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## GLOSSARY

**Glossary**

TO RECEIVE THE UPDATES
TO THE
IPCC GUIDELINES FOR NATIONAL
GREENHOUSE GAS INVENTORIES

The development of the *IPCC Guidelines for National Greenhouse Gas Inventories* is an ongoing process and the first phase has now been completed. The *Guidelines* will need to be updated periodically as better data and scientific understanding support better estimation methods. For this reason, the *Guidelines* have been published in loose-leaf form to allow for the insertion of periodical updates. If you wish to receive information concerning future updates please fill in and return, by mail or fax, the coupon below. This will result in your registration as a Guidelines user and you will be notified of subsequent updates and their price.

Please send any change of address to: IPCC WGI Technical Support Unit, Hadley Centre, Meteorological Office, London Road, Bracknell, RG12 2SY, United Kingdom.

**IPCC**
**IPCC WGI Technical Support Unit**
**Hadley Centre**
**Meteorological Office**
**London Road**
**Bracknell, RG12 2SY**
**United Kingdom**

**Fax: (44 1344) 856912**

Please send me information concerning future updates of the *IPCC Guidelines for National Greenhouse Gas Inventories.*
*(Please write in CAPITAL LETTERS)*

Company name:.....

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Position: .....

Address:.....

.....

City and post code: .....

Country: .....

E-mail:..... Tel:..... Fax:.....

Date:..... Signature:.....

# ACKNOWLEDGEMENTS

The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (Revised Guidelines)* were accepted by the Intergovernmental Panel on Climate Change (IPCC) at its Twelfth Session (Mexico City, 11-13 September 1996). Earlier, Working Group I of the IPCC at its Sixth Session (Mexico City, 10 September 1996) had accepted and then forwarded the *Revised Guidelines* to the IPCC. The IPCC-XII recommended that the *Revised Guidelines* "are ready for use by Parties to the UN Framework Convention on Climate Change (UNFCCC) in the preparation of their National Communications with regard to inventories, at a time to be agreed by the Parties of the Convention." It is, therefore, extremely gratifying that the consensus effort of nearly one hundred and forty scientists and national experts from more than thirty countries has resulted in the publication of the *Revised Guidelines*.

At the Fourth Session of the Subsidiary Body for Scientific and Technological Advice (SBSTA-4, Geneva, 16-18 December 1996), Parties to the Convention decided how, and when, the *Revised Guidelines* are to be applied. To assist Parties in meeting their commitments and targets, and to monitor progress, it is essential that national GHG emission inventories contain the best possible information for all major GHG sources and sinks. As such, inventories must be consistent, comparable, complete, and transparent. The *Revised Guidelines* provide such a methodology for the estimation and periodic update of national greenhouse gas (GHG) inventories, and thus comply with the requirements of Articles 4 and 12 of the UNFCCC.

The *Revised Guidelines* were developed over a two-year period and draw extensively upon the previous *Guidelines*. Where possible, the *Revised Guidelines* improved upon the early 1995 *Guidelines* by the synthesis and assessment of relevant new data. These improved data are critical for regions of the world where baseline information is still sparse. In areas of scientific advancement, existing methodologies were revised, and additional methodologies were developed and assessed. A *Summary of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* can be found in Annex 3 of the *Reporting Instructions*.

We are indebted to the Co-chairs of the *IPCC Expert Groups* and the Experts who generously supported this work. Their dedication to quality and timeliness was truly remarkable. Core funding for the IPCC Unit for GHG Inventories is provided through the IPCC Trust Fund. Other contributions, financial and otherwise, have been received from numerous governments (Canada, European Union, Netherlands, Norway, United Kingdom, United States) and several institutions, organisations and programmes (European Environment Agency, Institute of Environmental Studies, United Nations Environment Programme Country Studies, United States Country Studies Programme). We are most grateful to the governments of Brazil, Switzerland, Thailand and the United

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Professor B. Bolin
Chairman of the IPCC

Dr. N. Sundararaman
Secretary of the IPCC

**Contributors to the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories***

**Chapter 1: Energy**

***Co-Chairs of Expert Group on Fuel Combustion***

Simon Eggleston *(United Kingdom)*.

Jean-Yves Garnier (IEA).

David Mobley (USA).

***Expert/Author for Non-$CO_2$ Tier 1 Approach***

K. Mareckova (Slovak Republic).

***Experts/Authors for Harmonisation Between IPCC and CORINAIR Inventories***

J. P. Fontelle (France), K. E. Joerss (Germany), T. Simmons (United Kingdom), K. Tréanton (IEA).

***Experts/Authors for Emissions from Aircraft***

N. A. Kilde (Denmark), and J. Olivier (The Netherlands).

***Experts/Contributors***

W. Barbour (USA), L. Beck (USA), P.L. Canegallo (Italy), F. Carnovale (Australia), M. Emmott (United Kingdom), G. McInnes (Denmark) J. Meijer (IEA), R. Montgomery (Luxembourg), H.S. Mukunda (India), T. Pulles (The Netherlands), E. Radwanski (Poland), S. Richardson (United Kingdom), M. Ritter (Austria), H. Saddler (Australia), Z. Samaras (Greece), and T. Simmons (United Kingdom).

**Chapter 2: Industrial Processes**

***Co-Chairs of Expert Group on Industrial Processes and 'New Gases'***

Art Jaques (Canada).

Audun Rosland (Norway).

***Secretary of the Expert Group***

F. Weidemann (Norway).

***Experts/Authors***

H.T. Haukås (Norway), A. Jaques (Canada), F. Neitzert (Canada), A. Rosland (Norway), K. Rypdal (Norway), and F. Weidemann (Norway).

***Experts/Contributors***

F. Carnovale (Australia), M. T. Duarte Neves Anacleto (Portugal), C. Ebert (USA), T. Fukushima (Japan), E. Kvist (Sweden), J. Lupinacci (USA), K. Mareckova (Slovak Republic), A. McCulloch (United Kingdom), J.G.J. Olivier (The Netherlands), H. Oonk (The Netherlands), K.I Øren (Norway), G. Salway (United Kingdom), T. Simmons (United Kingdom), and V. Simpson (United Kingdom).

**Chapter 4: Agriculture**

***Co-Chairs of Expert Group on Nitrous Oxide from Agricultural Soils***

Carolien Kroeze (The Netherlands).

Arvin Mosier (USA).

***Experts/Authors***

C. Kroeze (The Netherlands), A. Mosier (USA), C. Nevison (USA), O. Oenema (The Netherlands), S. Seitzinger (USA), and O. van Cleemput (Belgium).

***Experts/Contributors***

L. Bakken (Norway), P. Bielek (Slovak Republic), S. Bogdanov (Bulgaria), Y. Bonduki (Venezuela), A. F. Bouwman (The Netherlands), R.A. Delmas (France), F.J. Dentener (The Netherlands), R. Francisco (Philippines), J. Freney (Australia), S. Frolking (USA), P. Groffman (USA), O. Heinemeyer (Germany), R. Karaban (Russian Federation), L. Klemedtsson (Sweden), P.A. Leffelaar (The Netherlands), E. Lin (China), K. Minami (Japan), W.J. Parton (USA), D.C. Parashar (India), R. Scholes (South Africa), R. Sherlock (New Zealand) K. Smith (United Kingdom), H.G. van Faassen (The Netherlands), E. Veldkamp (USA), G.L. Velthof (The Netherlands), and G.X. Xing (China).

***Chair of Expert Group on Methane Emissions from Rice Cultivation***

Dieter H. Ehhalt (Germany).

***Experts/Authors***

R. Conrad (Germany), A. P. Mitra (India), H.U. Neue (Philippines), and R. Sass (USA).

***Experts/Contributors***

S. Bhattacharya (India), K. Boonpragob (Thailand), O.T. Denmead (Australia), Y.A. Husin (Indonesia), M.C. Jain (India), P. Jermsawatdipong (Thailand), N. Krairapanond (Thailand), K. Minami (Japan), D.C. Parashar (India), D. Phantumvanit, S. Piamphongsant (Thailand), G.Y. Shi (China), O. Siriratpiriya (Thailand), S. Towprayoon (Thailand), G.X. Xing (China), L. Xu (China), and S.H. Yun (Republic of Korea).

**Chapter 5: Land-use Change and Forestry**

***Co-Chairs of Expert Group on Land-use Change and Forestry***

Sandra Brown (USA).

Youba Sokona (Senegal).

***Convening Experts/Authors***

S. Brown (USA) and J. Winjum (USA).

***Experts/Authors***

A. Kokorin (Russian Federation) and M. Lorenzini (Italy).

***Experts/Contributors***

S. Amous (Tunisia), S. Calman (New Zealand), P. Cheng (Australia), H. Eriksson (Sweden), P. Frost (Zimbabwe), T. Karjalainen (Finland), J. Mindas (Slovak Republic), N.H. Ravindranath (India) and Y. Sokona (Senegal).

***Co-chairs of Expert Group on Emissions and Uptake of $CO_2$ from Soils***

Arvin Mosier (USA).

Keith Paustian (USA).

***Convening Expert/Author***

K. Paustian (USA).

***Experts/Authors***

H. Janzen (Canada), H. Tiessen (Canada), and M. van Noordwijk (Indonesia).

***Experts/Contributors***

O. Andrén (Sweden), E. Davidson (USA), H. Eswaran (USA), E. Fernandes (USA), P. Grace (Australia), R. Houghton (USA), J. Kimble (USA), T. Kolchingina (Russian Federation), R. Lal (USA), M. Scholes (South Africa), P. Smith (United Kingdom), G. Tian (Nigeria), P. Woomer (Kenya), and L. Zhong (China).

**Chapter 6: Waste**

***Co-Chairs of Expert Group on Waste***

Elisabeth Aitchison (United Kingdom).

Chris Franklin (United Kingdom).

Tom Kerr (USA).

Cindy Jacobs (USA).

***Experts/Authors***

E. Aitchison (United Kingdom), C. Franklin (United Kingdom), C. Jacobs (USA) and J. Woodbury (USA).

***Experts/Contributors***

D. Augenstein (USA), A.D. Bhide (India), D. Becker (The Netherlands), J. Bogner (USA), K. Butterback-Bahl (Germany), T. Beer (Australia), P. Czepiel (USA), L. de Rome (United Kingdom), D. Gaudioso (Italy), B. Hamelers (The Netherlands), K. Hogan (USA), N. A. Kilde (Denmark), A. Lifshits (Russian Federation), E. Matthews (USA), M. Meadows (United Kingdom), M. Milton (United Kingdom), P. Manczarski (Poland), H. Oonk (The Netherlands), F. Otieno (South Africa), R. Pipatti (Finland), S. Thorneloe (USA), A. van Amstel (The Netherlands), and I. Grietje Zeeman (The Netherlands).

***IPCC/OECD/IEA Secretariats***

C. Allen (OECD), Y. Bonduki (IPCC/OECD), B.A. Callander (IPCC), J.C. Corfee-Morlot (OECD), J.Y. Garnier (IEA), A. Glynn-Garnier (IPCC/OECD), D.J. Griggs (IPCC), J. Lakeman (IPCC), B. Lim (IPCC/OECD), I. Mamaty (IPCC/OECD), J. Meijer (IEA), S. Michel (IEA), B. Nyenzi (IPCC), T. Simmons (IEA), J. Stein (IPCC/OECD), and K. Tréanton (IEA).

**The *Revised 1996 IPPC Guidelines for National Greenhouse Inventories* contain material from the *1995 IPCC Guidelines for National Greenhouse Inventories (1995 Guidelines).* The Co-Chairs of the previous Expert Groups are given in the *1995 Guidelines*.**

# PREFACE

Signature of the United Nations Framework Convention on Climate Change (UNFCCC) by around 150 countries in Rio de Janeiro in June 1992 indicated widespread recognition that climate change is potentially a major threat to the world's environment and economic development.

The ultimate objective of the Convention is the stabilisation of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The Convention also calls for all Parties to commit themselves to the following objectives:

- to develop, update periodically, publish and make available to the Conference of the Parties (COP) their national inventories of anthropogenic emissions by sources and removals by sinks, of all GHG not controlled by the Montreal Protocol.
- to use comparable methodologies for inventories of GHG emissions and removals, to be agreed upon by the COP.

The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories Guidelines* (*Revised Guidelines*) are intended to assist all Parties in implementing these objectives.

Since 1991, development of the *Revised Guidelines* has been undertaken by the Working Group I of the IPCC under the *IPCC/OECD/IEA Programme on National Greenhouse Gas Inventories*. The objectives of the programme are:

- to develop and refine an internationally-agreed methodology and software for calculation and reporting of national GHG emissions;
- to encourage widespread use of the methodology by countries participating in the IPCC and Parties to the UNFCCC;
- to establish a data management system for collection, review and reporting of national data.

The *Revised Guidelines* are approved internationally and developed through an international process which has included:

- wide dissemination of drafts and collection of comments from national experts;
- testing of methods through development of preliminary inventories;

- country studies which ensure that methods are tested in a wide variety of national contexts;
- technical and regional workshops held in Africa, Asia, Latin America, Central Europe and Western Europe;
- informal expert groups convened to recommend improvements on specific aspects of the methodology.

The *1995 Guidelines* were approved in November 1994. In March 1995, the Conference of the Parties (COP) of the Framework Convention on Climate Change adopted the *Guidelines* for the preparation of National Communications by Annex I Parties of the Convention. These *Guidelines* were more recently recommended for use by non-Annex I Parties at COP 2, July 1996.

Recognising that the *Guidelines* are a living document, the IPCC approved a second phase of activity in 1994. The *Revised Guidelines* now include revised methodologies and default data for Fuel Combustion, Industrial Processes, Agricultural Soils, Land-Use Change and Forestry, Waste and Methane from Rice Fields. Several additional methodologies for the estimation of halofluorocarbons (HFCs), perfluorinated hydrocarbons (PFCs), sulphur hexafluoride ($SF_6$), ozone and aerosol precursors, and direct GHG ($CO_2$, $CH_4$, $N_2O$) are in the *Revised Guidelines*.

Over the coming year, the Programme will continue to work on methods development, including assessment, monitoring, and validation of the *Revised Guidelines*. Unlike earlier programmes, products will no longer focus on revisions of the *Revised Guidelines*, as no major changes to the methods are anticipated for three to five years, with the possible exception of the land-use change and forestry sector. The new mode of operation places emphasis on the following areas:

- evaluation of the quality of national greenhouse gas inventory data;
- comparative scientific and technical analysis of alternative greenhouse gas inventory methodologies and their implication for policy;
- further methodological work in the area of land-use change and forestry;
- continued harmonisation with other international and national greenhouse gas inventory methodologies;
- updating emission factors and default data in all source/sink sectors of the *Revised Guidelines*.

Another area of general activity will be field testing of the IPCC Methodology. The object of this activity is to ensure that country experience gained through the implementation of the *Revised Guidelines* is incorporated into methods development and into future reiterations of the *Revised Guidelines*.

# OVERVIEW OF THE IPCC GUIDELINES

This document is one volume of the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*.

The series consists of three books:

- THE GREENHOUSE GAS INVENTORY REPORTING INSTRUCTIONS
- THE GREENHOUSE GAS INVENTORY WORKBOOK
- THE GREENHOUSE GAS INVENTORY REFERENCE MANUAL

These books together provide the range of information needed to plan, carry out and report results of a national inventory using the IPCC system.

The *Reporting Instructions* (Volume 1) provides step-by-step directions for assembling, documenting and transmitting completed national inventory data consistently, regardless of the method used to produce the estimates. These instructions are intended for all users of the IPCC *Guidelines* and provide the primary means of ensuring that all reports are consistent and comparable.

The *Workbook* (Volume 2) contains suggestions about planning and getting started on a national inventory for participants who do not have a national inventory available already and are not experienced in producing such inventories. It also contains step-by-step instructions for calculating emissions of carbon dioxide ($CO_2$) methane ($CH_4$), nitrous oxide ($N_2O$), halocarbons (HFCs, PFCs), sulphur hexafluoride ($SF_6$), ozone and aerosol precursors, from six major emission source categories. It is intended to help experts in as many countries as possible to start developing inventories and become active participants in the inventories programme.

The *Reference Manual* (Volume 3) provides a compendium of information on methods for estimation of emissions for a broader range of greenhouse gases and a complete list of source types for each. It summarises a range of possible methods for many source types. It also provides summaries of the scientific basis for the inventory methods recommended and gives extensive references to the technical literature. It is intended to help participants at all levels of experience to understand the processes which cause greenhouse gas emissions and removals to occur and the estimation methods used in compiling inventories.

## Contents of the IPCC Guidelines

All three volumes begin with the following sections:

Acknowledgements
Preface
Overview of the IPCC Guidelines

The contents of each volume are as follows:

**Volume 1: Greenhouse Gas Inventory Reporting Instructions**

Introduction to the Reporting Instructions
Chapter 1: Understanding the Common Reporting Framework
Chapter 2: Reporting the National Inventory
Tables: Sectoral Report Tables
Summary Report Tables
Overview Table
Annex 1: Managing Uncertainties
Annex 2: IPCC and CORINAIR Source Categories
Annex 3: Summary of the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*
Glosary

**Volume 2: Greenhouse Gas Inventory Workbook**

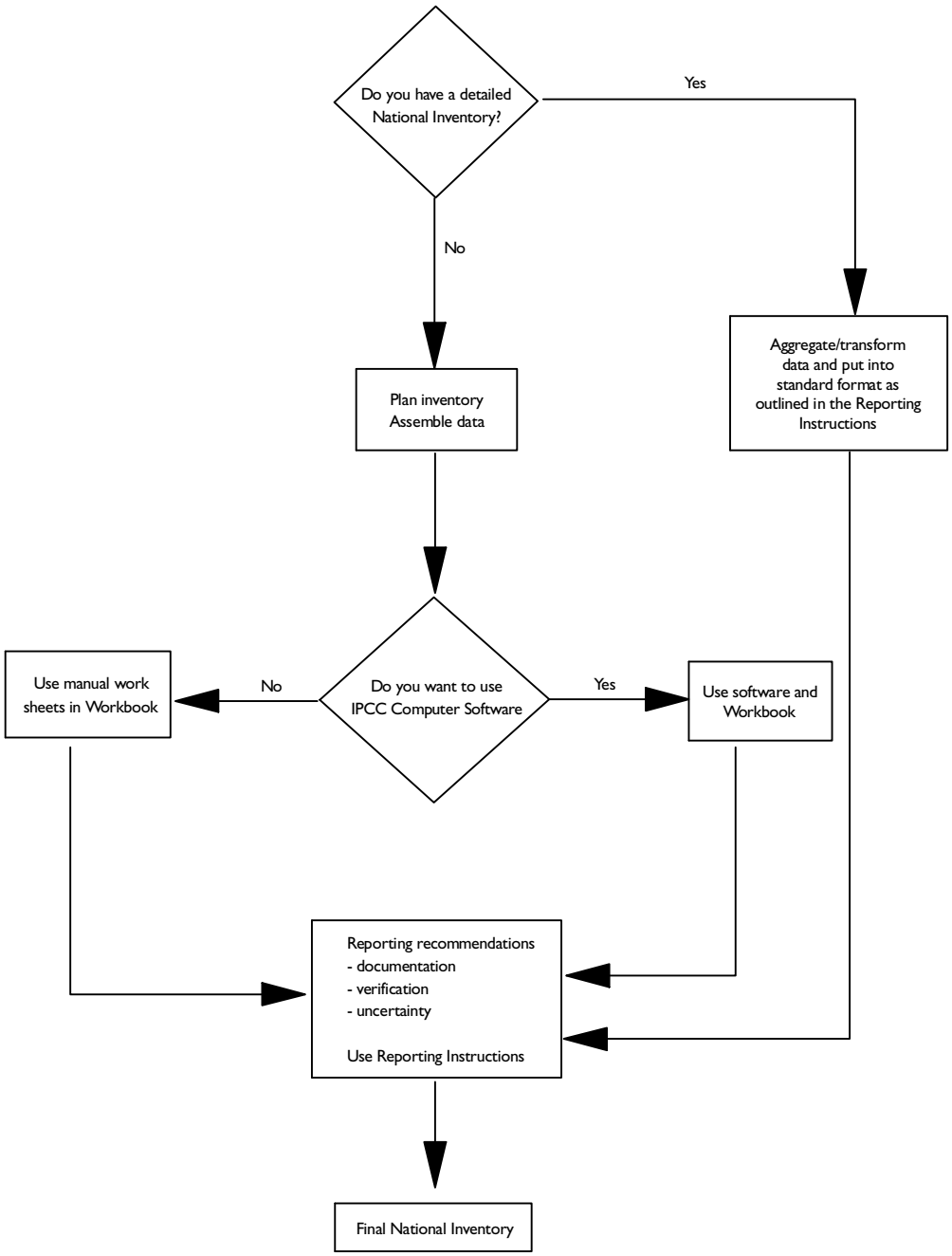
Introduction to the Workbook
Module 1: Energy
Module 2: Industrial Processes
Module 3: Solvent and Other Product Use
Module 4: Agriculture
Module 5: Land-Use Change and Forestry
Module 6: Waste

**Volume 3: Greenhouse Gas Inventory Reference Manual**

Introduction to the Reference Manual
Chapter 1: Energy
Chapter 2: Industrial Processes
Chapter 3: Solvent and Other Product Use
Chapter 4: Agriculture
Chapter 5: Land-Use Change & Forestry
Chapter 6: Waste

## Before you start...

This diagram explains the stages needed to make a national inventory which meets IPCC standards.



The flow diagram above illustrates how the different types of users (working at different levels of inventory detail) can use the various volumes of the *Guidelines*. You should recognise that reality is more complex than this simple explanatory chart. Many countries may have some parts of the inventory complete at a high level of detail but may only be getting started on other parts. It is quite likely that some users will need to do several iterations of the thinking process reflected in the diagram with regard to different parts of their inventory.

The stages outlined in the flow diagram are:

**Question 1**
**Do you have a detailed national inventory?**

**Answer: Yes**

If your country already has a complete national inventory, you should transform the data it contains into a form suitable for use by IPCC. This means transforming it into a standard format. In order to do this, use Volume 1 of the *IPCC Guidelines*, *Reporting Instructions*. This gives details of the way in which data should be reported and documented.

**Answer: No**

You should start to plan your inventory and assemble the data you will need to complete the Worksheets in this book. Refer to the *Getting Started* section of the *Workbook*.

**Question 2**
**Do you want to use the IPCC computer software?**

**Answer: Yes**

If you want to use the IPCC software, you will still follow the instructions included in the *Workbook* to assemble the data you have collected into an inventory (see margin box). You will use the software instead of the printed worksheets to enter data.

**Answer: No**

If you do not use the IPCC software, use the *Workbook* and the Worksheets it contains to assemble the data you have collected into an inventory.

**Finally...**

Inventory data should be returned to IPCC in the form recommended in the *Reporting Instructions*. It is important that, where you have used a methodology other than the IPCC Default Methodology, it is properly documented. This will ensure that national inventories can be aggregated and compared in a systematic way in order to produce a coherent regional and global picture.

