efficiency [%] × (Hours operation of desulphurization unit [h/yr] / Hours operation of furnace [h/yr]) × (Processing capacity of desulphurization unit [m^3/yr] / max exhaust gas emission [m^3/yr])

The General Survey of the Emissions of Air Pollutants data were used for all items.

Desulphurization efficiency: (SO_2 volume before treatment – SO_2 volume after treatment) / volume of smoke and soot

- ***Activity data***

  - ***Energy consumption of metallurgical coal or coke***

The activity data was calculated by multiplying the consumption of materials (under [44: Metallurgical coal] and [45: Metallurgical coke]) provided in the *General Survey of the Emissions of Air Pollutants* by gross calorific value.

  - ***Nitrogen content of iron/ironstone and other materials***

The activity data was calculated by multiplying the weighted average of nitrogen content, calculated from the nitrogen content and consumption of the materials (under [41: Iron/ironstone] and [46: Other materials]) provided in the *General Survey of the Emissions of Air Pollutants*, by the consumption volume of the material.

  - ***Sulfur content of various materials***

The activity data was calculated by multiplying the weighted average of sulfur content, calculated on the basis of sulfur content and consumption of the material (under [44: Metallurgical coal] through [46:Other materials]) provided in the *General Survey of the Emissions of Air Pollutants*, by the consumption volume of the material.

2） CO

- ***Methodology for Estimating Emissions***

Emissions of CO from the specified sources were calculated by multiplying the energy consumption per facility type by Japan’s own emission factor.

- ***Emission factors***

CO emission factors were established based on the summary data in the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996).

- ***Activity data***

Energy consumption according to facility type determined from General Energy Statistics was used for activity data.

3） NMVOC

- ***Methodology for Estimating Emissions***

Emissions of NMVOC from the specified sources were calculated by multiplying the energy consumption per facility type by Japan’s own emission factor.

- ***Emission factors***

  NMVOC emission factors were established by multiplying the CH_4 emission factor for each facility per fuel type by the ratio of NMVOC emission to CH_4 emission factor per fuel type. The CH_4 emission factors were established from the summary data provided in the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996), while the NMVOC/CH_4 emission factor ratios were determined from the *report on Screening Survey Regarding Measures to Counter Global Warming* (Japan Environmental Sanitation Center) and *Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions* (Institute of Behavioral Science).

- ***Activity data***

  Energy consumption according to facility type determined from General Energy Statistics (Agency for Natural Resources and Energy) was used for activity data.

A3.1.1.1.b. Small facilities (commercial and other sector, manufacturing sector)

- ***Methodology for Estimating Emissions***

  NO_x, CO, NMVOC, and SO_2 emitted by the specified sources were calculated by multiplying energy consumption per facility type by Japan's own emission factor.

- ***Emission factors***

  ➢ ***NO_x and SO_2***

  Emission factors for NO_x and SO_x were established for each fuel type for [0102: Heating system boilers] for facilities listed in [L: Heating systems for buildings/other places of business] in the *General Survey of the Emissions of Air Pollutants* by aggregating emission and energy consumption per fuel type.

  ➢ ***CO***

  The emission factors established for [0102: Heating system boilers] based on the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996) were adopted as the CO emission factors.

  ➢ ***NMVOC***

  NMVOC emission factors were established by multiplying the CH_4 emission factors for [0102: Heating system boilers] by the ratio of NMVOC emission to CH_4 emission factor per fuel type. The CH_4 emission factors were established from the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996), while the NMVOC/CH_4 emission factor ratios were determined from the *report on Screening Survey Regarding Measures to Counter Global Warming* (Japan Environmental Sanitation Center) and *Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions* (Institute of Behavioral Science).

- ***Activity data***

  To determine NO_X and SO_2, energy consumption by small facilities per fuel type was calculated by subtracting energy consumption per fuel type, identified by the *General Survey of the Emissions of Air Pollutants*, from energy consumption per fuel type provided in the *General Energy Statistics* (Agency for Natural Resources and Energy). If the activity data shown in the *General Survey of the Emissions of Air Pollutants* exceeded the activity data provided in the *General Energy Statistics*, the activity data for the specified sources was deemed to be zero. The fuels covered were town gas, LPG, kerosene, and heating oil A. Energy consumption from General Energy Statistics (Agency for Natural Resources and Energy) was used for CO and NMVOCs.

A3.1.1.1.c. Residential sector

- ***Methodology for Estimating Emissions***

NO_x, CO, NMVOC, and SO_2 emissions from the target source were calculated by multiplying energy consumed per facility type by Japan's own emission factor or the IPCC default emission factor.

- ***Emission factors***

➢ ***NO_X***

For solid fuels (steaming coal and coal briquettes), emission factors were established by converting the default values provided in the *Revised 1996 IPCC Guidelines* to gross calorific values.

For liquid (kerosene) and gaseous (LPG, town gas) fuels, the emission factors per usage per fuel type provided in the reports by Air Quality Management Bureau, Ministry of the Environment were used. This report calculated the emission factors by weighting the average concentration of NO_x emissions per source unit, obtained through questionnaires and interviews in the household gas appliances industry.

➢ ***CO***

For solid fuels (steaming coal and coal briquettes), emission factors were established by converting the default values provided in the *Revised 1996 IPCC Guidelines* to gross calorific values.

For liquid (kerosene) and gaseous (LPG, town gas) fuels, the emission factors per usage per fuel type provided in the reports by Institute of Behavioral Science were used. This report tabulated the emission factors by usage and fuel using the actual values measured in Tokyo, Yokohama city and Chiba Prefecture.

➢ ***NMVOC***

For all of the solid (steaming coal and coal briquettes), liquid (kerosene), and gaseous (LPG and town gas) fuels, emission factors were established by converting the default values provided in the *Revised 1996 IPCC Guidelines* to gross calorific values.

➢ ***SO_2***

For solid fuels (steaming coal and coal briquettes), emission factors were established by converting the default values provided in the *Revised 1996 IPCC Guidelines* to gross calorific values.

For liquid fuel (kerosene), emission factors were calculated from energy consumption, specific gravity and sulfur content based on the fuel characteristics of kerosene described in information material compiled by the Petroleum Association of Japan.

- ***Activity data***

Consumption by type of fuel for residential use in *General Energy Statistics* has been taken for the activity data. The fuels covered were steaming coal, coal briquettes, kerosene, LPG, and town gas. For the amount of residential fuel consumption by type of use, the ratio of consumption by energy source and by type of use per household, in the Handbook of Energy & Economic Statistics in Japan (The Energy Data and Modeling Center) is used.

A3.1.1.1.d. Incineration of waste for energy purposes and with energy recovery

Emissions of NOx, CO, NMVOC and SO_2 from the incineration of waste for energy purposes and from the incineration of waste with energy recovery are reported in the data input cells for “Other Fuels” under the relevant subcategories of 1.A.1 and 1.A.2. Explanations for methodology for estimating emissions, emission factors, and activity data are all given in the section “3.1.5. Wastes”.

A3.1.1.2. Mobile Combustion (1.A.3: NO_x, CO, NMVOC, and SO_2)

A3.1.1.2.a. Road Transportation (1.A.3.b.)

1） NO_x, CO, and NMVOC

- ***Methodology for Estimating Emissions***

NO_x, CO, and NMVOC emissions from the specified mobile sources were calculated by multiplying the distance traveled per year for each vehicle type per fuel by Japan’s own emission factor.

- ***Emission factors***

Emission factors were established from the measured values for each vehicle class per fuel type (Ministry of the Environment). The NMVOC emission factors, however, were calculated by multiplying the emission factor of total hydrocarbon (THC) (per Ministry of the Environment) by the percentage of NMVOC in the THC emission (per Ministry of the Environment).

Table A 3-1 NO_x emission factors for automobiles

Fuel	Vehicle Type	Unit	1990	1995	2000	2005	2007	2008	2009
Gasoline	Light Vehicle	gNOx/km	0.230	0.159	0.157	0.079	0.057	0.045	0.035
	Passenger Vehicle (including LPG)	gNOx/km	0.237	0.203	0.199	0.080	0.059	0.047	0.037
	Light Cargo Truck	gNOx/km	0.873	0.658	0.375	0.200	0.154	0.128	0.106
	Small Cargo Truck	gNOx/km	1.115	0.897	0.478	0.087	0.056	0.042	0.032
	Regular Cargo Truck	gNOx/km	1.833	1.093	0.560	0.162	0.094	0.061	0.043
	Bus	gNOx/km	4.449	3.652	2.438	0.090	0.063	0.052	0.040
	Special Vehicle	gNOx/km	1.471	0.873	0.429	0.121	0.078	0.052	0.037
Diesel	Passenger Vehicle	gNOx/km	0.636	0.526	0.437	0.448	0.414	0.384	0.361
	Small Cargo Truck	gNOx/km	1.326	1.104	1.005	1.009	0.902	0.829	0.744
	Regular Cargo Truck	gNOx/km	5.352	4.586	4.334	4.497	4.235	4.028	3.759
	Bus	gNOx/km	4.226	3.830	3.597	4.070	3.724	3.502	3.212
	Special Vehicle	gNOx/km	3.377	2.761	2.152	3.626	3.358	3.164	2.923

Source: Ministry of the Environment

Table A 3-2 CO emission factors for automobiles

Fuel	Vehicle Type	Unit	1990	1995	2000	2005	2007	2008	2009
Gasoline	Light Vehicle	gCO/km	1.749	1.549	1.543	0.971	0.791	0.692	0.607
	Passenger Vehicle (including LPG)	gCO/km	2.325	2.062	2.034	0.936	0.763	0.667	0.582
	Light Cargo Truck	gCO/km	10.420	8.540	5.508	2.773	2.225	2.032	1.887
	Small Cargo Truck	gCO/km	9.656	10.079	8.309	2.075	1.330	1.013	0.785
	Regular Cargo Truck	gCO/km	12.624	10.601	8.950	3.616	2.155	1.601	1.208
	Bus	gCO/km	26.209	25.079	21.938	2.072	1.589	1.320	1.140
	Special Vehicle	gCO/km	12.466	10.666	8.924	2.298	1.528	1.138	0.886
Diesel	Passenger Vehicle	gCO/km	0.480	0.432	0.429	0.374	0.348	0.317	0.288
	Small Cargo Truck	gCO/km	0.975	0.896	0.808	0.601	0.483	0.413	0.343
	Regular Cargo Truck	gCO/km	3.221	2.988	2.440	2.042	1.670	1.437	1.205
	Bus	gCO/km	2.579	2.534	2.200	2.035	1.618	1.386	1.131
	Special Vehicle	gCO/km	2.109	1.893	1.297	1.601	1.273	1.075	0.881

Source: Ministry of the Environment

Table A 3-3 NMVOC emission factors for automobiles

Fuel	Vehicle Type	Unit	1990	1995	2000	2005	2007	2008	2009
Gasoline	Light Vehicle	gHC/km	0.128	0.050	0.048	0.043	0.033	0.027	0.023
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.077	0.030	0.029	0.026	0.020	0.016	0.014
	Passenger Vehicle (including LPG)	gHC/km	0.189	0.112	0.104	0.030	0.024	0.020	0.017
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.113	0.067	0.062	0.018	0.014	0.012	0.010
	Light Cargo Truck	gHC/km	1.058	0.610	0.274	0.151	0.115	0.096	0.079
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.635	0.366	0.165	0.091	0.069	0.058	0.048
	Small Cargo Truck	gHC/km	1.188	0.882	0.346	0.068	0.041	0.030	0.022
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.713	0.529	0.208	0.041	0.025	0.018	0.013
	Regular Cargo Truck	gHC/km	1.658	0.959	0.471	0.103	0.064	0.043	0.029
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.995	0.575	0.283	0.062	0.039	0.026	0.018
	Bus	gHC/km	3.604	3.164	2.193	0.065	0.037	0.029	0.023
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	2.162	1.899	1.316	0.039	0.022	0.017	0.014
	Special Vehicle	gHC/km	1.619	0.786	0.317	0.081	0.050	0.035	0.025
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.972	0.472	0.190	0.048	0.030	0.021	0.015
Diesel	Passenger Vehicle	gHC/km	0.109	0.098	0.097	0.089	0.084	0.078	0.072
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.065	0.059	0.058	0.053	0.051	0.047	0.043
	Small Cargo Truck	gHC/km	0.389	0.343	0.258	0.206	0.150	0.119	0.090
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.233	0.206	0.155	0.124	0.090	0.071	0.054
	Regular Cargo Truck	gHC/km	1.634	1.488	1.040	0.753	0.588	0.488	0.394
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.980	0.893	0.624	0.452	0.353	0.293	0.237
	Bus	gHC/km	1.273	1.255	0.995	0.807	0.604	0.495	0.381
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.764	0.753	0.597	0.484	0.362	0.297	0.229
	Special Vehicle	gHC/km	1.101	0.965	0.526	0.575	0.431	0.350	0.276
		%	60%	60%	60%	60%	60%	60%	60%
		gNMVOC/km	0.661	0.579	0.316	0.345	0.259	0.210	0.165

Top row: THC emission factors;

Middle row: Percentage of NMVOC in the THC emission;

Source: Ministry of the Environment

- ***Activity data***

The activity data used the travel distance per year for each vehicle class per fuel type, which were calculated by multiplying distances traveled in a year for each vehicle class per fuel type, provided in the *Statistical Yearbook of Motor Vehicle Transport* (Ministry of Land, Infrastructure, Transport and

Tourism), by the percentage of the distances per fuel types calculated from fuel consumption and cost data.

2） SO_2

- ***Methodology for Estimating Emissions***

The emissions of SO_2 from these sources were calculated by multiplying fuel consumption by vehicle class and fuel types by Japan’s own emission factor.

- ***Emission factor***

Sulfur content (by weight) of each fuel type was used to establish emission factors.

Table A 3-4 Sulfur content (by weight) by fuel type

		1990	1995	2000	2005	2007	2008	2009
Gasoline	%	0.008%	0.008%	0.008%	0.008%	0.008%	0.008%	0.008%
Diesel	%	0.350%	0.136%	0.136%	0.136%	0.136%	0.136%	0.136%
LPG	%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%

Source: Gasoline/LPG – The Institute of Behavioral Science, Diesel oil – Petroleum Association of Japan

- ***Activity data***

Activity data was calculated by multiplying fuel consumption for each vehicle class per fuel type by specific gravity of each fuel type, and converting the resultant values to weight. The fuel consumption data was reported in the *Statistical Yearbook of Motor Vehicle Transport* (Ministry of Land, Infrastructure, Transport and Tourism).

- ***Completeness***

Emissions of NOx, CO, NMVOCs, and SO_2 from natural gas vehicles and motorcycles are reported as “NE”.

A3.1.1.2.b. Civil Aviation (1.A.3.a: NO_x, CO, NMVOC)

- ***Methodology for Estimating Emissions***

NO_x, CO, and NMVOC emissions from the specified sources were calculated by multiplying the fuel consumption converted to net calorific value by the default emission factors provides in the *Revised 1996 IPCC Guidelines*.

- ***Emission factors***

The default emission factors provided for the “Jet and Turboprop Aircraft” category in the *Revised 1996 IPCC Guidelines* were used.

Table A 3-5 IPCC default emission factors for civil aviation

Gas	EF[g/MJ]
NO_X	0.29
CO	0.12
NMVOC	0.018

Source: Revised 1996 IPCC Guidelines, Vol. 3; Page 1.90, Table 1-47

- ***Activity data***

Figures for jet fuel consumption (for domestic scheduled flights and others [commuter, sightseeing and charter flights]) in the *Statistical Yearbook of Air Transport* (Ministry of Land, Infrastructure, Transport and Tourism) were converted to net calorific value for the calculation of activity data.

- ***Completeness***

Emissions of NOx, CO, and NMVOCs from aviation fuel consumption are reported as “NE”.

A3.1.1.2.c. Navigation (1.A.3.d.: NO_x, CO, NMVOC)

- ***Methodology for Estimating Emissions***

NO_x, CO, and NMVOC emissions from the specified sources were calculated by multiplying the fuel consumption converted to net calorific value by the default emission factors provided in the *Revised 1996 IPCC Guidelines*.

- ***Emission factors***

The default emission factors provided for the “Ocean-Going Ships” category in the *Revised 1996 IPCC Guidelines* were used.

Table A 3-6 IPCC default emission factors for ocean-going ships

Gas	Emission factor［g/MJ］
NO_x	1.8
CO	0.18
NMVOC	0.052

Source: Revised 1996 IPCC Guidelines, Vol. 3; Page 1.90, Table 1-48

- ***Activity data***

The marine fuel consumption data per fuel type (diesel, heating oil A, heating oil B, and heating oil C) provided in the *General Energy Statistics* (Agency for Natural Resources and Energy) were converted to net calorific value for the calculation of activity data. The consumption data were based on the statistical data on marine transport (coastal services [passenger and freight]) in the *The Survey on Transport Energy* (Ministry of Land and Transport).

A3.1.1.2.d. Railways (1.A.3.c.: NO_x, CO, and NMVOC)

- ***Methodology for Estimating Emissions***

NO_x, CO, and NMVOC emissions from the specified sources were calculated by multiplying fuel consumption converted to net calorific value by the default emission factors provided in the *Revised 1996 IPCC Guidelines*.

- ***Emission factors***

The default emission factors provided for the “Locomotives” category in the *Revised 1996 IPCC Guidelines* were used.

Table A 3-7 IPCC default emission factors for locomotives

Gas	Emission factor [g/MJ]
NO_x	1.8
CO	0.61
NMVOC	0.13

Source: Revised 1996 IPCC Guidelines, Vol. 3; Page 1.89, Table 1-47

- ***Activity data***

  The diesel oil consumption by railways in the *General Energy Statistics* (Agency for Natural Resources and Energy) was used for the calculation of activity data.

A3.1.1.3. Fugitive emissions from fuels (1.B.: NMVOC)

A3.1.1.3.a. NMVOCs fugitive emissions at oil refinery

- ***Methodology for Estimating Emissions***

  NMVOC emissions from the specified sources were calculated by multiplying the capacity of oil refineries (BPSD: Barrels Per Served Day) by Japan’s own emission factors and annual days of operation.

- ***Emission factor***

  Based on the *Study on the total system for prevention of HC-Vapor in petroleum industries* (Agency of Natural Resources and Energy, 1975), the emission factor was established as 0.05767 (g-NMVOC/BPSD). The number of days of operation for atmospheric distillation was established as 350 days.

- ***Activity data***

  Figures for the BPSD based on the results of surveys conducted by the Ministry of Economy, Trade and Industry, were used for the calculation of activity data.

A3.1.1.3.b. NMVOCs emissions from lubricant oil production

- ***Methodology for Estimating Emissions***

  NMVOC emissions from the specified sources were calculated by multiplying gross sales amount to consumers by Japan’s own emission factors for toluene and methyl ethyl ketone.

- ***Emission factors***

  Based on internal documents of Yokohama city, emission factors were established for toluene and methyl ethyl ketone.

Table A 3-8 Toluene and methyl ethyl ketone emission factors in lubricant oil production

Gas	Emission factor (g/kl)
Toluene	333.2
Methyl ethyl ketone	415.5

Source: Yokohama city

- ***Activity data***

  Figures for gross sales amount to consumers, provided in the *Yearbook of Mineral Resources and Petroleum Production Statistics* (Ministry of Economy, Trade and Industry), were used for the calculation of activity data.

A3.1.1.3.c. NMVOCs fugitive emissions at storage facilities

- ***Methodology for Estimating Emissions***

  NMVOC emissions from the specified sources were calculated on the assumption that yearly emissions were the same as the 1983 volume of losses from breathing and acceptance for cone-roof type storage tanks and shipping losses from floating-roof type storage tanks at refineries and storage tanks (Petroleum Association of Japan).

- ***Emission factor***

  No emission factors were established.

- ***Activity data***

  No activity data were used.

A3.1.1.3.d. NMVOCs fugitive emissions at shipping facilities

- ***Methodology for Estimating Emissions***

  NMVOC emissions from specified sources were calculated by multiplying the 1983 figures for NMVOC emissions from ships and tank lorries/freight cars by the 1983 ratio of amount of shipment or that of sales to consumers.

- ***Emission factor***

  No emission factors were established.

- ***Activity data***

  Figures for shipment of crude oil not to be refined, gross sales amount of gasoline to consumers, export of gasoline, gross sales amount of naphtha to consumers, export of naphtha, gross sales amount of jet fuel to consumers and export of jet fuel provided in the *Yearbook of Mineral Resources and Petroleum Products Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data. Table A3-9 shows the relationship between the NMVOC emission sources and activity data.

Table A 3-9 Relationship between the NMVOC emission sources and activity data

NMVOC emission source		Activity data used in calculation
Ships	Crude oil	shipment of crude oil not to be refined
	Gasoline	gross sales amount of gasoline to consumers
		export of gasoline
	Naphtha	gross sales amount of naphtha to consumers
		export of naphtha
	Jet fuel	gross sales amount of jet fuel to consumers
		export of jet fuel
Tank lorries /Freight cars	Gasoline	gross sales amount of gasoline to consumers
	Naphtha	gross sales amount of naphtha to consumers
	Jet fuel	gross sales amount of jet fuel to consumers

A3.1.1.3.e. NMVOCs fugitive emissions from gas stations

- ***Methodology for Estimating Emissions***

  NMVOC emissions from specified sources were calculated by multiplying amount of sales to consumers by Japan’s own emission factors for oil accepting and providing, and subtracting the portion of fuels prevented from fugitive emissions by a vapor return facility.

- ***Emission factor***

  Emission factors were established for oil accepting and for oil providing, based on the *Study on the* *total system for prevention of HC-Vapor in petroleum industries* (Agency of Natural Resources and Energy, 1975).

Table A 3-10 Emission factors at gas stations during oil accepting and providing

	Emission factor (kg/kl)
Oil accepting	1.08
Oil providing	1.44

Source: Study on the total system for prevention of HC-Vapor in petroleum industries (Agency of Natural Resources and Energy, 1975)

- ***Activity data***

Figures for sales amount of gasoline (for automobiles) in the *Yearbook of Mineral Resources and Petroleum Products Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data.

Fugitive emissions prevented by a vapor return facility during oil accepting at gas stations were calculated by the following equation:

Calculation of fugitive emissions prevented by vapor return facility during oil accepting

Fugitive emissions prevented by vapor return facility during oil accepting [t]
= ΣPrefecture {(gasoline sales per prefecture [ML] × emission factor for oil accepting [kg/kl])
× (No. of service stations with vapor return facility per prefecture
/ No. of service stations per prefecture)}

Based on the data provided in the *Yearbook of Mineral Resources and Petroleum Products Statistics* (Ministry of Economy, Trade and Industry). For the number of service stations after FY 2001, the number of service stations registered under law was used.

A3.1.2. Industrial Processes

A3.1.2.1. Mineral Products, Chemical Industry, Metal Production, and Other Production (2.A., 2.B., 2.C., 2.D.,: NO_x, SO_2)

- ***Methodology for Estimating Emissions***

NO_x and SO_2 emissions from the specified sources were calculated for sources not included in the following facilities or operations by isolating the emissions from the Industrial Processes sector.

Facility: [0101– 0103: Boilers]; [0601– 0618: Metal rolling furnaces, metal furnaces, and metal forge furnaces]; [1101–1106: Drying ovens]; [1301–1304: Waste incinerators]; [2901–3202: Gas turbines, diesel engines, gas engines, and gasoline engines]

Operation: [A–D: Accommodation/eating establishments, health care/educational and academic institutions, pubic bathhouses, laundry services]; [F–L: Agriculture/fisheries, mining, construction, electricity, gas, heat distribution, building heating/other operations]

➢ ***NO_X***

If raw material falls under either [44: Metallurgical coal] or [45: Metallurgical coke], the following equation is used:

Calculation of NO_X emissions from metallurgical coal or coke (for Industrial Processes sector)

NOx emissions from metallurgical coal or coke [t-NOx]
= NOx emission factor per origin [t-NOx/kcal] ´ energy consumed per material [kcal]
× (1 – denitrification rate [%])

If raw material falls under either [41: Iron/ironstone] or [46: Other], the following equation is used:

Calculation of NO_x emissions from iron/ironstone or other material (for Industrial Processes sector)
NOx emissions from iron/iron ore or other material [t-NOx]
= Nitrogen content per material [t-NOx] × (1 – denitrification rate [%])

If, however, the emissions from the Industrial Processes sector calculated by the above equations exceed the emission volume listed in the *General Survey of the Emissions of Air Pollutants*, the total emissions listed in the Survey are considered to be the emissions from the Industrial Processes sector. Materials listed in the categories [42: Sulfide minerals] and [43: Non-ferrous metal ores] are excluded from the calculation due to the lack of data.

➢ SO_2

Based on the consumption and sulfur contents of the materials in the categories from [41: Iron/ironstone] to [46: Other materials], SO_2 emissions from the Industrial Processes sector are calculated as follows:

Calculation of SO_2 emissions (in the Industrial Processes sector)
SO_2 emissions [t-SO_2]
= Sulfur content per material [t-SO_2] ´ (1 – desulphurization rate [%])

● Emission factor

➢ NO_x emission factors for metallurgical coal and coke

NO_x emission factors for the materials used in calculation of NO_x emissions from metallurgical coal and coke (in the Industrial Processes sector) were established for each facility and material type based on the *General Survey of the Emissions of Air Pollutants*.

➢ Denitrification rate

The denitrification rate was calculated by the following equation:

Calculation of denitrification rate
Denitrification rate [%]
= Denitrification efficiency [%] ´ (Hours of operation of denitrification unit [h/yr]
/ Hours of operation of furnace [h/yr]) ´ (Processing capacity of denitrification unit [m3/yr]
/ max. exhaust gas emission [m3/yr])

The General Survey of the Emissions of Air Pollutants data were used for all items.

Denitrification efficiency: (NO_x volume before treatment – NO_x volume after treatment) / volume of smoke and soot

➢ Desulphurization rate

The desulphurization rate was calculated by the following equation:

Calculation of desulphurization rate
Desulphurization rate [%]
= Desulphurization efficiency [%] ´ (Hours operation of desulphurization unit [h/yr]
/ Hours operation of furnace [h/yr]) ´ (Processing capacity of desulphurization unit [m3/yr]
/ max. exhaust gas emission [m3/yr])

The General Survey of the Emissions of Air Pollutants data were used for all items.

Desulphurization efficiency: (SO_2 volume before treatment – SO_2 volume after treatment) / volume of smoke and soot

- ***Activity data***

  - ***Energy consumption of metallurgical coal or coke***

    The activity data was calculated by multiplying the consumption of materials (under [44: Metallurgical coal] and [45: Metallurgical coke]) provided in the *General Survey of the Emissions of Air Pollutants* by gross calorific value.

  - ***Nitrogen content of iron/ironstone and other materials***

    The activity data was calculated by multiplying the weighted average of nitrogen content, calculated from the nitrogen content and consumption of the materials (under [41: Iron/ironstone] and [46:Other raw materials]) provided in the *General Survey of the Emissions of Air Pollutants*, by the consumption volume of the material.

  - ***Sulfur content of various materials***

    The activity data was calculated by multiplying the weighted average of sulfur content, calculated on the basis of sulfur content and consumption of the material (under [41: Iron/ironstone] through [46: Other materials]) provided in the *General Survey of the Emissions of Air Pollutants*, by the consumption volume of the material.

A3.1.2.2. Other (2.G.: NMVOC)

A3.1.2.2.a. NMVOCs emissions from petrochemical manufacturing

- ***Methodology for Estimating Emissions***

  NMVOCs emissions from petrochemical manufacturing were calculated by multiplying the production volume per type of petrochemical product by Japan’s own emission factors.

- ***Emission factors***

  Emission factors were established based on the *Basic Study on HC Sources* (Institute of Behavioral Science, 1987).

Table A 3-11 NMVOC emission factors by petrochemical product

Petrochemical product	Emission factor (kg/t)
Propylene oxide	0.828
Vinyl chloride monomer	3.288
Styrene monomer	0.529
Vinyl acetate	1.299
B.T.X.	0.080
Ethylene oxide	0.421
Acrylonitrile	1.035
Butadiene	0.210
Polyethylene (produced under middle-low pressure)	1.851
Polyethylene (produced under high pressure)	1.088
ABS, AS resins	1.472
Synthetic rubber	0.248
Acetaldehyde	0.016
Terephthalic acid	0.534
Polypropylene	2.423
Ethylene and Propylene	0.016

Source: Basic Study on HC Sources (Institute of Behavioral Science, 1987).

- ***Activity data***

  Figures in the petrochemical production volume by type in the *Yearbook of Mineral Resources and Petroleum Products Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data.

A3.1.2.2.b. NMVOCs emissions from storage facilities for chemical products

- ***Methodology for Estimating Emissions***

  NMVOCs emissions from storage facilities for chemical products were calculated on the assumption that the emission volumes were same as the 1983 combined yearly emissions of “Petrochemicals” and “Others”, given in the *Basic Study on HC Sources* (Institute of Behavioral Science, 1987). “Petrochemicals” covered base chemicals (for the chemical industry); “Other” covered solvents (shipped primarily for non-feedstock use).

- ***Emission factors***

  No emission factors were established.

- ***Activity data***

  No activity data were calculated.

A3.1.2.2.c. NMVOCs emissions from shipping facilities for chemical products

- ***Methodology for Estimating Emissions***

  NMVOCs emissions from shipping facilities for chemical products were calculated on the assumption that the emission volumes were same as the 1983 combined yearly emissions of “Petrochemicals” and “Others”, shown in the *Basic Study on HC Sources* (Institute of Behavioral Science, 1987). “Petrochemicals” covered base chemicals (for the chemical industry); “Other” covered solvents (shipped primarily for non-feedstock use).

- ***Emission factors***

  No emission factor has been established.

- ***Activity data***

  No activity data has been established.

A3.1.3. Sectors that use solvents and other products

A3.1.3.1. NMVOCs emissions from paint solvent use (3.A.: NMVOC)

- ***Methodology for Estimating Emissions***

  Emissions of NMVOC were calculated by multiplying the consumption of solvent by the NMVOC emission rate (the percentage of NMVOC not removed but released into atmosphere).

- ***Emission factors***

  The NMOVC emission rate (92.54[%] = 100[%] – 7.46[%]) calculated from the NMVOC removal rate (7.46[%]) estimated by the Ministry of the Environment (1983) was used as the emission factor.

- ***Activity data***

Consumption of solvent was calculated by multiplying the 1990 data for solvent consumption per solvent type by the 1990 ratio of solvent consumption in paint production. The consumption data were extracted from the *Present condition and prospect about VOCs in Paint Industry* (Japan Paint Manufacturers Association). The solvent consumption ratio was provided in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry). As the statistical records on solvent consumption in paint production were discontinued, the data for 2001 were substituted for values for years 2002 and beyond.

Calculation of annual consumption of paint solvent A in Year X

Annual consumption of paint solvent A in Year X [t]
＝Annual consumption of paint solvent A in 1990 [t]
×(Annual consumption of paint production solvent B in Year X [t]
/Annual consumption of paint production solvent B in 1990 [t])

Table A 3-12 Relationship of types of paint solvents and solvents for paint production used in calculation

Types of Paint Solvent (A)	Types of Paint Production Solvents Used in Calculation (B)
Aliphatic compound hydrocarbon	Mineral spirit
Alicyclic compound hydrocarbon	Toluene, xylene, and other aromatic hydrocarbon
Aromatic compound hydrocarbon	Toluene, xylene, and other aromatic hydrocarbon
Petroleum mixed solvent	Mineral spirit
Alcohol solvent	Alcohol solvent
Ether, Ether Alcohol solvent	Alcohol solvent
Ester solvent	Ester solvent
Ketone solvent	Ketone solvent
Chloric solvent	Solvent with a high boiling point
Other non-chloric solvent	Solvent with a high boiling point

A3.1.3.2. Degreasing, dry cleaning (3.B.: NMVOC)

A3.1.3.2.a. NMVOCs emissions from metal cleansing

- ***Methodology for Estimating Emissions***

NMVOCs emissions from metal cleansing were calculated by multiplying the shipping amount of solvents (trichloro ethylene and tetrachloro ethylene) in degreasing by Japan’s own emission factor.

- ***Emission factors***

Emission factors were established as the ratio of emission to shipment (0.66 [Mg/t] = 88,014 / 133,000), based on data for 1983 in the *Report on the Survey of Measures for Stationary Sources of Hydrocarbons* (Institute of Behavioral Science, 1991).

- ***Activity data***

Shipping amount of solvents was calculated by multiplying the sales volume of trichloro ethylene and tetrachloro ethylene, provided in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry), by the ratio of consumption for metal cleansing use to total consumption of organic chloric solvent (3 type) (0.2 = 11,266 / 56,350), shown in documents from the Perchlo Association.

A3.1.3.2.b. NMVOCs emissions from dry cleaning

- ***Methodology for Estimating Emissions***

NMVOCs emissions from dry cleaning were calculated on the assumption that the volume of NMOVC emissions was the same as the volume of solvents used in dry cleaning (petroleum solvents and tetrachloro ethylene).

- ***Emission factors***

No emission factors were established, as all the solvents used in dry cleaning were assumed to be discharged into the atmosphere.

- ***Activity data***

Estimates by the Institute of Cleaning Research were used for the calculation of the annual consumption of petroleum solvents and tetrachloro ethylene in 1990 and 1991.

Annual consumption in 1992 and in subsequent years was calculated by the following equation on the assumption that solvent consumption was proportional to the number of machines in operation:

Calculation of annual consumption of solvents in Year X

Annual consumption of solvents in Year X [t]

= Σpetroleum-based solvent/tetrachloroethylene {annual consumption of petroleum solvents or tetrachloroethylene in 1991 [t] × (the number of machines in operation in Year X / the number of machines in operation in 1991)}

A3.1.3.3. Chemical products, manufacture and processing (3.C.: NMVOC)

A3.1.3.3.a. NMVOCs emissions from paint production

- ***Methodology for Estimating Emissions***

NMVOCs emissions from paint production were calculated by multiplying the amount of solvent treated in paint production by Japan’s own emission factors.

- ***Emission factors***

Emission factors were established based on the *Manual to control HC emissions* (Air Quality Management Bureau, Ministry of the Environment, 1982).

Table A 3-13 Emission factors for solvents used as raw material for paints

Solvent	Emission factor (%)
Toluene	0.3
Xylene	0.2
Other aromatic hydrocarbon	0.2
Mineral spirit	0.2
Alcohol solvent	0.3
Ester solvent	0.3
Methyl isobutyl ketone	0.3
Other ketones	0.2
Solvent with a high boiling point	0.1

Source: Manual to control HC emissions (Air Quality Management Bureau, Ministry of the Environment, 1982)

- ***Activity data***

Amount of solvent treated in paint production in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry) was used for the calculation of activity data. The usage of ketone solvents was allocated to "Methyl isobutyl ketone" and "Other ketones" (with approx. 63% allocated to methyl isobutyl ketones), based on the interview survey results included in *Manual to control HC emissions* (Air Quality Management Bureau, Ministry of the Environment, 1982). For 2002 and subsequent years, the 2001 values were used because the statistics were discontinued.

A3.1.3.3.b. NMVOCs emissions from printing ink production

- ***Methodology for Estimating Emissions***

NMVOCs emissions from printing ink production were calculated by multiplying amount of solvent treated in paint production, by Japan's own emission factors.

- ***Emission factors***

Emission factors were established based on the results of surveys conducted by the Ministry of the Environment, as well as *Basic study on HC sources* (Institute of Behavioral Science, 1987).

Table A 3-14 Emission factors for solvents used as materials in printing ink

Solvent	Emission factor
Petroleum solvent a)	0.00033
Aromatics hydrocarbon a)	0.00108
Alcohol solvent a)	0.00105
Ester, ether solvent b)	0.00117

Source: a: Surveys by the Ministry of the Environment

b: Basic Study on HC sources (Institute of Behavioral Science, 1987) Activity data

- ***Activity data***

Amount of solvent treated in paint production in the Yearbook of Chemical Industries Statistics (Ministry of Economy, Trade and Industry) were used for the calculation of activity data. For 2002 and subsequent years, the 2001 values were used because the statistics were discontinued.

A3.1.3.3.c. NMVOCs emissions from printing ink solvent use

- ***Methodology for Estimating Emissions***

NMVOCs emissions from printing ink solvent use were calculated by multiplying the 1983 figures for NMVOC emissions from printing ink solvent use by the ratio of 1983 and each year about shipment amount of solvent.

- ***Emission factor***

Emission factors were established as "0.3".

- ***Activity data***

Shipment amount of solvent in the *Yearbook of Chemical Industries Statistics* (Ministry of Economy, Trade and Industry) were used for the calculation of activity data.

A3.1.3.3.d. NMVOCs emissions from polyethylene laminate

- ***Methodology for Estimating Emissions***

  NMVOCs emissions from polyethylene laminate were calculated on the assumption that the yearly emissions equaled the 1983 emissions data provided in the *Basic study on HC sources* (Institute of Behavioral Science, 1987)

- ***Emission factor***

  No emission factors were established.

- ***Activity data***

  No activity data were calculated.

A3.1.3.3.e. NMVOCs emissions from solvent-type adhesive use

- ***Methodology for Estimating Emissions***

  NMVOCs emissions from solvent-type adhesive use were assumed to equal the amount of solvents (xylene, toluene) used in adhesives.

- ***Emission factors***

  No emission factors were established as all the solvents used in adhesives were assumed to be discharged into the atmosphere.

- ***Activity data***

  Shipment amount of adhesive were calculated by multiplying amount of adhesives shipment by type (on calendar year basis), shown in the *Current survey report on adhesive* (Japan Adhesive Industry Association), by solvent content rate for each type shown in the *Current survey report on adhesive* (Japan Adhesive Industry Association).

Table A 3-15 Solvent content in adhesives by type

Adhesive	Solvent content (%)
Vinyl acetate resin solvent type	65
Other resin solvent type	50
CR solvent type	71
Other synthetic rubber solvent type	76
Natural rubber solvent type	67

Source: Current survey report on adhesive (Japan Adhesive Industry Association)

A3.1.3.3.f. NMVOCs emissions from gum solvent use

- ***Methodology for Estimating Emissions***

  NMVOCs emissions from gum solvent use were calculated by multiplying the consumption of solvents in rubber by NMVOC emission rate (the percentage of NMVOC not removed but released into atmosphere).

- ***Emission factors***

  The NMVOC emission rate (92.7[%] = 100[%] – 7.3[%]) was used. This was calculated from the 1983 estimate of the NMVOC removal rate (7.3%), provided in the *Basic study on HC sources* (Institute of Behavioral Science, 1987).

- ***Activity data***

The annual consumption of solvents in rubber was calculated by multiplying the consumption of petrol for solvent use by the ratio of the amount of rubber petrol use to total amount of gum solvent use (0.42 = 21,139 / 50,641). The consumption data were obtained either from the *Statistics of rubber products* (Ministry of Economy, Trade and Industry) or the results of surveys by the Japan Rubber Manufacturers Association; the usage rate was provided by the *Basic study on HC sources* (Institute of Behavioral Science, 1987).

A3.1.3.4. Other (3.D.: NMVOC)

A3.1.3.4.a. NMVOCs emissions from other solvent use for production

- ***Methodology for Estimating Emissions***

NMVOCs emissions from other solvent use for production were calculated on the assumption that the yearly emissions equaled the 1983 emissions shown in the *Basic study on HC sources* (Institute of Behavioral Science, 1987).

- ***Emission factor***

No emission factors were established.

- ***Activity data***

No activity data were calculated.

A3.1.4. Agriculture

A3.1.4.1. Field burning of agricultural residues (4.F.)

A3.1.4.1.a. Rice Straw, Rice Chaff & Straw of Wheat, Barley, Oats and Rye (4.F.1.: CO)

- ***Methodology for Estimating Emissions***

CO emissions from the specified sources were calculated by using Japan's own Methodology for Estimating Emissions shown below (Rye and oats were excluded from the estimate because there are no Japan-specific emission factors for them):

<u>Calculation of CO emission from burning of rice straw, chaff, and wheat straw</u>

CO emission from burning of rice and wheat straw and chaff ［t-CH4］

＝$\Sigma_{\text{rice straw, wheat straw, chaff}}$ (amount of rice or wheat straw or chaff burnt ［t］

× carbon content (dry weight) × percentage of carbon released as CO

× mol ratio of CO to CO2 in emitted gases)

- ***Emission factors***

Emission factors were established for each parameter based on the measured data available in Japan.

Table A 3-16 Carbon content of rice/wheat straw and chaff

	Carbon content	Note
Rice straw	0.356	Adopted the mean value between 0.369[a] and 0.342[b].
Chaff	0.344	Value measured by Bando et al.[a]
Wheat straw	0.356	Assumed to be the same as for rice straw

Source: a: Bando, Sakamaki, Moritomi, and Suzuki, "Study of analysis of emissions from biomass burning" (from the 1991 Report on Studies on Comprehensive Promotion Cost of Environmental Studies (National Institute of Environmental Studies, 1992))

b: Y Miura and T Kan'no, "Emissions of trace gases (CO_2, CO, CH_4, and N_2O) resulting from rice straw burning", Soil Sci. Plant Nutr., 43(4),849–854, 1997

Table A 3-17 Percentage of carbon emitted as CO from rice and wheat straw and chaff

	Percentage of carbon emitted as CO	Note
Rice straw	0.684	Adopted the median value between 0.8[a] and 0.567[b].
Chaff	0.8	Value measured by Bando et al.[a]
Wheat straw	0.684	Assumed to be the same as for rice straw

Source: a: Bando, Sakamaki, Moritomi, and Suzuki, "Study of analysis of emissions from biomass burning" (from the 1991 Report on Studies on Comprehensive Promotion Cost of Environmental Studies (National Institute of Environmental Studies, 1992))

b: Y Miura and T Kan'no, "Emissions of trace gases (CO_2, CO, CH_4, and N_2O) resulting from rice straw burning", Soil Sci. Plant Nutr., 43(4),849–854, 1997

Table A 3-18 Mol ratio of CO to CO_2 in gases emitted from burning rice and wheat straw and chaff

	Mol ratio of CO to CO_2 in emitted gas	Note
Rice straw	0.219	Adopted the mean value between values by a and b.
Chaff	0.255	Value measured by Bando et al.[a]
Wheat straw	0.219	Assumed to be the same as for rice straw

Source: a: Bando, Sakamaki, Moritomi, and Suzuki, "Study of analysis of emissions from biomass burning" (from the 1991 Report on Studies on Comprehensive Promotion Cost of Environmental Studies (National Institute of Environmental Studies, 1992))

b: Y Miura and T Kan'no, "Emissions of trace gases (CO_2, CO, CH_4, and N_2O) resulting from rice straw burning", Soil Sci. Plant Nutr., 43(4),849–854, 1997

- ***Activity data***

Amounts of rice straw, chaff, and wheat straw burned were drawn from amounts used in 4.F.1. to calculate CH_4 and N_2O emissions from the burning of agricultural residue. Amounts of wheat straw burned were obtained by using the following equation.

Amount of wheat/barley straw burned = (amounts of wheat and barley burned) × 0.5

Note: Based on expert judgment, the ratio of straw to chaff was set at 1:1.

A3.1.5. Land Use, Land-Use Change and Forestry

A3.1.5.1. Biomass burning (5(V))

- ***Methodology for Estimating Emissions***

For CO and NOx emissions due to biomass burning, Tier 1 method is used.

- ***Forest land***

CO

$$bbGHG_f = L_{forestfires} \times ER$$

NOx

$$bbGHG_f = L_{forestfires} \times ER \times NC_{ratio}$$

$bbGHG_f$: GHG emissions due to forest biomass burning
$L_{forest\ fires}$: Carbon released due to forest fires(tC/yr)
ER : Emission ratio (CO：0.06, NO_x：0.121)
NC_{ratio} : NC ratio

- ***Emission Factor***

- ***Emission ratio***

The following values are applied to emission ratios for CO and NOx due to biomass burning.
CO: 0.06, NOx: 0.121
(default value stated in the GPG-LULUCF, Table 3A.1.15)

- ***NC ratio***

The following values are applied to NC ratio of NOx.
NC ratio: 0.01 (default value stated in the GPG-LULUCF p.3.50)

- ***Activity data***

For activity in Forest land, carbon released by forest fire is used. For detailed information, see the description on the activity data in section 7.13 in Chapter 7.

A3.1.6. Wastes

A3.1.6.1. Waste incineration (6.C.)

A3.1.6.1.a. Municipal Solid Waste Incineration (6.C.–)

- ***Methodology for Estimating Emissions***

The NO_x, CO, NMVOC, and SO_2 emissions from the specified sources were calculated by multiplying the incineration amount of MSW in each incinerator type (Continuous Incinerators, Semi-continuous Incinerators, Batch type Incinerators, Gasification melting furnaces) by Japan’s own emission factors. These emissions are categorized following the methods given in chapter 8 based on incinerations either with or without energy recovery. The former emissions are reported in the Energy sector, while the latter are reported in the Waste sector.

- ***Emission factors***

- ***NO_X, SO_2***

For incinerators, emission factors were established for each incinerator type by using the emission volume and volume of treated waste identified in the *General Survey of the Emissions of Air Pollutants*. (The categories of incinerator types included: [1301: Waste incinerator (municipal solid waste; continuous system)] and [1302: Waste incinerator (municipal solid waste; batch system)]). The incineration material was [53: Municipal solid waste].) It should be noted that while the *General*

Survey of the Emissions of Air Pollutants classified the incinerators into two classes (Continuous and Batch), this report classifies incinerators into three classes ("Continuous", "Semi-continuous", and "Batch type") by dividing the Continuous system and assigning those which operated for less than 3,000 hours to the "Semi-continuous" class.

For gasification melting furnaces, the value for Continuous Incinerators with a similar incineration method was used.

Table A 3-19 NO_x and SO_2 emission factors for municipal waste incineration by facility type

	Item	Unit	1990	2000	2005	2007	2008	2009
NOx	Continuous Incinerator	kg-NOx/t	1.238	1.127	1.127	1.127	1.127	1.127
	Semi-Continuous Incinerator	kg-NOx/t	1.055	1.226	1.226	1.226	1.226	1.226
	Batch type Incinerator	kg-NOx/t	1.137	1.850	1.850	1.850	1.850	1.850
	Gasification melting furnace	kg-NOx/t	1.238	1.127	1.127	1.127	1.127	1.127
SO_2	Continuous Incinerator	kg-SO_2/t	0.555	0.361	0.361	0.361	0.361	0.361
	Semi-Continuous Incinerator	kg-SO_2/t	0.627	0.712	0.712	0.712	0.712	0.712
	Batch type Incinerator	kg-SO_2/t	1.073	1.714	1.714	1.714	1.714	1.714
	Gasification melting furnace	kg-SO_2/t	0.555	0.361	0.361	0.361	0.361	0.361

The data after 2000 were used for 2001 and subsequent years.

Source: Research of Air Pollutant Emissions from Stationary Sources (Ministry of the Environment)

- ***CO***

For incinerators, based on the emission factors for individual facilities summarized in the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996) as well as other reports, the emission factors were established for each incinerator class. It should be noted that while the Atmospheric Environment Society report subdivided the facilities by furnace type (e.g., stoker, fluidized bed, etc.), this report determined the emission factors for three classes of "Continuous", "Semi-continuous" and "Batch type" by weighting the average of incinerated volume for each furnace.

For gasification melting furnaces, the value for continuous stoker furnaces with a similar incineration method was used.

Table A 3-20 CO emission factors for municipal waste incineration by facility type

	Furnace Type	Unit	1990	2000	2005	2007	2008	2009
CO	Continuous Incinerator	gCO/t	557	555	554	554	554	554
	Semi-Continuous Incinerator	gCO/t	548	567	591	610	613	613
	Batch type Incinerator	gCO/t	8,237	8,298	8,341	8,347	8,343	8,343
	Gasification melting furnace	gCO/t	567	567	567	567	567	567

Source: Reports on Greenhouse gas emissions estimation methodology (Japan Sociality Atmospheric Environment, 1996), and others.

- ***NMVOC***

For both incinerators and gasification melting furnaces, NMVOC emission factors were established by multiplying the CH_4 emission factors for each furnace type per fuel type by "NMVOC/CH_4", the emission ratio for fuel type. The ratio was determined by using the reference material by Japan Environmental Sanitation Center and Institute of Behavioral Science, which estimated CH_4 and NMVOC emissions per unit calorific value.

Table A 3-21 NMVOC emission factors for municipal waste incineration by facility type

	Furnace Type	Unit	1990	2000	2005	2007	2008	2009
NMVOC	Continuous Incinerator	gNMVOC/t	0.9	0.9	0.3	0.3	0.3	0.3
	Semi-Continuous Incinerator	gNMVOC/t	7.8	8.5	2.2	2.3	2.4	2.4
	Batch type Incinerator	gNMVOC/t	9.1	9.5	1.5	1.5	1.5	1.5
	Gasification melting furnace	gNMVOC/t	-	0.6	0.8	0.8	0.8	0.8

Source: Report on Screening Survey Regarding Measures to Counter Global Warming (Japan Environmental Sanitation Center, 1989), Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions (Institute of Behavioral Science, 1984)

- ***Activity data***

For incinerators, the activity data used was the incineration volume for each facility type as calculated by multiplying the incineration volume of municipal waste by the incineration rate for each facility type. The incineration volume data were extracted from the *Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use)* by the Ministry of the Environment. The incineration rate was calculated in the *Waste Treatment in Japan* published by the Ministry of the Environment.

For gasification melting furnaces, the activity data used was the volume incinerated in gasification melting furnaces, calculated from data in the Ministry of the Environment's "*Waste Treatment in Japan*."

A3.1.6.1.b. Industrial Wastes Incineration (6.C.–)

- ***Methodology for Estimating Emissions***

NO_x, CO, NMVOC, and SO_2 emissions from the specified sources were calculated by multiplying the incineration amount of industrial waste for each waste type by Japan's own emission factors. These emissions are categorized following the methods given in chapter 8 based on incinerations either with or without energy recovery. The former emissions are reported in the Energy sector, while the latter are reported in the Waste sector.

- ***Emission factors***

➢ ***NO_X, SO_2***

An emission factor was established for each type of industrial solid waste using the emission volume and volume of treated industrial solid waste identified by the *General Survey of the Emissions of Air Pollutants*. The categories of incinerator types included: [1303: Waste incinerator (industrial solid waste; continuous system)] and [1304: Waste incinerator (industrial solid waste; batch system)]. The incinerator fuel covered the categories [23: Fuel Wood] and [54: Industrial solid waste]). The six types of industrial waste were "Waste paper or waste wood", "Sludge", "Waste oil", "Waste plastics", "Waste textiles", and "Animal/plant residue, livestock carcasses". Category [23: Sawn Timber] was used for "Waste paper or waste wood", "Waste textiles", and "Animal/plant residues, livestock carcasses", while category [54: Industrial waste] was used for "Sludge", "Waste oil", and "Waste plastics". However, no emission factor was set for the mixed burning of multiple waste types.

Table A 3-22 NO_x and SO_2 emission factors for industrial waste by facility type

	Item	Unit	1990	2000	2005	2007	2008	2009
NOx	"Fuel Wood 23"	kg-NOx/t	1.545	5.828	5.828	5.828	5.828	5.828
	"Industrial Waste 54"	kg-NOx/t	0.999	1.415	1.415	1.415	1.415	1.415
SO_2	"Fuel Wood 23"	kg-SO_2/t	1.528	2.118	2.118	2.118	2.118	2.118
	"Industrial Waste 54"	kg-SO_2/t	1.179	1.352	1.352	1.352	1.352	1.352

The data after 2000 were used for 2001 and subsequent years.

Source: Research of Air Pollutant Emissions from Stationary Sources (Ministry of the Environment)

- ***CO***

Based on the emission factors for individual facilities summarized in the *Reports on Greenhouse gas emissions estimation methodology* (Japan Sociality Atmospheric Environment, 1996) as well as other reports, an emission factor was established for each type of industrial solid waste. The six types of industrial waste were “Waste paper or waste wood”, “Sludge”, “Waste oil”, “Waste plastics”, “Waste textiles”, and “Animal/plant residues, livestock carcasses”. The emission factor for “wood waste” was used for “Waste textiles” and “Animal/plant residues, livestock carcasses”, for which there are no measurements. No emission factor was set for the mixed burning of multiple waste types.

Table A 3-23 CO emission factors for industrial waste incinerators by operation type

Item	Unit	1990	2000	2005	2007	2008	2009
Waste Paper, Waste Wood	gCO/t	1,334	1,334	1,334	1,334	1,334	1,334
Waste Oil	gCO/t	127	127	127	127	127	127
Waste Plastics	gCO/t	1,790	1,790	1,790	1,790	1,790	1,790
Sludge	gCO/t	2,285	2,285	2,285	2,285	2,285	2,285
Waste textile	gCO/t	1,334	1,334	1,334	1,334	1,334	1,334
Animal and Plant residues	gCO/t	1,334	1,334	1,334	1,334	1,334	1,334

Source: Reports on Greenhouse gas emissions estimation methodology (Japan Sociality Atmospheric Environment, 1996) and others

- ***NMVOC***

NMVOC emission factors were established by multiplying the CH_4 emission factors for each furnace type per fuel type by “NMVOC/CH_4”, the emission ratio for fuel type. The ratio was determined by using the reference materials by Japan Environmental Sanitation Center and Institute of Behavioral Science, which estimated CH_4 and NMVOC emissions per unit calorific value.

Table A 3-24 NMVOC emission factors for industrial waste incineration by facility type

Item	Unit	1990	2000	2005	2007	2008	2009
Waste Paper, Waste Wood	gNMVOC/t	2.48	2.48	25.28	25.28	25.28	25.28
Waste Oil	gNMVOC/t	0.54	0.54	0.45	0.45	0.45	0.45
Waste Plastics	gNMVOC/t	3.40	3.40	0.90	0.90	0.90	0.90
Sludge	gNMVOC/t	1.61	1.61	0.17	0.17	0.17	0.17
Waste textile	gNMVOC/t	2.48	2.48	25.28	25.28	25.28	25.28
Animal and Plant residues	gNMVOC/t	2.48	2.48	25.28	25.28	25.28	25.28

Source: Report on Screening Survey Regarding Measures to Counter Global Warming (Japan Environmental Sanitation Center, 1989)

Study of Establishment of Methodology for Estimation of Hydrocarbon Emissions (Institute of Behavioral Science, 1984)

- ***Activity Data***

The activity data used the incineration volume data for each type of waste extracted from the Report of the Research on the State of Wide-range Movement and Cyclical Use of Wastes (the Volume on Cyclical Use) and the Waste Treatment in Japan published by the Ministry of the Environment.

A3.1.6.1.c. Incineration in Conjunction with Use of Waste as Fuel and Raw Material (1.A.-)

- ***Methodology for Estimating Emissions***

CO and NMVOC emissions from this source were estimated by multiplying the amounts of fuel/raw material burned for each waste type by a Japan-specific emission factor. These emissions are reported in Energy sector (1.A.) following the methodologies given in chapter 8 (Waste).

- ***Emission Factors***

➢ ***CO***

The CO emission factors (fixed unit basis) for furnace types, which are used for counting emissions from 1A Stationary Sources, were determined by using the calorific values in General Energy Statistics to convert to weight-based emission factors. For the calorific values of waste tires from FY2005 and on, values from the Agency for Natural Resources and Energy's "The Reexamination of Standard Calorific Values and Their Revised Values to Be Applied from FY2005 and on" (2007) were used.

