



Report of IPCC Scoping Meeting for a Methodology Report(s) to refine the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

29-31 August 2016, Minsk, BELARUS

IPCC Task Force on National Greenhouse Gas Inventories

November 2016



Supporting material prepared for consideration by the Intergovernmental Panel on Climate Change. This supporting material has not been subject to formal IPCC review processes. Neither the papers presented at the scoping meeting nor this report have been subjected to IPCC review.

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IPCC Task Force on National Greenhouse Gas Inventories (TFI)

Technical Support Unit

% Institute for Global Environmental Strategies

2108 -11, Kamiyamaguchi

Hayama, Kanagawa

JAPAN, 240-0115

Fax: +81-46-855-3808

<http://www.ipcc-nggip.iges.or.jp>

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Foreword

We are pleased to present this report of the scoping meeting for a Methodology Report(s) to refine the IPCC 2006 Guidelines for National Greenhouse Gas Inventories which was held on 29-31 August 2016 in Minsk, Belarus.

The IPCC, at its 43rd Session on 11-13 April 2016 in Nairobi, Kenya, decided the strategy and timeline for its next series of reports during the Sixth Assessment Report (AR6) cycle. Following those decisions by the IPCC, its Task Force on National Greenhouse Gas Inventories (TFI) will embark upon a new project to produce a Methodology Report(s) to refine methodologies on national greenhouse gas inventories which will be one of the main products by the IPCC in the next few years.

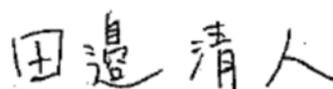
The first important step in this process is to convene a scoping meeting to prepare an outline of the Methodology Report(s) in accordance with the IPCC procedures. Preparation of the scoping meeting started in May 2016 with a call for nomination of experts to participate in the meeting which was issued to IPCC Member States and Observer Organizations. Invitees to the meeting were selected by the Bureau of TFI (TFB) with assistance of the TFI Technical Support Unit (TFI TSU), taking account of balance of expertise, geographical representation, gender balance and so on. The selection went well enough to result in a list of participants with a good and balanced coverage of sectors and issues, which eventually helped achieve an overall success of the scoping meeting held on 29-31 August 2016 in Minsk, Belarus.

The conclusions of this scoping meeting were agreed by the TFB, and submitted to the IPCC for consideration at the 44th Session in October 2016 in Bangkok, Thailand.

We would like to thank all those involved in this meeting, namely, the experts who participated, the members of TFB, and the members of TFI TSU, for their contribution to make this meeting a success. In particular, we would like to express our sincere gratitude to the Government of Belarus and its Ministry of the Natural Resources and Environmental Protection and Research Center "Ecology" for their generous support by hosting this meeting.



Eduardo Calvo Buendia
Co-Chair
Task Force on National Greenhouse Gas Inventories
Intergovernmental Panel on Climate Change



Kiyoto Tanabe
Co-Chair
Task Force on National Greenhouse Gas Inventories
Intergovernmental Panel on Climate Change

List of Acronyms and Abbreviations

AD	Activity Data
AFOLU	Agriculture, Forestry and Other Land Use
BOG	Break-out Group
CDM	Clean Development Mechanism
EF	Emission Factor
EFDB	Emission Factor Database
FAQ	Frequently Asked Questions
GHG	Greenhouse Gas
GFOI	Global Forest Observations Initiative
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
FFPRI	The Forestry and Forest Products Research Institute
HWP	Harvested Wood Product
IPCC	Intergovernmental Panel on Climate Change
IPCC AR6	Intergovernmental Panel on Climate Change- Sixth Assessment Report
IPPU	Industrial Processes and Product Use
ISO	International Standards Organisation
MCFs	Methane Conversion Factors
MGD	Methods and Guidance Document
REDD+	Reducing Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RS	Remote Sensing
PA	Paris Agreement
TFI	Task Force on National Greenhouse Gas Inventories
TOC	Table of Contents
TOR	Terms of Reference
VS	Volatile Solids
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

The goal of the scoping meeting was to prepare the proposal of the scope and format of the Methodology Report(s) to refine the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines), and to discuss and amend, as appropriate, draft terms of reference (TOR), draft table of contents (TOC) and draft work plan for the Methodology Report(s), prepared by the TFI Technical Support Unit (TFI TSU). To achieve these aims, the scoping meeting took full account of issues identified by the four technical assessment expert meetings held in 2015 and 2016 as well as decisions taken at the 43rd Session of the IPCC.

At the first plenary, scene-setting presentations were delivered by the TFI TSU so that all the participants could share understanding of objectives and expected outcome of the meeting. Discussion on the format of the Methodology Report(s) and some other issues followed these presentations. Subsequently the meeting split into 5 break-out groups (BOGs) for further detailed discussion, particularly on the draft TOC based on the annotated list of issues prepared by TFI TSU. Some of these BOGs split into smaller sub-groups during the discussion.

The scoping meeting agreed on the scope and format of the Methodology Report and forwarded it to the Task Force Bureau (TFB) for its consideration.

Regarding the draft TOC and the draft TOR including the work plan and the instructions to experts and authors, the scoping meeting recognized that further work is required to harmonize and integrate the outputs from each BOG as well as to reflect discussion at the final plenary. The scoping meeting agreed that TFI TSU should undertake that work in consultation with TFB.

1. Introduction

The (TFI) held an Expert Meeting on Systematic Assessment of TFI Products from 25-27 August 2014 in Ottawa, Canada, which assessed the TFI products currently available, including the 2006 IPCC Guidelines. Taking the discussion at this expert meeting into account, the (TFB) at its 26th Meeting in Ottawa (28 - 29 August 2014) concluded that the 2006 IPCC Guidelines provide a technically sound methodological basis of national greenhouse gas inventories. However, to maintain their scientific validity, certain refinements may be required, taking into account scientific and other technical advances that have matured sufficiently since 2006.

Following these conclusions by the TFB, the TFI carried out a technical assessment of IPCC Inventory Guidelines through an on-line questionnaire survey and four expert meetings in 2015^{1,2} and 2016^{3,4}. The on-line survey revealed that there had been abundant new scientific and empirical knowledge published since 2006 which the IPCC should take into account, particularly with respect to data for emission factor development for some categories and gases.

Therefore, the refinement of the 2006 IPCC Guidelines is necessary in order to provide an updated and sound scientific basis for supporting the preparation and continuous improvement of national greenhouse gas inventories. The refinement work would not revise the 2006 IPCC Guidelines, but would update, supplement and/or elaborate them where gaps or out-of-date science are identified by the scoping meeting and agreed by the Panel. The outcome of this refinement work would be used in conjunction with the 2006 IPCC Guidelines and would provide supplementary guidance.

A Methodology Report(s) would be produced as a major output(s) of this refinement work to address the following three needs while avoiding a fundamental revision of the 2006 IPCC Guidelines, taking full account of issues identified by the technical assessment expert meetings held in 2015 and 2016.

- Providing supplementary methodologies for sources or sinks of greenhouse gases only where currently there are gaps or where new technologies and production processes have emerged requiring elaborated methodologies or for sources or sinks that are not well covered by the 2006 IPCC Guidelines;
- Providing updated default values of emission factors and other parameters based on the latest available science only where significant differences from currently adopted factors are identified;
- Providing additional or alternative up-to-date information and guidance, where possible, as clarification or elaboration of existing guidance in the 2006 IPCC Guidelines.

With this background, a proposal on “Refinement of 2006 IPCC Guidelines for National Greenhouse Gas Inventories, including production of a Methodology Report(s)” was considered by the IPCC at its 43rd Session (11-13 April 2016, Nairobi, Kenya). The Panel approved the proposal⁵, and decided to consider the outline of the Methodology Report(s) at the 44th Session of the IPCC in October 2016, and to consider the draft Methodology Report(s) at a Plenary session of the IPCC in May 2019⁶.

In accordance with these decisions, a scoping meeting for a Methodology Report(s) to refine the 2006 IPCC Guidelines was held on 29-31 August 2016, followed by the 28th meeting of TFB, on 1-2 September, in Minsk, Belarus. The meeting was attended by 94 experts, 14 members of TFB, and 7 members of TFI TSU. The work was carried out in the plenary, 5 break-out groups (BOG's) and 3 sub-break-out groups.

The scoping meeting aimed to consider the scope and format of the Methodology Report(s), and to prepare draft TOR, draft TOC and draft work plan for the Methodology Report(s).

¹ Expert Meeting for Technical Assessment of IPCC Inventory Guidelines (Energy, IPPU, Waste Sectors), 29 June - 1 July 2015, Geneva, Switzerland

² Expert Meeting for Technical Assessment of IPCC Inventory Guidelines (AFOLU Sector) 13-16 July 2015, São Paulo, Brazil

³ Expert meeting for Technical Assessment of IPCC Inventory Guidelines: follow-up on specified issues from the 2015 expert meetings 25-26 April 2016, Wollongong, Australia

⁴ Expert meeting for Technical Assessment of IPCC Inventory Guidelines (Cross-sectoral issues) 27-29 April 2016, Wollongong, Australia

⁵ Decision IPCC/XLIII-8 “Update of methodologies on National Greenhouse Gas Inventories”

⁶ Decision IPCC/XLIII-7. Sixth Assessment Report (AR6) Products. Strategic Planning

Discussions and conclusions of the meeting are summarized in this report, and the above mentioned draft documents are also presented.

2. Meeting Discussions

The scoping meeting for a Methodology Report(s) to refine the 2006 IPCC Guidelines started with a welcome address from His Excellency Dr. Andrei Kovkhuto, the Minister of the Natural Resources and Environmental Protection of the Republic of Belarus, followed by opening remarks from IPCC TFI Co-Chairs. The opening session was followed by presentations from TSU. In addition to the presentations, the following meeting documents were prepared by the TFI TSU for consideration by the meeting participants: the two options on recommendation on the format of the Methodology Report(s), Draft (TOR), Draft (TOC), Draft work Plan, Draft instructions to Authors.

Mr Andrej Kranjc (Head, TSU) gave the first presentation and explained the background, objectives, tasks, and organization of the meeting. Mr Kiyoto Tanabe (Co-Chair, TFI) highlighted the procedures for the preparation, review, acceptance, approval, adoption and publication of IPCC reports plus question on the format of the new Methodology Report(s). This included, but not limited to, either a single Methodology Report which covers multiple sectors/categories/issues or a set of multiple Methodology Reports, each of them addressing a particular category/issue. Mr Pavel Shermanau (TSU) gave a presentation on the background, aims, scope, significance and prioritisation criteria, approach, IPCC 43 (April 2016) mandate for work on the Refinement of the 2006 Guidelines and outcomes of the Cross-sectoral issues identified for the Methodology Report(s) from the Expert and Follow-up Meetings conducted in 2015 and 2016. Ms Baasansuren Jamsranjav (TSU) gave presentation on an overview of the Technical Assessment of the 2006 IPCC Inventory Guidelines: Sectoral Issues plus the outcomes of the Expert and Follow-up Meetings conducted in 2015 and 2016. Finally, Ms Sekai Ngarize (TSU) gave a presentation on the Expected Outcomes and Outputs of the scoping meeting. The presentation also highlighted that these outputs will be the core of the proposal documents to the IPCC Panel for its consideration in October 2016.