**AVAILABILITY/USE OF COMPUTER SOFTWARE**

IPCC computer software is available with the IPCC Guidelines. The software includes the same simple default methods as presented in the *Workbook* and the Sectoral and Summary Tables for reporting inventories, as presented in the *Reporting Instructions*. It is available in English only.

This version of the software is being produced in Excel 5.0.

If you would like to receive a copy of the software, send a letter or fax to:

IPCC UNIT FOR GHG INVENTORIES

Pollution Prevention and Control Division
OECD, Environment Directorate
2, rue André-Pascal
75775 PARIS CEDEX 16
FRANCE

FAX: (33-1) 45 24 78 76

## General Notes on the Guidelines

**Scope:**

- The IPCC *Guidelines* are designed to estimate and report on national inventories of anthropogenic greenhouse gas emissions and removals.

In general terms "anthropogenic" refers to greenhouse gas emissions and removals that are a direct result of human activities or are the result of natural processes that have been affected by human activities. Users may include any human-induced emissions and removals in their inventory as long as they can be clearly documented and quantified.

- National inventories should include greenhouse gas emissions and removals taking place within national (including administered) territories and offshore areas over which the country has jurisdiction. There are, however, four qualifications of this principle in the *Guidelines*:

  (a) Emissions based upon fuel sold to ships or aircraft engaged in **international** transport should not be included in national totals but reported separately.

  (b) Emissions from road vehicles should be attributed to the country where the fuel is loaded into the vehicle. The error in national emissions introduced in the case of road transport is expected to be small.

  (c) Emissions from the combustion or decay of wood and wood products are assumed to take place in the country in which the wood was harvested and within a year of harvesting. This is because it has been determined that the most workable approach to estimating $CO_2$ emissions and removals from forests is to account for changes in stocks of standing biomass in forests and other locations. The simple assumption is that wood removed from stocks releases $CO_2$ emissions in the year and in the country where the wood was removed. While the IPCC method allows for accounting of exports and carbon stored in products, it does not yet provide a methodology, which is a priority for future work.

  (d) In line with the principle of national emissions, the IPCC methodology accounts for the bulk of greenhouse gas emissions related to fuel combustion in the country in which those emissions are released. The IPCC methodology for carbon stored in non-fuel products manufactured from fuels as raw materials takes into account emissions released from those products during their use or destruction. Emissions are attributed to the country where the conversion to non-energy products takes place, even when the products are traded internationally. This is believed to be a relatively small net error, but it is also a priority for future work.

**Data Quality and Time Frame:**

- The data available to estimate anthropogenic greenhouse gas emissions resulting from fuel combustion are generally of a better quality than the data available to estimate greenhouse gas emissions and removals in the areas of agriculture and land use change/forestry. Accordingly, while the IPCC *Guidelines* request an emission figure for a single year in most source/sink sectors, three-year averages (with the base year in the middle) are preferred in the areas of agriculture and land use change/forestry. In addition, the IPCC *Guidelines* recognise that greenhouse gas emissions and removals in the area of land use change/forestry can occur over an extended period of time once the activity has been completed. For example, when estimating emissions

from the abandonment of forests and grasslands, users are requested to estimate emissions related to two time periods of previous activity: (a) 0 - 20 years ago, and (b) 20 - 100 years ago.

**Default Method:**

- The IPCC *Guidelines* contain "default" methodologies for the estimation of greenhouse gas emissions and removals. Users are encouraged to go beyond these minimum default methods where possible, and report the results.

  The IPCC *Guidelines* also include a number of "default" assumptions and data for use in the estimation of greenhouse gas emissions and removals. This default information is included primarily to provide users with a starting point from which they can develop their own national assumptions and data. Indeed, national assumptions and data are always preferred because the default assumptions and data may not always be appropriate for specific national contexts.

  In general, therefore, default assumptions and data should be used only when national assumptions and data are not available. Section 2 of the Introduction to the IPCC Greenhouse Gas Inventory *Workbook* provides information on the quality of the default data available in different greenhouse gas source/sink categories. When it is indicated that the data available are of low quality, users should recognise that the default data do not provide a basis for the development of a definitive inventory of that source/sink category.

- Many of the categories of greenhouse gas emissions and removals can be estimated only with large ranges of uncertainty. Quite naturally, some national experts have developed methods which are designed to produce ranges of estimates rather than point estimates for highly uncertain categories. The IPCC *Guidelines*, however, require that users provide a single point estimate for each gas and emissions/removal category. This is simply to make the task of compilation, comparison and evaluation of national reports manageable. Users are encouraged to provide uncertainty ranges or other statements of confidence or quality along with the point estimates. The procedures for reporting uncertainty information are discussed in the *Greenhouse Gas Inventory Reporting Instructions*.

**Double Counting of Emissions:**

The methods proposed for the estimation of emissions sometimes simplify the inventory construction in order to use data which are more readily available than those needed for a detailed and more precise approach. In certain cases this may cause or increase the risk of double counting emissions. There are two areas where this may occur in the *Guidelines*.

1) All countries preparing $CO_2$ inventories using the IPCC *Guidelines* are asked to estimate the emissions from fuel combustion using the IPCC Reference Approach either as the primary means of preparing the inventory or as a verification stage following the preparation of an inventory using national methods. The Reference Approach is a simple procedure which demands relatively little data and lends itself to wide-spread application as a "common denominator".

The Reference Approach provides an upper bound to $CO_2$ emissions inferred from the country's supply of fossil fuels by identifying the carbon content, subtracting from it the carbon stored in non-energy products and products made from fuels used as raw material, adjusting for carbon which remains unburnt and multiplying by 44/12. It is an upper bound[1] because some of the carbon will be emitted in forms other than $CO_2$, in part because fuel combustion is not always complete but also because fuels may leak or evaporate. Consequently the $CO_2$ emissions figure obtained from the Reference Approach will include carbon emitted as $CH_4$, CO or NMVOC. At the same time the *Guidelines* encourage countries to estimate separate inventories for these gases and when this is done these gases are reported twice, in their emitted form and as $CO_2$. It is in this sense that they are "double counted".

Use of the Reference Approach carries with it two consequences which should be carefully noted.

Because the Reference Approach uses fossil fuel supply statistics as a basis for determining the carbon supply

- Not all carbon based emissions from fossil fuel are reported twice. The Reference Approach $CO_2$ estimate will not include emissions from combustion or release of fossil fuels for which the corresponding quantities (activity data) are not included in national production or import figures. Notable examples of activities which lead to emissions not included are the venting of natural gases from coal mining and handling and oil and gas production. Emissions from the flaring of natural gases are also excluded. As a result, when emissions from these activities are included in the relevant inventories using the fugitive emissions methodologies recommended in the *Guidelines* no "double counting" occurs.

- $CO_2$ emissions from biomass used as fuels are excluded from the total $CO_2$ emissions figure. The restriction of the Reference Approach to fossil fuels results from the sustainable nature of biofuels. The $CO_2$ emissions are, however, reported for information purposes. Note that non-$CO_2$ emissions from biofuels are included in their respective inventories.

2) Double counting may also occur when *calculated* emissions from the manufacture of products from fuels used as raw materials or from the use of fuels for their physical properties (e.g. lubricants) include emissions produced from the later destruction of these products. The double count will be with any separate reporting within the Waste module of the *Guidelines* of emissions from destruction.

3) When a national $CO_2$ inventory is constructed from emissions estimated for each source category using emission factors derived from measurements on combustion plant, care should be taken to include the $CO_2$ equivalent of other fossil carbon based emissions from the source

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[1] In practice, because of inaccuracies in the supply statistics and/or emission factors, $CO_2$ estimates from the Reference Approach may be less than those obtained by summing all $CO_2$ emissions from the combustion of fuel.

category. In this manner, the resulting total $CO_2$ emissions can be compared with the result of the $CO_2$ Reference Approach as part of the inventory verification stage. If, however, $CO_2$ emission factors, derived from the carbon content of the fuel, are used then no addition of the $CO_2$ equivalent of carbon gases is required.

# INTRODUCTION TO THE REPORTING INSTRUCTIONS

## I Using the Reporting Instructions

If you are engaged in preparing a national inventory you should read the *Reporting Instructions*. Even if you have already made an inventory, or have started to do so, and are simply reporting existing data to IPCC, you should still read them. These instructions provide the primary means of ensuring that all reports are consistent, transparent and comparable. The remaining chapters in this book are as follows:

Chapter 1: *Understanding the Common Reporting Framework* contains a listing of the categories you should use when reporting emissions and removals. Each of the categories is further broken down into sub-categories and given a definition if necessary. It also contains a listing of the basic fuel categories, some standard equivalents and unit definitions, and descriptions of the Sectoral Report Tables and Summary Report Tables used for reporting an inventory in IPCC format.

Chapter 2: *Reporting the National Inventory* contains step-by-step instructions for completing the Sectoral Report Tables and Summary Report Tables that are used to bring together and make a record of the estimates which have been made in your own inventory.

Tables: You will use these tables to assemble data from your national greenhouse gas inventory and present them in the IPCC reporting format. Finally, having completed the Sectoral Report Tables and the Summary Report Tables, you can assess the quality and completeness of the inventory by completing the Overview Table which provides a synoptic view of the results of the IPCC Greenhouse Gas Inventory.

Annex 1: *Managing Uncertainties* provides guidance on the theoretical considerations involved in taking account of uncertainties in creating an inventory.

Annex 2: *IPCC and CORINAIR Source Categories* looks at the ways in which data assembled for the CORINAIR inventory conducted by the European Union (EU) member countries as well as by the United Nations Economic Commission for Europe (UNECE) and IPCC data relate to each other.

Glossary: A glossary containing definitions of terms used in the *Guidelines* can be found at the end of this book.

## 2 Underlying Principles

The *Revised 1996 IPCC Guidelines* allow for the use of a range of methods at different levels of detail, including methods which are appropriate to national conditions. Default methods and assumptions are provided for calculating the major emissions and removals of greenhouse gases at the minimum acceptable level of detail. The IPCC default methods have been developed with efficiency in mind. They build on data that are readily available and should be easily applicable to all countries of the world. More detailed methods are also discussed in the *Guidelines* and national experts are encouraged to use them wherever this is possible and likely to produce more accurate national estimates. In some cases, national experts may choose to use an entirely different methodology if they believe this better reflects their national situation. Common reporting instructions are therefore needed to accommodate inventories developed at different levels of detail and (potentially) with different methods. The objective of the instructions is to establish minimum requirements for reporting data which allow for comparison and identification of differences in inventory construction (transparency). For this reason the IPCC recommends that all users of the *Guidelines* follow the *Reporting Instructions* explicitly when they communicate their national inventories to the IPCC or other international bodies.

Several main principles underlie the *Revised 1996 IPCC Reporting Instructions*:

- Common Reporting Framework

  The core of the reporting system is the establishment and use of a standard table format using common source/sink categories and common fuel categories. Common definitions of pollutants, units, and time intervals are necessary. Ultimately, all countries should be working toward complete greenhouse gas inventories within each, and across all, greenhouse gases.

  Emission inventory results should be transmitted using the Sectoral and Summary Report Tables . Use of these reporting conventions will not only enhance the comparability of data, it will facilitate the speed with which inventories can be processed, made available in summary form, aggregated and reviewed internationally.

- Documentation Standards

  Documentation standards are necessary to ensure transparency of national inventories and hence to allow the inventory to be reviewed. By providing the necessary documentation, the comparability of national inventories can also be evaluated. Therefore, along with Sectoral and Summary Report Tables, countries should provide the worksheets used to develop the national inventory, containing at least

all major assumptions activity data and emission factors. The IPCC also recommends that, countries submit a description of the method used, any definitions, as well as other relevant assumptions that cannot be summarised in table form. Enough data should be provided to allow a third party to reconstruct the inventory from national activity data and assumptions (the working definition of *transparency*).

To limit the volume of data to be provided, written documentation should focus on describing fully any differences in method and assumptions from the IPCC default methods.

- Verification and Uncertainty Assessment

  To improve the quality of inventory data and to help assess the uncertainty surrounding estimates, the *Revised 1996 IPCC Reporting Instructions* recommend that inventories be verified through the use of a set of simple checks for completeness and accuracy of submissions. These checks can be performed centrally, although it is preferable for the countries to do as much as possible themselves. Finally, an uncertainty assessment should also be conducted as far as possible and summarised for each major part of the inventory. Conceptual guidance for the assessment of the uncertainty of emission estimates are provided in Annex I *Managing Uncertainties*. Other approaches to describing uncertainty associated with point estimates of emissions and removals are also possible. Whether you use one of the approaches provided by the IPCC or another approach, you should include an uncertainty discussion in your inventory submission.

Each of these three principles is addressed in more detail in the following chapters.

# 3 Basic Information to Help Work with the IPCC Guidelines

## Prefixes and multiplication factors

The following multiplication factors are used throughout the *Guidelines*:

| Multiplication Factor | Abbreviation | Prefix | Symbol |
|---|---|---|---|
| 1 000 000 000 000 000 | $10^{15}$ | peta | P |
| 1 000 000 000 000 | $10^{12}$ | tera | T |
| 1 000 000 000 | $10^{9}$ | giga | G |
| 1 000 000 | $10^{6}$ | mega | M |
| 1 000 | $10^{3}$ | kilo | k |
| 100 | $10^{2}$ | hecto | h |
| 10 | $10^{1}$ | deca | da |
| 0.1 | $10^{-1}$ | deci | d |
| 0.01 | $10^{-2}$ | centi | c |
| 0.001 | $10^{-3}$ | milli | m |
| 0.000 001 | $10^{-6}$ | micro | μ |

## Abbreviations for chemical compounds

The following abbreviations are used in the *Guidelines*:

| | |
|---|---|
| $CH_4$ | Methane |
| $N_2O$ | Nitrous Oxide |
| $CO_2$ | Carbon Dioxide |
| CO | Carbon Monoxide |
| $NO_x$ | Nitrogen Oxides |
| NMVOC | Non-Methane Volatile Organic Compound |
| $NH_3$ | Ammonia |
| CFCs | Chlorofluorocarbons |
| HFCs | Hydrofluorocarbons |
| PFCs | Perfluorocarbons |
| $SO_2$ | Sulphur Dioxide |
| $SF_6$ | Sulphur hexafluoride |
| $CCl_4$ | Carbon tetrachloride |
| $C_2F_6$ | Hexafluoroethane |

## Standard equivalents

| | |
|---|---|
| 1 tonne of oil equivalent (toe) | $1 \times 10^{10}$ calories |
| $10^3$ toe | 41.868 TJ |
| 1 short ton | 0.9072 tonne |
| 1 tonne | 1.1023 short tons |
| 1 tonne | 1 megagram |
| 1 kilotonne | 1 gigagram |
| 1 megatonne | 1 teragram |
| 1 kilogram | 2.2046 lbs |
| 1 hectare | $10^4$ $m^2$ |
| 1 calorie $_{IT}$ | 4.1868 Joules |
| 1 atmosphere | 101.325 kPa |

## Units[1] and abbreviations

The following abbreviations are used in the *Guidelines*:

| | |
|---|---|
| cubic metre | $m^3$ |
| hectare | ha |
| gram | g |
| tonne | t |
| joule | J |
| degree Celsius | °C |
| calorie | cal |
| year | yr |
| capita | cap |
| gallon | gal |
| dry matter | dm |

[1] For decimal prefixes see previous page.

# 1 UNDERSTANDING THE COMMON REPORTING FRAMEWORK

*This chapter contains a listing, with definitions, of the categories you should use when reporting emissions and removals. The source/sink categories have been grouped into sectors as follows:*

- *Energy*
- *Industrial Processes*
- *Solvent and Other Product Use*
- *Agriculture*
- *Land-Use Change and Forestry*
- *Waste*

*The sectors and their source/sink categories are described and discussed in the chapters of the Reference Manual and the modules of the Workbook. This chapter also contains a brief explanation of the principles underlying the Sectoral Tables and Summary Report Tables for reporting national inventories.*

## 1.1 Source/sink categories

- Users of the *Revised 1996 IPCC Guidelines* are requested to estimate and report all anthropogenic emissions and removals of greenhouse gases. The numerous sources and sinks are categorised and described on the following pages. The source/sink categories are grouped into the major sectors shown overleaf. The proposed categories should cover most activities emitting or removing greenhouse gases. However, some countries may need to add activities to the "Other" sector in order to cover their particular circumstances. If so, then the nature of the activities should be carefully described so that the list of sectors and their source/sink categories can be updated by the IPCC at a later date.
- All activities are limited to anthropogenic activities and related emissions and removals.
- Recognising that the IPCC needs to accommodate other existing inventory programmes, Annex 2 *IPCC and CORINAIR Source Categories* provides details of correspondences with CORINAIR, a programme developed by the Commission of European Communities for use in Europe.

| | SECTORS | DESCRIPTION OF ACTIVITIES INCLUDED |
|---|---|---|
| | | |
| 1 | **ENERGY** | Total emission of all greenhouse gases from stationary and mobile energy activities (fuel combustion as well as fugitive fuel emissions). |
| 2 | **INDUSTRIAL PROCESSES** | Emissions within this sector comprise by-product or fugitive emissions of greenhouse gases from industrial processes. Emissions from fuel combustion in industry should be reported under Energy.<br><br>Emissions should, wherever possible, be reported according to the ISIC Group or Class within which they occur. |
| 3 | **SOLVENT AND OTHER PRODUCT USE** | This category pertains mainly to NMVOC emissions resulting from the use of solvents and other products containing volatile compounds. |
| 4 | **AGRICULTURE** | Describes all anthropogenic emissions from this sector, except for fuel combustion emissions and sewage emissions, which are covered in Energy and Waste modules. |
| 5 | **LAND-USE CHANGE & FORESTRY** | Total emissions and removals from forest and land-use change activities. |
| 6 | **WASTE** | Total emissions from waste management. |
| 7 | **OTHER** | Any other anthropogenic source or sink not referred to above (must be appropriately documented). |

| | | | | |
|---|---|---|---|---|
| **1 ENERGY** | | | | Total emission of all greenhouse gases from stationary and mobile energy activities (fuel combustion as well as fugitive fuel emissions).<br>Sum of categories 1 A & B. |
| 1 A | FUEL COMBUSTION ACTIVITIES | | | Total emissions of all greenhouse gases from all fuel combustion activities as described further below. $CO_2$ emissions from combustion of biomass fuels are **not** included in totals for the energy sector. They may not be net emissions if the biomass is sustainably produced. If biomass is harvested at an unsustainable rate (that is, faster than annual regrowth), net $CO_2$ emissions will appear as a loss of biomass stocks in the *Land-Use Change and Forestry* module. Other greenhouse gases from biomass fuel combustion **are** considered net emissions and are reported under *Energy*. (Sum of 1 A 1 to 1 A 5). Incineration of waste for waste-to-energy facilities should be reported here and not under Section 6C. Emissions based upon fuel for use on ships or aircraft engaged in international transport (1 A 3 a i and 1 A 3 d i) should, as far as possible, not be included in national totals but reported separately. |
| | 1 A 1 | | ENERGY INDUSTRIES | Comprises emissions from fuels combusted by the fuel extraction or energy-producing industries. |
| | 1 A 1 | a | Public Electricity and Heat Production | Sum of emissions from public electricity generation, public combined heat and power generation, and public heat plants. Public utilities are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included. Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity which supports their primary activity) should be assigned to the sector where they were generated and not under 1 A 1 a. Autoproducers may be in public or private ownership. |
| | | | *i Public Electricity Generation* | Comprises emissions from all fuel use for electricity generation except those from combined heat and power plants. |
| | | | *ii Public Combined Heat and Power Generation (CHP)* | Emissions from production of both heat and electrical power for sale to the public, at a single facility; co-generation plant. |
| | | | *iii Public Heat Plants* | Production of heat for sale by pipe network. |
| | 1 A 1 | b | Petroleum Refining | All combustion activities supporting the refining of petroleum products. Does not include evaporative emissions, which should be reported separately under 1 A 3 b v or 1 B 2 a below. |
| | 1 A 1 | c | Manufacture of Solid Fuels and Other Energy Industries | Combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal. Emissions from own on-site fuel use should be included. |
| | | c | *i Manufacture of Solid Fuels* | Emissions arising from fuel combustion for the production of coke, brown coal briquettes and patent fuel. |
| | | c | *ii Other Energy Industries* | Combustion emissions arising from the energy-producing industries own (on-site) energy use not mentioned above. This includes the emissions from own-energy use in coal mining and oil and gas extraction. Combustion emissions from pipeline transport should be reported under 1 A 3 e. |

| | | |
|---|---|---|
| 1 A 2 | MANUFACTURING INDUSTRIES AND CONSTRUCTION (ISIC - 3RD REVISION)[1] | Emissions from combustion of fuels in industry including combustion for the generation of electricity and heat. Emissions from autoproducers should be assigned to the sector where they were generated and an attempt made to separately identify the emissions associated with autogeneration from those associated with process heat. Emissions from fuel combustion in coke ovens within the iron and steel industry should be reported under 1 A 1 c and not within manufacturing industry. Emissions from the industry sector should be specified by subsectors that correspond to the International Standard Industrial Classification of All Economic Activities (ISIC). Energy used for transport by industry should not be reported here but under Transport (1 A 3 below). Emissions arising from off-road and other mobile machinery in industry should, if possible, be broken out as a separate subcategory. For each country, the emissions from the largest fuel-consuming industrial categories (ISIC) should be reported, as well as those from significant emitters of pollutants. A suggested list of categories is outlined below. |
| 1 A 2 | a Iron and Steel (ISIC Group 271 and Class 2731) | |
| 1 A 2 | b Non-Ferrous Metals (ISIC Group 272 and Class 2732) | |
| 1 A 2 | c Chemicals (ISIC Division 24) | |
| 1 A 2 | d Pulp, Paper and Print (ISIC Divisions 21 and 22) | |
| 1 A 2 | e Food Processing, Beverages and Tobacco (ISIC Divisions 15 and 16) | |
| 1 A 2 | f Other | The remaining emissions from fuel combustion in industry should be reported here. This also includes emissions from the construction branch. Please specify what is reported, as far as possible by ISIC categories. Care should be taken not to double count emissions from construction by including them also in Categories 1 A 3 e ii and/or 1 A 5. |
| 1 A 3 | TRANSPORT | Emissions from the combustion and evaporation of fuel for all transport activity, regardless of the sector, specified by subsectors as follows. Emissions from fuel sold to any air or marine vessel engaged in international transport (international bunker fuels) should as far as possible be excluded from the totals and subtotals in this category and should be reported separately. |
| 1 A 3 | a Civil Aviation | Emissions from international civil aviation and domestic air transport (commercial, private, agricultural, etc.), including take-offs and landings. Exclude use of fuel at airports for ground transport which is reported under 1 A 3 e *Other Transportation* (below). Also exclude fuel for stationary combustion at airports; report this information under the appropriate stationary combustion category. |
| | *i International Aviation (International Bunkers)* | Emissions which relate to fuel use for international civil aviation. Note that these emissions are to be excluded as far as possible from national totals but should be reported separately. (In other inventory methodologies, landing and take-off (LTO) cycle emissions are often considered as domestic emissions. For the purpose of greenhouse gas emissions inventories, fuel used during landing and take-off for an international flight stage is considered to be part of *International Bunkers* fuel use.) |
| | *ii Domestic* | Includes all civil domestic passenger and freight traffic inside a country (not used as international bunkers) and including take-offs and landings for these flight stages. |