Table A 3-25 CO emission factors from incineration in conjunction with use of waste as fuel and raw material

Application	Units	Waste oil	RDF	RPF	Waste tires (FY2004 and before)	Waste tires (FY2005 and after)	Waste plastics	Waste wood
Simple incineration	kgCO/t	0.13	1.79	1.79	1.79	1.79	-	-
Boilers	kgCO/t	0.052	0.24	0.39	0.28	0.44	0.034	3.64
Cement kilns	kgCO/t	49.1	19.8	32.2	23.0	36.5	32.2	-
Other furnaces	kgCO/t	0.052	0.24	0.39	0.28	0.44	-	-
Pyrolysis furnaces	kgCO/t	-	-	-	0.021	0.033	-	-
Gasification	kgCO/t	-	-	-	0.015	0.024	-	-

➢ ***NMVOC***

Just as for the incineration of municipal solid waste and industrial waste, emission factors were determined from documents with estimates of emissions of CH_4 and NMVOCs per unit calorific values.

Table A 3-26 NMVOC emissions factors from incineration in conjunction with use of waste as fuel and raw material

Application	Units	Waste oil	RDF	RPF	Waste tires (FY2004 and before)	Waste tires (FY2005 and after)	Waste plastics	Waste wood
Boilers	kgNMVOC/t	0.015	0.00027	0.00043	0.00031	0.00049	0.010	0.12
Cement kilns	kgNMVOC/t	0.048	-	0.043	0.031	0.049	0.043	-
Pyrolysis furnaces	kgNMVOC/t	-	-	-	0.0051	0.0080	-	-
Gasification	kgNMVOC/t	-	-	-	0.0089	0.0141	-	-

- ***Activity data***

We used the same activity data that were used when estimating CH_4 emissions from the use of waste as fuel and raw material.

A3.1.7. Other sectors

A3.1.7.1. Smoking (7.–: CO)

- ***Methodology for Estimating Emissions***

  CO emissions were calculated by multiplying the volume of cigarette sales by Japan’s own emission factor.

- ***Emission factor***

  The emission factor (0.055 [g-CO/cigarette]) was provided by Japan Tobacco Inc.

- ***Activity data***

  The volume of cigarette sales published on Tobacco Institute of Japan website (http://www.tioj.or.jp/) was used for activity data.

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Annex 4. CO_2 Reference Approach and Comparison with Sectoral Approach, and Relevant Information on the National Energy Balance

This chapter explains a comparison between reference approach and sectoral approach in accordance with the UNFCCC Reporting Guidelines on Annual Inventories (FCCC/SBSTA/2006/9, paragraph 31).

A4.1. Difference in Energy Consumption

As shown in Table A 4-1, fluctuations of difference of energy consumption between the reference approach and the sectoral approach during 1990-2009 range between -3.11% and -0.29%. It is relatively low compared to the inventories from other countries.

Energy consumption from wastes used for energy and from the incineration of wastes with energy recovery, which had been reported as NE (Not Estimated) in previous submissions, are calculated in the sectoral approach from the 2011 inventory submission in accordance with the *1996 Revised IPCC Guidelines* and the *Good Practice Guidance (2000)*. Therefore, the energy consumption from sectoral approach and the difference in energy consumption between the reference approach and the sectoral approach are changed from the 2011 inventory submission.

Difference of solid fuels in 2008 was quite a large value (5.91%), because of coal (Imported Steam Coal [\$130[1]]) stock change increasing.

Table A 4-1 Comparison of Energy Consumption

[10^15J]

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Reference Approach												
Liquid fuels	9,689	10,191	9,503	9,200	9,211	9,167	8,926	8,913	8,468	8,528	7,850	7,172
Solid fuels	3,270	3,603	4,175	4,267	4,409	4,534	4,967	4,736	4,796	5,010	4,894	4,358
Gaseous fuels	2,097	2,534	3,130	3,126	3,215	3,365	3,354	3,388	3,746	4,082	4,013	3,974
Other fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total RA	**15,056**	**16,328**	**16,809**	**16,593**	**16,835**	**17,066**	**17,246**	**17,037**	**17,010**	**17,620**	**16,757**	**15,504**
Sectoral Approach												
Liquid fuels	9,550	10,051	9,450	9,133	9,275	9,094	8,934	8,903	8,390	8,402	7,726	7,105
Solid fuels	3,354	3,635	4,118	4,220	4,484	4,605	4,721	4,808	4,787	4,955	4,621	4,401
Gaseous fuels	2,106	2,548	3,136	3,137	3,238	3,371	3,371	3,368	3,756	4,106	4,021	4,011
Other fuels	259	294	348	359	379	408	416	436	438	444	439	416
Total	**15,268**	**16,529**	**17,052**	**16,848**	**17,375**	**17,478**	**17,443**	**17,515**	**17,371**	**17,907**	**16,807**	**15,932**
Difference (%)												
Liquid fuels	1.46%	1.39%	0.56%	0.74%	-0.69%	0.80%	-0.10%	0.10%	0.93%	1.50%	1.60%	0.95%
Solid fuels	-2.50%	-0.88%	1.39%	1.10%	-1.65%	-1.54%	5.20%	-1.51%	0.19%	1.11%	5.91%	-0.97%
Gaseous fuels	-0.44%	-0.55%	-0.20%	-0.32%	-0.72%	-0.19%	-0.50%	0.62%	-0.28%	-0.57%	-0.18%	-0.91%
Other fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	**-1.39%**	**-1.21%**	**-1.43%**	**-1.51%**	**-3.11%**	**-2.36%**	**-1.13%**	**-2.73%**	**-2.08%**	**-1.60%**	**-0.29%**	**-2.69%**

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[1] Code number of the *General Energy Statistics* (Energy Balance Table)

A4.2. Difference in CO_2 Emissions

As shown in Table A 4-2, fluctuations of a difference of CO_2 emissions between the reference approach and the sectoral approach during 1990-2009 range between -1.92% and 2.00%. Emissions from wastes used for energy and from the incineration of wastes with energy recovery, which had been reported in waste sector (6.C.) in previous submissions, are reported in the energy sector (1.A.) from the 2009 inventory submission in accordance with the *1996 Revised IPCC Guidelines* and the *Good Practice Guidance (2000)*.

Difference of solid fuels in 2008 was quite a large value (5.26%), because of coal (Imported Steam Coal [$130]) stock change increasing.

Table A 4-2 Comparison of CO_2 Emissions

[Tg CO_2]

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Reference Approach												
Liquid fuels	659.1	692.4	647.0	626.3	626.7	623.9	607.8	606.4	575.7	580.5	534.5	488.7
Solid fuels	294.6	324.2	377.6	385.5	399.0	410.3	450.0	428.7	434.2	453.7	442.6	394.5
Gaseous fuels	103.7	125.3	154.8	154.6	159.0	166.4	165.8	167.6	185.2	201.9	198.5	196.5
Other fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total RA	**1,057**	**1,142**	**1,179**	**1,166**	**1,185**	**1,201**	**1,224**	**1,203**	**1,195**	**1,236**	**1,176**	**1,080**
Sectoral Approach												
Liquid fuels	646.2	677.3	635.1	613.1	622.9	611.4	600.4	597.8	562.0	563.7	518.4	475.1
Solid fuels	308.6	331.7	376.5	384.9	409.6	419.7	431.1	437.9	436.7	451.5	420.5	401.5
Gaseous fuels	104.3	126.2	155.3	155.3	160.4	167.0	166.9	166.8	186.4	203.3	199.5	198.7
Other fuels	9.1	10.5	13.1	14.2	15.0	15.8	15.6	15.1	14.2	14.4	14.1	14.4
Total	**1,068**	**1,146**	**1,180**	**1,167**	**1,208**	**1,214**	**1,214**	**1,218**	**1,199**	**1,233**	**1,153**	**1,090**
Difference (%)												
Liquid fuels	1.99%	2.23%	1.87%	2.17%	0.62%	2.05%	1.22%	1.43%	2.44%	2.98%	3.11%	2.85%
Solid fuels	-4.54%	-2.26%	0.29%	0.17%	-2.60%	-2.24%	4.38%	-2.11%	-0.57%	0.49%	5.26%	-1.76%
Gaseous fuels	-0.57%	-0.71%	-0.32%	-0.45%	-0.88%	-0.40%	-0.65%	0.45%	-0.61%	-0.69%	-0.53%	-1.08%
Other fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	**-1.01%**	**-0.33%**	**-0.06%**	**-0.08%**	**-1.92%**	**-1.10%**	**0.79%**	**-1.24%**	**-0.34%**	**0.26%**	**2.00%**	**-0.92%**

A4.3. Comparison between Differences in Energy Consumption and that of CO_2 Emissions

The difference in energy consumption and the difference in CO_2 emissions generally show a similar tendency for their trends.

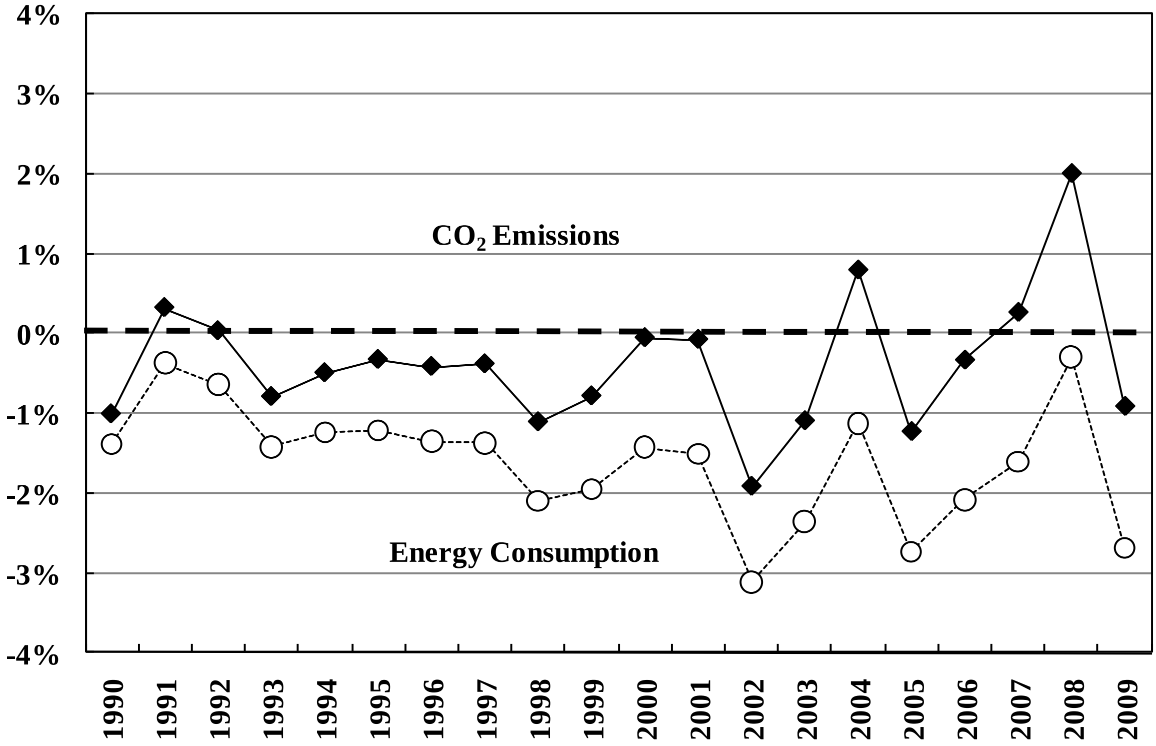

Figure A 4-1 Trends in Difference of Energy Consumption and CO_2 Emissions

A4.4. Causes of the difference between Reference Approach and Sectoral Approach

The difference in energy consumption and in CO_2 emissions can be explained by the difference of the amount of carbon which were deducted as feedstock and non-energy use in each approach, and ‘Other Conversions & Blending’ [#2700], ‘Other Input/Output’ [#3000], ‘Stock Change’ [#3500], ‘Statistical Discrepancy’ [#4000] ,and “energy loss” and “carbon imbalance” of ‘Oil Products’ [#2600] of the Energy Balance Table (*General Energy Statistics*).

The default values given in the *Revised 1996 IPCC Guidelines* were used for the fractions of carbon stored for feedstock and non-energy in reference approach.

1） Matters not sufficiently considered in the calculation process of Reference Approach

In the current estimation of reference approach, it was assumed that the amount of energy subtracted the energy amount for non-energy use from the national energy amount supplied was completely combusted. However, in real situations, some of the energy amount combusted is left without being combusted. The increase or decrease of the remaining energy amount were not considered in the current estimation of reference approach.

【Other Input/Output [#3000]】

In oil refining and other parts of the energy conversion sector, energy source shipment/drawdown amounts do not necessarily match production/receipt amounts. Other than energy received through one's own imports or that produced by refining, factors involved include returns from consumption/sales sectors of products once shipped, transactions of small amounts of byproduct energy from other companies, stock buildups and drawdowns due to product storage tank installation or decommissioning at factories and business sites, and losses due to accidents or fires.

When energy source inconsistencies due to such causes in the energy conversion sector are determined, the other input/output sector accounts for the amount. However, this input/output are not reflected under reference approach emission calculation.

【Stock Change [#3500]】

The increase or decrease of stock were not reflected under reference approach emission calculation.

CO_2 emissions from wastes used for energy and from the incineration of wastes with energy recovery originate from carbon in waste oil, waste plastics, waste tire, synthetic textile scrap and other non-biogenic waste which were incinerated. These amounts of carbons may not be reflecting the actual conditions in the deduction of carbon for feedstock and non-energy use in the calculation of the reference approach. The methodology for calculating the amount of stored carbon as feedstock and non-energy use in the reference approach should be examined and revised in the future.

2） Matters which cannot be avoided for the characteristics of survey data

【Statistical Discrepancy [#4000]】

Statistical discrepancy is originally the intrinsic error arising at the sampling stage in statistical studies (source error), and mutual discrepancies among the statistics for supply, conversion, and consumption. It is sometimes difficult to guess where discrepancies come from (relative error).

These errors induce the discrepancies among domestic supply, conversion, and final energy consumption, calculated as difference between both approaches.

3） Matters related to the difference of energy and carbon balance between energy input and output

【Other Conversions & Blending [#2700]】

This sector represents energy conversion that does not belong to any of the sectors from #2100 Commercial Power Generation to #2600 Oil Products, and actions considered to be energy conversion in which coal or oil product brands are changed by only simple operations such as blending or moisture adjustment.

Carbon weight is considered to be consistent before and after blending or conversions. However, given that carbon content per calorific value is changed following such as blending, in statistics, carbon weight could be varied before and after blending or conversions. This difference can generate the variation between two approaches.

【Oil Products [#2600]】

Energy loss and carbon imbalance during the process of oil production produce the difference between input and output of energy or carbon.

Table A 4-3 Comparison of CO_2 emissions (detail)

[Gg-CO_2]

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
RA	**1,057,427**	**1,141,966**	**1,179,346**	**1,166,441**	**1,184,667**	**1,200,526**	**1,223,561**	**1,202,642**	**1,195,192**	**1,236,089**	**1,175,623**	**1,079,691**
Liquid fuels	659,104	692,444	646,974	626,340	626,747	623,890	607,770	606,374	575,734	580,471	534,521	488,653
Solid fuels	294,611	324,221	377,604	385,525	398,965	410,252	449,953	428,702	434,223	453,747	442,626	394,488
Gaseous fuels	103,711	125,302	154,767	154,575	158,955	166,384	165,837	167,566	185,235	201,872	198,476	196,550
Other fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SA	**1,068,260**	**1,145,769**	**1,180,044**	**1,167,384**	**1,207,886**	**1,213,888**	**1,213,986**	**1,217,696**	**1,199,277**	**1,232,916**	**1,152,590**	**1,089,728**
Liquid fuels	646,223	677,349	635,121	613,057	622,889	611,372	600,423	597,813	562,037	563,675	518,395	475,108
Solid fuels	308,620	331,720	376,521	384,881	409,624	419,659	431,080	437,937	436,698	451,548	420,521	401,542
Gaseous fuels	104,301	126,198	155,261	155,279	160,359	167,045	166,918	166,823	186,374	203,273	199,525	198,689
Other fuels	9,116	10,503	13,142	14,167	15,014	15,812	15,565	15,122	14,168	14,419	14,149	14,390
RA-SA	**-10,833**	**-3,803**	**-698**	**-943**	**-23,219**	**-13,362**	**9,575**	**-15,054**	**-4,085**	**3,173**	**23,033**	**-10,037**
Liquid fuels	12,881	15,095	11,854	13,284	3,858	12,519	7,348	8,560	13,697	16,795	16,126	13,545
Solid fuels	-14,009	-7,499	1,084	644	-10,659	-9,407	18,873	-9,235	-2,475	2,199	22,105	-7,054
Gaseous fuels	-589	-896	-494	-704	-1,404	-662	-1,081	743	-1,139	-1,402	-1,050	-2,139
Other fuels	-9,116	-10,503	-13,142	-14,167	-15,014	-15,812	-15,565	-15,122	-14,168	-14,419	-14,149	-14,390
Statistical Discrepancy	**-10,465**	**3,381**	**-1,258**	**-1,504**	**-12,510**	**-9,485**	**-3,088**	**-19,607**	**8,471**	**8,797**	**12,460**	**5,147**
Liquid fuels	-3,708	3,839	-5,664	-5,292	-12,641	-10,667	-15,985	-15,724	2,881	2,443	1,239	731
Solid fuels	-6,796	-693	3,915	3,343	-320	836	12,409	-4,361	6,111	6,428	11,586	5,039
Gaseous fuels	39	236	491	446	450	346	488	478	-521	-73	-366	-624
Other Conversions & Blending	**-2,828**	**-3,076**	**-1,189**	**-1,277**	**-782**	**-775**	**-601**	**-1,110**	**-1,233**	**-1,475**	**-1,134**	**-981**
Liquid fuels	803	1,058	1,119	1,091	1,136	1,171	1,161	1,193	1,151	1,093	1,082	1,055
Solid fuels	-2,807	-3,078	-1,121	-1,168	-709	-709	-546	-1,059	-1,131	-1,361	-1,044	-903
Gaseous fuels	-825	-1,056	-1,186	-1,201	-1,210	-1,237	-1,216	-1,244	-1,253	-1,206	-1,172	-1,134
Stock Change	**1,452**	**1,878**	**2,225**	**4,268**	**-8,722**	**-6,234**	**9,121**	**556**	**-2,851**	**-2,625**	**15,694**	**-9,877**
Liquid fuels	788	1,311	-976	1,209	-3,753	-1,853	-2,369	270	2,234	-1,292	1,740	-690
Solid fuels	681	757	2,934	2,912	-4,286	-4,504	12,005	-1,097	-5,567	-990	13,635	-8,584
Gaseous fuels	-18	-190	268	148	-683	123	-515	1,383	482	-344	318	-602
Other Input/Output	**-895**	**-642**	**2,106**	**623**	**1,878**	**2,010**	**1,625**	**2,577**	**-1,385**	**1,174**	**1,374**	**1,429**
Liquid fuels	-895	-642	2,106	623	1,878	2,010	1,625	2,577	-1,385	1,174	1,374	1,429
Solid fuels	0	0	0	0	0	0	0	0	0	0	0	0
Gaseous fuels	0	0	0	0	0	0	0	0	0	0	0	0
Oil Products	**1,257**	**1,057**	**6,121**	**8,664**	**9,025**	**10,777**	**8,166**	**10,182**	**875**	**4,019**	**3,016**	**4,043**
Liquid fuels	1,518	1,351	6,476	9,032	9,399	11,162	8,548	10,600	1,278	4,393	3,387	4,295
Solid fuels	0	0	0	0	0	0	0	0	0	0	0	0
Gaseous fuels	-261	-294	-355	-368	-374	-385	-382	-418	-403	-374	-371	-253
Total	**-11,478**	**2,598**	**8,004**	**10,775**	**-11,111**	**-3,707**	**15,222**	**-7,401**	**3,877**	**9,890**	**31,410**	**-240**
Liquid fuels	-1,493	6,917	3,060	6,663	-3,981	1,822	-7,021	-1,083	6,160	7,811	8,824	6,821
Solid fuels	-8,921	-3,015	5,727	5,086	-5,314	-4,377	23,868	-6,517	-587	4,077	24,177	-4,448
Gaseous fuels	-1,064	-1,304	-783	-975	-1,816	-1,152	-1,626	199	-1,695	-1,997	-1,591	-2,613
(RA-SA)-(Total)	**645**	**-6,401**	**-8,703**	**-11,718**	**-12,107**	**-9,655**	**-5,647**	**-7,653**	**-7,963**	**-6,717**	**-8,377**	**-9,798**
Liquid fuels	14,375	8,178	8,794	6,620	7,839	10,696	14,368	9,643	7,537	8,985	7,303	6,724
Solid fuels	-5,088	-4,484	-4,643	-4,443	-5,345	-5,030	-4,995	-2,718	-1,888	-1,878	-2,072	-2,606
Gaseous fuels	475	408	289	271	412	490	545	544	556	595	542	474
Other fuels	-9,116	-10,503	-13,142	-14,167	-15,014	-15,812	-15,565	-15,122	-14,168	-14,419	-14,149	-14,390

Annex 5. Assessment of Completeness and (Potential) Sources and Sinks of Greenhouse Gas Emissions and Removals Excluded

A5.1. Assessment of Completeness

Current inventory is submitted in accordance with the common reporting format (CRF), which requires entering emission data or a notation key[1] such as “NO”, “NE”, or “NA” for all sources. This chapter presents the definition of notation keys and decision trees for the application of them, both of which are based on the UNFCCC reporting Guidelines (FCCC/CP/1999/7, FCCC/CP/2002/8 or FCCC/SBSTA/2004/8) and the results of Committee for Greenhouse Gases Emissions Estimation Methods in 2002.

This chapter also reports source categories which have not been estimated because i) applicability of IPCC default values is not assured, ii) default methodologies and default values are not provided, iii) activity data is not available, iv) actual condition of GHG emissions or removals is not understood clearly.

A5.2. Definition of Notation Keys

When reviewing the appropriateness of applying notation keys shown in the UNFCCC reporting guideline, it is necessary to establish a common concept for an application of these keys for each sector, but unclear points described in Table A5-1 are found as below regarding the use of the notation key.

- The explanation of “NO” in the UNFCCC reporting guidelines can be taken that “NO” may be applied to both situations when there are no emissions or removals because the activities do not exist in Japan, and when emissions or removals do not occur in principle although the activities do exist.

- The first sentence of the “NA” explanation in the UNFCCC reporting guidelines seems to imply that “NA” may be applied to both situations as for “NO”. However, because the second sentence states that “If categories... are shaded, they do not need to be filled in”, it also seems to mean that “NA” is applied only when the activities exist but there are no emissions or removals in principle.

In the Committee for Greenhouse Gases Emissions Estimation Methods in 2002, the meanings of the notation keys are defined based on the following policy (as shown in Table A5-2).

- It was decided that “NA” is applied when the activity does exist in Japan, but in principle there are no GHG emissions or removals, while “NO” will apply when the activity itself does not exist and there are no emissions or removals.

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[1] These were called "standard indicators" in FCCC/CP/1999/7, but were changed to "notation keys" in FCCC/CP/2002/8.

If the UNFCCC reporting guidelines are revised in future, the review of the definitions of notation keys and the way to fill them in CRF will be conducted.

Table A 5-1 Notation keys indicated in UNFCCC reporting guidelines

Notation Key	Explanation
NO (Not Occurring)	"NO" (not occurring) for emissions by sources and removals by sinks of greenhouse gases that do not occur for a particular gas or source/sink category within a country;
NE (Not Estimated)	"NE" (not estimated) for existing emissions by sources and removals by sinks of greenhouse gases which have not been estimated. Where "NE" is used in an inventory for emissions or removals of CO_2, CH_4, N_2O, HFCs, PFCs or SF_6, the Party should indicate why emissions could not be estimated, using the completeness table of the common reporting format;
NA (Not Applicable)	"NA" (not applicable) for activities in a given source/sink category that do not result in emissions or removals of a specific gas. If categories in the common reporting format for which "NA" is applicable are shaded, they do not need to be filled in;
IE (Included Elsewhere)	"IE" (included elsewhere) for emissions by sources and removals by sinks of greenhouse gases estimated but included elsewhere in the inventory instead of the expected source/sink category. Where "IE" is used in an inventory, the Party should indicate, using the completeness table of the common reporting format, where in the inventory the emissions or removals from the displaced source/sink category have been included and the Party should give the reasons for this inclusion deviating from the expected category;
C (Confidential)	"C" (confidential) for emissions by sources and removals by sinks of greenhouse gases which could lead to the disclosure of confidential information, given the provisions of paragraph 27 above; (para 27: Emissions and removals should be reported on the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information.

Source : UNFCCC reporting guidelines on annual inventories (FCCC/SBSTA/2004/8)

* The notation key "0" was deleted at COP8 from the revised UNFCCC reporting guidelines (FCCC/CP/2002/8).

Table A 5-2 Definition of Notation Keys

Notation Key	Definition
NO (Not Occurring)	Used when there are no activities that are linked to emissions or removals for a certain source.
NE (Not Estimated)	Used when the emissions or removals of a certain source cannot be estimated.
NA (Not Applicable)	Used when an activity associated with a certain source does exist, but in principle it accompanies no occurrence of specific GHG emissions or removals. "NA" is not applied when there are no GHG emissions or removals because the GHGs in raw materials have been removed.
IE (Included Elsewhere)	IE is used when an emissions or removals are already included in other sources. For assuring the completeness of CRF, the sources in which the emissions or removals are included and the reasons for including it elsewhere are to be recorded in the table.
C (Confidential)	Used for confidential information relating to business or the military. However, in consideration of transparency in calculation of emissions or removals, information will be reported to the extent that it does not hinder business or other operations (for example, reporting the aggregated total of several substances).

A5.3. Decision Tree for Application of Notation Keys

Decision tree for the application of notation keys, based on UNFCCC reporting Guidelines (FCCC/CP/1999/7 FCCC/CP/2002/8 or FCCC/SBSTA/2004/8) and the results of Committee for Greenhouse Gases Emissions Estimation Methods in 2002, is shown in Figure A5-1.

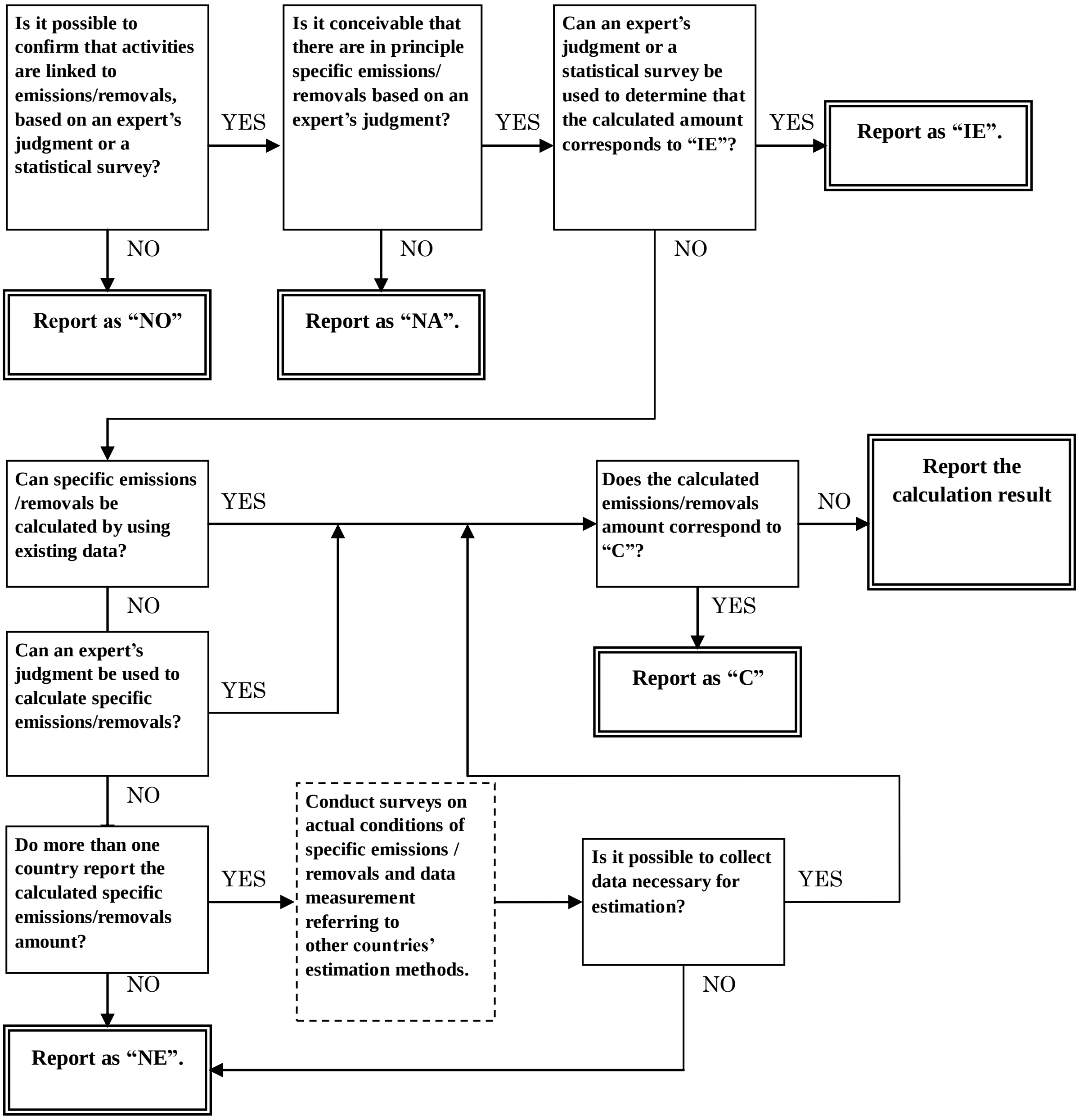

Figure A 5-1 Decision tree for application of notation keys

A5.4. Source categories not estimated in Japan's inventory

Source categories dissolved not estimate status in this year and categories still not estimated in Japan's inventory are listed below. Note that the actual emissions 1990-1994 of HFCs, PFCs and SF_6 are not estimated.

Table A 5-3 Dissolution of “NE” categories for 2009

Code	Sector	Source category				Gas
1	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Cropland converted to Grassland	Dead Organic Matter	Carbon Stock Change
2	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Wetland converted to Grassland	Dead Organic Matter	Carbon Stock Change
3	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Cropland converted to Wetlands	Dead Organic Matter	Carbon Stock Change
4	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Grassland converted to Wetlands	Dead Organic Matter	Carbon Stock Change
5	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Settlements converted to Wetlands	Dead Organic Matter	Carbon Stock Change
6	Land - use Change and Forestry	Other land	Land Converted to Other land	Cropland Converted to Other land	Dead Organic Matter	Carbon Stock Change
7	Land - use Change and Forestry	Other land	Land Converted to Other land	Grassland Converted to Other land	Dead Organic Matter	Carbon Stock Change

Table A 5-4 “NE” categories for 2009

Code	Sector	Source category				GHG
1	Energy	Fugitive Emissions from Fuels	Solid Fuels	Coal Mining		CO_2
2	Energy	Fugitive Emissions from Fuels	Solid Fuels	Coal Mining		N_2O
3	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		CO_2
4	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		CH_4
5	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		N_2O
6	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Refining/Storage	CO_2
7	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Distribution of Oil Products	CO_2
8	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Distribution of Oil Products	CH_4
9	Industrial Processes	Mineral Products	Asphalt roofing			CO_2
10	Industrial Processes	Mineral Products	Road Paving with Asphalt			CO_2
11	Industrial Processes	Chemical Industry	Ammonia Production			CH_4
12	Industrial Processes	Metal Production	Aluminium Production			CH_4
13	Solvent and Other Product Use	Degreasing and Dry-Cleaning				CO_2
14	Solvent and Other Product Use	Chemical Product, Manufacture and Processing				CO_2
15	Solvent and Other Product Use	Other	Other Use of N_2O			N_2O
16	Agriculture	Enteric Fermentation	Poultry			CH_4
17	Agriculture	Field Burning of Agricultural Residues	Other			CH_4
18	Agriculture	Field Burning of Agricultural Residues	Other			N_2O
19	Land - use Change and Forestry	Cropland	Cropland remaining Cropland	Soil		Carbon Stock Change
20	Land - use Change and Forestry	Cropland	Cropland remaining Cropland	Biomass Burning	Controlled Burning	CO_2
21	Land - use Change and Forestry	Cropland	Cropland remaining Cropland	Biomass Burning	Controlled Burning	CH_4
22	Land - use Change and Forestry	Cropland	Cropland remaining Cropland	Biomass Burning	Controlled Burning	N_2O
23	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Forest Land converted to Cropland	Soil (Organic soils)	Carbon Stock Change
24	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Grassland converted to Cropland	Soil (Organic soils)	Carbon Stock Change
25	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Wetland converted to Cropland	Soil (Organic soils)	Carbon Stock Change
26	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Other Land converted to Cropland	Dead Organic Matter	Carbon Stock Change
27	Land - use Change and Forestry	Cropland	Land Converted to Cropland	Other Land converted to Cropland	Soil	Carbon Stock Change
28	Land - use Change and Forestry	Cropland	Land Converted to Cropland	N_2O emissions from disturbance	Controlled Burning	N_2O
29	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Wild land	Living Biomass	Carbon Stock Change
30	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Wild land	Dead Organic Matter	Carbon Stock Change
31	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Wild land	Soil	Carbon Stock Change
32	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Grazed meadow	Soil	Carbon Stock Change
33	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Pasture land	Soil	Carbon Stock Change
34	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	CO_2
35	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	CH_4
36	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Wildfires	N_2O
37	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	CO_2
38	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	CH_4
39	Land - use Change and Forestry	Grassland	Grassland remaining Grassland	Biomass Burning	Controlled Burning	N_2O
40	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Forest Land converted to Grassland	Soil (Organic soils)	Carbon Stock Change
41	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Cropland converted to Grassland	Soil (Organic soils)	Carbon Stock Change
42	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Wetland converted to Grassland	Soil	Carbon Stock Change
43	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Other Land converted to Grassland	Dead Organic Matter	Carbon Stock Change
44	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Other Land converted to Grassland	Soil	Carbon Stock Change
45	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	CO_2
46	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	CH_4
47	Land - use Change and Forestry	Grassland	Land Converted to Grassland	Biomass Burning	Wildfires	N_2O
48	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Flooded land	Living Biomass	Carbon Stock Change

Table A 5-4 "NE" categories for 2009 (cont.)

Code	Sector	Source category				GHG
49	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Flooded land	Dead Organic Matter	Carbon Stock Change
50	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Flooded land	Soil	Carbon Stock Change
51	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	CO_2
52	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	CH_4
53	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Wildfires	N_2O
54	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	CO_2
55	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	CH_4
56	Land - use Change and Forestry	Wetlands	Wetlands remaining Wetlands	Biomass Burning	Controlled Burning	N_2O
57	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Forest Land converted to Wetlands	Soil	Carbon Stock Change
58	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Cropland converted to Wetlands	Soil	Carbon Stock Change
59	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Grassland converted to Wetlands	Soil	Carbon Stock Change
60	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Settlements converted to Wetlands	Soil	Carbon Stock Change
61	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Other Land converted to Wetlands	Dead Organic Matter	Carbon Stock Change
62	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Other Land converted to Wetlands	Soil	Carbon Stock Change
63	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	CO_2
64	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	CH_4
65	Land - use Change and Forestry	Wetlands	Land converted to Wetlands	Biomass Burning	Wildfires	N_2O
66	Land - use Change and Forestry	Settlements	Settlements remaining Settlements			CH_4
67	Land - use Change and Forestry	Settlements	Settlements remaining Settlements			N_2O
68	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Other than Urban Green Areas	Living Biomass	Carbon Stock Change
69	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Other than Urban Green Areas	Dead Organic Matter	Carbon Stock Change
70	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Other than Urban Green Areas	Soil	Carbon Stock Change
71	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Urban Green Areas subject to RV	Soil	Carbon Stock Change
72	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Urban Green Areas not subject to RV	Dead Organic Matter	Carbon Stock Change
73	Land - use Change and Forestry	Settlements	Settlements remaining Settlements	Urban Green Areas not subject to RV	Soil	Carbon Stock Change
74	Land - use Change and Forestry	Settlements	Land Converted to Settlements	Forest Land Converted to Settlements	Soil	Carbon Stock Change
75	Land - use Change and Forestry	Settlements	Land Converted to Settlements	Cropland Converted to Settlements	Soil	Carbon Stock Change
76	Land - use Change and Forestry	Settlements	Land Converted to Settlements	Grassland Converted to Settlements	Soil	Carbon Stock Change
77	Land - use Change and Forestry	Other land	Land Converted to Other land	Forest Land Converted to Other land	Soil	Carbon Stock Change
78	Land - use Change and Forestry	Other land	Land Converted to Other land	Cropland Converted to Other land	Soil	Carbon Stock Change
79	Land - use Change and Forestry	Other land	Land Converted to Other land	Grassland Converted to Other land	Soil	Carbon Stock Change
80	Land - use Change and Forestry	Harvested Wood Product				CO_2
81	Land - use Change and Forestry	Harvested Wood Product				CH_4
82	Land - use Change and Forestry	Harvested Wood Product				N_2O
83	Waste	Wastewater Handling	Domestic and Commercial Wastewater			CH_4
84	Waste	Wastewater Handling	Domestic and Commercial Wastewater			N_2O
85	Waste	Waste Incineration				N_2O

Annex 6. Additional Information to be Considered as Part of the NIR Submission or Other Useful Reference Information

A6.1. Details on Inventory Compilation System and QA/QC Plan

The main parts of the QA/QC Plan for Japan's greenhouse gas inventory are excerpted.

A6.1.1. Introduction to QA/QC Plan

The QA/QC Plan is an internal document that documents, among other things, the specifics of all QA/QC activities in all processes from the start of National Inventory Report compilation to the final report, the compilation schedule, and the apportionment of all involved entities' roles. It organizes and systematizes the QA/QC activities of inventory compilation and clarifies what each entity involved in compilation is supposed to do. Additionally, it is prepared for the purpose of guaranteeing the implementation of QA/QC activities.

A6.1.2. QA/QC plan's scope

The QA/QC Plan's scope includes the processes of preparing, reporting, and reviewing the inventory under the Framework Convention on Climate Change, and the supplementary information on sinks under Kyoto Protocol Articles 3.3 and 3.4, as stipulated in Article 7.1 of the Protocol.

A6.1.3. Roles and responsibilities of each entity involved in the inventory preparation process

Following are the agencies involved in the inventory compilation process, and the roles of those agencies.

1） *Ministry of the Environment (Low-carbon Society Promotion Office, Global Environment Bureau)*

- The single national agency responsible for preparing Japan's inventory, which was designated pursuant to the Kyoto Protocol Article 5.1.
- It is responsible for editing and submitting the inventory.

2） *Greenhouse Gas Inventory Office of Japan (GIO), Center for Global Environmental Research, National Institute for Environmental Studies*

- Performs the actual work of inventory compilation. Responsible for inventory calculations, editing, and the archiving and management of all data.

3） *Relevant Ministries/Agencies*

The relevant ministries and agencies have the following roles and responsibilities regarding inventory compilation.

- Preparation of activity data, emission factor data, and other data needed for inventory compilation, and submission of the data by the submission deadline.
- Quality control (QC) of the data provided to the Ministry of the Environment and the GIO.
- Confirmation and verification of the inventory (CRF, NIR, spreadsheets, and other information) prepared by the Ministry of the Environment and the GIO.
- (When necessary), responding to questions from expert review teams about the statistics

controlled by relevant ministries and agencies, or about certain data they have prepared, and preparing comments on draft reviews.

- (When necessary), responding to visits by expert review teams.

4） *Relevant Organizations*

Relevant organizations have the following roles and responsibilities regarding inventory compilation.

- Preparation of activity data, emission factor data, and other data needed for inventory compilation, and submission of the data by the submission deadline.
- Quality control (QC) of the data provided to the Ministry of the Environment and the GIO.
- (When necessary), responding to questions from expert review teams about the statistics controlled by relevant organizations, or about certain data they have prepared, and preparing comments on draft reviews.

5） *Committee for the Greenhouse Gas Emissions Estimation Methods*

The Committee for the Greenhouse Gas Emissions Estimation Methods (the Committee) is a committee created and run by the Ministry of the Environment. Its role is to consider the methods for calculating inventory emissions and removals, and consider the selection of parameters such as activity data and emission factors. Under the Committee is the inventory working group (WG) that examines crosscutting issues, and breakout groups that consider sector-specific problems (Breakout group on Energy and Industrial Processes, Breakout group on Transport, Breakout group on F-gas [HFCs, PFCs, and SF_6], Breakout group on Agriculture, Breakout group on Waste, and Breakout group on LULUCF). The inventory WG and breakout groups comprise experts in various fields, and consider suggestions for inventory improvements. Improvement suggestions are considered once more by the Committee before approval.

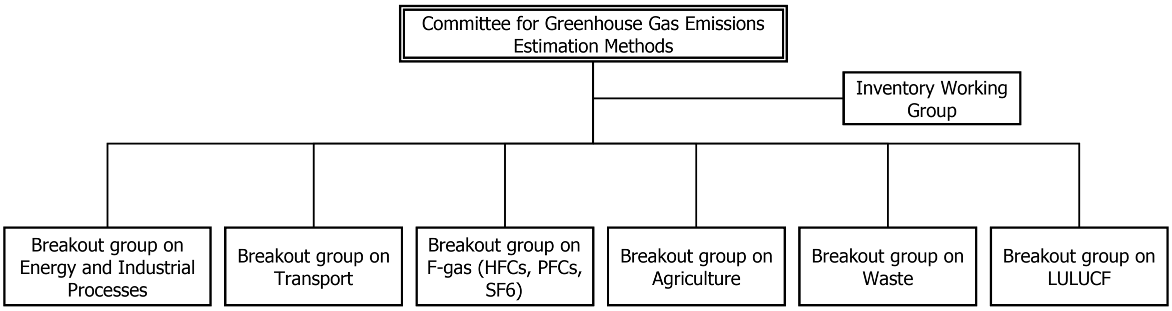

Figure A 6-1 Structure of the Committee for the Greenhouse Gas Emissions Estimation Methods

6） *Private Consulting Companies*

Private consultant companies that are contracted by the Ministry of the Environment to perform tasks related to inventory compilation play the following roles in inventory compilation based on their contracts.

- Quality control (QC) of inventory (CRF, NIR, spreadsheets, and other information) compiled by the Ministry of the Environment and the GIO.
- (When necessary), providing support for responding to questions from expert review teams and for preparing comments on draft reviews.
- (When necessary), providing support for responding to visits by expert review teams.

7） GHG Inventory Quality Assurance Working Group (Expert Peer Review) (QA-WG)

The GHG Inventory Quality Assurance Working Group (the QA-WG) is an organization that is for QA activities, and comprises experts who are not directly involved in inventory compilation. Its role is to assure inventory quality and to identify places that need improvement by conducting detailed reviews of each emission source and sink in the inventory.

A6.1.4. Collection process of activity data

When the activity data needed for calculations are available from sources such as publications and the internet, the necessary data are gathered from these media. Data that are not released in publications, the internet, or in other media, and unpublished data that are used when compiling the inventory are obtained by the Ministry of the Environment or the GIO by requesting them from the relevant ministries and agencies and the relevant organizations which control those data. The main relevant ministries and agencies and relevant organizations that provide data are as shown in Table A 6-1.

Table A 6-1 List of the main relevant ministries and agencies and the relevant organizations (data providers)

Ministries/Agencies/Organizations		Major data or statistics
Relevant Ministries/ Agencies	Ministry of the Environment	Research of Air Pollutant Emissions from Stationary Sources / volume of waste in landfill / volume of incinerated waste / number of people per *johkasou* facility / volume of human waste treated at human waste treatment facilities
	Ministry of Economy, Trade and Industry	General Energy Statistics / Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke / Yearbook of Iron and Steel, Non-ferrous Metals, and Fabricated Metals Statistics / Yearbook of Chemical Industry Statistics / Yearbook of Ceramics and Building Materials Statistics / Census of Manufactures / General outlook on electric power supply and demand
	Ministry of Land, Infrastructure, Transport and Tourism	Annual of Land Transport Statistics / Survey on Transport Energy / Statistical Yearbook of Motor Vehicle Transport / Survey on Current State of Land Use,Survey on Current State of Urban Park Development / Sewage Statistics
	Ministry of Agriculture, Forestry and Fisheries	Crop Statistics / Livestock Statistics / Vegetable Production and Shipment Statistics / World Census of Agriculture and Forestry / Statistics of Arable and Planted Land Area / Handbook of Forest and Forestry Statistics / Table of Food Supply and Demand
	Ministry of Health, Labour and Welfare	Statistics of Production by Pharmaceutical Industry
Relevant Organizations	Federation of Electric Power Companies	Amount of Fuel Used by Pressurized Fluidized Bed Boilers
	Japan Coal Energy Center	Coal Production
	Japan Cement Association	Amount of clinker production / Amount of waste input to in raw material processing / Amount of RPF incineration
	Japan Iron and Steel Federation	Emissions from Coke Oven Covers, Desulfurization Towers, and Desulfurization Recycling Towers
	Japan Paper Association	Amount of final disposal of industrial waste / Amount of RPF incineration

A6.1.5. Selection process of emission factors and estimation methods

Calculation methods for Japan’s emission and removal amounts are determined by having the Committee explore calculation methods suited to Japan’s situation for all the activity categories necessary for calculating Japan’s greenhouse gas emission and removal amounts, based on the 1996 Revised IPCC Guidelines, GPG (2000), GPG-LULUCF, and the 2006 IPCC Guidelines.

A6.1.6. Improvement process of estimations for emissions and removals

In Japan, improvements in calculation methods are considered in accordance with necessity whenever an inventory item requiring improvement is identified because of, for example, a UNFCCC review or an observation by the QA-WG, progress in international negotiations such as the creation of new guidelines, progress or changes in scientific research or in the compilation of statistics, or the acquisition of new information by the system for calculating, reporting, and publishing GHG emissions. Proposals for improving the estimation of emissions and removals are considered by scientific research or the Committee, and the results are incorporated into the inventory. Figure A 6-2 below is a diagram of the inventory improvement process.

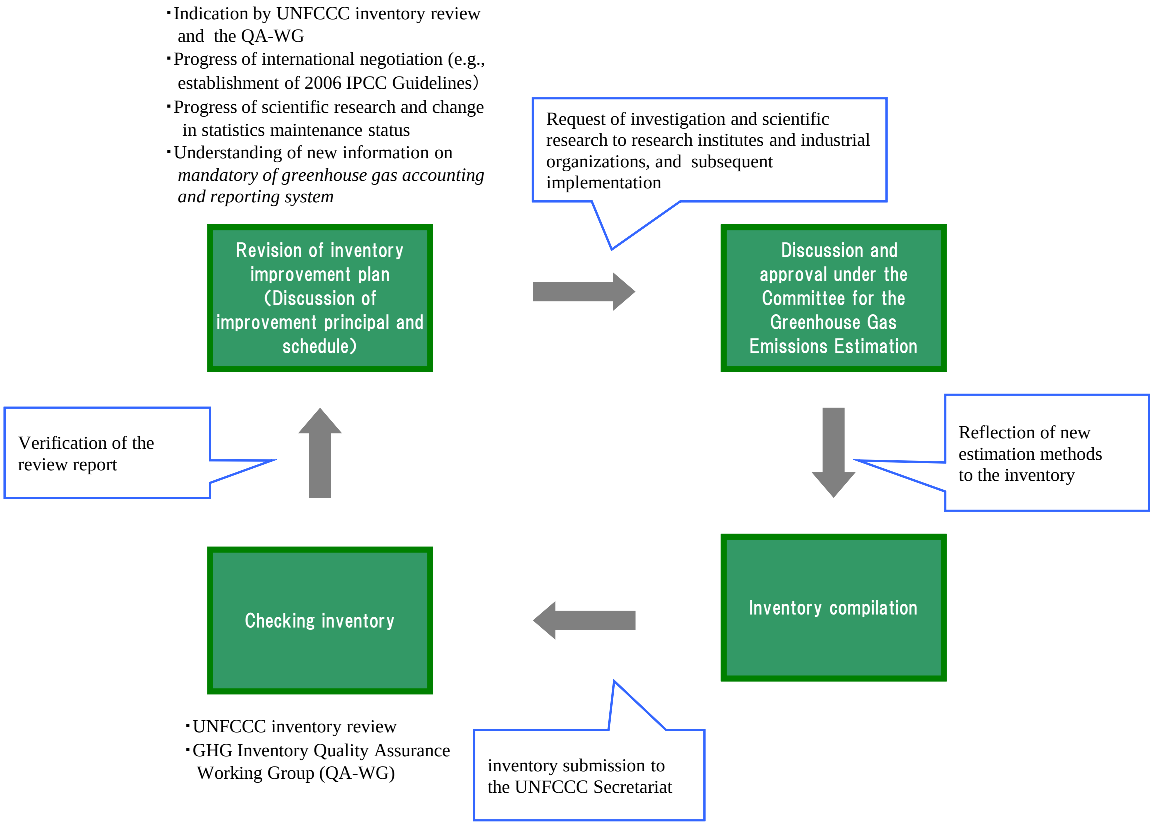

Figure A 6-2 Diagram of the inventory improvement process

A6.1.7. QA/QC activity

When compiling the inventory in Japan, inventory quality is controlled by performing quality control (QC) activities (such as checking the correctness of calculations and archive of documents) at each step in accordance with GPG (2000) and GPG-LULUCF. In Japan, the quality control activities relating to inventory compilation performed by personnel belonging to agencies involved in inventory compilation—that is, the Ministry of the Environment (including the GIO and private consultant companies), relevant ministries and agencies, and relevant organizations—are considered to be QC. External reviews by experts who are outside the inventory compilation system (the QA-WG) are considered to be QA (quality assurance). They verify and assess data quality from the perspectives of scientific knowledge and data availability with respect to current calculation methods. Table A 6-2 sketches Japan’s QA/QC activities.

Table A 6-2 Summary of Japan's QA/QC activity

	Implementing entity	Main contents of activity
QC (Quality Control)	Ministry of the Environment (Low-carbon Society Promotion Office, Global Environment Bureau)	・Progress management of the inventory compilation and overall control ・Check of inventory compiled by the GIO (CRF, NIR, spreadsheets, and other information) ・Establishment and revision of QA/QC plan ・Check of the inventory improvement plan ・Holding the meeting of the Committee for the Greenhouse Gas Emissions Estimation Methods
	Greenhouse Gas Inventory Office of Japan, Center for Global Environmental Research, National Institute for Environmental Studies (GIO)	・QC check in inventory compilation ・Archiving of QA/QC activity records and relevant data and documents ・Development of information system ・Making of inventory improvement plan ・Making of revised QA/QC plan
	Relevant Ministry and Agencies (including the Ministry of the Environment) and relevant organizations	・Preparation of activity data, emission factor, and other data needed for inventory compilation, and submission of the data by the submission deadline. ・Check of various data supplying to the GIO ・Check and validation of inventory compiled by the GIO (CRF, NIR, spreadsheets, and other information)
	Committee for the Greenhouse Gas Emissions Estimation Methods	・Discussion and Assessment for estimation methods, emission factors, and activity data
	Private Consultant Companies	・Check of inventory compiled by the GIO (CRF, NIR, spreadsheets, and other information)
QA (Quality Assurance)	Inventory Quality Assurance Working Group (QA-WG)	・Expert peer review to validate estimation methods, emission factors, and activity data ・Inventory assessment

A6.1.7.1. QC activity

A6.1.7.1.a. General QC procedures (Tier 1)

General QC procedures include the general items to be confirmed which are related to the calculation, data processing, completeness, and documentation applicable to all emission source and sink categories. General QC procedures are implemented by each inventory compiler.

Following are the QC activities conducted by the sectoral experts (SEs), who perform the work of compiling the emissions/removals estimation files for each category, the CRF master files and NIR; the National Inventory compiler (NIC), who integrates the information from the individual SEs and compiles the inventory; and the data providers, who provide the activity data and other data used to calculate emissions and removals.

This section describes the QC activities of the GIO and private consultant companies in parts 1) and 2), and the QC activities conducted by the relevant ministries and agencies and the relevant organizations in part 3).

1） Sectoral expert (SE)

SEs perform the following QC activities.

- ➢ Checking for transcription errors in data entry and referencing
- ➢ Checking to ensure that emissions are accurately estimated
- ➢ Checking to see that parameters and emission units are accurately recorded, and that proper

conversion factors are used
- Checking the conformity of databases and/or files
- Checking the consistency of data from one category to another
- Checking the accuracy of inventory data behavior from one processing step to the next
- Checking completeness
- Checking time series consistency
- Checking trends
- Conducting comparisons with past estimated values
- Checking that uncertainties in emissions and removals are accurately estimated and calculated
- Carrying out reviews of internal documentation
- Checking that the assumptions and criteria for selecting activity data and emission factors are documented

2） National inventory compiler (NIC)

The NIC performs the following QC activities when preparing CRF files.
- Confirming that CRF Reporter data provided by SEs are imported without omission
- Confirming that the information needed for the documentation box is properly entered
- Confirming that the reasons for “NE” and “IE” are correctly entered
- Confirming that the key category analysis results are correctly entered
- Confirming that recalculations have been correctly performed
- Confirming time series consistency for emissions
- Confirming inventory completeness
- Confirming that CRF Reporter data are correctly transferred to CRF Excel files
- Confirming that emissions are correctly totaled

3） Data providers

Relevant ministries and agencies and relevant organizations that provide activity data and other data in the inventory compilation process conduct the following QC activities from the perspectives of the completeness/representativeness, accuracy, consistency, and transparency of the data provided.
- Confirming that the provided data are correctly transcribed to input sheets
- Confirming that, in gathering and processing the data, the following QC checks are carried out among those responsible, or by using the system and other means
- Performing verification to guarantee data accuracy (such as by comparison with and verification of other, similar data)
- Evaluating data uncertainty
- (When data span multiple years), confirming that data have been prepared with methods that are consistent over the entire time span
- (When data preparation methods differ over time), documenting related information (such as reasons for changes and what has been changed)
- (When provided data are obtained by complete enumeration), confirming that all areas of concern to the study are covered
- (When provided data are obtained by sampling), confirming grounds (such as checks by experts) enabling one to judge that the representativeness of study samples is sufficiently guaranteed

- (When estimates are made in the processing of study data), confirming that QA (such as checks by experts and reviews) has been performed on the soundness of the estimation methods
- Documenting information on the above items (such as data estimation methods and signs of checks by experts)
- Documenting procedures for preparing statistics and performing studies
- Archive of related information, including the above-mentioned documents, in prescribed locations

A6.1.7.1.b. QC procedure for each category (Tier 2)

As part of the QC activities in Japan, private consultant companies perform external QC on the estimation files prepared by the GIO, and on the CRF and NIR drafts. In addition to confirming the data entered into estimation files for each emission source category and the equations for calculating emissions, private consultant companies use estimation files like those of the GIO to calculate total greenhouse gas emissions, and carry out mutual verification of emission estimation results. They also send to the relevant ministries and agencies the sets of files for estimation files, CRF, NIR, and the drafts of published documents for domestic release showing estimated values for emissions and removals. And they confirm and verify the content of categories relevant to each ministry or agency (coordination with the relevant ministries and agencies).