In the ensuing plenary discussions as well as in the final plenary discussions that took place on Day 3, participants commented on several items as listed below:

- **Format of the methodology report(s)** - *There were two options on format of methodology report: some participants expressed a view "to have a consolidated version of the 2006 IPCC Guidelines, the 2013 Wetlands Supplement and the 2019 Refinement of the 2006 Guidelines, including additional supporting material", whilst others preferred a single Methodology report which covers multiple sectors/categories/issues, consistent with the current structure of the 2006 Guidelines. However, on the first option some participants indicated that before seeing final product it would be premature to discuss integration.*
- **Terms of Reference** - *The TOR sets out the background, scope, mandate for the refinement work, approach and a work plan for the production of the methodology report(s). Participants raised some concerns on the references to the Paris Agreement (PA) in the TOR and agreed to delete any references to the PA, given the diverging views and the fact that negotiations under the PA are still ongoing. The TFI Co-Chair clarified that when the technical assessment of the 2006 Guidelines started, there was no PA and it was simply recognized by IPCC that there are some areas that can be enhanced or improved due to recent scientific advancements. Therefore, the primary purpose of this refinement work was not supporting the PA, however, this refinement will be useful to the Parties to the UNFCCC.*
- *Some participants argued that the scoping meeting need to note that the global stock take process under the UNFCCC considers emissions of GHGs and GHGs emissions estimates need to be verified including the use of the most recent IPCC methodologies. The IPCC-TFI play a key part of the global stock take by providing methodological guidance on GHGs estimation and this clarified our connection with the PA, in particular its articles 12 and 14.*
- *The scoping meeting agreed that the TOR should clarify the scope of the methodology report to provide supplementary guidance. It was agreed that the three types of refinements include update, elaboration and new guidance plus use of no refinement where no changes are indicated in the relevant chapter, section or paragraph. The types of refinements are attached as an Annex to the TOR, and these refinements should reflect the latest developments in the science.*
- **Table of Contents** - *There was overall agreement that the TOC needs to reflect the current structure of the 2006 Guidelines and, where relevant, the design of TOC must have a place-holder and allow*

authors to add required additions. To that effect, the scoping meeting agreed that the issue of flexibility in dealing with additional items not raised during the technical assessment or scoping meeting, could be addressed via a more detailed TOC with guidance to authors.

- **Draft Instructions to Experts and Authors** - These instructions to experts and authors are intended as guidance to experts and authors contributing to a new Methodology Report. They are intended to ensure a consistent and coherent approach across all the volumes or chapters, including the use of common terminology.
- Participants were encouraged to send comments to the TFI-TSU during the course of the scoping meeting week. Comments on the Draft Instructions to Experts and Authors were circulated to participants during the scoping meeting. Overall, there was general agreement that the Draft Instructions to Experts and Authors should reflect that this work aims to cover all the different IPCC inventory sectors but only the categories where the science is considered to be sufficiently developed or where new or additional guidance is required, namely the categories that were selected through technical assessment conducted in 2015 and 2016, and the Scoping Meeting held in August 2016 using the significance and prioritization criteria (see para 21 of the Draft Instructions to Experts and Authors).
- **Draft Work Plan** - No major amendments were made to the draft work plan prepared by the TFI TSU as it reflected the "Strategic Planning Schedule AR6" which was agreed and proposed by the IPCC Executive Committee. Some participants expressed their concern about the timing of the expert review of first-order draft as well as the government/expert review of second-order draft because they are scheduled for vacation seasons.

Some participants also highlighted the need to verify issues arising from the UNFCCC GHG reviews on the use of the 2006 IPCC Guidelines and find a way to make linkages to the UNFCCC reviews and for authors to capture experiences of using the 2006 Guidelines in the methodology report. It was considered that given the limited experience on the use of the 2006 Guidelines, the UNFCCC would be able to make a detailed summary of issues arising from the use of 2006 Guidelines, possibly in 2017 at the latest. It was agreed that it would be useful if the UNFCCC Secretariat could continue to provide feedback to the IPCC.

Other relevant issues coming of the plenary discussions included, the need to better understand what will happen to issues addressed by other means other than the methodology report, and this included issues to be addressed via FAQs, EFDB, expert meeting with its technical bulletin or meeting report and FAQs. The TFI indicated that these processes are ongoing; our mandate for the scoping meeting is to provide guidance to the plenary on what needs to be done in terms of the outline of the methodology report. However, it may be complex and resource intensive to address all of these issues immediately. TFB will consider prioritisation of these issues in due course. In addition, the EFDB Editorial Board last November already took into account some of the issues raised during the technical assessment.

After the TSU presentations and plenary discussions, five BOGs were convened in the afternoon of Day 1 to continue discussions with the main objective of producing sectoral TOCs as a key output of the scoping meeting:

- BOG1: TOC for Cross-Sectoral Issues (Volume 1 of 2006 IPCC Guidelines)
- BOG2: TOC for issues on Energy Sector (Volume 2 of 2006 IPCC Guidelines)
- BOG3: TOC for issues on IPPU Sector (Volume 3 of 2006 IPCC Guidelines)
- BOG4: TOC for issues on AFOLU Sector (Volume 4 of 2006 IPCC Guidelines),

This BOG was further divided into 3 sub-BOGs: (i) Agriculture sub-BOG, (ii) Forestry and Other Land Use – FOLU sub-BOG and (iii) Flooded Lands sub-BOG.

- BOG5: TOC for issues on Waste Sector (Volume 5 of 2006 IPCC Guidelines)

Scoping meeting presentations are summarised under section 2 of this report (Meeting Discussions) and the presentation files are available at the IPCC-TFI website <http://www.ipcc-nggip.iges.or.jp/>. The list of participants is attached in Annex 6.

The BOGs discussions were focused on issues identified during the technical assessment and outcomes of the Expert Meeting in 2015 and Follow-up meeting in 2016. However, some new items were added during the scoping meeting that had not been raised during the technical assessment.

The BOGs presented the outcome of their discussions to the plenary during the course of the week and in the afternoon on the final day. Summaries of BOG discussions are included under each BOG, please note that a cross-sectoral sub-BOG was convened in day 2 to address two items: (a) How to deal with non-CO₂ emissions due to biogas production, and (b) Reporting of CO₂ emissions from biomass for energy. The following sections of the report summarize the BOG outcomes including the results of the cross-sectoral sub-BOG and TOC, plus the final discussions/conclusions of the meeting.

The cross-sectoral sub-BOG was made up of experts from Energy BOG, FOLU sub-BOG and Agriculture sub-BOG, the aim of the cross-sectoral BOG was to agree a harmonised approach to the treatment and reporting of non-CO₂ emissions due to biogas production and CO₂ emissions from biomass for energy, in the relevant sectors.

- On the reporting of CO₂ emissions from biomass for energy, the BOG agreed that the IPCC could identify the scientific consequences around which HWP approach to implement. Noting that if a political decision was made not to use the production approach, then the scoping meeting, which is mainly a technical and scientific process, should not attempt to prejudge the decision of SBSTA46 under the UNFCCC.
- The group acknowledged emissions of CO₂ from biomass fuels which are estimated and reported in the AFOLU sector as part of the AFOLU methodology. In the reporting tables, emissions from combustion of biofuels are reported as information items but not included in the sectoral or national totals to avoid double counting. For biomass, only that part of the biomass that is combusted for energy purposes should be estimated for inclusion as an information item in the Energy sector. The emissions of CH₄ and N₂O, however, are estimated and included in the sector and national totals because their effect is, in addition to the stock changes, estimated in the AFOLU sector.
- Some participants highlighted that because these emissions are reported as memo item, in practice, it means that some countries are not reporting these emissions and therefore better guidance was needed; for example, there is not enough information on decay rates and guidance on how to treat wood pellets, though some recent work from the Chatham House (UK) showed how these missing emissions could be captured. Whilst other indicated that if the importing country uses the production approach, the assumption of carbon neutrality is not valid, particularly for cases where a developing country which does not report emissions from HWP exports to Annex 1 countries; there is a risk that these emissions will not be reported by either country or even a risk of double counting.
- Participants noted that a harmonised/consistent approach used by all countries would work but in the meantime a solution was a proposal for a technical note guidance box in the AFOLU sector explaining the implications on the choice of approaches for the reporting of carbon from HWP, in particular when the importing country is using a different method than the exporting country. (See Annex 5 to this report for proposal). The BOG agreed that from a reporting perspective the technical note should also be included in the energy sector that allows countries to distinguish HWP from domestic and imported sources.
- On the issue of how to deal with fugitive loss of methane due to biogas production, participants agreed that these emissions should be divided based on where the amount of biogas comes from, i.e., waste, agriculture or energy. Participants expressed the need for an additional section in the methodology report that would deal with guidance on fugitive loss of methane due to biogas production in the relevant sectors.

2.1 BOG 1: TOC for Cross-Sectoral issues (Volume 1 of 2006 IPCC Guidelines)

Co-facilitators: Justin Goodwin (UK) and Fahmuddin Agus (Indonesia)

Rapporteur: Justin Goodwin (UK)

The participants of BOG1 agreed to consider all cross-cutting issues. A technical survey indicated the necessity to expand a methodological work focusing on developing countries and their country-specific emission factors. In many cases developing countries cannot accommodate emission factors which are based on developed countries' circumstances and are different in climate and technological and/or other conditions.

Participants identified the challenge of how countries should move from Tier 1 to Tier 2. The 2006 IPCC Guidelines focus on providing guidance on lower level tiers, leaving nationally specific approaches to national inventory compilers to design and document. After the 2006 IPCC Guidelines were developed, many countries started obtaining GHG emission reports from entities within their jurisdiction (e.g. PRTRs - Pollutant release and transfer registers) for much but not all of specific sectors. Based on the experiences gained by such countries, new guidance is needed to supplement the 2006 IPCC Guidelines on how the data reported from facilities can be used in national GHG inventories (for emission estimation and/or QA/QC).

Regarding Methodological Choice and Identification of Key Categories it was stressed that at Wollongong Expert Meeting (2016) this item was identified as high priority and therefore for consideration at the scoping meeting. The general guidance is that key categories are those worth investing in to develop accurate estimation methods. Under the UNFCCC guidelines the status of a category being key has many consequences, however, some inventories identify too many small key categories. There is a need to explore if and how the technical guidance for the identification of key categories can be improved. The feedback from the use by the Parties of the methods can be a good input, in particular, the issue of aggregation/disaggregation of categories is one that has not shown good results in the application of the analysis by many Parties, therefore there is a need for improving the guidance on this subject.

Participants considered that time series consistency is vital. The guidance is fine but how to apply that guidance has proved to be more difficult. Some countries have gained a lot of experience in ensuring time series consistency in their national greenhouse gas inventories, and there has been considerable discussion on this issue during the UNFCCC inventory review process. Additional practical guidance could be developed based on such experiences.

Draft TOC 1: Cross-Sectoral Issues

Chapter 1 Introduction to the 2006 IPCC Guidelines

Issue 1: Provide a better description on how to implement a national inventory management system that manages all parts of Volume 1, implements continuous improvement and leads to the development of mature inventories.

Location in 2006 IPCC Guidelines: New Section in Chapter 1

Type of refinement: New guidance

Guidance to Authors: New Guidance on national inventory management systems (be consistent with requirements) that implements continuous improvement. Consider existing literature. Include:

- *How to start inventories where resources are limited? Matching priorities and resources. How to improve inventories over time?*
 - *Where to start (e.g. fuel consumption? – IEA data)*
- *Provide some advice on how to start inventory process in absence of Tier 2 info. Make sure that the Value of moving to higher tiers is clearly stated: e.g. T1 default EFs may not account for abatement or newer more efficient technologies; therefore, T1 may overestimate and there is an incentive to invest in tier 2.*
- *Consider including criteria (check list) to decide if country EFs are appropriate*
- *Management of inventory process: identify inventory requirements and uses, planning, identification of tasks and responsibilities, planning of inventory cycle and timelines*
- *Inventory improvement plans and prioritisation*
- *Integrating Key Category Analysis (KCA), Time series consistency, data collection, QA/QC and Uncertainty analysis into single management of inventories*
- *Stakeholder engagement, institutional arrangements (e.g. legal arrangements, agreements, appointments...). Linking to existing in-country expertise including statistical systems etc., identifying roles and responsibilities*
- *Data management (data flow, archiving, documentation, long-term storage)*
- *Use of appropriate inventory software and data structures*
- *Review processes (internal, external, as part of QA/QC...)*

Issue 2: Clarify the concept of “anthropogenic emissions and removals”.