[1] International Standard Industrial Classification of all Economic Activities, Series M No. 4, Rev. 3, United Nations, New York, 1990.

| | | | | |
|---|---|---|---|---|
| 1 A 3 | b | Road Transportation | | All combustion and evaporative emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on highways. |
| | | *i* | *Cars* | Automobiles designated primarily for transport of persons and having a capacity of 12 persons or fewer. Gross vehicle weight rating of 3900 kg or less. |
| | | | *Passenger cars with 3-way catalysts* | Passenger car emissions from vehicles with 3-way catalysts. |
| | | | *Passenger cars without 3-way catalysts* | Passenger car emissions from vehicles without 3-way catalysts. |
| | | *ii* | *Light Duty Trucks* | Vehicles with a gross vehicle weight of 3900 kg or less designated primarily for transportation of light-weight cargo or which are equipped with special features such as four-wheel drive for off-road operation. |
| | | | *Light duty trucks with 3-way catalysts* | Light Duty Truck emissions from vehicles with 3-way catalysts. |
| | | | *Light duty trucks without 3-way catalysts* | Light Duty Truck emissions from vehicles without 3-way catalysts. |
| | | *iii* | *Heavy Duty Trucks and Buses* | Any vehicle rated at more than 3900 kg gross vehicle weight or designed to carry more than 12 persons at a time. |
| | | *iv* | *Motorcycles* | Any motor vehicle designed to travel with not more than three wheels in contact with the ground and weighing less than 680 kg. |
| | | *v* | *Evaporative Emissions from Vehicles* | Evaporative emissions are included here (they are estimated with the same activity data as are used for estimating combustion emissions). |
| 1 A 3 | c | Railways | | Includes emissions from both freight and passenger traffic routes. |
| 1 A 3 | d | Navigation | | Emissions from fuels used to propel water-borne vessels, including hovercraft and hydrofoils. |
| | | *i* | *International Marine (Bunkers)* | Comprises emissions from fuels burned by sea-going ships of all flags that are engaged in international transport. These emissions should as far as possible be excluded from national totals and reported separately. |
| | | *ii* | *National Navigation* | Emissions from fuel used for navigation of all vessels not engaged in international transport, except fishing (which should be reported under 1 A 4 c iii). Note that this may include journeys of considerable length between two ports in a country (e.g. San Francisco to Honolulu). |
| 1 A 3 | e | | Other Transportation | Combustion emissions from all remaining transport activities including pipeline transportation, ground activities in airports and harbours, and off-road activities not otherwise reported under 1 A 4 c Agriculture or 1 A 2. Manufacturing Industries and Construction. Military transport should be reported under 1 A 5 (see 1 A 5 *Other*, below). |
| | | *i* | *Pipeline Transport* | |
| | | *ii* | *Off -road* | |

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|---|---|---|---|
| | 1 A 4 | OTHER SECTORS | Emission from combustion activities as described below. Emissions from autoproducers should be assigned to the sector where they were generated and an attempt made to separately identify the emissions associated with autogeneration from those associated with process heat. |
| | 1 A 4 a | Commercial / Institutional | Emission from fuel combustion in commercial and institutional buildings. (All activities included in ISIC categories 4103, 42, 6, 719, 72, 8, and 91-96). |
| | 1 A 4 b | Residential | All emissions from fuel combustion in households. |
| | 1 A 4 c | Agriculture / Forestry / Fishing | Emissions from fuel combustion in agriculture, forestry, or domestic inland, coastal and deep-sea fishing. This includes traction vehicles, pump fuel use, grain drying, horticultural greenhouses and other agriculture, forestry or fishing related fuel use. (Activities included in ISIC categories 05, 11, 12, 1302). Highway agricultural transportation is excluded. |
| | | i *Stationary* | |
| | | ii *Off-road Vehicles and Other Machinery* | |
| | | iii *Fishing* | |
| | 1 A 5 | OTHER (Not elsewhere specified) | All remaining emissions from non-specified fuel combustion. Include emissions from military fuel use. |
| | 1 A 5 a | Stationary | |
| | 1 A 5 b | Mobile | Vehicles and Other Machinery, Marine and Aviation (not included in 1 A 4 c ii or elsewhere). |
| 1 B | FUGITIVE EMISSIONS FROM FUELS | | Fugitive emissions are intentional or unintentional releases of gases from anthropogenic activities. In particular, they may arise from the production, processing, transmission, storage and use of fuels, and include emissions from combustion only where it does not support a productive activity (e.g., flaring of natural gases at oil and gas production facilities). Evaporative emissions from vehicles are included under Road Transport as Subsection 1 A 3 b v.<br>Sum of 1 B 1 & 1 B 2. |
| | 1 B 1 | SOLID FUELS | Total release of methane during coal mining and post-mining activities. Combustion emissions from colliery methane recovered and used should be excluded here and reported under Fuel Combustion Emissions. |
| | 1 B 1 a | Coal Mining | Total emissions from underground and surface mining and post-mining activities. |
| | | *i Underground Mines* | |
| | | *Mining activities* | Emissions from underground mines, brought to the surface by ventilation systems. |
| | | *Post-mining activities* | Emissions from coal after extraction from the ground, which occur during preparation, transportation, storage, or final crushing prior to combustion. |

| | | | |
|---|---|---|---|
| | | *ii Surface Mines* | Total emissions from surface mining and post-mining activities. |
| | | *Mining activities* | Emissions primarily from the exposed coal surfaces and coal rubble, but also emissions associated with the release of pressure on the coal. |
| | | *Post-mining ativities* | Emissions from coal after extraction from the ground, during preparation, transportation, storage, or final crushing prior to combustion. |
| 1 B 1 | b | Solid Fuel Transformation | Fugitive emissions arising during the manufacture of secondary and tertiary products from solid fuels. |
| 1 B 1 | c | Other | Fugitive emissions from fuel treatment plants not elsewhere specified. |
| 1 B 2 | | OIL AND NATURAL GAS | Total fugitive emissions from oil and gas activities. Fugitive emissions may arise from equipment exhaust (non-combustion), leakages, upsets and mishaps at any point in the chain from production through final use. Note also that emissions from flaring are included (the combustion is considered a non-productive activity). |
| 1 B 2 | a | Oil | |
| | | *i Exploration* | Fugitive emissions from oil exploration only. |
| | | *ii Production* | Fugitive emissions from the production of crude oil only. |
| | | *iii Transport* | Fugitive emissions resulting from the loading and unloading of crude oil from tankers. |
| | | *iv Refining/ Storage* | Fugitive emissions from the refining of oil and from storage in tanks. |
| | | *v Distribution of Oil Products* | Emissions (primarily NMVOCs) from transport and handling of oil products. |
| | | *vi Other* | |
| 1 B 2 | b | Natural Gas | |
| | | *i Production/ Processing* | Emissions from the production of gas, gas gathering systems and gas separation plants. |
| | | *ii Transmission/ Distribution* | Emissions from pipelines for long distance and local transport of methane, compressor stations and their maintenance facilities. |
| | | *iii Other leakage* | Release of gas at point of use, including residential, commercial, industrial and electricity generation users. |
| 1 B 2 | c | Venting and Flaring | The release and/or combustion of excess gas at facilities for the production of oil or gas and for the processing of gas. |
| | | *i Oil* | |
| | | *ii Gas* | |
| | | *iii Combined (in case oil and gas cannot be separated)* | |

| | | | |
|---|---|---|---|
| **2** | **INDUSTRIAL PROCESSES** | | Emissions within this sector comprise by-product or fugitive emissions of greenhouse gases from industrial processes. Emissions from fuel combustion in industry should be reported under Energy. In instances where industrial process emissions result jointly from chemical processes and fuel combustion it may be difficult to assign the emission(s) to either sector. Where the main purpose of the fuel combustion is to use the heat released, the resulting emissions should be assigned to the Energy sector.<br><br>Emissions should, wherever possible, be reported according to the ISIC Group or Class within which they occur. Certain methods in Chapter and Module 2, however, infer final GHG emissions from supply of the GHG, equipment containing it (for example, air conditioning equipment) or a stock material with which emissions are linked (for example, limestone). In these cases, assignment of emissions to ISIC activities may be difficult or incomplete. |
| 2 A | MINERAL PRODUCTS | | (ISIC[2] Division 26) |
| | 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 | |
| | 2 A 6 | ROAD PAVING WITH ASPHALT | |
| | 2 A 7 | OTHER | Please specify. |
| 2 B | CHEMICAL INDUSTRY | | (ISIC Division 24) |
| | 2 B 1 | AMMONIA PRODUCTION | |
| | 2 B 2 | NITRIC ACID PRODUCTION | |
| | 2 B3 | ADIPIC ACID PRODUCTION | |
| | 2 B 4 | CARBIDE PRODUCTION | |
| | 2 B 5 | OTHER | Please specify. |
| 2 C | METAL PRODUCTION | | (ISIC Division 27) |
| | 2 C 1 | IRON AND STEEL PRODUCTION | |

[2] International Standard Industrial Classification of all Economic Activities, Series M No. 4, Rev. 3, United Nations, New York, 1990.

| | | | |
|---|---|---|---|
| | 2 C 2 | FERROALLOYS PRODUCTION | |
| | 2 C 3 | ALUMINIUM PRODUCTION | |
| | 2 C 4 | $SF_6$ USED IN ALUMINIUM AND MAGNESIUM FOUNDRIES | |
| | 2 C 5 | OTHER | Please specify. |
| 2 D | OTHER PRODUCTION | | (ISIC Divisions 15 and 29) |
| | 2 D 1 | PULP AND PAPER | |
| | 2 D 2 | FOOD AND DRINK | |
| 2 E | PRODUCTION OF HALOCARBONS AND SULPHUR HEXAFLUORIDE | | (Possibly ISIC Class 2411 or 2429) |
| | 2 E 1 | BY-PRODUCT EMISSIONS | |
| | 2 E 2 | FUGITIVE EMISSIONS | |
| | 2 E 3 | OTHER | Please specify. |
| 2 F | CONSUMPTION OF HALOCARBONS AND SULPHUR HEXAFLUORIDE | | |
| | 2 F 1 | REFRIGERATION AND AIR CONDITIONING EQUIPMENT | |
| | 2 F 2 | FOAM BLOWING | |
| | 2 F 3 | FIRE EXTINGUISHERS | |
| | 2 F 4 | AEROSOLS | |
| | 2 F 5 | SOLVENTS | |
| | 2 F 6 | OTHER | Please specify. |
| 2 G | OTHER | | |

| | | |
|---|---|---|
| **3 SOLVENT AND OTHER PRODUCT USE** | | This category covers mainly NMVOC emissions resulting from the use of solvents and other products containing volatile compounds. When the solvents and other products are, or are produced from, petroleum products, the carbon in the NMVOC emissions will be included in the $CO_2$ inventory if the Reference Approach for $CO_2$ emissions from energy is used. See note on double counting in "Overview of the IPCC Guidelines". Emissions from the consumption of halocarbons and sulphur hexafluoride should be reported in the Industrial Processes Chapter under 2 F. All other non-energy emissions not included under Industrial Processes are reported here. |
| | 3 A PAINT APPLICATION | |
| | 3 B DEGREASING & DRY CLEANING | |
| | 3 C CHEMICAL PRODUCTS, MANUFACTURE & PROCESSING | |
| | 3 D OTHER | Includes use of $N_2O$ as a carrier gas, anaesthetic, and propellant. |

| | |
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| **4 AGRICULTURE** | Describes all anthropogenic emissions from this sector except for fuel combustion and sewage emissions, which are covered in Energy 1 A and Waste 6 B, respectively. Sum of all agriculture categories 4 A, B, C, D, E, F & G. |
| 4 A ENTERIC FERMENTATION | Methane production from herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. Both ruminant (e.g. cattle, sheep) and non-ruminant animals (e.g. pigs, horses) produce $CH_4$, although ruminants are the largest source (per unit of feed intake). |
| 4 A 1 CATTLE | |
| 4 A 1 a Dairy | Cattle producing milk for commercial exchange and calves and heifers being grown for dairy purposes. |
| 4 A 1 b Non-Dairy | All non-dairy cattle including: cattle kept or grown for meat production, draft animals, and breeding animals. |
| 4 A 2 BUFFALO | |
| 4 A 3 SHEEP | |
| 4 A 4 GOATS | |
| 4 A 5 CAMELS AND LLAMAS | |
| 4 A 6 HORSES | |
| 4 A 7 MULES AND ASSES | |
| 4 A 8 SWINE | |
| 4 A 9 POULTRY | |
| 4 A 10 OTHER | Please specify. |
| 4 B MANURE MANAGEMENT | Methane and nitrous oxide are produced from the decomposition of manure under low oxygen or anaerobic conditions. These conditions often occur when large numbers of animals are managed in a confined area (e.g. dairy farms, beef feedlots, and swine and poultry farms), where manure is typically stored in large piles or disposed of in lagoons and other types of manure management systems. Methane emissions are covered in Sections 4 B 1 to 4 B 9 and $N_2O$ emissions in Sections 4 B 10 to 4 B 12 below. |
| 4 B 1 CATTLE | |
| 4 B 1 a Dairy | |
| 4 B 1 b Non-Dairy | |
| 4 B 2 BUFFALO | |
| 4 B 3 SHEEP | |
| 4 B 4 GOATS | |
| 4 B 5 CAMELS AND LLAMAS | |
| 4 B 6 HORSES | |
| 4 B 7 MULES AND ASSES | |
| 4 B 8 SWINE | |
| 4 B 9 POULTRY | |

| | | | | |
|---|---|---|---|---|
| ` | | 4 B 10 | ANAEROBIC | |
| | | 4 B 11 | LIQUID SYSTEMS | |
| | | 4 B 12 | SOLID STORAGE AND DRYLOT | |
| | | 4 B 13 | OTHER | Please specify. |
| | 4 C | RICE CULTIVATION | | The anaerobic decomposition of organic material in flooded rice fields produces methane, which escapes to the atmosphere by ebullition (bubbling up) through the water column, diffusion across the water/air interface, and transport through the rice plants. It is suggested that these $CH_4$ emissions be based on lowland rice ecosystems without organic amendments relating to water regime, where lowland refers to fields flooded for a significant period of time. Correction factors for soils with organic amendments should be applied as necessary. Any $N_2O$ emissions from the use of nitrogen-based fertilisers in rice cultivation should be reported under 4 D *Agricultural Soils*. |
| | | 4 C 1 | IRRIGATED | Water regime is fully controlled. |
| | | 4 C 1 a | Continuously flooded | |
| | | 4 C 1 b | Intermittently flooded | |
| | | | *i Single aeration* | Fields have a single aeration during the cropping season at any growth stage. |
| | | | *ii Multiple aeration* | Fields have more than one aeration period during the cropping season. |
| | | 4 C 2 | RAINFED | Water regime depends solely on precipitation. |
| | | 4 C 2 a | Flood prone | The water level may rise up to 50 cm during the cropping season. |
| | | 4 C 2 b | Drought prone | Drought periods occur during every cropping season. |
| | | 4 C 3 | DEEPWATER | Floodwater rises to more than 50 cm for a significant period of time during the cropping season. |
| | | 4 C 3 a | Water depth 50-100 cm | Fields inundated with water depth from 50 - 100 cm. |
| | | 4 C 3 b | Water depth 100 cm | Fields inundated with water depth 100 cm. |
| | | 4 C 4 | OTHER | |
| | 4 D | AGRICULTURAL SOILS | | Emissions and removals of $CH_4$ and $N_2O$ from agricultural soil/land and NMVOCs from crops. These are influenced by irrigation practices, climatic variables, soil temperature and humidity. Any $N_2O$ emissions from the use of nitrogen-based fertilisers in rice cultivation should be reported here. $N_2O$ emissions may be related to the use of both organic and inorganic fertilisers, biological Nitrogen fixation, and return of crop residues to the field or to animal production. Non-$CO_2$ greenhouse gas emissions associated with the use of compost and human waste as fertilisers should also be recorded in this category. Emissions of $N_2O$ from sewage are to be reported under Waste (6 B) and $N_2O$ emissions from animal waste management systems other than grazing under manure management (4 B). Emissions of $N_2O$ from manure used for fuel are reported under the Energy Module (1 A). |

| | | |
|---|---|---|
| 4 E | PRESCRIBED BURNING OF SAVANNAS | Emissions of $CH_4$, CO, $N_2O$, and $NO_x$ from the burning of savannas*. Savannas are burned to control the growth of vegetation, remove pests and weeds, promote the nutrient cycle and to encourage the growth of new grass for animal grazing. $CO_2$ from savanna burning is noted for information but is not included in the inventory total since it is assumed that an equivalent amount of $CO_2$ is removed by regrowing vegetation in the following year.<br>*Savannas are tropical and subtropical formations with continuous grass cover, occasionally interrupted by trees and shrubs, which exist in Africa, Latin America, Asia, and Australia. |
| 4 F | FIELD BURNING OF AGRICULTURAL RESIDUES | Emission of non-$CO_2$ greenhouse gases from burning (in the field) of crop residue and other agricultural wastes on site. These include woody crop residues (e.g. coconut shells, jute sticks, etc.); cereal residues (e.g. rice and wheat straw, maize stalks, etc.); green crop residues (e.g. groundnut straw, soybean tops, etc.). The burning of agricultural waste for energy is excluded here but included under fuel combustion activities in Section 1 A. $CO_2$ from vegetal or biomass burning is noted for information but is not included in the inventory total, since it is assumed that a roughly equivalent amount of $CO_2$ is removed by regrowth of the next crop. |
| | 4 F 1 CEREALS | Emissions from the on-site burning of residue from cereal crops harvested for dry grain, including but not limited to wheat, barley, maize, oats, rye, rice, millet and sorghum. |
| | 4 F 2 PULSE | Emissions from the on-site burning of residue from pulse crops harvested for dry grain, including but not limited to pea, bean and soya. |
| | 4 F 3 TUBER AND ROOT | Emissions from the on-site burning of residue from tuber and root crops, including but not limited to potatoes, feedbeet, sugarbeet, girasol (Jerusalem artichoke) and peanut. |
| | 4 F 4 SUGAR CANE | Emissions from the on-site burning of sugar cane crop residue. |
| | 4 F 5 OTHER | Emissions from the on-site burning of residue from crops not included above. |
| 4G | OTHER | Describe each emission source/sink in detail. |

| | | | |
|---|---|---|---|
| **5** | **LAND-USE CHANGE & FORESTRY** | | Total emissions and removals from forest and land use change activities as described below. These activities have an impact on three different carbon sources/sinks: aboveground biomass, belowground biomass and soil carbon.<br>Sum of 5 A, B, C, D & E. |
| 5 A | CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS | | Emissions and removals of $CO_2$ from decreases or increases in biomass stocks due to forest management, logging, fuelwood collection, etc. The category is either a net source if biomass harvest/destruction exceeds regrowth in the inventory year, or a net sink if regrowth exceeds harvest/destruction. Include afforestation under 5 A 5. |
| | 5 A 1 | TROPICAL FORESTS | . |
| | 5 A 1 a | Wet/ very moist | |
| | 5 A 1 b | Moist, short dry season | |
| | 5 A 1 c | Moist, long dry season | |
| | 5 A 1 d | Dry | |
| | 5 A 1 e | Mountain moist | |
| | 5 A 1 f | Mountain dry | |
| | 5 A 1 g | Plantations | |
| | 5 A 1 h | Other | |
| | 5 A 2 | TEMPERATE FORESTS | . |
| | 5 A 2 a | Coniferous | |
| | 5 A 2 b | Broadleaf | |
| | 5 A 2 c | Plantations | |
| | 5 A 2 d | Other | |
| | 5 A 3 | BOREAL FORESTS | . |
| | 5 A 3 a | Mixed broadleaf/Coniferous | |
| | 5 A 3 b | Coniferous | |
| | 5 A 3 c | Forest tundra | |
| | 5 A 4 | GRASSLANDS/ TUNDRA | Emissions and removals of $CO_2$ from grasslands including tropical savanna and boreal tundra. |
| | 5 A 5 | OTHER | Emissions and removals of $CO_2$ from other biomass categories, including village and farm trees, etc.[3] |

[3] These categories are organised by ecosystem. The "Other" category is intended to account for biomass which is found in locations other than the major ecosystem types listed. This includes dispersed trees in villages, farms, urban areas, etc., and also includes additional ecosystem types which may be important for biomass accounting in specific countries. Afforestation programmes which create forests will be accounted for in the appropriate forest ecosystem category. Afforestation which produces dispersed trees, e.g., urban tree planting, would be accounted for in "Other."