A6.1.7.2. QA activity

Quality assurance (QA) refers to assessment of inventory quality by third units that are not directly involved in inventory compilation. In Japan the following QA is conducted to assure inventory quality.

1. GHG Inventory Quality Assurance Working Group (Expert Peer Review)
2. Internal QA

A6.1.7.2.a. GHG Inventory Quality Assurance Working Group (Expert Peer Review) (QA-WG)

1） *Summary*

The QA-WG performs detailed reviews (expert peer reviews) by experts not directly involved in inventory compilation for each emission source and sink in order to assure inventory quality and to identify places that need improvement.

2） *Scope of review*

The GHG Inventory Quality Assurance Working Group performs reviews mainly in the following areas.

- Confirming the soundness of estimation methods, activity data, emission factors, and other items.
- Confirming the soundness of content reported in the CRF and NIR.

3） *QA-WG in FY 2010*

The QA-WG was newly established in FY 2009 as a result of discussions within the Committee held in FY 2008 in order to enhance Japan’s QA/QC activities. The QA-WG fulfils QA activities for inventory preparation, reporting and reviewing as required for the Annex I Parties under the FCCC as well as the Kyoto Protocol by implementing a detailed review by experts, who are not directly involved in or related to the inventory preparation process, for each source and/or sink. The secretariat for the QA-WG was established within the GIO. The secretariat and the Ministry of the Environment determined the sectors and categories to be reviewed by the QA-WG. The experts for the QA-WG were selected by taking the following requirements into account.

<Requirements for QA-WG review expert>

a. No direct involvement in the inventory preparation process for estimating emissions/ removals from the sectors/categories to be reviewed (i.e., no involvement in the Committee, the data creation and the data provision for those sectors/categories)
b. No specific interests related to the inventory and the capability to judge objectively without being affected by any specific organizations and/or stakeholders.
c. Sufficient skills, knowledge and experiences to assure the quality of the inventory

The Industrial processes, and the Solvent and other product use sectors were reviewed by two experts in FY 2010, and the schedule for the QA-WG was as follows.

Table A 6-3 Schedule for the QA-WG in FY 2010

Schedule	Matter
Mid-May, 2010	Selection of experts by the Ministry of Environment of Japan and the secretariat
Late-May	Visit and briefing of the experts
June to Early-August	Review by the experts (The detailed review of the Inventory, the listing of dubious and controversial points, and proposal for improvements)
27 August	Holding of the QA-WG meeting
September to January 2011	Bringing up and discussion of suggestions from the QA-WG to each breakout group in the Committee

Key data and the methods of estimation used in these sectors have been validated by QA-WG. The QA-WG identified some issues and submitted them to the Committee. Other issues that have not been resolved by the committee are presented in each category of the “f) Source-specific Planned Improvement” section in this report. In addition, the QA-WG identified insufficient explanations and incorrect descriptions in the NIR 2010 and addressed them in this report to improve transparency and accuracy.

The MOE and the secretariat will annually determine the sectors/categories to be reviewed by the QA-WG, with the aim of reviewing the entire inventory within the next few years.

A6.1.7.2.b. Internal QA

Internal QA consists of inventory checking by staff members who are not among the SEs responsible for each category.

The GIO has one or two SEs for each category who prepare the estimation files, CRF, and NIR, but SEs mutually assure the quality of each other’s work by checking the content of inventory categories in whose preparation they are not directly involved.

A6.1.8. Response for UNFCCC inventory review

The convention inventory and Kyoto Protocol supplementary information on sinks that Japan submits each year are to be reviewed by an expert review team (ERT) pursuant to UNFCCC inventory review guidelines[1], Kyoto Protocol Article 8, Decision 22/CMP.1, and other requirements. Specifically, rigorous checks are performed in accordance with Japan's prescribed estimation method guidelines[2] from perspectives including: Are emissions and removals accurately and completely estimated and reported? Are transparent explanations provided for estimation methods? Are QA/QC activities and uncertainty assessments performed appropriately?

Because the inventory review has great significance for attaining Japan's emission reduction targets under the Kyoto Protocol, it is necessary to address this matter after having made careful preparations. The system shown in Figure A 6-3 is used for responding to reviews.

The Ministry of the Environment, which in Japan is responsible for editing and submitting the inventory, is assigned to be the agency with overall control (responsibility) for review response, while the GIO performs the actual work, such as preparing source materials. Communication with the UNFCCC Secretariat is performed by the Ministry of Foreign Affairs. The relevant ministries and agencies, relevant organizations, and private consultant companies[3] that are involved in inventory compilation cooperate with review response through activities including providing relevant information, support for source material preparation, and QC implementation.

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[1] FCCC/CP/2002/8

[2] 1996 Revised IPCC Guidelines, Good Practice Guidance (2000)、GPG-LULUCF

[3] Private consultant companies cooperate in correspondence of the reviews based on the operating agreement with the Ministry of the Environment.

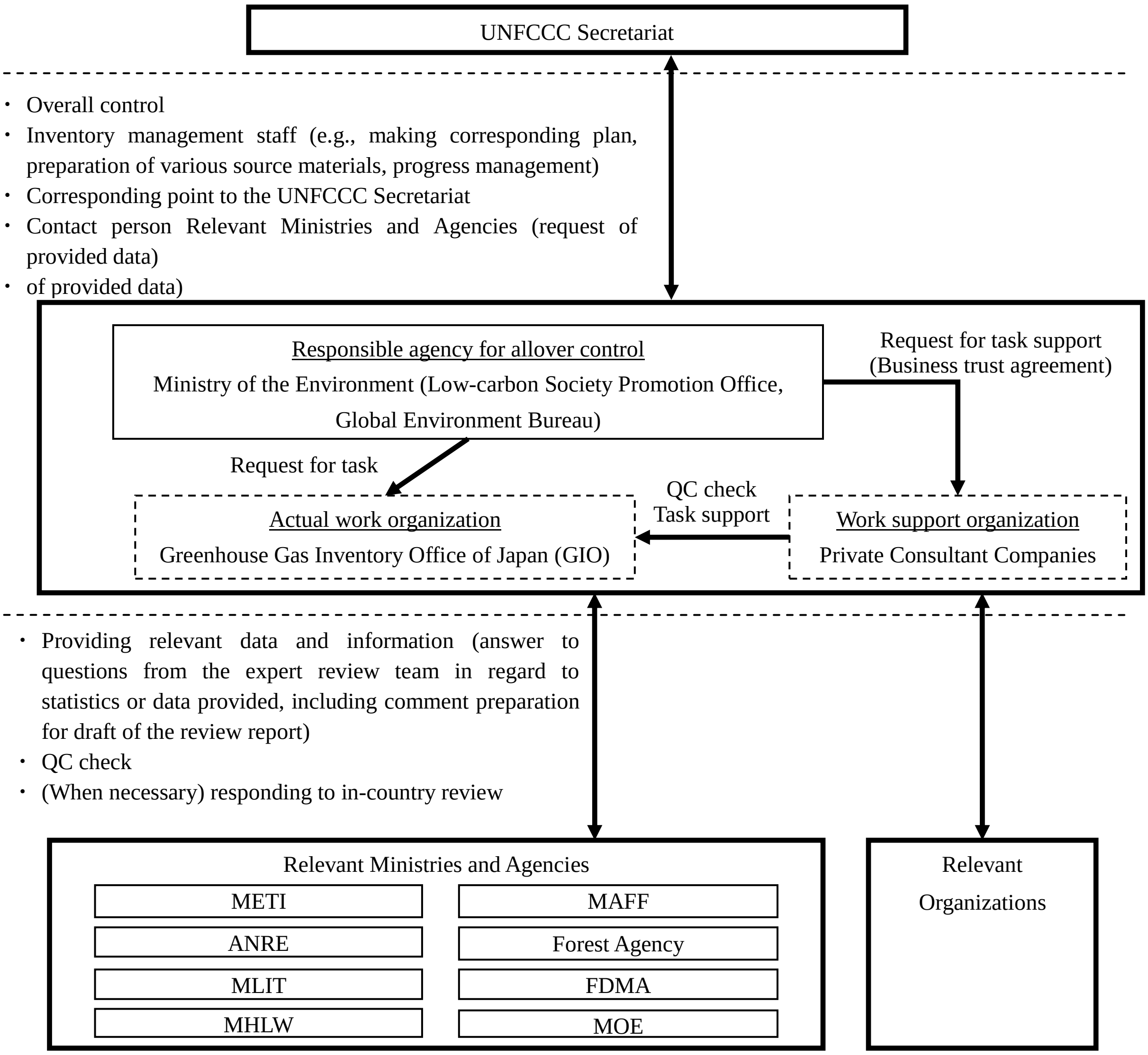


Figure A 6-3 Basic structure of Japan's national system corresponding to inventory review

A6.1.9. Documentation and archiving of inventory information

In Japan, the information needed for inventory compilation is documented and as a rule archived by the agency which compiles the inventory (the GIO).

A6.1.9.1. Documentation of information

The GIO documents all the inventory-related information in electronic or printed form and archives it. Examples of information that must be archived follow.

- The inventories submitted every year to the UNFCCC Secretariat, and the related files
- Published materials for preliminary and finalized data
- Statistical data and provided data (including data providers, time period when provided, and other related information) used in compiling the inventory
- Information on the discussion process and discussion results related to the selection of activity data, estimation methods, emission factors, and other items (relevant source materials for the discussion process by the Committee for the Greenhouse Gas Emissions Estimation Methods)
- Records of communications with related entities in the inventory compilation process

- Information on inventory recalculations (such as reasons for recalculations, and when performed)
- Record of QA/QC activities conducted
- Comments by experts on the inventory
- In relation to UNFCCC inventory reviews, review reports and records of questions and answers with expert review teams
- Internal documents on inventory compilation, including the QA/QC Plan

A6.1.9.2. Archiving of information

1） Archiving electronic information

ｉ） *Inventory-related electronic information*

- Each year’s emissions/removals estimation files and CRF- and NIR-related files have file names with the year the estimation is for and the year it was performed, and files are saved in folders prescribed for each year.
- Electronic files of statistical data, provided data, etc. used to prepare the inventory’s emissions/removals estimates and other, related data are given file names with the date on which the data were obtained and the data provider, and saved in prescribed folders.
- Source materials in electronic form (files in Word, PDF, or other format) used when considering emissions/removals estimation methods are labeled with the source material title and the date the file was obtained (and if necessary the file provider), and saved in prescribed folders.
- If the exchange of information on the inventory has been conducted by email, the email files are saved in prescribed folders.

ｉｉ） *Backup and risk management of electronic information*

- The CGER server, where inventory-related information is stored, is automatically backed up to two other locations every day.
- Once a year, after submission of the annual inventory to the UNFCCC Secretariat, all inventory-related electronic information is saved to CD-ROMs and other electronic media and archived.

2） Archiving printed form

- Books of statistics, data and source materials (including faxes) in printed form that have been provided, and other source materials in printed form that have been used in inventory emissions/removals estimates are filed in a prescribed storage location.

A6.1.9.3. QC activity for documentation and archiving of inventory information

Immediately after the inventory is submitted to the UNFCCC Secretariat, the GIO carries out QC activities related to the documentation and archive of inventory information.

Annex 7. Methodology and Results of Uncertainty Assessment

A7.1. Methodology of Uncertainty Assessment

A7.1.1. Background and Purpose

Under the United Nations Framework Convention on Climate Change (UNFCCC), Annex I Parties are required to submit their inventories on greenhouse gases emissions and removals (hereafter, 'inventory') to the UNFCCC secretariat. *Good Practice Guidance (2000)*, adopted in May 2000, further requires parties to quantitatively assess and report the uncertainty of their inventories. It should be noted that uncertainty assessment is intended to contribute to continuous improvement in the accuracy of inventories and that a high or low uncertainty assessed will not affect the justice of an inventory nor result in the comparison of accuracy among parties' inventories.

Japan considered uncertainty of its inventory in the Committee for the Greenhouse Gases Emissions Estimation Methods in FY 2001 and again in FY 2006. Japan has annually conducted uncertainty assessment based on the Committee's results since then.

This document will be used as a guideline for conducting the uncertainty assessment of Japan's inventories. It may be subjected to be adjusted as appropriate.

A7.1.2. Overview of Uncertainty Assessment Indicated in the Good Practice Guidance

A7.1.2.1. About Uncertainty Assessment

A7.1.2.1.a. What is uncertainty?

- The term "uncertainty" refers to the degree of discrepancy in various data in comparison with a true value, stemming from number of characteristics with lack of sureness including representational reliability of measurements, and it is a concept that is much broader than that of accuracy.
- The uncertainty of emissions from a particular source is obtained by calculating and applying the uncertainty associated with the source's emission factor, and the uncertainty of activity data.
- The *Good Practice Guidance* requires uncertainty of emissions from a source to be calculated using the method given below.

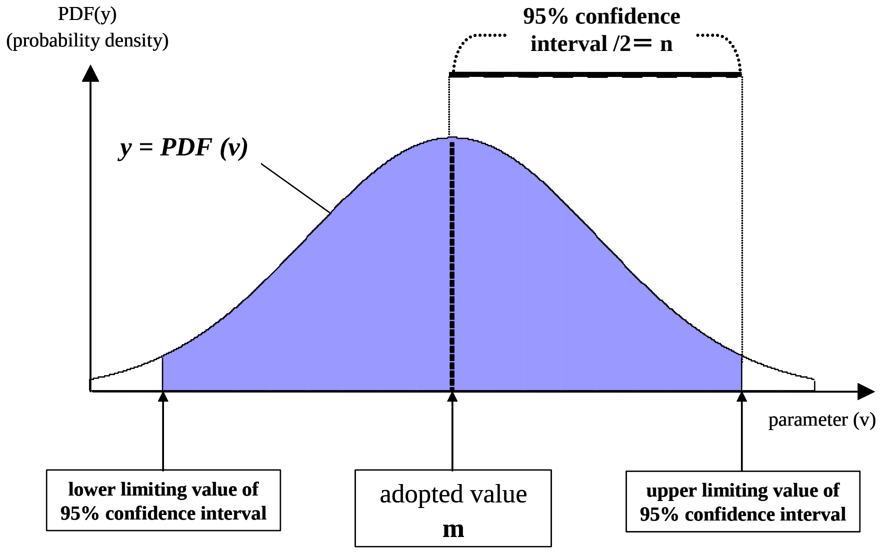
$$U = \sqrt{{U_{EF}}^2 + {U_A}^2}$$

U : Uncertainty of the emissions of the source (%)
U_{EF} : Uncertainty of the emission factor (%)
U_A : Uncertainty of the activity data (%)

A7.1.2.1.b. Methodology of identifying the uncertainties of emission factors and activity data of each source

- The standard deviations of the observed values of an emission factor are used to set the probability density function, and uncertainty is assessed by seeking a 95 percent confidence interval.

$$\text{Uncertainty of EF or A} = \frac{\text{95\% confidential interval / 2 (n)}}{|\ \text{Adopted Value of EF or A (m)}\ |}$$



A7.1.2.1.c. Method of determining the uncertainty of total national emissions

- By combining the uncertainties of emissions from all sources, it is possible to assess the uncertainty of Japan’s total inventory.
- When there is no correlation between multiple uncertainties, and they are normally distributed, the *Good Practice Guidance* suggests two rules of expedience that relate to combining method (addition and multiplication) of uncertainties. This report adopts Rule A, given in Table 6.1 of the *Good Practice Guidance*, for the calculations.

$$U_{Total} = \frac{\sqrt{(U_1 \times E_1)^2 + (U_2 \times E_2)^2 + \cdots + (U_n \times E_n)^2}}{E_1 + E_2 + \cdots + E_n}$$

U_{Total} : Uncertainties of National Total Emissions (%)
U_i : Uncertainties of the Emissions from Source “ i ” (%)
E_i : the Emissions from Source “ i ” (Gg)

A7.1.2.2. 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 the reasons of uncertainty in emission factors or activity data.

Examples of common reasons of uncertainty in emission factors
➢ Uncertainties associated with a continuous monitoring of emissions - Refers to uncertainties arising from differences in conditions at the time of measurement, such as measurements that are taken annually.
➢ Uncertainties associated with an establishment of emission factors - Startup and shutdown in operation of machinery, etc., can give different emission rates relative to activity data. In these cases, the data should be partitioned, with separate emission factors and probability density functions derived for steady-state, startup and shutdown conditions. - Emission factors may depend on load of operation. In these cases, the estimation of total

emissions and the uncertainty analysis may need to be stratified to take account of load, which is expressed, for example, as a percentage of full capacity. This could be done by the regression analysis and scatter plots of the emission rate against seemingly influential variables (e.g., emissions versus load) with load becoming a part of the required activity data.

- Adoption of results from measurements taken for other purposes may not be representative. For example, methane measurements made for safety reasons at coalmines and landfills may not reflect total emissions. In such cases, the ratio between the measured data and total emissions should be estimated for the uncertainty analysis.

- ➢ Uncertainties associated with an estimation of emission factors from limited measured data
  - The distribution of emission factors may often differ from the normal distribution. When the distribution is already known, it is appropriate to estimate according to expert judgment, by appending a document that provides the theoretical background.

Examples of common reasons of uncertainty in activity data

- ➢ Interpretation of statistical differences: Statistical differences in energy balances usually represent a difference between amounts of primary fuels and amounts of fuels identified in the categories under ‘final consumption’ and ‘in transformation’. They can give an indication of sizes of the uncertainties of the data, especially where long time series are considered.
- ➢ Interpretation of energy balances: Production, use, and import/export data should be consistent. If not, this may give an indication of the uncertainties.
- ➢ Crosschecks: It may be possible to compare two types of activity data that apply to the same source to provide an indication of uncertainty ranges. For example, the sum of vehicle fuel consumption should be commensurate with the total of fuel consumption calculated by multiplying vehicle-km by fuel consumption efficiency for all types of vehicles.
- ➢ Vehicle numbers and types: Some countries maintain detailed vehicle registration databases with data on vehicles by type, age, fuel type, and emission control technology, all of which can be important for a detailed bottom-up inventory of methane (CH_4) and nitrous oxide (N_2O) emissions from such vehicles. Others do not have such detailed information and this will tend to increase the uncertainty.
- ➢ Smuggling of fuel across borders: Imported fuel and the sum of sectoral fuel consumption may be compared as a crosscheck.
- ➢ Biomass fuels: Where formal markets for these fuels do not exist, consumption estimates may be much less accurate than for fuels in general.
- ➢ Livestock population data: Accuracy will depend on the extent and reliability of national census and survey methods, and there may be different accounting conventions for animals that do not live for a whole year.

A7.1.2.3. Methodology of Uncertainty Assessment

The *Good Practice Guidance* suggests that uncertainty is assessed through expert judgment and actual data with consideration to the sources of uncertainty indicated in section above.

A7.1.3. Methodology of Uncertainty Assessment in Japan’s Inventories

A7.1.3.1. Principle of Uncertainty Assessment

The following method of uncertainty assessment is used, with regard for both convenience of the compilation and suggestions made in the *Good Practice Guidance*, in a manner that as far as possible ensures there is no deviation from assessment standards among categories.

A7.1.3.2. Separation between Emission Factors and Activity Data

The equation for estimating emissions from individual sources is generally represented as follows.

E (Emissions) = EF (Emission Factor) × A (Activity Data)

There are sources of emissions, however, where emissions are derived from stochastic equations comprising three or more parameters, and it becomes unclear which combination of parameters should be deemed as the emission factor and the activity data.

In such cases, emission factor and activity data are basically defined in accordance with the concept of emission factor described in the *Enforcement Ordinance for the Law Concerning the Promotion of Measures to Cope with Global Warming* (March 1999).

Example: A stochastic equation comprising three or more parameters

- Emission source: Methane emissions from a waste burial site (food scraps)
- Stochastic equation :

Volume of emissions from the source
= Carbon content in food scraps × Gas conversion rate of food scraps
× Proportion of methane in generated gas × 16/12
× Food scraps broken down during the basic period of calculation, expressed in tons

= (*Emission Factor*: Carbon content of food scraps
× Gas conversion rate of food scraps
× Proportion of methane in gas generated × 16/12)
× (*Activity Data*: Food scraps broken down during the basic period of calculation, expressed in tons)

A7.1.3.3. Uncertainty Assessment of Emission Factors

The uncertainty of emission factors is assessed using the following decision tree.

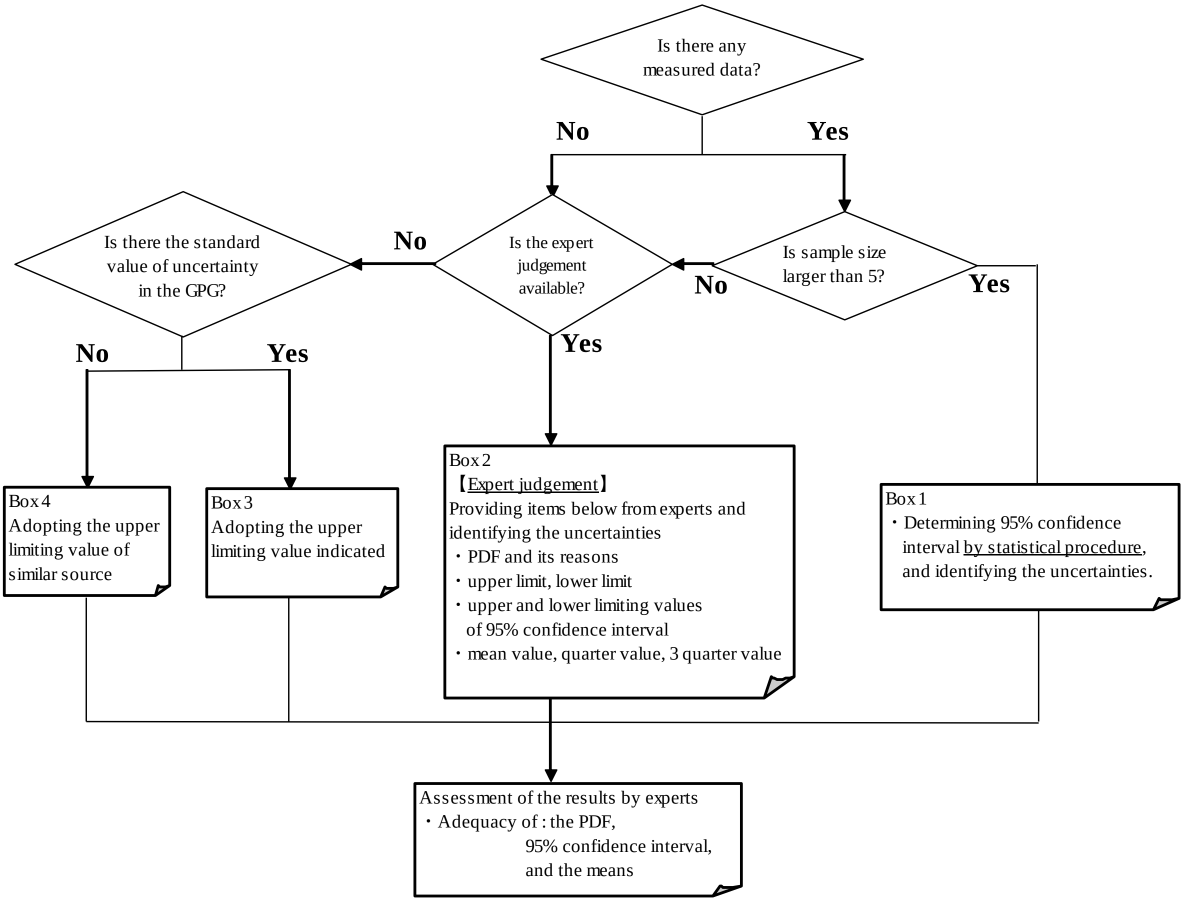


Figure A7-1 Decision tree for assessing uncertainty associated with emission factors established by the *Committee for the GHGs Emissions Estimation Methods*

- ➢ If an appropriate assessment cannot be made using the decision tree above, it may be done using a method that has been considered and deemed as appropriate. In such cases, the reason why an appropriate assessment could not be achieved using the decision tree, and the method applied, will both need to be clearly explained.

A7.1.3.3.a. Case where there is measurement data with five or more samples (Box 1)

Where data from actual measurements is available and there are five or more[1] samples, uncertainty is assessed quantitatively in accordance with the guidelines below.

Guidelines for assessment of uncertainty associated with emission factors
Guideline 1 Where data from actual measurements is available and there are five or more samples, the central limit theorem says that the distribution of averages will follow a normal distribution curve. Assuming that all averages $\bar{x}$ and standard deviations $\sigma / \sqrt{n}$ follow a normal distribution curve, uncertainty need to be assessed on the basis of the data used to establish the emission factor only.

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[1] The *Good Practice Guidance* cites "adequate samples", but for convenience, the Secretariat of *Committee for the GHGs Estimation Methods* suggests the use of five or more.

Guideline 2

In assessing uncertainty, it is assumed that systematic error inherent to individual items of data is already a factor in the distribution. Therefore, systematic error inherent to individual items of data need not be investigated.

Guideline 3

Items that may contribute to uncertainty, but which may not be readily quantitatively assessable, should be recorded for the future investigation. If, through expert judgment, it is possible to estimate their uncertainty, the uncertainty shall be estimated in accordance with expert judgment.

a） When it is not possible to use statistical methods to derive the distribution of data used in calculating emission factors

1） Emission factor has been established by calculating a simple average of the sample data

Where the emission factor has been calculated using a simple average, it is assumed that the data used in calculating the emission factor follows a normal distribution curve. Therefore, the standard deviation of the sample is divided by the square root of the number of samples to estimate the standard deviation of the emission factor σ_{EF}, and uncertainty is calculated by finding the 95 percent confidence interval in accordance with Equation 1.1.

$$Uncertainty\,of\ Emission\,Factor(\%) = \frac{1.96 \times \sigma_{EF}}{|EF|} \quad \text{... Equation 1.1.}$$

σ_{EF} : Standard Deviation of Average
EF : Emission Factor

2） Emission factor has been calculated using a weighted average of the sample data

Where the emission factor has been derived using a weighted average of the sample data, it is assumed that the data used in calculating the emission factor follows a normal distribution.

Therefore, the standard deviation σ_{EF} of the sample is derived using the equation below. Uncertainty is calculated by finding the 95 percent confidence interval of the averages in accordance with Equation 1.1. Note that the equation does not account for the uncertainty of weights wi.

The weight applied in the weighted average, wi ($\sum wi = 1$)
Sample averages : $EF = \sum (wi \times EFi)$
Unbiased variance of sample averages :

$$\sigma_{EF}^2 = \sum \left\{ w_i \times \left(EF_i - \overline{EF} \right)^2 \right\} / \left(1 - \sum w_i^2 \right) \times \sum w_i^2$$

b） When the distribution of data used in calculating emission factor is derived using statistical methods

When it is possible to derive the distribution of data used in calculating the emission factor by using statistical methods, it is assumed that the data follows a normal distribution, and the uncertainty of each piece of data is estimated on the basis of section “*a) When it is not possible to use statistical methods to derive the distribution of data used in calculating emission factors*”. The uncertainty of each piece of data is then determined using Equation 1.2, and the standard deviation of the emission factor σ_{EF} is calculated, to obtain the uncertainty.

When weight averaging is done to obtain at emission factors, the emission factor *EF* is expressed as follows, where the emission factor of each sub-category is EF_i, the weight variable is A_i, and the total of weight variables is *A*.

$$EF = \frac{\sum_i EF_i \times A_i}{\sum_i A_i} = \frac{\sum_i EF_i \times A_i}{\mathrm{A}}$$

Substituting the distribution of the emission factor *EF*, σ_{EF}^2, and the distributions of the individual emission factors EF_i and individual weight variables A_i, σ_{EFi}^2 and σ_{Ai}^2, then σ_{EF}^2 is calculated as follows, using an equation known as the Error Propagation Equation.

$$\sigma_{EF}^{2} = \sum_i \left\{ \left(\frac{\partial EF}{\partial EF_i} \right)^2 \sigma_{EFi}^{2} + \left(\frac{\partial EF}{\partial A_i} \right)^2 \sigma_{Ai}^{2} \right\} = \sum_i \left\{ \frac{A_i^2}{A^2} \sigma_{EFi}^{2} + \frac{\left(EF_i - EF\right)^2}{A^2} \sigma_{Ai}^{2} \right\}$$

... Equation 1.2.

Thus, the uncertainty of the emission factor U is obtained using the following equation.

$$U = \frac{1.96 \times \sigma_{EF}}{|\ EF\ |}$$

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.

A7.1.3.3.b. Case where there is no actual measurement data, or there are less than five samples

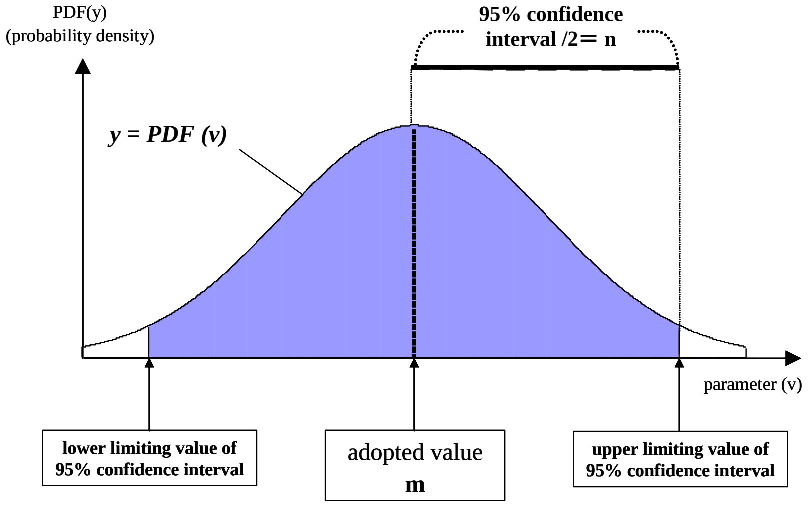
When there is no actual measurement data, or there are less than five samples, uncertainty shall be assessed by expert judgment.

a） When expert judgment is feasible (Box 2)

1） When the distribution of the probability density function of emission factors can be obtained using expert judgment

In this case, uncertainty should be assessed in accordance with expert judgment for the following. The expert providing the expert judgment, the basis for their decision, and factors contributing to uncertainty that are excluded from consideration, should be documented, and the document should be retained.

- Distribution and evidence
- Upper and lower limiting values
- Upper and lower limiting values of the 95% confidence interval
- Mean, first, and third quartile values



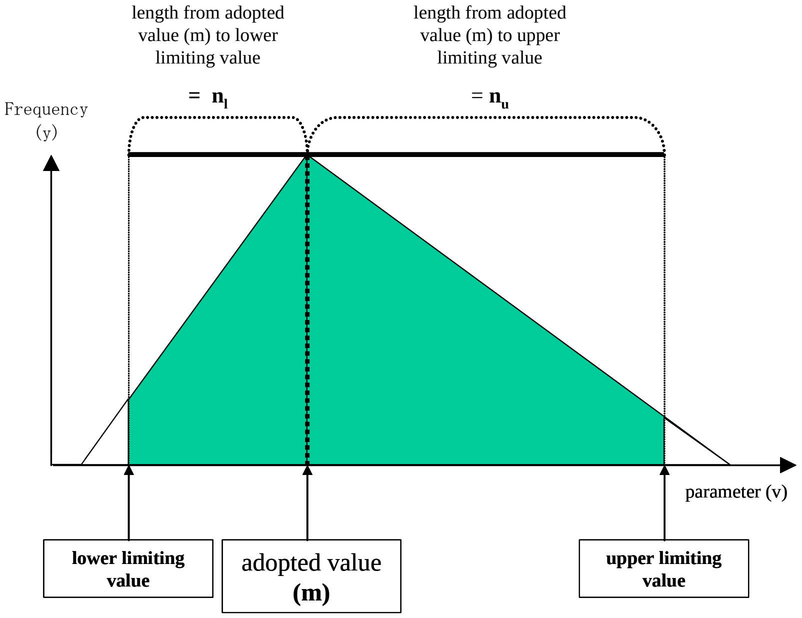
$$\text{Uncertainty of EF or A} = \frac{\text{95\% confidential interval / 2 (n)}}{|\text{ Adopted Value of EF or A (m) }|}$$

2） *When the distribution of the probability density function of emission factors cannot be obtained using expert judgment*

Ask an expert for the upper and lower limiting values appropriate to emission factors in Japan, and draw a triangular distribution for the emission factors 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 used is larger than the upper limiting value, the emission factor should be used as the upper limiting value. If the emission factor used is smaller than the lower limiting value, the emission factor should be used as the lower limiting value.

The expert providing the expert judgment, the basis for their decision, and factors contributing to uncertainty that are excluded from consideration, should be documented, and the document should be retained.



Uncertainty in this context is calculated using the following equation.

Uncertainty to the lower limiting value U_l (%)
= – {distance to lower limiting value (n_l)/mode (m)}

Uncertainty to the upper limiting value U_u (%)
= + {distance to upper limiting value (n_u)/mode (m)}

Uncertainty is expressed in the form, –○% to +●%, but in assessing overall uncertainty for Japan, the largest absolute value should be used.

b） *When expert judgment is not possible*

1） *A standard value for uncertainty is provided in the Good Practice Guidance (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 safe side, 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	
1.A. CO_2	5％
1.A. CH_4, N_2O	3％～10％
1.A.3. Transport(CH_4, N_2O)	5％
2. Industrial Processes	
Excluding HFCs, PFCs, SF_6	1％～100％
HFCs, PFCs, SF_6	5％～50％
3. Solvent and Other Product Use	-*
4. Agriculture	2％～60％
5. Land Use Change and Forestry	-**
6. Waste	5％～100％

* Category 3: The use of organic solvents and other such products are not dealt within the GPG (2000).

** Category 5: Changes in land use and forestry are not dealt with in the GPG (2000).

A7.1.3.3.c. Methods for Combining Uncertainties of Emission Factors

The basic method for combining uncertainties is Tier 1 in the *Good Practice Guidance*. When a correlation between elements is strong, uncertainties may be combined using the Monte Carlo method (Tier 2 in the *Good Practice Guidance*).

a） *Uncertainty of emission factor derived from a combination of multiple parameters*

The uncertainty of an emission factor may be obtained at from the uncertainty of multiple parameters using the equation given below, in situations of the type described in the example in Section A7.1.3.2..

$$U_{EF} = \sqrt{U_1^2 + U_2^2 + \cdots + U_n^2}$$

U_{EF} : Uncertainties of Emission Factors (%)
U_i : Uncertainties of Parameter “i” (%)

A7.1.3.4. Uncertainty Assessment of Activity Data

The uncertainty of activity data is assessed in accordance with the decision tree depicted below.

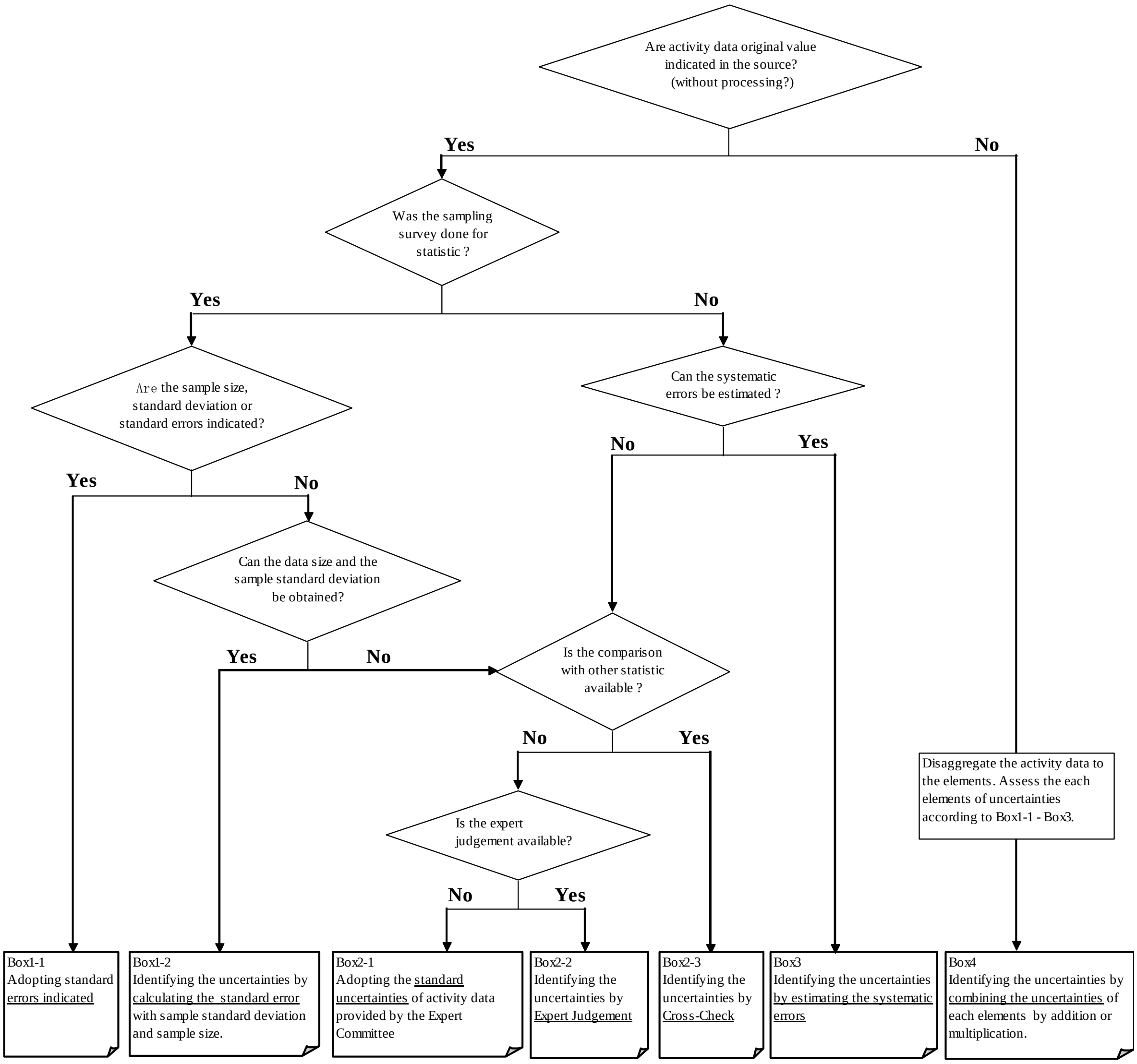


Figure A7-2 Decision tree for assessing uncertainty associated with activity data established by the *Committee for the GHGs Emissions Estimation Methods*

- If an appropriate assessment cannot be made using the decision tree above, it may be done using a method that has been considered and deemed as appropriate. The reason why an appropriate assessment could not be achieved using the decision tree, and the method applied, will both need to be clearly explained.

A7.1.3.4.a. Using statistical values for activity data

When using statistical values for activity data, uncertainty should be quantitatively assessed in accordance with the following guidelines.

Guidelines for assessment of uncertainty associated with activity data
Guideline 1 Only the sample error needs to be considered as part of uncertainty assessment in sample surveys.

Guideline 2

In situations other than sample surveys, if it is possible to estimate a systemic error, it should be considered as part of an uncertainty assessment.

Guideline 3

In situations other than sample surveys, if it is not possible to estimate a systemic error, uncertainty should be assessed through crosschecks, or by expert judgment.

Guideline 4

Where quantitative assessment is difficult, factors that would contribute to uncertainty should be recorded for a future investigation.

a） Statistical values based on a sample survey

1） The publisher has made errors public (Box 1-1)

When the publisher of a statistical document has made the sampling errors public in the sample survey, it should be used as the uncertainty of the activity data.

2） The publisher has not made errors public (Box 1-2)

Enquire the publisher of the statistical document for the size of the sample, the sample average, and the standard deviation of the sample. Under the assumption that the distribution of the sample reproduces the distribution of the population, assessment of uncertainty from the statistical values should be done.

$$Uncertainty\ U = \left(1.96 \times s / \sqrt{n}\right) / X_{ad}$$

X_{ad} : Sample average
S : Standard deviation of sample
n : Number of items of data

If, however, distribution is asymmetrical, the uncertainty U is calculated by dividing the difference between the value of the 95 percent confidence limit furthest from X_{ad} and the average value, by X_{ad}.

Confirmation of the estimation method for Japan from values drawn from the sample survey and, as far as possible, estimation of the uncertainty associated with the estimation method should be done also (e.g., multiply the sample average of the number of head of livestock raised per farm by the number of farms).

3） Amount of data and sample standard deviation are not available, and crosschecking is possible (Box 2-3)

In the case of statistics drawn from a sample survey, where the amount of data and the sample standard deviation are not available, but it is possible to compare the relevant statistical value with multiple other statistical values, uncertainty should be assessed using the same means as in the second case described at section A1.2.3 in the page A1.7 of the *Good Practice Guidance*.

$$Uncertainty\ U = \left(1.96 \times s\right) / X_{ap}$$

X_{ap} : Value used for activity data
s : Standard deviation (data to be cross-checked)

However, if a distribution is asymmetrical, the uncertainty U may be calculated by dividing the difference between the value of the 95 percent confidence limit furthest from X_{ap} and the average value, by X_{ap}.

Also, when there is a single other statistical value only, the assessment should be done using the same method described at 2) “When the distribution of the probability density function of emission factors cannot be obtained using expert judgment” in *Section 7.1.3.3.b.*.

4） *Amount of data and sample standard deviation are not available, and expert judgment is available (Box 2-2)*

In the case of statistics drawn from a sample survey where the amount of data and sample standard deviation are not available, ask an expert for the upper and lower limiting values appropriate to activity data in Japan, and draw a triangular distribution for activity data (see diagram at Section A7.1.3.3.b.) 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 should be taken as the lower limiting value.

The experts providing the expert judgment, the basis for their decision, and factors contributing to uncertainty that are excluded from consideration, should be documented, and the document should be retained.

5） *Amount of data and sample standard deviation are not available, and expert judgment is unavailable (Box 2-1)*

The following standard values established by the *Committee for the GHGs Emissions Estimations Methods* will be used.

Table A7-1 Uncertainty of sample statistics established by the Committee for the GHGs Emissions Estimation Methods

	Fundamental statistics	Other statistics
Sample survey	50 [%]	100 [%]

The values for fundamental 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 fundamental statistics have been deemed to be twice the fundamental statistics.

b） *Statistical values not based on a sample survey*

1） *Systemic error can be estimated (Box 3)*

Where a systemic error can be estimated, it should be estimated and used. The method by which the systemic error is calculated should be documented, and the document should be retained.

2） *Systemic error cannot be estimated, and crosschecking is possible (Box 2-3)*

Where systemic error cannot be estimated, but it is possible to compare the relevant statistical value with other statistical values, uncertainty should be assessed using the same means as in Case 2 described at A1.2.3 of Section A1.7 of the *Good Practice Guidance*.

3） Systemic error cannot be estimated, crosschecking is not possible, and expert judgment is available (Box 2-2)

Same as for "*4) Amount of data and sample standard deviation are not available, and expert judgment is available (Box 2-2)*" in Section 7.1.3.4.a.

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 A7-2 Uncertainty of sample statistics established by the Committee for the GHGs Emissions Estimation Methods

	Fundamental statistics	Other statistics
Survey of total population (no rounding)	5 [%]	10 [%]
Survey of total population (rounding)	20 [%]	40 [%]

The values for fundamental 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 fundamental statistics have been deemed to be twice the fundamental statistics.

A7.1.3.4.b. Using statistical values processed as activity data (Box 3)

a） Breakdown of each element of activity data and assessment

Activity data should be broken down as shown in the following example.

- Emission source : CO_2 emission from incineration of naphtha in the chemical industry
- Stochastic equation :

Activity data for relevant emission source
= Naphtha consumption × 20% (remaining 80% is fixed in the product) [2]
- ammonia raw material

After being broken down, each element of the statistical values should be assessed for uncertainty using the method shown at section "*7.1.3.4.a. Using statistical values for activity data*".

In the example above, for elements based on survey research, such as the figure of 20%, uncertainty should be assessed on the basis of the method shown at section "*7.1.3.3. Uncertainty Assessment of Emission Factors*".

b） Combining elements

Combine each element using the sum and product methods of combination, and assess the uncertainty.

- Sum method (Rule A): Where uncertainty quantities are to be combined by addition.
  Activity data is expressed as $A_1 + A_2$

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[2] Environmental Agency, *The Estimation of CO_2 Emission in Japan*, 1992

$$U_{A\text{-}total} = \frac{\sqrt{(U_{A1} \times A_1)^2 + (U_{A2} \times A_2)^2}}{A_1 + A_2}$$

U_{An} : Uncertainty of element An (%)

- Product method: Where uncertainty quantities are to be combined by multiplication. Activity data is expressed as $A_1 \times A_2$

$$U_A = \sqrt{U_{A1}^2 \times U_{A2}^2}$$

U_{An} : Uncertainty of element An (%)

A7.1.3.5. Uncertainty Assessment of Emissions

A7.1.3.5.a. Uncertainty assessment of emissions from individual emission sources

1） Emissions estimated from emission factor and activity data

Use the product combination equation given at Tier 1 of the *Good Practice Guidance* on the results of emission factor assessment from the previous section and the activity data, and assess the uncertainty of emissions from each emission source.

$$U_{Ei} = \sqrt{U_{EFi}^2 + U_{Ai}^2}$$

U_{Ei} : Uncertainty of emissions from emission source *i* (%)
U_{EFi} : Uncertainty of element An (%)
U_{Ai} : Uncertainty of element An (%)

2） Actual measurements taken of emissions

When emissions are derived from actual measurement, uncertainty of emissions should be assessed directly, in accordance with “*7.1.3.3. Uncertainty Assessment of Emission Factors*”.

A7.1.3.5.b. Calculating uncertainty of total emissions

Combine the results of assessments of emission uncertainty for multiple emission sources to assess the uncertainty of total Japanese emissions of greenhouse gases. The uncertainty of emissions from multiple sources should be combined using the product combination equation given at Tier 1 in the *Good Practice Guidance*.

$$U_{Total} = \frac{\sqrt{(U_1 \times E_1)^2 + (U_2 \times E_2)^2 + \cdots + (U_n \times E_n)^2}}{E_1 + E_2 + \cdots + E_n}$$

U_{Total} : Uncertainty of total Japanese emissions (%)
U_i : Uncertainty of emission source i (%)
E_i : Emissions from emission source i (Gg)

When the uncertainties of emissions from multiple sources are combined, only the uncertainty of emissions should be indicated. Combination of the uncertainties for both emission factor and activity data should not be done.

A7.2. Results of Uncertainty Assessment

A7.2.1. Assumption of Uncertainty Assessment

Uncertainty Assessment is basically conducted based on the results of uncertainty assessment in

Committee for the Greenhouse Gases Emissions Estimation Methods in FY 2006.

A7.2.2. Uncertainty of Japan's Total Emissions

In FY 2009, total net emissions in Japan were approximately 1,138 million tons (carbon dioxide equivalents). Uncertainty of total net emissions has been assessed at 2% and uncertainty introduced into the trend in total net emissions has been assessed at 1%.

Table A7-3 Uncertainty of Japan's Total Net Emissions

IPCC Category	GHGs	Emissions / Removals [Gg-CO_2 eq.]		Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions[1)]	rank
		A	[%]	B		C	
1A. Fuel Combustion (CO_2)	CO_2	1,089,728.4	90.1%	1%	10	0.74%	2
1A. Fuel Combustion (Stationary:CH_4,N_2O)	CH_4、N_2O	5,077.1	0.4%	27%	4	0.12%	8
1A. Fuel Combustion (Transport:CH_4,N_2O)	CH_4、N_2O	2,852.9	0.2%	351%	1	0.88%	1
1B. Fugitive Emissions from Fuels	CO_2、CH_4、N_2O	429.5	0.0%	19%	5	0.01%	9
2. Industrial Processes (CO_2,CH_4,N_2O)	CO_2、CH_4、N_2O	41,977.7	3.5%	7%	7	0.26%	7
2. Industrial Processes (HFCs,PFCs,SF_6)	HFCs、PFCs、SF_6	21,794.5	1.8%	31%	3	0.60%	4
3. Solvent & other Product Use	N_2O	120.5	0.0%	5%	9	0.00%	10
4. Agriculture	CH_4、N_2O	25,402.1	2.1%	18%	6	0.40%	5
5. LULUCF	CO_2、CH_4、N_2O	-71,523.5	-5.9%	5%	8	0.32%	6
6. Waste	CO_2、CH_4、N_2O	21,830.5	1.8%	34%	2	0.65%	3
Total Net Emissions	(D)	1,137,689.7		(E) [2)] **2%**			

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

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

Hereafter, the same method for calculating uncertainty assessment has been used in each sector appearing in Table A7-4 and the following tables.

A7.2.3. Energy Sector

A7.2.3.1. Fuel Combustion (CO_2)

Carbon-Hydrogen ratio of hydrocarbons is strongly correlating with calorific value in theory, then, standard deviation of sample data of each fuel's calorific value are used for uncertainty assessment based on assumption that deviation of carbon content and that of calorific value is equal. The uncertainty of energy consumption in TJ given in the *General Energy Statistics* was assessed based on the given statistical error of solid fuels, liquid fuels, and gaseous fuels, since it was difficult to set uncertainty by fuel types and industry.

Table A7-4 Results of uncertainty assessment of fuel combustion (CO_2)

IPCC Category			GHGs	Emissions / Removals [Gg-CO_2 eq.] A	EF/RF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B 3)	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion	Solid Fuels	Steel Making Coal	CO_2	12,106.3	3.5%	1.2%	4%	19	0.04%	16
		Steam Coal (imported)	CO_2	238,984.7	2.0%	1.2%	2%	31	0.49%	**1**
		Steam Coal (indigenous)	CO_2	0.0	2.0%	1.2%	2%	31	0.00%	38
		Hard Coal	CO_2	0.0	4.5%	1.2%	5%	16	0.00%	38
		Coke	CO_2	87,691.2	1.7%	1.2%	2%	39	0.16%	6
		Coal Tar	CO_2	1,694.0	5.0%	1.2%	5%	14	0.01%	28
		Coal Briquette	CO_2	0.0	5.0%	1.2%	5%	14	0.00%	38
		Coke Oven Gas	CO_2	13,336.0	2.0%	1.2%	2%	31	0.03%	20
		Blast Furnace Gas	CO_2	38,235.1	3.8%	1.2%	4%	17	0.13%	7
		Converter Furnace Gas	CO_2	9,494.7	2.9%	1.2%	3%	20	0.03%	21
	Liquid Fuels	Crude Oil for Refinery	CO_2	0.0	0.8%	2.3%	2%	26	0.00%	38
		Crude Oil for Power Generation	CO_2	9,893.3	0.9%	2.3%	2%	25	0.02%	24
		Vitumous Mixture Fuel	CO_2	0.0	0.4%	2.3%	2%	30	0.00%	38
		NGL & Condensate	CO_2	100.5	1.6%	2.3%	3%	21	0.00%	36
		Naphtha	CO_2	473.2	0.1%	2.3%	2%	34	0.00%	31
		Reformed Material Oil	CO_2	0.0	0.1%	2.3%	2%	34	0.00%	38
		Gasoline	CO_2	133,370.8	0.03%	2.3%	2%	38	0.27%	**3**
		Jet Fuel	CO_2	12,989.7	1.0%	2.3%	3%	24	0.03%	19
		Kerosene	CO_2	47,943.0	0.05%	2.3%	2%	37	0.10%	10
		Gas Oil or Diesel Oil	CO_2	83,261.0	1.2%	2.3%	3%	23	0.19%	**4**
		Heating Oil A	CO_2	45,194.4	1.5%	2.3%	3%	22	0.11%	9
		Heating Oil B	CO_2	53.4	5.0%	2.3%	6%	10	0.00%	35
		Heating Oil C	CO_2	54,837.2	0.6%	2.3%	2%	27	0.11%	8
		Lubricating Oil	CO_2	191.3	5.0%	2.3%	6%	10	0.00%	32
		Asphalt	CO_2	10,482.3	0.6%	2.3%	2%	27	0.02%	23
		Non Asphalt Heavy Oil Products	CO_2	0.0	0.6%	2.3%	2%	27	0.00%	37
		Oil Coke	CO_2	12,635.5	5.0%	2.3%	6%	10	0.06%	12
		Galvanic Furnace Gas	CO_2	123.6	2.9%	2.3%	4%	18	0.00%	33
		Refinary Gas	CO_2	33,897.6	5.0%	2.3%	6%	10	0.16%	**5**
		LPG	CO_2	27,005.6	0.1%	2.3%	2%	34	0.05%	13
	Gaseous Fuels	LNG	CO_2	118,336.9	0.1%	0.3%	0%	42	0.03%	17
		Indigenous Natural Gas	CO_2	2,403.8	0.6%	0.3%	1%	40	0.00%	30
		Town Gas*	CO_2	79,430.3	0.5%	0.3%	1%	41	0.04%	15
		Small Scale Town Gas*	CO_2	1,172.8	0.1%	0.3%	0%	42	0.00%	34
	Other Fuels	Municipal Solid Waste (Plastics)	CO_2	5,692.0	4.3%	16.0%	17%	6	0.08%	11
		Municipal Solid Waste (Waste textile)	CO_2	1,114.7	4.3%	22.4%	23%	**5**	0.02%	22
		Industrial Solid Waste (Waste Mineral Oil)	CO_2	100.9	4.8%	104.4%	105%	**1**	0.01%	27
		Industrial Solid Waste (Plastics)	CO_2	360.1	4.8%	100.0%	100%	**3**	0.03%	18
		Raw material and fuel use of MSW	CO_2	410.6	4.3%	16.0%	17%	6	0.01%	29
		Raw material and fuel use of ISW (Waste Mineral Oil)	CO_2	2,955.3	4.8%	104.4%	105%	**1**	0.27%	**2**
		Raw material and fuel use of ISW (Waste Plastics)	CO_2	1,418.5	4.8%	12.3%	13%	9	0.02%	25
		Raw material and fuel use of Waste tire	CO_2	946.0	4.8%	14.5%	15%	8	0.01%	26
		Fuel use of RDF and RPF	CO_2	1,392.2	42.6%	10.6%	44%	**4**	0.05%	14
	Sub Total			1,089,728.4			1%		0.74%	
Total Emissions			（D）	1,137,689.7			2%			

* Reported in Gaseous Fuels according to the main material; LNG

3) $B = \sqrt{a^2 + b^2}$ (Hereafter, the same method has been used in each sector appearing in TableA7-5 and following)

A7.2.3.2. Stationary Combustion (CH_4 and N_2O)

Table A7-5 Results of uncertainty assessment of fuel combustion

IPCC Category			GHGs	Emissions / Removals [Gg-CO_2 eq.] A	EF/RF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (Stationary)			CH_4	561.6	— 4)	— 4)	47%	12	0.02%	2
			N_2O	4,083.3	— 4)	— 4)	33%	15	0.12%	1
C. Waste Incineration	Municipal Solid Waste		CH_4	2.5	—	—	101%	7	0.00%	10
			N_2O	293.6	—	—	42%	13	0.01%	**3**
	Industrial Solid Waste		CH_4	0.2	111.5%	100.0%	150%	**2**	0.00%	15
			N_2O	3.1	58.8%	100.0%	116%	**4**	0.00%	6
	Raw material and fuel use of MSW		CH_4	0.0	179.4%	10.0%	180%	**1**	0.00%	18
			N_2O	0.0	111.2%	10.0%	112%	**5**	0.00%	17
	Raw material and fuel use of ISW	Waste Oil（total)	CH_4	0.5	—	—	74%	10	0.00%	8
			N_2O	11.4	—	—	41%	14	0.00%	11
		Waste Plastics	CH_4	3.5	91.7%	10.0%	92%	8	0.00%	14
			N_2O	4.6	29.7%	10.0%	31%	17	0.00%	7
		Waste Wood	CH_4	84.2	80.2%	100.0%	128%	**3**	0.01%	**4**
			N_2O	14.1	45.3%	100.0%	110%	6	0.00%	**5**
	Raw material and fuel use of Waste tire		CH_4	1.1	—	—	91%	9	0.00%	13
			N_2O	5.1	—	—	26%	18	0.00%	12
	Fuel use of RDF and RPF		CH_4	0.3	—	—	49%	11	0.00%	16
			N_2O	8.0	—	—	33%	16	0.00%	9
Sub Total				5,077.1			27%		0.12%	
Total Emissions			（D）	1,137,689.7			2%			

4) Because “—” means aggregation of detailed sub-categories, uncertainties of EF/RF and AD can not be calculated for this level of disaggregation of categories.