Location in 2006 IPCC Guidelines: Section 1.1 Concepts, with Guidance contained in the Revised Supplementary Methods and Good Practice Guidance arising from the Kyoto Protocol (2013 KP Supplement) Chapter 2.3.4 and 2.3.5 and the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse: Wetlands (2013 Wetlands Supplement)

Type of refinement: Update

Guidance to Authors: (Update of Section 1.1 Concepts, Chapter 1, and Volume 1 with Guidance contained in the IPCC 2013 KP Supplement chapter 2.3.4 and 2.3.5 and the 2013 Wetlands Supplement) need to agree what goes here and the more detailed info in AFOLU chapter. Only a sentence or two here summarising additional material in wetlands supplement. Check other definitions are still valid/complete – inputs needed from all sectors authors.

Chapter 2 Approaches to Data Collection

Issue 1: Add guidance for the development of country-specific emission factors, focusing on developing countries.

Location in 2006 IPCC Guidelines: New guidance in Chapter 2

Type of refinement: New guidance

Guidance to Authors: Provide more guidance on developing country-specific emission factors:

- *Explore ways to use available data to produce more appropriate EFs. Re-examine datasets used for global defaults to derive regional EFs.*
- *Advice on what to do if there are no appropriate EFs or if global default EF is not appropriate, how to get from Tier1 to higher Tiers (maybe more a clarification of existing guidelines).*

- *Indication of source categories that are more sensitive (significant) to country-specific EF (e.g. by using UNFCCC database and EFDB) Examples of sector specific approaches Addition of more rationale, references and background information on the default parameters used for the country specific EF*
- *Consider use of atmospheric concentration data to refine EFs (e.g. F-gases) link to validation chapter.*
- *“Australia example”:*
- *Consider “Decision tree approach” that can be applied on different source specific categories a “Systematic way to make consistent choices in the use of facility-specific data”*
- *Use of CDM “database” and/or scientific papers for description of cases where country specific EF where developed (taking into consideration the need of consistency with IPCC methodologies)*
- *General: Links to capacity building opportunities and training materials (FAQ)*

Issue 2: Add guidance for activity data collection; technical survey indicated there is a capacity problem to gather and manage national data which can be addressed by an additional guidance.

Location in 2006 IPCC Guidelines: New guidance in Chapter 2

Type of refinement: New guidance

Guidance to Authors: New guidance to develop country-specific emission factors and additional guidance on activity data collection:

- *New Guidance/suggestions on what to do in the absence of required national statistical data. How to get representative data.*
- *Additional guidance to activity data collection: Provide clarity on representative sample Confidential data:*
 - *Example of agreement for disclosure confidential information*
 - *Provisions of examples for incorporating confidential data*
- *Refinement of the “multi-year averaging” provision with additional exception listed for guidance for AFOLU tier 3 approaches drawing on IPCC KP Supplement chapter 2.3 (link to time series consistency).*
- *Update links to international database and more detailed description on data available and its potential use*
- *New tools/technologies for data collection (e.g. companies’ surveys) for completeness purposes*
- *General: Links to capacity building opportunities and training materials (FAQ)*

Issue 3: Add guidance on the integration of GHG emissions reported from facilities into national GHG inventories

Location in 2006 IPCC Guidelines: New guidance in Chapter 2

Type of refinement: New guidance

Guidance to Authors: New Guidance on the integration of GHG emissions and activity data reported from industrial facilities and other entities into national GHG inventories covering time series consistency, comparability, consistency and completeness. Use as a basis “TFI Technical Bulletin 1: “Use of Facility– specific Data in National Greenhouse Gas Inventories” and the “Report of the IPCC Expert Meeting on Use of Models and Measurements in GHG Inventories”.

Chapter 3 Uncertainties

Issue: Refine guidance on uncertainty based on the latest scientific knowledge and simplification of guidance by providing more default values, calculation examples and best practices.

Location in 2006 IPCC Guidelines: Chapter 3

Type of refinement: Update

Guidance to Authors: Chapter to be made more user-friendly – substance of guidance does not change but guidance needs to be more user-friendly with more up-front about why and how this is used.

- i) *Update language to be consistent with international standard definitions (BIPM) of uncertainty, accuracy etc;*
- ii) *Emphasis why this is needed – identify improvements and guide methodological choice;*
 - a. *Discussion on how to use uncertainty as a way to improve the inventory development (focusing effort on large sources of uncertainty or reducing model complexity (e.g., simple decision tree);*

- iii) *Strong links to data collection chapter – collecting uncertainty data is an integral part of data collection;*
- iv) *Incorporation of methodological development and/or case studies on issues, such as spatial variability, regional upscaling, correlation/autocorrelation, resampling techniques, addressing representativeness of data, trend analysis, population vs. mean variance;*
- v) *Propagation of uncertainty applying Approach 1 for some sources and Approach 2 for others. Address large percentage uncertainties when using Equation 3.1 in Chapter 3, Volume 1 of the 2006 IPCC Guidelines. Expand good practice for Monte Carlo simulations (more direction but not be overly prescriptive);*
- vi) *Inclusion of guiding principles for conducting an uncertainty analysis. Provide additional simplified explanation of procedures with case studies and decision trees;*
- vii) *Potential for a useful tool that may need to be updated covering at least Approach 1. Consider if Approach 2 (Monte Carlo) should be usefully included.*

Literature: over 50 relevant articles based on a brief search of the literature published since 2006, and over 10 years of reporting by parties to the UNFCCC. Literature may be useful for general guidance that can supplement the existing methods (however it should not be a scientific review of the methods).

It was noted that it might be a need to address specific issues on uncertainty analysis in the sectoral sections of a report, technical bulletin, etc.

Chapter 4 Methodological Choice and Identification of Key Categories

Issue: Add guidance on key category analysis to address treatment of disaggregation of categories, trend analysis, equations for trend analysis and the need for consistent definition of significant subcategories across the different volumes of the 2006 IPCC Guidelines.

Location in 2006 IPCC Guidelines: Chapter 4 (and relevant guidance in the other volumes)

Type of refinement: Elaboration

Guidance to Authors: Review this in light of general management chapter/section to separate management decisions from methodological choice. Elaboration of Chapter 4, Volume 1 to improve guidance on key category analysis to address treatment of disaggregation of categories, trend analysis, equations for trend analysis and the need for consistent definition of significant subcategories across the different volumes of the 2006 IPCC Guidelines.

Additional guidance on key categories analysis in particular on:

- *Aggregation/Disaggregation of categories to ensure a limited number of Key Categories is identified that are suitable for the use of improved methodologies;*
- *Trend analysis in situations of large fluctuations in emissions;*
- *Reconsider equation for trend analysis (in the cases of small sources and net sources and net sinks);*
- *Tools – update and improve;*
- *Definition of “significant subcategories” across different parts of the guidelines (e.g. subcategories which make up 60% of the key category emissions according to their contribution in Volume 1 and 25-30% of the emissions of a key category in the AFOLU Volume).*

Chapter 5 Time Series Consistency

Issue: Provide practical guidance on how to apply existing guidance on time series consistency because this proved to be a problem for many countries.

Location in 2006 IPCC Guidelines: Chapter 5

Type of refinement: Elaboration

Guidance to Authors:

- *Elaboration of Chapter 5, Volume 1 to add examples on time series consistency: Incorporate examples of country approaches (for example: Canada “merging of data sets from different time periods”, Finland “methods for F gases”, and others) Explore if there are new methods available. Time series consistency should not preclude improvements or addition of new categories in current year and future.*
- *Dealing with large inter-annual variability (link to data collection).*
- *Guidance on ensuring transparency.*
- *Guidance on transparency where underlying EFs or other parameters are changing over time.*

Chapter 6 Quality Assurance / Quality Control and Verification

Issue 1: Add guidance on the use and reporting of models

Location in 2006 IPCC Guidelines: New Section in Chapter 6

Type of refinement: New guidance

Guidance to Authors: New guidance on reporting of the use of models. Use as a basis the "Report of the IPCC Expert Meeting on Use of Models and Measurements in GHG Inventories", accessible via the link: http://www.ipcc-nggip.iges.or.jp/public/mtdocs/pdfiles/1008_Model_and_Facility_Level_Data_Report.pdf

Issue 2: Elaborate user-friendly description of verification, validation, audit and QA/QC because users are unclear on their IPCC meanings compared to outer definitions, such as ISO as used by CDM.

Location in 2006 IPCC Guidelines: Section 6.1, Box 6.1

Type of refinement: Elaboration

Guidance to Authors: In Box 6.1, provide user-friendly descriptions of verification, validation, audit and QA/QC as used in IPCC guidelines and differentiate them with other uses of the terms.

Issue 3: Update/elaborate verification guidance because the existing guidance is outdated (especially the guidance on comparisons with atmospheric measurements and new datasets).

Location in 2006 IPCC Guidelines: Section 6.10

Type of refinement: Update/Elaboration

Guidance to Authors:

- 1) *There is a need to discuss various ways to verify emission estimates in the context of the latest science with case examples:*
 - i) *atmospheric concentration data;*
 - ii) *independent monitoring of carbon stocks and fluxes;*
 - iii) *other approaches.*

The refinement work should not be focused on developing detailed methods, but reference more detailed examples that have been published elsewhere. Also, other uses of these data should be discussed, for example, direct emission measurements to prepare better emission factors where other information is limited, describe circumstances where this is possible and the limitations (link to data collection chapter 2). Guidance on the reporting of the use of such data. It was noted that it might be a need for some follow-up in the sectoral guidance about the use of atmospheric data and other data. Outline how this can be used to improve inventories. Examples. This will be advisory not mandatory. (Use IPCC workshop report on use of concentration data).

- 2) *Development or improvement of guidance on the verification using other estimation results like FAOSTAT emissions database for AFOLU (along the lines of the IEA data). Authors should consider other dataset as well. (Use IPCC workshop report on use of AFOLU data).*

Chapter 7 Precursors and Indirect Emissions

Issue: Elaborate clearer guidance for the calculation of indirect CO₂ emissions.

Location in 2006 IPCC Guidelines: Section 7.2.1.5

Type of refinement: Elaboration

Guidance to Authors: Make clear that a sufficient inventory contains only emissions estimated in Volumes 2-5. This section is additional information. Authors should emphasise transparency and the need to avoid double counting. There is no intention to include additional gases or emission factors in the guidelines. Avoid mention of specific metrics but could warn on implications of different types of metrics should people want to use them.

Chapter 8 Reporting Guidance and Tables – No refinement

2.2 BOG 2: TOC for issues on Energy Sector (Volume 2 of 2006 IPCC Guidelines)

Co-facilitators: John David Watterson (UK) and Dario Gomez (Argentina).

Rapporteur: Ole-Kenneth Nielsen (Denmark)

Discussions in the Energy BOG were focused on Fugitive emissions, no major changes needed for stationary and mobile combustion. The refinement should be made for underground and surface coal mines, abandoned surface coal mines, as well as update for oil and gas industry including abandoned oil and gas wells including a new guidance on unconventional oil and gas industries.

The group was asked to consider 6 issues (see Annex 3). Each issue had a proposed method of refinement associated with it, and a description of the work for the refinement. The group reviewed the proposed refinements and made suggestions about the treatment of the refinements which the future section and chapter authors could consider. The group then created a complete TOC for the energy chapter. The group also identified other new issues which were not in the primary list of 6 issues (underground and surface coal mines, abandoned surface mines, treatment of biomass). The full list of issues considered by the group are set out in Table 1.