| | | | | |
|---|---|---|---|---|
| 5 B | FOREST AND GRASSLAND CONVERSION<br>Time period is an important element in estimating emissions from many of these categories. For example, the IPCC default method recommends time periods of 10 years for biomass decay. | | | This category includes conversion of existing forests and natural grasslands to other land uses. Emissions of $CO_2$, $CH_4$, CO, $N_2O$, $NO_x$ and NMVOCs from the burning and decay of biomass. |
| | 5 B 1 | TROPICAL FORESTS | | |
| | 5 B 1 | a | Wet/very moist | |
| | 5 B 1 | b | Moist, short dry season | |
| | 5 B 1 | c | Moist, long dry season | |
| | 5 B 1 | d | Dry | |
| | 5 B 1 | e | Mountain moist | |
| | 5 B 1 | f | Mountain dry | |
| | 5 B 1 | g | Plantations | |
| | 5 B 1 | h | Other | |
| | 5 B 2 | TEMPERATE FORESTS | | |
| | 5 B 2 | a | Coniferous | |
| | 5 B 2 | b | Broadleaf | |
| | 5 B 2 | c | Plantations | |
| | 5 B 2 | d | Other | |
| | 5 B 3 | BOREAL FORESTS | | |
| | 5 B 3 | a | Mixed broadleaf/Coniferous | |
| | 5 B 3 | b | Coniferous | |
| | 5 B 3 | c | Forest tundra | |
| | 5 B 4 | GRASSLANDS/TUNDRA | | Emissions of $CO_2$ from grasslands including tropical savanna and boreal tundra. |
| | 5 B 5 | OTHER | | Emissions from conversion of ecosystem types (e.g. wastelands, desert, etc.) not otherwise covered in any of the above categories. |

| | | |
|---|---|---|
| 5 C | ABANDONMENT OF MANAGED LANDS | Removal of $CO_2$ from the abandonment of formerly managed lands (e.g. croplands and pastures). This category includes conversion of managed to abandoned lands. The categories below are determined by the type of biomass which regrows on the abandoned land. |
| | 5 C 1 TROPICAL FORESTS | |
| | 5 C 2 TEMPERATE FORESTS | |
| | 5 C 3 BOREAL FORESTS | |
| | 5 C 4 GRASSLANDS/TUNDRA | |
| | 5 C 5 OTHER | Removals from abandoned land regrown to any biomass type other than forests or grasslands. |
| 5 D | $CO_2$ EMISSIONS AND REMOVALS FROM SOIL | Emissions and removals of $CO_2$ in soil associated with land-use change and management. Includes $CO_2$ emissions from liming of agricultural soil. |
| 5 E | OTHER | Emissions and removals (sources and sinks) of $CO_2$ from land use or land-use change activities which can not be included under the categories provided above. Emissions of NMVOC from the living trees in managed forests and $N_2O$ or $CH_4$ emissions/removals from the soil of managed forests are reported here. Managed forests include all trees planted or managed by man for profit, pleasure, wind or water-erosion protection etc. |

| | | |
|---|---|---|
| **6 WASTE** | | Total emissions from solid waste disposal on land, wastewater, waste incineration and any other waste management activity. Any $CO_2$ emissions from fossil-based products (incineration or decomposition) should be accounted for here but see note on double counting under Section 2 "Reporting the National Inventory." $CO_2$ from organic waste handling and decay should not be included (see below).<br>Sum of 6 A, B, C & D. |
| 6 A | SOLID WASTE DISPOSAL ON LAND | Methane is produced from anaerobic microbial decomposition of organic matter in solid waste disposal sites. Carbon dioxide ($CO_2$) is also produced but only $CO_2$ from non-biologic or inorganic waste sources should be reported here. |
| 6 A 1 | MANAGED WASTE DISPOSAL ON LAND | A managed solid waste disposal site must have controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control fires) and will include at least one of the following: cover material; mechanical compaction; or levelling of the waste. |
| 6 A 2 | UNMANAGED WASTE DISPOSAL SITES | These are all other solid waste disposal sites that do not fall into the above category. |
| 6 A 3 | OTHER | Other solid waste disposal on land. |
| 6 B | WASTEWATER HANDLING | Methane and nitrous oxide are produced from anaerobic decomposition of organic matter by bacteria in sewage facilities and from food processing and other industrial facilities during wastewater handling. $N_2O$ may also be released from wastewater handling and human waste. Methane emissions are covered in 6 B 1 and 6 B 2, nitrous oxide emissions in 6 B 2. |
| 6 B 1 | INDUSTRIAL WASTEWATER | Handling of liquid wastes and sludge from industrial processes such as: food processing, textiles, or pulp and paper production. This may involve such things as wastewater collection and treatment, ponds, or discharge into surface water. |
| 6 B 2 | DOMESTIC AND COMMERCIAL WASTEWATER | Handling of liquid wastes and sludge from housing and commercial sources (including human waste) through: wastewater collection and treatment, open pits / latrines, ponds, or discharge into surface waters. $N_2O$ emissions from discharge of human sewage to aquatic environments are included here. |
| 6 B 3 | OTHER | |
| 6 C | WASTE INCINERATION | Incineration of waste, not including waste-to-energy facilities. Emissions from waste burnt for energy are reported under the Energy Module, 1 A. Emissions from burning of agricultural wastes should be reported under Section 4. All non-$CO_2$ greenhouse gases from incineration should be reported here as well as $CO_2$ from non-biological waste. |
| 6 D | OTHER | Release of greenhouse gases from other waste handling activities. |

| | |
|---|---|
| **7 OTHER** | Efforts should be made to fit all emission sources/sinks into the six categories described above. If it is impossible to do so, however, this category may be used, accompanied by a detailed explanation of the source/sink activity. |

## 1.2 Fuel Categories

Common terms and definitions of fuels are necessary for countries to describe emissions from fuel combustion activities consistently. A list of fuel types is provided below. Definitions for each of these fuels are given in the Glossary included in these *Reporting Instructions*. The list is organised into five major fuel types: liquid, solid, gas, biomass and other. It should be noted that "other fuels" are distinct from fuels listed in the biomass fuels category because they represent fuels that include biomass and non-biomass components.

**BASIC FUELS HIERARCHY**
**(Fuel Combustion Only)**

| **MAIN FUEL CATEGORIES** (Included in totals of greenhouse gases Sources) | | |
|---|---|---|
| *CATEGORY* | *SUBCATEGORY* | |
| LIQUID (Crude oil and petroleum products) | CRUDE OIL | |
| | ORIMULSION | |
| | NATURAL GAS LIQUIDS | |
| | GASOLINE | Motor Gasoline |
| | | Aviation Gasoline |
| | | Jet Gasoline |
| | (JET KEROSENE) | |
| | OTHER KEROSENE | |
| | SHALE OIL | |
| | GAS/DIESEL OIL | |
| | RESIDUAL FUEL OIL | |
| | LIQUEFIED PETROLEUM GAS | |
| | ETHANE | |
| | NAPHTHA | |
| | BITUMEN | |
| | LUBRICANTS | |
| | PETROLEUM COKE | |
| | REFINERY FEEDSTOCK | |
| | OTHER OIL | Refinery Gas |
| | | Paraffin Waxes |
| | | White Spirit |
| | | Other |

| *CATEGORY* | *SUBCATEGORY* |
|---|---|
| SOLID (Coal and coal products) | ANTHRACITE * |

| | | |
|---|---|---|
| | COKING COAL | |
| | OTHER BITUMINOUS COAL | |
| | SUB-BITUMINOUS COAL | |
| | LIGNITE | |
| | OIL SHALE | |
| | PEAT | |
| | COKE | Coke Oven Coke |
| | | Gas Coke |
| | BKB/PATENT FUEL | Patent Fuel |
| | | Brown Coal Briquettes |
| | DERIVED GASES | Gas Works Gas |
| | | Coke Oven Gas |
| | | Blast Furnace Gas |
| GAS | NATURAL GAS | |
| OTHER FUELS | MUNICIPAL SOLID WASTE (GARBAGE) | |
| | INDUSTRIAL WASTE | |
| BIOMASS<br>(Excluded from $CO_2$ emissions totals.) | SOLID | Wood/Wood Waste |
| | | Charcoal |
| | | Other Solid Biomass |
| | LIQUID | Bio-alcohol |
| | | Sulphur Lies (Black Liquor) |
| | GAS | Landfill Gas |
| | | Sludge Gas |
| TOTAL<br>(Primary fossil fuel supply) | | |

* If anthracite not separately identifiable, include with Other Bituminous Coal.

## 1.3 Reporting Major Sources at Differing Levels of Detail: Sectoral and Summary Report Tables.

The Sectoral and Summary Report Tables in this book allow the user to report the inventory at different aggregate levels of detail. There are six Sectoral Report Tables (Tables 1 to 6) to report emissions and removals at a more detailed sub-category level. The two Summary Report Tables (Tables 7A & 7B) are for aggregated emissions and removals, differing in their level of detail.

Some of the main features of the Sectoral and Summary Report Tables are summarised below.

Energy

- If a detailed, Sectoral Approach for energy has been used for the estimation of $CO_2$ from fuel combustion you are still asked to **complete and report the Worksheet 1-1 from the Reference Approach in the Workbook for verification purposes.**
- Total energy emissions from both the Reference and the Sectoral Approaches should be reported in the Sectoral and Summary Report Tables. **Do not add up $CO_2$ emissions calculated from both approaches**. An explanation of any significant differences between these results should be provided.
- Countries are asked to report emissions from international aviation and marine bunkers and $CO_2$ from biomass for energy under Memo Items. **Emissions from International Bunkers should <u>not</u> be included in national totals.** $CO_2$ emissions from the combustion of biomass fuels are accounted for in the Land-Use Change and Forestry Sector, if the wood has been produced unsustainably.

Industrial Processes

- HFCs, PFCs and $SF_6$ should be reported in two ways, as potential and actual emissions.

Notation Key

- As far as possible, countries should use the Sectoral and Summary Report Tables outlined in this document to summarise final inventory results. The notation shown in the key (see box) should be used to show where countries believe the identified source is zero (0). Where countries have opted not to estimate (NE) a particular source of each greenhouse gas, this should be shown. Data problems may limit the possibility of separating out each source individually; in this case it is included elsewhere (IE) and this should also be included in the table with a footnote indicating where the emission source/sink has been reported. Finally, countries may report a particular category as not occurring (NO) in their country.

| NOTATION KEY | |
|---|---|
| 0 | Source is estimated to be zero |
| NE | Not estimated |
| IE | Estimated but included elsewhere |
| NO | Not occurring |

Additional Gases

- To avoid duplication of effort, reporting of substances covered under the Montreal Protocol is not required. However, countries wishing to

report these substances and additional gases for completeness may do so, using the spare copies of the Summary Report Tables where the column headings have been left blank.

Overview

- The Overview Table (8A) should be used by countries to summarise their own assessment of completeness (e.g. partial, full estimate, not estimated) and quality (high, medium or low) of major source/sink inventory estimates. It gives a brief overview of the categories that have been taken into account in the emission inventory, as well as the level of documentation and disaggregation of the categories (see the Notation Key for a full explanation). The Disaggregation Key (8B) which follows the Overview Table gives a detailed explanation of the key used for the level of disaggregation for an inventory.

Data Completeness

- In all tables used by countries to summarise their inventory data, footnotes should be added to indicate if emission estimates are incomplete, or representative of only a part of the total activity, for any particular source or sink category. In this way countries are expected to report on the completeness of each individual emission estimate.

## 1.4 Worksheets

**Worksheets** are **essential** for **transparency** and reconstruction of the inventory.

**Remember to provide all worksheets, containing at least activity data and emission factors, used to prepare the inventory for each sector, along with Sectoral and Summary Report Tables.**

# 2 REPORTING THE NATIONAL INVENTORY

*This chapter contains step by step instructions for reporting a national greenhouse gas inventory.*

## How To Report Your Inventory

At the end of these reporting instructions you should have

- filled in the Sectoral Report Tables
- filled in the Summary Report and Overview Tables
- prepared an Inventory Report which contains the required numerical and text documentation (see step 5)

Do Step 1 if you have an existing inventory and would like to report it to the IPCC. If you are working from a completed CORINAIR inventory (see Annex 2). If you are using the *Workbook* methods and you now want to report your inventory, go directly to Step 2 to begin to fill out the Sectoral Report Tables.

Remember that the *Reference Manual (Volume 3)* contains background information and full explanations of the methodologies referred to here.

### STEP 1 REVIEW THE IPCC COMMON REPORTING FRAMEWORK

#### Inventory Scope

You are requested to provide a complete inventory for 1990. This should include all anthropogenic emissions by source and removals by sink of greenhouse gases and ozone precursors, except those covered by the Montreal Protocol.

You have the option to add other greenhouse gases or precursors to your inventory report. If you add other gases you should use the IPCC source category structure as far as possible. If you add or change the definitions of any categories to report these additional gases, you should clearly explain these changes. Use the spare copies of Tables 7A & 7B with blank column headings to report these emissions. Countries that wish to report Montreal Protocol substances for completeness may do so using this procedure.

#### Standard Units (pollutants, activity data and emission factors)

All estimates should be reported in gigagrams (Gg) of the pollutant. Preferred units for activity data, emission factors and other data are indicated in each of the worksheets of the *Workbook (Volume 2)*.

## Source/Sink Categories

Your emissions inventories should use the IPCC source/sink categories as far as possible. The structure for reporting inventory information is summarised in the preceding chapter and in the Tables in this book.

Compare the IPCC source/sink categories (Chapter 1: Understanding the Common Reporting Framework) with the categories already used in your national inventory. Where there are differences it may be possible to allocate a larger category among appropriate smaller IPCC categories. Alternatively, if there is no way to allocate the category, you could report several of your smaller categories at a higher level of aggregation in the IPCC structure. .

If your inventory cannot be re-structured to fit the IPCC model, or if you must show estimates under an "other" category, you should:

- explain precisely where there are differences and what they are, and
- explain precisely what is included in "other" categories.

## Time Periods

Inventories are prepared on a calendar year basis. In the Agriculture and Land-Use Change/Forestry categories, it may be desirable to estimate average emissions over a several year period. The *Workbook* methods describe default recommendations which are summarised in the table below.

TABLE 2-1
TIME PERIODS

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | PERIOD |
|---|---|
| 1 Energy | |
| A Fuel Combustion Activities | Yearly figures |
| B Fugitive Fuel Emission | Yearly figures |
| 2 Industrial Processes | Yearly figures<br>Previous yearly figures |
| 3 Solvent and Other Product Use | Yearly figures |
| 4 Agriculture | |
| A Enteric Fermentation | Three-year average |
| B Animal Wastes | Three-year average |
| C Rice Cultivation | Three-year average |
| D Agricultural Soils | Three-year average |
| E Prescribed Burning of Savannas | Three-year average |
| F Field Burning of Agricultural Residues | Three-year average |
| 5 Land-Use Change/Forestry | |
| A Changes in Forest and Other Woody Biomass Stocks | Three-year average |
| B Forest and Grassland Conversion<br>- Immediate release from on-site burning<br>- Delayed release from decay | <br>Three-year average<br>Previous 10 years average |
| C Abandonment of Managed Lands | Cumulative figures over previous 20 years<br>Total figures more than 20 years ago |
| D $CO_2$ Emissions and Removals from soil | Yearly figures<br>Previous 20 year figures |
| 6 Waste | Yearly figures |

Review these assumptions and be prepared to:

- explain if, and precisely where, your inventory has different time period assumptions, and
- explain the reasoning why the averaging periods were chosen.

## STEP 2 FILL IN THE SECTORAL AND SUMMARY REPORT TABLES

You should fill in Sectoral and Summary Report Tables for the main source/sink categories that you have included in your inventory. If your data do not conform to the IPCC source/sink category structure, you should

clearly footnote on the corresponding table(s) any differences and provide an explanation of the differences in the documentation note of the inventory. If you have estimated ranges of uncertainty for emission or supporting data, read Task (c) of this step before beginning.

**Task a: Complete Sectoral Report Tables.**

EITHER: transfer emission estimates data from worksheets

OR convert your existing inventory data into Sectoral Report format (Tables 1 to 6). As explained above under Step 1, this may require transforming your data to fit the IPCC source/sink category structure.

**CONVERTING CORINAIR INVENTORIES**

CORINAIR is one type of detailed inventory system. Guidance for converting a CORINAIR Inventory into an IPCC inventory is given in Annex 2.

**Task b: Complete Summary Report Tables.**

This is done by transferring data from the Sectoral Report Tables into Summary Report Tables 7A & 7B.

**Task c: Report Uncertainty Ranges**

An approach to estimating the uncertainty associated with point emission estimates and emission factors is described in Annex 1.

If you have ranges of uncertainty for point emission estimates by source/sink of greenhouse gas, as well as for emission factors or activity data, you can report the ranges by using the same Sectoral and Summary Report Tables. These tables should be in addition to the point estimates that are requested in Task (a) and (b) of this Step (above).

If you have ranges that you would like to report, please:

- make copies of the Sectoral or Summary Report Tables.
- mark them clearly with a heading "UNCERTAINTY RANGES" and the corresponding uncertainty area, e.g. EMISSION ESTIMATES, EMISSION FACTORS and/or ACTIVITY DATA.
- for each data point fill in the ranges if available.

## STEP 3 VERIFICATION

**Task a: Checking Results**

Countries are asked to carry out the following types of verification and summarise results (in text form) in the inventory report:

- checks for arithmetic errors
- checks of country estimates against independently published estimates
- checks of national activity data with international statistics (default data)
- checks of $CO_2$ emissions from fuel combustion calculated using national methods with the IPCC Reference Approach (see below).

Further verification checks that may be done centrally, or assisted centrally are:

- cross-country comparisons of estimates through use of a single set of source categories

- cross-country comparisons of emission factors

A more detailed sample set of questions for countries to consider in reviewing the quality of their own inventories is provided below.

**Verification**

In completing the inventory you should also make a report in which you summarise the verification procedures you have used. This report should include an overall assessment of the quality and completeness of each of the main source and sink estimates for each greenhouse gas. You should ask yourself the following questions about your inventory when attempting to provide an overall assessment of the inventory's quality and completeness.

**Method**

- Is the approach well documented and reproducible?
- Have results been checked against other methods of estimation?
- Are measurement data part of the estimate? If so, has the source activity been summarised in part (for the remaining non-measured part of the activity) and has it been summarised in total? Have you verified that the emissions from a given activity are not included in several source categories?

**Emission estimates**

- Have any estimates been compared with measured emission and concentration data?
- In some instances it is possible to cross-check emission estimates against roughly comparable statistics (e.g. for NMVOC, solvent production + imports - exports should equal total of applications). Have these checks been done and if so how do these data compare?
- Have results been compared for reasonableness with outside or independently published estimates? This could include comparison with estimates from a country of similar size or economic profile.

**Activity data assumptions**

- Does the level of activity reported cross-check reasonably well with other sources of information on this activity, e.g. with international statistics?
- Do units match emission factors reported?

**Emission factors**

- Do emission factors represent operating cycles or conditions from the region reporting?
- Are the sources of emission factors well documented? Are the conventions the same as those found in the activity data e.g. using net calorific value?
- Have emission factors been compared with other sources (taking into account technologies, maintenance, operating cycles, or other conditions that may influence emission factors)?

If you have already performed some verification, please describe what you did and what you found.

**Task b: $CO_2$ from Fuel Combustion - Standard Verification**

With respect to $CO_2$ emissions from energy, all users are asked to provide a standard set of information that will assist the verification process. This means that:

- Users who have estimated their $CO_2$ emissions from energy using the Reference Approach outlined in *Volume 2* of the *Guidelines* should include the worksheets used to estimate these emissions in the documentation submitted with their inventory.
- Users who have used their own methodology or the IPCC Sectoral Approach to estimate $CO_2$ emissions from energy should present the results of their work in the Sectoral Table for Energy provided in the Reporting Instructions, along with the worksheets used for calculations. They should also estimate their $CO_2$ emissions from energy using the Reference Approach provided in *Volume 2* of the *Guidelines*. It is recommended that users provide (in text form) an explanation for any significant differences between these two sets of results.

**Task c: Assessing Quality**

Prepare a brief self-assessment of the quality of the resulting inventory and of the verification that has been performed. A simplified format for reporting on the quality and completeness of the inventory is suggested in the Overview Table and Disaggregation Key (Tables 8A and 8B) in this book. This should be included with the other tables in the Inventory Report.

## STEP 4 DOCUMENTATION

Prepare text to accompany the inventory which should:

- describe any differences from IPCC source/sink category structure;
- describe any differences from IPCC default methods for the estimation of greenhouse gases and precursors;
- clearly describe the estimation methods, as well as major assumptions that may not have been captured in the worksheets , for all greenhouse gases contained in the inventory;
- provide complete references to all data sources used to construct the inventory;
- highlight any new or interesting data sources, references or research findings used to construct the inventory;
- describe any significant changes in emission factors and other assumptions from those used in previous inventories that have been submitted.

You are also invited to report any difficulties you faced in developing and reporting the inventory (e.g. lack of data, lack of resources etc.).

## STEP 5 ASSEMBLING AND TRANSMITTING THE INVENTORY

Assemble all elements of the National Inventory, including:

- Sectoral Report Tables
- Summary Report Tables
- Overview Table
- Uncertainty Estimates (if available)
- Written documentation
- Computer diskette containing data (if applicable)
- Any supporting documents

Mail the complete package to:

**IPCC/OECD/IEA PROGRAMME FOR NATIONAL GHG INVENTORY.**
**OECD, Environment Directorate**
**2, rue André-Pascal**
**75775 PARIS CEDEX 16**
**FRANCE**

**FAX: (33-1) 45 24 78 76**

### DOCUMENTATION STANDARDS

- National inventory reports should provide minimum information to enable the results to be reconstructed, and to justify the choice of methodology and data used. This means, for example, that to the extent possible, activity data should be provided at the level of detail at which the emissions are estimated.
- If worksheets from *Volume 2* of the *Guidelines* have been used to estimate greenhouse gas emissions in the inventory, these worksheets should be part of the documentation included in the inventory submission. Comparable worksheets should be provided when estimation procedures other than the IPCC Guidelines are used.
- Documentation should contain enough information to explain differences between national methods and data, and the IPCC default methods and assumptions. Reasons for the differences should be explained and sources of emission factors and other national data should also be clearly cited. Minimum requirements include: emission factors, activity data, and a list of references documenting any differences from IPCC recommend-ations.
- Measurement studies containing new values should be referenced, and made available upon request. It is preferable that new emission factors be taken from published sources.
- Any significant changes in emission factors and other assumptions from those used in previous inventories that have been submitted should be clearly referenced and explained.
- Documentation should be kept for future years (by the country and by the IPCC) and countries are encouraged to publish the documentation of their inventories. This extensive record keeping will facilitate the recalculation of historical inventory estimates when changes in national methods or assumptions occur.

# TABLES

| | |
|---|---|
| **Title of Inventory** | |
| **Contact Name** | |
| **Title** | |
| **Organisation** | |
| **Address** | |
| | |
| | |
| **Phone** | |
| **Fax** | |
| **E-Mail** | |
| **Is uncertainty addressed?** | |
| **Related documents filed with IPCC** | |

**ALL USERS SHOULD REPORT THEIR INVENTORY INFORMATION IN THE FORMAT PRESCRIBED BY THE FOLLOWING TABLES. USERS ARE, OF COURSE, REQUIRED TO FILL IN ONLY THOSE SPACES ON THE TABLES THAT RELATE TO THE GASES AND SOURCE/SINK CATEGORIES THEY HAVE ESTIMATED AND INCLUDED IN THEIR INVENTORY.**

REPORTING INSTRUCTIONS

Countries are urged to report data at least at the level of aggregation of the Sectoral Tables. The tables are based on the common source/sink categories found in Chapter 1 - Understanding the Common Reporting Framework of Volume 1 of the *Revised 1996 IPCC Guidelines*. In the event that country inventory methods differ drastically from IPCC methods and cannot be converted immediately, it is requested that a hard copy of the more detailed report be included with the submission, explaining the subsectors that were used and where differences lie.

Please provide completed copies of all Worksheets used to calculate the inventory.