A7.2.3.3. Mobile Combustion (CH_4 and N_2O)

Table A7-6 Results of uncertainty assessment of mobile combustion (CH_4 and N_2O)

IPCC Category		GHGs	Emissions / Removals [Gg-CO2eq.] A	EF/RF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A.Fuel Combustion (Transport)	a. Civil Aviation	CH_4	4.6	200.0%	10.0%	200%	**4**	0.00%	6
		N_2O	98.3	10000.0%	10.0%	10000%	**1**	0.86%	**1**
	b. Road Transportation	CH_4	159.5	40.0%	50.0%	64%	6	0.01%	**4**
		N_2O	2,404.9	50.0%	50.0%	71%	**5**	0.15%	**2**
	c. Railways	CH_4	0.7	—	—	14%	7	0.00%	8
		N_2O	76.8	—	—	11%	8	0.00%	7
	d. Navigation	CH_4	20.7	200.0%	13.0%	200%	**3**	0.00%	**5**
		N_2O	87.4	1000.0%	13.0%	1000%	**2**	0.08%	**3**
	Sub Total		2,852.9			351%		0.88%	
Total Emissions		（D）	1,137,689.7			2%			

(Note) CO_2 emissions from 1A Fuel Combustion (Transport) have been reported in Table A7-4.

A7.2.3.4. Fugitive Emissions from Fuel

Table A7-7 Results of uncertainty assessment of fugitive emissions from fuel

IPCC Category					GHGs	Emissions / Removals [Gg-CO_2eq.] A	EF/RF 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	CH_4	15.3	—	—	5%	24	0.00%	12
				Post-Mining Activities	CH_4	19.8	200.0%	10.0%	200%	**1**	0.00%	**2**
			ii. Surface Mines	Mining Activities	CH_4	10.2	200.0%	10.0%	200%	**1**	0.00%	**3**
				Post-Mining Activities	CH_4	0.9	200.0%	10.0%	200%	**1**	0.00%	11
	2. Oil and Natural Gas	a. Oil		i. Exploration	CO_2	0.02	25.0%	10.0%	27%	7	0.00%	20
					CH_4	0.02	25.0%	10.0%	27%	6	0.00%	21
					N_2O	0.00007	25.0%	10.0%	27%	**4**	0.00%	24
				ii. Production	CO_2	0.08	25.0%	5.0%	25%	9	0.00%	17
					CH_4	9.4	25.0%	5.0%	25%	9	0.00%	9
				iii. Transport	CO2	0.0051	25.0%	5.0%	25%	9	0.00%	22
					CH_4	1.6	25.0%	5.0%	25%	9	0.00%	14
				iv. Refining / Storage	CH_4	14.4	25.0%	0.9%	25%	23	0.00%	7
		b. Natural Gas		ii. Production / Processing	CO_2	0.4	25.0%	5.0%	25%	9	0.00%	16
					CH_4	272.5	25.0%	5.0%	25%	9	0.01%	**1**
				iii. Transmission	CH_4	23.0	25.0%	10.0%	27%	**4**	0.00%	**4**
				iv. Distribution	CH_4	15.5	25.0%	8.7%	26%	8	0.00%	6
		c. Venting and Flaring	Venting	i. oil	CO_2	0.0	25.0%	5.0%	25%	9	0.00%	23
					CH_4	9.0	25.0%	5.0%	25%	9	0.00%	10
			Flaring	i. oil	CO_2	20.7	25.0%	5.0%	25%	9	0.00%	**5**
					CH_4	0.90	25.0%	5.0%	25%	9	0.00%	15
					N_2O	0.061	25.0%	5.0%	25%	9	0.00%	18
				ii. Gas	CO_2	13.9	25.0%	5.0%	25%	9	0.00%	8
					CH_4	1.8	25.0%	5.0%	25%	9	0.00%	13
					N_2O	0.051	25.0%	5.0%	25%	9	0.00%	19
	Sub Total					429.5			19%		0.01%	
Total Emissions					（D）	1,137,689.7			2%			

A7.2.4. Industrial Processes

A7.2.4.1. CO_2, CH_4 and N_2O

For emissions sources with actual data available for emission factors, the emission factor dataset is deemed to be a sample of the total dataset, and the uncertainty assessment is achieved statistically. It is not a synthesis of the uncertainties of measured error of emissions from each operating site.

Table A7-8 Results of uncertainty assessment of industrial processes (CO_2, CH_4 and N_2O)

IPCC Category				GHGs	Emissions / Removals [Gg-CO_2 eq.]	EF/RF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
					A	a	b	B		C	
2. Industrial Processes	A. Mineral Products	1. Cement Production		CO_2	24,755.1	3.0%	10.0%	10%	15	0.23%	**1**
		2. Lime Production		CO_2	5,370.6	15.0%	5.0%	16%	14	0.07%	**3**
		3. Limestone & Dolomite Use	Limestone	CO_2	6,109.2	16.4%	4.8%	17%	12	0.09%	**2**
			Dolomite	CO_2	1,335.3	3.5%	3.9%	5%	17	0.01%	9
		4. Soda Ash Production and Use		CO_2	138.2	15.0%	6.3%	16%	13	0.00%	10
	B. Chemical Industries	1. Ammonia Production		CO_2	1,908.8	22.5%	5.0%	23%	11	0.04%	**5**
		Chemical Industries other than Anmonia		CO_2	579.4	77.2%	5.0%	77%	8	0.04%	**4**
		2. Nitric Acid,		N_2O	476.9	46.0%	5.0%	46%	10	0.02%	6
		3. Adipic Acid		N_2O	1,082.6	9.0%	2.0%	9%	16	0.01%	7
		4. Carbide		CH_4	0.66	100.0%	10.0%	100%	**5**	0.00%	17
		5. Other	Carbon Black	CH_4	4.7	54.8%	5.0%	55%	9	0.00%	14
			Ethylene	CH_4	2.3	77.2%	5.0%	77%	7	0.00%	16
			Dichloroethylene	CH_4	0.34	100.7%	5.0%	101%	**4**	0.00%	18
			Styrene	CH_4	2.0	113.2%	5.0%	113%	**3**	0.00%	15
			Methanol	CH_4	0.0	NA	NA	NA	NA	NA	NA
			Coke	CH_4	86.7	98.5%	5.0%	99%	6	0.01%	8
	C. Metal Production	1. Iron and steel		CO_2	112.0	―	―	5%	18	0.00%	12
				CH_4	10.7	163.0%	5.0%	163%	**1**	0.00%	11
		2. Ferroalloy		CH_4	2.3	163.0%	5.0%	163%	**1**	0.00%	13
	Sub Total				41,977.7			7%		0.26%	
Total Emissions				（D）	1,137,689.7			2%			

A7.2.4.2. F-gases

Table A7-9 Results of uncertainty assessment of industrial processes (F-gases)

IPCC Category					GHGs	Emissions / Removals [Gg-CO_2 eq.]	EF/RF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
						A	a	b	B		C	
2. Industrial Processes (F-gas)	C. Metal Production	3. Aluminium			PFCs	11.0	33.0%	5.0%	33%	30	0.00%	21
		4. SF6 Used in Aluminium and Magnesium Foundries			SF_6	239.0	−	5.0%	5%	32	0.00%	19
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	39.8	2.0%	5.0%	5%	31	0.00%	22
		2. Fugitive Emissions			HFCs	182.4	100.0%	10.0%	100%	**1**	0.02%	12
					PFCs	399.5	100.0%	10.0%	100%	**1**	0.04%	6
					SF_6	260.5	100.0%	10.0%	100%	**1**	0.02%	9
	F. Consumption of F-gas	1. Refrigeration and Air Conditionin Equipment	Domestic Refrigerator	manufacturing	HFCs	369.1	50.0%	40.0%	64%	6	0.02%	10
				stock	HFCs	IE	50.0%	40.0%	64%	6	0.00%	25
				disposal	HFCs	IE	−	40.0%	40%	20	0.00%	25
			Commercial Refrigerator	manufacturing	HFCs	9,772.3	50.0%	40.0%	64%	6	0.55%	**1**
				stock	HFCs	IE	50.0%	40.0%	64%	6	0.00%	25
				disposal	HFCs	IE	−	40.0%	40%	20	0.00%	25
			Stationary Air-Conditioning	manufacturing	HFCs	2,617.5	50.0%	40.0%	64%	6	0.15%	**2**
				stock	HFCs	IE	50.0%	40.0%	64%	6	0.00%	25
				disposal	HFCs	IE	−	40.0%	40%	20	0.00%	25
			Mobile Air-Conditioning	manufacturing	HFCs	2,492.4	50.0%	40.0%	64%	6	0.14%	**3**
				stock	HFCs	IE	50.0%	40.0%	64%	6	0.00%	25
				disposal	HFCs	IE	−	40.0%	40%	20	0.00%	25
		2. Foam Blowing		manufacturing	HFCs	144.2	50.0%	50.0%	71%	**4**	0.01%	15
				stock	HFCs	146.0	50.0%	50.0%	71%	**4**	0.01%	14
		3. Fire Extinguisher		manufacturing	HFCs	6.5	50.0%	40.0%	64%	6	0.00%	20
		4. Aerosols / MDI	Aerosols	manufacturing	HFCs	82.2	−	40.0%	40%	20	0.00%	18
				stock	HFCs	525.1	−	40.0%	40%	20	0.02%	11
			MDI	manufacturing	HFCs	4.4	−	40.0%	40%	20	0.00%	23
				stock	HFCs	197.6	−	40.0%	40%	20	0.01%	16
		5. Solvents			PFCs	1,142.1	−	40.0%	40%	20	0.04%	**5**
		7. Semiconductor Manufacture			HFCs	92.4	50.0%	40.0%	64%	6	0.01%	17
					PFCs	1,715.2	50.0%	40.0%	64%	6	0.10%	**4**
					SF_6	606.3	50.0%	40.0%	64%	6	0.03%	7
		8. Electrical Equipment		manufacturing	SF_6	262.9	30.0%	40.0%	50%	19	0.01%	13
				stock	SF_6	482.6	50.0%	40.0%	64%	6	0.03%	8
		9. Other - Railway Silicon Rectifiers			PFCs	3.6	−	40.0%	40%	20	0.00%	24
	Sub Total					21,794.5			31%		0.60%	
Total Emissions					（D）	1,137,689.7			2%			

(Note) Uncertainty of SF_6 emissions from 2.C.4 Magnesium Foundries applies the same value as that of 2.C.3 Aluminium

A7.2.5. Solvents and Other Product Use

Table A7-10 Results of uncertainty assessment of solvent and other product use

IPCC Category			GHGs	Emissions / Removals [Gg-CO$_2$ eq.] A	EF/RF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
3. Solvent and Other Product Use	D. Other	Anaesthesia	N_2O	120.5	－	5.0%	5%	1	0.00%	1
	Sub Total			120.5			5%		0.00%	
Total Emissions			（D）	1,137,689.7			2%			

A7.2.6. Agriculture

Table A7-11 Results of uncertainty assessment of Agriculture

IPCC Category				GHGs	Emissions / Removals [Gg-CO$_2$ eq.] A	EF/RF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
4. Agriculture	A. Enteric Fermentation	Dairy Cattle		CH_4	3,208.4	—	5.0%	15%	63	0.04%	14
		Non-Dairy Cattle		CH_4	3,379.4	—	5.0%	19%	62	0.06%	12
		Buffalo		CH_4	0.09	50.0%	100.0%	112%	44	0.00%	57
		Sheep		CH_4	1.06	50.0%	100.0%	112%	44	0.00%	44
		Goat		CH_4	1.23	50.0%	100.0%	112%	44	0.00%	43
		Swine		CH_4	227.6	50.0%	0.7%	50%	58	0.01%	20
		Horse		CH_4	31.4	50.0%	100.0%	112%	44	0.00%	25
	B. Manure Management	Dairy Cattle		CH_4	1,847.900	—	—	78%	54	0.13%	**5**
				N_2O	606.4	—	—	91%	52	0.05%	13
		Non-Dairy Cattle		CH_4	96.845	—	—	73%	56	0.01%	22
				N_2O	890.9	—	—	125%	42	0.10%	9
		Buffalo		CH_4	0.003	100.0%	100.0%	141%	31	0.00%	63
				N_2O	0.014	100.0%	100.0%	141%	31	0.00%	62
		Swine		CH_4	289.108	—	0.7%	106%	48	0.03%	16
				N_2O	1,283.8	—	0.7%	92%	51	0.10%	8
		Poultry		CH_4	62.114	—	10.7%	54%	57	0.00%	26
		(Hen, Broiler)		N_2O	1,942.5	—	10.7%	80%	53	0.14%	**3**
		Sheep		CH_4	0.072	100.0%	100.0%	141%	31	0.00%	58
				N_2O	1.2	100.0%	100.0%	141%	31	0.00%	42
		Goat		CH_4	0.053	100.0%	100.0%	141%	31	0.00%	59
				N_2O	5.3	100.0%	100.0%	141%	31	0.00%	31
		Horse		CH_4	3.631	100.0%	100.0%	141%	31	0.00%	32
				N_2O	31.2	100.0%	100.0%	141%	31	0.00%	23
	C. Rice Cultivation	Continuously Flooded		CH_4	194.1	116.3%	0.3%	116%	43	0.02%	18
		Intermittently Flooded	Straw amendment	CH_4	3,757.3	—	0.3%	32%	61	0.10%	7
			Various compost	CH_4	1,001.6	—	0.3%	32%	60	0.03%	15
			No-amendment	CH_4	613.5	—	0.3%	46%	59	0.02%	17
	D. Agricultural Soils	1. Direct Soil Emissions	Synthetic Fertilizers	N_2O	1,150.4	—	—	139%	39	0.14%	**1**
			Animal Waste AQplied to Soils	N_2O	1,045.2	—	—	152%	30	0.14%	**2**
			N-Fixing Crops	N_2O	82.5	—	—	99%	49	0.01%	21
			Crop residues	N_2O	607.8	—	—	211%	16	0.11%	6
			Organic soil	N_2O	116.6	—	—	712%	**1**	0.07%	11
		2. Pasture, Range		N_2O	12.6	—	—	133%	40	0.00%	28
		3. Indirect Emissions	Atmospheric Deposition	N_2O	1,281.3	—	—	75%	55	0.08%	10
			N Leaching & Run-off	N_2O	1,545.6	—	—	97%	50	0.13%	**4**
	F. Field Burning of Agricultural Residue	1. Cereals	Wheat	CH_4	6.9	—	—	186%	20	0.00%	30
				N_2O	1.5	—	—	185%	24	0.00%	38
			Barley	CH_4	1.7	—	—	185%	22	0.00%	36
				N_2O	0.4	—	—	187%	18	0.00%	48
			Maize	CH_4	29.0	418.0%	50.0%	421%	7	0.01%	19
				N_2O	6.1	423.0%	50.0%	426%	**3**	0.00%	27
			Oats	CH_4	0.7	—	—	156%	28	0.00%	45
				N_2O	0.6	—	—	170%	27	0.00%	47
			Rye	CH_4	0.038	—	—	130%	41	0.00%	60
				N_2O	0.018	—	—	154%	29	0.00%	61
			Rice	CH_4	20.1	178.0%	50.0%	185%	23	0.00%	24
				N_2O	8.1	175.0%	50.0%	182%	26	0.00%	29
		2. Pulse	Peas	CH_4	0.08	481.0%	20.0%	481%	**2**	0.00%	50
				N_2O	0.05	423.0%	20.0%	423%	**5**	0.00%	54
			Soybeans	CH_4	1.69	176.0%	50.0%	183%	25	0.00%	37
				N_2O	1.12	182.0%	50.0%	189%	17	0.00%	40
			Other (Adzuki beans)	CH_4	0.26	179.0%	50.0%	186%	21	0.00%	49
				N_2O	0.16	180.0%	50.0%	187%	19	0.00%	52
			Other (kidney beans)	CH_4	0.06	418.0%	50.0%	421%	7	0.00%	53
				N_2O	0.03	418.0%	50.0%	421%	7	0.00%	55
			Other (peanuts)	CH_4	0.09	418.0%	50.0%	421%	7	0.00%	51
				N_2O	0.03	418.0%	50.0%	421%	7	0.00%	56
		3. Tuber & Roots	Potatoes	CH_4	0.4	418.0%	20.0%	418%	15	0.00%	41
				N_2O	0.6	419.0%	20.0%	419%	14	0.00%	39
			Other: Sugarbeet	CH_4	1.2	417.0%	50.0%	420%	13	0.00%	33
				N_2O	1.1	419.0%	50.0%	422%	6	0.00%	34
		4. Sugar Cane		CH_4	0.8	418.0%	50.0%	421%	7	0.00%	35
				N_2O	0.3	423.0%	50.0%	426%	**3**	0.00%	46
	Sub Total				25,402.1			18%		0.40%	
Total Emissions				（D）	1,137,689.7			2%			

A7.2.7. LULUCF

Table A7-12 Results of uncertainty assessment of LULUCF

IPCC Category			GHGs	Emissions / Removals [Gg-CO_2 eq.]	EF/RF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank 5)
				A	a	b	B		C	
5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land	CO_2	-73,331.6	–	–	5%	12	0.32%	**1**
		2. Land converted to Forest Land	CO_2	-346.3	–	–	16%	9	0.00%	7
			CH_4	8.7	25.0%	84.8%	88%	**2**	0.00%	10
			N_2O	0.9	75.6%	84.8%	114%	**1**	0.00%	12
	B. Cropland	1. Cropland remaining Cropland	CO_2	IE,NA,NE,NO	–	–	–	—	—	—
		2. Land converted to Cropland	CO_2	257.5	–	–	20%	8	0.00%	8
			CH_4	NE,NO	–	–	–	—	—	—
			N_2O	7.6	–	–	86%	**3**	0.00%	11
	C. Grassland	1. Grassland remaining Grassland	CO_2	IE,NA,NE	–	–	–	—	—	—
		2. Land converted to Grassland	CO_2	-276.2	–	–	37%	7	0.01%	6
			CH_4	NE,NO	–	–	–	—	—	—
			N_2O	NE,NO	–	–	–	—	—	—
	D. Wetlands	1. Wetlands remaining Wetlands	CO_2	NE,NO	–	–	–	—	—	—
		2. Land converted to Wetlands	CO_2	22.7	–	–	38%	6	0.00%	9
			CH_4	NE,NO	–	–	–	—	—	—
			N_2O	NE,NO	–	–	–	—	—	—
	E. Settlements	1. Settlements remaining Settlements	CO_2	-765.2	–	–	78%	**4**	0.05%	**2**
		2. Land converted to Settlements	CO_2	1,581.2	–	–	8%	11	0.01%	**4**
			CH_4	NE,NO	–	–	–	—	—	—
			N_2O	NE,NO	–	–	–	—	—	—
	F. Other Land	1. Other Land remaining Other Land	CO_2	—	–	–	–	—	—	—
		2. Land converted to Other Land	CO_2	1,049.0	–	–	12%	10	0.01%	**5**
			CH_4	NO	–	–	–	—	—	—
			N_2O	NO	–	–	–	—	—	—
	G. Other	CO_2 emissions from agricultural lime application	CO_2	268.3	-50%	9%	51%	**5**	0.01%	**3**
	Sub Total			-71,523.5			5%		0.32%	
Total Emissions			(D)	1,137,689.7			2%			

5) Numbers of the rank have been assessed based on the absolute values of "Combined uncertainty as % of total national emissions".

A7.2.8. Waste

Table A7-13 Results of uncertainty assessment of Waste

IPCC Category				GHGs	Emissions / Removals [Gg-CO_2 eq.]	EF/RF Uncertainty [%]	AD Uncertainty [%]	Combined Uncertainty [%]	rank	Combined uncertainty as % of total national emissions	rank
					A	a	b	B		C	
6. Waste	A. Solid Waste Disposal on Land	1. Managed Waste Disposal on Land	Kitchen Garbage	CH_4	398.38	42.4%	32.4%	53%	30	0.02%	12
			Waste PAQer	CH_4	1,305.50	42.4%	42.7%	60%	26	0.07%	6
			Waste Textile	CH_4	84.35	43.8%	42.9%	61%	25	0.00%	21
			Waste Wood	CH_4	935.84	42.5%	56.6%	71%	21	0.06%	7
			Digested Sewage Sludge	CH_4	34.23	44.2%	32.0%	55%	28	0.00%	29
			Other Sewage Sludge	CH_4	170.65	44.2%	32.0%	55%	28	0.01%	17
			Human Waste Sludge	CH_4	68.65	44.2%	32.6%	55%	27	0.00%	23
			Water Purification Sludge	CH_4	34.71	108.6%	31.7%	113%	8	0.00%	22
			Organic Sludge from Manufacture	CH_4	210.56	54.0%	33.4%	63%	24	0.01%	14
			Livestock Waste	CH_4	27.74	46.9%	49.4%	68%	23	0.00%	28
		3. Other	Illegal Disposal	CH_4	38.65	42.5%	66.8%	79%	16	0.00%	25
	B. Wastewater Handling	1. Industrial Wastewater		CH_4	102.73	60.0%	37.4%	71%	22	0.01%	19
				N_2O	126.08	300.0%	51.1%	304%	**1**	0.03%	9
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant	CH_4	235.90	30.9%	10.4%	33%	32	0.01%	18
				N_2O	639.26	145.7%	10.4%	146%	**5**	0.08%	**5**
			Private Sewerage Tank	CH_4	425.51	86.8%	10.0%	87%	14	0.03%	10
				N_2O	270.93	71.0%	10.0%	72%	20	0.02%	13
			Human-Waste Treatment Plant	CH_4	13.77	100.0%	12.3%	101%	11	0.00%	31
				N_2O	5.75	100.0%	33.9%	106%	9	0.00%	33
			Degradation of domestic wastewater in nature	CH_4	469.50	—	—	76%	17	0.03%	11
				N_2O	45.38	—	—	76%	17	0.00%	24
	C. Waste Incineration	Municipal Solid Waste	Plastics	CO_2	2,913.33	4.3%	16.0%	17%	35	0.04%	8
			Waste textile	CO_2	570.53	4.3%	22.4%	23%	34	0.01%	15
				CH_4	1.27	—	—	101%	12	0.00%	35
				N_2O	150.29	—	—	42%	31	0.01%	20
		Industrial Solid Waste	Waste mineral oil	CO_2	3,968.60	4.8%	104.4%	105%	10	0.36%	**2**
			Plastics	CO_2	4,646.22	4.8%	100.0%	100%	13	0.41%	**1**
				CH_4	8.88	111.5%	100.0%	150%	**4**	0.00%	32
				N_2O	1,471.06	58.8%	100.0%	116%	7	0.15%	**4**
		Specially Contorolled Industrial Solid Waste		CO_2	1,884.83	—	—	167%	**2**	0.28%	**3**
				CH_4	1.24	—	—	142%	6	0.00%	34
				N_2O	16.10	—	—	159%	**3**	0.00%	26
	D. Oher	Decomposition of petroleum-derived surface-active agent		CO_2	513.7	—	—	25%	33	0.01%	16
		Composting of Organic Waste		CH_4	24.7	—	—	74%	19	0.00%	30
				N_2O	21.9	—	—	86%	15	0.00%	27
	Sub Total				21,830.5			34%		0.65%	
Total Emissions				(D)	1,137,689.7			2%			

6) Regarding 6A1, uncertainty of "Anaerobic landfill", which is the largest source under this sub-category, has been used.
7) Regarding 6A2, uncertainty of "Gappei-shori johkasou", which is the largest source under this sub-category, has been used.
8) Regarding CH_4 of 6C MSW, uncertainty of "Semi-Continuous Incinerator" has been used.
9) Regarding CH_4 of 6C ISW, uncertainty of "Waste Paper and Waste Wood" has been used.
10) Regarding N_2O of 6C ISW, uncertainty of "Waste Plastics" has been used.
11) Regarding 6C Fuel use of RDF and RPF, uncertainty of "RDF" has been used.

A7.2.9. Consideration of the results

The result of uncertainty assessment shows that Japan's uncertainty of total net emissions is approximately 2%. This value is relatively smaller compared to 21.3% of UK indicated in the *Good Practice Guidance*. It is attributed to the fact that the ratio of Japan's N_2O emission from "4.D.1. Agricultural Soils (Direct Soil Emissions)" to the national total emissions is small compared to that of UK (the ratios of Japan and UK reported in their inventories submitted in 2003 were 0.28% and 4.1%, respectively).

Below are the results of sensitivity analysis with N_2O emissions from this source, uncertainty of emission factor and national total emissions (calculation used the reported values of inventories submitted in 2003).

Table A7-14 Sensitivity Analysis on N_2O emissions from "4.D. Agricultural Soils 1 Direct Emissions"

	N_2O Emissions [Gg-CO_2eq.]	Uncertainty of EF	Uncertainty of Total Emissions	Note
Original	3,597.58	129.9%	2.4%	2001 Emissions contained in the GHG inventory submitted in 2003.
Case 1	3,597.58	500%	2.6%	EF uncertainty was assumed to be same as UK's case.
Case 2	71,951.53	129.9%	4.8%	Emissions were assumed to be approximately 5% of national total emissions in 2001.

A7.2.10. Issues in Uncertainty Assessment

- According to the method indicated in the *Revised 1996 IPCC Guidelines*, only emission sources of which emissions had already been calculated were the subject of uncertainty assessment. No assessment has been made for emission sources not estimated (NE), or of those portions unconfirmed in emission sources for which only partial calculation has been done (PART). Therefore, it should be remembered that the uncertainty of total emissions prepared by compiling the uncertainty of emissions from each source, does not depict the uncertainty of inventory in the context of the realities of emissions.
- In the sources recalculated, consideration is needed whether to re-assess the uncertainties or not.
- Where it was not possible to carry out a statistical assessment of the uncertainty of activity data, the values were derived from those established by the Committee for the GHGs Emissions Estimations Methods, which have established the uncertainty values in relation to whether the data were derived from specified statistics, or whether they were obtained from total population surveys. But further consideration needs to be given to improve the appropriateness of this approach.
- In carrying out a statistical assessment of uncertainty, it was assumed that the averages of all samples followed a normal distribution. In some cases, however, it means that the emission factor or activity data could, in fact, be negative. Emissions can only be positive under the present IPCC guidelines, so further consideration would need to be given for the possibility to assume that the emission factor or activity data follows some other distribution.
- Consideration on application of probability density function (PDF) with Monte-Carlo analysis is further issue. Further consideration on analysis with more disaggregated sources or each coefficients are needed.

- 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.）

A7.2.11. Reference Material

Results of the uncertainty assessment for this year in accordance with Table 6.1 of *GPG (2000)* are indicated below.

A					B	C	D	E	F	G	H		I	J	K	L	M
IPCC Source Category					Gas	Base year emissions / removals	2009 emissions / removals	Activity Data Uncertainty	EForRF Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2008		Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by EForRF Uncertainty	Uncertainty in trend in National Emissions introduced by Activity Data Uncertainty	Uncertainty introduced into the Trend in Total National Emissions
						Input Data	Input Data	Input Data	Input Data	(E^2+F^2)^1/2	G*D/ΣD	H^2	Note B	D/ΣC	I*F Note C	J*E*√2	(K^2+L^2)^1/2
						Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%		%	%	%	%	%
Total						1,187,046.78	1,137,689.69				2%	0.0%					1%
1A. Fuel Combustion	Solid Fuels	Steel Making Coal			CO_2	9,244.05	12,106.35	1.2%	3.5%	4%	0.0%	0.0%	0.3%	1.0%	0.0%	0.0%	0.0%
		Steam Coal (imported)			CO_2	88,401.29	238,984.72	1.2%	2.0%	2%	0.5%	0.0%	13.0%	20.1%	0.3%	0.3%	0.4%
		Steam Coal (indigenous)			CO_2	20,125.86	0.00	1.2%	2.0%	2%	0.0%	0.0%	-1.6%	0.0%	0.0%	0.0%	0.0%
		Hard Coal			CO_2	0.00	0.00	1.2%	4.5%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Coke			CO_2	117,790.21	87,691.23	1.2%	1.7%	2%	0.2%	0.0%	-2.1%	7.4%	0.0%	0.1%	0.1%
		Coal Tar			CO_2	3,173.39	1,694.01	1.2%	5.0%	5%	0.0%	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
		Coal Briquette			CO_2	310.20	0.00	1.2%	5.0%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Coke Oven Gas			CO_2	15,976.84	13,335.96	1.2%	2.0%	2%	0.0%	0.0%	-0.2%	1.1%	0.0%	0.0%	0.0%
		Blast Furnace Gas			CO_2	43,496.15	38,235.06	1.2%	3.8%	4%	0.1%	0.0%	-0.3%	3.2%	0.0%	0.1%	0.1%
		Converter Furnace Gas			CO_2	9,303.92	9,494.71	1.2%	2.9%	3%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%
	Liquid Fuels	Crude Oil for Refinery			CO_2	1.91	0.00	2.3%	0.8%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Crude Oil for Power Generation			CO_2	58,483.38	9,893.33	2.3%	0.9%	2%	0.0%	0.0%	-3.9%	0.8%	0.0%	0.0%	0.0%
		Vitumous Mixture Fuel			CO_2	0.00	0.00	2.3%	0.4%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		NGL & Condensate			CO_2	1,380.12	100.47	2.3%	1.6%	3%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		Naphtha			CO_2	1,297.82	473.20	2.3%	0.1%	2%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		Reformed Material Oil			CO_2	0.00	0.00	2.3%	0.1%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Gasoline			CO_2	103,913.39	133,370.77	2.3%	0.0%	2%	0.3%	0.0%	2.8%	11.2%	0.0%	0.4%	0.4%
		Jet Fuel			CO_2	9,140.23	12,989.68	2.3%	1.0%	3%	0.0%	0.0%	0.4%	1.1%	0.0%	0.0%	0.0%
		Kerosene			CO_2	64,049.60	47,943.00	2.3%	0.1%	2%	0.1%	0.0%	-1.1%	4.0%	0.0%	0.1%	0.1%
		Gas Oil or Diesel Oil			CO_2	98,847.94	83,260.98	2.3%	1.2%	3%	0.2%	0.0%	-1.0%	7.0%	0.0%	0.2%	0.2%
		Heating Oil A			CO_2	74,790.57	45,194.43	2.3%	1.5%	3%	0.1%	0.0%	-2.2%	3.8%	0.0%	0.1%	0.1%
		Heating Oil B			CO_2	1,865.42	53.43	2.3%	5.0%	6%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		Heating Oil C			CO_2	143,715.21	54,837.20	2.3%	0.6%	2%	0.1%	0.0%	-7.0%	4.6%	0.0%	0.2%	0.2%
		Lubricating Oil			CO_2	67.74	191.29	2.3%	5.0%	6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Asphalt			CO_2	5,510.07	10,482.31	2.3%	0.6%	2%	0.0%	0.0%	0.4%	0.9%	0.0%	0.0%	0.0%
		Non Asphalt Heavy Oil Products			CO_2	7.76	0.01	2.3%	0.6%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Oil Coke			CO_2	9,505.00	12,635.46	2.3%	5.0%	6%	0.1%	0.0%	0.3%	1.1%	0.0%	0.0%	0.0%
		Galvanic Furnace Gas			CO_2	146.60	123.60	2.3%	2.9%	4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Refinary Gas			CO_2	27,354.02	33,897.63	2.3%	5.0%	6%	0.2%	0.0%	0.6%	2.9%	0.0%	0.1%	0.1%
		LPG			CO_2	37,373.48	27,005.65	2.3%	0.1%	2%	0.1%	0.0%	-0.7%	2.3%	0.0%	0.1%	0.1%
	Gaseous Fuels	LNG			CO_2	76,303.80	118,336.95	0.3%	0.1%	0%	0.0%	0.0%	3.8%	10.0%	0.0%	0.0%	0.0%
		Indigenous Natural Gas			CO_2	2,225.86	2,403.76	0.3%	0.6%	1%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
		Town Gas*			CO_2	34,211.10	79,430.30	0.3%	0.5%	1%	0.0%	0.0%	3.9%	6.7%	0.0%	0.0%	0.0%
		Small Scale Town Gas*			CO_2	1,130.79	1,172.76	0.3%	0.1%	0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
	Other Fuels	Municipal Solid Waste (Plastics)			CO_2	5,856.61	5,691.98	16.0%	4.3%	17%	0.1%	0.0%	0.0%	0.5%	0.0%	0.1%	0.1%
		Municipal Solid Waste (Waste textile)			CO_2	584.61	1,114.68	22.4%	4.3%	23%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Industrial Solid Waste (Waste Oil)			CO_2	20.63	100.86	104.4%	4.8%	105%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Industrial Solid Waste (Plastics)			CO_2	30.87	360.09	100.0%	4.8%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of MSW			CO_2	0.00	410.57	16.0%	4.3%	17%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of ISW (Waste Oil)			CO_2	2,018.99	2,955.26	104.4%	4.8%	105%	0.3%	0.0%	0.1%	0.2%	0.0%	0.4%	0.4%
		Raw material and fuel use of ISW (Waste Plastics)			CO_2	54.32	1,418.48	12.3%	4.8%	13%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%
		Raw material and fuel use of Waste tire			CO_2	524.23	946.02	14.5%	4.8%	15%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Fuel use of RDF and RPF			CO_2	25.63	1,392.20	10.6%	42.6%	44%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%
1A. Fuel Combustion (Stationary)					CH_4	592.63	561.62	10.0%	45.9%	47%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	2,574.00	4,083.29	10.0%	31.4%	33%	0.1%	0.0%	0.1%	0.3%	0.0%	0.0%	0.1%
	Other Fuels	Municipal Solid Waste (Plastics)			CH_4	11.33	2.48	10.0%	100.2%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Municipal Solid Waste (Waste textile)			N_2O	369.25	293.62	10.0%	40.6%	42%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Industrial Solid Waste (Waste Oil)			CH_4	0.02	0.18	100.0%	111.5%	150%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Industrial Solid Waste (Plastics)			N_2O	3.30	3.13	100.0%	58.8%	116%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of MSW			CH_4	0.00	0.00	10.0%	179.4%	180%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.00	0.01	10.0%	111.2%	112%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material an fuel use of ISW	Waste Oil		CH_4	0.25	0.48	10.0%	72.8%	74%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	4.90	11.40	10.0%	39.6%	41%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Waste Plastics		CH_4	0.01	3.54	10.0%	91.7%	92%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.05	4.64	10.0%	29.7%	31%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Waste Wood		CH_4	36.94	84.19	100.0%	80.2%	128%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	6.18	14.08	100.0%	45.3%	110%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Raw material and fuel use of Waste tire			CH_4	0.65	1.07	10.0%	90.8%	91%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1.55	5.09	10.0%	23.7%	26%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Fuel use of RDF and RPF			CH_4	0.00	0.25	10.0%	48.1%	49%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.16	8.00	10.0%	30.9%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1A.Fuel Combu (Transport)	a. Civil Aviation				CH_4	2.94	4.61	10.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	69.75	98.32	10.0%	10000.0%	10000%	0.9%	0.0%	0.0%	0.0%	0.3%	0.0%	0.3%
	b. Road Transportation				CH_4	266.66	159.46	50.0%	40.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	3,901.71	2,404.93	50.0%	50.0%	71%	0.1%	0.0%	-0.1%	0.2%	-0.1%	0.1%	0.2%
	c. Railways				CH_4	1.18	0.73	—	—	14%	0.0%	0.0%	0.0%	0.0%	—	—	—
					N_2O	121.38	76.81	—	—	11%	0.0%	0.0%	0.0%	0.0%	—	—	—
	d. Navigation				CH_4	26.45	20.71	13.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	111.58	87.35	13.0%	1000.0%	1000%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1B. Fugitive Emissions from Fuels	1. Solid Fuels	a. Coal Mining	i. Underground Mines	Mining Activities	CH_4	2,551.70	15.32	5.4%	0.0%	5%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%
				Post-Mining Activities	CH_4	233.53	19.82	10.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ii. Surface Mines	Mining Activities	CH_4	19.50	10.22	10.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				Post-Mining Activities	CH_4	1.70	0.89	10.0%	200.0%	200%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2. Oil and Natural Gas	a. Oil		i. Exploration	CO_2	0.03	0.02	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	0.03	0.02	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.00	0.00	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				ii. Production	CO_2	0.11	0.08	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	12.80	9.43	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				iii. Transport	CO_2	0.00	0.01	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	0.76	1.57	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				iv. Refining / Storage	CH_4	14.73	14.37	0.9%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		b. Natural Gas		ii. Production / Processing	CO_2	0.25	0.43	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	159.12	272.46	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				iii. Transmission	CH_4	15.12	22.99	10.0%	25.0%	27%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				iv. Distribution	CH_4	13.69	15.45	8.7%	25.0%	26%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		c. Venting and Flaring	Venting	i. oil	CO_2	0.01	0.00	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	12.19	8.98	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Flaring	i. oil	CO_2	28.17	20.74	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	1.22	0.90	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.08	0.06	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				ii. Gas	CO_2	8.06	13.87	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	1.04	1.79	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.03	0.05	5.0%	25.0%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2. Industrial Processes	A. Mineral Products	1. Cement Production			CO_2	37,904.87	24,755.14	10.0%	3.0%	10%	0.2%	0.0%	-1.0%	2.1%	0.0%	0.3%	0.3%
		2. Lime Production			CO_2	6,674.45	5,370.58	5.0%	15.0%	16%	0.1%	0.0%	-0.1%	0.5%	0.0%	0.0%	0.0%
		3. Limestone & Dolomite Use	Limestone		CO_2	9,054.75	6,109.24	4.8%	16.4%	17%	0.1%	0.0%	-0.2%	0.5%	0.0%	0.0%	0.0%
			Dolomite		CO_2	1,467.50	1,335.30	3.9%	3.5%	5%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		4. Soda Ash Production and Use			CO_2	267.28	138.19	6.3%	15.0%	16%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Chemical Industries	1. Ammonia Production			CO_2	3,384.68	1,908.78	5.0%	22.5%	23%	0.0%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.0%
		Chemical Industries other than			CO_2	824.39	579.42	5.0%	77.2%	77%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Nitric Acid,			N_2O	765.70	476.91	5.0%	46.0%	46%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Adipic Acid			N_2O	7,501.25	1,082.59	2.0%	9.0%	9%	0.0%	0.0%	-0.5%	0.1%	0.0%	0.0%	0.0%
		4. Carbide			CH_4	0.42	0.66	10.0%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		5. Other	Carbon Black		CH_4	5.83	4.67	5.0%	54.8%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Ethylene		CH_4	1.88	2.27	5.0%	77.2%	77%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Dichloroethylene		CH_4	0.28	0.34	5.0%	100.7%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Styrene		CH_4	1.45	1.98	5.0%	113.2%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Methanol		CH_4	3.52	0.00	5.0%	113.2%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Coke		CH_4	324.84	86.72	5.0%	98.5%	99%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Metal Production	1. Iron and steel			CO_2	356.09	111.99	4.5%	0.0%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					CH_4	15.47	10.67	5.0%	163.0%	163%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Ferroalloy			CH_4	3.89	2.27	5.0%	163.0%	163%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

A					B	C	D	E	F	G	H		I	J	K	L	M
IPCC Source Category					Gas	Base year emissions / removals	2009 emissions / removals	Activity Data Uncertainty	EForRF Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2008		Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by EForRF Uncertainty	Uncertainty in trend in National Emissions introduced by Activity Data Uncertainty	Uncertainty introduced into the Trend in Total National Emissions
						Input Data	Input Data	Input Data	Input Data	(E^2+F^2)^1/2	G*D/ΣD	H^2	Note B	D/ΣC	I*F Note C	J*E*√2	(K^2+L^2)^1/2
						Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%		%	%	%	%	%
Total						1,187,046.78	1,137,689.69				2%	0.0%					1%
2. Industrial Processes (F-gas)	C. Metal Production	3. Aluminium			PFCs	69.74	11.02	5.0%	33.0%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. SF6 Used in Aluminium and Magnesium Foundries			SF_6	119.50	239.00	5.0%	0.0%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	E. Production of F-gas	1. By-product Emissions (HCFC-22)			HFCs	16,965.00	39.78	5.0%	2.0%	5%	0.0%	0.0%	-1.4%	0.0%	0.0%	0.0%	0.0%
		2. Fugitive Emissions			HFCs	480.12	182.36	10.0%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					PFCs	762.85	399.48	10.0%	100.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					SF_6	4,708.30	260.51	10.0%	100.0%	100%	0.0%	0.0%	-0.4%	0.0%	-0.4%	0.0%	0.4%
	F. Consumption of F-gas	1. Refrigeration and Air Conditioning Equipment	Domestic Refrigerator	manufacturing	HFCs	11.34	369.11	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	0.00	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.00	0.00	40.0%	0.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Commercial Refrigerator	manufacturing	HFCs	42.48	9,772.26	40.0%	50.0%	64%	0.6%	0.0%	0.8%	0.8%	0.4%	0.5%	0.6%
				stock	HFCs	0.00	0.00	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.00	0.00	40.0%	0.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Stationary Air-Conditioning	manufacturing	HFCs	0.00	2,617.46	40.0%	50.0%	64%	0.1%	0.0%	0.2%	0.2%	0.1%	0.1%	0.2%
				stock	HFCs	0.00	0.00	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.00	0.00	40.0%	0.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Mobile Air-Conditioning	manufacturing	HFCs	786.58	2,492.43	40.0%	50.0%	64%	0.1%	0.0%	0.1%	0.2%	0.1%	0.1%	0.1%
				stock	HFCs	0.00	0.00	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				disposal	HFCs	0.00	0.00	40.0%	0.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Foam Blowing		manufacturing	HFCs	451.76	144.17	50.0%	50.0%	71%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	146.01	50.0%	50.0%	71%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Fire Extinguisher		manufacturing	HFCs	0.00	6.55	40.0%	50.0%	64%	0.0%	0.0%	NA	NA	NA	NA	NA
		4. Aerosols / MDI	Aerosols	manufacturing	HFCs	0.00	82.16	40.0%	0.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	1,365.00	525.10	40.0%	0.0%	40%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
			MDI	manufacturing	HFCs	0.00	4.38	40.0%	0.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				stock	HFCs	0.00	197.61	40.0%	0.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		5. Solvents			PFCs	10,263.55	1,142.15	40.0%	0.0%	40%	0.0%	0.0%	-0.7%	0.1%	0.0%	0.1%	0.1%
		7. Semiconductor Manufacture			HFCs	3,144.23	92.36	40.0%	50.0%	64%	0.0%	0.0%	-0.2%	0.0%	-0.1%	0.0%	0.1%
					PFCs	157.89	1,715.19	40.0%	50.0%	64%	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%
					SF_6	1,128.66	606.31	40.0%	50.0%	64%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		8. Electrical Equipment		manufacturing	SF_6	9,560.00	262.90	40.0%	30.0%	50%	0.0%	0.0%	-0.7%	0.0%	-0.2%	0.0%	0.2%
				stock	SF_6	1,444.99	482.56	40.0%	50.0%	64%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
		9.Other - Railway Silicon Rectifiers			PFCs	0.00	3.63	40.0%	0.0%	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3. SOPU	D. Other	Anaesthesia			N_2O	287.07	120.50	5.0%	0.0%	5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4. Agriculture	A. Enteric Fermentation	Dairy Cattle			CH_4	4,044.60	3,208.35	5.0%	14.2%	15%	0.0%	0.0%	-0.1%	0.3%	0.0%	0.0%	0.0%
		Non-Dairy Cattle			CH_4	3,322.55	3,379.42	5.0%	18.0%	19%	0.1%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%
		Buffalo			CH_4	0.25	0.09	100.0%	50.0%	112%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Sheep			CH_4	1.88	1.06	100.0%	50.0%	112%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Goat			CH_4	2.22	1.23	100.0%	50.0%	112%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Swine			CH_4	261.75	227.64	0.7%	50.0%	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Horse			CH_4	43.37	31.42	100.0%	50.0%	112%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Manure Management	Dairy Cattle			CH_4	2,587.79	1,847.90	10.0%	77.0%	78%	0.1%	0.0%	-0.1%	0.2%	0.0%	0.0%	0.0%
					N_2O	840.93	606.40	10.0%	90.1%	91%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Non-Dairy Cattle			CH_4	93.83	96.85	10.0%	71.8%	73%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	869.12	890.94	10.0%	125.1%	125%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Buffalo			CH_4	0.01	0.00	100.0%	100.0%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.04	0.01	100.0%	100.0%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Swine			CH_4	333.44	289.11	0.7%	106.1%	106%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1,479.89	1,283.79	0.7%	91.6%	92%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
		Poultry (Hen, Broiler)			CH_4	73.82	62.11	10.7%	52.6%	54%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	2,288.25	1,942.50	10.7%	78.9%	80%	0.1%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
		Sheep			CH_4	0.13	0.07	100.0%	100.0%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	2.20	1.24	100.0%	100.0%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Goat			CH_4	0.10	0.05	100.0%	100.0%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	9.54	5.29	100.0%	100.0%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Horse			CH_4	5.01	3.63	100.0%	100.0%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	43.04	31.18	100.0%	100.0%	141%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Rice Cultivation	Continuously Flooded			CH_4	242.62	194.06	0.3%	116.3%	116%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Intermittently Flooded	Straw amendment		CH_4	4,578.50	3,757.28	0.3%	31.7%	32%	0.1%	0.0%	-0.1%	0.3%	0.0%	0.0%	0.0%
			Various compost amendment		CH_4	1,188.09	1,001.64	0.3%	31.9%	32%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			No-amendment		CH_4	950.47	613.53	0.3%	46.3%	46%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
	D. Agricultural Soils	1. Direct Soil Emissions	Synthetic Fertilizers		N_2O	1,909.02	1,150.44	10.0%	138.3%	139%	0.1%	0.0%	-0.1%	0.1%	-0.1%	0.0%	0.1%
			Animal Waste Applied to Soils		N_2O	1,345.05	1,045.15	10.0%	151.3%	152%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			N-Fixing Crops		N_2O	97.18	82.51	10.0%	98.0%	99%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Crop residues		N_2O	683.81	607.75	10.0%	210.6%	211%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			Organic soil		N_2O	120.40	116.63	10.0%	711.6%	712%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Pasture, Range and Paddock Manure			N_2O	11.91	12.62	10.0%	132.5%	133%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Indirect Emissions	Atmospheric Deposition		N_2O	1,578.59	1,281.33	10.0%	74.5%	75%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			N Leaching & Run-off		N_2O	2,151.92	1,545.59	10.0%	96.4%	97%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
	F. Field Burning of Agricultural Residue	1. Cereals	Wheat		CH_4	8.74	6.89	10.0%	186.0%	186%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1.91	1.51	10.0%	184.3%	185%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Barley		CH_4	3.05	1.71	10.0%	185.2%	185%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.71	0.40	10.0%	186.8%	187%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Maize		CH_4	39.63	29.03	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	8.39	6.15	50.0%	423.0%	426%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Oats		CH_4	0.35	0.74	10.0%	155.7%	156%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.24	0.63	10.0%	169.2%	170%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Rye		CH_4	0.03	0.04	10.0%	129.5%	130%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.02	0.02	10.0%	153.8%	154%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Rice		CH_4	43.28	20.13	50.0%	178.0%	185%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	17.50	8.14	50.0%	175.0%	182%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Pulse	Peas		CH_4	0.17	0.08	20.0%	481.0%	481%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.11	0.05	20.0%	423.0%	423%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Soybeans		CH_4	1.62	1.69	50.0%	176.0%	183%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1.07	1.12	50.0%	182.0%	189%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (Adzuki beans)		CH_4	0.47	0.26	50.0%	179.0%	186%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.28	0.16	50.0%	180.0%	187%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (kidney beans)		CH_4	0.11	0.06	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.07	0.03	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other (peanuts)		CH_4	0.16	0.09	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.06	0.03	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Tuber & Roots	Potatoes		CH_4	0.61	0.44	20.0%	418.0%	418%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.78	0.56	20.0%	419.0%	419%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other: Sugarbeet		CH_4	1.24	1.16	50.0%	417.0%	420%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	1.14	1.07	50.0%	419.0%	422%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4. Sugar Cane			CH_4	1.19	0.84	50.0%	418.0%	421%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
					N_2O	0.38	0.26	50.0%	423.0%	426%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

A				B	C	D	E	F	G	H		I	J	K	L	M
IPCC Source Category				Gas	Base year emissions / removals	2009 emissions / removals	Activity Data Uncertainty	EForRF Uncertainty	Combined Uncertainty	Combined Uncertainty as % of Total National Emissions in 2008		Type A Sensitivity	Type B Sensitivity	Uncertainty in trend in National Emissions introduced by EForRF Uncertainty	Uncertainty in trend in National Emissions introduced by Activity Data Uncertainty	Uncertainty introduced into the Trend in Total National Emissions
					Input Data	Input Data	Input Data	Input Data	(E^2+F^2)^1/2	G*D/ΣD	H^2	Note B	D/ΣC	I*F Note C	J*E*√2	(K^2+L^2)^1/2
					Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%	%		%	%	%	%	%
Total					1,187,046.78	1,137,689.69				2%	0.0%					1%
5. LULUCF	A. Forest Land	1. Forest Land remaining Forest Land		CO_2	-76,762.09	-73,331.60	—	—	5%	-0.3%	0.0%	0.0%	-6.2%	—	—	—
		2. Land converted to Forest Land		CO_2	-1,874.11	-346.33	—	—	16%	0.0%	0.0%	0.1%	0.0%	—	—	—
				CH_4	8.31	8.73	84.8%	25.0%	88%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	0.84	0.89	84.8%	75.6%	114%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Cropland	1. Cropland remaining Cropland		CO_2	IE,NA,NE,NO	IE,NA,NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
		2. Land converted to Cropland		CO_2	2,532.77	257.51	—	—	20%	0.0%	0.0%	-0.2%	0.0%	—	—	—
				CH_4	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
				N_2O	90.02	7.60	—	—	86%	0.0%	0.0%	0.0%	0.0%	—	—	—
	C. Grassland	1. Grassland remaining Grassland		CO_2	IE,NA,NE	IE,NA,NE	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
		2. Land converted to Grassland		CO_2	-441.28	-276.24	—	—	37%	0.0%	0.0%	0.0%	0.0%	—	—	—
				CH_4	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
				N_2O	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
	D. Wetlands	1. Wetlands remaining Wetlands		CO_2	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
		2. Land converted to Wetlands		CO_2	86.72	22.72	—	—	38%	0.0%	0.0%	0.0%	0.0%	—	—	—
				CH_4	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
				N_2O	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
	E. Settlements	1. Settlements remaining Settlements		CO_2	-621.88	-765.22	—	—	78%	-0.1%	0.0%	0.0%	-0.1%	—	—	—
		2. Land converted to Settlements		CO_2	5,286.52	1,581.21	—	—	8%	0.0%	0.0%	-0.3%	0.1%	—	—	—
				CH_4	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
				N_2O	NE,NO	NE,NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
	F. Other Land	1. Other Land remaining Other Land		CO_2	—	—	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
		2. Land converted to Other Land		CO_2	1,567.30	1,049.01	—	—	12%	0.0%	0.0%	0.0%	0.1%	—	—	—
				CH_4	NO	NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
				N_2O	NO	NO	—	—	—	0.0%	0.0%	NA	NA	NA	NA	NA
	G. Other	CO_2 emissions from agricultural lime application		CO_2	550.22	268.25	9.2%	-50.0%	51%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6. Waste	A. Solid Waste Disposal on Land	1. Managed Wast Disposal on Land	Kitchen Garbage	CH_4	1,320.61	398.38	32.4%	42.4%	53%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
			Waste Paper	CH_4	3,060.53	1,305.50	42.7%	42.4%	60%	0.1%	0.0%	-0.1%	0.1%	-0.1%	0.1%	0.1%
			Waste Textile	CH_4	198.78	84.35	42.9%	43.8%	61%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Waste Wood	CH_4	966.07	935.84	56.6%	42.5%	71%	0.1%	0.0%	0.0%	0.1%	0.0%	0.1%	0.1%
			Sewage Sludge	CH_4	118.29	34.23	32.0%	44.2%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Other Sewage Sludge	CH_4	589.70	170.65	32.0%	44.2%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Human Waste Sludge	CH_4	260.92	68.65	32.6%	44.2%	55%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Water Purification Sludge	CH_4	72.66	34.71	31.7%	108.6%	113%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Organic Sludge from Manufacture	CH_4	1,029.57	210.56	33.4%	54.0%	63%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
			Livestock Waste	CH_4	29.62	27.74	49.4%	46.9%	68%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		3. Other	Illegal Disposal	CH_4	7.29	38.65	66.8%	42.5%	79%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	B. Wastewater Handling	1. Industrial Wastewater		CH_4	109.91	102.73	37.4%	60.0%	71%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	119.38	126.08	51.1%	300.0%	304%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		2. Domestic and Commercial Wastewater	Sewage Treatment Plant	CH_4	181.48	235.90	10.4%	30.9%	33%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	491.78	639.26	10.4%	145.7%	146%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
			Private Sewerage Tank	CH_4	451.84	425.51	10.0%	86.8%	87%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	468.72	270.93	10.0%	71.0%	72%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Human-Waste Treatment Plant	CH_4	110.14	13.77	12.3%	100.0%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	69.56	5.75	33.9%	100.0%	106%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Degradation of domestic wastewater in nature	CH_4	1,264.60	469.50	10.0%	75.4%	76%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
				N_2O	137.38	45.38	10.0%	75.4%	76%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	C. Waste Incineratior	Municipal Solid Waste	Plastics	CO_2	5,040.90	2,913.33	16.0%	4.3%	17%	0.0%	0.0%	-0.2%	0.2%	0.0%	0.1%	0.1%
			Waste textile	CO_2	503.19	570.53	22.4%	4.3%	23%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				CH_4	9.75	1.27	10.0%	100.2%	101%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	317.82	150.29	10.0%	40.6%	42%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Industrial Solid Waste	Waste Mineral Oil	CO_2	3,651.84	3,968.60	104.4%	4.8%	105%	0.4%	0.0%	0.0%	0.3%	0.0%	0.5%	0.5%
			Plastics	CO_2	2,120.24	4,646.22	100.0%	4.8%	100%	0.4%	0.0%	0.2%	0.4%	0.0%	0.6%	0.6%
				CH_4	3.60	8.88	100.0%	111.5%	150%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	1,195.67	1,471.06	100.0%	58.8%	116%	0.1%	0.0%	0.0%	0.1%	0.0%	0.2%	0.2%
		Specially Contorolled Industrial Solid Waste		CO_2	946.78	1,884.83	100.0%	133.1%	167%	0.3%	0.0%	0.1%	0.2%	0.1%	0.2%	0.2%
				CH_4	0.12	1.24	100.0%	100.3%	142%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	5.95	16.10	100.0%	123.2%	159%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	D. Oher	Decomposition of petroleum-derived surface-active agent		CO_2	702.83	513.71	10.0%	22.4%	25%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Composting of Organic Waste		CH_4	14.48	24.74	10.0%	73.3%	74%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
				N_2O	12.83	21.91	10.0%	85.7%	86%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Annex 8. Hierarchical Structure of Japan's National GHG Inventory File System

Multiple MS Excel files have been used when estimating Japanese inventory. The explanation of each MS Excel file and the hierarchical structure of Japanese National GHGs Inventory (JNGI) file system are shown below.