Table 1. Full list of issues considered by the energy sector group

Issue	Description	Suggested approach to refinement
#1	Category 1.A.1.c. Manufacture of solid fuels. Development of guidance for estimating GHG emissions from charcoal production	New Guidance
#2	Category 1.B.1. Fugitive emissions: Solid Fuels. Development of guidance for estimating GHG fugitive emissions from abandoned or decommissioned surface mines	New Guidance
#3	Category 1.B.2. Fugitive emissions: Oil and Natural Gas. Development of guidance for estimating GHG fugitive emissions from abandoned or decommissioned oil and gas wells	New Guidance
#4	Category 1.B.2. Fugitive emissions: Oil and Natural Gas. Development of guidance for estimating GHG emissions from unconventional oil and gas production such as shale gas, shale oil, tight gas, tight oil and CBM	New Guidance
#5	Category 1.B.2. Fugitive emissions: Oil and Natural Gas. Update or addition of default emission factors of fugitive emissions from oil and gas by reflecting current practices and the latest measurement data	Update and/or Elaboration
#6	Category 1.B.3. Fugitive emissions: Other emissions from Energy production. Provision of clearer guidance on fuel transformation considering linkages with the methodology on fugitive emissions under IPPU	New Guidance
New E1	Treatment of biomass. Location in 2006 IPCC Guidelines: Section 2.3.3.4. Link to issue related to biomass combustion and methodologies for HWP (Location in 2006 IPCC Guidelines: Section 2.2.3.4 of Volume 2)	Elaboration
New E2	Underground coal mines. Location in 2006 IPCC Guidelines Section 4.1.3 of Volume 2. Elaborate chapter to include guidance on emissions from exploration and CO ₂ emissions	Elaboration
New E3	Surface coal mining. Location in 2006 IPCC Guidelines: Section 4.1.4 of Volume 2. Elaborate chapter to include guidance on emissions from exploration and CO ₂ emissions	Elaboration
New E4	New section on abandoned surface coal mines. Location in 2006 IPCC Guidelines: no current guidance	New Guidance

The group suggested some of the issues identified could be handled within the structure of the existing 2006 IPCC Guidelines structure, but proposed a new section “fuel transformation” (to be section 4.3) to handle issues #1 (charcoal production) and #6 (fugitives and IPPU).

Table 2 shows the proposed treatment of the issues by the energy sector group, and provides guidance on issues that should be covered in the drafting to future authors. The suggested approaches to refinement are not reproduced in this table, but are given in the last column of Table 1. Other sections of the energy chapter will need to be updated to reflect any changes and to ensure internal consistency within the chapter.

Table 2. Proposed treatment of the issues by the energy sector group

Issue	Section of current 2006 IPCC Guidelines	Description	Guidance to authors
New E1	2.3.3.4	Treatment of biomass. Location in 2006 IPCC Guidelines: Section 2.3.3.4. Link to issue related to biomass combustion and methodologies for HWP (Location in 2006 IPCC Guidelines: Section 2.2.3.4 of Volume 2)	Add bullet linking to HWP section (Chapter 12 of Volume 4) clarifying that depending on the choice of HWP methodology there could be under or overestimations.
New E2	4.1.3	Elaborate chapter to include guidance on emissions from exploration and CO ₂ emissions	No specific guidance developed in the meeting
New E3 #2	4.1.4	Elaborate chapter to include guidance on emissions from exploration and CO ₂ emissions	Add new section to follow on from Section 4.1.5 “Abandoned underground coal mines” 4.1.X Issue #2 Abandoned surface coal mines
New E4	No current guidance.	New section on abandoned surface coal mines	Suggested TOC below. 4.1.X.1 Choice of method (including decision tree) 4.1.X.2 Choice of emission factors 4.1.X.3 Choice of activity data 4.1.X.4 Completeness 4.1.X.5 Developing a consistent time series 4.1.X.6 Uncertainty assessment
#3, #4, #5	4.2	Update of chapter including update/inclusion of EFs representative for current practice. Additional guidance for unconventional oil and gas production and abandoned wells.	Consider applicability of tier 1 EFs. Time specific tier 1 EFs. Consider separate exploration EFs for oil and natural gas. Consider possible guidance for emissions from biogas transmission and distribution. Maintain current TOC. Graphical presentation of oil and natural gas segment boundaries.
#1, #6	4.3	New section on fuel transformation	Include guidance on charcoal production, coke production (check for consistent representation with the IPPU sector), other fuel transformation (solid to liquid, liquid to gaseous, biomass to gaseous, biomass to liquid, etc.) not included elsewhere. Ensure transparency regarding allocation between energy and IPPU, suggest an overview table on the types of fuel transformation and where guidance is provided Suggested TOC: 4.3.1 Overview, description of sources 4.3.2 Methodological issues 4.3.2.1 Choice of method (including decision tree) 4.3.2.2 Choice of emission factor 4.3.2.3 Choice of activity data 4.3.2.4 Completeness 4.3.2.5 Developing consistent time series 4.3.2.6 Uncertainty assessment 4.3.3 Inventory Quality Assurance/Quality Control (QA/QC) 4.3.4 Reporting and documentation

The sections that need updating are not given in Table 2, but are outlined in the proposed revised TOC for the energy chapter. The proposed TOC on energy chapter provided below was harmonized by TSU to be consistent across chapters.

Draft TOC 2: Energy

Chapter 1 Introduction – *No refinement*

Chapter 2 Stationary Combustion

2.1 Overview - *No refinement*

2.2 Description of sources - *No refinement*

2.3 Methodological issues

Issue: Link to issue related to biomass combustion and methodologies for HWP

Location in 2006 IPCC Guidelines: Section 2.3.3.4

Type of refinement: Elaboration

Guidance to Authors: Add bullet linking to HWP section (Chapter 12 of Volume 4) clarifying that depending on the choice of HWP methodology there could be under- or overestimations.

2.4 Uncertainty assessment - *No refinement*

2.5 Inventory Quality Assurance/Quality Control QA/QC - *No refinement*

2.6 Worksheets - *No refinement*

Chapter 3 Mobile Combustion - *No refinement*

Chapter 4 Fugitive Emissions

4.1 Fugitive emissions from mining, processing, storage and transportation of coal

Issue1: Elaborate chapter to include guidance on emissions from exploration and CO₂ emissions (Underground coal mines, Surface coal mining)

Location in 2006 IPCC Guidelines: Sections 4.1.3 and 4.1.4 (Sections 4.1.1, 4.1.2 and 4.1.6 are relevant)

Type of refinement: Elaboration

Guidance to Authors: (none)

Issue2: Include new section on abandoned surface coal mines

Location in 2006 IPCC Guidelines: Not applicable. (Next to Section 4.1.5. Sections 4.1.1, 4.1.2 and 4.1.6 are relevant)

Type of refinement: New guidance

Guidance to Authors: There would need to editorial changes to other parts of the chapter to reflect this new chapter. If insufficient information, the collected information could be included as an appendix. Suggested TOC below.

4.1. X.1 Choice of method (including decision tree)

4.1. X.2 Choice of emission factors

4.1. X.3 Choice of activity data

4.1. X.4 Completeness

4.1. X.5 Developing a consistent time series

4.1. X.6 Uncertainty assessment

4.1.6 Completeness for coal mining

Will need updating based on the changes to other sections?

4.2 Fugitive emissions from oil and natural gas systems

Issue: Update chapter including update/inclusion of EFs representative for current practice. Additional guidance for unconventional oil and gas production and abandoned wells.

Location in 2006 IPCC Guidelines: Sections 4.2

Type of refinement: Update

Guidance to Authors: Consider applicability of tier 1 EFs. Time specific tier 1 EFs. Consider separate exploration EFs for oil and natural gas. Consider possible guidance for emissions from biogas transmission and distribution. Maintain current TOC. Graphical presentation of oil and natural gas segment boundaries

4.3 Fuel transformation [New]

Issue: Include new section on fuel transformation

Location in 2006 IPCC Guidelines: New Section in Chapter 4 (Next to Section 4.2)

Type of refinement: New guidance

Guidance to Authors: Include guidance on charcoal production, coke production (check for consistent representation with the IPPU sector), other fuel transformation (solid to liquid, liquid to gaseous, biomass to gaseous, biomass to liquid, etc.) not included elsewhere. Important with transparency regarding allocation between energy and IPPU, suggest an overview table on the types of fuel transformation and where guidance is provided. Suggested TOC below.

4.3.1 Overview, description of sources

4.3.2 Methodological issues

4.3.2.1 Choice of method (including decision tree)

4.3.2.2 Choice of emission factor

4.3.2.3 Choice of activity data

4.3.2.4 Completeness

4.3.2.5 Developing consistent time series

4.3.2.6 Uncertainty assessment

4.3.3 Inventory Quality Assurance/Quality Control (QA/QC)

4.3.4 Reporting and documentation

Chapter 5 Carbon Dioxide Transport, Injection and Geological Storage - *No refinement*

Chapter 6 Reference Approach - *No refinement*

2.3 BOG 3: TOC for issues on IPPU Sector (Volume 3 of 2006 IPCC Guidelines)

Co-facilitator: Elsa Hatanaka (Japan)

Rapporteur: Deborah Ottinger (USA)

The BOG considered 9 issues related to the Chemical industry, Metal industry, Electronics industry and Refrigeration and air conditioning (RAC) (see Annex 3). 3 issues were added by meeting participants (CO₂ from Aluminium production, PFCs from Textile Industry and PFCs from water-proofing electronic circuit boards).

There are some issues that are not well covered in the current guidance and can be introduced as new. For example, the 2006 Guidelines do not provide specific guidance for hydrogen production, although Chapter 3.2 Ammonia production (Volume 3, p.3.11) and section on Methanol production (Volume 3, p. 3.58) refer to the steam reforming process (syngas technology). Also, the production of rare earth elements is not in the 2006 IPCC Guidelines.

The update of emissions factors is relevant to nitric acid production, fluorochemical production, semiconductor industry. For Iron and Steel there is a need in clarification of the scope of each emission factor (whether if combustion and fugitive emissions are included), particularly the emission factor for coke.

Aluminium chapter needs a refinement of existing guidance but also elaborating a guidance on “low-voltage anode effect” PFC emissions and CO₂ emissions from carbon-contained materials (see Guidance to authors).

As for RAC, the experts suggested that the user-friendliness of the chapter needs to be increased. It can be done by adding examples of activity data collection and the distribution of ODS substitutes by application within countries, adding a box with “recipe”-style guidance on how to launch the ODS substitutes inventory, and further emphasizing the availability of data from bodies and literature associated with the implementation of the Montreal Protocol.

The issue concerning Magnesium Production was declined because of the absence of sufficient literature.

The proposed TOC on IPPU chapter provided below which was harmonized by TSU to be consistent across chapters.

Draft TOC 3: Industrial Processes and Product Use

Chapter 1 Introduction - *No refinement*

Chapter 2 Mineral Industry Emission - *No refinement*

Chapter 3 Chemical Industry Emissions

3.1 Introduction - *No refinement*

3.2 Ammonia production - *No refinement*

3.3 Nitric acid production

Issue: Update guidance on appropriate emission factors to use for dual pressure technologies for Nitric Acid Production

Location in 2006 IPCC Guidelines: Section 3.3.2.2 and Table 3.3

Type of refinement: Update

Guidance to Authors: Add a new default EF into the Table 3.3 Chapter 3 Volume 3 (p.3.23) to include dual pressure technologies and, if literature is available, potentially other technologies. For examples of dual pressure technology emission factors, refer to 2007 EU IPPC/BAT study on Large Volume Inorganic Chemicals.