# TABLE 1 SECTORAL REPORT FOR ENERGY

**(Sheet 1 of 3)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | |
|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
| **Total Energy** | | | | | | | |
| **A Fuel Combustion Activities** (Sectoral Approach) | | | | | | | |
| **1 Energy Industries** | | | | | | | |
| a Public Electricity and Heat Production | | | | | | | |
| b Petroleum Refining | | | | | | | |
| c Manufacture of Solid Fuels and Other Energy | | | | | | | |
| **2 Manufacturing Industries and Construction** | | | | | | | |
| a Iron and Steel | | | | | | | |
| b Non-Ferrous Metals | | | | | | | |
| c Chemicals | | | | | | | |
| d Pulp, Paper and Print | | | | | | | |
| e Food Processing, Beverages and Tobacco | | | | | | | |
| f Other (please specify) | | | | | | | |

# TABLE 1 SECTORAL REPORT FOR ENERGY

**(Sheet 2 of 3)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | |
|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
| **3 Transport** | | | | | | | |
| a Civil Aviation | | | | | | | |
| b Road Transportation | | | | | | | |
| c Railways | | | | | | | |
| d Navigation | | | | | | | |
| e Other (please specify) | | | | | | | |
| **4 Other Sectors** | | | | | | | |
| a Commercial/Institutional | | | | | | | |
| b Residential | | | | | | | |
| c Agriculture/Forestry/Fishing | | | | | | | |
| **5 Other (please specify)** | | | | | | | |
| **B Fugitive Emissions from Fuels** | | | | | | | |
| **1 Solid Fuels** | | | | | | | |
| a Coal Mining | | | | | | | |
| b Solid Fuel Transformation | | | | | | | |
| c Other (please specify) | | | | | | | |
| **2 Oil and Natural Gas** | | | | | | | |
| a Oil | | | | | | | |
| b Natural Gas | | | | | | | |
| c Venting and Flaring | | | | | | | |

# TABLE 1 SECTORAL REPORT FOR ENERGY

**(Sheet 3 of 3)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ |
| **Memo Items[1]:** | | | | | | | |
| **International Bunkers** | | | | | | | |
| Aviation | | | | | | | |
| Marine | | | | | | | |
| **$CO_2$ Emissions from Biomass** | | | | | | | |

1 Please do not include in energy totals.

# TABLE 2 SECTORAL REPORT FOR INDUSTRIAL PROCESSES

**(Sheet 1 of 2)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ | HFCs | | PFCs | | $SF_6$ | |
| | | | | | | | | P | A | P | A | P | A |
| **Total Industrial Processes** | | | | | | | | | | | | | |
| **A Mineral Products** | | | | | | | | | | | | | |
| 1 Cement Production | | | | | | | | | | | | | |
| 2 Lime Production | | | | | | | | | | | | | |
| 3 Limestone and Dolomite Use | | | | | | | | | | | | | |
| 4 Soda Ash Production and Use | | | | | | | | | | | | | |
| 5 Asphalt Roofing | | | | | | | | | | | | | |
| 6 Road Paving with Asphalt | | | | | | | | | | | | | |
| 7 Other (please specify) | | | | | | | | | | | | | |
| **B Chemical Industry** | | | | | | | | | | | | | |
| 1 Ammonia Production | | | | | | | | | | | | | |
| 2 Nitric Acid Production | | | | | | | | | | | | | |
| 3 Adipic Acid Production | | | | | | | | | | | | | |
| 4 Carbide Production | | | | | | | | | | | | | |
| 5 Other (please specify) | | | | | | | | | | | | | |
| **C Metal Production** | | | | | | | | | | | | | |
| 1 Iron and Steel Production | | | | | | | | | | | | | |
| 2 Ferroalloys Production | | | | | | | | | | | | | |
| 3 Aluminium Production | | | | | | | | | | | | | |
| 4 $SF_6$ Used in Aluminium and Magnesium Foundries | | | | | | | | | | | | | |
| 5 Other (please specify) | | | | | | | | | | | | | |

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach.

# TABLE 2 SECTORAL REPORT FOR INDUSTRIAL PROCESSES

**(Sheet 2 of 2)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ | HFCs | | PFCs | | $SF_6$ | |
| | | | | | | | | P | A | P | A | P | A |
| **D Other Production** | | | | | | | | | | | | | |
| 1 Pulp and Paper | | | | | | | | | | | | | |
| 2 Food and Drink | | | | | | | | | | | | | |
| **E Production of Halocarbons and Sulphur Hexafluoride** | | | | | | | | | | | | | |
| 1 By-product Emissions | | | | | | | | | | | | | |
| 2 Fugitive Emissions | | | | | | | | | | | | | |
| 3 Other (please specify) | | | | | | | | | | | | | |
| **F Consumption of Halocarbons and Sulphur Hexafluoride** | | | | | | | | | | | | | |
| 1 Refrigeration and Air Conditioning Equipment | | | | | | | | | | | | | |
| 2 Foam Blowing | | | | | | | | | | | | | |
| 3 Fire Extinguishers | | | | | | | | | | | | | |
| 4 Aerosols | | | | | | | | | | | | | |
| 5 Solvents | | | | | | | | | | | | | |
| 6 Other (please specify) | | | | | | | | | | | | | |
| **G Other (please specify)** | | | | | | | | | | | | | |

P = Potential emissions based on Tier 1 Approach. A= Actual emissions based on Tier 2 Approach.

# TABLE 3 SECTORAL REPORT FOR SOLVENT AND OTHER PRODUCT USE

**(Sheet 1 of 1)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | |
|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ | $N_2O$ | NMVOC |
| **Total Solvent and Other Product Use** | | | |
| **A Paint Application** | | | |
| **B Degreasing and Dry Cleaning** | | | |
| **C Chemical Products, Manufacture and Processing** | | | |
| **D Other (please specify)** | | | |

Please account for the quantity of carbon released in the form of NMVOC in both the NMVOC and the $CO_2$ columns.

Note: The *Revised 1996 IPCC Guidelines* do not provide methodologies for the calculation of emissions of $N_2O$ from solvent and other product use. If you have reported such data, you should provide additional information (activity data and emission factors) used to make these estimates.

# TABLE 4 SECTORAL REPORT FOR AGRICULTURE

**(Sheet 1 of 2)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | |
|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC |
| **Total Agriculture** | | | | | |
| **A Enteric Fermentation** | | | | | |
| 1 Cattle | | | | | |
| 2 Buffalo | | | | | |
| 3 Sheep | | | | | |
| 4 Goats | | | | | |
| 5 Camels and Llamas | | | | | |
| 6 Horses | | | | | |
| 7 Mules and Asses | | | | | |
| 8 Swine | | | | | |
| 9 Poultry | | | | | |
| 10 Other (please specify) | | | | | |
| **B Manure Management** | | | | | |
| 1 Cattle | | | | | |
| 2 Buffalo | | | | | |
| 3 Sheep | | | | | |
| 4 Goats | | | | | |
| 5 Camels and Llamas | | | | | |
| 6 Horses | | | | | |
| 7 Mules and Asses | | | | | |
| 8 Swine | | | | | |
| 9 Poultry | | | | | |

# TABLE 4 SECTORAL REPORT FOR AGRICULTURE

**(Sheet 2 of 2)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | |
|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC |
| **B Manure Management (cont...)** | | | | | |
| 10 Anaerobic | | | | | |
| 11 Liquid Systems | | | | | |
| 12 Solid Storage and Dry Lot | | | | | |
| 13 Other (please specify) | | | | | |
| **C Rice Cultivation** | | | | | |
| 1 Irrigated | | | | | |
| 2 Rainfed | | | | | |
| 3 Deep Water | | | | | |
| 4 Other (please specify) | | | | | |
| **D Agricultural Soils** | | | | | |
| **E Prescribed Burning of Savannas** | | | | | |
| **F Field Burning of Agricultural Residues** | | | | | |
| 1 Cereals | | | | | |
| 2 Pulse | | | | | |
| 3 Tuber and Root | | | | | |
| 4 Sugar Cane | | | | | |
| 5 Other (please specify) | | | | | |
| **G Other (please specify)** | | | | | |

Note: The *Revised IPCC 1996 Guidelines* do not provide methodologies for the calculation of $CH_4$ emissions, and $CH_4$ and $N_2O$ removals from agricultural soils, or $CO_2$ emissions from savanna burning or agricultural residues burning. If you have reported such data, you should provide additional information (activity data and emission factors) used to make these estimates.

# TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY

**(Sheet 1 of 1)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | |
|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ Emissions | $CO_2$ Removals | $CH_4$ | $N_2O$ | $NO_x$ | CO |
| **Total Land-Use Change and Forestry** | (1) | (1) | | | | |
| **A Changes in Forest and Other Woody Biomass Stocks** | (1) | (1) | | | | |
| 1 Tropical Forests | | | | | | |
| 2 Temperate Forests | | | | | | |
| 3 Boreal Forests | | | | | | |
| 4 Grasslands/Tundra | | | | | | |
| 5 Other (please specify) | | | | | | |
| **B Forest and Grassland Conversion** | (1) | (1) | | | | |
| 1 Tropical Forests | | | | | | |
| 2 Temperate Forests | | | | | | |
| 3 Boreal Forests | | | | | | |
| 4 Grasslands/Tundra | | | | | | |
| 5 Other (please specify) | | | | | | |
| **C Abandonment of Managed Lands** | (1) | (1) | | | | |
| 1 Tropical Forests | | | | | | |
| 2 Temperate Forests | | | | | | |
| 3 Boreal Forests | | | | | | |
| 4 Grasslands/Tundra | | | | | | |
| 5 Other (please specify) | | | | | | |
| **D $CO_2$ Emissions and Removals from Soil** | (1) | (1) | | | | |
| **E Other (please specify)** | | | | | | |

(1) Please do not provide an estimate of both $CO_2$ emissions and $CO_2$ removals. You should estimate "net" emissions of $CO_2$ and place a single number in either the $CO_2$ emissions or $CO_2$ removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

# TABLE 6 SECTORAL REPORT FOR WASTE

**(Sheet 1 of 1)**

| SECTORAL REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | |
|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ [1] | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC |
| **Total Waste** | | | | | | |
| **A Solid Waste Disposal on Land** | | | | | | |
| 1 Managed Waste Disposal on Land | | | | | | |
| 2 Unmanaged Waste Disposal Sites | | | | | | |
| 3 Other (please specify) | | | | | | |
| **B Wastewater Handling** | | | | | | |
| 1 Industrial Wastewater | | | | | | |
| 2 Domestic and Commercial Wastewater | | | | | | |
| 3 Other (please specify) | | | | | | |
| **C Waste Incineration** | | | | | | |
| **D Other (please specify)** | | | | | | |

[1] Note that $CO_2$ from waste disposal and incineration should only be included if it stems from non-biological or inorganic waste sources.

# TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

**(Sheet 1 of 3)**

| SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ Emissions | $CO_2$ Removals | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ | HFCs | | PFCs | | $SF_6$ | |
| | | | | | | | | | P | A | P | A | P | A |
| **Total National Emissions and Removals** | | | | | | | | | | | | | | |
| **1 Energy** | | | | | | | | | | | | | | |
| A Fuel Combustion (Sectoral Approach) | | | | | | | | | | | | | | |
| 1 Energy Industries | | | | | | | | | | | | | | |
| 2 Manufacturing Industries and Construction | | | | | | | | | | | | | | |
| 3 Transport | | | | | | | | | | | | | | |
| 4 Other Sectors | | | | | | | | | | | | | | |
| 5 Other (please specify) | | | | | | | | | | | | | | |
| B Fugitive Emissions from Fuels | | | | | | | | | | | | | | |
| 1 Solid Fuels | | | | | | | | | | | | | | |
| 2 Oil and Natural Gas | | | | | | | | | | | | | | |
| **2 Industrial Processes** | | | | | | | | | | | | | | |
| A Mineral Products | | | | | | | | | | | | | | |
| B Chemical Industry | | | | | | | | | | | | | | |
| C Metal Production | | | | | | | | | | | | | | |
| D Other Production | | | | | | | | | | | | | | |
| E Production of Halocarbons and Sulphur Hexafluoride | | | | | | | | | | | | | | |
| F Consumption of Halocarbons and Sulphur Hexafluoride | | | | | | | | | | | | | | |
| G Other (please specify) | | | | | | | | | | | | | | |

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach.

# TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

**(Sheet 2 of 3)**

| SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ Emissions | $CO_2$ Removals | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ | HFCs | | PFCs | | $SF_6$ | |
| | | | | | | | | | P | A | P | A | P | A |
| **3 Solvent and Other Product Use** | | | | | | | | | | | | | | |
| **4 Agriculture** | | | | | | | | | | | | | | |
| A Enteric Fermentation | | | | | | | | | | | | | | |
| B Manure Management | | | | | | | | | | | | | | |
| C Rice Cultivation | | | | | | | | | | | | | | |
| D Agricultural Soils | (1) | (1) | | | | | | | | | | | | |
| E Prescribed Burning of Savannas | | | | | | | | | | | | | | |
| F Field Burning of Agricultural Residues | | | | | | | | | | | | | | |
| G Other (please specify) | | | | | | | | | | | | | | |
| **5 Land-Use Change & Forestry** | (1) | (1) | | | | | | | | | | | | |
| A Changes in Forest and Other Woody Biomass Stocks | (1) | (1) | | | | | | | | | | | | |
| B Forest and Grassland Conversion | | | | | | | | | | | | | | |
| C Abandonment of Managed Lands | (1) | (1) | | | | | | | | | | | | |
| D $CO_2$ Emissions and Removals from Soil | (1) | (1) | | | | | | | | | | | | |
| E Other (please specify) | | | | | | | | | | | | | | |
| **6 Waste** | | | | | | | | | | | | | | |
| A Solid Waste Disposal on Land | | | | | | | | | | | | | | |
| B Wastewater Handling | | | | | | | | | | | | | | |
| C Waste Incineration | | | | | | | | | | | | | | |
| D Other (please specify) | | | | | | | | | | | | | | |
| **7 Other (please specify)** | | | | | | | | | | | | | | |

# TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

**(Sheet 3 of 3)**

| SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CO_2$ Emissions | $CO_2$ Removals | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ | HFCs | | PFCs | | $SF_6$ | |
| | | | | | | | | | P | A | P | A | P | A |
| **Memo Items:** | | | | | | | | | | | | | | |
| **International Bunkers** | | | | | | | | | | | | | | |
| Aviation | | | | | | | | | | | | | | |
| Marine | | | | | | | | | | | | | | |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | | | | | | |

(1) Please do not provide an estimate of both $CO_2$ emissions and $CO_2$ removals. You should estimate "net" emissions of $CO_2$ and place a single number in either the $CO_2$ emissions or $CO_2$ removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

# TABLE 7B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

**(Sheet 1 of 1)**

| SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ Emissions | $CO_2$ Removals | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | $SO_2$ | HFCs | | PFCs | | $SF_6$ | |
| | | | | | | | | | | P | A | P | A | P | A |
| **Total National Emissions and Removals** | | | | | | | | | | | | | | | |
| **1 Energy** | Reference Approach(1) | | | | | | | | | | | | | | |
| | Sectoral Approach(1) | | | | | | | | | | | | | | |
| A Fuel Combustion | | | | | | | | | | | | | | | |
| B Fugitive Emissions from Fuels | | | | | | | | | | | | | | | |
| **2 Industrial Processes** | | | | | | | | | | | | | | | |
| **3 Solvent and Other Product Use** | | | | | | | | | | | | | | | |
| **4 Agriculture** | | | | | | | | | | | | | | | |
| **5 Land-Use Change & Forestry** | | (2) | (2) | | | | | | | | | | | | |
| **6 Waste** | | | | | | | | | | | | | | | |
| **7 Other (please specify)** | | | | | | | | | | | | | | | |
| **Memo Items:** | | | | | | | | | | | | | | | |
| **International Bunkers** | | | | | | | | | | | | | | | |
| Aviation | | | | | | | | | | | | | | | |
| Marine | | | | | | | | | | | | | | | |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | | | | | | | |

P = Potential emissions based on Tier 1 Approach. A = Actual emissions based on Tier 2 Approach.

(1) For verification purposes, countries are asked to report the results of their calculations using the Reference Approach and explain any differences with the Sectoral Approach. Do not include the results of both the Reference Approach and the Sectoral Approach in national totals.

(2) Please do not provide an estimate of both $CO_2$ emissions and $CO_2$ removals. You should estimate "net" emissions of $CO_2$ and place a single number in either the $CO_2$ emissions or $CO_2$ removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

# TABLE 8A OVERVIEW TABLE FOR NATIONAL GREENHOUSE GAS INVENTORIES

**(Sheet 1 of 3)**

| OVERVIEW TABLE | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ | | $CH_4$ | | $N_2O$ | | $NO_x$ | | CO | | NMVOC | | $SO_2$ | | HFCs | | PFCs | | $SF_6$ | | Documen-tation | Disaggrega-tion | Footnotes |
| | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | | | |
| **Total National Emissions and Removals** | | | | | | | | | | | | | | | | | | | | | | | |
| **1 Energy** | | | | | | | | | | | | | | | | | | | | | | | |
| A Fuel Combustion Activities | | | | | | | | | | | | | | | | | | | | | | | |
| Reference Approach | | | | | | | | | | | | | | | | | | | | | | | |
| Sectoral Approach | | | | | | | | | | | | | | | | | | | | | | | |
| 1 Energy Industries | | | | | | | | | | | | | | | | | | | | | | | |
| 2 Manufacturing Industries and Construction | | | | | | | | | | | | | | | | | | | | | | | |
| 3 Transport | | | | | | | | | | | | | | | | | | | | | | | |
| 4 Other Sectors | | | | | | | | | | | | | | | | | | | | | | | |
| 5 Other (please specify) | | | | | | | | | | | | | | | | | | | | | | | |
| B Fugitive Emissions from Fuels | | | | | | | | | | | | | | | | | | | | | | | |
| 1 Solid Fuels | | | | | | | | | | | | | | | | | | | | | | | |
| 2 Oil and Natural Gas | | | | | | | | | | | | | | | | | | | | | | | |
| **2 Industrial Processes** | | | | | | | | | | | | | | | | | | | | | | | |
| A Mineral Products | | | | | | | | | | | | | | | | | | | | | | | |
| B Chemical Industry | | | | | | | | | | | | | | | | | | | | | | | |
| C Metal Production | | | | | | | | | | | | | | | | | | | | | | | |
| D Other Production | | | | | | | | | | | | | | | | | | | | | | | |
| E Production of Halocarbons and Sulphur Hexafluoride | | | | | | | | | | | | | | | | | | | | | | | |

# TABLE 8A OVERVIEW TABLE FOR NATIONAL GREENHOUSE GAS INVENTORIES

**(Sheet 2 of 3)**

| OVERVIEW TABLE | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CO_2$ | | $CH_4$ | | $N_2O$ | | $NO_x$ | | CO | | NMVOC | | $SO_2$ | | HFCs | | PFCs | | $SF_6$ | | Documen-tation | Disaggre-gation | Footnotes |
| | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | | | |
| **Industrial Processes (cont...)** | | | | | | | | | | | | | | | | | | | | | | | |
| F Consumption of Halocarbons and Sulphur Hexafluoride | | | | | | | | | | | | | | | | | | | | | | | |
| Potential [1] | | | | | | | | | | | | | | | | | | | | | | | |
| Actual [2] | | | | | | | | | | | | | | | | | | | | | | | |
| G Other (please specify) | | | | | | | | | | | | | | | | | | | | | | | |
| **3 Solvent and Other Product Use** | | | | | | | | | | | | | | | | | | | | | | | |
| **4 Agriculture** | | | | | | | | | | | | | | | | | | | | | | | |
| A Enteric Fermentation | | | | | | | | | | | | | | | | | | | | | | | |
| B Manure Management | | | | | | | | | | | | | | | | | | | | | | | |
| C Rice Cultivation | | | | | | | | | | | | | | | | | | | | | | | |
| D Agricultural Soils | | | | | | | | | | | | | | | | | | | | | | | |
| E Prescribed Burning of Savannas | | | | | | | | | | | | | | | | | | | | | | | |
| F Field Burning of Agricultural Residues | | | | | | | | | | | | | | | | | | | | | | | |
| G Other (please specify) | | | | | | | | | | | | | | | | | | | | | | | |
| **5 Land-Use Change & Forestry** | | | | | | | | | | | | | | | | | | | | | | | |
| A Changes in Forest and Other Woody Biomass Stocks | | | | | | | | | | | | | | | | | | | | | | | |
| B Forest and Grassland Conversion | | | | | | | | | | | | | | | | | | | | | | | |

[1] Potential emissions based on Tier 1 Approach.

[2] Actual emissions based on Tier 2 Approach.