Table A 8-1 Explanation of each MS Excel file

category	file name	contents
	JPN-2011-1990-v1.1.xls ～ JPN-2011-2009-v1.1.xls	Common reporting format provided by UNFCCC secretariat
1. Energy	1A-L3-nonCO2-1990-2011.xls ～ 1A-L3-nonCO2-2009-2011.xls	Non-CO_2 emissions from stationary facilities
	1A-L3-CO2-1990-2011.xls ～ 1A-L3-CO2-2009-2011.xls	CO_2 emissions from fuel combustions
	1A-L3-NOxSO2-2011.xls	Emissions of Non-CO_2 from stationary combustion
	1A-L3-CRF-2011.xls	CRF format data of GHG emissions from fuel combution (including emissions by energy use of waste)
	1A-L3-timeseries-2011.xls	Time-series data of GHG emissions from fuel combution
	1A-L2-MAP-IEF-1990-2011.xls ～ 1A-L2-MAP_IEF-2009-2011.xls	Implied Emission Factors of Non-CO2 from stationary combustion
	1A-L2-nonCO2-ADEF-2011.xls	Activity Data and Emission Factors of Non-CO_2 from fuel combustion
	1A-L2-nonCO2-EF-2011.xls	Emission Factors of Non-CO_2 from fuel combustion
	1A-L2-EBEF-2011.xls	Emission Factors for CO_2 from fuel combustion
	1A-L1-EB-2011.xls	Data of the General Energy Statistics using in Mobile (CH_4, N_2O), Fugitive emissions from fuels and IP sector
	1A3-L3-CH4N2O-2011.xls	GHG emissions from Mobile Combustion (transport sector) (except CO_2)
	1A3-L2-ADEF-2011.xls	Activity Data and Emission Factors for Mobile Combustion (transport sector)
	1B-L3-2011.xls	Fugitive GHG emissions from fuels
	1B-L2-ADEF-2011.xls	Activity Data and Emission Factors for Fugitive Emissions from Fuels
2. Industrial Processes	2-L2-ADEF-2011.xls	Activity Data and Emission Factors of Caotegory2 (except F-gas)
	2-L3-2011.xls	GHG emissions from Category2 (Industrial Processes)
	2-L3-Fgas-2011.xls	F-gas (HFCs, PFCs, SF_6) emissions
3. Solvent and Other Product Use	3-L3-2011.xls	N2O emissions from anesthesia
4. Agriculture	4A-L3-CH4-2011.xls	CH_4 emissions from enteric fermentation
	4B-L3-CH4N2O-2011.xls	GHG emissions from manure management
	4C-L3-CH4-2011.xls	CH_4 emissions from rice cultivation
	4D-L3-N2O-2011.xls	N_2O emissions from agricultural soils
	4F-CH4N2OCO-2011.xls	GHG emissions from field burning of agricultural residues
	4-L2-ADEF-2011.xls	Activity Data and Emission Factors of Caotegory4
5. LULUCF	5-L3-nonCSC-2011.xls	GHG emissions excluindg carbon stock change
	5A-L3-CO2-2011.xls	CO_2 emissions and removals from forest land
	5B-L3-CO2-2011.xls	CO_2 emissions and removals from cropland
	5C-L3-CO2-2011.xls	CO_2 emissions and removals from grassland
	5D-L3-CO2-2011.xls	CO_2 emissions and removals from wetlands
	5E-L3-CO2-2011.xls	CO_2 emissions and removals from settlements
	5F-L3-CO2-2011.xls	CO_2 emissions and removals from other land
	5-L2-DOM-2011.xls	Carbon stock changes for dead organic matters (DOM)
	5-L2-Soil-2011.xls	Carbon stock changes for soils
	5-L2-LB-2011.xls	Carbon stock changes for living biomass
	5-L2-LandArea-2011.xls	Land area for each land use category
	5-L2-nonCSC-2011.xls	Activity data for GHG emissions excluindg carbon stock change
6. Waste	6A3-L2-AD-2011.xls	Activity data of solid waste disposal on land (other)
	6A-L3-2011.xls	GHGs emissions from solid waste disposal on land
	6A-L2-AD-2011.xls	Activity data of solid waste disposal on land
	6B-L3-2011.xls	GHGs emissions from wastewater handling
	6B-L2-AD-2011.xls	Activity data of wastewater handling
	6B-L2-EF-2011.xls	Emission Factor of wastewater handling
	6C-L3-nonCO2-2011.xls	GHGs emissions from waste incineration (exclude CO_2)
	6C-L2-AD-2011.xls	Activity data of waste incineration
	6C-L3-CO2-2011.xls	CO_2 emissions from waste incineration
	6C-L3-Energy-2011.xls	GHGs (CO2, CH4, N2O, CO, NOx, SOx, NMVOC) Emissions from the incineration of waste for energy and use as alternative fuels
	6D-L3-2011.xls	GHGs emissions from other waste
	6D-L2-2011.xls	Activity data of other waste
7. Other	7-L3-2011.xls	CO Emissions from tobaccos
Memo Item	1C-L3-bunker-2011.xls	GHGs emissions from bunker fuels

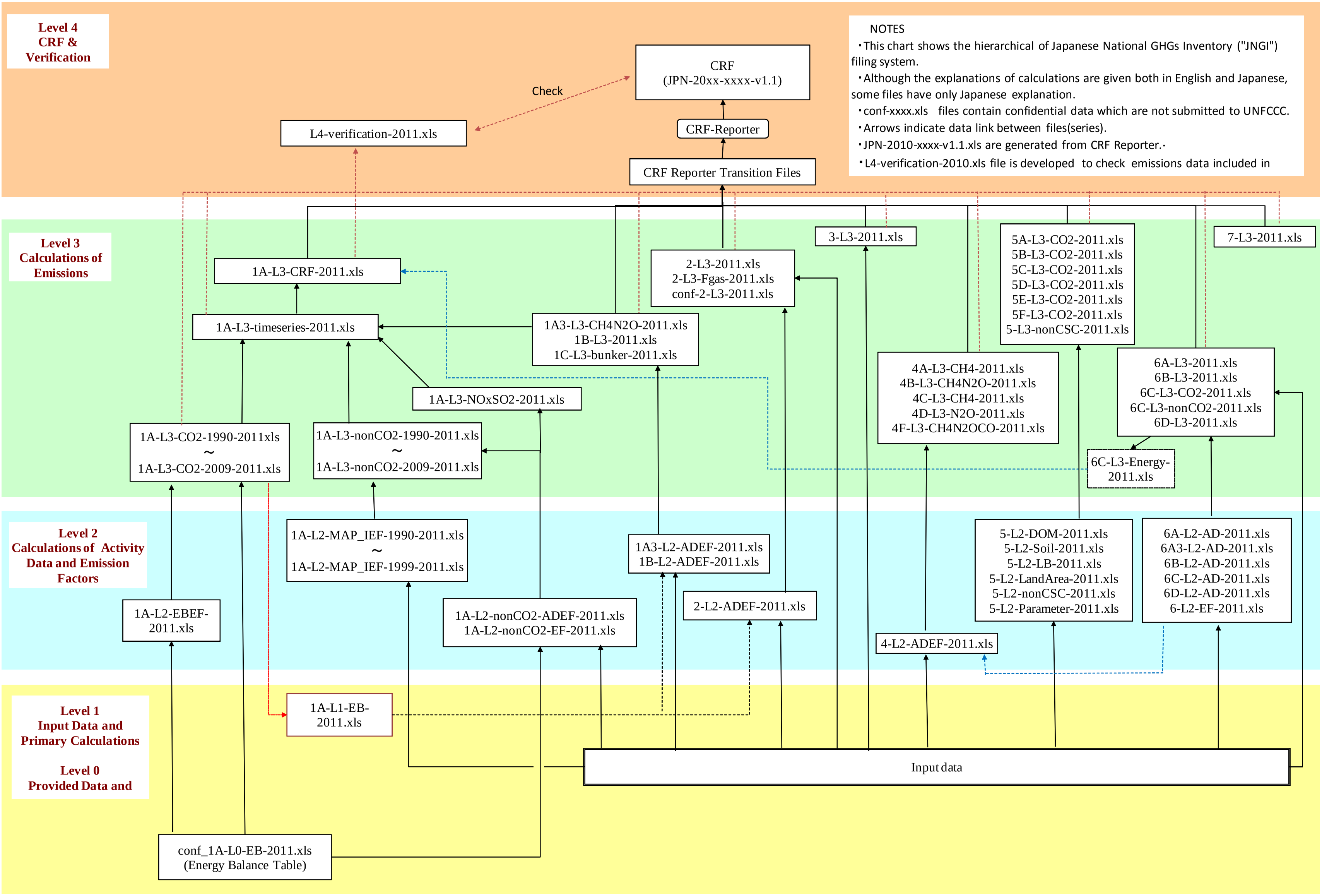
NOTES
・This chart shows the hierarchical of Japanese National GHGs Inventory ("JNGI") filing system.
・Although the explanations of calculations are given both in English and Japanese, some files have only Japanese explanation.
・conf-xxxx.xls files contain confidential data which are not submitted to UNFCCC.
・Arrows indicate data link between files(series).
・JPN-2010-xxxx-v1.1.xls are generated from CRF Reporter.・
・L4-verification-2010.xls file is developed to check emissions data included in

Figure A 8-1 Hierarchical structure of Japan's National GHG Inventory File System

Annex 9. Summary of Common Reporting Format

“Summary.2 Table” of the CRF indicated below shows emissions and removals for every year. During 1990-1994, Japan had reported only potential emissions of HFCs, PFCs, and SF_6. In Table.10 of the CRF showing the trend each year, between 1990 and 1994, the potential emissions of HFCs, PFCs, and SF_6 are shown, and from 1995 onward, actual emissions of HFCs, PFCs, SF_6 are shown.

A9.1. Emissions[1] and Removals in 1990

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1990
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
SINK CATEGORIES	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,071,520.21**	**31,909.66**	**31,706.03**	**17,930.00**	**5,670.00**	**38,240.00**	**1,196,975.91**
1. Energy	**1,068,296.26**	**3,927.00**	**6,778.53**				**1,079,001.79**
A. Fuel Combustion (Sectoral Approach)	1,068,259.64	889.86	6,778.42				1,075,927.91
1. Energy Industries	324,253.21	29.72	926.82				325,209.76
2. Manufacturing Industries and Construction	371,311.49	355.49	1,373.68				373,040.66
3. Transport	211,053.69	297.23	4,204.42				215,555.34
4. Other Sectors	161,641.24	207.42	273.50				162,122.16
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	36.62	3,037.14	0.11				3,073.88
1. Solid Fuels	NE,NO	2,806.43	NE,NO				2,806.43
2. Oil and Natural Gas	36.62	230.71	0.11				267.45
2. Industrial Processes	**59,934.01**	**357.58**	**8,266.95**	**17,930.00**	**5,670.00**	**38,240.00**	**130,398.54**
A. Mineral Products	55,368.85	NA,NO	NA,NO				55,368.85
B. Chemical Industry	4,209.07	338.22	8,266.95	NA	NA	NA	12,814.24
C. Metal Production	356.09	19.36	NO	IE,NE	IE,NA,NE	IE,NA,NE	375.45
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				17,930.00	5,670.00	38,240.00	61,840.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**287.07**				**287.07**
4. Agriculture		**17,831.10**	**13,463.55**				**31,294.64**
A. Enteric Fermentation		7,676.61					7,676.61
B. Manure Management		3,094.12	5,533.01				8,627.13
C. Rice Cultivation		6,959.68					6,959.68
D. Agricultural Soils(3)		NA	7,897.89				7,897.89
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		100.68	32.65				133.32
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-69,675.83**	**8.31**	**90.86**				**-69,576.66**
A. Forest Land	-78,636.21	8.31	0.84				-78,627.05
B. Cropland	2,532.77	NE,NO	90.02				2,622.79
C. Grassland	-441.28	NE,NO	NE,NO				-441.28
D. Wetlands	86.72	NE,NO	NE,NO				86.72
E. Settlements	4,664.64	NE,NO	NE,NO				4,664.64
F. Other Land	1,567.30	NO	NO				1,567.30
G. Other	550.22	NA,NE	NA,NE				550.22
6. Waste	**12,965.78**	**9,785.67**	**2,819.08**				**25,570.53**
A. Solid Waste Disposal on Land	NA,NE,NO	7,639.75					7,639.75
B. Waste-water Handling		2,117.96	1,286.81				3,404.77
C. Waste Incineration	12,262.95	13.48	1,519.44				13,795.87
D. Other	702.83	14.48	12.83				730.14
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	30,829.18	42.30	275.80				31,147.29
Aviation	13,189.32	7.84	130.44				13,327.60
Marine	17,639.86	34.47	145.36				17,819.69
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,747.30**						**18,747.30**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,266,552.57
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,196,975.91

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

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[1] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

A9.2. Emissions[2] and Removals in 1991

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS (Sheet 1 of 1)

Inventory 1991
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 (1)**	**CH_4**	**N_2O**	**HFCs (2)**	**PFCs (2)**	**SF_6 (2)**	**Total**
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,073,189.32**	**31,669.89**	**31,193.94**	**18,070.00**	**6,370.00**	**43,498.00**	**1,203,991.15**
1. Energy	**1,076,104.87**	**3,690.74**	**7,061.09**				**1,086,856.70**
A. Fuel Combustion (Sectoral Approach)	1,076,051.20	895.98	7,060.93				1,084,008.11
1. Energy Industries	326,986.60	31.16	959.89				327,977.66
2. Manufacturing Industries and Construction	366,282.86	356.15	1,453.74				368,092.74
3. Transport	222,466.79	299.61	4,367.41				227,133.82
4. Other Sectors	160,314.95	209.06	279.89				160,803.90
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	53.67	2,794.76	0.16				2,848.59
1. Solid Fuels	NE,NO	2,538.33	NE,NO				2,538.33
2. Oil and Natural Gas	53.67	256.43	0.16				310.26
2. Industrial Processes	**61,027.71**	**347.49**	**7,539.75**	**18,070.00**	**6,370.00**	**43,498.00**	**136,852.96**
A. Mineral Products	56,520.30	NA,NO	NA,NO				56,520.30
B. Chemical Industry	4,184.37	329.15	7,539.75	NA	NA	NA	12,053.27
C. Metal Production	323.04	18.34	NO	IE,NE	IE,NA,NE	IE,NA,NE	341.38
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				18,070.00	6,370.00	43,498.00	67,938.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**356.85**				**356.85**
4. Agriculture		**17,955.09**	**13,270.98**				**31,226.06**
A. Enteric Fermentation		7,787.92					7,787.92
B. Manure Management		3,089.18	5,501.83				8,591.01
C. Rice Cultivation		6,977.75					6,977.75
D. Agricultural Soils(3)		NA	7,736.49				7,736.49
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		100.24	32.66				132.90
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-76,927.83**	**6.22**	**84.80**				**-76,836.81**
A. Forest Land	-85,984.13	6.22	0.63				-85,977.28
B. Cropland	1,651.35	NE,NO	84.17				1,735.52
C. Grassland	-521.87	NE,NO	NE,NO				-521.87
D. Wetlands	78.26	NE,NO	NE,NO				78.26
E. Settlements	5,571.84	NE,NO	NE,NO				5,571.84
F. Other Land	1,749.44	NO	NO				1,749.44
G. Other	527.29	NA,NE	NA,NE				527.29
6. Waste	**12,984.57**	**9,670.35**	**2,880.48**				**25,535.40**
A. Solid Waste Disposal on Land	NA,NE,NO	7,569.93					7,569.93
B. Waste-water Handling		2,075.74	1,309.01				3,384.75
C. Waste Incineration	12,298.12	13.08	1,561.19				13,872.39
D. Other	686.45	11.60	10.28				708.32
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	32,531.98	44.64	291.02				32,867.64
Aviation	13,919.12	8.27	137.65				14,065.05
Marine	18,612.86	36.36	153.37				18,802.60
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,870.94**						**18,870.94**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,280,827.96
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,203,991.15

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

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[2] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

A9.3. Emissions[3] and Removals in 1992

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1992
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,081,951.12**	**31,404.63**	**31,348.39**	**19,750.00**	**6,370.00**	**47,800.00**	**1,218,624.14**
1. Energy	**1,083,526.98**	**3,438.11**	**7,257.04**				**1,094,222.12**
A. Fuel Combustion (Sectoral Approach)	1,083,470.03	910.77	7,256.86				1,091,637.66
1. Energy Industries	333,717.45	31.85	931.52				334,680.82
2. Manufacturing Industries and Construction	358,404.85	352.17	1,571.52				360,328.54
3. Transport	226,859.69	302.67	4,459.34				231,621.71
4. Other Sectors	164,488.04	224.07	294.48				165,006.59
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	56.95	2,527.34	0.17				2,584.46
1. Solid Fuels	NE,NO	2,267.52	NE,NO				2,267.52
2. Oil and Natural Gas	56.95	259.82	0.17				316.94
2. Industrial Processes	**61,026.54**	**322.22**	**7,452.41**	**19,750.00**	**6,370.00**	**47,800.00**	**142,721.16**
A. Mineral Products	56,600.40	NA,NO	NA,NO				56,600.40
B. Chemical Industry	4,101.09	304.45	7,452.41	NA	NA	NA	11,857.96
C. Metal Production	325.05	17.76	NO	IE,NE	IE,NA,NE	IE,NA,NE	342.81
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				19,750.00	6,370.00	47,800.00	73,920.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**413.01**				**413.01**
4. Agriculture		**18,044.60**	**13,141.65**				**31,186.25**
A. Enteric Fermentation		7,830.18					7,830.18
B. Manure Management		3,061.96	5,457.83				8,519.79
C. Rice Cultivation		7,059.04					7,059.04
D. Agricultural Soils(3)		NA	7,653.03				7,653.03
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		93.42	30.79				124.21
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-76,626.63**	**4.34**	**79.83**				**-76,542.46**
A. Forest Land	-86,327.89	4.34	0.44				-86,323.11
B. Cropland	1,746.62	NE,NO	79.39				1,826.01
C. Grassland	-465.57	NE,NO	NE,NO				-465.57
D. Wetlands	248.68	NE,NO	NE,NO				248.68
E. Settlements	6,259.38	NE,NO	NE,NO				6,259.38
F. Other Land	1,435.05	NO	NO				1,435.05
G. Other	477.11	NA,NE	NA,NE				477.11
6. Waste	**14,024.24**	**9,595.37**	**3,004.45**				**26,624.06**
A. Solid Waste Disposal on Land	NA,NE,NO	7,533.47					7,533.47
B. Waste-water Handling		2,036.55	1,294.27				3,330.82
C. Waste Incineration	13,325.34	13.43	1,699.63				15,038.41
D. Other	698.90	11.91	10.55				721.37
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	32,937.28	45.03	294.87				33,277.18
Aviation	14,216.76	8.45	140.60				14,365.81
Marine	18,720.51	36.58	154.28				18,911.37
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,419.27**						**18,419.27**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,295,166.60
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,218,624.14

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

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[3] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

A9.4. Emissions[4] and Removals in 1993

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1993
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,071,408.89**	**31,153.23**	**31,099.48**	**21,310.00**	**8,860.00**	**45,410.00**	**1,209,241.61**
1. Energy	**1,077,164.28**	**3,268.92**	**7,311.16**				**1,087,744.36**
A. Fuel Combustion (Sectoral Approach)	1,077,111.06	929.70	7,311.00				1,085,351.76
1. Energy Industries	315,598.93	31.64	939.88				316,570.45
2. Manufacturing Industries and Construction	357,499.46	352.95	1,615.27				359,467.67
3. Transport	231,727.93	295.51	4,432.21				236,455.65
4. Other Sectors	172,284.75	249.59	323.64				172,857.98
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	53.21	2,339.23	0.16				2,392.61
1. Solid Fuels	NE,NO	2,075.76	NE,NO				2,075.76
2. Oil and Natural Gas	53.21	263.46	0.16				316.84
2. Industrial Processes	**59,959.49**	**320.55**	**7,302.85**	**21,310.00**	**8,860.00**	**45,410.00**	**143,162.89**
A. Mineral Products	55,733.90	NA,NO	NA,NO				55,733.90
B. Chemical Industry	3,894.83	303.85	7,302.85	NA	NA	NA	11,501.53
C. Metal Production	330.76	16.70	NO	IE,NE	IE,NA,NE	IE,NA,NE	347.46
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				21,310.00	8,860.00	45,410.00	75,580.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**411.66**				**411.66**
4. Agriculture		**18,127.86**	**12,984.96**				**31,112.82**
A. Enteric Fermentation		7,781.42					7,781.42
B. Manure Management		3,002.79	5,364.14				8,366.93
C. Rice Cultivation		7,247.60					7,247.60
D. Agricultural Soils(3)		NA	7,588.86				7,588.86
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		96.05	31.97				128.02
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-79,488.92**	**23.91**	**76.16**				**-79,388.85**
A. Forest Land	-86,671.65	23.91	2.43				-86,645.31
B. Cropland	931.02	NE,NO	73.73				1,004.75
C. Grassland	-539.60	NE,NO	NE,NO				-539.60
D. Wetlands	139.59	NE,NO	NE,NO				139.59
E. Settlements	4,401.59	NE,NO	NE,NO				4,401.59
F. Other Land	1,768.57	NO	NO				1,768.57
G. Other	481.56	NA,NE	NA,NE				481.56
6. Waste	**13,774.05**	**9,411.99**	**3,012.69**				**26,198.72**
A. Solid Waste Disposal on Land	NA,NE,NO	7,400.77					7,400.77
B. Waste-water Handling		1,985.41	1,298.13				3,283.54
C. Waste Incineration	13,093.30	13.36	1,703.54				14,810.19
D. Other	680.75	12.45	11.03				704.22
7. Other ***(as specified in Summary 1.A)***	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	34,935.20	49.40	310.66				35,295.26
Aviation	13,856.19	8.23	137.03				14,001.45
Marine	21,079.01	41.17	173.63				21,293.81
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**17,568.73**						**17,568.73**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,288,630.46
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,209,241.61

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

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[4] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

A9.5. Emissions[5] and Removals in 1994

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1994
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,129,465.89**	**30,470.74**	**32,264.48**	**28,840.00**	**12,274.00**	**45,410.00**	**1,278,725.11**
1. Energy	**1,133,210.28**	**2,907.80**	**7,611.05**				**1,143,729.13**
A. Fuel Combustion (Sectoral Approach)	1,133,159.13	928.26	7,610.90				1,141,698.29
1. Energy Industries	356,359.51	33.79	1,011.78				357,405.09
2. Manufacturing Industries and Construction	365,878.17	361.90	1,758.80				367,998.87
3. Transport	243,681.03	297.21	4,513.41				248,491.64
4. Other Sectors	167,240.42	235.36	326.91				167,802.69
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	51.15	1,979.53	0.16				2,030.84
1. Solid Fuels	NE,NO	1,712.96	NE,NO				1,712.96
2. Oil and Natural Gas	51.15	266.57	0.16				317.88
2. Industrial Processes	**61,189.78**	**320.85**	**8,298.10**	**28,840.00**	**12,274.00**	**45,410.00**	**156,332.74**
A. Mineral Products	56,698.93	NA,NO	NA,NO				56,698.93
B. Chemical Industry	4,145.10	303.40	8,298.10	NA	NA	NA	12,746.60
C. Metal Production	345.76	17.45	NO	IE,NE	IE,NA,NE	IE,NA,NE	363.21
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				NE,NO	NE,NO	NE,NO	NE,NO
F. Consumption of Halocarbons and SF_6 (2)				28,840.00	12,274.00	45,410.00	86,524.00
G. Other	NO	NO	NO	NE,NO	NE,NO	NE,NO	NE,NO
3. Solvent and Other Product Use	**NA,NE**		**438.02**				**438.02**
4. Agriculture		**17,990.78**	**12,708.49**				**30,699.27**
A. Enteric Fermentation		7,691.88					7,691.88
B. Manure Management		2,942.69	5,250.91				8,193.60
C. Rice Cultivation		7,263.40					7,263.40
D. Agricultural Soils(3)		NA	7,426.42				7,426.42
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		92.82	31.15				123.97
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-81,203.08**	**17.75**	**69.79**				**-81,115.54**
A. Forest Land	-87,015.40	17.75	1.80				-86,995.85
B. Cropland	881.33	NE,NO	67.99				949.32
C. Grassland	-507.62	NE,NO	NE,NO				-507.62
D. Wetlands	116.81	NE,NO	NE,NO				116.81
E. Settlements	3,363.06	NE,NO	NE,NO				3,363.06
F. Other Land	1,666.01	NO	NO				1,666.01
G. Other	292.73	NA,NE	NA,NE				292.73
6. Waste	**16,268.90**	**9,233.56**	**3,139.03**				**28,641.50**
A. Solid Waste Disposal on Land	NA,NE,NO	7,288.13					7,288.13
B. Waste-water Handling		1,919.78	1,261.42				3,181.21
C. Waste Incineration	15,566.99	14.49	1,867.73				17,449.21
D. Other	701.91	11.15	9.88				722.95
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	36,093.69	50.02	322.19				36,465.90
Aviation	15,066.49	8.95	149.00				15,224.44
Marine	21,027.20	41.06	173.19				21,241.46
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**17,803.39**						**17,803.39**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,359,840.65
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,278,725.11

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

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[5] Potential emissions of HFCs, PFCs and SF_6 are reported due to the generation of CRF Reporter

A9.6. Emissions and Removals in 1995

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1995
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 [1]**	**CH_4**	**N_2O**	**HFCs [2]**	**PFCs [2]**	**SF_6 [2]**	**Total**
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**1,142,109.93**	**29,614.03**	**32,718.60**	**20,260.17**	**14,240.36**	**16,961.45**	**1,255,904.54**
1. Energy	**1,145,820.01**	**2,647.39**	**8,346.53**				**1,156,813.93**
A. Fuel Combustion (Sectoral Approach)	1,145,769.09	1,037.51	8,346.38				1,155,152.98
1. Energy Industries	344,948.18	34.41	1,432.52				346,415.12
2. Manufacturing Industries and Construction	370,539.38	437.59	1,915.66				372,892.64
3. Transport	251,166.53	308.40	4,649.84				256,124.77
4. Other Sectors	179,115.00	257.11	348.35				179,720.46
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	50.92	1,609.87	0.16				1,660.95
1. Solid Fuels	NE,NO	1,344.68	NE,NO				1,344.68
2. Oil and Natural Gas	50.92	265.19	0.16				316.26
2. Industrial Processes	**61,338.27**	**322.37**	**8,212.71**	**20,260.17**	**14,240.36**	**16,961.45**	**121,335.34**
A. Mineral Products	56,761.48	NA,NO	NA,NO				56,761.48
B. Chemical Industry	4,219.57	304.45	8,212.71	NA	NA	NA	12,736.73
C. Metal Production	357.22	17.92	NO	IE,NE	69.74	119.50	564.38
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				17,445.12	762.85	4,708.30	22,916.27
F. Consumption of Halocarbons and SF_6 [2]				2,815.05	13,407.78	12,133.65	28,356.48
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**437.58**				**437.58**
4. Agriculture		**17,676.22**	**12,393.98**				**30,070.21**
A. Enteric Fermentation		7,606.43					7,606.43
B. Manure Management		2,893.04	5,151.97				8,045.01
C. Rice Cultivation		7,082.74					7,082.74
D. Agricultural Soils [3]		NA	7,210.41				7,210.41
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		94.01	31.61				125.62
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry [1]	**-81,582.75**	**8.66**	**61.58**				**-81,512.51**
A. Forest Land	-87,359.16	8.66	0.88				-87,349.63
B. Cropland	825.54	NE,NO	60.71				886.25
C. Grassland	-480.65	NE,NO	NE,NO				-480.65
D. Wetlands	362.83	NE,NO	NE,NO				362.83
E. Settlements	3,278.38	NE,NO	NE,NO				3,278.38
F. Other Land	1,486.82	NO	NO				1,486.82
G. Other	303.50	NA,NE	NA,NE				303.50
6. Waste	**16,534.40**	**8,959.39**	**3,266.21**				**28,760.00**
A. Solid Waste Disposal on Land	NA,NE,NO	7,073.71					7,073.71
B. Waste-water Handling		1,859.33	1,243.89				3,103.22
C. Waste Incineration	15,866.57	14.87	2,012.15				17,893.59
D. Other	667.83	11.48	10.17				689.48
7. Other ***(as specified in Summary 1.A)***	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: [4]							
International Bunkers	38,179.77	51.56	342.39				38,573.71
Aviation	16,922.99	10.06	167.36				17,100.41
Marine	21,256.78	41.50	175.03				21,473.30
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,487.35**						**18,487.35**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,337,417.05
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,255,904.54

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.7. Emissions and Removals in 1996

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1996
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,150,321.76**	**28,881.55**	**33,712.55**	**19,906.20**	**14,783.02**	**17,535.35**	**1,265,140.42**
1. Energy	**1,157,958.90**	**2,521.89**	**8,482.92**				**1,168,963.72**
A. Fuel Combustion (Sectoral Approach)	1,157,909.53	961.40	8,482.77				1,167,353.70
1. Energy Industries	345,134.72	36.20	1,463.73				346,634.65
2. Manufacturing Industries and Construction	378,811.73	380.74	1,979.75				381,172.22
3. Transport	256,750.56	314.17	4,736.70				261,801.43
4. Other Sectors	177,212.53	230.29	302.59				177,745.40
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	49.37	1,560.49	0.15				1,610.01
1. Solid Fuels	NE,NO	1,297.15	NE,NO				1,297.15
2. Oil and Natural Gas	49.37	263.34	0.15				312.86
2. Industrial Processes	**61,696.11**	**312.02**	**9,220.07**	**19,906.20**	**14,783.02**	**17,535.35**	**123,452.75**
A. Mineral Products	57,112.69	NA,NO	NA,NO				57,112.69
B. Chemical Industry	4,203.43	293.80	9,220.07	NA	NA	NA	13,717.30
C. Metal Production	379.99	18.22	NO	IE,NE	65.88	143.40	607.48
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				16,052.32	1,007.80	4,182.50	21,242.62
F. Consumption of Halocarbons and SF_6 (2)				3,853.88	13,709.34	13,209.45	30,772.67
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**420.94**				**420.94**
4. Agriculture		**17,294.20**	**12,120.82**				**29,415.02**
A. Enteric Fermentation		7,551.46					7,551.46
B. Manure Management		2,859.09	5,089.03				7,948.13
C. Rice Cultivation		6,793.69					6,793.69
D. Agricultural Soils(3)		NA	7,001.56				7,001.56
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		89.96	30.22				120.18
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-86,284.10**	**28.37**	**54.46**				**-86,201.28**
A. Forest Land	-91,333.96	28.37	2.88				-91,302.72
B. Cropland	658.84	NE,NO	51.58				710.41
C. Grassland	-464.36	NE,NO	NE,NO				-464.36
D. Wetlands	650.92	NE,NO	NE,NO				650.92
E. Settlements	2,532.97	NE,NO	NE,NO				2,532.97
F. Other Land	1,378.79	NO	NO				1,378.79
G. Other	292.70	NA,NE	NA,NE				292.70
6. Waste	**16,950.85**	**8,725.08**	**3,413.34**				**29,089.27**
A. Solid Waste Disposal on Land	NA,NE,NO	6,874.27					6,874.27
B. Waste-water Handling		1,823.78	1,266.03				3,089.80
C. Waste Incineration	16,310.38	15.24	2,136.87				18,462.50
D. Other	640.47	11.79	10.44				662.70
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	30,958.25	35.39	285.44				31,279.08
Aviation	18,441.91	10.96	182.38				18,635.25
Marine	12,516.34	24.43	103.06				12,643.83
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,547.51**						**18,547.51**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,351,341.70
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,265,140.42

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.8. Emissions and Removals in 1997

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1997
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 (1)**	**CH_4**	**N_2O**	**HFCs (2)**	**PFCs (2)**	**SF_6 (2)**	**Total**
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,144,914.91**	**27,829.57**	**34,380.04**	**19,905.11**	**16,164.62**	**14,998.12**	**1,258,192.37**
1. Energy	**1,154,948.65**	**2,227.88**	**8,714.35**				**1,165,890.88**
A. Fuel Combustion (Sectoral Approach)	1,154,900.68	950.64	8,714.20				1,164,565.52
1. Energy Industries	342,054.20	38.03	1,509.35				343,601.58
2. Manufacturing Industries and Construction	381,142.92	361.97	2,114.78				383,619.67
3. Transport	258,734.10	315.25	4,784.51				263,833.85
4. Other Sectors	172,969.46	235.38	305.56				173,510.41
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	47.97	1,277.25	0.15				1,325.37
1. Solid Fuels	NE,NO	1,006.86	NE,NO				1,006.86
2. Oil and Natural Gas	47.97	270.39	0.15				318.51
2. Industrial Processes	**59,024.03**	**260.90**	**9,792.47**	**19,905.11**	**16,164.62**	**14,998.12**	**120,145.24**
A. Mineral Products	54,495.36	NA,NO	NA,NO				54,495.36
B. Chemical Industry	4,144.19	242.58	9,792.47	NA	NA	NA	14,179.23
C. Metal Production	384.48	18.33	NO	IE,NE	59.43	191.20	653.44
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				15,077.99	1,416.80	2,581.20	19,075.99
F. Consumption of Halocarbons and SF_6 (2)				4,827.12	14,688.39	12,225.72	31,741.22
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**404.60**				**404.60**
4. Agriculture		**16,847.98**	**11,927.58**				**28,775.56**
A. Enteric Fermentation		7,505.45					7,505.45
B. Manure Management		2,816.67	5,031.14				7,847.81
C. Rice Cultivation		6,440.28					6,440.28
D. Agricultural Soils(3)		NA	6,867.78				6,867.78
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		85.58	28.66				114.24
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-86,604.99**	**34.31**	**46.00**				**-86,524.68**
A. Forest Land	-91,176.64	34.31	3.48				-91,138.84
B. Cropland	541.92	NE,NO	42.52				584.44
C. Grassland	-446.63	NE,NO	NE,NO				-446.63
D. Wetlands	124.53	NE,NO	NE,NO				124.53
E. Settlements	2,178.68	NE,NO	NE,NO				2,178.68
F. Other Land	1,869.53	NO	NO				1,869.53
G. Other	303.61	NA,NE	NA,NE				303.61
6. Waste	**17,547.22**	**8,458.50**	**3,495.04**				**29,500.76**
A. Solid Waste Disposal on Land	NA,NE,NO	6,654.04					6,654.04
B. Waste-water Handling		1,777.43	1,275.81				3,053.24
C. Waste Incineration	16,891.99	14.71	2,208.32				19,115.02
D. Other	655.23	12.32	10.91				678.46
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	35,432.29	43.17	323.34				35,798.80
Aviation	19,134.37	11.37	189.23				19,334.97
Marine	16,297.92	31.80	134.12				16,463.84
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**19,107.10**						**19,107.10**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,344,717.05
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,258,192.37

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.9. Emissions and Removals in 1998

SUMMARY 2 SUMMARY REPORT FOR CO$_2$ EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1998
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO$_2$ [(1)]	CH$_4$	N$_2$O	HFCs [(2)]	PFCs [(2)]	SF$_6$ [(2)]	Total
	CO$_2$ equivalent (Gg)						
Total (Net Emissions) [(1)]	**1,109,518.45**	**27,005.29**	**32,844.55**	**19,415.96**	**13,411.82**	**13,624.11**	**1,215,820.18**
1. Energy	**1,125,032.90**	**2,058.76**	**8,582.18**				**1,135,673.84**
A. Fuel Combustion (Sectoral Approach)	1,124,990.17	920.79	8,582.05				1,134,493.00
1. Energy Industries	332,405.28	39.82	1,534.40				333,979.50
2. Manufacturing Industries and Construction	357,838.95	324.21	2,038.11				360,201.27
3. Transport	257,853.86	304.24	4,685.71				262,843.81
4. Other Sectors	176,892.07	252.52	323.83				177,468.42
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	42.73	1,137.98	0.13				1,180.84
1. Solid Fuels	NE,NO	872.46	NE,NO				872.46
2. Oil and Natural Gas	42.73	265.52	0.13				308.38
2. Industrial Processes	**53,376.38**	**243.52**	**8,577.87**	**19,415.96**	**13,411.82**	**13,624.11**	**108,649.67**
A. Mineral Products	49,443.45	NA,NO	NA,NO				49,443.45
B. Chemical Industry	3,639.82	227.37	8,577.87	NA	NA	NA	12,445.07
C. Metal Production	293.11	16.15	NO	IE,NE	49.40	406.30	764.96
D. Other Production	IE						IE
E. Production of Halocarbons and SF$_6$				14,053.43	1,389.50	2,103.20	17,546.13
F. Consumption of Halocarbons and SF$_6$ [(2)]				5,362.53	11,972.92	11,114.61	28,450.06
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**377.05**				**377.05**
4. Agriculture		**16,548.59**	**11,786.46**				**28,335.05**
A. Enteric Fermentation		7,466.79					7,466.79
B. Manure Management		2,770.83	4,986.39				7,757.21
C. Rice Cultivation		6,229.14					6,229.14
D. Agricultural Soils[(3)]		NA	6,772.69				6,772.69
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		81.84	27.39				109.23
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[(1)]	**-86,411.02**	**10.68**	**39.79**				**-86,360.55**
A. Forest Land	-91,019.31	10.68	1.08				-91,007.55
B. Cropland	549.38	NE,NO	38.71				588.09
C. Grassland	-421.04	NE,NO	NE,NO				-421.04
D. Wetlands	504.37	NE,NO	NE,NO				504.37
E. Settlements	2,168.35	NE,NO	NE,NO				2,168.35
F. Other Land	1,507.25	NO	NO				1,507.25
G. Other	299.97	NA,NE	NA,NE				299.97
6. Waste	**17,520.19**	**8,143.73**	**3,481.20**				**29,145.12**
A. Solid Waste Disposal on Land	NA,NE,NO	6,384.58					6,384.58
B. Waste-water Handling		1,732.18	1,258.77				2,990.95
C. Waste Incineration	16,911.07	14.53	2,211.41				19,137.01
D. Other	609.12	12.44	11.02				632.58
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: [(4)]							
International Bunkers	37,361.08	45.77	340.73				37,747.59
Aviation	20,001.55	11.89	197.80				20,211.24
Marine	17,359.53	33.89	142.93				17,536.35
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO$_2$ Emissions from Biomass	**17,556.58**						**17,556.58**

Total CO$_2$ Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,302,180.73
Total CO$_2$ Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,215,820.18

(1) For CO$_2$ from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO$_2$ from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.10. Emissions and Removals in 1999

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1999
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,144,239.34**	**26,387.23**	**26,411.47**	**19,934.46**	**10,395.49**	**9,309.93**	**1,236,677.93**
1. Energy	**1,160,147.36**	**2,078.35**	**8,802.38**				**1,171,028.08**
A. Fuel Combustion (Sectoral Approach)	1,160,109.30	949.93	8,802.26				1,169,861.49
1. Energy Industries	349,785.30	42.67	1,636.33				351,464.31
2. Manufacturing Industries and Construction	365,074.78	328.47	2,128.16				367,531.41
3. Transport	260,017.18	302.99	4,679.03				264,999.20
4. Other Sectors	185,232.04	275.79	358.74				185,866.57
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	38.06	1,128.42	0.12				1,166.60
1. Solid Fuels	NE,NO	865.69	NE,NO				865.69
2. Oil and Natural Gas	38.06	262.73	0.12				300.91
2. Industrial Processes	**53,400.15**	**236.22**	**2,000.86**	**19,934.46**	**10,395.49**	**9,309.93**	**95,277.12**
A. Mineral Products	49,180.61	NA,NO	NA,NO				49,180.61
B. Chemical Industry	3,965.06	220.14	2,000.86	NA	NA	NA	6,186.06
C. Metal Production	254.49	16.08	NO	IE,NE	29.12	645.30	944.99
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				14,260.55	1,270.88	1,529.60	17,061.03
F. Consumption of Halocarbons and SF_6 (2)				5,673.90	9,095.49	7,135.03	21,904.42
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**362.53**				**362.53**
4. Agriculture		**16,228.80**	**11,694.07**				**27,922.87**
A. Enteric Fermentation		7,407.75					7,407.75
B. Manure Management		2,717.58	4,933.09				7,650.67
C. Rice Cultivation		6,024.77					6,024.77
D. Agricultural Soils(3)		NA	6,734.81				6,734.81
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		78.70	26.17				104.87
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-86,638.01**	**5.20**	**36.08**				**-86,596.72**
A. Forest Land	-90,861.99	5.20	0.53				-90,856.25
B. Cropland	510.96	NE,NO	35.55				546.51
C. Grassland	-408.04	NE,NO	NE,NO				-408.04
D. Wetlands	480.13	NE,NO	NE,NO				480.13
E. Settlements	1,776.49	NE,NO	NE,NO				1,776.49
F. Other Land	1,570.93	NO	NO				1,570.93
G. Other	293.52	NA,NE	NA,NE				293.52
6. Waste	**17,329.84**	**7,838.67**	**3,515.54**				**28,684.05**
A. Solid Waste Disposal on Land	NA,NE,NO	6,128.80					6,128.80
B. Waste-water Handling		1,683.35	1,221.57				2,904.92
C. Waste Incineration	16,677.27	14.04	2,282.92				18,974.22
D. Other	652.58	12.48	11.05				676.10
7. Other ***(as specified in Summary 1.A)***	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	36,022.49	43.75	329.04				36,395.28
Aviation	19,576.46	11.63	193.60				19,781.70
Marine	16,446.03	32.11	135.44				16,613.59
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,260.06**						**18,260.06**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,323,274.65
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,236,677.93

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.11. Emissions and Removals in 2000

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2000
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,164,226.90**	**25,796.91**	**28,978.85**	**18,800.43**	**9,519.49**	**7,188.49**	**1,254,511.08**
1. Energy	**1,180,079.82**	**2,006.00**	**8,821.40**				**1,190,907.22**
A. Fuel Combustion (Sectoral Approach)	1,180,043.79	962.85	8,821.29				1,189,827.94
1. Energy Industries	357,574.13	43.63	1,719.13				359,336.89
2. Manufacturing Industries and Construction	376,777.84	351.50	2,152.76				379,282.10
3. Transport	259,076.39	297.91	4,586.55				263,960.85
4. Other Sectors	186,615.43	269.81	362.85				187,248.08
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	36.03	1,043.15	0.11				1,079.29
1. Solid Fuels	NE,NO	769.13	NE,NO				769.13
2. Oil and Natural Gas	36.03	274.02	0.11				310.16
2. Industrial Processes	**53,983.02**	**195.78**	**4,690.09**	**18,800.43**	**9,519.49**	**7,188.49**	**94,377.30**
A. Mineral Products	49,841.59	NA,NO	NA,NO				49,841.59
B. Chemical Industry	3,893.01	178.95	4,690.09	NA	NA	NA	8,762.04
C. Metal Production	248.42	16.84	NO	IE,NE	17.78	1,027.70	1,310.74
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				12,659.84	1,359.00	860.40	14,879.24
F. Consumption of Halocarbons and SF_6 (2)				6,140.59	8,142.70	5,300.39	19,583.69
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**340.99**				**340.99**
4. Agriculture		**16,044.72**	**11,613.08**				**27,657.80**
A. Enteric Fermentation		7,369.97					7,369.97
B. Manure Management		2,677.89	4,884.82				7,562.71
C. Rice Cultivation		5,919.76					5,919.76
D. Agricultural Soils(3)		NA	6,702.76				6,702.76
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		77.10	25.50				102.60
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-87,329.80**	**7.75**	**32.70**				**-87,289.34**
A. Forest Land	-90,704.66	7.75	0.79				-90,696.12
B. Cropland	356.18	NE,NO	31.91				388.09
C. Grassland	-405.73	NE,NO	NE,NO				-405.73
D. Wetlands	453.04	NE,NO	NE,NO				453.04
E. Settlements	1,407.49	NE,NO	NE,NO				1,407.49
F. Other Land	1,231.02	NO	NO				1,231.02
G. Other	332.87	NA,NE	NA,NE				332.87
6. Waste	**17,493.86**	**7,542.66**	**3,480.59**				**28,517.10**
A. Solid Waste Disposal on Land	NA,NE,NO	5,880.99					5,880.99
B. Waste-water Handling		1,635.02	1,208.89				2,843.91
C. Waste Incineration	16,837.95	13.33	2,259.90				19,111.18
D. Other	655.91	13.31	11.79				681.02
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	36,731.88	45.17	333.30				37,110.35
Aviation	19,542.61	11.61	191.78				19,746.00
Marine	17,189.28	33.55	141.52				17,364.35
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,846.04**						**18,846.04**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,341,800.42
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,254,511.08

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.12. Emissions and Removals in 2001

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2001
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,148,954.63**	**25,003.99**	**25,542.32**	**16,168.06**	**7,902.31**	**5,962.42**	**1,229,533.73**
1. Energy	**1,167,416.32**	**1,771.66**	**8,835.12**				**1,178,023.11**
A. Fuel Combustion (Sectoral Approach)	1,167,383.88	933.48	8,835.02				1,177,152.39
1. Energy Industries	349,730.24	43.68	1,945.07				351,718.99
2. Manufacturing Industries and Construction	366,480.21	325.89	2,111.49				368,917.59
3. Transport	261,120.73	292.19	4,409.50				265,822.42
4. Other Sectors	190,052.70	271.72	368.97				190,693.38
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	32.44	838.18	0.10				870.72
1. Solid Fuels	NE,NO	570.30	NE,NO				570.30
2. Oil and Natural Gas	32.44	267.88	0.10				300.42
2. Industrial Processes	**52,758.23**	**147.50**	**1,414.89**	**16,168.06**	**7,902.31**	**5,962.42**	**84,353.40**
A. Mineral Products	48,948.92	NA,NO	NA,NO				48,948.92
B. Chemical Industry	3,598.60	131.66	1,414.89	NA	NA	NA	5,145.14
C. Metal Production	210.71	15.84	NO	IE,NE	15.73	1,147.20	1,389.48
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				9,713.43	1,082.60	788.70	11,584.73
F. Consumption of Halocarbons and SF_6 (2)				6,454.63	6,803.99	4,026.52	17,285.13
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**343.60**				**343.60**
4. Agriculture		**15,863.11**	**11,525.63**				**27,388.74**
A. Enteric Fermentation		7,325.24					7,325.24
B. Manure Management		2,652.15	4,839.23				7,491.39
C. Rice Cultivation		5,810.23					5,810.23
D. Agricultural Soils(3)		NA	6,661.64				6,661.64
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		75.49	24.75				100.24
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-87,465.86**	**12.34**	**29.83**				**-87,423.69**
A. Forest Land	-90,547.34	12.34	1.25				-90,533.74
B. Cropland	295.53	NE,NO	28.58				324.11
C. Grassland	-393.90	NE,NO	NE,NO				-393.90
D. Wetlands	415.71	NE,NO	NE,NO				415.71
E. Settlements	1,186.08	NE,NO	NE,NO				1,186.08
F. Other Land	1,330.74	NO	NO				1,330.74
G. Other	247.31	NA,NE	NA,NE				247.31
6. Waste	**16,245.95**	**7,209.37**	**3,393.25**				**26,848.57**
A. Solid Waste Disposal on Land	NA,NE,NO	5,600.63					5,600.63
B. Waste-water Handling		1,581.70	1,190.95				2,772.65
C. Waste Incineration	15,615.42	12.61	2,189.52				17,817.54
D. Other	630.53	14.44	12.79				657.75
7. Other ***(as specified in Summary 1.A)***	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	33,571.42	40.10	305.92				33,917.44
Aviation	18,721.34	11.13	183.72				18,916.19
Marine	14,850.08	28.97	122.20				15,001.25
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**17,203.99**						**17,203.99**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,316,957.42
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,229,533.73

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.13. Emissions and Removals in 2002

SUMMARY 2 SUMMARY REPORT FOR CO$_2$ EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2002
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO$_2$ (1)	CH$_4$	N$_2$O	HFCs (2)	PFCs (2)	SF$_6$ (2)	Total
	CO$_2$ equivalent (Gg)						
Total (Net Emissions) (1)	**1,184,858.08**	**24,057.20**	**24,806.99**	**13,693.03**	**7,388.02**	**5,579.50**	**1,260,382.82**
1. Energy	**1,207,916.78**	**1,339.37**	**8,541.93**				**1,217,798.09**
A. Fuel Combustion (Sectoral Approach)	1,207,885.84	932.94	8,541.83				1,217,360.62
1. Energy Industries	381,372.56	35.64	1,879.01				383,287.21
2. Manufacturing Industries and Construction	372,966.83	330.83	2,128.68				375,426.34
3. Transport	255,478.88	281.62	4,148.14				259,908.63
4. Other Sectors	198,067.58	284.85	386.01				198,738.44
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	30.94	406.44	0.10				437.47
1. Solid Fuels	NE,NO	118.34	NE,NO				118.34
2. Oil and Natural Gas	30.94	288.10	0.10				319.13
2. Industrial Processes	**49,951.88**	**141.54**	**1,238.77**	**13,693.03**	**7,388.02**	**5,579.50**	**77,992.75**
A. Mineral Products	46,345.45	NA,NO	NA,NO				46,345.45
B. Chemical Industry	3,385.48	124.90	1,238.77	NA	NA	NA	4,749.16
C. Metal Production	220.95	16.64	NO	IE,NE	14.83	1,123.30	1,375.72
D. Other Production	IE						IE
E. Production of Halocarbons and SF$_6$				6,456.62	1,009.92	860.40	8,326.94
F. Consumption of Halocarbons and SF$_6$ (2)				7,236.41	6,363.26	3,595.80	17,195.47
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**334.05**				**334.05**
4. Agriculture		**15,672.20**	**11,467.97**				**27,140.17**
A. Enteric Fermentation		7,276.11					7,276.11
B. Manure Management		2,630.65	4,810.72				7,441.37
C. Rice Cultivation		5,693.94					5,693.94
D. Agricultural Soils(3)		NA	6,633.89				6,633.89
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		71.50	23.36				94.86
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-88,646.87**	**20.53**	**26.64**				**-88,599.69**
A. Forest Land	-90,390.01	20.53	2.08				-90,367.39
B. Cropland	267.37	NE,NO	24.55				291.92
C. Grassland	-373.36	NE,NO	NE,NO				-373.36
D. Wetlands	103.03	NE,NO	NE,NO				103.03
E. Settlements	288.22	NE,NO	NE,NO				288.22
F. Other Land	1,188.00	NO	NO				1,188.00
G. Other	269.89	NA,NE	NA,NE				269.89
6. Waste	**15,636.28**	**6,883.56**	**3,197.63**				**25,717.46**
A. Solid Waste Disposal on Land	NA,NE,NO	5,319.75					5,319.75
B. Waste-water Handling		1,530.49	1,175.79				2,706.28
C. Waste Incineration	15,059.23	19.51	2,009.61				17,088.36
D. Other	577.05	13.80	12.23				603.07
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	36,728.93	42.96	335.74				37,107.63
Aviation	21,149.32	12.57	207.55				21,369.44
Marine	15,579.61	30.39	128.19				15,738.19
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO$_2$ Emissions from Biomass	**17,917.42**						**17,917.42**

Total CO$_2$ Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,348,982.51
Total CO$_2$ Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,260,382.82

(1) For CO$_2$ from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO$_2$ from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.14. Emissions and Removals in 2003

SUMMARY 2 SUMMARY REPORT FOR CO$_2$ EQUIVALENT EMISSIONS (Sheet 1 of 1)

Inventory 2003
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO$_2$ (1)	CH$_4$	N$_2$O	HFCs (2)	PFCs (2)	SF$_6$ (2)	Total
	CO$_2$ equivalent (Gg)						
Total (Net Emissions) (1)	**1,180,877.48**	**23,519.56**	**24,479.80**	**13,761.68**	**7,181.45**	**5,253.91**	**1,255,073.89**
1. Energy	**1,213,922.12**	**1,294.17**	**8,266.71**				**1,223,483.00**
A. Fuel Combustion (Sectoral Approach)	1,213,887.66	904.81	8,266.61				1,223,059.08
1. Energy Industries	395,368.37	36.29	1,916.13				397,320.79
2. Manufacturing Industries and Construction	373,172.66	347.73	2,100.94				375,621.33
3. Transport	252,947.16	269.68	3,877.18				257,094.02
4. Other Sectors	192,399.48	251.11	372.36				193,022.94
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	34.46	389.36	0.11				423.92
1. Solid Fuels	NE,NO	93.86	NE,NO				93.86
2. Oil and Natural Gas	34.46	295.49	0.11				330.06
2. Industrial Processes	**49,127.25**	**133.88**	**1,259.55**	**13,761.68**	**7,181.45**	**5,253.91**	**76,717.72**
A. Mineral Products	45,757.07	NA,NO	NA,NO				45,757.07
B. Chemical Industry	3,128.60	117.37	1,259.55	NA	NA	NA	4,505.53
C. Metal Production	241.57	16.50	NO	IE,NE	15.21	1,125.53	1,398.81
D. Other Production	IE						IE
E. Production of Halocarbons and SF$_6$				5,459.50	965.60	812.60	7,237.70
F. Consumption of Halocarbons and SF$_6$ (2)				8,302.18	6,200.65	3,315.79	17,818.61
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**320.83**				**320.83**
4. Agriculture		**15,517.65**	**11,398.71**				**26,916.35**
A. Enteric Fermentation		7,163.64					7,163.64
B. Manure Management		2,595.28	4,780.26				7,375.54
C. Rice Cultivation		5,690.55					5,690.55
D. Agricultural Soils(3)		NA	6,596.35				6,596.35
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		68.18	22.10				90.27
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-97,743.71**	**3.90**	**21.90**				**-97,717.91**
A. Forest Land	-99,137.69	3.90	0.40				-99,133.40
B. Cropland	269.69	NE,NO	21.51				291.19
C. Grassland	-358.68	NE,NO	NE,NO				-358.68
D. Wetlands	68.80	NE,NO	NE,NO				68.80
E. Settlements	191.27	NE,NO	NE,NO				191.27
F. Other Land	976.53	NO	NO				976.53
G. Other	246.37	NA,NE	NA,NE				246.37
6. Waste	**15,571.81**	**6,569.98**	**3,212.10**				**25,353.89**
A. Solid Waste Disposal on Land	NA,NE,NO	5,049.60					5,049.60
B. Waste-water Handling		1,489.71	1,183.34				2,673.05
C. Waste Incineration	15,055.29	16.79	2,016.48				17,088.56
D. Other	516.53	13.87	12.28				542.68
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	37,506.71	45.52	340.95				37,893.18
Aviation	20,387.64	12.12	200.08				20,599.83
Marine	17,119.07	33.40	140.87				17,293.34
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO$_2$ Emissions from Biomass	**18,296.50**						**18,296.50**