3.4 Adipic acid production - *No refinement*

3.5 Caprolactam, glyoxal and glyoxylic acid production - *No refinement*

3.6 Carbide production - *No refinement*

3.7 Titanium dioxide production - *No refinement*

3.8 Soda ash production - *No refinement*

3.9 Petrochemical and carbon black production - *No refinement*

3.10 Fluorochemical production

Issue: Update guidance and default Tier 1 emission factors for production of fluorinated compounds other than HCFC-22

Location in 2006 IPCC Guidelines: Section 3.10.2.2

Type of refinement: Update/Elaboration

Guidance to Authors:

1. In the Tier 1 method, update the default EF of 0.5 percent, which appears to be a factor of five to ten smaller than the uncontrolled EFs implied by information gathered from GHG Inventory reports and from the US GHG Reporting Program and possibly other countries.
2. In the Tier 3 method, update and elaborate the guidance to reflect two significant emission sources:
 - a. provide guidance for estimating emissions from equipment leaks in addition to emissions from process vents, and
 - b. update the guidance to reflect the fact that products are emitted in addition to by-products.

3.11 Hydrogen production [New]

Issue: Develop guidance for estimating GHG emissions from hydrogen production

Location in 2006 IPCC Guidelines: New Section in Chapter 3 (Next to Section 3.10)

Type of refinement: New guidance

Guidance to Authors: Provide a separate method for hydrogen production, cross-referencing it with the production of other chemicals (e.g., ammonia) and Energy (refineries). A method is provided in the USEPA Greenhouse Gas Reporting Program (GHGRP).

Chapter 4 Metal Industry Emissions

4.1 Introduction - *No refinement*

4.2 Iron & steel and metallurgical coke production

Issue: Update emission factors for Iron and Steel Production and elaborate methodological guidance.

Location in 2006 IPCC Guidelines: Section 4.2.2.3 and Table 4.1

Type of refinement: Update/Elaboration

Guidance to Authors: Update of emission factors for Iron and Steel Production. Provide clarification of the scope of each EF (whether if combustion and fugitive emissions are included), particularly the emission factor

for coke. Ensure that emissions categorized consistently between Iron and Steel and Fugitive Emissions chapter in Energy Sector (especially fuel transformation).

4.3 Ferroalloy production - No refinement

4.4 Primary aluminium production

Issue: Elaborate guidance and emissions factors to incorporate “low-voltage anode effect” PFC emissions and integrate this guidance into the existing methodology on “high-voltage anode effect” PFC emissions. Update of the Tier 1 and Tier 2 defaults.

Location in 2006 IPCC Guidelines: Section 4.4

Type of refinement: Update/Elaboration

Guidance to Authors:

1. Elaborate the guidance (all Tiers) to include methods and emission factors to estimate emissions from low-voltage anode effect (both propagating and non-propagating) PFC emissions.
2. Update the Tier 1 emission factors and Tier 2 default slope factors to reflect recent measurements of emissions during high-voltage anode effects (may be combined with update number 1 as appropriate)
3. Update uncertainties of default EFs

Issue: Develop a new methodology for the CO₂ emissions from the alumina production. Ensuring completeness and avoiding double counting

Location in 2006 IPCC Guidelines: New guidance in Section 4.4

Type of refinement: New guidance

Guidance to Authors: World-wide production of alumina is more than 100 mln. tons. There are three types of alumina production technology used: low-temperature Bayer, high-temperature Bayer, production for nepheline ore. The process itself has several sources of GHG emissions: lime calcination, bauxites or nepheline sintering processes for high-temperature Bayer and nepheline with using of carbon contained solutions from the next processes, Alumina hydrate calcination. Also, some additional processes utilize CO₂ emissions:

- using a part of CO₂ emissions from the sintering process for the carbonization processes to remove Si from the pulp
- using of red mud for SO₂ and CO₂ emissions removal from the high temperature processes removal.

4.5 Magnesium production - No refinement

4.6 Lead production - No refinement

4.7 Zinc production - No refinement

4.8 Rare Earth elements [New]

Issue: Develop a new guidance on GHG emissions (PFCs and CO₂) from production of Rare Earth elements

Location in 2006 IPCC Guidelines: New Section in Chapter 4 (Next to Section 4.7)

Type of refinement: New guidance

Guidance to Authors: Add a method for estimating PFC and CO₂ emissions from production (electrolysis) of rare earth elements where fluorine-containing solvents are used in the metal bath with carbon anodes. Existing studies indicate that the PFC emission factors for rare earth elements may be three orders of magnitude higher than the PFC emission factors for primary aluminium production. It is expected that more literature will be available within the next two years. Authors should verify the availability of reliable emission factor measurements and verify whether the magnitude of emissions justifies the development of new guidance for this source category.

Chapter 5 Non-Energy Products from Fuels and Solvent use - No refinement

Chapter 6 Electronics Industry Emissions

Issue: Update guidance and default Tier 1 and Tier 2 emission factors for Semiconductor Industry, improvement of the Tier 3 guidance and elaboration of guidance on generation of by-products from abatement technologies (CF₄ from NF₃)

Location in 2006 IPCC Guidelines: Section 6.2.1 and 6.2.2, and 6.3.1 (uncertainty, to the extent necessary)

Type of refinement: Update/Elaboration/New guidance

Guidance to Authors:

1. Update guidance and Tier 1 and 2 default emission factors:
 - a. to reflect the large set of additional emission factor measurements that came to light during the development of the U.S. GHG Reporting Program
 - b. to distinguish between emission factors for 150/200 mm and 300 mm wafer sizes
 - c. to include additional process types and fluorinated GHGs (as both input gases and by-products) as well as additional fluorinated heat transfer fluids.
2. Add new guidance and emission factors for emissions of nitrous oxide during vapour deposition and other processes
3. Add new guidance on the generation of by-products from abatement technologies (particularly CF₄ from NF₃), updating default destruction and removal efficiencies in Table 6.6 (and guidance regarding their use) as appropriate.
4. Elaborate the Tier 3 guidance to define “recipes” (processes used to etch patterns onto semiconductor devices or to clean chemical vapour deposition chambers) and “similarity” among recipes.
5. Update uncertainty estimates of emission factors in Table 6.9.

Chapter 7 Emissions of Fluorinated Substitutes for Ozone Depleting Substances

7.1 Introduction - No refinement

7.2 Solvents (non-aerosol) - No refinement

7.3 Aerosols (propellants and solvents) - No refinement

7.4 Foam blowing agents - No refinement

7.5 Refrigeration and air conditioning

Issue: Add examples (collection of activity data, distribution of ODS substitutes by application within countries). Elaborate by adding a box with “recipe-style” guidance on how to launch the ODS substitutes inventory. Elaborate the reference to Montreal Protocol. Update emission factors by further segregating equipment types, regions, and time periods where possible.

Location in 2006 IPCC Guidelines: Sections 7.5.2.1 - for the recipe, 7.5.2.2 - for emission factors, 7.5.2.3 - for activity data

Type of refinement: Update/Elaboration

Guidance to Authors: The user-friendliness of the chapter needs to be increased. Suggest adding examples regarding the collection of activity data and the distribution of ODS substitutes by application within countries, e.g., broadening the set of countries to include developing as well as developed countries. Also suggest adding a box with “recipe”-style guidance on how to launch the ODS substitutes inventory, and further emphasizing the availability of data from bodies and literature associated with the implementation of the Montreal Protocol. Literature is available to support tighter and more disaggregated ranges for emission rates. This literature consists of NIRs, Montreal Protocol UNEP TEAP/TOC Reports, and Technical studies by particular applications, European studies, engineering research literature.

7.6 Fire protection - No refinement

7.7 Other applications - No refinement

Chapter 8 Other Product Manufacture and Use

8.1 Introduction - No refinement

8.2 Emissions of SF₆ and PFCs from electrical equipment - No refinement

8.3 Use of SF₆ and PFCs in other products

Issue 1: Develop guidance for PFCs (GHG) emissions from Textile Industry.

Location in 2006 IPCC Guidelines: New guidance in Section 8.3

Type of refinement: New guidance

Guidance to Authors: (none)

Issue 2: Develop guidance for PFCs (GHG) emissions from water-proofing electronic circuit boards

Location in 2006 IPCC Guidelines: New guidance in Section 8.3

Type of refinement: New guidance

Guidance to Authors: (none)

8.4 N₂O from product uses - No refinement

2.4 BOG 4: TOC for issues on AFOLU Sector (Volume 4 of 2006 IPCC Guidelines)

Co-facilitators: Marcelo Rocha (Brazil) and Stephen Ogle (USA)

Rapporteur: Dominique Blain (Canada)

The group noted that items for the AFOLU could be further disaggregated by topic and to facilitate discussions, the Co-Facilitators further subdivided the AFOLU BOG into 3 sub-BOGs: (i) Agriculture sub-BOG, (ii) Forestry and Other Land Use – FOLU sub-BOG and (iii) Flooded Lands sub-BOG. The final TOC was made up of the outputs from each of sub-BOG. The group consensus was that the guidance was largely complete, but did need some updates based on the feedback from on-line questionnaire survey and previous expert meetings in 2015 and 2016. Therefore, sub-BOG discussions were based on the outcomes of the expert meetings in 2015 and 2016 and annotated list of issues prepared by TSU (See Annex 3).

Agriculture Sub-BOG

The agriculture sub-BOG aimed at finalizing any outstanding issues identified during the two expert meetings in 2015 and 2016, this included bringing into the Methodology report some items that were raised during scoping meeting or that were initially suggested for the EFBD. The discussion was focused on the issues listed below for 3A and 3C agriculture categories.

Livestock – 3A

The discussion was focused on the items listed below:

- Improvement of parameters based on different feeding strategies for ruminants;
- Harmonize manure management systems for CH₄ and N₂O so that emissions factors for both sources are based on the same manure management systems (Note: Default factors for Manure CH₄ emission are not currently based on manure management system even though default factors for Manure N₂O are assigned for specific emission factors, which is an inconsistency between the approaches);
- Development of the new default MCFs to support countries in producing higher Tier values consistent with the defaults;
- Current guidance on C and N from bedding needs to be consistent with the updated livestock characterization and therefore additional guidance for higher tiers is necessary, this means that there is a need to consider carbon from bedding in the VS estimate;
- Development/update guidance on how to deal with avoided methane emissions due to biogas production;
- Reconsideration of the methodology of estimating nitrogen excretions;
- Development of the MCF factors, N₂O estimation of N₂O from liquid manure storage based on surface area of manure storage;
- Updated factors for volatilization and leaching of N from manure management systems that does not include guidance for all manure management systems;
- Improve quality control guidance on livestock emission calculation with discussion of an optional mass balance approach to evaluate the robustness of inventory results.

The discussion points can be summarized as covering the following items which were included in the final TOC:

- *Livestock and feed Characterization*

The BOG considered additional guidance on how to derive a time series of methane conversion rates and corresponding activity data for dairy cows and other cattle. This means careful analysis on representativeness of feeding strategies for regional and global conditions. The main concern is that different models produce different methane conversion rates so that guidance on model applications is needed. The group agreed to include in the TOC the following:

- Guidance on improved descriptions of feeding systems,*

- ii. *Development of consistent system for manure management between source categories (regional/climate/stratified) for basic and enhanced characterization for livestock populations.*
 - ***Methane emissions from enteric fermentation***
 - (i) *Improve parameters based on different feeding strategies for cattle and sheep.*
 - ***Methane Emissions from Manure Management***
 - (i) Update methodology, temperature relationships, Tier 1 Emission Factors to be developed for specific manure management systems and Tier 2 parameters to be updated for different manure management systems
 - (ii) Update guidance on how to deal with non-CO₂ emissions due to biogas production.
 - ***N₂O emissions from manure management***

The BOG considered the outcomes of the two expert meetings in 2015 and 2016 i.e., based on these outcomes it may be useful to re-evaluate and update, if appropriate, the default N excretion rates for applicability in world regions. Clarify the animal categories (e.g., rabbit values are for mother+children).

Emission factors for N₂O: new data available. Current Table 10.21 contains a lot of expert judgement. EFs can be re-evaluated and updated, if appropriate, with new measured data, in particular for treatment systems. In addition, the current Table 10.22 and 10.23 does not provide default values for N losses from all manure management systems, and no guidance about addressing losses of N from systems that are not listed in the tables.