# TABLE 8A OVERVIEW TABLE FOR NATIONAL GREENHOUSE GAS INVENTORIES

**(Sheet 3 of 3)**

| OVERVIEW TABLE | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | $CO_2$ | | $CH_4$ | | $N_2O$ | | $NO_x$ | | CO | | NMVOC | | $SO_2$ | | HFCs | | PFCs | | $SF_6$ | | Documen-tation | Disaggre-gation | Footnotes |
| | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | Estimate | Quality | | | |
| **5 Land-Use Change & Forestry (cont....)** | | | | | | | | | | | | | | | | | | | | | | | |
| C Abandonment of Managed Lands | | | | | | | | | | | | | | | | | | | | | | | |
| D $CO_2$ Emissions and Removals from Soil | | | | | | | | | | | | | | | | | | | | | | | |
| E Other (please specify) | | | | | | | | | | | | | | | | | | | | | | | |
| **6 Waste** | | | | | | | | | | | | | | | | | | | | | | | |
| A Solid Waste Disposal on Land | | | | | | | | | | | | | | | | | | | | | | | |
| B Wastewater Handling | | | | | | | | | | | | | | | | | | | | | | | |
| C Waste Incineration | | | | | | | | | | | | | | | | | | | | | | | |
| D Other (please specify) | | | | | | | | | | | | | | | | | | | | | | | |
| **7 Other (please specify)** | | | | | | | | | | | | | | | | | | | | | | | |
| **Memo Items:** | | | | | | | | | | | | | | | | | | | | | | | |
| **International Bunkers** | | | | | | | | | | | | | | | | | | | | | | | |
| Aviation | | | | | | | | | | | | | | | | | | | | | | | |
| Marine | | | | | | | | | | | | | | | | | | | | | | | |
| **$CO_2$ Emissions from Biomass** | | | | | | | | | | | | | | | | | | | | | | | |

| NOTATION KEY FOR OVERVIEW TABLE | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Estimates** | | **Quality** | | **Documentation** | | **Disaggregation *** | |
| *code* | *Meaning* | *code* | *Meaning* | *code* | *Meaning* | *code* | *Meaning* |
| **PART** | Partly estimated | **H** | High Confidence in Estimation | **H** | High (all background information included) | **1** | Total emissions estimated |
| **ALL** | Full estimate of all possible sources | **M** | Medium Confidence in Estimation | **M** | Medium (some background information included) | **2** | Sectoral split |
| **NE** | Not estimated | **L** | Low Confidence in Estimation | **L** | Low (only emission estimates included) | **3** | Subsectoral split |
| **IE** | Estimated but included elsewhere | | | | | | |
| **NO** | Not occurring | | | | | | |
| **NA** | Not applicable | | | | | | |
| * See following table for a complete explanation of each code. | | | | | | | |

# TABLE 8B EXPLANATION OF DISAGGREGATION KEY FOR OVERVIEW TABLE

**(Sheet 1 of 2)**

| DISAGGREGATION KEY FOR OVERVIEW TABLE | | | | |
|---|---|---|---|---|
| Disaggregation 1 | Disaggregation 2 | | Disaggregation 3 | |
| Total National Emissions and Removals | | | | |
| 1 Energy | | | | |
| 1 A Fuel Combustion | 1 A 1 to 1 A 5 | Energy Industries to Other | 1 A | Any Subsectors of 1 A 1 to 1 A 5. For example, rail transport or industry sectors |
| 1 B Fugitive Emissions from Fuels | 1 B 1 | Solid Fuels | 1 B | Any further breakdown, for example gas venting or post-mining activities |
| | 1 B 2 | Oil and Natural Gas | | |
| 2 Industrial Processes | 2A | Mineral Product | 2 | Any further quantitative breakdown by industrial sector, for example, paper, nitric acid, cement |
| | 2 B | Chemical Industry | | |
| | 2 C | Metal Production | | |
| | 2 D | Other Production | | |
| | 2 E | Production of Halocarbons and Sulphur Hexaflouride | | |
| | 2F | Consumption of Halocarbons and Sulphur Hexaflouride | | |
| | 2G | Other | | |
| 3 Solvent and Other Product Use | 3 A to 3 D | | 3 | Any further quantitative breakdown by product |
| 4 Agriculture | | | | |
| 4 A Enteric Fermentation | 4 A | | 4 A | Animal types e.g. cattle, goats |
| 4 B Manure Management | 4 B | | 4 B | |
| 4 C Rice Cultivation | 4 C | | 4 C | Any further quantitative breakdown |
| 4 D Agricultural Soils | 4 D | Breakdown by type of fertiliser or another characteristic | 4 D | Several characteristics taken into account, such as type of fertiliser, soil, crop or area |
| 4 E Prescribed Burning of Savannas | 4 E | | 4 E | |
| 4 F Field Burning of Agricultural Residues | 4 F | | 4 F | Any further quantitative breakdown |
| 4 G Other | 4 G | | 4 G | |
| 5 Land-Use Change & Forestry | 5 A | Changes in Forests and other Woody Biomass Stocks | 5 A | Any further quantitative breakdown, e.g. by type of forest. |
| | 5 B | Forest and Grassland Conversion | 5 B | |
| | 5 C | Abandonment of Managed Land | 5 C | |

# TABLE 8B EXPLANATION OF DISAGGREGATION KEY FOR OVERVIEW TABLE

**(Sheet 2 of 2)**

| DISAGGREGATION KEY FOR OVERVIEW TABLE | | | | |
|---|---|---|---|---|
| Disaggregation 1 | Disaggregation 2 | | Disaggregation 3 | |
| Land-Use Change & Forestry (cont....) | 5 D | $CO_2$ Emissions and Removals from Soil | 5 D | |
| | 5 E | Other | 5 E | |
| 6 Waste | 6 A | Solid Waste Disposal on Land | 6 A | Any further quantitative breakdown. |
| | 6 B | Wastewater Handling | 6 B | |
| | 6 C | Waste Incineration | 6 C | |
| | 6 D | Other | 6 D | |
| 7 Other | 7 | | 7 | |

# ANNEX I
# MANAGING UNCERTAINTIES

*Uncertainties are inevitable in any estimate of national emissions or removals. Some important causes of uncertainty are:*

- *differing interpretations of source and sink category or other definitions, assumptions, units etc.*
- *use of simplified representations with "averaged" values, especially emission factors and related assumptions to represent characteristics of a given population*
- *uncertainty in the basic socio-economic activity data which drives the calculations*
- *inherent uncertainty in the scientific understanding of the basic processes leading to emissions and removals.*

*A major objective of the IPCC methodology is to help national experts reduce uncertainty in their greenhouse gas inventories to the minimum level possible. However, the approach also recognises that significant uncertainties will remain despite these efforts, and that these uncertainties will vary widely:*

- *between different greenhouse gases*
- *between source categories for each gas*
- *between countries reporting the same gases and sources (depending on approach, levels of detail, use of default or country specific data etc.)*

*It is important to provide as thorough an understanding as possible of the uncertainties involved when estimates are provided for scientific or policy uses. A simple method for expressing the confidence or uncertainty of point estimates* qualitatively *is given elsewhere in the Reporting Instructions. However it is more useful to express uncertainty* quantitatively *and systematically in the form of well developed confidence intervals. This Annex provides some initial suggestions for developing quantitative uncertainty information. However, at present, it is only possible to provide a conceptual framework which relies on users to supply statistical data or equivalent expert judgement. IPCC/OECD consider the consistent estimation of uncertainty to be critically important, and will make it the focus of future work. Individual experts are encouraged to estimate uncertainty ranges as well as possible and to report results with their inventories. This will be of assistance with the ongoing work of developing methods.*

## A1.1 Sources of Uncertainty

### Definitions

Use of the IPCC *Reporting Instructions* will minimise variability or uncertainty which would otherwise be introduced by issues of definition. The IPCC *Reporting Instructions* provides common definitions of source categories and

other terms, units, procedures, etc. The source categories are set out in Chapter 1 Understanding the Common Reporting Framework.

## Estimation Methodology

The IPCC/OECD programme has sought consensus among researchers, sectoral interest groups and national technical experts on the best practicable default estimation procedures for priority gases and sources. These default methodologies are described in Volume 2 of the *Guidelines*, the *Greenhouse Gas Inventory Workbook*. By using these methods countries can minimise variations or uncertainties in national estimates which would be introduced by a *choice* of methodology. However, it must be recognised that default methods represent a compromise between the level of detail which would be needed to create the most accurate estimates for each country and the input data likely to be available or readily obtainable in most countries. In many cases, the simplest default methods are simplifications with general default values which introduce large uncertainties into a national estimate. Within many of the default methods different optional levels of detail are provided to reflect whether users have detailed data for their national situation or have to rely strictly on general default values. There may be considerable variation in how well the general default values represent conditions of the actual population of source activities in a particular country. For example, the uncertainty relating to default carbon emission coefficients for the global population of fossil fuel combustion sources may be characterised as quite low (5-10 per cent) in the IPCC methodology; but national experts for a particular country may know that the characteristics of such fuels in their country vary widely from global average values. In such a country, use of default values would introduce a larger uncertainty. Thus, even for the simplest application of the default methods, it is not possible to provide general uncertainty values for all countries.

The *Reference Manual* provides more options, including ways of doing calculations at greater levels of detail and, in some cases, alternative methodologies. Users of the IPCC *Guidelines* may use their own methodologies if they believe these will provide more accurate results for their national situation. Alternative methods should be carefully documented and results reported in the standard IPCC source and sink categories. Documentation of alternative methods may involve presentation of new empirical data which may in turn provide a basis for the improvement of the default procedures and data. However, whichever methods are used - default methods, more detailed versions of default methods, or entirely different methods - users should determine as far as possible the ranges of uncertainty introduced by the emission factors and other input assumptions used, whatever their source.

## Socio-economic Activity Data

The IPCC default methodologies identify activity data from international socio-economic data series wherever possible. International compilations of socio-economic activity data do not generally include quantitative uncertainty estimates around country-level data summaries. Some of the national sources that provide data to the international series may have

quantified uncertainty for their own national data. As with uncertainty in methodology and emission factors, the inventory developers must judge the quality of activity data used in their own national inventory.

## Underlying Scientific Understanding

Current scientific understanding of the various human-induced processes which lead to emissions and removals of greenhouse gases to and from the atmosphere is incomplete. In some cases, where substantial measurement data exist and have been thoroughly analysed, this understanding provides a basis for accurate calculations of global and national emissions. In many cases, however, data and analysis have not attained this state. This variation affects the uncertainty inherent in the various components of the default methods, as well as the estimates using other methodologies. Table A1-1 provides an *illustrative* assessment of the relative uncertainties in the scientific basis for global emission estimates for some key components of the IPCC methodology. The overall uncertainty ranges shown here are based on an interpretation of the uncertainty information presented by the IPCC (1992). The allocation of overall uncertainty to the emission factor and activity data components has been made for illustrative purposes only on the basis of judgement by the IPCC/OECD technical staff. These values should not be used for estimating uncertainty for a particular national inventory. They are provided to assist users of the *Guidelines* to consider relative uncertainties in the basic science underlying different components of their inventories.

TABLE A1-1
UNCERTAINTIES DUE TO EMISSION FACTORS AND ACTIVITY DATA

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Gas** | **Source category** | **Emission factor** $U_E$ | **Activity data** $U_A$ | **Overall uncertainty** $U_T$ |
| $CO_2$ | Energy | 7% | 7% | 10% |
| $CO_2$ | Industrial Processes | 7% | 7% | 10% |
| $CO_2$ | Land Use Change and Forestry | 33% | 50% | 60% |
| $CH_4$, | Biomass Burning | 50% | 50% | 100% |
| $CH_4$ | Oil and Nat. Gas Activities | 55% | 20% | 60% |
| $CH_4$ | Coal Mining and Handling Activities | 55% | 20% | 60% |
| $CH_4$ | Rice Cultivation | $^3/_4$ | $^1/_4$ | 1 |
| $CH_4$ | Waste | $^2/_3$ | $^1/_3$ | 1 |
| $CH_4$ | Animals | 25% | 10% | 25% |
| $CH_4$ | Animal waste | 20% | 10% | 20% |
| $N_2O$ | Industrial Processes | 35% | 35% | 50% |
| $N_2O$ | Agricultural Soils | | | 2 orders of magnitude |
| $N_2O$ | Biomass Burning | | | 100% |

*Note*: Individual uncertainties that appear to be greater than ± 60% are not shown. Instead judgement as to the relative importance of emission factor and activity data uncertainties are shown as fractions which sum to one.

## A1.2 Procedures for Quantifying Uncertainty

### Estimating Uncertainty of Components

To estimate uncertainty by source category and gas for a national inventory, it is necessary to develop information like that shown in Table A1-1, but specific to the individual country, methodology and data sources used. In scientific and process control literature the 95 per cent (± 2) confidence limit is often regarded as appropriate for range definition. Where there is sufficient information to define the underlying probability distribution for conventional statistical analysis, a 95 per cent confidence interval should be calculated as a definition of the range. Uncertainty ranges can be estimated using classical analysis (see Robinson) or the Monte Carlo technique (in Eggleston, 1993). Otherwise the range will have to be assessed by national experts.

If possible ranges should be developed separately for

- emission factors (and other assumptions in the estimation method) (column 3 of Table A1-1).
- socio-economic activity data (column 4 of Table A1-1)

## Combining Uncertainties

It is necessary to derive the overall uncertainty arising from the combination of emission factor and activity data uncertainty. IPCC/OECD suggest that emission factor and activity data ranges are regarded as estimates of the 95 per cent confidence interval, expressed as a percentage of the point estimate, around each of two independent components (either from statistically based calculations or informal *ex ante* judgements).

On this interpretation (for quoted ranges extending not more than 60 per cent above or below the point estimate) the appropriate measure of overall *percentage* uncertainty $U_T$ for the emissions estimate would be given by the square root of the sum of the squares of the *percentage* uncertainties associated with the emission factor ($U_E$) and the activity data ($U_A$). That is, for each source category:

$$U_T = \pm\sqrt{\left(U_E^2 + U_A^2\right)}; \text{ so long as } |U_E|, \ |U_A| < 60\% \ [1]$$

For individual uncertainties greater than 60 per cent the sum of squares procedure is not valid. All that can be done is to combine limiting values to define an overall range, though this leads to upper and lower limiting values which are asymmetrical about the central estimate[2].

Estimated total emission for each gas is of course the summation $\Sigma\ C_i$ where $C_i$ is the central estimate of the emission of the gas in the source category. The appropriate measure of *uncertainty* in total emissions in emissions units (not percentages) is then:

$$E = \pm(1/100)\cdot\sqrt{\left(\sum U_{T,i}^2 \cdot C_i^2\right)}$$

where $U_{T,i}$ is the overall percentage uncertainty for the source category of the gas from Table A1-1. Source categories for which symmetrical limiting values cannot be defined (because $|U_E|$ or $|U_A|$ exceeds 60 per cent) cannot sensibly be treated in this way. The uncertainty might be handled by reporting that total emissions from gas X are estimated to be Y Mt, of which $Y_1$ Mt had an estimated uncertainty of ± $E_1$ Mt and $Y_2$ Mt had a range of uncertainty between - L Mt and + U Mt.

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[1] The 60% limit is imposed because the rule suggested for $U_T$ requires $\sigma$ to be less than about 30% of the central estimate, and we are interpreting the quoted range as $\pm 2\sigma$

[2] If uncertainties due to the emission factor and the activity data are ± E% and ± A% respectively, and the upper and the lower limits of overall uncertainty are U% and L% respectively, then U% = (E+A+E·A/100) and L% = (E+A-E·A/100).

## A1.3 Implications

If the assumptions in Table A1.1 are correct then typical uncertainties in national emissions estimates range between:

- ± 10% for $CO_2$ from fossil fuels although this may be lower for some countries with good data and where source categories are well defined (IPCC, 1993; von Hippel et al., 1993)
- ± 20% and ± 100% for individual methane sources (though the overall error might be ± 30%)
- perhaps two orders of magnitude for estimates of nitrous oxide from agricultural soils

These uncertainties will affect the level of quantitative understanding of atmospheric cycles of greenhouse gases that can be derived using the summation of inventories.

The situation is less critical for monitoring emissions mitigation options, because the profile of the emissions time series will be relatively insensitive to revisions to the emissions estimation methodology. However very different levels of uncertainty for different gases will be inevitable for some time to come, and this will need to be recognised in any move towards a comprehensive approach to greenhouse gas mitigation.

## A1.4 References

(IPCC) Intergovernmental Panel on Climate Change (1992), *Climate Change 1992: The Supplement to the IPCC Scientific Assessment*.

The method for combining errors in a multiplicative chain are given in many statistical textbooks, but note Jennifer Robinson's discussion (On uncertainty in the computation of global emissions from biomass burning, *Climatic Change*, 14, 243-262) about the difficulties which arise at high coefficients of variation.

H S Eggleston (1993), "Uncertainties in the estimates of emissions of VOCs from Motor Cars." Paper presented at the *TNO/EURASAP Workshop on the Reliability of VOC Emission Databases*, June 1993, Delft, The Netherlands.

IPCC (1993), "Preliminary IPCC national GHG inventories: in depth review." Report presented at the *IPCC/OECD Workshop on National GHG Inventories*, October 1993, Bracknell, UK.

von Hippel et al. (1993), "Estimating greenhouse gas emissions from fossil fuel combustion", *Energy Policy*, 691-702, June 1993.

# ANNEX 2
# IPCC AND CORINAIR SOURCE CATEGORIES

*This chapter briefly explains the origins of the IPCC and CORINAIR, the correspondences between the IPCC and CORINAIR/UNECE source categories, and outlines how to report the results from the CORINAIR inventory system in an IPCC format. At present, CORINAIR/UNECE is the only known inventory programme used by many countries of which the scope and objectives significantly overlap those of the IPCC. Many individual countries certainly have other detailed national inventory approaches which have similar characteristics to CORINAIR. For these countries, this example of reconciling IPCC and CORINAIR source categories may be helpful in addressing similar conversion problems. The IPCC/OECD/IEA Programme will work with interested countries and other organisations as far as possible to help achieve correspondence with IPCC categories in order to avoid duplication of effort at national and international levels.*

## A2.1 Origins

The IPCC source and sink categories for the estimation and reporting of national inventories of greenhouse gas emissions is slightly different than categories that have been developed by the Commission of European Communities (CEC) for use in Europe. The reasons for these differences lie, first, in the origin of the two inventory systems and, second, in the primary uses for the inventory data. However, for the recent inventories (from 1994 and onwards) these systems are consistent and harmonised.

The European Union (EU) emission inventory programme (CORINAIR) was set up by the European Council of Ministers in 1985 to assist in the development of consistent, comparable and transparent national inventories for "conventional" air pollutants such as $SO_x$, $NO_x$, and VOC. The first CORINAIR inventories were developed for 1985. The next CORINAIR inventories, for the year 1990, were initiated by the European Environment Agency Task Force. For these inventories, the pollutant list was extended to include $NH_3$, CO, $CO_2$ and $N_2O$, as well as to separate $CH_4$ from NMVOC. Support was given to Central and Eastern European countries resulting in emission inventories for 1990, covering 29 countries.

A further development of the CORINAIR system came in 1991, when the United Nations Economic Commission for Europe (UNECE) helped define the main CORINAIR categories as a basis for reporting under the Long Range Transboundary Air Pollution (LRTAP) Convention. The pollutants of interest not only include those covered in specific protocols (i.e. $SO_x$, $NO_x$, and VOC) but also pollutants that influence the critical loads of acidic deposition, such as $NH_3$. In 1992, the UNECE also established a Task Force on Emission Inventories (TFEI) with a main objective to develop a guidebook for emission inventories summarising the CORINAIR/UNECE recommendations on estimation and verification methods.

## A2.2 CORINAIR Methodology and its Applications

The joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook (EMEP/CORINAIR Guidebook) was first published in February, 1996. It is available as a CD-ROM and on the Internet. The UNECE/TFEI will continue its work of improving and updating the EMEP/CORINAIR Guidebook in co-operation with the European Environment Agency (EEA). In 1995, the CORINAIR project was integrated into the work programme of the EEA, and the European Topic Centre on Air Emissions (ETC/AE) was contracted to continue the CORINAIR project. The main task of the ETC/AE is to assist the participation of the EU-15 countries, as well as other European countries to report national inventories as required under international obligations. The CORINAIR project is an annual European air emission inventory, for which the list of pollutants has been extended to include heavy metals and persistent organic pollutants (POPs), from the reporting year 1994 onwards.

The CORINAIR methodology requires countries to collect emission estimates using a detailed source nomenclature (SNAP) and a detailed spatial level (NUTS level 3). From the resulting emission inventory, the methodology can be used to aggregate, allocate and report emission estimates for different reporting purposes. For example:

- IPCC format (UN FCCC);
- UNECE/EMEP (LRTAP Convention);
- EU Monitoring Mechanism of $CO_2$ and other greenhouse gas emissions.

Complete harmonisation between the IPCC and CORINAIR source categories has been achieved for the reporting year 1994, and onwards.

The purpose of inventory development under UNECE is to support the monitoring of progress of the implementation of the LRTAP protocols. One of the principal users of the inventories are modellers who support the implementation of the Protocols under the LRTAP. The main requirement of the modellers is to estimate the sources of $SO_x$, $NO_x$, NMVOC, and $NH_3$ emissions on a 50 km x 50 km square grid basis across Europe. These data are then the basis of the calculations estimating acidic deposition and photochemical oxidants across Europe which tie back to the concepts of "critical loads" for acidificate and “critical levels” for photochemical oxidant. The calculations show national progress or future acquirement to meet these critical thresholds.

## A2.3 Correspondences Between IPCC and CORINAIR Source Categories

The UNECE requirement to establish a much more detailed understanding of the physical source and geographic distribution of emissions has led to source categories based on the physical characteristics of the sources of pollutants. The IPCC has proceeded on the basis that socio-economic sources are the easiest and most appropriate groupings for describing

emissions, which in turn will facilitate the use of inventories for policy analysis.

The CORINAIR/UNECE system uses type of physical plant or vehicle, as the fundamental basis for emission estimation. This allows high accuracy in description of individual point or mobile sources and in use of appropriate emission factors for conventional pollutants. From the resulting detailed emissions inventory, the methodology can be used to aggregate, allocate and report emission estimates for different reporting purposes. For example, the CORINAIR methodology has been improved to include energy statistics and to enable countries to report emissions in complete accordance with the *IPCC Guidelines*.

An overview of correspondence between IPCC and CORINAIR source categories at the highest aggregated IPCC level (Short Summary Report Table, 7B) is presented in the following table.

**TABLE A2-1**
**CORRESPONDENCES BETWEEN IPCC AND CORINAIR MAIN SOURCE CATEGORIES**

| IPCC | CORINAIR |
|---|---|
| **1 Energy** | |
| 1 A Fuel Combustion Activities | 01 Combustion in Energy and Transformation Industry<br>02 Non-industrial Combustion Plants<br>03 Combustion in Manufacturing Industry<br>07 Road Transport<br>08 Other Mobile Sources and Machinery |
| 1 B Fugitive Emissions from Fuels | 05 Extraction and Distribution of Fossil Fuels and Geothermal Energy |
| **2 Industrial Processes** | 04 Production Processes |
| **3 Solvent and Other Product Use** | 06 Solvent and Other Product Use |
| **4 Agriculture** | 1001 Cultures with Fertilisers (except animal manure)<br>1002 Cultures without Fertilisers<br>1003 On-Field Burning of Stubble, Straw....<br>1004 Enteric Fermentation<br>1005 Manure Management<br>1006 Use of Pesticides |
| **5 Land-Use Change & Forestry** | Managed Deciduous Forests<br>Managed Coniferous Forests<br>Changes in Forest and other Woody Biomass Stocks<br>Forest and Grassland Conversion<br>Abandonment of Managed Lands<br>$CO_2$ Emissions and Removals from Soil<br>Others |
| **6 Waste** | 09 Waste Treatment and Disposal |
| **Memo Items** | |
| International Aviation Bunkers | 080502 International Airport Traffic<br>080504 International Cruise Traffic |
| International Marine Bunkers | 080404 International Sea Traffic |
| $CO_2$ Emissions from Biomass | Biomass fuels in categories 01, 02, 03, 07, 08 |

## A2.4 Harmonisation Between IPCC and CORINAIR Source Categories

Progress has been made in the harmonisation of the IPCC and EMEP/CORINAIR methodologies to allow more direct comparison of the two approaches. These changes are mainly in the Energy Chapter of the *Revised 1996 IPCC Guidelines*:

- Biomass fuels are allocated to the various source categories.
- Emissions from fuel used for electricity and heat production by autoproducers are included in the sector where they are generated and not within the transformation industries.
- Treatment of evaporative emissions (NMVOCs) from road transport in the Tier 2 method of IPCC is made consistent with CORINAIR. Combustion and evaporative emissions are to be reported separately. However, in the Tier 1 IPCC method, all emissions from road transport are included together under fuel combustion.

Development of a Tier 2 method for estimating emissions from aircraft.

## A2.5 How to Transform a CORINAIR Inventory into an IPCC Inventory

For the IPCC Short Summary Report Table (Table 7B), which is at the most aggregated level of reporting, Table A2-1 provides correspondence for the CORINAIR definitions. For the Summary Report (Table 7A) and the Sectoral Report Tables (Tables 1-6), more detailed alignment between the IPCC source/sink categories and the CORINAIR definitions is required. The joint UNECE/CORINAIR Guidebook and appropriate computer programme have been revised to facilitate conversion from a CORINAIR to an IPCC inventory at the level of detail required for the Sectoral Report Tables.

Further information can be obtained from:

**Andre Jol**
**European Environment Agency**
**Phone: (45 33) 367 144 / Fax: (45 33) 367 191**
**e-mail: jol@eea.dk**

## A2.6 Looking Forward

Both the IPCC and the UNECE/CORINAIR programmes are committed to on-going harmonisation between the two methodologies which have become increasingly compatible over the years. In order to ensure that the CORINAIR methodology evolves in a completely consistently manner with the *IPCC Guidelines,* there will continue to be regular contact between the two programmes. This will both facilitate an exchange of ideas and minimise duplication of effort.