Total CO$_2$ Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,352,791.80
Total CO$_2$ Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,255,073.89

(1) For CO$_2$ from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO$_2$ from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.15. Emissions and Removals in 2004

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2004
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,180,746.39**	**23,079.39**	**24,520.73**	**10,552.49**	**7,478.30**	**5,095.89**	**1,251,473.18**
1. Energy	**1,214,020.86**	**1,272.54**	**8,006.39**				**1,223,299.79**
A. Fuel Combustion (Sectoral Approach)	1,213,985.86	899.57	8,006.28				1,222,891.72
1. Energy Industries	390,980.48	35.27	1,916.36				392,932.12
2. Manufacturing Industries and Construction	378,733.43	354.85	2,144.97				381,233.26
3. Transport	252,413.86	249.67	3,568.30				256,231.84
4. Other Sectors	191,858.09	259.78	376.64				192,494.51
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	34.99	372.96	0.11				408.07
1. Solid Fuels	NE,NO	66.51	NE,NO				66.51
2. Oil and Natural Gas	34.99	306.45	0.11				341.56
2. Industrial Processes	**48,959.48**	**143.54**	**1,657.60**	**10,552.49**	**7,478.30**	**5,095.89**	**73,887.29**
A. Mineral Products	45,529.84	NA,NO	NA,NO				45,529.84
B. Chemical Industry	3,171.80	126.53	1,657.60	NA	NA	NA	4,955.94
C. Metal Production	257.84	17.01	NO	IE,NE	14.80	1,111.02	1,400.67
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				1,469.74	866.84	764.80	3,101.38
F. Consumption of Halocarbons and SF_6 (2)				9,082.75	6,596.66	3,220.06	18,899.47
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NA,NE**		**297.54**				**297.54**
4. Agriculture		**15,392.92**	**11,331.62**				**26,724.54**
A. Enteric Fermentation		7,064.07					7,064.07
B. Manure Management		2,550.19	4,751.79				7,301.98
C. Rice Cultivation		5,712.00					5,712.00
D. Agricultural Soils(3)		NA	6,558.29				6,558.29
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		66.65	21.54				88.19
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-97,258.29**	**12.12**	**19.06**				**-97,227.11**
A. Forest Land	-98,601.60	12.12	1.23				-98,588.26
B. Cropland	234.66	NE,NO	17.83				252.49
C. Grassland	-347.71	NE,NO	NE,NO				-347.71
D. Wetlands	62.41	NE,NO	NE,NO				62.41
E. Settlements	219.08	NE,NO	NE,NO				219.08
F. Other Land	938.61	NO	NO				938.61
G. Other	236.27	NA,NE	NA,NE				236.27
6. Waste	**15,024.34**	**6,258.28**	**3,208.51**				**24,491.14**
A. Solid Waste Disposal on Land	NA,NE,NO	4,776.05					4,776.05
B. Waste-water Handling		1,453.29	1,190.87				2,644.16
C. Waste Incineration	14,517.64	15.38	2,005.62				16,538.65
D. Other	506.70	13.56	12.01				532.28
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA**	**NA**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	39,113.12	47.56	355.43				39,516.11
Aviation	21,190.20	12.59	207.95				21,410.75
Marine	17,922.92	34.97	147.47				18,105.36
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**18,188.60**						**18,188.60**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,348,700.30
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,251,473.18

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.16. Emissions and Removals in 2005

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2005
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,191,957.43**	**22,685.43**	**24,036.45**	**10,566.32**	**7,002.07**	**4,807.94**	**1,261,055.64**
1. Energy	**1,217,733.23**	**1,282.78**	**7,944.96**				**1,226,960.97**
A. Fuel Combustion (Sectoral Approach)	1,217,695.63	887.04	7,944.84				1,226,527.52
1. Energy Industries	406,037.97	37.23	2,157.27				408,232.47
2. Manufacturing Industries and Construction	371,228.70	350.70	2,118.23				373,697.63
3. Transport	247,009.69	236.69	3,289.09				250,535.47
4. Other Sectors	193,419.28	262.42	380.25				194,061.95
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	37.60	395.74	0.12				433.46
1. Solid Fuels	NE,NO	73.56	NE,NO				73.56
2. Oil and Natural Gas	37.60	322.18	0.12				359.90
2. Industrial Processes	**50,031.45**	**133.87**	**1,299.94**	**10,566.32**	**7,002.07**	**4,807.94**	**73,841.58**
A. Mineral Products	46,902.66	NA,NO	NA,NO				46,902.66
B. Chemical Industry	2,886.85	116.98	1,299.94	NA	NA	NA	4,303.77
C. Metal Production	241.93	16.89	NO	IE,NE	14.80	1,157.31	1,430.93
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				816.01	837.49	975.12	2,628.62
F. Consumption of Halocarbons and SF_6 (2)				9,750.31	6,149.78	2,675.51	18,575.60
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**NA,NE**		**266.41**				**266.41**
4. Agriculture		**15,310.21**	**11,238.86**				**26,549.07**
A. Enteric Fermentation		7,002.30					7,002.30
B. Manure Management		2,503.33	4,749.47				7,252.80
C. Rice Cultivation		5,739.10					5,739.10
D. Agricultural Soils(3)		NA	6,468.22				6,468.22
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		65.48	21.17				86.65
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-90,298.29**	**9.14**	**15.67**				**-90,273.48**
A. Forest Land	-92,020.09	9.14	0.93				-92,010.01
B. Cropland	277.08	NE,NO	14.74				291.82
C. Grassland	-335.58	NE,NO	NE,NO				-335.58
D. Wetlands	15.78	NE,NO	NE,NO				15.78
E. Settlements	578.46	NE,NO	NE,NO				578.46
F. Other Land	954.80	NO	NO				954.80
G. Other	231.25	NA,NE	NA,NE				231.25
6. Waste	**14,491.04**	**5,949.43**	**3,270.61**				**23,711.08**
A. Solid Waste Disposal on Land	NA,NE,NO	4,516.55					4,516.55
B. Waste-water Handling		1,402.84	1,160.49				2,563.33
C. Waste Incineration	13,984.22	14.27	2,096.16				16,094.65
D. Other	506.81	15.77	13.97				536.55
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA**	**NA**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	41,564.88	52.15	375.86				41,992.88
Aviation	21,336.33	12.68	209.39				21,558.39
Marine	20,228.55	39.47	166.47				20,434.49
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**21,743.33**						**21,743.33**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,351,329.12
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,261,055.64

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.17. Emissions and Removals in 2006

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2006
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,178,515.94**	**22,276.82**	**24,007.03**	**11,742.22**	**7,315.75**	**4,910.86**	**1,248,768.61**
1. Energy	**1,199,312.92**	**1,324.31**	**7,728.40**				**1,208,365.63**
A. Fuel Combustion (Sectoral Approach)	1,199,277.03	916.06	7,728.28				1,207,921.37
1. Energy Industries	394,358.50	39.16	2,155.49				396,553.15
2. Manufacturing Industries and Construction	373,287.05	364.96	2,126.98				375,778.99
3. Transport	243,632.49	220.98	3,070.96				246,924.43
4. Other Sectors	187,998.99	290.95	374.85				188,664.80
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	35.89	408.25	0.11				444.26
1. Solid Fuels	NE,NO	68.12	NE,NO				68.12
2. Oil and Natural Gas	35.89	340.14	0.11				376.14
2. Industrial Processes	**50,102.06**	**133.09**	**1,624.72**	**11,742.22**	**7,315.75**	**4,910.86**	**75,828.70**
A. Mineral Products	47,005.76	NA,NO	NA,NO				47,005.76
B. Chemical Industry	2,918.74	115.93	1,624.72	NA	NA	NA	4,659.40
C. Metal Production	177.55	17.16	NO	IE,NE	14.82	1,091.08	1,300.62
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				938.25	879.14	1,366.36	3,183.75
F. Consumption of Halocarbons and SF_6 (2)				10,803.97	6,421.79	2,453.41	19,679.17
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**NA,NE**		**242.34**				**242.34**
4. Agriculture		**15,211.28**	**11,247.55**				**26,458.82**
A. Enteric Fermentation		6,999.93					6,999.93
B. Manure Management		2,438.80	4,756.40				7,195.20
C. Rice Cultivation		5,707.49					5,707.49
D. Agricultural Soils(3)		NA	6,470.12				6,470.12
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		65.06	21.03				86.09
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-84,554.21**	**2.44**	**13.12**				**-84,538.65**
A. Forest Land	-86,443.29	2.44	0.25				-86,440.60
B. Cropland	295.00	NE,NO	12.87				307.88
C. Grassland	-338.54	NE,NO	NE,NO				-338.54
D. Wetlands	23.80	NE,NO	NE,NO				23.80
E. Settlements	941.00	NE,NO	NE,NO				941.00
F. Other Land	737.48	NO	NO				737.48
G. Other	230.34	NA,NE	NA,NE				230.34
6. Waste	**13,655.17**	**5,605.70**	**3,150.90**				**22,411.77**
A. Solid Waste Disposal on Land	NA,NE,NO	4,203.56					4,203.56
B. Waste-water Handling		1,369.69	1,161.12				2,530.82
C. Waste Incineration	13,132.81	13.29	1,972.81				15,118.91
D. Other	522.36	19.16	16.97				558.49
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA**	**NA**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	38,991.92	48.99	352.50				39,393.41
Aviation	19,964.61	11.87	195.93				20,172.40
Marine	19,027.31	37.12	156.58				19,221.01
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**21,976.71**						**21,976.71**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,333,307.26
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,248,768.61

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.18. Emissions and Removals in 2007

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2007
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,212,545.50**	**21,763.61**	**22,700.97**	**13,279.24**	**6,411.99**	**4,407.45**	**1,281,108.77**
1. Energy	**1,232,953.08**	**1,289.76**	**7,640.70**				**1,241,883.54**
A. Fuel Combustion (Sectoral Approach)	1,232,915.55	873.57	7,640.58				1,241,429.70
1. Energy Industries	446,855.25	44.88	2,220.01				449,120.14
2. Manufacturing Industries and Construction	370,254.70	370.10	2,173.46				372,798.26
3. Transport	237,830.98	206.59	2,890.59				240,928.16
4. Other Sectors	177,974.62	252.00	356.52				178,583.13
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	37.53	416.20	0.12				453.84
1. Solid Fuels	NE,NO	51.48	NE,NO				51.48
2. Oil and Natural Gas	37.53	364.72	0.12				402.37
2. Industrial Processes	**49,344.83**	**134.15**	**860.18**	**13,279.24**	**6,411.99**	**4,407.45**	**74,437.85**
A. Mineral Products	46,142.38	NA,NO	NA,NO				46,142.38
B. Chemical Industry	2,990.43	116.85	860.18	NA	NA	NA	3,967.46
C. Metal Production	212.02	17.30	NO	IE,NE	14.69	1,089.34	1,333.35
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				497.61	783.02	1,198.82	2,479.45
F. Consumption of Halocarbons and SF_6 (2)				12,781.64	5,614.28	2,119.29	20,515.20
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**NA,NE**		**159.95**				**159.95**
4. Agriculture		**15,067.55**	**11,060.75**				**26,128.30**
A. Enteric Fermentation		6,974.46					6,974.46
B. Manure Management		2,376.24	4,773.45				7,149.69
C. Rice Cultivation		5,652.17					5,652.17
D. Agricultural Soils(3)		NA	6,266.55				6,266.55
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		64.68	20.75				85.43
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-83,761.26**	**2.04**	**11.70**				**-83,747.52**
A. Forest Land	-85,235.01	2.04	0.21				-85,232.76
B. Cropland	258.97	NE,NO	11.50				270.47
C. Grassland	-314.91	NE,NO	NE,NO				-314.91
D. Wetlands	28.67	NE,NO	NE,NO				28.67
E. Settlements	623.44	NE,NO	NE,NO				623.44
F. Other Land	552.63	NO	NO				552.63
G. Other	324.96	NA,NE	NA,NE				324.96
6. Waste	**14,008.85**	**5,270.10**	**2,967.69**				**22,246.65**
A. Solid Waste Disposal on Land	NA,NE,NO	3,909.72					3,909.72
B. Waste-water Handling		1,327.31	1,140.11				2,467.42
C. Waste Incineration	13,447.65	12.40	1,809.28				15,269.34
D. Other	561.20	20.66	18.30				600.16
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA**	**NA**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	37,259.15	47.81	335.79				37,642.75
Aviation	18,358.58	10.91	180.16				18,549.66
Marine	18,900.57	36.90	155.63				19,093.09
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**22,957.60**						**22,957.60**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,364,856.28
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,281,108.77

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.19. Emissions and Removals in 2008

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2008
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,134,902.40**	**21,234.85**	**22,454.78**	**15,298.30**	**4,616.01**	**3,795.22**	**1,202,301.56**
1. Energy	**1,152,627.89**	**1,265.77**	**7,279.49**				**1,161,173.15**
A. Fuel Combustion (Sectoral Approach)	1,152,590.04	857.48	7,279.37				1,160,726.90
1. Energy Industries	419,990.90	43.61	2,155.54				422,190.05
2. Manufacturing Industries and Construction	336,063.81	360.21	2,103.91				338,527.93
3. Transport	228,099.17	190.18	2,678.09				230,967.44
4. Other Sectors	168,436.17	263.47	341.84				169,041.47
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	37.85	408.29	0.12				446.26
1. Solid Fuels	NE,NO	45.83	NE,NO				45.83
2. Oil and Natural Gas	37.85	362.46	0.12				400.43
2. Industrial Processes	**45,738.96**	**121.48**	**1,262.15**	**15,298.30**	**4,616.01**	**3,795.22**	**70,832.12**
A. Mineral Products	43,009.10	NA,NO	NA,NO				43,009.10
B. Chemical Industry	2,574.10	106.46	1,262.15	NA	NA	NA	3,942.70
C. Metal Production	155.77	15.02	NO	IE,NE	14.67	652.47	837.94
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				701.41	523.80	1,288.21	2,513.42
F. Consumption of Halocarbons and SF_6 (2)				14,596.89	4,077.55	1,854.54	20,528.97
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**NA,NE**		**129.10**				**129.10**
4. Agriculture		**14,897.53**	**10,859.88**				**25,757.41**
A. Enteric Fermentation		6,913.78					6,913.78
B. Manure Management		2,320.82	4,761.90				7,082.72
C. Rice Cultivation		5,598.59					5,598.59
D. Agricultural Soils(3)		NA	6,077.45				6,077.45
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		64.35	20.53				84.87
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-78,350.51**	**21.65**	**10.57**				**-78,318.30**
A. Forest Land	-79,934.29	21.65	2.20				-79,910.45
B. Cropland	224.16	NE,NO	8.37				232.53
C. Grassland	-302.63	NE,NO	NE,NO				-302.63
D. Wetlands	16.29	NE,NO	NE,NO				16.29
E. Settlements	506.27	NE,NO	NE,NO				506.27
F. Other Land	834.04	NO	NO				834.04
G. Other	305.63	NA,NE	NA,NE				305.63
6. Waste	**14,886.05**	**4,928.42**	**2,913.59**				**22,728.06**
A. Solid Waste Disposal on Land	NA,NE,NO	3,585.94					3,585.94
B. Waste-water Handling		1,309.66	1,156.72				2,466.38
C. Waste Incineration	14,355.64	11.98	1,738.41				16,106.03
D. Other	530.41	20.84	18.46				569.71
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA**	**NA**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	34,849.64	44.23	314.53				35,208.40
Aviation	17,517.99	10.41	171.92				17,700.32
Marine	17,331.65	33.81	142.62				17,508.09
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**21,597.87**						**21,597.87**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,280,619.85
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,202,301.56

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

A9.20. Emissions and Removals in 2009

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2009
Submission 2011 v1.1
JAPAN

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**1,073,028.71**	**20,716.98**	**22,149.54**	**16,671.73**	**3,271.47**	**1,851.27**	**1,137,689.69**
1. Energy	**1,089,763.54**	**1,233.52**	**7,090.79**				**1,098,087.84**
A. Fuel Combustion (Sectoral Approach)	1,089,728.39	839.32	7,090.68				1,097,658.39
1. Energy Industries	386,428.90	41.93	2,070.18				388,541.02
2. Manufacturing Industries and Construction	318,571.47	363.72	2,023.10				320,958.29
3. Transport	222,914.64	185.51	2,667.41				225,767.57
4. Other Sectors	161,813.37	248.16	329.98				162,391.51
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	35.15	394.20	0.11				429.46
1. Solid Fuels	NE,NO	46.25	NE,NO				46.25
2. Oil and Natural Gas	35.15	347.95	0.11				383.21
2. Industrial Processes	**40,308.64**	**109.58**	**1,559.50**	**16,671.73**	**3,271.47**	**1,851.27**	**63,772.19**
A. Mineral Products	37,708.45	NA,NO	NA,NO				37,708.45
B. Chemical Industry	2,488.20	96.64	1,559.50	NA	NA	NA	4,144.34
C. Metal Production	111.99	12.95	NO	IE,NE	11.02	239.00	374.96
D. Other Production	IE						IE
E. Production of Halocarbons and SF_6				222.14	399.48	260.51	882.13
F. Consumption of Halocarbons and SF_6 (2)				16,449.59	2,860.96	1,351.76	20,662.32
G. Other	NO	NO	NO	NA,NO	NA,NO	NO	NA,NO
3. Solvent and Other Product Use	**NA,NE**		**120.50**				**120.50**
4. Agriculture		**14,778.60**	**10,623.51**				**25,402.11**
A. Enteric Fermentation		6,849.21					6,849.21
B. Manure Management		2,299.73	4,761.36				7,061.09
C. Rice Cultivation		5,566.50					5,566.50
D. Agricultural Soils(3)		NA	5,842.03				5,842.03
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		63.15	20.13				83.28
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-71,540.69**	**8.73**	**8.49**				**-71,523.47**
A. Forest Land	-73,677.93	8.73	0.89				-73,668.32
B. Cropland	257.51	NE,NO	7.60				265.11
C. Grassland	-276.24	NE,NO	NE,NO				-276.24
D. Wetlands	22.72	NE,NO	NE,NO				22.72
E. Settlements	815.99	NE,NO	NE,NO				815.99
F. Other Land	1,049.01	NO	NO				1,049.01
G. Other	268.25	NA,NE	NA,NE				268.25
6. Waste	**14,497.22**	**4,586.56**	**2,746.75**				**21,830.53**
A. Solid Waste Disposal on Land	NA,NE,NO	3,303.02					3,303.02
B. Waste-water Handling		1,247.42	1,087.40				2,334.82
C. Waste Incineration	13,983.52	11.38	1,637.44				15,632.34
D. Other	513.71	24.74	21.91				560.35
7. Other *(as specified in Summary 1.A)*	**NA,NO**	**NA,NO**	**NA,NO**	**NA**	**NA**	**NA,NO**	**NA,NO**

Memo Items: (4)							
International Bunkers	30,794.11	39.18	277.79				31,111.08
Aviation	15,403.53	9.15	151.16				15,563.85
Marine	15,390.58	30.02	126.62				15,547.23
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**19,754.98**						**19,754.98**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	1,209,213.17
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	1,137,689.69

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

Annex 10. Japan's Information Required under Article 7, Paragraph 1 of the Kyoto Protocol

The government of Japan submits this information in accordance with paragraph 2, Decision 15/CMP.1. Correspondence between requirement and contents of this information are shown in the table below.

Related part of guidelines for information under KP 7.1	Section of this report
Section D	A10.1. Greenhouse Gas Inventory Information
paragraph 4	A10.1.1. Steps taken to improve estimates in areas that were previously adjusted
paragraphs 5 - 9	A10.1.2. Information of Article 3, paragraph 3 and paragraph 4
Section E	A10.2. Information on ERU, CER, tCER, lCER, AAU and RMU
paragraphs 11	A10.2.1. Information on ERU, CER, tCER, lCER, AAU and RMU
paragraphs 12-17	A10.2.2. Information on discrepancy and other issues
paragraph 18	A10.2.3. Calculation of its commitment period reserve in accordance with decision 11/CMP.1 (Article 17 of the Kyoto Protocol)
Section F	A10.3. Changes in national systems in accordance with Article 5, paragraph 1
Section G	A10.4. Changes in national registries
	A10.4.1 Summary of changes made on national registry of Japan in 2010
	A10.4.2 Information relevant to the changes made on national registry of Japan
Section H	A10.5. Minimization of adverse impacts in accordance with Article 3, paragraph 14
	A10.5.1 Executive summary
	A10.5.2 Actions to minimize adverse impacts in accordance with Article 3, paragraph 14

A10.1. Greenhouse Gas Inventory Information

A10.1.1. Steps taken to improve estimates in areas that were previously adjusted

Japan has not taken any step on this issue because there was no specific area that was previously adjusted in the initial review and the annual inventory review for the 2007 and 2010 submissions.

A10.1.2. Information of Article 3, paragraph 3 and paragraph 4

See the information of Article 3, paragraphs 3 and 4 (Annex 11) that Japan submitted according to the paragraph 2 of Decision 15/CP.10.

A10.2. Information on ERU, CER, tCER, lCER, AAU and RMU

A10.2.1. Information on ERU, CER, tCER, lCER, AAU and RMU

For information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs in Japan's National Registry, see the annex "Standard Electric Format for Reporting of Information on Kyoto Protocol Units" submitted on the basis of Decision 14/CMP. 1.

A10.2.2. Information on discrepancy and other issuses

- There is no discrepancy to be reported under paragraph 12 of the annex to decision 15/CMP.1.
- There is no notification regarding lCERs to be replaced due to a reversal of storage under paragraph 13 of the annex to decision 15/CMP.1.
- There is no notification regarding lCERs to be replaced due to non-submission of certification report under paragraph 14 of the annex to decision 15/CMP.1.
- There is no record of non-replacement identified by the transaction log under paragraph 15 of the annex to decision 15/CMP.1.
- There are no units that are invalid for use towards compliance with commitments under paragraph 16 of the annex to decision 15/CMP.1.
- There is no discrepant transaction that needs actions to correct problem under paragraph 17 of the annex to decision 15/CMP.1.

A10.2.3. Calculation of its commitment period reserve in accordance with decision 11/CMP.1 (Article 17 of the Kyoto Protocol)

Japan's commitment period reserve is 5,335,431,899 t-CO_2 eq., the same as the value reported in the previous submission.

A10.3. Changes in national systems in accordance with Article 5, paragraph 1

In Japan's national system, the change that shall be reported under paragraph 21 of Decision 15/CMP.1 since the previous submission is described as follows:

- The name of "Climate Change Policy Division, Global Environment Bureau" was changed to "Low-carbon Society Promotion Office, Global Environment Bureau".

A10.4. Changes in national registries

A10.4.1. Summary of changes made on national registry of Japan in 2010

Reporting Items	Descriptions of Changes
15/CMP.1, annex II, para 32. (a) Change of name or contact	Contact of the registry administrator (RSA) of Japan was changed to follows: (Before) Mr.Yasushi Ninomiya, yasushi_ninomiya@env.go.jp (After) Mr. Yuji Mizuno, yuji_mizuno@env.go.jp
15/CMP.1, annex II, para 32. (b) Change of cooperation arrangement	No change
15/CMP.1, annex II, para 32. (c) Change to database or the capacity of national registry	No change
15/CMP.1, annex II, para 32. (d) Change of conformance to technical standards	No change
15/CMP.1, annex II, para 32. (e) Change of procedures to minimize discrepancies	No change
15/CMP.1, annex II, para 32. (f) Change of security measures	No change
15/CMP.1, annex II, para 32. (g) Change of a list of publicly accessible information	Information on unit holdings and transactions is made publicly available on the basis of Standard Electronic Format (SEF) to meet the requirement specified in decision 14/CMP.1. In April 2010, the information for 2009 was published. The following information is not published due to confidentiality concerns: - Unit holdings at an individual account level - Identity of accounts to which Japan's national registry transferred units and those from which it acquired units. In addition, for better readability, information on units is not associated with their respective serial numbers.
15/CMP.1, annex II, para 32. (h) Change of the internet address	The internet address of Japan's national registry has been changed as follows: (Before) http://www.registry.go.jp (After) http://www.registry.go.jp/public_info_en.html
15/CMP.1, annex II, para 32. (i) Change of measures for ensuring data integrity	No change
15/CMP.1, annex II, para 32. (j) Change of test results	No change

A10.4.2. Information relevant to the changes made on national registry of Japan

- In March 2010, some documents of the Data Exchange Standards for registry systems under the Kyoto Protocol (DES) were revised. The revised documents and their impacts on Japan's national registry are described as follows:
  - The revised DES main text (version 1.1.5) was released in which an account level reconciliation function was introduced for registries that connect to Supplementary Transaction Logs (STLs). There is no change made on Japan's national registry in relation to the release as Japan's national registry does not connect to any STLs.

  As this new function was added to the International Transaction Logs (ITL) version 1.8.2, a test was successfully executed in the test environment in April 2010 to ensure there was no impact on Japan's national registry.
  - ➢ The revised DES annex E (List of checks and Response Codes for Message Processing, version 1.1.7) was released in which a new response code was added to reflect the enhancement of the ITL check function on the registry operational statuses. The response code was added to Japan's national registry to accommodate the change.
- In March 2010, new functions were added in Japan's national registry in order to expedite both international and domestic transactions of Kyoto units, and enhance credibility of the registry in processing these transactions. These added functions do not require international communications; therefore, there is no impact on the functions of the ITL and other national registries.
- In March 2010, a new function was added in Japan's national registry which sends e-mails to notify registry administrators when reconciliation is completed, when transactions get terminated, and when Japan's national registry receives AcceptMessages and AcceptITLNotices from the ITL. This function does not require international communications; therefore, there is no impact on the functions of the ITL and other national registries.
- Public information on the unit holdings and transactions conducted was updated in April 2010, on the basis of the SEF for 2009, for the purpose of meeting the requirement specified in decision 13/CMP.1. The following information, which is requested to be made publicly available in decision 13/CMP.1, has not been made so due mostly to confidentiality concerns (relevant paragraph numbers of the annex to decision 13/CMP.1 are indicated in parentheses):
  - ➢ The full name of the representative of the account holder (paragraph 45(e))
  - ➢ Serial numbers of ERUs, CERs, AAUs and RMUs those are subject of this public information (paragraph 47)
  - ➢ The total quantity of ERUs, CERs, AAUs and RMUs in each account at the beginning of the year (the total quantity is only available by account type) (paragraph 47(a))
  - ➢ The identity of the transferring accounts from which ERUs, CERs, AAUs and RMUs were acquired by national registry of Japan during the year (the identity of the transferring registries is available) (paragraph 47(d))
  - ➢ The identity of the acquiring accounts to which ERUs, CERs, AAUs and RMUs were transferred from national registry of Japan during the year (the identity of the acquiring registries is available) (paragraph 47(g))
  - ➢ Current holdings of ERUs, CERs, AAUs and RMUs in each account (the current holdings are only available by account type) (paragraph 47(l))
- In May 2010, some documents of the DES were revised with regard to the changes in the message flow between national registries and the ITL. The revised documents and their impacts on Japan's national registry are described as follows:
  - ➢ The revised DES main text (version 1.1.6) was released. Amendments were made to Japan's national registry so that it was adjusted to the new message flow.
  - ➢ In September 2010, a test was successfully conducted in the test environment to confirm transactions were properly processed when the ITL and Japan's national registry used new message flow. Functions of Japan's national registry were fixed in relation to the new

  message flow.
  - ➢ The revised DES annex B (Web Services and Functions for Transaction Processing, version 1.1.3) was released. There is no change made on Japan's national registry in relation to the release.
  - ➢ The revised DES annex C (Web Services and Functions for Reconciliation, version 1.1.1) was released. There is no change made on Japan's national registry in relation to the release.
  - ➢ The DES annex E (List of checks and Response Codes for Message Processing, version 1.1.8) was released. The response codes regarding the message flow were changed in Japan's national registry.
- In September 2010, some documents of the DES were revised. A heartbeat monitoring function was added to the ITL to check the connectivity between the Community Independent Transaction Log (CITL, a transaction log established for the implementation of the EU emissions trading scheme) and the ITL. The revised documents and their impacts on Japan's national registry are described as follows:
  - ➢ The revised DES main text (version 1.1.7) was released. There is no change made on Japan's national registry in relation to the release.
  - ➢ The DES annex F (Definition of Identifiers, version 1.2) was released. There is no change made on Japan's national registry in relation to the release.
- In September 2010, Annex E of the DES (List of checks and Response Codes for Message Processing, version 1.1.9) was revised, in order to set a limit on the number of unit blocks that can be processed by the ITL in a single transaction. Response codes were added in Japan's national registry to accommodate the change.
- In November 2010, information on Japan's national registry administrators was changed.
- In November 2010, Operating System (OS) of registry administrator's PCs and browser were upgraded. There is no impact on the functions of the ITL and other national registries.
- In November 2010, a part of the hardware of Japan's national registry was renewed and operating system and middleware of the registry were upgraded. There is no impact on the functions of the ITL and other national registries.
- In December 2010, some documents of DES were revised, in which a response code was added regarding a list of national registries. The revised documents and their impacts on Japan's national registry are described as follows:
  - ➢ The revised DES main text (version 1.1.8) was released. There is no change made on Japan's national registry in relation to the release.
  - ➢ The revised DES annex E (List of checks and Response Codes for Message Processing, version 1.1.10) was released. The response code was added in Japan's national registry as well.

A10.5. Minimization of adverse impacts in accordance with Article 3, paragraph 14

A10.5.1. Executive summary

It is difficult to identify specific adverse impacts due to response measures implemented by Japan in the field of climate change policy. The fluctuation in price of crude oil is caused by balance between supply and demand and numerous other factors (e.g., trend in crude oil futures market or the economy), and it is uncertain whether there exists a causal link or if so what extent is from adverse impacts of climate change policy.

In addition, response measures may cause direct and/or indirect effects to various stakeholders. However, it does not deny any benefit from implementation of response measures. Efforts toward low-carbon society will be accelerated throughout the world, and such activities should not be discouraged.

A10.5.2. Actions to minimize adverse impacts in accordance with Article 3, paragraph 14

Japan has strived in such a way as shown below, believing that these actions are important to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention in implementing the commitments under Article 3, paragraph 1 of the Protocol.

At the same time, Japan believes that it should be noted that it is impossible to evaluate these efforts since the method of evaluation is currently under international negotiation.

- ***Technical assistance in the energy and environmental sectors***

Based on the Japan's Cooperation Initiative for Clean Energy and Sustainable Growth presented at the 2nd East Asia Summit in January 2007 and the agreement reached at Asian Ministerial Energy Roundtable held in April 2009, we provided the cooperation in human resource development through accepting trainees and dispatching experts in the area of energy conservation and renewable energy to countries in East Asia and Middle East. We assisted these countries in the establishment and implementation of legal systems of energy conservation and renewable energy. In addition, in a joint policy studies among research institutions from Japan and countries like China and India, we compared country policies related to energy conservation that will benefit the host countries' policy making process and also estimated possibilities of energy use reductions of highly energy-consuming industries. .

Additionally, technical assistance in the field of energy and environment by Japan has long been provided throughout the world, contributing to the sustainable economic growth of developing countries. Through Japan International Cooperation Agency (JICA), depending on the needs of developing countries, Japan has been providing assistance in human resource development such as dispatching experts and providing training programs in Japan.

- ***Assistance to oil producing countries in diversifying their economies***

In April 2009, the 3rd Asian Ministerial Energy Roundtable was held in Japan where we requested that regulatory agencies take more coordinated action to strengthen surveillance on commodity futures trading markets and enhance its transparency. Furthermore, parties have agreed to conduct specific projects such as formulation of a demand and supply projection, sharing of leading projects concerning energy conservation and renewable energy, and provision of training opportunities (e.g., Japan will accept 2000 trainees over 3 years).

- ***Development of carbon capture and storage (CCS) technologies***

Recognizing that CCS is an innovative technology that may achieve highly efficient carbon emissions reductions, Japan has been implementing a large-scale demonstration projects toward practical use of CCS by 2020, and researches and developments on cost reductions and safety improvements. In addition, Japan actively exchanged information on CCS technologies with other countries such as the United States of America, etc.

- ***Withdrawing support for the use of environmentally unsound and unsafe technologies***

Japan is of the understanding that there are originally no supports for the use of environmentally unsound and unsafe technologies.

Annex 11. Supplementary Information on LULUCF activities under Article 3, Paragraphs 3 and 4 of the Kyoto Protocol

A11.1. Summary of removal related trends, and emission and removals from KP LULUCF activities

Japan reports supplementary information on Afforestation/Reforestation (AR), Deforestation (D), Forest management (FM) and Revegetation (RV) as LULUCF activities under Article 3, Paragraphs 3 and 4 of the Kyoto Protocol. Table A 11-1 shows the activity coverage and other information relating to activities under Article 3.3 and elected activities under Article 3.4. The net removals in FY2009 by those activities are 47,089 Gg-CO_2 eq. (Table A11-2).

Table A 11-1 Activity coverage and other information relating to activities under Article 3.3 and elected activities under Article 3.4 (CRF-Table NIR 1)

Activity		**Change in carbon pool reported[(1)]**					**Greenhouse gas sources reported[(2)]**						
		Above-ground biomass	**Below-ground biomass**	**Litter**	**Dead wood**	**Soil**	**Fertilization[(3)]**	**Drainage of soils under forest management**	**Disturbance associated with land-use conversion to croplands**	**Liming**	**Biomass burning[(4)]**		
							N_2O	**N_2O**	**N_2O**	**CO_2**	**CO_2**	**CH_4**	**N_2O**
Article 3.3 activities	**Afforestation and Reforestation**	R	R	R	R	R	IE			NO	IE	R	R
	Deforestation	R	R	R	R	R			R	R	NO	NO	NO
Article 3.4 activities	**Forest Management**	R	R	R	R	R	IE	NO		NO	IE	R	R
	Cropland Management	NA	NA	NA	NA	NA			NA	NA	NA	NA	NA
	Grazing Land Management	NA	NA	NA	NA	NA				NA	NA	NA	NA
	Revegetation	R	R	R	IE	NR				R	NO	NO	NO

*R: Reported, NR: Carbon stock changes are not reported according to paragraph 21 in the Annex to decision 16/CMP.1

Table A11-2 Accounting summary for activities under Article 3.3 and 3.4 of the Kyoto Protocol (CRF Information Table)

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	**BY**	**Net emissions/removals**			**Accounting Parameters**	**Accounting Quantity**
		2008	**2009**	**Total**		
	(Gg CO_2 equivalent)					
A. Article 3.3 activities						
A.1. Afforestation and Reforestation						-804.65
A.1.1. Units of land not harvested since the beginning of the commitment period		-389.56	-415.08	-804.65		-804.65
A.1.2. Units of land harvested since the beginning of the commitment period						
A.2. Deforestation		2,429.33	3,086.51	5,515.84		5,515.84
B. Article 3.4 activities						
B.1. Forest Management (if elected)		-45,388.82	-49,005.74	-94,394.56		-94,394.56
3.3 offset					4,711.19	-4,711.19
FM cap					238,333.33	-89,683.37
B.2. Cropland Management (if elected)	NA	NA	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA	NA	NA
B.4. Revegetation (if elected)	-47.06	-729.70	-754.84	-1,484.54	-94.12	-1,390.42

*The net removals by FM after application of 3.3 offset are lower than the upper limit (13 Mt-C times five (238,333 Gg-CO_2)) given in the Appendix to decision 16/CMP.1.

*Since the total anthropogenic greenhouse gas emissions by sources and removals by sinks in managed forest since 1990 is larger than the net source of emissions incurred under Article 3.3, the offset rule according to paragraph 10 of the Annex to decision 16/CMP.1 is applied to Japan.

*Methodologies for estimation and accounting of Article 3.3 and 3.4 activities are continuously reviewed. The values in Table A11-2 are estimated by using the current methodologies, and are only reported and not accounted for in the 2011 submission since Japan elected entire commitment period accounting. The issuance of removal units from LULUCF activities under the Kyoto Protocol is to be performed at the end of the first commitment period.

*Total values and results of summing up each element are not always same because of display digit.

A11.2. General information

A11.2.1. Definition of forest and any other criteria

The Japan's definitions of forest are identified as the following, in accordance with decision 16/CMP.1 and the requirement from GPG-LULUCF.

Minimum value for forest area:	0.3 [ha]
Minimum value for tree crown cover:	30 [%]
Minimum value for tree height:	5 [m]
Minimum value for forest width:	20 [m]

Forest with minimum values for forest area, tree crown cover and forest width (mentioned above) are consistent with forests under the existing forest planning system in Japan. Although minimum value for tree height is not defined under the existing system, forests under usual composition of tree species and climate condition in Japan usually reach tree height of 5 m at maturity *in situ*. Each prefecture has surveyed and compiled information on resources of forests under the forest planning system into Forest Registers, which is primarily intended to prepare for establishing forest plans. Therefore, forests under the forest planning system are considered as forests under the Kyoto Protocol and Forest registers are suitable as basic data source for reporting. This is the same concept as used for reporting of LULUCF forest sector under the Convention.

Definitions of forest mentioned above are consistent with those in the Global Forest Resources Assessment 2005 (FRA2005) by Food and Agriculture Organization of the United Nation (FAO) (Table A11-3).

Table A11-3 Japan's forest category and definition used in reporting to FAO

Category		Definition
Forest		Land on which trees and/or bamboo grow collectively, together with those trees and bamboo, or any other land that is provided for collective growth of trees and/or bamboo which are 0.3 ha or more. Lands that are utilized mainly for agriculture, residential use or other similar purposes, and trees and bamboo on these lands are not included.
	Forest with standing trees	Forest that has tree crown cover of 30 percent or higher (including young stands).
	Forest with less standing trees (Cut-over forests, lesser stocked forests)	Forest that does not fall under "forest with standing trees" or "bamboo forest".
	Bamboo forest	Forest that does not fall under "forest with standing trees" and is mainly dominated by bamboo (excluding sasa).

* See section 7.2.2. for more detailed definition of each category

Before 1996, Japan classified forests with standing trees into two sub-categories, "Intensively managed forest" and "Semi-natural forest" in Forestry Status Survey. Since 2002, Japan has introduced new sub-categories which are "Ikusei-rin forest" and "Tennensei-rin forest". In these new sub-categories, degrees of human-induced activities and stratification of forest have been taken into account. In ikusei-rin forests, intensively managed forests regenerated mainly by planting after felling and semi-natural forests regenerated by supplementary works such as site preparation are included. Definitions of intensively managed forest, semi-natural forest, ikusei-rin forest and tennensei-rin forest are shown below.

Table A11-4 Definitions of intensively managed forest, semi-natural forest, ikusei-rin forest and tennensei-rin forest

<table>
<tr><th colspan="2">Sub-categories by regeneration method</th><th colspan="2">Sub-categories by management types</th></tr>
<tr><td>Intensively managed forest</td><td>Forest regenerated by planting and so on.</td><td rowspan="2">Ikusei-rin forest</td><td rowspan="2">Forest where practices for establishment and maintenance of single-storied forests (“Ikusei-tansou-rin” practices) have been carried out after clear cutting ,or where forest practices for establishment and maintenance of multi-storied forests (“Ikusei-fukusou-rin” practices) have been carried out after selective cutting (including temporally single-storied forest in practice).</td></tr>
<tr><td rowspan="2">Semi-natural forest</td><td rowspan="2">Forest which is not classified as intensively managed forest.</td></tr>
<tr><td>Tennensei-rin forest</td><td>Forest where practices which establishment and maintenance of forests mainly depending on natural power are carried out. These practices include logging prohibition for land and natural environment conservation and preservation of the species.</td></tr>
</table>

A11.2.2. Elected activities under Article 3, paragraph 4 of the Kyoto Protocol

Japan elected FM and RV defined by decision 16/CMP.1 in paragraph 6 of the Annex, as “additional human-induced activities related to changes in GHG emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories” defined by Article 3, paragraph 4 of the Kyoto Protocol.

A11.2.2.1. Forest Management

FM is defined by decision 16/CMP.1 in paragraph 1(f) of the Annex as “a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner”. Japan interprets the definition of “FM” as the following with recalling GPG-LULUCF which the party is requested to use in accordance with decision 16/CMP.1, paragraph 2

- In “Ikusei-rin forest”, activities for “FM” are appropriate forest practices including regeneration (land preparation, soil scarification, planting, etc.), tending (weeding, pre-commercial cutting, etc.), thinning and harvesting which have been carried out since 1990.
- In “Tennensei-rin forest” activities for “FM” are practices for protection or conservation of forests including controlling logging activities and land-use change which have been carried out by laws.

A11.2.2.2. Revegetation

RV is defined by decision 16/CMP.1 ANNEX paragraph 1(e) as “a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 ha and does not meet the definitions of AR”.
Japan interprets the definition of “RV” as the following with recalling GPG-LULUCF.

- Practices for creation of “park and green space”, “public green space”, and “private green space guaranteed by administration” which have been carried out in settlements since 1990[1]. Activities which cover less than an area of 0.05 ha or meet the definitions of AR are not included in “RV”.

A11.2.3. Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The forest definition explained in section A11.2.1 is not changed over time. Same forest definition is used for AR and D under Article 3.3 as well as FM under Article 3.4. The definitions of FM and RV explained in section A11.2.2 above have been implemented and applied consistently over time.

A11.2.4. Description of precedence conditions and/or hierarchy among elected Article 3.4 activities, and how they have been consistently applied in determining how land was classified

Japan interprets that FM activities are occurred only in forest land and RV activities are occurred only in settlements and wetlands. Therefore, there is no overlapping between FM and RV.

A11.3. Land-related information

A11.3.1. Spatial assessment unit used for determining the area of the units of land under Article 3.3

In accordance with the definition of forest explained in section A11.2.1, Japan determines spatial assessment unit used for determining the area of the units of land under Article 3.3 as 0.3 ha.

A11.3.2. Methodology used to develop the land transition matrix

A11.3.2.1. Description of land transition matrix (CRF-NIR Table 2)

Table A11-5 shows the land transition matrix related to the activities under Article 3.3 and Article 3.4. FM area in Japan is estimated by using the narrow approach concept which described in section 4.2.7.1, Chapter 4 of GPG-LULUCF. Therefore, new FM area is identified every year due to the progress of FM practices in managed forest which previously had not been categorized as FM area. This area appears as the land transition from “Other” to “FM” in Table A11-5. In a similar fashion, sites where RV practices are newly performed become new RV area and appears as the land transition from “Other” to “RV” in Table A11-5.

While there are some cases that activity categories of land before transition cannot be separated at the moment (e.g. D in FM land and D in non-FM land), transition from “Other” to certain activities is temporarily used for such a case in this table.

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[1] Those RV practices are occurred in Settlements category (and Wetlands category for a small proportion of activities) of the LULUCF land use categories for reporting under the Convention.

Table A11-5 Land Transition Matrix of Kyoto Protocol Activities (CRF-Table NIR 2)

FROM 2008	TO 2009	Article 3.3 activities		Article 3.4 activities				Other	Total
		Afforestation and reforestation	Deforestation	Forest Management (if elected)	Cropland Management (if elected)	Grazing Land Management (if elected)	Revegetation (if elected)		
		(kha)							
Article 3.3 activities	Afforestation and Reforestation	27.54	0.00						27.54
	Deforestation		301.10						301.10
Article 3.4 activities	Forest Management (if elected)		IE	13642.15					13642.15
	Cropland Management$^{(4)}$ (if elected)	-	-		-	-	-		0.00
	Grazing Land Management$^{(4)}$ (if elected)	-	-		-	-	-		0.00
	Revegetation$^{(4)}$ (if elected)	0.00			-	-	73.30		73.30
Other		0.72	8.34	709.37	-	-	2.75	23024.74	23745.92
Total area		28.26	309.44	14351.52	0.00	0.00	76.05	23024.74	37790.00

A11.3.2.2. Overview of the procedures to estimate emissions and removals

This section gives an overview of the procedures to estimate emissions and removals for AR, D and FM activities in Japan.

For AR and D activities, emissions and removals are estimated in AR and D areas which are firstly detected for each prefecture based on sample survey data.

For FM activity, emissions and removals are estimated by firstly subtracting those in AR land from those in all managed forests for each prefecture, and then applying FM ratio determined by sample survey to the remaining emissions and removals.

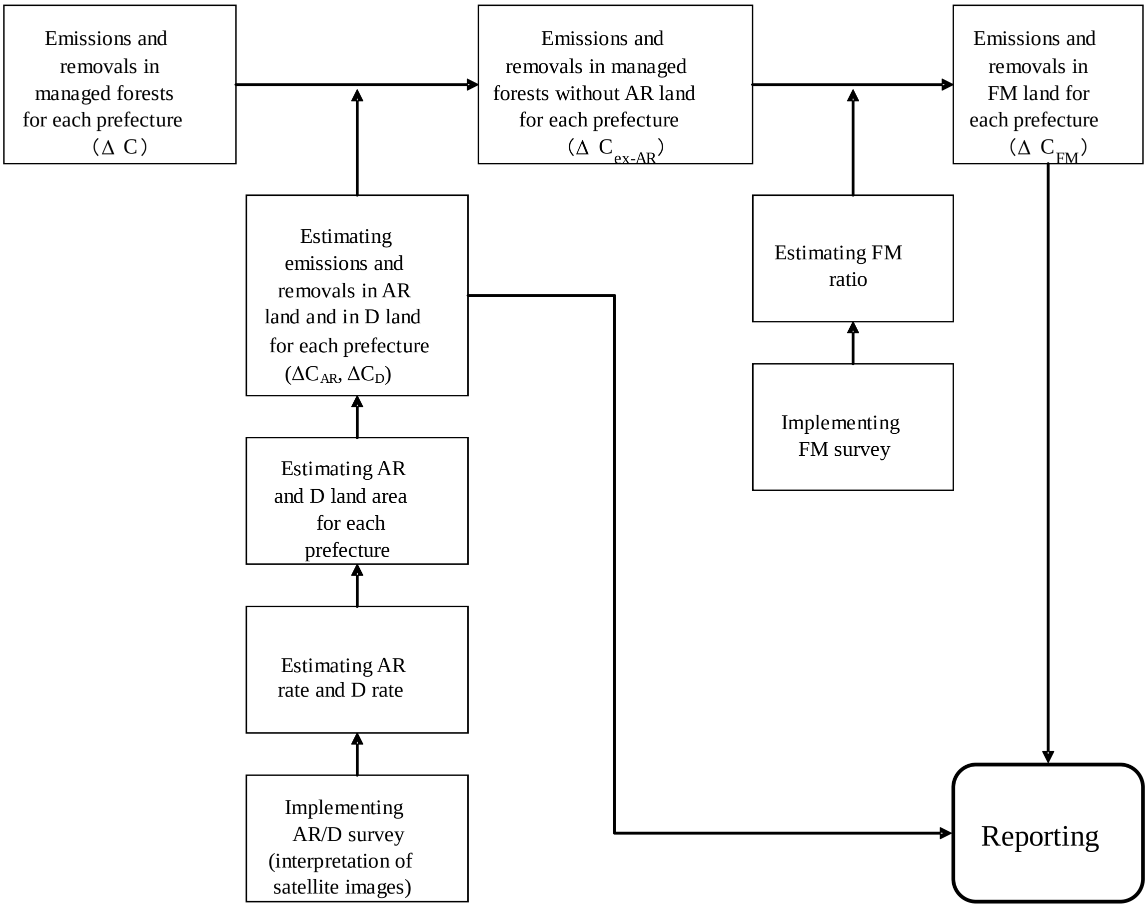

Figure A 11-1 The procedures to estimate emissions and removals for AR, D and FM activities

A11.3.2.3. Afforestation/Reforestation and Deforestation

A11.3.2.3.a. Procedure

Japan identifies change of forest cover in each sample plot by using orthophotos at the end of 1989 and recent satellite images, taking into account spatial assessment unit (0.3 ha). Plots identified as non-forest land converted to forest land due to human-induced forestation practice are categorized as AR plot, and plots identified as forest land converted to non-forest land are categorized as D plot (Hayashi *et al.*., 2008). Satellite images of the country are updated and interpreted half-and-half in two years (e.g. satellite images of 2007 were interpreted in FY2008 and FY2009), and AR and D land areas are calculated based on the result of the interpretation. Detailed procedures are as follows:

1. Set the plot points on the whole country in a grid, interval of which is 500 m (approximately 1,500 thousand plots).
2. Detect land conversion between forest and non-forest at each plot point. Plots which are difficult for interpretation due to some reasons will be excluded from “available sample plots” which are used for following estimation.
3. Estimate AR rate for FY1990-FY2009: AR plots number for FY1990-FY2007 is calculated by using orthophotos at the end of 1989 and satellite images of 2005 and 2007. The increase of AR plots number for FY2008 is estimated to be equal to half the increase of AR plots number during FY2005-FY2007 (two years), which is the difference in results of the interpretation of orthophotos and satellite images of 2005 and 2007. In a similar way, the increase of AR plot number for FY2009 is estimated to be equal to half the increase of AR plots number during FY2007-FY2009 based on the difference in results of the interpretation of orthophotos and satellite images of 2007 and 2009 (interpretation work for the 2009 estimation carried out in FY2010 covers half of national land). AR rate for FY1990-FY2009 is estimated through dividing the increase of AR plots numbers in each year by “available sample plots” number at the time and then summating.
4. Estimate D rate for FY1990-FY2009: D plots number for each fiscal year during FY1990-FY2007 is estimated by multiplying the total D plots number during FY1990-FY2007, which is obtained by using orthophotos at the end of 1989 and the satellite images of 2005 and 2007, by land conversion ratio in each fiscal year provided by statistics. D plots number for FY2008 is estimated to be equal to half the number of D plots number during FY2005 to FY2007 (two years), which is the difference in results of the interpretation of orthophotos and satellite images of 2005 and 2007. In a similar way, D plot number for FY2009 is estimated to be equal to half the increase of D plots number during FY2007-FY2009 based on the difference in results of the interpretation of orthophotos and satellite images of 2007 and 2009 (interpretation work for the 2009 estimation carried out in FY2010 covers half of national land). D rate for FY1990-FY2009 is estimated through dividing the number of D plots numbers in each year by “available sample plots” number at the time and then summating. The land use status after D is analyzed at each plot point and this data is used for the estimation of new land use status in D land.
5. Calculate AR land area during FY1990-FY2009 by multiplying land area for each prefecture by AR rate. In the same way, calculate D land area for each prefecture during FY1990-FY2009 by multiplying land area for each prefecture by D rate.

Although Forest Registers are used as basic data source for reporting since forests under the forest planning system are considered as forests under the Kyoto Protocol in Japan, orthophotos and satellite images are used for AR and D detection. This is because that there are difficulties for data in Forest Registers in reconstructing the forest status during FY1990-FY2005 and in distinguishing AR which are direct human-induced activities from forest expansion due to other causes.

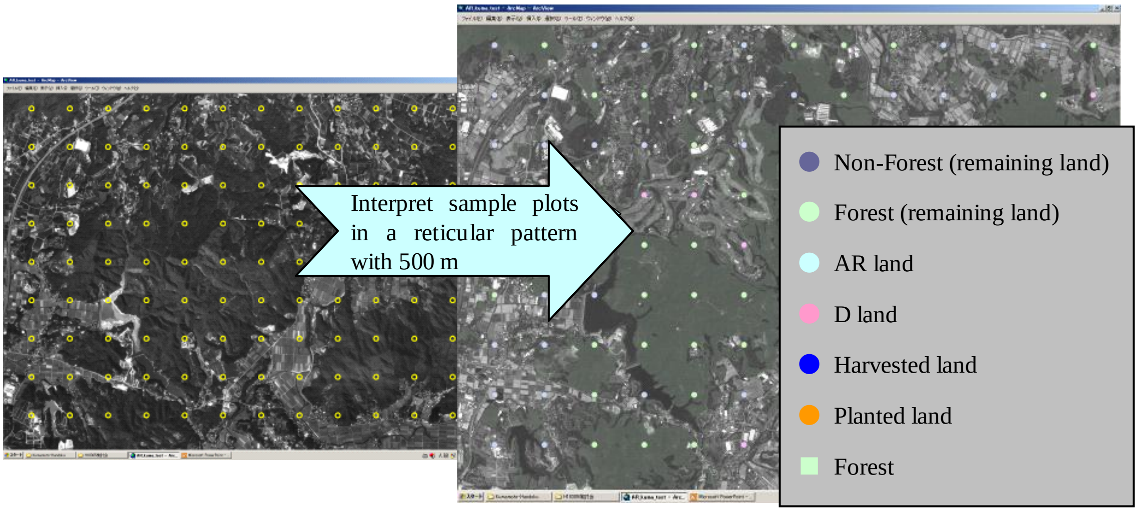

Figure A11-2　　ARD land identification by interpreting remote sensing images

A11.3.2.3.b. Data

Japan detected the ARD land area by using the following data.

Table A11-6 Data used in ARD land detection

	Resolution [m]	Data format
Ortho air-photo (at the end of 1989)	1	Raster
SPOT-5/HRV-P(after 2005, 2007 and 2009)	2.5	Raster

A11.3.2.3.c. Land-use change in deforested land

Japan determined the area of D land in accordance with the procedures mentioned in section A11.3.2.3.a. In addition, since these procedures do not cover continuous tracking of land-use change at D land, the following method is examined to complement tracking land-use change at D land.

Japan has compiled land-use mesh data “Digital National Land Information” continuously over time. Although this mesh data could not be used directly to monitor land-use change in the plots identified as D land because this mesh data is not absolutely consistent with the system mentioned in section A11.3.2.3.a. (e.g. definition, resolution and land identification method), it can detect overall tendency of land use transition at D plot. The result of the analysis of using this mesh data shows that D land is hardly converted to other land use again. Therefore, Japan assumed that the status of land use after D will continue to be the same and secondary land use change will not occur.

A11.3.2.4. Forest Management

A11.3.2.4.a. Procedure

Japan estimated FM land area for Ikusei-rin forests and Tennensei-rin forests according to the following procedures.

a） Ikusei-rin forests

1. Implement field survey in private forests and national forests to identify lands which have been subject to FM activities (the number of sample plots are systematically distributed by tree species and regions; then, sample plots are selected randomly from the National Forest Resource Database (NFRDB)).

Survey item: current status of forests (tree species, stand age, the number of trees, etc), status and contents of practices since 1990, etc.