N₂O estimation from liquid manure storage based on surface area of manure storage: Surface area is inconsistent with the available activity data in most countries and does not suit for a lower tier method.

The BOG agreed to include the following items in the final TOC:

- (i) *Update N excretion parameters for all livestock categories considering updated livestock characterization in Section 10.2*
- (ii) *Update emission factors for N₂O for manure management system descriptions.*
- (iii) *Update manure management volatilization and leaching factors with manure management systems identified in Section 10.2.*
- (iv) *Update N losses from manure management systems in Tables 10.22 and 10.23.*
- (v) *Provide text on quality control procedures that use a mass balance approach to evaluate C and N flows through animal management systems.*

Agriculture – 3C

Soils

For direct N₂O emissions from managed soils the BOG discussed the need to evaluate EF1 and considered options for stratification/disaggregation (e.g. climate zone). The group took into account that there are a lot of new high-quality measurements available and stratification by climate zone, such as wet and dry climates, is an option to produce default EF1 values. The BOG also acknowledged that new findings are available to be considered in higher Tiers, e.g. simulation model approaches and non-linear N₂O response to fertilizers. The group also considered the need to evaluate emissions factors for indirect N₂O, both the amount of leaching/runoff and volatilization, as well as the indirect emission factor. There was a general consensus that there is adequate evidence to update defaults with new data, and the elaboration of existing guidance, based on further disaggregation, specifically for climate factors. It is important to note that the current default non-disaggregated method would be retained because some compilers may not have sufficient data in the country to disaggregate N management data. Further guidance and case examples could be included for movement to higher Tiers. Data are also incomplete for estimating N inputs from crop residue in Table 11.2. The group concluded that compilers should be able to assign default factors for all crops, which is currently not possible. At a minimum, values could be provided for assignment to crops that are not listed in the table.

Direct N₂O Emissions from Managed Soils (3.C.4):

The BOG agreed to include the following items in the final TOC:

- (i) Update N_2O EF1, stratification by climate
- (ii) Update crop parameters for calculating residue quantity and N
- (iii) Update the EF3 for N applied to soils, pasture, range and paddock by grazing animals
- (iv) Update emission factor for rice production (N_2O)

Indirect N_2O emissions (3.C.5)

The BOG agreed to include the following items in the final TOC:

- (i) Evaluate emissions factors for indirect N_2O , both the amount of leaching/runoff and volatilization, as well as the indirect emission factor.

Forestry and Other Land Use – FOLU sub-BOG (FOLU) – 3B

This BOG aimed to clarify any outstanding items and considered issues for forest land, cropland and grassland management activities, wetlands - Flooded land, need to update technical parameters for HWP, generic methodologies applicable to all land uses categories (Chapter 2) in relation to the biomass, DOM, soils and non- CO_2 emissions and additional guidance on tier 3 methods and use of remote sensing data for consistent representation of lands (Chapter 3). These discussions were based on issues raised during the expert meeting in 2015 and 2016 and where relevant issues emerging from the scoping meeting. The BOG discussions focused on the following issues:

- Updating default values for litter and develop default values for deadwood (Table 2.2, page. 2.27, 2006 IPCC Guidelines);
- Updating values for BEF/BCEF, harvest losses and root/shoot ratio, average biomass stocks and average biomass increments;
- Updating guidance on activity data (including natural disturbances), for land representation to link land classification system with digital maps (Remote Sensing or GIS data) and also stratified by climate, soil and land use, plus the relevant annexes in the 2006 IPCC Guidelines;
- Updating/development of guidance on mineral soils under Cropland, particularly on carbon stock change factors (Category 3.B.2, CO_2);
- Updating/development of guidance on mineral soils under Grassland, particularly on carbon stock change factors (Category 3.B.3, CO_2);
- Revision of the emission factor for flooded land (Wetlands) and to fully develop a methodology for estimating CH_4 emissions from flooded lands and possible refinement of methodology for estimating CO_2 ;
- Updating default biomass carbon parameters for settlements;
- *Development of new Tier 2 method for mineral soils that requires less activity data than the current default method for all land use categories and ensure that soil C stock changes can be addressed for all land use changes, including changes to and from wetlands for the Tier 1 and 2 methods. The current method is data intensive and only about 20% of the parties reporting to the UNFCCC have been able to successfully apply the Tier 1 or higher Tier method. Due the limited reporting, the group advised that an alternative Tier 2 method could be developed that would be more country-specific and require less activity data. However, the current Tier 1 method is valid and should be retained for those parties that have invested resources and successfully applied the approach;*
- Updating the relevant technical parameters for HWP, whilst maintaining the existing approaches in the 2006 IPCC Guidelines

Flooded land sub-BOG (FOLU) – 3B

The BOG discussed amongst other things “natural” reservoirs (= regulated lakes) used for hydroelectricity generation that do not have substantial changes in water area in comparison with the pre-flooded ecosystem. These do not meet the definition of “Flooded Land” in the 2006 IPCC Guidelines although they can be significant

sources of GHGs and the same methodology can be applied as reservoirs for hydroelectricity that meet the definition of “Flooded Land” in the 2006 IPCC Guidelines. The group considered the need for clarification on guidance for treatment of these reservoirs and whether we need to change the definition of “Flooded Land”?

The participants also discussed “net emissions” approach as identified by the 2016 expert meetings, i.e., (Anthropogenic emissions to be included in the inventory = Post-flood emissions – Pre-flood emissions.). However, it was considered that this is not consistent with the Managed Land Proxy in the 2006 IPCC Guidelines (meaning all emissions from managed land should be included in the inventory).

- In relation to the discussion about “Net emissions” approach, the following were noted.
- IPCC Inventory Guidelines provide methods to estimate and report national GHG emissions/removals, but do not deal with “accounting” (= relating to emission reduction commitment).

The BOG also agreed that guidance was needed on the Emissions Pathways/Processes for methane (CH₄) including:

- Methane diffusive emissions
- Methane ebullition (bubbles)
- Turbine degassing
- Downstream degassing (after the dam)
- Rooted emergent vegetation/macrophytes
- Emissions from Draw-down land

Participants identified the need for refinement of methane emission factors for flooded land (dams, ditches/canal networks, aquaculture ponds) and development of a methodology for estimating methane emissions.

The BOG also agreed that additional guidance on Emissions Pathways/Processes for CO₂ was needed for the following:

- Diffusive flux
- CO₂ in bubbles
- OM burial (sediment)
- Downstream degassing
- Draw-down land emissions

Participants identified the need for a methodology for estimating CO₂ emissions (dams, ditches/canal networks, aquaculture ponds)

The BOG agreed to include the following items in the final TOC:

- i. Update CO₂ emission factors for land converted to flooded land (Wetlands) and fully develop a consistent methodology for estimating CO₂ and CH₄ emissions from flooded lands (both land converted to flooded land and flooded land remaining flooded land);*
- ii. Clarify that section 7.5 on future methodological development of the 2006 IPCC Guidelines is no longer relevant;*
- iii. Develop guidance to implement new Tier 2 method for mineral soils that requires less activity data than the current default method, taking into consideration Chapter 5 of the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. The current method is data intensive and only about 20% of the parties reporting to the UNFCCC have been able to successfully apply the Tier 1 or higher Tier method. Due the limited reporting, the group advised that an alternative Tier 2 method could be developed that would be more country-specific and require less activity data. However, the current Tier 1 method is valid and should be retained for those parties that have invested resources and successfully applied the approach.*

The draft TOC prepared by the group is presented at the final plenary session on Day 3 and the meeting agreed to the draft TOC proposed by the BOG. It was also agreed that further work is required to harmonize and integrate the outputs from each BOG as well as to reflect discussion at the final plenary. The harmonized final draft TOC for the AFOLU sector is given below.

Draft TOC 4: AFOLU Sector

Chapter 1 Introduction - *No refinement*

Chapter 2 Generic Methodologies Applicable to Multiple Land-use Categories

2.1 Introduction - *No refinement*

2.2 Inventory framework - *No refinement*

2.3 Generic methods for CO₂ emissions and removals

2.3.1 Change in biomass carbon stocks (above-ground biomass and below-ground biomass)

Issue 1: Develop guidance on the use of allometric equations for biomass estimation

Location in 2006 IPCC Guidelines: New Subsection in Section 2.3.1

Type of refinement: New guidance

Guidance to Authors: Authors should refer to the Annotated List of Issues. In addition, authors should consider approaches based on individual tree and stand level allometric equations, including considering validation.

Issue 2: Develop guidance on how to use biomass density (amount per unit area) maps generated from remote sensing data for biomass estimation

Location in 2006 IPCC Guidelines: New Subsection in Section 2.3.1

Type of refinement: New guidance

Guidance to Authors: This is a new issue that was not identified in previous expert meetings. Authors should pay special attention to issues related to time series consistency

2.3.2 Change in carbon stocks in dead organic matter

Issue 1: Update default values for litter stocks and develop default values for deadwood stocks

Location in 2006 IPCC Guidelines: Section 2.3.2.1, IPCC default values for litter and dead wood (Table 2.2),

Type of refinement: Update/Elaboration

Guidance to Authors (optional): Authors should refer to the Annotated List of Issues

Issue 2: Develop equation 2.18 for estimating DOM_{out} and associated default values

Location in 2006 IPCC Guidelines: Section 2.3.2.1, IPCC default values for litter and dead wood (Table 2.2)

Type of refinement: Elaboration

Guidance to Authors: Authors should refer to the Annotated List of Issues

2.3.3 Change in carbon stocks in soils

Issue 1: Update reference carbon stocks.

Location in 2006 IPCC Guidelines: Section 2.3.3.1, Table 2.3

Type of refinement: Update

Guidance to Authors (optional): Revise soil reference C stocks working with ISRIC and their Guidelines global database on soil pedons. Issue raised during Scoping Meeting, discussed at Sao Paulo expert meeting.

Issue 2: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 2.3.3.1

Type of refinement: New guidance

Guidance to Authors (optional): An approach is proposed in the meeting material from the expert meeting held in Wollongong which can be a starting point for the development of the method (See presentation by S. Ogle Guidelines). The proposed method uses crop yield data as a basis for estimating carbon input in croplands, along with NPP data for grasslands, forestland, wetlands and settlements. The proposed method then estimates a steady-state carbon stock based on the three-pool carbon model originally developed in the Century Model (equations are provided in Ogle Guidelines, S.M., A. Swan and K. Paustian. 2012. No-till management impacts on crop productivity, carbon input and soil carbon sequestration. *Agriculture, Ecosystems and Environment* 149:37-49). The method requires an estimate of carbon input from organic

amendments, tillage data and irrigation data. Consider Table with defaults for C:N ratios and lignin contents for crops and other vegetation. Soil texture and mean climate data are also needed. Consider linkages with dead organic matter methods. Methodology should be compared against Tier 1 methodology and results provided in a box. Refer to annotated list of issues, FOLU, Issue #4.

Issue 3: Elaborate Tier 3 Methodologies with case study examples for soils.

Location in 2006 IPCC Guidelines: Tier 3 methods, Section 2.3.3.1,

Type of refinement: Elaboration

Guidance to Authors (optional): Further elaboration on Tier 3 methods for soil C with case study examples in a Box based on parties who have developed Tier 3 methods with model-based assessments.

2.4 Non-CO₂ emissions

Issue: Replace defaults for cropland mass of fuel with crop residue estimation method in Chapter 11 for soil N₂O method to ensure consistency in the calculation of residues between the two categories, and provide a basis to estimate mass of fuel for all crops instead of just the 4 crops listed in Table 2.4.

Location in 2006 IPCC Guidelines: Section 2.4, Table 2.4

Type of refinement: Update

Guidance to Authors (optional): The goal is to make the calculation of residue amounts, consistent between the soil N₂O and non-CO₂ greenhouse gas emissions from biomass burning. Minor updates may also be needed to Table 11.2. New issue raised by scoping meeting experts.