# ANNEX 3
# SUMMARY OF THE REVISED 1996 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES

## A3.1 Background

This Annex summarises additions and revisions to the *1995 IPCC Guidelines for National Greenhouse Gas Inventories* (*1995 IPCC Guidelines*). It also describes efforts made by the IPCC to harmonise methods with others. The additions and revisions were accepted by the IPCC at its Twelfth Session held in Mexico City (11-13 September 1996) after acceptance by Working Group I at its Sixth Session held in Mexico City (10 September 1996) in accordance with IPCC procedures. They are called the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Within this Annex, a revision of an existing methodology or default data is referred to as a *'revision', 'revised method'* or *'revised data'*. Additional methods and default data are defined as *'new'* methods or *'new data'*.

## A3.2 Energy

The Energy Chapter contains the following improvements and additions:

- Harmonisation of international (IPCC and CORINAIR) emission estimation methodologies and allocating of emissions from autoproducers[1] to the sector where they are generated and not to the transformation[2] sector (*revision)*;
- Development of a *new* Tier 1 method for estimating non-$CO_2$ Greenhouse Gas (GHG) and $SO_2$ emissions based on fuel consumption;
- Development of a *new* Tier 2 method for estimating emissions from aircraft;
- Inclusion of *new* default values for various types of traditional biomass fuels;
- Clarification of the definition of National Navigation (the definition of International Marine Bunkers remains unchanged).

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[1] An autoproducer is defined as an entity which produces electricity and/or heat for sale in addition to its primary activities.

[2] The transformation sector comprises the conversion of primary forms of energy to secondary and further transformation (e.g. coking coal to coke, heavy fuel oil to electricity)

## A3.3 Industrial Processes

The Industrial Process Chapter contains a broad range of *new* estimation methodologies for the so-called "new gases", that is perfluorocarbons, PFCs (e.g. $CF_4$ and $C_2F_6$), HFCs (e.g. HFC-125 and HFC-134a), sulphur hexafluoride ($SF_6$), the direct GHG ($CO_2$, $CH_4$, and $N_2O$), and ozone and aerosol precursors ($SO_2$, NOx, CO, NMVOC) from industrial, non-energy, processes.

***Direct GHG:*** The *new* methodologies cover $CO_2$, $CH_4$, and $N_2O$ emissions from the production of mineral compounds, chemical industries and metal manufacture. The estimation of $CO_2$ emissions from cement production remains unchanged, but the methodologies for $N_2O$ emissions from nitric and adipic acid production have been revised.

***Aerosol and ozone precursors:*** For $SO_2$, NOx, CO, NMVOC, *new* methodologies are presented, which draw upon and improve existing international methodologies. The sectors covered are: mineral compounds production, chemical industries and metal manufacture.

***Fluorocarbons and $SF_6$:*** For HFCs and PFCs, and $SF_6$, methodologies are provided to estimate by-product and fugitive emissions from aluminium (Al) and magnesium (Mg) manufacturing processes, as well as emissions from their production and consumption. Two approaches are given: Tier 1 (a, b) for *potential* emissions, and Tier 2, for *actual* emissions. *Potential emissions* of PFCs, HFCs, and $SF_6$, are equal to the amount of a chemical consumed in a country, minus the amount of a chemical recovered for destruction or export in the year of consideration. *Actual* emissions estimates take into account the time lag between consumption and emissions. The Tier 2 methodology is, therefore, the more accurate estimation approach.

## A3.4 Land-use Change and Forestry

Several revisions to the methods for the Land-use Change and Forestry Chapter are provided. One such revision is to the method for estimating $CO_2$ fluxes from soils, as described below.

The *revisions* to the Land-use Change and Forestry Chapter greatly extend and improve the range and quality of default data, particularly for the tropics, where national forestry statistics are sometimes less accessible than in the temperate or boreal regions. The *revisions* can be summarised by changes in (a) default data and in (b) methods, as follows:

### Default data

***Classification system for land cover types:*** A *revised* system more consistent with sources of national, regional and international data, such as forest conversion rates and forest inventories was developed. The *revised* classification system better reflects the diversity of forest types. For the tropics, three classes of forests have been replaced with six, based on differences in rainfall amount, seasonality, and altitude.

***Rates of forest conversion:*** *New* FAO default data are provided for each country and forest type according to the proposed land-cover classification

system. These data have been compiled for the tropics for the 1980-90 period. Such *revisions* were incorporated because country-level data are often difficult to obtain for many tropical countries; the *1995 IPCC Guidelines* contain no such data.

***Aboveground biomass for native tropical forests:*** Emissions estimates from land-use change and forestry can be highly sensitive to such input data and therefore a priority was given to improving aboveground biomass data. Since publication of the *1995 IPCC Guidelines*, better datasets have become available drawing upon larger regional studies. The *revisions* now include a large database of default values for Africa, America, and Asia for the *revised* land-cover classification system. Additional data based on individual forest inventories (suitable for converting to biomass) for many tropical countries are also included. None of the default values are separated into primary and secondary forests (as in *1995* IPCC *Guidelines)* because it was felt by experts that this was not a practical classification, given the variability of definitions in different regions.

***Rates of tropical forest regrowth:*** *Revised* default data are given for forest regrowth; the data are related to the biomass data and are reported for the three tropical regions by forest type, according to the *revised* classification system.

### Methods

***Estimation of net $CO_2$ emissions from soil carbon:*** In the *1995 IPCC Guidelines*, $CO_2$ estimates are based upon the product of the rate of change in area of a given land-use and the rate of change of soil carbon. The *revised* method estimates changes in soil carbon pools associated with altered land-use or land management practices. Thus, all categories of agriculturally-impacted lands, including conversions of forest or other vegetation to agriculture, land abandonment, shifting cultivation and permanent agriculture, are included in the methodology. A default stock method is employed to estimate $CO_2$ fluxes associated with agricultural activities for a 20-year inventory period. This area of the IPCC Methodology has been much improved because better scientific data is now available. The *revised* method is more compatible with potential policy analysis.

## A3.5 Agriculture

Three sections of this Chapter have been *revised*, that are, (1) methane emissions from rice cultivation, (2) nitrous oxide emissions from agricultural soils and (3) manure management. For the estimation of $N_2O$ emissions, the default methods and data are *new*.

### Methane Emissions from Rice Cultivation

In the *1995 IPCC Guidelines*, the estimation of $CH_4$ emissions from wetland rice cultivation is a function of the $CH_4$ emission factor, area of rice cultivated and the season length. One critical default parameter is the $CH_4$ emission factor, which is based upon temperature. It was determined that the relationship between $CH_4$ emissions and soil temperature as assumed in

the *1995 IPCC Guidelines* was no longer appropriate because new data suggest that the seasonally integrated $CH_4$ flux depends much more on the input of organic carbon, water regime, time and duration of drainage and soil type than on local temperature. The *revised* methodology is a function of the emission factor integrated over a cropping season for particular rice water regime, for a given organic amendment, and of the annual harvested area cultivated under these conditions. The latter is given by the cultivated area times the number of cropping seasons per year.

The *revisions* to the method use internationally-agreed definitions for rice eco-systems classified according to the water regime and a range of $CH_4$ emission scaling factors relative to continuously flooded rice eco-systems and for soils without organic amendment. A default seasonally integrated emission factor is also provided for the continuously-flooded regime, without-organic amendment.

## Nitrous Oxide Emissions from Agricultural Soils and Manure Management

A *new* default method for calculating national emissions of $N_2O$ from agriculture is provided. The *new* $N_2O$ method is a revision of the method in the *1995 IPCC Guidelines.* It includes more sources of $N_2O$ from agricultural activities and makes explicit recommendations on $N_2O$ emission factors. The *new* method accounts for the application of N-fertilisers to the soil and N uptake in crops and subsequently tracks the flow of N as it moves through the (anthropogenic) animal and human food chain. Three categories of $N_2O$ sources are distinguished in the *new* methodology, (1) direct emissions from agricultural soils, (2) emissions from animal production, and (3) $N_2O$ emissions indirectly induced by agricultural activities[3]. Because a larger number of sources and pathways are considered, the *new* $N_2O$ methodology affects several source sectors. Emissions are reported in several sections of the 1995 *IPCC Guidelines*, namely, Manure Management (Section 4.2, 1995 *IPCC Guidelines*), Agricultural Soils (Section 4.5, *1995 IPCC Guidelines*), and Waste (Section 6.3, *1995 IPCC Guidelines*). The input data required can be obtained from FAO databases.

The *new* method provides a comprehensive description of $N_2O$ emissions from agriculturally-related activities by accounting for previously omitted $N_2O$ sources. Using this method, global $N_2O$ emission estimates imply that atmospheric $N_2O$ input from agricultural production as a whole has apparently been previously underestimated by at least 70%. Nitrous oxide emissions resulting from atmospheric deposition are assigned to the $NO_x$ or $NH_3$ emitting country[4].

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[3] It is however recognised that there are other sources of anthropogenic atmospheric inputs of N-compounds to soils e.g., $NO_x$ from fuel combustion. Only compounds directly applied to agricultural soils are considered.

[4] In some countries and regions, other conventions related to long range transboundary air pollution are addressing the issue of atmospheric transport and deposition in greater detail.

## A3.6 Waste

The Chapter on Waste addresses various topics, including: improved waste disposal data, evaluation of the methodologies for solid waste and wastewater, definitions of activities and uncertainties of $CH_4$ emission estimates. The main improvements to the methods and default data are as follows:

### Solid Waste

***Site classification:*** A *new* term - solid waste disposal site - has been proposed to refer to all sites and to replace the terminology in *1995 IPCC Guidelines* for 'landfills' and 'open dumps'. The *new* term was proposed because experience suggests that the existing categories do not adequately include the entire range of waste disposal sites that exists in all countries. Solid waste disposal sites include all sites where waste is deposited and is likely to generate some methane. Sites are further classified according to the level of site management and depth.

***Methane correction factor:*** The *new* site classification is used to derive a methane correction factor (MCF) to account for the methane generation potential of the site. The amount of methane produced depends in part upon the available oxygen and the level of compaction of the waste. In general, waste in managed sites potentially generates more methane than waste in unmanaged sites. Furthermore, the deeper the site, the greater the methane generation potential. The methane correction factor for each type of site reflects these differences in methane generation potential. The site classification recognises that some developing countries, or countries with-economies-in-transition, may have a majority of less-well managed or unmanaged sites, often with a lower methane-producing potential than well managed sites.

***Waste data:*** A wide range of *revised* and *new* default data on waste generation, composition and disposal data in many additional developed and developing countries is provided. A definition for Municipal Solid Waste and a method for calculating the Degradable Organic Carbon content of various waste streams are now included in the *revised* Chapter.

***Methodology***: The default methodology was evaluated and retained. The methodology uses a zero-order equation requiring data on population, waste landfills, and waste composition as proposed by Bingemar and Crutzen (1987).

### Wastewater

A *revised* method and default data for calculating emissions from wastewater and sludge is included. The amount of $CH_4$ produced from these systems depends upon several factors, including the characteristics of the wastewater and the management system, and temperature. These factors are highly dependent upon the waste treatment system used. The *revised* methodology allows countries to tailor the estimation approaches more precisely to their wastewater management systems. This is accomplished by the MCF that accounts for the differing $CH_4$ generating potential of

different wastewater management systems. In addition, the *revised* methodology uses data that is commonly available from most countries, or which can be estimated by wastewater experts.

### Human sewage

A *new* methodology and default data are provided for the estimation of $N_2O$ nitrous oxide emissions from human sewage disposed to land, and in subsequent run-off to rivers and estuaries. There is no such methodology in *1995 IPCC Guidelines*.

## A3.7 Harmonisation of International Emission Estimation Methodologies

Progress has been made in the harmonisation of the IPCC and EMEP/CORINAIR methodologies to allow more direct comparison of the two approaches. These changes are mainly in the Energy Chapter, but harmonisation was a theme in all other chapters, including Industrial Processes. Examples of harmonisation are given below from the Energy Chapter:

- Biomass fuels are allocated to the various source categories *(new)*. As in *1995 IPCC Guidelines*, $CO_2$ from biomass will not be reported in national totals as this is captured in the Land-use Change and Forestry Chapter
- Emissions from fuel used for electricity and heat production by autoproducers will be included in the sector where it is generated and not with the transformation industries.
- Treatment of evaporative emissions (NMVOCs) from road transport in the Tier 2 method of IPCC is made consistent with CORINAIR. Combustion and evaporative emissions are to be reported separately. However, in the *new* Tier 1 IPCC method, all emissions from road transport are included together under fuel combustion.
- Development of a *new* Tier 2 method for estimating emissions from aircraft.

## References

*Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks* (1996).

*Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook* (1996), 1st Edition, European Environmental Agency.

*1995 IPCC Guidelines for National Greenhouse Gas Inventories*, Reporting Instructions (Volume 1); Workbook (Volume 2); Reference Manual (Volume 3).

**Table 1. Additions/revisions to the *1995 IPCC Guidelines for National Greenhouse Gas Inventories***

| Sector[1] | Volume | Chapter/Section | Summary of additions/revisions[2] |
|---|---|---|---|
| **1. Energy** | Reference Manual (Volume 3) | Chapter 1, Energy | Main changes are :<br>• assignment of GHG emissions from autoproducers to the sector where they were generated and not to the transformation sector (*revision*);<br>• development of a Tier 1 method for estimating non- $CO_2$ GHG and $SO_2$ emissions based on fuel consumption (*new*);<br>• development of a Tier 2 method for estimating emissions from aircraft (*new*);<br>• inclusion of default values for various types of traditional biomass fuels (*new*);<br>• clarification of the definition of National Navigation (the definition of International Marine Bunkers remains unchanged) |
| | Workbook (Volume 2) | Module 1, Energy | |
| **2. Industrial Processes** | Reference Manual (Volume 3) | Chapter 2, Industrial Processes | *New* methods and default data for the estimation of emissions of<br>• direct greenhouse gases ($CO_2$, $CH_4$, and $N_2O$) and $SO_2$ from:<br>- mineral production;<br>- chemical industries;<br>- metal manufacture.<br>• ozone precursors (NOx, CO, NMVOC) from :<br>- chemical industries<br>- metal manufacture<br>• halocarbons (PFCs, HFCs) and sulphur hexafluoride ($SF_6$) from metal manufacture, use and production.<br>- Tier 1 (a): for bulk chemicals;<br>- Tier 1 (b): for bulk chemicals and chemicals stored in products;<br>- Tier 2 : product (containing PFCs, HFCs, $SF_6$) lifetimes are taken into account. |
| | Workbook (Volume 2) | Module 2, Industrial Processes | |

1 Chapter 3, "Solvents and other product use" has not been revised.

2 A revision of an existing methodology or default data is referred to as a '*revision*'. In cases where an additional method has been developed and default data provided, this is defined as '*new*'.

**Table 1. Additions/revisions to the 1995 IPCC Guidelines for National Greenhouse Gas Inventories (continued)**

| Sector[1] | Volume | Chapter/Section | Summary of additions/revisions[2] |
|---|---|---|---|
| **4. Agriculture** | Reference Manual (Volume 3) | Chapter 4: Agriculture, Methane Emissions from Rice Cultivation | • *Revised* method and *new* default data for the estimation of Methane Emissions from Rice Cultivation uses:<br>- internationally-agreed definitions of rice ecosystems (*revision*);<br>- default data (e.g. seasonally integrated $CH_4$ emission factors) (*new*);<br>- scaling factors for $CH_4$ emissions factors relative to continuously flooded fields (without-organic amendment) (*new*). |
| | Reference Manual (Volume 3) | Chapter 4: Agriculture, Agricultural Soils and Manure Management | Additions and revisions include:<br>• default method for the estimation of nitrous oxide emissions from Manure Management and Agricultural soils *(new)*;<br>• *revised* default emission factors for the estimation of direct emissions of $N_2O$ from soils (*revision*);<br>• default data (e.g. $N_2O$ emission factors for animal waste and for indirect emissions) (*new*). |
| | Workbook (Volume 2) | Module 4 : Agriculture Agricultural Soils, Manure Management, and Methane Emissions from Rice Cultivation | |
| **5. Land-use Change & Forestry** | Reference Manual (Volume 3) | Chapter 5, Land-use Change & Forestry | • *Revised /new* default data and classification are suggested for:<br>- land-cover types (*revision*);<br>- rates of forest conversion (*new*);<br>- aboveground biomass for native tropical forests (*revision*);<br>- rates of tropical forest regrowth (*revision*)<br>• Method for the estimation of $CO_2$ fluxes from agricultural soils (*revision*) and default data (*new*). |
| | Workbook (Volume 2) | Module 5, Land-use Change & Forestry | |

[1] Chapter 3, "Solvents and other product use" has not been revised.
[2] A revision of an existing methodology or default data is referred to as a '*revision*'. In cases where an additional method has been developed and default data provided, this is defined as '*new*'.

**Table 1. Additions/revisions to the *1995 IPCC Guidelines for National Greenhouse Gas Inventories* (continued)**

| Sector[1] | Volume | Chapter/Section | Summary of additions/revisions[2] |
|---|---|---|---|
| **6. Waste** | Reference Manual (Volume 3) | Chapter 6, Waste | • Solid waste disposal<br>*Revised/new* data and classification are listed below for:<br>- solid waste disposal site classification: definition encompasses all sites classified in the current *Guidelines* (*revision*);<br>- methane correction factor to account for the methane generation potential of the site (*new*);<br>- wider range of default data for waste generation, composition and disposal data (*revision*).<br>• Wastewater<br>- *revised* approach and default data for calculating $CH_4$ emissions (*revision*).<br>• Human sewage<br>- method and default data for the estimation of $N_2O$ emissions (*new*). |
| | Workbook (Volume 2) | Module 6, Waste | |

[1] Chapter 3, "Solvents and other product use" has not been revised.
[2] A revision of an existing methodology or default data is referred to as a '*revision*'. In cases where an additional method has been developed and default data provided, this is defined as '*new*'.

# GLOSSARY

*Starred items (*) in the definitions denote headings appearing elsewhere in this* Glossary.

**Activity data**

Data on the magnitude of human activity resulting in emissions or removals taking place during a given period of time. In the energy sector for example, the annual activity data for fuel combustion sources are the total amounts of fuel burned. Annual activity data for methane emissions from enteric fermentation are the total number of animals being raised, by species.

**Adipic acid**

A material primarily used in the chemical industry as an intermediate step in the production of nylon. The process of producing adipic acid also produces nitrous oxide ($N_2O$) as a by-product.

**Afforestation**

Planting of new forests on lands which, historically, have not contained forests. These newly created forests are included in the category Changes in Forest and Other Woody Biomass Stocks in the Land Use Change and Forestry module of the emissions inventory calculations.

*See also* Reforestation.

**Alcohol**

For the purposes of the inventory preparation alcohols include methyl alcohol (methanol), ethyl alcohol (ethanol) and tertiary butyl alcohol (TBA) (2-methyl propan-2-ol).

Alcohol produced from non-biomass sources for use as a blending component in fuels should be included with refinery feedstocks figures in the inventory.

Bio-alcohol used in fuels should be reported as a liquid biomass for information only.

**Anaerobic**

Conditions in which oxygen is not readily available. These are important for the production of methane emissions. Whenever organic material

decomposes in anaerobic conditions (in landfills, flooded rice fields, etc.) methane is likely to be formed.

**Andosol**

A soil developed in volcanic ash. Generally Andosols have good drainage and are prone to fertility problems

**Anthracite**

A high rank coal with generally less than 10 per cent volatile matter.

**Anthropogenic**

Man-made, resulting from human activities. In the *Guidelines*, *anthropogenic* emissions are distinguished from *natural* emissions. Many of the greenhouse gases are emitted naturally. It is only the man-made increments over natural emissions which may be perturbing natural balances.

**API Gravity**

(American Petroleum Institute Gravity). A measurement scale, related to density, for crude oil or other liquid hydrocarbons, based on the formula

$$\text{degrees } API = \frac{141.5}{\text{specific gravity}} - 131.5$$

where the specific gravity measurement is made at 60°F. Its application enables a linear scale to be used on the stem of a density-measuring device like a hydrometer.

**Apparent consumption**

A concept used in the calculation of $CO_2$ emissions from fossil fuel consumption. This concept deals with *apparent* rather than *actual* consumption because it tracks the consumption of primary fuels to an economy with adjustments for net imports and stock changes in secondary fuels. While this procedure ensures that all of the carbon in fuels is accounted for, it is important to note that it does not produce actual consumption by specific fuel or fuel product. In cases where exports of secondary fuels exceed imports, it will produce negative numbers. This is clearly not an accurate estimate of the consumption of secondary fuel. It is merely an adjustment to the primary fuel supply calculated elsewhere in the worksheet.

**Aviation Gasoline**

*See* Gasoline.

**Base year**

The year for which the inventory is to be taken. This is currently 1990. In some cases (such as estimating $CH_4$ from rice production) the base year is simply the middle of a three-year period over which an average must be taken.

**Benzole**

A mixture of light hydrocarbons used as a solvent and sometimes blended into gasoline. Benzole should be included with refinery feedstocks in the inventory.

**Biochemical oxygen demand (BOD)**

The amount of oxygen consumed by the organic material in wastewater during the decomposition of the waste materials in the wastewater. BOD is used as a measure of the organic content of wastewater. *See* Section 6.3.2 of the *Reference Manual.*

**Biomass**

Non-fossilised organic material both above ground and below ground, and both living and dead, e.g., trees, crops, grasses, tree litter, roots etc.. When burned for energy purposes, these are referred to as *biomass fuels*. Biomass fuels also include gases recovered from the decomposition of organic material.

**Bitumen**

Solid, semi-solid or viscous hydrocarbon with a colloidal structure, brown to black in colour, obtained as a residue in the distillation of crude oil by vacuum distillation of oil residues from atmospheric distillation. It is soluble in carbon bisulphate, non-volatile, thermoplastic (between 150°C and 200°C) with insulating and adhesive properties. Bitumen is used mainly in road construction and is also known as asphalt.

**Bituminous Coal**

Includes Anthracite*, Steam coal (other than anthracite) and Coking coal*. In the *Guidelines* steam coal is referred to as "Other Bituminous Coal".

Coal with a gross calorific value greater than 23 865 kJ/kg (5 700 kcal/kg) on an ash-free but moist basis and with a mean random reflectance of vitrinite of at least 0.6.

**BKB (Braunkohlenbriketts)**

A composition fuel manufactured from brown coal. The brown coal is crushed, dried and moulded under high pressure into an even-shaped briquette without the addition of binders. Also includes peat briquettes.

**Black Liquor**

*See* Sulphite Lies.

**Blast Furnace Gas (BFG)**

Obtained as a by-product in operating blast furnaces; it is recovered on leaving the furnaces and used partly within the plant and partly in other steel industry processes or in power stations equipped to burn it. Any Oxygen Steel Furnace Gas should be included in this category.

**BOD**

*See* Biochemical oxygen demand.

**Boreal**

Northern biotic area characterised especially by dominance of coniferous forests.

**Bunker fuels (International)**

Fuels consumed for international marine and air transportation.

**Calcination**

Chemical process in the manufacture of cement in which the raw materials (primarily limestone – calcium carbonate) are heated in kilns producing lime and $CO_2$.