2. Estimate ratio of these FM land area (FM ratio) according to the survey findings.

Table A11-7 FM ratio for Ikusei-rin forests (private forests / national forests)

Sub-category / Tree species		Region	Private forest	National forest
Intensively managed forest	Japanese cedar	Tohoku, Kita-kanto, Hokuriku,	0.74	0.81
		Tosan	0.56	0.71
		Minami-kanto, Tokai	0.63	0.77
	Hinoki cypress	Kinki, Chugoku, Shikoku, Kyusyu	0.68	0.81
		Tohoku, Kanto, Chubu	0.70	0.80
	Japanese larch	Kinki, Chugoku, Shikoku, Kyusyu	0.67	0.73
	Other	All	0.57	0.72
Semi-natural forest / All		All	0.22	0.70

* Data at the end of 2009. About 17,000 sample plots are located all across the country.
* These regions are generally used broad boundaries which aggregated several prefectures.

3. After AR land area for each prefecture is subtracted from total forest area, the remaining forest area for each prefecture is multiplied by FM ratio for each tree species, regions and age class.

b） Tennensei-rin forests

For Tennensei-rin forests, identify forest lands subject to practices for protection or conservation of forests including controlling logging activities and land-use change which have been carried out by laws by using the NFRDB.

Table A11-8 Area of protected/conserved Tennensei-rin forests [Unit: kha]

Protected / Conserved forest type	Private forest	National forest	Total
Protection Forest	2,494	4,224	6,718
Area for Conservation facility installation project	1	0	1
Protected Forest	0	752	752
Special Protected Zones in National Parks	41	104	145
Class I Special Zones in National Parks	35	142	178
Class II Special Zones in National Parks	119	192	311
Special Protected Zones in Quasi-National Parks	9	38	47
Class I Special Zones in Quasi-National Parks	31	104	136
Class II Special Zones in Quasi-National Parks	98	84	182
Special Zone in National Environment Conservation Area	0	9	9
Special Seed Forest	1	1	1
Total	2,830 (2,644)	5,649 (4,265)	8,479 (6,909)

* NFRDB (1st April 2009)
* This table includes forest with less standing trees.
* ( ) means total land area excluding overlaps.

A11.3.2.4.b. Data

a） Basic data for estimation

The basic data sources for FM estimation are Forest Registers and yield tables developed by prefectures or Regional Forest Offices. Some of yield tables were developed by Forestry and Forest Products Research Institute. These Forest Registers and yield tables are also used for reporting under the convention. The detailed information on Forest Register and yield tables is provided in section 7.4.1.b).1, Chapter 7 of this report.

b） Development of the National Forest Resources Database

To estimate emissions from or removals by forest, Forestry Agency has developed the National Forest Resources Database (NFRDB). In the NFRDB, Forest Registers which are the basic data source for estimating and reporting, administrative information including Forest Planning Map and geographical location information including orthophotos and satellite images like Landsat-TM and SPOT are archived.

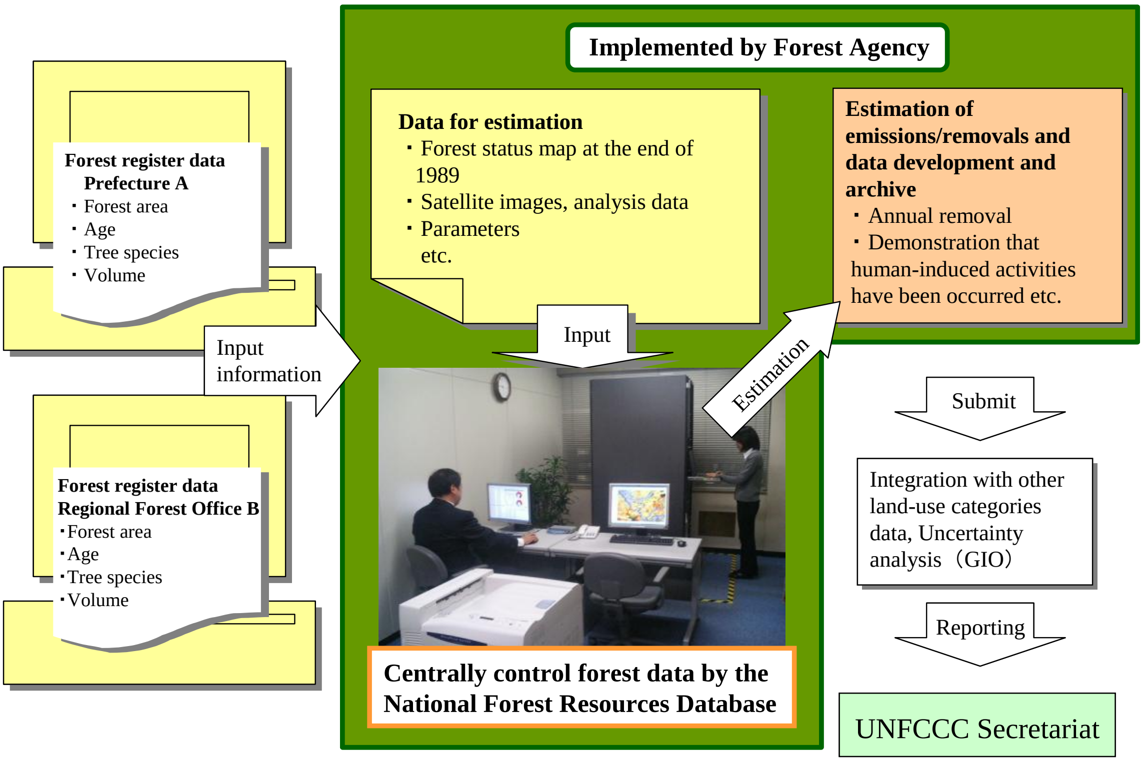

Figure A11-3 Summary of the National Forest Resources Database

A11.3.2.5. Revegetation

A11.3.2.5.a. Procedure

Japan estimated RV land area by types of urban green area according to the following procedures.

a） Urban parks

1. Rearrange the information on the notification date and the establishment area as of the end of each correspond fiscal year during the commitment period for all urban parks which are installed

in our country.

2. Extract urban parks which have been notified since 1st January 1990 and its establishment area is 500 m^2 or more.
3. Rearrange urban parks extracted in Step 2 depending upon the address and count the establishment area depending upon geographical boundary (prefecture).
4. Separate establishment area into settlements and wetlands by using area ratio of urban parks occupied in river zone [wetlands].
5. Calculate area of land which was qualified as forest land on 31st December 1989 by multiplying establishment area estimated in Step 4 by "area ratio of land has been converted from forest land to settlements or wetlands for the past 20 years". This area is excluded from establishment area because it qualified as D. Remaining area is considered as RV land area (Accurately, it means that RV land area in FY1989 is estimated (not 31st December 1989) because calculation is based on FY2009 data. However, it is considered to be conservative because it does not lead over-estimation of RV land area)[2].
6. Calculate area of "Remaining land (Settlements remaining Settlements, Wetlands remaining Wetlands)" and "Land converted to other land-use category (Cropland / Grassland / Wetlands / Other land converted to Settlements, Cropland / Grassland / Settlements / Other land converted to Wetlands) by multiplying land area estimated in Step 5 by "area ratio of land converted to Settlements or Wetlands in the single year[3]".

b） Green area on road

1. Calculate the number of tall trees for each geographic boundary (prefecture) at the end of each fiscal year during the commitment period based on "Road Tree Planting Status Survey" which was implemented in the correspond next fiscal year.
2. Calculate the number of tall trees on 31st March 1990 by using linear interpolations of two surveyed data (1986 and 1991) from "Road Tree Planting Status Survey". Then, calculate the number of tall trees for each prefecture on 31st March 1990 by multiplying these values by the ratio of the number of tall trees for each prefecture on 31st March 2007. Ratio of the number of tall trees on 31st March 1990 is fixed to the value on 31st March 2007.
3. Calculate the number of tall trees which have been planted since 1st April 1990 by subtracting value estimated in Step 1 from one in Step 2 (RV is considered to be an activity which takes place after 1st January 1990. However, Japan considers RV as an activity after 1st April 1990 because "Road Tree Planting Status Survey" has been implemented on fiscal year basis).
4. Estimate the ratio of the number of tall trees planted on the road which planted area is less than 500 m^2 by using data (general road: 1.00%, expressway: 0.00%, significant level: 95%) from sampling survey implemented in 2006.
5. Estimate land area per tall tree by using modeled data (general road: 0.0062 ha/tree, expressway: 0.0008 ha/tree, significant level: 95%) from sampling survey implemented in 2006

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[2] The same procedure of exclusion D land using the ratio of conversion land from forest to settlements during the past 20 years per all settlements is applied to other RV subcategories.

[3] Land use change from previous year to each correspondent year is applied in the case of area ratio of "single year" is used.

(These modeled data are calculated by dividing randomly sampled RV land area by the number of tall trees planted on the land).

6. Calculate area of tall tree planted land which is 500 m^2 or more by multiplying values estimated in Step 4 & 5 by the number of tall trees for each geographical boundary (prefecture) estimated in Step 3.

Area of land which have been planted since 1st April 1990 and its area is 500 m^2 or more (ha)
= 3. the number of tall trees which have been planted since 1st April 1990 (tree)
* 4. Ratio of the number of tall trees planted on the land which is 500 m^2 or more (%)
* 5. Land area per tall tree (ha/tree)

7. Calculate area of land which was qualified as forest land on 31st December 1989 by multiplying area estimated in Step 6 by “area ratio of land has been converted from Forest land to Settlements or Wetlands for the past 20 years”. This area is excluded because it qualified as D. Remaining area is considered as RV land area.

8. Calculate area of “Remaining land (Settlements remaining Settlements)” and “Land converted to other land-use category (Cropland / Grassland / Wetlands / Other land converted to Settlements) by multiplying land area estimated in Step 7 by “area ratio of land converted to Settlements in the single year”.

c） Green area on port

1. Extract green area on port which have been established since 1st January 1990 and its service area is 500 m^2 or more. Then, rearrange its area depending on geographic boundaries (All green area on port could be reported because it is considered not to be qualified as forest land on 31st December 1989).

2. Calculate area of “Remaining land (Settlements remaining Settlements)” and “Land converted to other land-use category (Cropland / Grassland / Wetlands / Other land converted to Settlements) by multiplying land area estimated in Step 1 by “area ratio of land converted to Settlements in the single year”.

d） Green area around sewage treatment facility

1. Extract green area around sewage treatment facility which have been established since 1st January 1990 and its greening area are 500 m^2 or more. Then, rearrange its area depending on geographic boundaries.

2. Calculate area of land which was qualified as forest land on 31st December 1989 by multiplying greening area estimated in Step 1 by “area ratio of land has been converted from Forest land to Settlements for the past 20 years”. This area is excluded because it qualified as D. Remaining area is considered as RV land area.

3. Calculate area of “Remaining land (Settlements remaining Settlements)” and “Land converted to other land-use category (Cropland / Grassland / Wetlands / Other land converted to Settlements) by multiplying land area estimated in Step 2 by “area ratio of land converted to Settlements in the single year”.

e） Green area by greenery promoting system for private green space

1. Extract green area by greenery promoting system for private green space which greening area is 500 m^2 or more and rearrange their area depending on geographic boundaries. All of them are activities which takes place after 1st January 1990 because greenery promoting system has implemented since May 2001.

2. All green areas by greenery promoting system for private green space to be reported are "Remaining land" because they were not qualified as Forest land on 31st December 1989 and qualified as Settlements in recent year.

f） Green area along river and erosion control site

1. Extract greening works and erosion and sediment control works including hillside works in river zone which has been established since 1st January 1990 and which greening area is 500 m^2 or more (greening works: (1) – (8) in the following table, erosion and sediment control works: (9) – (11) in the following table). All works described in the following table are human-induced.

Table A11-9 RV projects in green area along river and erosion control site and definition of planted land area

RV works in green area along river and erosion control site	definition of planted land area
(1) Planting in inspection passage of excavated channel	Area of land from levee wall shoulder to private land
(2) Planting in face of river bank of excavated channel	Area of land from levee wall shoulder to private land
(3) Planting in backslope banquette	Area of embanked land
(4) Planting in levee marginal strip (second-class and third-class)	Area of marginal strip which is subject to greening works
(5) Planting in high water channel	Area of land from low-flow channel shoulder to foot of levee slope
(6) Planting in retarding basin	Area of retarding basin
(7) Planting in lake foreshore	Area of land from low-flow channel shoulder to foot of levee slope
(8) Planting in super levee	(Same as planting in excavated channel)
(9) Greening under erosion and sediment control works	Area of land which is subject to hillside works
(10) Greening under landslide control works	Area of land which is subject to hillside works
(11) Greening under steep slope failure prevention works	Area of land which is subject to hillside works

2. Calculate planted land area in green area along river and erosion control site for each geographic boundary (prefecture) extracted in Step 1. Double-counting between RV land and D land is prevented because forested land (on 1st January 1990) is not included in Step 1.

3. Calculate land area of "Wetlands remaining wetlands" and "Land converted to Wetlands (excluding Forest land converted to Wetlands)" by multiplying land area estimated in Step 2 by "area ratio of land converted to Wetlands (excluding Forest land converted to Wetlands) in the single year".

g） Green area around government buildings

1. Extract green area around government buildings which has been established since 1st January

1990 and which RV land area (= total land area - building area) is 500 m^2 or more.

2. Calculate RV land area for each geographic boundary (prefecture) extracted in Step 1.
3. Calculate area of land which was qualified as forest land on 31st December 1989 by multiplying land area estimated in Step 2 by "area ratio of land has been converted from Forest land to Settlements for the past 20 years". This area is excluded because it qualified as D. Remaining area is considered as RV land area.
4. Calculate area of "Remaining land (Settlements remaining Settlements)" and "Land converted to other land-use category (Cropland / Grassland / Wetlands / Other land converted to Settlements) by multiplying land area estimated in Step 3 by "area ratio of land converted to Settlements in the single year".

h） Green area around public rental housing

1. Extract green area around public rental housing which has been established since 1st January 1990 and which RV land area (= total land area - building area) is 500 m^2 or more.
2. Calculate RV land area for each geographic boundary (prefecture) extracted in Step 1.
3. Calculate area of land which was qualified as forest land on 31st December 1989 by multiplying land area estimated in Step 2 by "area ratio of land has been converted from Forest land to Settlements for the past 20 years". This area is excluded because it qualified as D. Remaining area is considered as RV land area.
4. Calculate area of "Remaining land (Settlements remaining Settlements)" and "Land converted to other land-use category (Cropland / Grassland / Wetlands / Other land converted to Settlements) by multiplying land area estimated in Step 3 by "area ratio of land converted to Settlements in the single year".

A11.3.2.5.b. Data

Data applied in estimating RV land area is shown below.

Table A11-10 Data applied in estimating RV land area

Sub-division	Data type	Method for data collection
Urban parks	・Area for each urban park	・Urban Parks Status Survey (FY2008, FY2009)
Green area on road	・Number of tall trees	・Road Tree Planting Status Survey (FY:1987, 1992, 1997, 2002, 2007, 2008, 2009, 2010)
	・Land area per tall tree	・Basic Data Collection Survey on Tall Tree Planting on the Road (February, 2007)
Green area on port	・Service area	・Complete census for FY2008 and FY2009
Green area around sewage treatment facility	・Green area	・Sewage treatment Facility Status Survey (FY2008, FY2009)
Green area by greenery promoting system for private green space	・Greening area ・Wall greening area ・The number of tall trees	・Application form for greenery promoting system for private green space ・Urban Greening Status Survey (FY2008, FY2009)
Green area along river and erosion control site	・Planted land area	・Survey on carbon dioxide absorption at source in river works (FY2008, FY2009)
Green area around government buildings	・Total land area and building area	・Complete census for FY2008 and FY2009
Green area around public rental housing	・Total land area and building area	・Progress survey on tree planting for public rental housing (FY2008, FY2009)

A11.3.3. Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Section 4.2.2.2 of GPG-LULUCF shows two methods for identifying and reporting of unit of land subject to Article 3.3 activities and lands subject to Article 3.4 activities. Reporting Method 1 entails delineating areas that include multiple land units subject to Article 3.3 and 3.4 activities by using legal, administrative, or ecosystem boundaries. Reporting Method 2 is based on the spatially explicit and complete geographical identification of all units of land subject to Article 3.3 activities and all lands subject to Article 3.4 activities.

Japan elects Reporting Method 1 in accordance with the decision tree indicated in Figure 4.2.4 in Chapter 4 of GPG-LULUCF, which means that the entire national land is stratified by using the geographic boundary of prefectures, and total area of each “unit of land” subject to each Article 3.3 activity and each “lands” subject to each Article 3.4 activity is reported within each boundary. Identification code is determined for each prefecture as shown in the following map. Each activity under Article 3.3 and 3.4 is detected as described in sections A11.3.2.3-A11.3.2.5, and units of land or lands subject to it are identified within prefectural boundary in accordance with Reporting Method 1.

This geographical boundary is applied for all units of land and lands: units of land subject to activities under Article 3.3, units of land subject to activities under 3.3 which would otherwise be included in land subject to elected activities under Article 3.4, under the provisions of paragraph 8 of the Annex to the decision 16/CMP.1 and lands subject to elected activities under Article3.4.

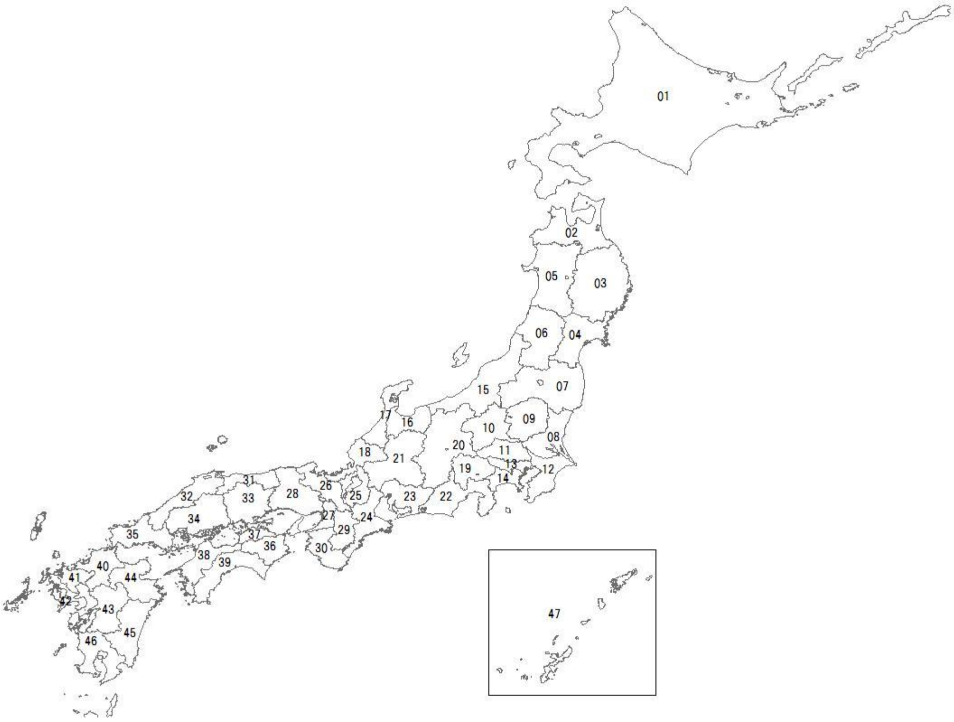

Figure A11-4 Japan’s determination of identification codes

Table A11-11 Relation between identification codes and prefectures

ID code	Prefecture	ID code	Prefecture	ID code	Prefecture
01	Hokkaido	17	Ishikawa	33	Okayama
02	Aomori	18	Fukui	34	Hiroshima
03	Iwate	19	Yamanashi	35	Yamaguchi
04	Miyagi	20	Nagano	36	Tokushima
05	Akita	21	Gifu	37	Kagawa
06	Yamagata	22	Shizuoka	38	Ehime
07	Fukushima	23	Aichi	39	Kochi
08	Ibaraki	24	Mie	40	Fukuoka
09	Tochigi	25	Shiga	41	Saga
10	Gunma	26	Kyoto	42	Nagasaki
11	Saitama	27	Osaka	43	Kumamoto
12	Chiba	28	Hyogo	44	Oita
13	Tokyo	29	Nara	45	Miyazaki
14	Kanagawa	30	Wakayama	46	Kagoshima
15	Niigata	31	Tottori	47	Okinawa
16	Toyama	32	Shimane		

A11.4. Activity-specific information

A11.4.1. Methods for carbon stock change and GHG emission and removal estimates

A11.4.1.1. Description of the methodologies and the underlying assumptions used

A11.4.1.1.a. Afforestation/Reforestation

a） Above-ground biomass, Below-ground biomass

- ***Methodology***

Carbon stock change in living biomass in AR land is calculated, using Tier 2 stock change method in accordance with GPG-LULUCF. In this method, biomass stock change is estimated by subtracting biomass stock change due to land conversion from the difference between total amount of biomass at two times.

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

ΔC_{LB} : Annual carbon stock change in living biomass [t-C/yr]

ΔC_{SC} : Annual carbon stock change due to biomass growth, felling, fuelwood gathering, disturbance after land conversion [t-C/yr]

ΔC_{L} : Annual carbon stock change due to land conversion [t-C/yr]

<u>Carbon stock change due to biomass growth, felling, fuelwood gathering and disturbance after land conversion</u>

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

ΔC_{SC} : Annual carbon stock change in living biomass [t-C/yr]

t_1, t_2 : Time point of carbon stock measurement

C_{t1} : Total carbon in biomass calculated at time t_1 [t-C]

C_{t2} : Total carbon in biomass calculated at time t_2 [t-C]

k : Type of forest management

The carbon stocks in living biomass is calculated from the volume for each tree species multiplied by wood density, biomass expansion factor, root-to-shoot ratio and carbon fraction.

$$C = \sum_{j} \left\{ [V_j \times D_j \times BEF_j] \times (1 + R_j) \times CF \right\}$$

C : Carbon stock in living biomass [t-C]
V : Volume [m^3]
D : Wood density [t-d.m./m^3]
BEF : Biomass expansion factor [dimensionless]
R : Root-to-shoot ratio [dimensionless]
CF : Carbon fraction (= 0.5[t-C/t-d.m.])
j : Tree species

Carbon stock change due to land conversion

Carbon stock change due to land conversion has been calculated as below, in accordance with GPG-LULUCF.

$$\Delta C_L = \sum_{i} \left\{ A_i \times (B_a - B_{b,i}) \times CF \right\}$$

ΔC_L : Annual biomass carbon stock change in land that has been converted from other land use type to forest [t-C/yr]
A_i : Annual increase of land area that has been converted from land use type *i* to forest [ha/yr]
Ba : Dry matter weight immediately per unit area after conversion to forest [t-d.m./ha]
Bb,i : Dry matter weight per unit area before conversion from land use type *i* to forest [t-d.m./ha]
CF : Carbon fraction of dry matter [t-C/t-d.m.]
i : Type of land use

- ***Parameters***

Data such as volume, biomass expansion factor, root-to-shoot ratio, wood density and carbon fraction are the same as those for reporting of LULUCF under the Convention. Detailed information is provided in section 7.4.1, Chapter 7 of this report.

Biomass stock data for each land use category which is used for estimation of biomass stock change due to land conversion are also the same as those for reporting of LULUCF under the Convention. Detailed information is provided in Table 7-5, Chapter 7 of this report.

- ***Activity data***

Activity data is AR land area which was calculated by using the procedure described in section A11.3.2.3 of this report.

b） *Dead wood, Litter and Soils*

- ***Methodology***

Carbon stock change in dead wood and litter in AR land was calculated in accordance with the basic stock change method provided by GPG-LULUCF under the assumption that carbon stocks would change linearly over 20 years from those in non-forest land to those in forest land at the age of 20. The calculation is conducted by using average carbon stocks derived from CENTURY-jfos model, and carbon stocks in dead wood and litter before land conversion are assumed zero.

$$\Delta C_{DW} = \sum_i \left\{ A_i \times (C_{DW20} - C_{DW,i}) / 20 \right\}$$

$$\Delta C_{LT} = \sum_i \left\{ A_i \times (C_{LT20} - C_{LT,i}) / 20 \right\}$$

ΔC_{DW} : Annual carbon stock change in dead wood [t-C/yr]

ΔC_{LT} : Annual carbon stock change in litter [t-C/yr]

A_i : Afforested or reforested land area converted from land use *i* [ha]

C_{DW20} : Average carbon stocks per unit area in dead wood of 20-year-old forests [t-C/ha]

C_{LT20} : Average carbon stocks per unit area in litter of 20-year-old forests [t-C/ha]

$C_{DW,i}$: Average carbon stocks per unit area in dead wood in land use *i* [t-C/ha] (assumed to be zero)

$C_{LT,i}$: Average carbon stocks per unit area in litter in land use *i* [t-C/ha] (assumed to be zero)

i : Type of land use (cropland, grassland, wetlands, settlements and other land)

Carbon stock change in soils in AR land was calculated in accordance with the basic stock change method provided by GPG-LULUCF under the assumption that carbon stocks would change linearly over 20 years from those in non-forest land to those in forest land at the age of 20. This calculation is conducted by using average carbon stocks derived from CENTURY-jfos model.

$$\Delta C_{Soil} = \sum_i \left\{ A_i \times (C_{Soil20} - C_{Soil,i}) / 20 \right\}$$

ΔC_{Soil} : Annual carbon stock change in soils [t-C/yr]

A_i : Afforested or reforested land area converted from land use *i* [ha]

C_{Soil20} : Average carbon stocks per unit area in soils of 20-year-old forests [t-C/ha]

$C_{Soil,i}$: Average carbon stocks per unit area in soils in land use *i* [t-C/ha]

i : Type of land use (cropland, grassland, wetlands, settlements and other land)

- ***Parameters***

Parameters were determined based on CENTURY-jfos model and relevant literature.

- ***Activity data***

AR land area was calculated by using the procedure described in section A11.3.2.3 of this report.

c） Other gases

1） Direct N_2O emissions from N fertilization

It is assumed that amount of nitrogen-based fertilizer applied in Forest land is counted in Agriculture sector. Therefore, this category has been reported as “IE”.

2） CO_2 emissions from agricultural lime application

According to a survey in 2009 for private forest, all prefectures answered no lime applied to forest management practices like regeneration and tending in private forest. There is also no lime applied to such forest management practices in national forest. Therefore, lime application in Forest land is considered as “not occurred” in Japan. This category has been reported as “NO” for all time series.

3） Biomass burning

GHG emissions from wild fire is existing in Japan as explained in section 7.14.a), Chapter 7 of this report. Since there is no data which directly express biomass burning status in AR land, GHG emissions in AR land is estimated by multiplying GHG emissions due to fire for all forest land by the ratio of AR land area to all forest land area. Carbon released due to fire for all forest land (national forest and private forest) is estimated by multiplying the damaged timber volume due to fire by wood density, biomass expansion factor and carbon fraction of dry matter. Calculations only for non CO_2 emissions are performed since CO_2 emissions are already included in the calculation of carbon stock change.

d）Results

Table A11-12　Net emissions and removals from AR activity

		2008	2009
		［Gg-CO_2］	［Gg-CO_2］
AR		-389.56	-415.08
	Above-ground biomass	-222.16	-239.70
	Below-ground biomass	-58.34	-63.45
	Dead wood	-65.69	-67.40
	Litter	-28.49	-29.24
	Soils	-14.91	-15.30
	Other gases	0.03	0.01

＊　CO_2）+：Emission, -: Removal

A11.4.1.1.b. Deforestation

a）Above-ground biomass, Below-ground biomass

- ***Methodology***

Carbon stock change of living biomass (above-ground biomass and below-ground biomass) in D land is estimated by adding forest living biomass loss due to land conversion and carbon stock change due to growth of living biomass in D land after land conversion, in accordance with GPG-LULUCF.
Forest living biomass loss due to land conversion is estimated from data in the NFRDB taking into account the status of D land such as tree species and forest, and all loss is allocated as emissions for the year of land conversion.

Carbon stock change due to growth of living biomass is estimated according to land use after conversion in D land. The land use categories except forest land where living biomass growth after conversion is calculated are land converted to grassland and land converted to settlements as explained in Table 7-5 in Chapter 7 of this report. D land which is converted to settlement with living biomass growth is the land subject to RV practices. This is the land subject to both Article 3.3 and 3.4 activities, and the carbon stock change in this land is reported under D activity. The calculation is performed according to the status of land use which is immediately after conversion in D land taking into account that D land is assumed to be hardly converted to other land use again as explained in section A11.3.2.3.c

$$\Delta C_{D-LB} = \Delta C_{DG-LB} + \Delta C_{DS-LB}$$

$$\Delta C_{DG-LB} = A_{5,DG} \times C_{G-LB}$$

$$\Delta C_{DS-LB} = \Delta C_{RV-LB} \times RA_{DS-RV}$$

$\Delta C_{D\text{-}LB}$: Annual carbon stock change due to living biomass growth after D activity [t-C/yr]
$\Delta C_{DG\text{-}LB}$: Carbon stock change in living biomass growth in grassland subject to D activity [t-C/yr]
$\Delta C_{DS\text{-}LB}$: Carbon stock change in living biomass growth in settlements subject to D activity [t-C/yr]
$\Delta C_{RV\text{-}LB}$: Carbon stock change in living biomass due to all RV practice [t-C/yr] (see section A11.4.1.1.d)
$A_{5,DG}$: Area of grassland subject to D activity within the past 5 years [ha]
$C_{G\text{-}LB}$: Carbon stock change per area in grassland [t-C/ha/yr]
$RA_{DS\text{-}RV}$: Ratio of Area subject to both D and RV activities within all area subject to RV activities

- ***Parameters***

Information relating to forest biomass loss is obtained from the NFRDB. The parameter in Table 7-5 is used for estimating carbon stock change due to living biomass growth after D activity in grassland. The parameters for estimating carbon stock change due to RV practices are the same as those used for RV activity.

- ***Activity data***

Land area on which D activity had occurred was calculated by the method described in A11.3.2.3. D land area where RV practices had taken place was calculated by the method described in A11.4.1.1.d.

b） Dead wood, Litter and Soils

Carbon stock change in dead wood, litter and soils associated with D is calculated in accordance with Tier 2 method in GPG-LULUCF. Japan assumed that all carbon stocks in dead wood and litter would be emitted at the time point when D activities occurred. Carbon stock change in soils was calculated under the assumption that soil carbon stocks would change linearly over 20 years to those in non-forest land. Carbon stocks before and after conversion were established based on the data in Table 7-6, Table 7-7 and Table 7-8 in Chapter 7 of this report, and data obtained from CENTURY-jfos model.

c） Other gases

1） N_2O emissions from disturbance associated with land-use conversion to cropland

GPG-LULUCF Tier 1 method that N_2O emission is estimated by using mineralized soil carbon due to disturbance associated with land-use conversion to cropland as activity data is applied. The same methodology and parameters explained in section 7.12 b), Chapter 7 of this report are used. Carbon loss due to mineralization as a result of conversion to cropland in D area is calculated by all carbon loss due to deforestation multiplied by the ratio of land use change to cropland in D area.

2） CO_2 emissions from agricultural lime application

CO_2 emissions from lime application in D land is estimated by the total CO_2 emission from lime application in cropland in accordance with GPG-LULUCF Tier 1 method multiplied by the ratio of D area to total area of cropland. Japan did not elect “Cropland Management (CM)” under Article 3.4 of the Kyoto Protocol, and then CO_2 emissions from agricultural lime application to be reported under the Kyoto Protocol are only those in Cropland converted from Forest land since 1990 (identified as D land). However, it is difficult to directly determine the amount of lime and dolomite applied in such lands. Therefore it is assumed that lime application is conducted uniformly in all Cropland.

3） Biomass burning

Prescribed fire associated with D activity is very rarely performed in Japan because of severe restriction imposed by the “Waste Management and Public Cleansing Law” and the “Fire Defense Law”. Therefore, CH_4, CO, N_2O, and NOx emissions are reported as “NO”.

d） Results

Table A11-13 Net emissions and removals from D activity

		2008 ［Gg-CO_2］	2009 ［Gg-CO_2］
D		2,429.33	3,086.51
	Above-ground biomass	1,268.71	1,616.25
	Below-ground biomass	332.98	422.39
	Dead wood	434.84	543.13
	Litter	173.57	217.35
	Soils	215.12	282.72
	Other gases	4.10	4.68

* CO_2）+： Emission, -: Removal

A11.4.1.1.c. Forest Management

a） Above-ground biomass, Below-ground biomass

● ***Methodology***

1. Estimate emissions/removals in all forest land by using biomass stock data stored in the NFRDB (based on stock change method).
2. Subtract emissions/removals relating to ARD activities from emissions/removals in all forest land. For Ikusei-rin forest, estimate emissions/removals in FM land by applying FM ratio for each tree species, region and age class. For Tennensei-rin forest, identify area of forest land with standing trees subject to practices for protection or conservation of forests including controlling logging activities and land-use change which have been implemented under laws, by using the NFRDB, and estimate emissions/removals.

● ***Parameters***

Parameters are the same as those used for AR.

b） Dead wood, Litter and Soils

● ***Methodology***

Carbon stock change in each pool is estimated by Tier 3 model method. It is estimated by multiplying carbon emissions/removals per area in each pool, which are calculated by CENTURY-jfos model for each type of forest management, by land area of each type of forest management and then summating.

$$\Delta C_{dls} = \sum_{k,m,j} (A_{k,m,j} \times (d_{k,m,j} + l_{k,m,j} + s_{k,m,j}))$$

ΔC_{dls} : Carbon stock change in dead wood, litter and soil [t-C/yr]
A : Area [ha]
d : Average carbon stock change per unit area in dead wood per area [t-C/ha/yr]
l : Average carbon stock change per unit area in litter per area [t-C/ha/yr]
s : Average carbon stock change per unit area in soils per area [t-C/ha/yr]
k : Type of forest management
m : Age class or forest age
j : Tree species

- ***Parameters***

Average carbon stock changes per unit area for dead wood, litter and soils are calculated by CENTURY-jfos model, which was modified CENTURY model (Colorado State University) to follow Japanese climate, soil, and vegetation conditions. Detailed explanation of CENTURY-jfos model is provided in section 7.4.1.b).2), Chapter 7 of this report.

c） Other gases

1） Direct N_2O emissions from N fertilization

It is assumed that amount of nitrogen-based fertilizer applied in Forest land is included in the amount of nitrogen-based fertilizer counted in Agriculture sector. Therefore, this category is reported as “IE”.

2） N_2O emissions from drainage of soils

Based on expert judgment, N_2O emissions are extremely low, because the soil drainage activities are very rarely conducted in Japan. Therefore, this category is reported as “NO”.

3） CO_2 emissions from agricultural lime application

According to a survey in 2009 for private forest, all prefectures answered no lime applied to forest management practices like regeneration and tending in private forest. There is also no lime applied to such forest management practices in national forest. Therefore, lime application in Forest land is considered as “not occurred” in Japan. This category has been reported as “NO” for all time series.

4） Biomass burning

Emissions due to biomass burning are estimated in the same way as in the case of AR by multiplying GHG emissions due to fire for all forest land by the ratio of FM land area to all forest land area.

d） Results

Table A11-14 Net emissions and removals from FM activity

		2008	2009
		［Gg-CO_2］	［Gg-CO_2］
FM		-45,388.82	-49,005.74
	Above-ground biomass	-34,747.68	-37,955.21
	Below-ground biomass	-8,758.73	-9,581.09
	Dead wood	134.69	540.79
	Litter	-472.06	-394.24
	Soils	-1,559.02	-1,621.64
	Other gases	13.99	5.64

* CO_2）+：Emission, -: Removal

A11.4.1.1.d. Revegetation

Methodologies for estimating GHG emissions and removals from RV activity are described in two cases: RV activity is performed 1) on the land where no land conversion has been happened (remaining land) and 2) on the land where land conversion has been happened (Conversion Land).

a）Remaining land: Above-ground biomass, Below-ground biomass

In this category, Japan estimates carbon stock change in above-ground biomass and below-ground biomass of tall trees planted in RV lands. Tall trees are consistent with definition in "Standards on quality and size of planted trees for public (draft)[4]".

- ***Methodology***

$$\Delta C_{RVLB} = \sum_i \left(\Delta C_{LBG,i} - \Delta C_{LBL,i}\right)$$

$$\Delta C_{LBG,i} = \Delta B_{LBG,i}$$

$$\Delta B_{LBG,i} = \sum_j \left(NT_{i,j} \times C_{Rate i,j}\right)$$

ΔC_{RVLB}	: Annual change in carbon stocks in living biomass in remaining RV land [t-C/yr]
ΔC_{LBG}	: Annual change in carbon stocks due to growth in living biomass in remaining RV land [t-C/yr]
ΔC_{LBL}	: Annual change in carbon stocks due to loss of living biomass in remaining RV land [t-C/yr]
ΔB_{LBG}	: Annual biomass growth in RV land [t-C/yr]
C_{Rate}	: Annual biomass growth per tree [t-C/tree/yr]
NT	: number of trees
i	: Land use type (urban parks, green area on road, green area on port, green area around sewage treatment facility and green area by greenery promoting system for private green space, Green area along river and erosion control site, green area around public rental housing and green area around government buildings)
j	: Tree species

- ***Parameters***[5]
  - ***Urban parks***

As a result of tree survey for sample urban parks[6], it could be assumed that the average age of tree population is less than or equal to 20 years and carbon stock change due to living biomass loss in urban parks is determined to be zero. Annual biomass growth in urban parks is calculated by using default values (0.0084-0.0142 t-C/tree/yr) provide in GPG-LULUCF (p. 3.297, Table 3A.4.1) and distribution ratio of tree types in sample urban parks[7]. For ratio of above-ground

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[4] "Standards on quality and size of planted trees for public (draft) " was decided by the Ministry of Land, Infrastructure, Transport and Tourism in order to promote proper enforcement of projects such as greening in public space. Tall tree is defined as tree which reaches 3 ~ 5 m height in the standards.

[5] In this reporting, Japan applied Tier 1b described in GPG-LULUCF. In the future, tier 2 method will be applied if country specific data on biomass growth is established.

[6] Kanagawa Prefecture is located in Japan's typical climate zone and has many types of urban parks. Japan determined randomly 129 sample urban parks in Kanagawa which have been notified since 1st January 1990. In addition, Japan implemented same survey in 3 urban parks in Chiba Prefecture which park type is not existed in Kanagawa.

[7] For Hokkaido, distribution ratio of tree types is calculated by using tree registers and plantation maps for all urban parks in Kushiro city and Yubari city. For other prefectures, distribution ratio of tree types is calculated by using tree registers and

biomass/below-ground biomass, default value provided in the 2006 IPCC Guidelines (root-to-shoot ratio: 0.26) is applied (see p. 8.9).

- ***Green area on road***

Japan calculated the average age of tree population by using data on the age of planted trees in sample roads which had been extracted randomly. As a result of its calculation, it could be assumed that the average age of tree population is less than or equal to 20 years and carbon stock change due to living biomass loss in green area on road is determined to be zero.

Annual biomass growth and ratio of above-ground biomass/below-ground biomass are calculated by using the same parameters as urban parks.

- ***Green area on port, Green area around sewage treatment facility, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings***

As in the case of urban parks, it could be assumed that carbon stock change due to living biomass loss in these green areas is zero because standard of planted trees, tree types and their distribution are applied in the same manner as urban parks.

Annual biomass growth and ratio of above-ground biomass/below-ground biomass are calculated by using the same parameters as urban parks.

- ***Green area by greenery promoting system for private green space***

It could be assumed that the average age of tree population is less than or equal to 20 years and carbon stock change due to living biomass loss in green area by greenery promoting system for private green space is determined to be zero because standard of planted trees is selected in the same manner as urban parks and all facilities has been certified since 2002.

Annual biomass growth and ratio of above-ground biomass/below-ground biomass are calculated by using the same parameters as urban parks.

- ***Activity data***
  - ***Urban parks***

Area of land remaining urban parks is calculated by multiplying area of urban parks by area ratio of land conversion for the whole country. Activity data for carbon stock change in living biomass in urban parks is the number of tall trees planted in urban parks which is calculated by multiplying area of urban parks obtained from “Urban Parks Status Survey” by the number of tall trees per area (Hokkaido: 340.1tree/ha, the other prefectures: 203.3 tree/ha).

In addition, the number of tall trees per area is calculated by using the number of tall trees and land area in sampling urban parks which significant level is 95%.[8]

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plantation maps for 321 urban parks extracted randomly.

[8] The number of tall trees per area in urban parks was calculated by using data from tree register and planting map which was measured in some urban parks (Hokkaido: 176, other prefectures: 321). For Hokkaido, sample data was not sufficient because tree register has not been developed completely.

Table A11-15 Area of urban parks which was not qualified as forest land on 31st December 1989[9]

At the end of 2009

	Percentage	Land-use category	Area ratio of land has been converted for the past 20 years	Area [ha]	RV Qualification
Urban parks which have been notified since 1st January 1990 and its establishment area is 500 m^2 or more	100.00%	Forest	4.89%	2,559.69	No
		Non-forest	95.11%	49,802.10	Yes
		Total	100.00%	52,361.79	-
Urban parks located in Settlements	90.85%	Forest	5.23%	2,488.25	No
		Non-forest	94.77%	45,082.44	Yes
		Total	100.00%	47,570.69	-
Urban parks located in Wetlands (they occupy the river section)	9.15%	Forest	1.49%	71.44	No
		Non-forest	98.51%	4,719.66	Yes
		Total	100.00%	4,791.10	-

Table A11-16 Area of urban parks (remaining land / converted land)

At the end of 2009

	Land-use Category	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Urban parks which have been notified since 1st January 1990 and its establishment area is 500 m^2 or more	Converted (except land converted from forest land)	0.24%	120.93	26,517
	Remaining	99.76%	49,681.17	10,893,893
	Total	100.00%	49,802.10	10,920,410
Urban parks located in Settlements	Converted (except land converted from forest land)	0.27%	120.57	26,439
	Remaining	99.73%	44,961.86	9,859,062
	Total	100.00%	45,082.44	9,885,501
Urban parks located in Wetlands (they occupy the river section)	Converted (except land converted from forest land)	0.01%	0.35	78
	Remaining	99.99%	4,719.31	1,034,831
	Total	100.00%	4,719.66	1,034,909

- ***Green area on road***

Activity data (the number of tall trees) in “Remaining green area on road” is calculated by the following procedures.

1. Calculate the number of tall trees in all green area on road in 31 March 1990 and the end of correspond fiscal year during the commitment period by using data from “Road Tree Planting Status Survey” which had been implemented in FY1987, FY1992 and correspond fiscal year during the commitment period.

2. Calculate the number of tall trees which have been planted since 1st April 1990 by subtracting the number for 31 March 1990 from one for the end of correspond fiscal year during the commitment period (RV is an activity which takes place after 1st January 1990. However, Japan considers it a activity after 1st April 1990 because it is impossible to estimate the number of tall trees which have been planted between 1st April 1990 and 31st March 1990).

3. Multiply the number of tall trees calculated in Step 2 by the ratio of the number of tall trees planted on the road which planted area is more than 500 m^2.

4. Multiply the number of tall trees calculated in Step 3 by the area ratio of green area on road

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[9] The percentage of in settlements and in wetlands is a measured value on 31 March 2007 from “urban Parks Status Survey” (2006).

which was qualified as Forest land in 31st December 1989.

5. Multiply the number of tall trees calculated in Step 4 by the area ratio of land remaining Settlements.

Table A11-17 Area of green area on road which has been qualified as RV

At the end of 2009

	Area of green area on road per tall tree [ha/tree]	The number of planted tall tree			Area ratio of planted land which is 500 m^2 or more [%]	Area ratio of land which was qualified as forest land on 31st December 1989 [%]	Area of green area on road which was qualified as RV [ha]	Activity data [the number of tall trees]
		31th March 1990	31th March 2010	FY1990 - FY2009				
	a	b	c	c-b	d	e	a*(c-b)*d/100*(100-e)/100	(c-b)*d/100*(100-e)/100
General road (managed by Ministry of Land, Infrastructure and Transport, Prefectures, local authority, public corporation)	0.006237	4,342,070	6,876,129	2,534,059	99.00%	5.23%	14,828	2,377,416
Highway (managed by now-defunct public corporation)	0.000830	1,096,380	8,198,153	7,101,773	100.00%	5.23%	5,585	6,730,305
Total	—	5,438,450	15,074,282	9,635,832	—	—	20,413	9,107,721

Table A11-18 Area of green area on road which has been qualified as RV and activity data [the number of tall trees] (remaining land / converted land)

At the end of 2009

		Land-use category	Area ratio of land has been converted for the current year	Activity data [the number of tall trees]	Area [ha]
Greenarea on road which have been notified since 1st January 1990 and its establishment area is 500 m^2 or more		Converted	0.27%	24,358	54.60
		Remaining	99.73%	9,083,363	20,358.85
		Total	100.00%	9,107,721	20,413.44
	General road	Converted	0.27%	6,358	39.66
		Remaining	99.73%	2,371,058	14,788.29
		Total	100.00%	2,377,416	14,827.94
	Highway	Converted	0.27%	18,000	14.94
		Remaining	99.73%	6,712,305	5,570.56
		Total	100.00%	6,730,305	5,585.50

- ***Green area on port***

Activity data for carbon stock change in living biomass in green area on port is the number of tall trees planted in green area on port, which is calculated by multiplying service area obtained from complete census by the number of tall trees per urban parks (Hokkaido: 340.1 tree/ha, the other prefectures: 203.3 tree/ha, these values are applied because of the similarities between urban parks and green area on port as mentioned above).

In addition, it has been assumed that all green area on port has been located in Settlements and not qualified as Forest land in 31 December 1989.

Table A11-19 Area of green area on port and activity data (remaining land / converted land)

At the end of 2009

Land-use Category	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Converted	0.27%	3.64	769
Remaining	99.73%	1,358.06	286,640
Total	100.00%	1,361.70	287,409

- ***Green area around sewage treatment facility***

Area of land remaining green area around sewage treatment facility is calculated in the same manner as urban parks. Activity data for carbon stock change in living biomass in green area around sewage treatment facility is obtained from "Sewage treatment Facility Status Survey" relevant to each fiscal year during the commitment period. The number of tall trees planted in green area around sewage treatment facility is calculated by multiplying greening area by the number of tall trees per greening area (Hokkaido: 129.8 tree/ha, the other prefectures: 429.2 tree/ha). The number of tall trees per greening area is determined from the number of tall trees and greening area for 59 facilities.[10]

In addition, all green area around sewage treatment facility has been located in Settlements.

Table A11-20 Green area around sewage treatment facility which was not qualified as Forest land in 31st December 1989

At the end of 2009

Land-use category	Area ratio of land has been converted for the past 20 years	Area (ha) (green area)	RV Qualification
Forest	5.23%	34.34	No
Non-forest	94.77%	622.13	Yes
Total	100.00%	656.47	-

Table A11-21 Area and activity data of Green area around sewage treatment facility [the number of tall trees] (remaining land / converted land)

At the end of 2009

Land-use category	Area ratio of land has been converted for the current year	Area [ha] (green area)	Activity data [the number of tall trees]
Converted	0.27%	1.66	672
Remaining	99.73%	620.47	250,727
Total	100.00%	622.13	251,399

- ***Green area by greenery promoting system for private green space***

Activity data (the number of tall trees) is available for each facility. Therefore, total number of tall trees is used as activity data.

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[10] The number of tall trees per area for green area around sewage treatment facility was established by using data on the number of tall trees and greening area measured in 59 green areas.

Table A11-22 Activity data and area of green area by greenery promoting system for private green space

Certification Year	Location	Area [m^2]	Breakdown of area[m^2]			Area	Activity data
			Ground	Roof	Wall	Wall green area by greenery promoting system for private green space[m^2]	The number of tall trees [tree]
2002	Minato-ku, Tokyo	17,244	1,314	2,042	106	3,356	335
2002	Minato-ku, Tokyo	19,708	3,285	736		4,021	147
2002	Minato-ku, Tokyo	52,766	10,679			10,679	672
2002	Minato-ku, Tokyo	84,780	8,846	7,493		16,339	813
2003	Minato-ku, Tokyo	5,519	1,654			1,654	167
2003	Osaka City	22,282	1,527	3,164	110	4,691	500
2005	Kawaguchi City	1,995	586	164	18	750	153
2006	Kyoto City	3,857	1,271			1,271	90
2006	Hiroshima City	4,453	130	783		913	1
2007	Hiroshima City	14,353	4,058			4,058	261
2007	Fukuoka City	5,689	602	799		1,401	19
2008	Ishikawa Prefecture	7,281	682	1,411		2,093	19
2009	Setagaya-ku, Tokyo	5,526	1,116			1,116	51
2009	Setagaya-ku, Tokyo	6,459	1,370			1,370	15
Total		251,912	37,120	16,592	234	53,712	3,243

- ***Green area along river and erosion control site***

Area of land remaining green area along river and erosion control site is calculated by multiplying area of this green area by area ratio of land conversion for the whole country (all green area along river and erosion control site are assumed to be located in wetlands). Activity data for living biomass (the number of tall trees) is calculated by multiplying this area by the number of tall trees per area (Hokkaido: 1470.8 tree/ha, the other prefectures: 339.0 tree/ha).[11]

Forested lands (at measurement time) are not qualified as green area along river and erosion control site. Therefore, land conversion from Forest land is not included in estimating activity data.

Table A11-23 Activity data and area of green area along river and erosion control site (remaining land / converted land)

At the end of 2009

	Land-use category	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Green area along river and erosion control site which has been established since 1st January 1990 and its establishment area is 500 m^2 or more	Converted	0.01%	0.11	64
	Remaining	99.99%	1,436.84	847,043
	Total	100.00%	1,436.95	847,107

- ***Green area around government buildings***

Area of land remaining green area around government buildings is calculated by multiplying area of this green area by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is calculated by multiplying this area by the number of tall trees per area (all prefecture: 112.1 tree/ha).[12]

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[11] For green area along river and erosion control site, the number of tall trees was measured in approximately 95% land of this green area. Based on this data, the number of planted trees per area was estimated in order to simplify the estimation of the number of tall trees in all green area.

[12] For green area around government buildings, the number of tall trees per area was estimated by dividing the number of tall

It is assumed that all green area around government buildings is located in Settlements because these areas are not located in the river zone.

Table A11-24 Green area around government buildings which was not qualified as Forest land in 31st December 1989

At the end of 2009

	Land-use category	Area ratio of land has been converted for the past 20 years	Area [ha] (green area)	RV Qualification
Green area around government buildings which has been established since 1st January 1990 and its establishment area is 500 m^2 or more	Forest	5.23%	15.50	No
	Non-forest	94.77%	280.91	Yes
	Total	100.00%	296.41	-

Table A11-25 Area and activity data of Green area around government buildings (remaining land / converted land)

At the end of 2009

	Land-use category	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Green area around government buildings which has been established since 1st January 1990 and its establishment area is 500 m^2 or more (qualified as RV)	Converted	0.27%	0.75	84
	Remaining	99.73%	280.15	31,405
	Total	100.00%	280.91	31,489

- ***Green area around public rental housing***

Area of land remaining green area around public rental housing is calculated by multiplying area of this green area by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is calculated by multiplying this area by the number of tall trees per area (all prefecture: 262.4 tree/ha).[13]

It is assumed that all green area around public rental housing is located in Settlements because these areas are not located in the river zone.

Table A11-26 Green area around public rental housing which was not qualified as Forest land in 31st December 1989

At the end of 2009

	Land-use category	Area ratio of land has been converted for the past 20	Area [ha] (green area)	RV Qualification
Green area around public rental housing which has been established since 1st January 1990 and its establishment area is 500 m^2 or	Forest	5.23%	118.41	No
	Non-forest	94.77%	2,145.41	Yes
	Total	100.00%	2,263.82	-

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trees by “total land area – building area” (these data were based on 20 facilities [planting maps were available]). Japan established same data for Hokkaido and other prefectures because sample data is no sufficient.

[13] For green area around public rental housing, the number of tall trees per area was estimated by dividing the number of tall trees by “total land area – building area” (these data were based on 28 facilities [planting maps were available]). Japan established same data for Hokkaido and other prefectures because sample data is no sufficient.

Table A11-27 Area and activity data of Green area around public rental housing (remaining land / converted land)

At the end of 2009

	Land-use category	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Green area around public rental housing which has been established since 1st January 1990 and its establishment area is 500 m^2 or more (qualified as RV)	Converted	0.27%	5.74	1,506
	remaining	99.73%	2,139.67	561,449
	Total	100.00%	2,145.41	562,955

b） Remaining land: Dead wood

- ***Urban parks***

The number of tall trees per land area used in estimation of activity data for living biomass includes trees which have been died and planted since park establishment, thus carbon stock change in dead wood is included in carbon stock change in living biomass. Therefore, this category is reported as “IE”.

- ***Green area on road***

The number of tall trees used in estimation of activity data for living biomass is surveyed every 5 years (implemented every year since 2007). This data includes effects of dead wood and planting, thus carbon stock change in dead wood is included in carbon stock change in living biomass. Therefore, this category is reported as “IE”.

- ***Green area on port, Green area around sewage treatment facility and Green area by greenery promoting system for private green space, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings***

This category is reported as “IE” based on the same assumption as urban parks.

c） Remaining land: Litter

Japan estimates carbon stock change in litter in urban parks and green area on port only. In other sub-categories, it is difficult to obtain detailed information on various managements (such as cleaning) actually taken place and estimate carbon stock change accurately. However, it is clear that litter and dead roots are generated every year and those organic materials are accumulated on sites although a part of litter and dead roots are removed to outside. This situation definitely produces increase of carbon stocks every year. Therefore, these sub-categories are not sources of GHGs and not included in the reporting (exclusion of these sub-categories is assumed to be conservative).

- ***Methodology***

$$\Delta C_{RVLit} = \Sigma (A_i \times L_{iti})$$

ΔC_{RVLit} : Annual change in carbon stocks in litter in remaining RV land [t-C/yr]

A : Area of remaining RV land [ha]

L_{it} : Annual change in carbon stocks in litter per RV land [t-C/ha/yr]

i : Land use type (urban parks and green area on port)

- ***Parameters***
  - ***Urban parks and Green area on port***

For litter, Japan estimates carbon stock change only in branches and leaves dropped naturally from tall trees. Carbon stock change in litter per urban park area is calculated by using annual accumulation of litter per a tall tree (Hokkaido: 0.0006 t-C/tree/yr, other prefectures: 0.0009 t-C/tree/yr) based on results of field survey in urban parks[14], the number of tall trees per area and ratio of litter moved to off-site due to management including cleaning (54.4%). As a result of calculation, carbon stock change in litter per urban park area is 0.0984 t-C/ha/yr for Hokkaido and 0.0830 t-C/ha/yr for other prefectures. In addition, carbon fraction in litter is assumed to be 0.5 t-C/t-d.m. which is a default value provided in GPG-LULUCF[15].

  - ***Green area on road, Green area around sewage treatment facility, Green area by greenery promoting system for private green space, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings***

Litter in these sub-categories includes branches and leaves dropped naturally and dead roots. A part of litter is remained on-site and leads to increase carbon stocks, although other litter is moved to off-site due to managements such as cleaning (such litter is dropped from trees planted after green area establishment). Dead roots also lead to increase carbon stocks because they are not moved to off-site.

Carbon stock change in these sub-categories could not be estimated accurately because it is difficult to obtain detailed information on various managements (such as cleaning). However, it is clear that input of litter and dead roots increases carbon stocks. Therefore, these sub-categories are not sources of GHGs and not included in the reporting (exclusion of these sub-categories is assumed to be conservative).