2.5 Additional generic guidance for Tier 3 methods

Issue 1: Provide guidance on how to address inter-annual variability

Location in 2006 IPCC Guidelines: Chapter 2.5

Type of refinement: Elaboration

Guidance to Authors: This is a new issue that was not identified in previous expert meetings. This relates to the discussion on managed land as a proxy. Authors should consider any relevant information, including such information contained in previous IPCC methodological reports published after the 2006 Guidelines.

Issue 2: Elaborate guidance on the use of Tier 3 methods

Location in 2006 IPCC Guidelines: Sections 2.5.1 and 2.5.2

Type of refinement: Elaboration

Guidance to Authors: Authors should consider, for example, category-specific issues, how to parameterize and evaluate Tier 3 models, the integration of data to models, and means to increase transparency. Include case studies demonstrating how parties have developed and worked with Tier 3 methods including models. Authors should also note the information contained in previous IPCC Expert Meeting reports.

Chapter 3 Consistent Representation of Lands

3.1 Introduction - No refinement

3.2 Land-use categories - No refinement

3.3 Representing land-use areas

Issue: Develop guidance on how remotely sensed data, ground based data, and ancillary data can be integrated and used to derive consistent time series estimates of land use and land-use change

Location in 2006 IPCC Guidelines: Section 3.3 and Annex 3A.1 and 3A.2

Type of refinement: Update/Elaboration/New guidance

Guidance to Authors: Authors should address the following issues:

- i) *How to integrate and use national and global data, products and tools for land use representation*
- ii) *How to derive IPCC land-use categories, including sub-stratification, using national and/or global land classification*
- iii) *Identification and tracking land-use change and disturbances, including how to deal with the seasonal nature of specific land-use categories, how to distinguish temporary forest losses from land-use change conversion, and monitoring regrowth*
- iv) *Validating activity data and estimation of uncertainties, including the appropriate use of reference data*
- v) *Consistency between projects or activities (e.g. REDD+) and IPCC inventory guidelines*

For further background information, authors should refer to the Annotated List of Issues from the Wollongong Expert Meeting, such as the references related to the GFOI MGD.

3.4 Matching land areas with factors for estimating greenhouse gas emissions and removals

Issue: Provide guidance on how to use methodologies within different methodological tiers in combination with different approaches for land representation

Location in 2006 IPCC Guidelines: New Subsection in Section 3.4

Type of refinement: New guidance

Guidance to Authors: Authors should address, *inter alia*, the application of the stock difference method for estimating carbon stock changes using activity data from different land representation approaches (e.g. as has been addressed in formulation A and B for SOC in mineral soils, in Boxes 2.1 and 2.2 in 2006 IPCC Guidelines).

3.5 Uncertainties associated with the Approaches - No refinement

Annex 3A.1 Examples of International land cover datasets

(See the above issue under Section 3.3)

Annex 3A.2 Development of land-use databases

(See the above issue under Section 3.3)

Chapter 4 Forest Land

4.1 Introduction - No refinement

4.2 Forest Land Remaining Forest Land

4.2.1 Biomass - No refinement

4.2.2 Dead organic matter - No refinement

4.2.3 Soil carbon

Issue 1: Update carbon stock change factors.

Location in 2006 IPCC Guidelines: Section 4.2.3.2

Type of refinement: Update

Guidance to Authors (optional): Recommend re-evaluation of the time periods over which the stock changes occur with the land use change factors. In particular, there needs to be updates to factors for tropical regions for land use change. Changes occur more rapidly when soils are more intensively managed with land use change and there is net carbon loss, such as conversion of from forest into crop production. In contrast, changes occur more slowly when more intensively managed soils are converted back to less intensive land uses. See Table 5.3 in the 2013 Wetlands Supplement (Chapter 5, Page 5.13) for an example of different time dynamics for the land use factor between losses of carbon with drainage and more intensive management compared to restoration of wetland soils that gain carbon. Refer to meeting scoping annotated list of issues (categories 3B).

Issue 2: Provide guidance and develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 4.2.3

Type of refinement: New guidance

Guidance to Authors (optional): Include parameters and activity data needs specific to forest lands in this section. Consider linkages with dead organic matter methods. Refer to annotated list of issues, FOLU Issue #4.

4.2.4 Non-CO₂ greenhouse gas emissions from biomass burning - No refinement

4.3 Land Converted to Forest Land

(All issues for Section 4.2 above apply to this Section similarly.)

4.4 Completeness, time series, QA/QC, and reporting and documentation

Issue: Develop guidance on how to ensure methodological consistency of time series, such as through the use of age class structure data

Location in 2006 IPCC Guidelines: Section 4.4.2 on time series consistency

Type of refinement: Elaboration

Guidance to Authors: This is a new issue that was not identified in previous expert meetings. Authors should consider any relevant information, including such information contained in previous IPCC methodological reports published after the 2006 IPCC Guidelines

4.5 Tables

Issue: Update values for BEF/BCEF and root/shoot ratio, average biomass stocks, and average biomass increments

Location in 2006 IPCC Guidelines: Tables 4.4, 4.5, 4.7, 4.8, 4.9, 4.10, 4.11A and 4.11B, 4.12

Type of refinement: Update/Elaboration

Guidance to Authors: Authors should refer to the Annotated List of Issues, noting that for Harvest losses, biomass expansion factors need to be mindful of the units in which harvest is reported (e.g. volume over- or under-bark). (Update/Elaboration text in Box 4.2, page 4.13-4.14). For BEF/BCEF authors to refer to Section 2.3.1, on generic methodologies applicable to all land uses

Chapter 5 Cropland

5.1 Introduction - No refinement

5.2 Cropland Remaining Cropland

5.2.1 Biomass

Issue: Update default biomass carbon parameters.

Location in 2006 IPCC Guidelines: Section 5.2.1.2, Tables 5.1, 5.2, 5.3

Type of refinement: Update

Guidance to Authors (optional): Issue initially identified as an EFDB improvement, elevated to methodology report during scoping meeting. Refer to co-chair summary of Sao Paulo meeting.

5.2.2 Dead organic matter - No refinement

5.2.3 Soil carbon

Issue 1: Update carbon stock change factors.

Location in 2006 IPCC Guidelines: Section 5.2.3.2, Table 5.5

Type of refinement: Update

Guidance to Authors (optional): Management factors for tillage are a priority for the update, but other management, input and land use factors should be evaluated. In addition, there needs to be updates to factors for tropical regions for land use change and management. Recommend re-evaluation of the time periods over which the stock changes occur with the land use change factors. Changes occur more rapidly when soils are more intensively managed with land use change and there is net carbon loss, such as conversion of from forest or grassland into crop production. In contrast, changes occur more slowly when more intensively managed soils are converted back to less intensively land uses. See Table 5.3 in the 2013 Wetlands Supplement (Chapter 5, Page 5.13) for an example of different time dynamics for the land use factor between losses of carbon with drainage and more intensive management compared to restoration of wetland soils that gain carbon. (Refer to annotated list of issues.

Issue 2: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 5.2.3

Type of refinement: New guidance

Guidance to Authors (optional): Include parameters and activity data needs specific to croplands in this section. Consider linkages with dead organic matter methods. Refer to annotated list of issues, FOLU Issue #4.

5.2.4 Non-CO₂ greenhouse gas emissions from biomass burning - No refinement

5.3 Land Converted to Cropland

(All issues for Section 5.2 above apply to this Section similarly.)

5.4 Completeness, time series, QA/QC, and reporting - No refinement

5.5 Methane emissions from rice cultivation

Issue: Develop regionally specific default EFs

Location in 2006 IPCC Guidelines: Section 5.5.2, Tables 5.11 to 5.14,

Type of refinement: Update

Guidance to Authors (optional): Provide emission and scaling factors for other practices and regions of the world, beyond the current values for Asia, based on literature review and analysis of available data, including studies from North, South America, and Africa to the extent that data are available. Update values for Asia if there is enough new literature and uncertainties are reduced. Issue raised during Scoping Meeting based on information from Sao Paulo expert meeting – elevated from EFDB to Methodology Report.

Annex 5A.1 Estimation of default stock change factors for mineral soil C emissions/removals for cropland

(See the above issues under Section 5.2.3.)

Chapter 6 Grassland

6.1 Introduction - *No refinement*

6.2 Grassland Remaining Grassland

6.2.1 Biomass

Issue: Update default biomass carbon parameters.

Location in 2006 IPCC Guidelines: Section 6.2.1.2, Table 6.1

Type of refinement: Update

Guidance to Authors (optional): Issue initially identified as an EFDB improvement, elevated to methodology report during scoping meeting. Refer to co-chair summary of Sao Paulo meeting.

6.2.2 Dead organic matter - *No refinement*

6.2.3 Soil carbon

Issue 1: Update carbon stock change factors.

Location in 2006 IPCC Guidelines: Section 6.2.3.2, Table 6.2

Type of refinement: Update

Guidance to Authors (optional): Update management, input and land use factors. Recommend re-evaluation of the time periods over which the stock changes occur with the land use change factors. There needs to be updates to factors for tropical regions for land use change and management. Changes occur more rapidly when soils are more intensively managed with land use change and there is net carbon loss, such as conversion of from forest or grassland into crop production. In contrast, changes occur more slowly when more intensively managed soils are converted back to less intensively land uses. See Table 5.3 in the 2013 Wetlands Supplement (Chapter 5, Page 5.13) for an example of different time dynamics for the land use factor between losses of carbon with drainage and more intensive management compared to restoration of wetland soils that gain carbon. Refer to scoping meeting annotated list of issues. ISSUE #5 (Category 3B).

Issue 2: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 6.2.3

Type of refinement: New guidance

Guidance to Authors (optional): Include parameters and activity data needs specific to grasslands in this section. Consider linkages with dead organic matter methods. Refer to annotated list of issues. Refer to scoping meeting annotated list of issues. (Category 3B).

6.2.4 Non-CO₂ greenhouse gas emissions from biomass burning - *No refinement*

6.3 Land Converted to Grassland

(All Issues for section 6.2 above apply to this Section similarly.)

6.4 Completeness, time series, QA/QC, and reporting - *No refinement*

Annex 6A.1 Estimation of default stock change factors for mineral soil C emissions/removals for grassland

(See the above issues under Section 6.2.3.)

Chapter 7 Wetlands

7.1 Introduction - No refinement

7.2 Managed peatlands - No refinement

7.3 Flooded Land

Issue: Update CO₂ emission factors for land converted to flooded land (Wetlands) and fully develop a consistent methodology for estimating CO₂ and CH₄ emissions from flooded lands (both land converted to flooded land and flooded land remaining flooded land).

Location in 2006 IPCC Guidelines: Section 7.3 and associated good practice guidance in Section 7.4, and Appendices 2 and 3; also relevant to Chapter 2, Section 2.3 (Generic Methodologies for CO₂ emissions and removals).