**Calorific value**

The calorific value of a fuel is a measure of its value for heating purposes. It is expressed in terms of the heat released from a specified unit quantity under defined conditions of complete combustion. The calorific value is sometimes referred to as the heating value of the fuel.

Two measures of calorific value are possible and are referred to as the net (NCV) and gross (GCV) calorific values. Also termed the lower (LHV) and higher (HHV) heating values.

The Gross Calorific Value is the total quantity of heat released during combustion when all water formed by the combustion reaction is returned to the liquid state.

The Net Calorific Value is the total quantity of heat released during combustion when all water formed by the combustion reaction remains in the vapour state.

The Net Calorific Value is therefore less than the Gross Calorific Value. For natural gas this difference is approximately 9-10 per cent whilst for oils and coals the difference is approximately 5 per cent.

Throughout the *Guidelines* net calorific values are used and expressed in SI units, for example TJ/kt. The term *Conversion Factor* has two uses. First, as net calorific value, to convert quantities expressed in natural units to energy units and, secondly as a scaling factor to convert one form of energy unit to another (e.g. Btus to GJ).

**CFCs**

*See* Chlorofluorocarbons.

**Charcoal**

A black, amorphous form of carbon made by heating wood or other organic matter in the absence of air.

**Chlorofluorocarbons (CFCs)**

Hydrocarbon derivatives consisting of carbon, chlorine and fluorine, in which chlorine and fluorine partly or completely replace the hydrogen. Chlorofluorocarbons are chemical substances which have been used in refrigeration, foam blowing etc.. CFCs contribute to the depletion of the earth's ozone layer in the upper atmosphere. Although they are greenhouse gases, they are not included in the *Guidelines* because they are already being regulated under the Montreal Protocol.

**Clinker**

An intermediate product created during the manufacture of cement. In the production of clinker, calcium carbonate is heated, producing lime and carbon dioxide. The carbon dioxide is normally released to the atmosphere as a waste product and is a significant global source of $CO_2$ emissions.

**Closed forest**

A dense forest with closed canopy through which sunlight does not penetrate sufficiently for grasses to grow on the forest floor. These forests contain a significantly greater amount of biomass per hectare than do open forests.

**Coke**

Coke is subdivided into:

*Coke-oven coke*

The solid product obtained from the carbonisation of coal, principally coking coal, at high temperature, low in moisture and volatile matter. Coke oven coke is used mainly in the iron and steel industry acting as energy source and chemical agent. Semi-coke, the solid product obtained from the carbonisation of coal at a low temperature, should be included in this category. Semi-coke is used as a domestic fuel or by the transformation plant itself. This heading also includes coke and semi-coke made from lignite.

*Gas coke*

A by-product of hard coal used for the production of town gas in gas works. Gas coke is used for heating purposes.

**Coke Oven Gas**

Obtained as a by-product of solid fuel carbonisation and gasification operations carried out by coke producers and iron and steel plants which are not connected with gasworks and municipal gas plants.

**Coking Coal**

Coal of calorific value greater than 23,865 kJ/kg (5,700 kcal/kg) on an ash free but moist basis with a mean random reflectance of vitrinite of at least 0.6.

Coal with a quality that allows the production of coke suitable to support a blast furnace charge. The following classification codes cover coals which fall into this category.

- International classification codes: (UN Geneva 1956): 323, 333, 334, 423, 433, 434, 435, 523, 533, 534, 535, 623, 633, 634, 635, 723, 733, 823.
- USA classification codes: Class II Group 2 "Medium volatile Bituminous".
- British classification: Classes 202, 203, 204, 301, 302, 400, 500, 600.
- Polish classification: Classes 33, 34, 35.1, 35.2, 36, 37.

**Conference of the Parties (COP)**

The Conference of the Parties under the UN Framework Convention on Climate Change.

**Continuously flooded (rice fields)**

Fields inundated for the duration of the growing season, whether water is provided by managed irrigation or by rain.

**Conversion factor**

*See* Calorific value.

**Crude Oil**

Crude oil is a mineral oil of natural origin comprising a mixture of hydrocarbons and associated impurities, such as sulphur. It exists in the liquid phase under normal surface temperature and pressure and its physical characteristics (density, viscosity, etc.) are highly variable. This category includes field or lease condensate recovered from associated and non-associated gas where it is commingled with the commercial crude oil stream.

Inputs other than crude oil and NGL should be included with crude oil and footnoted. These include hydrogen, synthetic crude oil such as mineral oils extracted from shales, bituminous sand etc. Although they are not hydrocarbons, additives and other chemical alloys such as tetraethyl lead should be included.

**Cultivar**

In horticulture, a particular strain or selected clone of a given species; a cultivated variety or subspecies (of rice). In taxonomy, a grouping below the subspecies level.

**Dairy cattle**

Cattle producing milk for commercial exchange and calves and heifers being grown for dairy purposes.

**Degradable organic carbon (DOC)**

The organic carbon that is accessible to biochemical decomposition. DOC is used in the method for the estimation of $CH_4$ from solid waste disposal on land. *See* the *Reference Manual.*

**Distillate Fuel Oil**

*See* Gas/Diesel Oil.

**DM**

*See* Dry matter.

**DOC**

*See* Degradable organic carbon.

**Dry (forest)**

Generally consistent with the definition of open forests in previous documents. Less than 1200 mm rainfall per year.

**Dry (rice fields)**

Upland fields which are seldom flooded during the growing season.

**Dry biomass**

*See* Dry matter.

**Dry matter (DM)**

In this *Workbook* dry matter refers to biomass which has dried to an *oven dry* state. This means that all loose water has been driven off but water that is part of the carbohydrate molecule and various volatiles still remains. By contrast, dry matter which is only *air dry* may contain 15% moisture.

**ECE**

Economic Commission for Europe. A United Nations body.

**Emission factor**

A coefficient that relates the activity data to the amount of chemical compound which is the source of later emissions. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions.

**Enteric fermentation**

A process of digestion in herbivores (plant-eating animals) which produces methane as a by-product.

**Ethane**

A naturally gaseous straight-chain hydrocarbon, ($C_2H_6$) extracted from natural gas and refinery gas streams.

**Evaporative emissions**

Evaporative emissions fall within the class of fugitive emissions and are released from area (rather than point) sources. These are often emissions of Non-Methane Volatile Organic Compounds (NMVOCs), and are

produced when the product is exposed to the air – for example in the use of paints or solvents.

**Excreta**

The faecal and urinary excretions of livestock and poultry. They include, but are not necessarily limited to, manure.

**FAO**

Food and Agriculture Organization of the United Nations.

**FCCC**

Framework Convention on Climate Change. A United Nations convention.

**Flaring**

The burning of gas which cannot be contained or used productively. In some cases, when associated natural gas is released along with oil from production fields remote from energy users, the gas is burned off as it escapes, primarily for safety reasons. Some flaring may also occur in the processing of oil and gas.

The IPCC *Guidelines* classify emissions from venting and flaring as fugitive emissions.

*See also* Venting.

**Fossil Fuel**

Fossil Fuel comprises combustible fuels formed from organic matter within the earth's crust over geological time scales and products manufactured from them. The fuels extracted from the earth and prepared for market are termed "Primary fuels" (e.g. coal, natural gas, crude oil, lignite) and fuel products manufactured from them are termed "Secondary fuels" (e.g. coke, blast furnace gas, gas/diesel oil.

**Fugitive emissions**

Fugitive emissions are intentional or unintentional releases of gases from anthropogenic activities. In particular, they may arise from the production, processing, transmission, storage and use of fuels, and include emissions from combustion only where it does not support a productive activity (e.g., flaring of natural gases at oil and gas production facilities).

**Gas Coke**

*See* Coke.

**Gas/Diesel Oil**

Gas/diesel oil is a medium distillate oil primarily distilling between 180°C and 380°C. Several grades are available depending on uses:

- diesel oil for diesel compression ignition (cars, trucks, marine, etc.);
- light heating oil for industrial and commercial uses;

- other gas oil, including heavy gas oils which distil between 380°C and 540°C, and which are used as petrochemical feedstocks.

**Gas Works Gas**

Covers all types of gases including substitute natural gas produced in public utility or private plants whose main purpose is manufacture, transport and distribution of gas. It includes gas produced by carbonisation (including gas produced by coke ovens and transferred to gas works gas), by total gasification with or without enrichment with oil products (LPG, residual fuel oil, etc.), by cracking of natural gas, and by reforming and simple mixing of gases and/or air.

**Gasoline**

Gasoline includes the following products:

*Aviation Gasoline*

This is motor spirit prepared especially for aviation piston engines, with an octane number suited to the engine, a freezing point of -60°C and a distillation range usually within the limits of 30°C and 180°C.

*Jet Gasoline (Naphtha type Jet Fuel or JPA)*

A light hydrocarbon oil distilling between 100°C and 250°C for use in aviation turbine power units. It is obtained by blending kerosenes and gasoline or naphthas in such a way that the aromatic content does not exceed 25 per cent in volume, and the vapour pressure is between 13.7 kPa and 20.6 kPa.

*Motor Gasoline*

Motor Gasoline consists of a mixture of light hydrocarbons distilling between 35°C and 215°C. It is used as a fuel for land-based spark ignition engines. Motor gasoline may include additives, oxygenates and octane enhancers, including lead compounds such as TEL (Tetraethyl lead) and TML (tetramethyl lead).

**GCV**

*See* Calorific value.

**Gley soil (also Gleysol)**

Occur on level land, usually with a high water table (poorly drained mineral soil).

**Greenhouse gases**

The current IPCC inventory includes six major greenhouse gases.

Three direct greenhouse gases are included: Carbon dioxide ($CO_2$), Methane ($CH_4$), Nitrous oxide ($N_2O$) and three precursor gases are included: Carbon monoxide (CO), Oxides of nitrogen ($NO_x$), Non-Methane Volatile Organic Compounds (NMVOCs).

Other gases which also contribute to the greenhouse effect are being considered for inclusion in future versions of the *Guidelines*.

**Gross calorific value (GCV)**

*See* Calorific value.

**Hard Coal**

Includes Coking Coal*, Anthracite* and other Bituminous Coal*.

**Heavy Fuel Oil**

*See* Residual Fuel Oil.

**HFCs**

*See* Hydrofluorocarbons.

**HHV**

*See* Calorific value.

**Higher heat value (HHV)**

*See* Calorific value.

**Hydrofluorocarbons (HCFC)**

Hyrocarbon derivatives consisting of one or more halogens which partly replace the hydrogen. The abbreviation HCFC followed by a number designates a chemical product of the chlorofluorocarbon (CFC) family.

**IEA**

The International Energy Agency. An autonomous body attached to the OECD.

*See also* OECD.

**INC**

Intergovernmental Negotiating Committee (for a Framework Convention on Climate Change).

**Intermittently flooded (rice fields)**

Fields not inundated for the duration of the growing season, whether water is provided by managed irrigation or by rain.

**IPCC**

The Intergovernmental Panel on Climate Change. A special intergovernmental body established by UNEP and the WMO to provide assessments of the results of climate change research to policy makers. The *Greenhouse Gas Inventory Guidelines* are being developed under the auspices of the IPCC and will be recommended for use by parties to the Framework Convention on Climate Change (FCCC).

**Jet Gasoline**

*See* Gasoline.

**Jet Kerosene**

This is a distillate used for aviation turbine power units. It has the same distillation characteristics between 150°C and 300°C (generally not above 250°C) and flash point as kerosene. In addition, it has particular specifications (such as freezing point) which are established by the International Air Transport Association (IATA).

**Kerosene (other than Jet Kerosene)**

Kerosene comprises refined petroleum distillate and is used in sectors other than aircraft transport. It distils between 150°C and 300°C.

**Kilns**

Equipment used in the manufacture of cement. Vessels in which the raw materials (primarily limestone - calcium carbonate) are heated to cause a chemical process known as calcination which produces lime and $CO_2$.

**LHV**

*See* Calorific value.

**Lignite**

Non-agglomerating coals with a gross calorific value less than 17,435 kJ/kg (4165 kcal/kg) and greater than 31 per cent volatile matter on dry mineral matter free basis.

The distinction between Sub-bituminous Coal* and Lignite is not normally made in Europe.

**Liquefied Petroleum Gas (LPG)**

LPGs are light saturated paraffinic hydrocarbons derived from the refinery processes, crude oil stabilisation and natural gas processing plants. They consist mainly of propane ($C_3H_8$) and butane ($C_4H_{10}$) or a combination of the two. They are normally liquefied under pressure for transportation and storage.

**Lower heat value (LHV)**

*See* Calorific value.

**LPG**

*See* Liquefied Petroleum Gas.

**Lubricants**

Lubricants are hydrocarbons produced from distillate or residue, and they are mainly used to reduce friction between bearing surfaces. This category includes all finished grades of lubricating oil, from spindle oil to cylinder oil, and those used in greases, including motor oils and all grades of lubricating oil base stocks.

**Manure**

Waste materials, produced by domestic livestock, which are managed for agricultural purposes. When manure is managed in a way that involves anaerobic decomposition, significant emissions of methane can result.

**Methanol**

Methanol produced from natural gas should be included with refinery feedstock figures.

**Moist (forest)**

These are evergreen dense forests which receive significant rainfall evenly throughout the year (i.e., there is not a distinct wet and dry season). Rainfall in these forests is 2000 mm per year or more.

**Montreal Protocol**

The international agreement which requires signatories to control and report emissions of CFCs and related chemical substances which deplete the earth's ozone layer. The Montreal Protocol was signed in 1987 in accordance with the broad principles for protection of the ozone layer agreed in the Vienna Convention (1985). The Protocol came into force in 1989 and established specific reporting and control requirements for ozone depleting substances.

**MSW**

*See* Municipal solid waste.

**Municipal solid waste (MSW)**

Solid waste that is collected regularly by municipalities, e.g. household and commercial trash and garbage.

**Naphtha**

Naphtha is a feedstock destined for either the petrochemical industry (e.g. ethylene manufacture or aromatics production) or for gasoline production by reforming or isomerisation within the refinery. Naphtha comprises material in the 30°C and 210°C distillation range.

**Natural Gas**

Natural gas comprises gases at normal temperature and pressure occurring in underground deposits. In its marketed state it consists mainly of methane. It includes both "non-associated" gas coming from fields producing hydrocarbons predominantly in gaseous form and "associated" gas produced in association with crude oil. It also includes methane recovered from coal mines (colliery gas).

Production is normally measured dry, i.e. after the removal of the natural gas liquids (NGL) and impurities present in the gas at the well head. It therefore excludes gas re-injected into the wells, gas flared and gas used at the production and treatment plants.

**Natural Gas Liquids (NGL)**

NGL are liquid or liquefied hydrocarbons recovered from natural gas in separation facilities or gas processing plants. Natural gas liquids include ethane, propane, butane (normal and iso-), (iso) pentane and pentanes plus (sometimes referred to as natural gasoline or plant condensate).

**Net calorific value (NCV)**

*See* Calorific value

**NGL**

*See* Natural Gas Liquids.

**Nitric acid**

A raw material used mainly as feedstock in fertiliser production and in the production of adipic acid. The production of nitric acid can also produce nitrous oxide ($N_2O$).

**NMVOC**

*See* Non-Methane Volatile Organic Compounds.

**Non-dairy cattle**

All cattle which are not dairy cattle, including cattle kept or grown for key production, draft animals and breeding animals.

**Non-Methane Volatile Organic Compounds (NMVOCs)**

A class of emissions which includes a wide range of specific organic chemical substances. Non-Methane Volatile Organic Compounds (NMVOCs) play a major role in the formation of ozone in the troposphere (lower atmosphere). Ozone in the troposphere is a greenhouse gas. It is also a major local and regional air pollutant, causing significant health and environmental damage. Because they contribute to ozone formation, NMVOCs are considered "indirect" greenhouse gases.

**OECD**

The Organisation for Economic Co-operation and Development. A regional organisation of free-market democracies in North America, Europe and the Pacific.

**Open forests**

Open forests are less dense than closed forests, do not have a closed canopy, and have grasses growing on the forest floor. These forests contain less biomass per hectare than do closed forests.

**Other Products**

The category "Other Products" included in the energy statistics provided by the IEA includes Refinery gas*, White spirit*, Paraffin waxes*, and other products not included elsewhere such as tar, grease and sulphur.

**Oxygen steel furnace gas**

Obtained as a by-product of the production of steel in an oxygen furnace: it is recovered on leaving the furnace. The gas is also known as converter gas or LD gas. Data should correspond to the quantity of gas used for the production of electricity or in cases where waste heat is recovered from the gas and sold to third parties. Quantities of this gas should be included with Blast Furnace Gas.

**Paraffin Waxes**

These are saturated aliphatic hydrocarbons. These waxes are residues extracted when dewaxing lubricant oils. They have a crystalline structure which is more-or-less fine according to the grade. Their main characteristics are as follows: they are colourless, odourless and translucent, with a melting point above 45°C.

**Patent Fuel**

A composition fuel manufactured from coal fines by shaping with the addition of a binding agent (pitch). Note that the amount of patent fuel produced can be slightly higher than the amount of coal consumed in the transformation process because of the addition of pitch.

**Peat**

Combustible, soft, porous or compressed sedimentary deposit of plant origin with a high water content (up to 90 per cent in its natural state), easily cut, of light to dark brown colour.

**Peat soil (also Histosol)**

A typical wetland soil with a high water table and an organic layer of at least 40 cm thickness (poorly drained organic soil).

**Perfluorocarbons (PFCs)**

Carbon tetrafluoride ($CF_4$) and hexafluorethane ($C_2F_6$) which are extremely potent greenhouse gases. The only known major source of these gaseous emissions is aluminium smelting. Production and emission of PFCs results from aluminium smelting during the occurrence of electrical arcing or "anode effects."

**Petroleum Coke**

Petroleum coke is a black solid residue, obtained mainly by cracking and carbonising residue feedstock, tar and pitches in processes such as delayed coking or fluid coking. It consists mainly of carbon (90 to 95 per cent) and has a low ash content.

**PFCs**

*See* Perfluorocarbons.

**Process emissions**

Emissions from industrial processes involving chemical transformations other than combustion.

**Refinery Feedstocks and Blending Components**

Refinery feedstocks are processed oils destined for further processing in refineries (e.g. straight run fuel oil or vacuum gas oil). For IPCC purposes they include non-biomass alcohols as oxygenates for blending in motor gasoline whether within or outside refineries.

**Refinery Gas (not liquefied)**

Refinery gas includes a mixture of non-condensable gases mainly consisting of hydrogen, methane, ethane, and olefins obtained during distillation of crude oil or treatment of oil products (e.g., cracking) in refineries. This also includes gases which are returned from the petrochemical industry.

**Reforestation**

Planting of forests on lands which have, historically, previously contained forests but which have been converted to some other use. Replanted forests are included in the category "Changes in Forest and Other Woody Biomass Stocks" in the Land Use Change and Forestry module of the emissions inventory calculations.

*See also* Afforestation.

**Residual Fuel Oil**

This covers all residual (heavy) fuel oils (including those obtained by blending). Kinematic viscosity is above 10 cSt at 80°C. The flash point is always above 50°C and density is always more than 0.90 kg/l.

**Ruminant animals**

Herbivores (grazing animals such as cattle, buffalo, sheep, goats and camels) which have a large free stomach or rumen. Digestion in anaerobic conditions in the rumen can create significant emissions of methane from ruminant animals.

**Savanna**

Savannas are tropical and subtropical formations with continuous grass cover, occasionally interrupted by trees and shrubs. Savannas are found in Africa, Latin America, Asia and Australia.

**Seasonal (forest)**

Semi-deciduous forests with a distinct wet and dry season and rainfall between 1200 and 2000 mm per year.

**Season length (in rice agriculture)**

The number of days during which rice is grown on a given field. The field is not necessarily flooded for the entire season.

**Sequestered carbon**

*See* Stored carbon.

**Sludge Gas**

Sewage gas and gas from the anaerobic decomposition of animal slurries.

**Steam Coal**

*See* Bituminous Coal.

**Stored carbon**

Carbon retained for long periods of time within non-fuel products manufactured from fuels.

**Sulphite Lies (Black Liquor)**

An alkaline spent liquor from the digesters in the production of sulphate or soda pulp during the manufacture of paper. The energy content derives from the lignin removed from the wood pulp.

**Sub-bituminous Coal**

Non-agglomerating coals with a gross calorific value between 17,435 kJ/kg (4165 kcal/kg) and 23,865 kJ/kg (5700 cal/kg) containing more than 31 per cent volatile matter on dry mineral matter free basis.

*See also* Lignite. The distinction between Sub-bituminous coal and Lignite is not normally made in Europe.

**Synthetic crude oil**

Synthetic crude oil, including mineral oils extracted from shales, bituminous sand etc. should be included with the figures for crude oil.

**Temperate (Rain Forests)**

Woodland of temperate but usually rather mild climate areas with heavy rainfall, usually including numerous kinds of trees and distinguished from a tropical rain forest by the presence of a dominant tree.

**Temperate Zone**

The area between the Tropic of Cancer and the Arctic Circle or between the Tropic of Capricorn and the Antarctic Circle.

**Trace gas emission ratios (Non-$CO_2$)**

Ratios for carbon compounds are mass of carbon released as $CH_4$ or CO (in units of C) relative to mass of total carbon released from burning (in units of C). Those for nitrogen compounds are expressed as the ratios of nitrogen released as $N_2O$ and $NO_x$ relative to the nitrogen content of the fuel (in units of N).

**Tropical (Rain Forests)**

Tropical woodland with an annual rainfall of at least 100 inches and marked by lofty broad leafed evergreen trees forming a continuous canopy.

**UNECE**

United Nations Economic Commission for Europe.

**UNEP**

United Nations Environment Programme.

**UNFCCC**

United Nations Framework Convention on Climate Change.

**US EPA**

United States Environmental Protection Agency.

**Vegetal Waste**

Includes wood waste, straw, bagasse etc.

**Venting**

The release of gas to the atmosphere which cannot be contained or used productively. In some cases, when associated natural gas is released along with oil from production fields remote from energy users, the gas is allowed to escape into the atmosphere.

The IPCC *Guidelines* classify emissions from venting and flaring as fugitive emissions.

*See also* Flaring.

**Volatile solids**

The amount of organic material that disappears after drying.

**Water management regime**

A variety of practices used to classify rice production into categories for estimating emissions of methane. The three major water management regimes are irrigated, rainfed and deepwater. Upland (dry) rice cultivation produces little or no methane, while the continuously flooded category is a significant source.

**White Spirit and SBP**

White Spirit and SBP are defined as refined distillate intermediates with a distillation in the naphtha/kerosene range. They are sub-divided as:

*Industrial Spirit (SBP):* light oils distilling between 30°C and 200°C. There are 7 or 8 grades of industrial spirit, depending on the position of the cut in the distillation range. The grades are defined according to the temperature difference between the 5 per cent volume and 90 per cent volume distillation points (which is not more than 60°C).

*White Spirit:* Industrial spirit with a flash point above 30°C. The distillation range of white spirit is 135°C to 200°C.

**WMO**

The World Meteorological Organization of the United Nations.