- ***Activity data***

It is similar to living biomass.

d） Remaining land: Soils

- ***Urban parks***

As results of field soil survey implemented in Kanto region, it is demonstrated that carbon stocks in urban parks increase for at least 20 years after their establishment. Therefore, these pools are assumed to be a sink. These results represent whole of country because soil carbon stock change in urban parks depends on land cover and their establishment procedures (regional variations are insignificant).
However, at this time, Japan could not estimate soil carbon stock change in all urban parks because relevant data is not available. Therefore, this category is reported as NR (not include in reporting).

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[14] Annual accumulation of litter dropped naturally was measured for some tree types by using litter traps installed in Takino Suzuran Kyuryo National Government Park (Hokkaido) and Showa Kinen National Government Park (Tokyo). Litter is defined as branches and leaves dropped on the surface. In selection of surveyed parks, large-sized and intensively managed national government parks in which continuous monitoring is available and different types trees have been planted are considered to be satisfied with measurement requirements. In addition, it is also considered that tree type distribution differs between Hokkaido and other prefectures. Therefore, Japan selected two surveyed parks, one for Hokkaido and the other for typical climate zone excluding Hokkaido.

[15] According to the GPG-LULUCF, this default value is originally provided for living biomass. However, Japan applies it to litter because it is assumed that carbon fraction in litter is similar to one in living biomass.

【Results of soil survey in urban parks】

（The number of surveyed parks） 10 （in Kanto region）

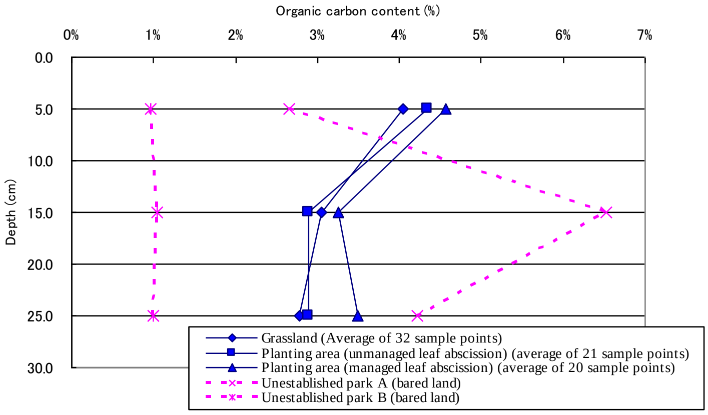
（Period） FY 2007

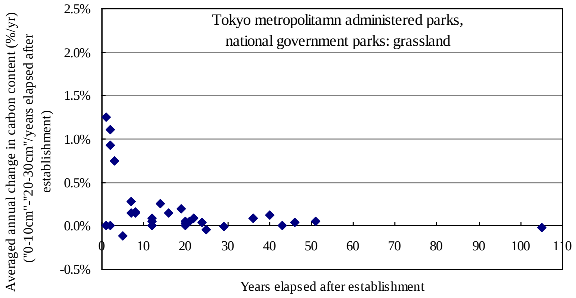
（Measurement item） organic carbon content of soils （surface-10 cm, 10-20 cm, 20-30 cm）

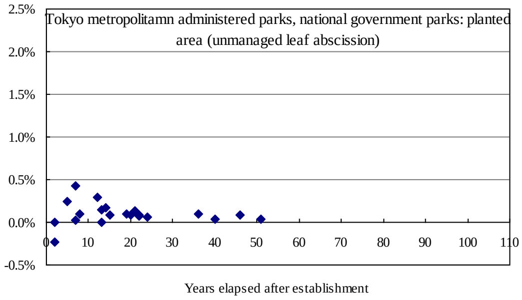
It was assumed that organic carbon distribution of soils (0-30 cm depth) in urban parks immediately following new establishment is uniform (carbon is not stored in surface layer) regardless of embankment or cut earth. It was supported by the results of trial pit soil sampling (implemented in 5 parks in 2007) which demonstrate that soil properties for 0-30 cm depth is uniform. Some urban parks (converted from forest land) are covered by soils which have similar properties to forest land. Such parks are qualified as deforestation, not revegetation.

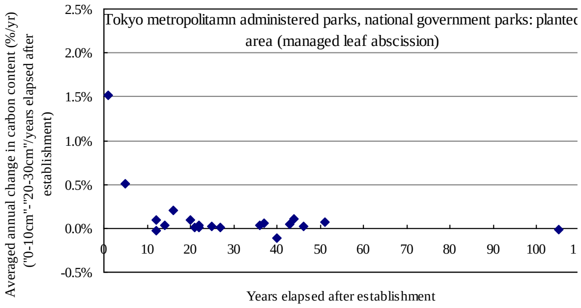
However, it is assumed that input of organic matter (from roots and litter to soils) in lawn and tall trees planted land leads carbon storage after new establishment of urban parks.

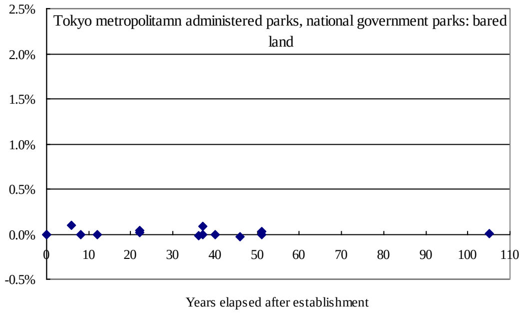
For example, it is expected that organic carbon stock for 10-30 cm depth fluctuate slowly, although carbon stock for surface layer fluctuate significantly. Most carbon is supplied to surface layer and the amount of carbon supplied to other layers is very few. In addition, microorganism decomposition is not active in other layers because they are subjected to pressure and be under anaerobic condition.











In this context, Japan assumes that organic carbon content for 10-30 cm depth is almost constant and defines "organic carbon content for surface-10 cm depth - organic carbon content for 20-30 cm depth" is equal to soil carbon stock change after establishment of parks. Following graphs show values calculated by dividing soil carbon stock change by years elapsed after establishment of parks.

These graphs show annual variation of organic carbon content. They indicate that annual carbon accumulation in parks immediately following new establishment is large and accumulation continues for more than 20 years after establishment regardless of land cover.

Consequently, soils in urban parks which have been established since 1990 and qualified as RV are assumed to be a sink.

- ***Green area on port, Green area around sewage treatment facility, Green area by greenery promoting system for private green space, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings***

It is assumed that patterns of soil carbon stocks in these green areas are similar to urban parks and green area on road because planting, establishment and management in these green areas are implemented in the same manner as urban parks and green area on road. Therefore, Japan assumes that these pools are not sources and not included in the reporting (NR). If methodologies on urban parks will be developed in the future, estimating and reporting by using these methodologies will be considered.

【Results of soil survey in green area on road (Green slopes of expressways)】

（The number of surveyed roads）5（in Kanto region）

（Period）2007

（Measurement item）organic carbon content of soils（surface-10 cm, 10-20 cm, 20-30 cm）

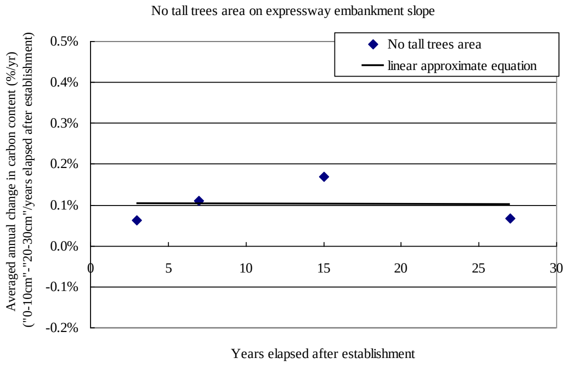
In most cases, embankment structure sections in expressways are qualified as RV (most of cut earth sections are qualified as D). Therefore, surveys were implemented for different embankment structure sections. As in urban parks, it was assumed that organic carbon distribution of soils (0-30 cm depth) in embankment structure sections immediately following new establishment is uniform (carbon is not stored in surface layer).

However, this survey also demonstrates that input of organic matter (from roots and litter to soils) leads carbon storage in surface layers after planting and generation of ground cover plants.

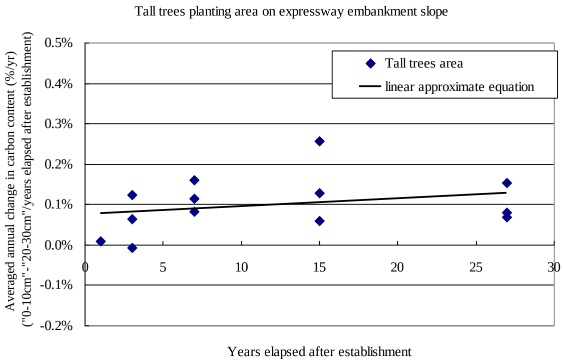
In addition, it is assumed that organic carbon for 10-30 cm depth fluctuate slowly for the same reason as urban parks (such as soil compaction).

In this context, Japan assumes that organic carbon content for 10-30 cm depth is almost constant and defines “organic carbon content for surface-10 cm depth - organic carbon content for 20-30 cm depth” is equal to soil carbon stock change after planting. Following graphs show values calculated by dividing soil carbon stock change by years elapsed after planting.

These graphs show annual variation of organic carbon content. They indicate that annual carbon is accumulated continuously regardless of land cover (even if the land is only covered by ground cover plants). Consequently, soils in green slopes of expressways which have been established since 1990 and qualified as RV are assumed to be a sink.



No tall trees area on expressway embankment slope



Tall trees planting area on expressway embankment slope

* Deference between urban parks and expressways

Annual carbon stock change in expressway slopes keeps constant in time series, although urban parks accumulate relatively large carbon immediately following their establishment. Annual carbon stock change depends on balance between carbon supply and its decomposition.

In urban parks immediately following their establishment, carbon supply may exceed its decomposition because litter supply from planted tall trees is relatively large and urban parks are covered by immature soils. After that, soils reach maturity and decomposition rate overtake carbon supply.

In expressways, little carbon is supplied immediately after seeding. After that, annual carbon stock change keeps constant because soils reach maturity according to increase of litter supply.

e） *Remaining land: Other gases*

1） *Direct N_2O emissions from N fertilization*

It is assumed that volume of nitrogen-based fertilizer applied to urban parks is included in demand for nitrogen-based fertilizers in Agriculture sector, although fertilization application in urban parks has been conducted in Japan. Therefore, these sources have been reported as “IE”.

2） *Carbon emissions from lime application*

Japan estimates carbon emissions from lime application in all sub-categories. For urban parks and green area on road (lime application is implemented only in green area on general road), the amount of lime applied per area is estimated. For other sub-categories, the amount of lime applied per area for urban parks is applied.

Estimation of carbon emissions is implemented for all RV land together because estimation method is similar regardless of remaining land or converted land.

● *Methodology*

$$C_{RVLm} = C_{RVCaCO3} + C_{RVCaMg(CO3)2}$$

$$C_{RVCaCO3} = \sum_i \left(A_i \times \Delta C_{RVCaCO3} \times 12.01/100.09 \right)$$

$$C_{RVMg(CO3)2} = \sum_i \left(A_i \times \Delta C_{RVMg(CO3)2} \times 12.01/184.41 \right)$$

C_{RVLm} : Annual carbon emissions in RV lands due to lime application [t-C/yr]
$C_{RVCaCO3}$: Carbon emissions in RV lands due to calcic limestone application
$C_{RVCaMg(CO3)2}$: Carbon emissions in RV lands due to dolomite application
A : Land area for RV lands (total of remaining land and converted land)
$\Delta C_{RViCaCO3}$: Amount of calcic limestone application to RV lands (land type *i*) per area
$\Delta C_{RViCaMg(CO3)2}$: Amount of dolomite application to RV lands (land type *i*) per area
12.01/100.09 : Ratio of molecular weight in calcic limestone
12.01/184.41 : Ratio of molecular weight in dolomite
i : Land type (urban parks, green area on road [general road])

● *Parameters*

➢ *Urban parks*

Amount of calcic limestone application per area is established as 298.4 g/ha/yr based on the results of questionnaire survey carried out for 11,274 urban parks. Amount of dolomite application per area is established as 1,088.4 g/ha/yr based on the results of questionnaire survey carried out for 9,346 urban parks.

In estimating carbon emissions, it is assumed that all carbon included in applied calcic limestone and dolomite are released to the atmosphere within the application year.

➢ *Green are on road*

The amount of calcic limestone application per tall tree is established as 0.3311 g/tree/yr based on the results of questionnaire survey implemented for 40 road managers. The amount of dolomite application per tall tree is established as 1.5431 g/tree/yr based on the results of questionnaire survey implemented for 40 road managers above-mentioned.

In estimating carbon emissions, it is assumed that all carbon included in applied calcic limestone and dolomite are released to the atmosphere within the application year.

➢ ***Green area on port, Green area around sewage treatment facility, Green area by greenery promoting system for private green space, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings***

Parameter values for urban parks are applied because lime application in these green areas is implemented in the same manner as urban parks (application pattern and frequency).

● *Activity data*

Area of all RV lands (regardless of remaining land or converted land) is used as activity data.

3） *Biomass burning*

In settlements or wetlands subjected to RV activities, burning of residues are essentially prohibited by the Law for waste treatment and cleaning. In addition, wild fires do not usually occur in lands subjected to RV activities because these lands are managed. Therefore, biomass burning activities which lead carbon emissions do not occur and Japan reports this category as “NO”.

f） *Land converted from other land-use category: Above-ground biomass, Below-ground biomass*

● *Methodology*

For RV activities, land conversion occurs due to establishment or building of “facilities” and all living biomass are basically replaced for one year (In the case of urban parks converted from cropland, new planting in urban parks are carried out after removal of trees in cropland).

In Japan’s basic estimation principles for land converted to RV land, facilities established newly by land conversion in the reporting year are defined as “Land converted to RV land”. Estimation methods are shown below.

$$\Delta C_{RVLUC} = \sum_{i} \left\{ A_i \times \left(C_{AfterLBi} - C_{BeforeLBi} \right) + \left(\Delta C_{RVLUCGi} - \Delta C_{RVLUCLi} \right) \right\}$$

$$\Delta C_{RVLUCGi} = \Delta B_{RVGi}$$

$$\Delta B_{RVGi} = \sum_{j} \left(NT_{i,j} \times C_{Ratei,j} \right)$$

ΔC_{RVLUC} : Annual change in carbon stocks in living biomass in converted RV land [t-C/yr]

A : Annual area of converted RV land [ha/yr]

$C_{AfterLB}$: Carbon stock in living biomass immediately following land conversion [t-C/ha]

$C_{BeforeLB}$: Carbon stock in living biomass immediately before land conversion [t-C/ha]

ΔC_{RVLUCG} : Annual change in carbon stocks in converted RV land due to growth in living biomass [t-C/yr]

ΔC_{RVLUCL} : Annual change in carbon stocks in converted RV land due to loss of living biomass [t-C/yr]

ΔB_{RVG} : Annual biomass growth in RV land [t-C/yr]

C_{Rates} : Annual biomass growth per tree [t-C/tree/yr]

NT : Number of trees

i : Land use type (Urban parks, Green area on road, Green area on port, Green area around sewage treatment facility, Green area by greenery promoting system for private green space, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings)

j : Tree species

- ***Parameters***

➢ *Urban parks*

Carbon stocks in living biomass immediately before conversion [t-C/ha] are the same as the one for Grassland, Cropland, Wetlands and Other land. Carbon stocks in living biomass immediately following conversion are assumed to be zero (When urban parks qualified as RV land were established, planting activities have been occurred and living biomass has been stocked. Japan assumes that these biomass stocks are zero because they were carried from other fields and they have not been grown by RV activities). In addition, it is assumed that living biomass before conversion is emitted due to RV land establishment.

The other parameters are assumed to be the same as ones for “Remaining urban parks”.

➢ *Green area on road, Green area on port, Green area around sewage treatment facility, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings*

Carbon stocks in living biomass immediately following and before conversion [t-C/ha] is the same as the one for urban parks converted from other land-use.

The other parameters are assumed to be the same as ones for “Remaining green area on road”, “Remaining green area on port”, “Remaining green area around sewage treatment facility”, “Remaining green area along river and erosion control site”, “Remaining green area around public rental housing” and “Remaining green area around government buildings”.

- ***Activity data***

➢ *Urban parks*

Area of land converted to urban parks is calculated by multiplying area of urban parks by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is estimated in the same manner as “Remaining urban parks”.

Table A11-28 Area of urban parks and activity data (remaining land / converted land)

At the end of 2009

	Land use category before conversion	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Urban parks which have been notified since 1st January 1990 and its establishment area is 500 m^2 or more (located in Settlements)	Remaining land	99.73%	44,961.86	9,859,062
	Cropland	0.23%	103.54	22,704
	Grassland	0.04%	17.03	3,735
	Wetlands	IE	IE	IE
	Other land	IE	IE	IE
	Total	100.00%	45,082.44	9,885,501
Urban parks which have been notified since 1st January 1990 and its establishment area is 500 m^2 or more (located in Wetlands [they occupy the river section])	Remaining land	99.99%	4,719.31	1,034,831
	Cropland	0.00%	0.08	18
	Grassland	0.00%	0.01	3
	Settlements	0.00%	0.00	1
	Other land	0.01%	0.26	56
	Total	100.00%	4,719.66	1,034,909

➢ *Green*

Area of land converted to green area on road is calculated by multiplying area of green area on road by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is estimated in the same manner as “Remaining green area on road”.

Table A11-29 Area of green area on road and activity data for each land-use category

At the end of 2009

	Land use category before conversion	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Green area on road which have been notified since 1st January 1990 and its establishment area is 500 m^2 or more	Remaining	99.73%	20,358.85	9,083,363
	Cropland	0.23%	46.88	20,918
	Grassland	0.04%	7.71	3,441
	Wetlands	IE	IE	IE
	Other land	IE	IE	IE
	Total	100.00%	20,413.44	9,107,721

- ***Green area on port***

Area of land converted to green area on port is calculated by multiplying service area of green area on port by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is estimated in the same manner as “Remaining green area on port”.

Table A11-30 Area of green area on port and activity data for each land-use category

At the end of 2009

Land use category before conversion	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Remaining land	99.73%	1,358.06	286,640
Cropland	0.23%	3.13	660
Grassland	0.04%	0.51	109
Wetlands	IE	IE	IE
Other land	IE	IE	IE
Total	100.00%	1,361.70	287,409

- ***Green area around sewage treatment facility***

Area of land converted to green area around sewage treatment facility is calculated by multiplying green area around sewage treatment facility by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is estimated in the same manner as “Remaining green area around sewage treatment facility”.

Table A11-31 Area of green area around sewage treatment facility and activity data for each land-use category

At the end of 2009

Land use category before conversion	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Remaining land	99.73%	620.47	250,727
Cropland	0.23%	1.43	577
Grassland	0.04%	0.24	95
Wetlands	IE	IE	IE
Other land	IE	IE	IE
Total	100.00%	622.13	251,399

- ***Green area along river and erosion control site***

Area of land converted to green area along river and erosion control site is calculated by multiplying planted land area by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is estimated in the same manner as "Remaining Green area along river and erosion control site".

Table A11-32 Area of green area along river and erosion control site and activity data for each land-use category

At the end of 2009

Land use category before conversion	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Remaining land	99.99%	1,436.84	847,043
Cropland	0.00%	0.02	14
Grassland	0.00%	0.00	2
Wetlands	0.00%	0.00	1
Other land	0.01%	0.08	46
Total	100.00%	1,436.95	847,106

- ***Green area around government buildings***

Area of land converted to green area around government buildings is calculated by multiplying "total land area – building area" by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is estimated in the same manner as "Remaining green area around government buildings".

Table A11-33 Area of green area around government buildings and activity data for each land-use category

At the end of 2009

Land use category before conversion	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Remaining land	99.73%	280.15	31,405
Cropland	0.23%	0.65	72
Grassland	0.04%	0.11	12
Wetlands	IE	IE	IE
Other land	IE	IE	IE
Total	100.00%	280.91	31,489

- ***Green area around public rental housing***

Area of land converted to green area around public rental housing is calculated by multiplying "total land area – building area" by area ratio of land conversion for the whole country. Activity data for living biomass (the number of tall trees) is estimated in the same manner as "Remaining green area around public rental housing".

Table A11-34 Area of green area around public rental housing and activity data for each land-use category

At the end of 2009

Land use category before conversion	Area ratio of land has been converted for the current year	Area [ha]	Activity data [the number of tall trees]
Remaining land	99.73%	2,139.67	561,449
Cropland	0.23%	4.93	1,293
Grassland	0.04%	0.81	213

g） Land converted from other land use category: Dead wood

When RV activity following land-use conversion is implemented, dead wood is removed to outside and supplemental planting is implemented before conversion because almost all of such lands are managed and trees are assumed to be "property". Therefore, dead wood is not left on the ground immediately before land-use conversion. Carbon stocks in dead wood immediately after conversion are assumed to be zero as a same as living biomass. Therefore, carbon stocks in dead wood before and after conversion are assumed to be zero.

Carbon stocks in dead wood accumulated for a year after conversion are reported as "IE" the same as "Remaining land".

h） Land converted from other land use category: Litter

Japan estimates carbon stock change in litter in urban parks and green area on port only (same as remaining land). On the other hand, other sub-categories (Green area on road, Green area around sewage treatment facility, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings) are not included in the reporting.

- ***Methodology***

$$\Delta C_{LUCRVLit} = \sum_i \left\{ A_i \times \left(C_{AfterLiti} - C_{BeforeLiti} \right) + A_i \times Lit_i \right\}$$

$C_{AfterLit}$: Carbon stock in litter immediately following land conversion [t-C/ha]
$C_{BeforeLit}$: Carbon stock in litter immediately before land conversion [t-C/ha]
$\Delta C_{LUCRVLit}$: Annual change in carbon stocks in litter in land converted to RV land [t-C/yr]
A : Area of converted RV land [ha/yr]
Lit : Annual change in carbon stocks in litter in RV land per area [t-C/ha/yr]
i : Land use type (urban parks and green area on port)

- ***Parameters***
  - ***Urban parks and Green area on port***

When urban parks are converted from cropland, grassland or wetlands, soils before conversion are not moved to off-site (in general, these soils are used after conversion continuously or covered by additional soils). Therefore, litters and dead roots accumulated before conversion do not decrease due to land conversion.

In addition, litter in urban parks immediately following conversion is very little. Therefore, carbon stock change in litter due to land conversion is assumed to be zero. The amount of carbon in litter accumulated for a year after conversion is estimated in the same manner as "Remaining urban parks".

- ***Green area on road, Green area around sewage treatment facility, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings***

Carbon stock change in litter due to land conversion is assumed to be zero for the same reason as urban parks.

The amount of carbon in litter accumulated for a year after conversion is not included in this reporting (same as "Remaining green area on road", "Remaining green area around sewage treatment facility", "Remaining green area along river and erosion control site", "Remaining green area around public rental housing" and "Remaining green area around government buildings").

Therefore, these sub-categories are not sources of GHGs and not included in the reporting (NR).

- ***Activity data***

Activity data is same as living biomass.

i） Land converted from other land use category: Soils

- ***Urban parks***

As mentioned above (in litter section), when urban parks are converted from cropland, grassland or wetlands, soils before conversion almost never been moved to off-site (even if moved to off-site, carbon in these soils are not emitted due to combustion). In general, these soils are used after conversion continuously or covered by additional soils. Therefore, soil carbon stocks do not change due to land conversion (carbon stocks may increase due to additional soils. However, Japan assumes that soil carbon stocks do not change because additional soils do not lead carbon sequestration from atmosphere).

Soil carbon stock change for a year after conversion is not included in the reporting (NR) for the same reason as "Remaining urban parks", although soils are assumed to be a sink.

- ***Green area on road, Green area on port, Green area around sewage treatment facility, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings***

These sub-categories are not sources of GHGs and not included in the reporting (NR) for the same reason as "Land converted to urban parks".

j） Land converted from other land use category: Other gases

1） Direct N_2O emissions from N fertilization

It is assumed that volume of nitrogen-based fertilizer applied to urban parks is included in demand for nitrogen-based fertilizers in Agriculture sector, although fertilization application in urban parks has been conducted in Japan. Therefore, these sources have been reported as "IE".

2） Carbon emissions from lime application

Estimation of carbon emissions from lime application is implemented based on methodologies described in “Remaining land: Other gases” for all RV land together because estimation method is similar regardless of remaining land or converted land.

3） Biomass burning

As in the case of “Remaining RV land”, biomass burning activities which release carbon do not occur. Therefore, this category has been reported as “NO”.

k） Results

Table A11-35 Emissions and removals from RV activity

		1990	2008	2009
		［Gg-CO_2］	［Gg-CO_2］	［Gg-CO_2］
RV		-47.06	-729.70	-754.84
	Above-ground biomass	-36.46	-566.97	-586.48
	Below-ground biomass	-9.48	-147.41	-152.48
	Dead wood	IE	IE	IE
	Litter	-1.12	-15.34	-15.90
	Soils	0.00	0.00	0.00
	Other gases	0.00	0.02	0.02

* CO_2）+：Emission, -: Removal

A11.4.1.2. Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Some carbon pools under RV activities (litter: Green area on road, Green area around sewage treatment facility, Green area along river and erosion control site, Green area around public rental housing and Green area around government buildings, soils: all sub-categories) are not included in the reporting. Some intermediate results of the ongoing research project relating to RV land by Ministry of Land, Infrastructure, Transport and Tourism show clear tendency that those carbon pools have been increasing although a little more research and analysis are necessary to quantify carbon stock change about these carbon pools. (Handa *et al.*., 2008)This does not lead over-estimation of removals because these carbon pools are not sources of GHGs.

A11.4.1.3. Information on whether or not indirect and natural GHG emissions and removals have been factored out

Japan does not factor out indirect, natural and pre-1990 effects specified in paragraph 7 in the Annex to decision 15/CMP.1 in estimating emissions/removals from activities under Article 3.3 and 3.4.

A11.4.1.4. Changes in data and methods since the previous submission (recalculations)

Area data of AR activity and RV data has been updated since the last submission. This result was reflected to calculation under GHG inventory.

For FM activity, "Losses" of carbon stock in both above-ground and below-ground biomass in the CRF Table 5 (KP-I) B.1. were changed to be reported as "IE" instead of "NO" because they are included in "Gains"[16].

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[16] When FM land is a net source, “Losses” cells were filled with values of carbon stock changes and “Gains” were reported as “IE”.

CO_2 emissions from lime application in AR land and FM land were changed to be reported as “NO” instead of “NE” based on new information available since the last submission.

Wrongly entered notation keys in the CRF tables of the last submission including biomass burning in D land and RV land was corrected.

A11.4.1.5. Uncertainty estimates

As a result of uncertainty assessment implemented by method provided in Annex 7, “7.1 Methodology of Uncertainty Assessment”, uncertainty of total emissions/removals from activities under Article 3.3 and 3.4 in 2009 has been assessed at 29%.

Table A11-36 Uncertainty of emissions and removals from activities under Article 3.3 and 3.4

Greenhouse gas source and sink activities	GHGs	Emissions/Removals [Gg CO_2eq.]		Emissions/Removals Uncertainty [%]	rank	Emissions/Removals Uncertainty as % of toral national emissions [%]	rank
			%				
Article 3.3 activities Afforestation and Reforestation	CO_2, N_2O, CH_4	-415	-1%	6%	3	0%	3
Article 3.3 activities Deforestation	CO_2, N_2O, CH_4	3,087	7%	3%	4	0%	4
Article 3.4 activities Forest management	CO_2, N_2O, CH_4	-49,006	-104%	27%	2	29%	1
Article 3.4 activities Revegetation	CO_2, N_2O, CH_4	-755	-2%	70%	1	1%	2
Total		-47,089	-100%	29%			

A11.4.1.5.a. Afforestation/Reforestation

Uncertainty of emissions/removals from AR activities in 2009 has been assessed at 6%.

Table A11-37 Uncertainty of emissions and removals from afforestation and reforestation activities

Greenhouse gas source and sink activities			GHGs	Emissions/ Removals [Gg CO2eq.]	AD Uncertainty [%]	EF/RF Uncertainty [%]	Combined Uncertainty [%]	rank	Combined Uncertainty as % of toral national emissions [%]	rank
Article 3.3 activities Afforestation and Reforestation	Change in carbon pool reported									
		Above-ground biomass	CO_2	-240	-	-	10%	6	6%	1
		Below-ground biomass	CO_2	-63	-	-	8%	7	1%	3
		Litter	CO_2	-67	-	-	11%	5	2%	2
		Dead wood	CO_2	-29	-	-	11%	4	1%	4
		Soil	CO_2	-15	-	-	19%	2	1%	5
	Greenhouse gas sources reported									
		Fertilization	N_2O	IE	-	-	-	-	-	-
		Drainage of soils under forest management	N_2O	-	-	-	-	-	-	-
		Disturbance associated with land-use conversion to croplands	N_2O	-	-	-	-	-	-	-
		Liming	CO_2	NO	NO	NO	NO	-	-	-
		Biomass burning	CO_2	IE	IE	IE	IE	-	-	-
			CH_4	0	-	-	13%	3	0%	7
			N_2O	0	-	-	22%	1	0%	6
	Total			-415			6%			

A11.4.1.5.b. Deforestation

Uncertainty of emissions/removals from D activities in 2009 has been assessed at 3%.

Table A11-38 Uncertainty of emissions and removals from deforestation activities

Greenhouse gas source and sink activities			GHGs	Emissions/ Removals [Gg CO2eq.]	AD Uncertainty [%]	EF/RF Uncertainty [%]	Combined Uncertainty [%]	rank	Combined Uncertainty as % of toral national emissions [%]	rank
Article 3.3 activities Dforestation	Change in carbon pool reported									
		Above-ground biomass	CO_2	1,616	-	-	5%	4	2%	1
		Below-ground biomass	CO_2	422	-	-	2%	7	0%	4
		Litter	CO_2	543	-	-	3%	6	1%	3
		Dead wood	CO_2	217	-	-	4%	5	0%	5
		Soil	CO_2	283	-	-	10%	3	1%	2
	Greenhouse gas sources reported									
		Fertilization	N_2O	-	-	-	-	-	-	-
		Drainage of soils under forest management	N_2O	-	-	-	-	-	-	-
		Disturbance associated with land-use conversion to croplands	N_2O	3	-	-	23%	2	0%	7
		Liming	CO_2	2	-	-	70%	1	0%	6
		Biomass burning	CO_2	NO	NO	NO	NO	-	-	-
			CH_4	NO	NO	NO	NO	-	-	-
			N_2O	NO	NO	NO	NO	-	-	-
	Total			3,087			3%			

A11.4.1.5.c. Forest Management

Uncertainty of emissions/removals from FM activities in 2009 has been assessed at 27%.

Table A11-39 Uncertainty of emissions/removals from forest management activities

Greenhouse gas source and sink activities			GHGs	Emissions/ Removals [Gg CO2eq.]	AD Uncertainty [%]	EF/RF Uncertainty [%]	Combined Uncertainty [%]	rank	Combined Uncertainty as % of toral national emissions [%]	rank
Article 3.4 activities Forest manafement	Change in carbon pool reported									
		Above-ground biomass	CO_2	-37,955	-	-	35%	1	27%	1
		Below-ground biomass	CO_2	-9,581	-	-	2%	7	0%	3
		Litter	CO_2	541	-	-	18%	3	0%	7
		Dead wood	CO_2	-394	-	-	5%	6	0%	4
		Soil	CO_2	-1,622	-	-	15%	5	1%	2
	Greenhouse gas sources reported									
		Fertilization	N_2O	IE	IE	IE	IE	-	-	-
		Drainage of soils under forest management	N_2O	NO	NO	NO	NO	-	-	-
		Disturbance associated with land-use conversion to croplands	N_2O	-	-	-	-	-	-	-
		Liming	CO_2	NO	NO	NO	NO	-	-	-
		Biomass burning	CO_2	IE	IE	IE	IE	-	-	-
			CH_4	5	-	-	16%	4	0%	6
			N_2O	1	-	-	26%	2	0%	5
	Total			-49,006			27%			

A11.4.1.5.d. Revegetation

Uncertainty of emissions/removals from RV activities in 2009 has been assessed at 70%.

Table A11-40 Uncertainty of emissions/removals from revegetation activities

Greenhouse gas source and sink activities			GHGs	Emissions/ Removals [Gg CO2eq.]	AD Uncertainty [%]	EF/RF Uncertainty [%]	Combined Uncertainty [%]	rank	Combined Uncertainty as % of toral national emissions [%]	rank
Article 3.4 activities Revegetation	Change in carbon pool reported									
		Above-ground biomass	CO_2	-586	-	-	86%	3	66%	1
		Below-ground biomass	CO_2	-152	-	-	106%	1	21%	2
		Litter	CO_2	-16	-	-	97%	2	2%	3
		Dead wood	CO_2	IE	IE	IE	IE	-	-	-
		Soil	CO_2	-	-	-	-	-	-	-
	Greenhouse gas sources reported									
		Fertilization	N_2O	IE	IE	IE	IE	-	-	-
		Drainage of soils under forest management	N_2O	-	-	-	-	-	-	-
		Disturbance associated with land-use conversion to croplands	N_2O	-	-	-	-	-	-	-
		Liming	CO_2	0	38%	4%	38%	4	0%	4
		Biomass burning	CO_2	NO	NO	NO	NO	-	-	-
			CH_4	NO	NO	NO	NO	-	-	-
			N_2O	NO	NO	NO	NO	-	-	-
	Total			-755			70%			

A11.4.1.6. Information on other methodological issues (method dealing with effects of natural disturbance[17])

A11.4.1.6.a. Afforestation/Reforestation and Deforestation

Effects of natural disturbance have been reflected in forest resources data when Forest Registers are updated every 5 years in each planning area.

A11.4.1.6.b. Forest Management

Effects of natural disturbance have been reflected in forest resources data when Forest Registers are updated every 5 years in each planning area.

A11.4.1.6.c. Revegetation

It is considered that windstorm, flood and insects are natural disturbance which have a considerable impact on carbon stock change on RV land. However, all land qualified as RV is under human induced management by administration etc. In addition, when disappearance of tall trees and outflow of soils are occurred in RV land located in the Settlements, business budget is often appropriated and urgent restoration measure is administered from viewpoint with respect to safety and view.

Consequently, effects of natural disturbance are not considered in estimation because it looks that carbon stocks do not change. Furthermore, carbon stock change due to post-disaster restoration practices which are not implemented in the year disaster occur does not lead double-counting because it is not considered in this reporting.

A11.4.1.7. The year of the onset of an activity, if after 2008

In this submission, all units of land and lands which start to be subject to activities under Article 3.3 or selected activities under Article 3.4 until 2009 are reported. The emissions and removals from the units of land and the lands which start to be subject to the activities in 2009 for the first time are not

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[17] Including fire,windthrow, insects, droughts, flooding and ice storms, etc.

included in the calculation of emissions and removals in 2008. Areas of such lands are shown below.

Table A11-41 Afforestation/Reforestation, Deforestation and Forest Management

Area of activities	Afforestation/Reforestation [kha]	Deforestation [kha]	Forest Management [kha]		
			Ikusei-rin forest	Tennensei-rin forest	Total
FY1990～FY200	28.3	309.4	7,443	6,909	14,352
（FY2009）	—	8.3	—	—	—

Table A11-42 Revegetation

Categories	Urban parks [ha]	Green area on road [ha]	Green area on port [ha]	Green area around sewage treatment facility [ha]	Green area by greenery promoting system for private green space [ha]
FY1990	3,431	1,484	138	44	0
FY2009	1,743	892	45	0	0
FY1990-FY2009	49,802	20,413	1,362	603	5
Categories	Green area along river and erosion control site [ha]	Green area around government buildings [ha]	Green area around public rental housing [ha]	Total [ha]	
FY1990	58	11	182	5,348	
FY2009	32	7	31	2,751	
FY1990-FY2009	1,437	281	2,145	76,049	

A11.5. Article 3.3

A11.5.1. Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

Japan detected change of the forest cover which has occurred since 1 January 1990 using orthophotos at the end of 1989 and recent satellite images. In doing so, AR and forest restoration through natural succession are distinguished through imagery interpretation whether each forest cover change are human-induced or not.

The following table is the results of AR land area detected by satellite images and the result of comparison between D land area and conversion area from forest obtained from existing statistical information (estimated based on conversion area from forest during 1990-2000 provided by *World Census of Agriculture and Forestry*). The result of the comparison shows consistency with each other, and indicates that the ARD detection is appropriate.

Table A11-43 Results of imagery interpretation of ARD land (March 2011)

Area of lands interpreted [km^2]	Plots qualified as AR （1990-2009）	AR rate [%] （1990-2009）	Area of lands qualified as AR Total [kha] （1990-2009）
355,533	464	0.079%	28.3

Area of lands interpreted [km^2]	Plots qualified as D （1990-2009）	D rate [%] （1990-2009）	Area of lands qualified as D Total [kha] （1990-2009）	Conversion area from forest estimated from existing statistical information [kha] （1990-2009）
355,533	5,498	0.870%	309.4	303.5

A11.5.2. Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

In Japan, land conversion from forest land to other land use means exclusion of the land from forest plans. Therefore, as far as area of harvested forest would remain included in forest plans, the area would be considered to be subject not to D but to temporary loss of biomass stock, and on Forest Registers, would be distinguished from D which means conversion to other land use..

Japan identifies forest cover change as D only in the case landform transformation or artificial construction are observed or obvious conversion to non-forest land such as cropland are detected through imagery interpretation using aerial photos and satellite images. By this methodology, D is distinguished from temporary loss of biomass stock in forest land.

A11.5.3. Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

Total area of forest land that has temporarily lost forest cover due to harvesting or disturbance and which are not classified as deforested but as “Forest with less standing trees” (cut-over forests, lesser stocked forests) in Forest Registers is about 1.14 million ha in 2009.

A11.5.4. Information on emissions and removals of greenhouse gases from lands harvested during the first commitment period following afforestation and reforestation

Japan assumes that all AR units of land have not been harvested during the first commitment period which is satisfied with the requirements under paragraph 4 of the Annex to decision 16/CMP.1, basically.

A11.6. Article 3.4

A11.6.1. Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

A11.6.1.1. Forest Management

Status of FM activities since 1 January 1990 has been investigated since FY2007 by sample survey including field survey, interview with forest owner’s association and detection of administrative information on subsidies forest practices, of Ikusei-rin forests throughout the country. Results of the survey have been used to estimate FM ratio.

A11.6.1.2. Revegetation

Japan demonstrates that RV activities have occurred since 1990 and are human induced based on the following reasons.

Table A11-44 Information that demonstrates that revegetation activities have occurred since 1st January 1990 and are human induced

Sub-division	Information that demonstrates that revegetation activities have occurred since 1st January 1990 and are human induced
Urban parks	Extraction of activities which have occurred since 1st January 1990 MLITT has implemented "Urban Parks Status Survey" and has collected data on the notificated year of urban parks. In the reporting, only urban parks which have been notified since 1st January 1990 are included. Although some urban parks have established before the notificated year, Japan considers that RV activities have occurred since the notificated year under "Urban Park Act". Demonstrate that activities are human induced Activity data (the number of tall trees) is calculated based on the number of tall trees per land area (tree/ha) which is developed by using data on tall trees human-induced planted. Its calculation procedure ensures that Japan extracts human induced activities.
Green area on road	Extraction of activities which have occurred since 1st January 1990 MLITT has implemented "Road Tree Planting Status Survey" every 5 years (implemented every year since 2007) and has collected data on the number of planted tall trees. Activity data after 1990 is calculated by extrapolating or interpolating these data. Demonstrate that activities are human induced In "Road Tree Planting Status Survey", only human-induced planted tall trees have been measured. Its measurement procedure ensures that Japan extracts human induced activities.
Green area on port	Extraction of activities which have occurred since 1st January 1990 MLITT has implemented complete census since 2006 and has collected relevant data (established year and service area) for green area on port which had been established since 1990. Demonstrate that activities are human induced Activity data (the number of tall trees) is calculated by using parameters of urban parks which are based on human-induced activities data.
Green area around sewage treatment facility	Extraction of activities which have occurred since 1st January 1990 MLITT has implemented "Sewage treatment Facility Status Survey" since 2006 and has collected relevant data (established year and greening area) for green area around sewage treatment facility which had been established since 1990. Demonstrate that activities are human induced Activity data (the number of tall trees) is calculated based on the number of tall trees per land area (tree/ha) which is developed by using data on tall trees human-induced planted. Its calculation procedure ensures that Japan extracts human induced activities.
Green area by greenery promoting system for private green	Extraction of activities which have occurred since 1st January 1990 It is clear that all green area by greenery promoting system for private green space has been established since 1st January 1990 because greenery promoting system has been implemented since 2001. Existing tall trees before 1990 in some green area are reported when it is notified by local authority mayor. It is excluded

space	from RV land area. Demonstrate that activities are human induced All green area by greenery promoting system for private green space has been human-induced established.
Green area along river and erosion control site	Extraction of activities which have occurred since 1st January 1990 MLITT has implemented "Survey on carbon dioxide absorption at source in river works" since 2007 and has collected relevant data (name, location, established year, planted land area [projected area] and the number of tall trees) for river works and erosion and sediment control works which had been implemented since 1990. Demonstrate that activities are human induced Activity data (the number of tall trees) is calculated based on the number of tall trees per land area (tree/ha) which is developed by using data on tall trees human-induced planted. Its calculation procedure ensures that Japan extracts human induced activities.
Green area around government buildings	Extraction of activities which have occurred since 1st January 1990 MLITT has implemented complete census since 2007 and has collected relevant data (name, location, established year, total land area and building area) for government buildings which had been established since 1990. Demonstrate that activities are human induced Activity data (the number of tall trees) is calculated based on the number of tall trees per land area (tree/ha) which is developed by using data on tall trees human-induced planted. Its calculation procedure ensures that Japan extracts human induced activities.
Green area around public rental housing	Extraction of activities which have occurred since 1st January 1990 MLITT has implemented "Progress survey on tree planting for public rental housing" since 2007 and has collected relevant data (name, location, established year, total land area and building area) for public rental housing which had been established since 1990. Demonstrate that activities are human induced Activity data (the number of tall trees) is calculated based on the number of tall trees per land area (tree/ha) which is developed by using data on tall trees human-induced planted. Its calculation procedure ensures that Japan extracts human induced activities.

A11.6.2. Information relating to Revegetation for the base year and the commitment period

The anthropogenic greenhouse gas removals in Revegetation for the base year are those from RV area in 1990. The area where RV activity was taken place in 1990 is directly obtained by activity data in each subcategory of RV. The anthropogenic greenhouse gas removals in Revegetation for the commitment period are those from RV area in each year. Those removals are reported within the relevant geographical locations. The data and the methodologies used are provided in section A11.3.2.5 and A11.4.1.1.d.

A11.6.3. Information that demonstrates the emissions and removals resulting from elected Article 3.4 activities are not accounted for under activities under Article 3.3 activities

A11.6.3.1. Information on emissions and removals by FM activities are not accounted for under Article 3.3 activities

AR and D is higher hierarchy than FM in the land classification system of Article 3.3 and 3.4 in Japan. Emissions and removals by AR and D are estimated in the first step, then emissions and removals by

FM are estimated by subtracting emissions and removals by AR from emissions and removals in managed forest as explained in section A11.3.2.2 (see Figure A11.1). Therefore, emissions and removals by FM could not be included in those by AR nor D.

A11.6.3.2. Information on emissions and removals from RV activities are not accounted under Article 3.3 activities

RV land is defined as the land which is not included in AR land as described in the definition section A11.2.2.2. Therefore, emissions and removals from RV could not be included in those from AR theoretically.

The area of D land which would otherwise be included in RV lands is reported in the CRF Table 5(KP-I) A.2.1. Since this land is classified as D land and is not included in RV land, all emissions and removals from this land is reported under D activity as described in the explanation of methodologies of D in section A11.4.1.1.b and those of RV in section A11.4.1.1.d. Therefore, there is no double count between D and RV and emissions and removals from RV could not be included in those from D.

A11.6.4. Information relating to Forest Management

A11.6.4.1. The definition of forest for this category conforms with the definition in item A11.2 above

In Japan, area and carbon stock change on land subject to FM activities are estimated by applying FM ratios to data of all forests which meet our country’s forest definition. Therefore, the definition of land subject to FM activities is consistent with our country’s forest definition.

On the other hand, not all managed forest reported under the Convention is subject to FM reported as Article 3.4 activity under the Kyoto Protocol in Japan, because FM forest consists of only the area where FM activities have been taken place since 1990 as described in section A11.3.2.4.

A11.6.4.2. The definition of forest management confirms with the definition in paragraph 1 (f) of the Annex to decision 16/CMP.1

Japan considers that FM activities which are reported under the Kyoto Protocol should be of sustainable system and whether this is fulfilled or not is judged from whether appropriate forest practices have been carried out in Ikusei-rin forests or whether practices for protection or conservation of forests including controlling logging activities and land-use change have been carried out by laws. Therefore, Japan’s definition of FM is consistent with the definition provided in “Decision 16/CMP.1” (a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological, economic and social function of the forest in a sustainable manner).

A11.6.4.3. Information on the extent GHG removals by sinks offsets the debit incurred under Article 3.3.

The total amount that FM removals offset the debit incurred under Article 3.3 is 4,711 Gg-CO_2 eq. in 2008 and 2009. Related information is provided in Table A11-2.

A11.7. Other information

A11.7.1. Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

In accordance with GPG-LULUCF, Chapter 5, the activity which meets following requirements is considered as key.

-The associated category under the UNFCCC is identified as key. In addition, Emissions/removals from the activity are greater than the smallest category that is identified as key in the UNFCCC inventory (Tier 1 level assessment).

-Estimation method is changed from previous reporting.

● *Corresponding with key categories under the UNFCCC*

Japan’s LULUCF key categories under the UNFCCC for 2009 (Annex 1 of this report) are as follows;

5.A.1. Forest land remaining Forest land (CO_2)
5.B.2. Land converted to Cropland (CO_2)
5.E.1. Settlements remaining Settlements (CO_2)
5.E.2. Land converted to Settlements (CO_2)
5.F.2. Land converted to Other land (CO_2)

In accordance with GPG-LULUCF, D, FM and RV may be identified as key under the Kyoto Protocol.

Table A11-45 Relationship between UNFCCC categories and Kyoto Protocol activities

UNFCCC category under the Convention	Kyoto Protocol category
5.A.1. Forest land remaining Forest land	FM
5.A.2. Land converted to Forest land	AR
5.B.1. Cropland remaining Cropland	
5.B.2. Land converted to Cropland	D
5.C.1. Grassland remaining Grassland	
5.C.2. Land converted to Grassland	D
5.D.1. Wetlands remaining Wetlands	RV
5.D.2. Land converted to Wetlands	D、RV
5.E.1. Settlements remaining Settlements	RV
5.E.2. Land converted to Settlements	D、RV
5.F.1. Other land remaining Other land	—
5.F.2. Land converted to Other land	D

※ The relationship between conventional categories and Kyoto categories in this table is based on GPG-LULUCF, p. 5.39, Table 5.4.4. and the definitions of Article 3.3 and 3.4 activities in Japan. Yellow shade indicates key categories under the UNFCCC.

● *Comparison with the smallest key category under the UNFCCC*

The smallest category for the UNFCCC (Tier 1 level assessment) for 2009 was 2.A.3. Limestone and Dolomite Use (CO_2) [7,445 Gg-CO_2]. As a result of comparison, only FM activity was greater than this category.

Therefore, D, FM and RV activities (CO_2) are identified as key for 2009.

A11.7.2. Further improvement

Methodological issues relating to Article 3.3 and Article 3.4 are identified under the Committee for Greenhouse Gas Emissions Estimation Methods- Breakout Group on LULUCF. They are updated every year taking into account the progress of the inventory-related work and issues identified by the Expert Review team. Many of improvement plans on LULUCF reporting under the Convention described in Chapter 7 of this report are closely linked to activities under Article 3.3 and Article 3.4 of the Kyoto Protocol. So, both the reporting under the Convention and the reporting under the Kyoto Protocol are discussed together. Major issues to be improved are as follows:

○ Improvement of methodology and data to estimate carbon stock change in soil due to land-use conversion which reflect changes in management practice more properly is under discussion in Japan.

○ A default value of annual biomass growth was used for RV activity. Japan is planning to measure annual biomass growth in a tall tree planted in RV land and determine country-specific value for dominant tree types (a few types).

○ Carbon stock change in soils is not included in the reporting because soils are not sources of GHGs under RV activities. Japan will continue to collect fundamental information on soil carbon and consider about estimation method.

A11.8. Information relating to Article 6

Japan has not carried out any projects under Article 6 of the Kyoto Protocol. Therefore, a special indication of whether the boundary of the geographical location encompasses land subject to the Article 6 project is not prepared.

A11.9. Information on the reporting status of paragraph 5 to 9 of the Annex to decision 15/CMP.1

The requirements for reporting about Article 3.3 and 3.4 which are set out in paragraph 5 to 9 of the annex to decision 15/CMP.1 are provided in sections shown in Table A11-46.

Table A11-46 List of reference sections for the requirements set in paragraph 5 to 9 of the Annex to decision 15/CMP.1

CHECKLIST FOR KP REPORTING (paragraphs 5-9 in the annex to decision 15/CMP.1)			**Paragraph**	**Main sections of Annex 11which provide relevant information**
Reporting requirements from paragraphs 5-9 in the annex to decision 15/CMP.1	**Information on how inventory methodologies have been applied taking into account IPCC good practice guidance for LULUCF and decision 16/CMP.1.**		6(a)	Detailed information is provided in each section
	Information on geographical location of the boundaries of areas that encompass:		6(b)	A11.3.3、A11.3.2
		Units of land subject to activities under Article 3.3	6(b)(i)	A11.3.3、A11.3.2
		Units of land subject to activities under Article 3.3, which would otherwise be included in land subject to elected activities under Article 3.4	6(b)(ii)	A11.3.3、A11.3.2 and CRF table 5(KP-I)A.2.1
		Land subject to elected activities under Article 3.4	6(b)(iii)	A11.3.3、A11.3.2
	Information on the spatial assessment unit for determining the area of accounting for afforestation, reforestation and deforestation.		6(c)	A11.3.1
	GHG emissions by sources and removals by sinks from LULUCF activities under Articles 3.3 and 3.4:			
		Emissions by sources and removals by sinks are clearly distinguished from emissions from Annex A sources.	5	A11.4.1: Methodology
		Emissions by sources and removals by sinks are reported for all geographical locations reported in current and previous	6(d)	A11.3.2.3、A11.3.2.4、A11.3.2.5
		Articles 3.3 or (elected) 3.4 activities emissions/removals are reported since the beginning of the commitment period or the onset of the activity.	6(d)	A11.4.1.7
		Information on which pools (above-ground / below-ground biomass, litter, dead wood and soil organic carbon) were not accounted for.	6(e)	A11.4.1.2
		Information on whether Articles 3.3 and (elected) 3.4 emissions/removals factor out removals from (i) elevated CO_2 concentrations above pre-industrial levels; (ii) indirect N deposition; and (iii) dynamic effects of age structure resulting from pre- 1 January 1990 activities.	7	A11.4.1.3
	Specific information to be reported for Article 3.3 activities:			
		Information that activities under Article 3.3 began on or after 1 January 1990 and before 31 December of the last year of the commitment period.	8(a)	A11.5.1
		Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation.	8(b)	A11.5.2、A11.5.3
		Information on emissions/removals from lands harvested during the 1st commitment period following afforestation and reforestation on these units of land since 1990.	8(c)	A11.5.4
	Specific information to be reported for Article 3.4 activities:			
		Information that activities under Article 3.4 occurred since 1 January 1990 and are human induced.	9(a)	A11.6.2
		Cropland management, grazing land management, revegetation: emissions/removals reported for each year of the commitment period and for the base year for each of the elected activities on the geographical locations reported.	9(b)	A11.6.1、A11.3.2.5、A11.4.1.1.d
		Information that emissions/removals from Article 3.4 activities are not accounted for under activities under Article 3.3.	9(c)	A11.6.3
		Forest management: information on the extent GHG removal by sinks offsets the debit incurred under Article 3.3.	9(d)	A11.6.4.3

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Abbreviations

1. Greenhouse Gasses

Table 1-1 6 Gasses controlled by Kyoto Protocol

Term	Gas
CO_2	Carbon dioxide
CH_4	Methane
N_2O	Nitrous oxide
HFCs	Hydrofluorocarbons
PFCs	Perfluorocarbons
SF_6	Sulphur hexafluoride

Table 1-2 Indirect gasses and precursors

Term	Gas
NOx	Sum of nitrogen oxide and nitrogen dioxide
CO	Carbon monoxide
NMVOC	Non-methane volatile organic compounds
SO_2	Sulphur dioxide

2. Prefixes and Units

Table 2-1 Prefixes

Term	Prefix	Definition
P	peta	10^{15}
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
h	hecto	10^{2}
da	deca	10^{1}
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}

Table 2-2 Units

Term	Definition
m^3	cubic metre
l	litter
a	are
ha	hectare
g	gram
t	tonne
J	joule
°C	degree Celsius
yr	year
cap	capita
d.m.	dry matter

3. Notation Keys

Table 3-1 Notation Keys (See Annex5.)

Notation Key	Definition
NO	Not Occurring
NE	Not Estimated
NA	Not Applicable
IE	Included Elsewhere
C	Confidential

4. Other Abbreviations

Table 4-1 Abbreviations

Terms	Definition
AAU	Assigned Amount Units
ARD	Afforestation, Reforestation and Deforestation
BFG	Blast Furnace Gas
BOD	Biochemical Oxygen Demand
CFG	Converter Furnace Gas
CGER	Center for Global Environmental Research
CO_2 eq.	Gas Emission in CO_2 equivalent
COD	Chemical Oxygen Demand
COG	Coke Oven Gas
CRF	Common Reporting Format
CS-EF	Country-Specific Emission Factor
CY	Calendar Year
EF	Emission Factor
FM	Forest Management
FY	Fiscal Year
GCV	Gross Calorific Value
GHG	Greenhouse Gas
GIO	Greenhouse Gas Inventory Office
GPG	Good Practice Guidance
GPG (2000)	Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000)
GPG-LULUCF	Good Practice Guidance for Land Use, Land-Use Change and Forestry
GWP	Global Warming Potential
IEA	International Energy Agency
IEF	Implied Emission Factor
IPCC	Intergovernmental Panel on Climate Change
JNGI	Japanese National GHG Inventory
L.D.converter	Linz-Donawitz converter
LDG	Linz-Donawitz converter Gas
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LULUCF	Land-Use, Land-Use Change and Forestry
MAFF	Ministry of Agriculture, Forestry and Fisheries
MDI	Metered Dose Inhalers
METI	Ministry of Economy, Trade and Industry
MOE	Ministry of Environment
MOFA	Ministry of Foreign Affairs of Japan
MIC	Ministry of Internal Affairs and Communications
MLIT	Ministry of Land, Infrastructure and Transport
MSW	Municipal Solid Waste
NCV	Net Calorific Value
NFRDB	National Forest Resource DataBase
NGL	Natural Gas Liquids
NIES	National Institute for Environmental Studies
NIR	National Inventory Report
QA/QC	Quality Assurance / Quality Control
RDF	Refuse Derived Fuel
RPF	Refuse Paper and Plastic Fuel
RV	Revegetation
TOE	Tonnes of Oil Equivalent
UNFCCC	United Nations Framework Convention on Climate Change