Type of refinement: New guidance/Update

Guidance to Authors: Additional information to be considered by authors:

- *Flooded lands are water bodies where human activities have caused substantial changes in surface area; including water bodies used for energy production, flood control, water storage, irrigation, navigation, recreation; they also include:*
 - *other impounded water bodies and farm ponds*
 - *run-of-the-river systems with substantial changes in water retention time, stratification, occurrence of hypoxia or other factors affecting methane and CO₂ emissions.*
- *Rice paddies are addressed in the Agriculture Chapter of the 2006 IPCC Guidelines.*
- *N₂O is considered elsewhere*
- *Excludes re-wetting of previously drained wetlands covered in 2013 Wetlands Supplement*

Pathways for Methane and CO₂ emissions to be considered:

- *Diffusive emissions*
- *Ebullition (bubbles)*
- *And, if sufficient scientific knowledge exists,*
 - *Downstream degassing (after the dam)*
 - *Rooted emergent vegetation/macrophytes*
 - *Emissions from draw - down zones*

Possible Modifiers for different-tier methodologies:

- *Latitude/temperature*
- *Age of reservoir*
- *Eutrophication (characterization of runoff)*
- *Catchment characteristics*
- *Soil type (carbon characteristics)*
- *Reservoir morphology*
- *Phytoplankton growth*
- *Sedimentation*
- *C delivery from the catchment*
- *Photomineralization*
- *Vegetation/macrophytes*
- *Water level management*

7.4 Completeness, time series consistency, and QA/QC - No refinement

7.5 Future methodological development

Issue: Clarify that this section of the 2006 IPCC Guidelines is no longer relevant

Location in the 2006 Guidelines: Section 7.5

Type of refinement: Elaboration

Guidance to Authors: Clarify that this section of the 2006 IPCC Guidelines is no longer relevant

7. X. Additional guidance on Tier 2 method for mineral soils [New]

Issue: Develop guidance to implement new Tier 2 method for mineral soils that requires less activity data than the current default method, taking into consideration Chapter 5 of the *2013 Wetland Supplement to the 2006 IPCC Guidelines: Wetlands*.

Location in 2006 IPCC Guidelines: New Section in Chapter 7 (Between Sections 7.3 and 7.4)

Type of refinement: New guidance

Guidance to authors: The current method is data intensive and only about 20% of the parties reporting to the UNFCCC have been able to successfully apply the Tier 1 or higher Tier method. Due the limited reporting, the group advised that an alternative Tier 2 method could be developed that would be more country-specific and require less activity data. However, the current Tier 1 method is valid and should be retained for those parties that have invested resources and successfully applied the approach.

Chapter 8 Settlements

8.1 Introduction - *No refinement*

8.2 Settlements Remaining Settlements

8.2.1 Biomass

Issue: Update default biomass carbon parameters.

Location in 2006 IPCC Guidelines: Section 8.2.1.2,

Type of refinement: Update

Guidance to Authors (optional): New issue identified during scoping meeting.

8.2.2 Dead organic matter - *No refinement*

8.2.3 Soil carbon

Issue: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 8.2.3

Type of refinement: New guidance

Guidance to Authors (optional): Include parameters and activity data needs specific to settlements in this section. Consider linkages with dead organic matter methods. Refer to scoping meeting annotated list of issues. (Category 3B).

8.3 Land Converted to Settlements

(All Issues for section 8.2 above apply to this Section similarly)

8.4 Completeness, time series consistency, QA/QC and reporting - *No refinement*

8.5 Basis for future methodological development

Issue: Clarify the elements in this section of the 2006 IPCC Guidelines that are no longer relevant

Location in the 2006 Guidelines: Section 8.5

Type of refinement: Elaboration

Guidance to Authors: Clarify the elements in this section of the 2006 IPCC Guidelines that are no longer relevant

Chapter 9 Other Land

9.1 Introduction - *No refinement*

9.2 Other Land Remaining Other Land - *No refinement*

9.3 Land Converted to Other Land

9.3.1 Biomass - *No refinement*

9.3.2 Dead organic matter - *No refinement*

9.3.3 Soil carbon

Issue: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 9.3.3

Type of refinement: New guidance

Guidance to Authors (optional): Include parameters and activity data needs specific to Other Lands in this section. Consider linkages with dead organic matter methods. Refer to scoping meeting annotated list of issues. (Category 3B).

9.4 Completeness, time series, QA/QC and reporting - *No refinement*

Chapter 10 Emissions from Livestock and Manure Management

10.1 Introduction - *No refinement*

10.2 Livestock population and feed characterisation

Issue 1: Update Section 10.2.2 to include guidance on improved description of feeding systems

Location in 2006 IPCC Guidelines: Section 10.2.2

Type of refinement: Update

Guidance to Authors (optional): Authors to consider feed quantity and quality related to gradient from intensive high productivity systems to lower productivity systems stratified by region and/or climate. This disaggregation in feed quantity and quality descriptions will improve the specification of the Tier 1 emission factors and Tier 2 models. Refer to annotated list of issues, related to Issue 1, AFOLU.

Issue 2: Develop consistent system descriptions for manure management between source categories (regionally/climatically stratified) for basic and enhanced characterisation for livestock populations

Location in 2006 IPCC Guidelines: Section 10.2.2

Type of refinement: Update

Guidance to Authors (optional): Authors to establish consistent relationship between livestock category, production system and manure management system, consideration of regional variation in management systems, Tables 10.14, 10.17, 10.21, 10.22, 10A.2. Refer to annotated list of issues, AFOLU, Issue #2 and #4 and considering issue raised in scoping meeting related to inconsistencies in manure management systems predicting N₂O emissions and other N loss, relative to methane.

10.3 Methane emissions from enteric fermentation

Issue: Improve parameters based on different feeding strategies for cattle and sheep.

Location in 2006 IPCC Guidelines: Section 10.3.2, Table 10.11 and Table 10.12

Type of refinement: Update

Guidance to Authors (optional): Authors to consider variation in parameters (particularly the methane conversion rate (Y_m) with variation in feed by productivity and region/climate. For non-ruminants, it is important to improve relationship between productivity and enteric/manure parameters, ensuring consistency between enteric emissions, volatile solid excretion and N excretion. Refer to annotated list of issues, AFOLU, Issue #1. Refer to scoping meeting annotated list of issues. (Category 3A and 3C).

10.4 Methane emissions from manure management

Issue 1: Update methodology, temperature relationships, Tier 1 Emission Factors and Tier 2 parameters for different manure management systems

Location in 2006 IPCC Guidelines: Section 10.4.2

Type of refinement: Update

Guidance to Authors (optional): Revise emission factors for specific manure management systems instead of region specific and temperature ranges as presented in current table. Authors to consider the validity of all aspects of the Tier 1 and 2 methodologies relative to new literature including volatile solids calculations and B₀. An entirely new approach could be developed based on estimating volatile solids for the number of livestock and then applying the emission factor by management systems, similar to manure management N₂O. Assure alignment between Enteric Fermentation parameters and the emission approach. Refer to annotated list of issues, Issue #2, AFOLU.

Issue 2: Update guidance on how to deal with non-CO₂ emissions due to biogas production.

Location in 2006 IPCC Guidelines: Section 10.4.2, Table 10.17

Type of refinement: Update

Guidance to Authors (optional): Authors to consider the robustness of all aspects of the Tier 1 and 2 methodologies relative to new studies. A new approach should consider fugitive emissions, digestate storage

and housing emissions. Authors should consider cross-cutting issues with Waste and Energy (e.g. fugitive emissions from the distribution and transmission of biogas and non-CO₂ emissions from combustion). Authors to consider whether available scientific evidence can support the development of a method to estimate N₂O emissions from biogas production in particular storage and spreading of digestate. Refer to scoping meeting annotated list of issues (3A&3C)

10.5 N₂O emissions from manure management

Issue 1: Update N excretion parameters for all livestock categories considering updated livestock characterization in Section 10.2.

Location in 2006 IPCC Guidelines: Section 10.5.2

Type of refinement: Update

Guidance to Authors (optional): Authors should consider consistency between livestock characterization and with enteric fermentation, volatile solid production and nitrogen excretion and productivity levels. Refer to annotated list of issues, AFOLU, Issue #4. New issue, not in annotated list of issues: Authors should consider a Tier 2 methodology for N excretion for swine and poultry.

Issue 2: Update emission factors for N₂O for manure management system descriptions.

Location in 2006 IPCC Guidelines: Section 10.5.2, Table 10.21

Type of refinement: Update

Guidance to Authors (optional): Authors should establish consistency between livestock characterization and with enteric fermentation, volatile solid production and nitrogen excretion. Authors to consider the robustness of all aspects of the methodology relative to new studies. Refer to annotated list of issues, AFOLU, Issue #4.

Issue 3: Update manure management volatilization and leaching factors with manure management systems identified in Section 10.2.

Location in 2006 IPCC Guidelines: Section 10.5.4, Tables 10.22 and 10.23,

Type of refinement: Update

Guidance to Authors (optional): Authors to consider the consistency with other elements of livestock production, values should be reviewed in consideration of the EMEP methodologies and parameters as well. New issue identified during scoping meeting: not in Annotated List of issues

Issue 4: Provide text on quality control procedures that use a mass balance approach to evaluate C and N flows through animal management systems.

Location in 2006 IPCC Guidelines: Section 10.5.6

Type of refinement: Elaboration

Guidance to Authors (optional): Authors to provide additional guidance on quality control on livestock and manure systems based on N and C flows. New issue raised at scoping meeting.

Chapter 11 N₂O Emissions from Managed Soils, and CO₂ Emissions from Lime and Urea Application

11.1 Introduction - *No refinement*

11.2 N₂O emissions from managed soils

11.2.1 Direct N₂O emissions

Issue 1: Update N₂O EF1, stratification by climate

Location in 2006 IPCC Guidelines: Section 11.2.1.2, Table 11.1

Type of refinement: Update

Guidance to Authors (optional): Authors consider retaining aggregated emission factor but adding disaggregated EFs by climate, analogous to water management scaling factors for rice cultivation (refer to annotated list of issues, AFOLU, Issue #5, presentation from Wollongong meeting, S. Ogle).

Issue 2: Update crop parameters for calculating residue quantity and N.

Location in 2006 IPCC Guidelines: Section 11.2.1.4, Table 11.2

Type of refinement: Update

Guidance to Authors (optional): Consider expanding crops and a general default for crops not listed in tables currently, to be used for soil N₂O and crop residue burning. New issue identified during scoping meeting: not in Annotated List of issues

Issue 3: Update the EF3 for N applied to soils, pasture, range and paddock by grazing animals.

Location in 2006 IPCC Guidelines: Section 11.2.1, Table 11.1

Type of refinement: Update

Guidance to Authors (optional): Recent literature suggests that current value is too high, see Annotated list, AFOLU Issue #6.

Issue 4: Update emission factor for rice production (N₂O)

Location in 2006 IPCC Guidelines: Section 11.2, Table 11.1

Type of refinement: Update

Guidance to Authors (optional): Literature review and refinement of existing factors based on recent publications, need factors for alternate wet/dry cycles. See Annotated list, Issue 8, AFOLU.

11.2.2 Indirect N₂O emissions

Issue: Evaluate emissions factors for indirect N₂O, both the amount of leaching/runoff and volatilization, as well as the indirect emission factor.

Location in 2006 IPCC Guidelines: Section 11.2.2, Table 11.3

Type of refinement: Update

Guidance to Authors (optional): See Annotated list, Issue #7 AFOLU. Note to authors, if there is not adequate evidence to reduce the uncertainty in the emission factor, the emission factors should not change.

11.2.3 Completeness, Time series, QA/QC - No refinement

11.3 CO₂ emissions from liming - No refinement

11.4 CO₂ emissions from urea fertilization - No refinement

Annex 11A.1 References for crop residue data in Table 11.2 - No refinement

Chapter 12 Harvested Wood Products (HWP)

Issue 1: Update the relevant technical parameters, maintaining the existing approaches in the 2006 IPCC Guidelines

Location in 2006 IPCC Guidelines: Chapter 12

Type of refinement: Update

Guidance to Authors: This is an issue that was not proposed for refinement in previous expert meetings. Authors shall retain all approaches in 2006 IPCC Guidelines. Authors should reflect the implications of the choice of the HWP approach, in particular when HWP are used in the Energy sector and imports and exports are involved, noting that *the authors of the Energy sector should make a reference in section 2.3.3.4 of the Chapter X of Volume 2*. Authors should consider any relevant information, including such information contained in IPCC methodological reports published after the 2006 IPCC Guidelines. Further refinements may be necessary pending the results of SBSTA46.

2.5 BOG 5: TOC for issues on Waste Sector (Volume 5 of 2006 IPCC Guidelines)

Co-facilitators: Deborah Bartram (USA) and Retno Gumilang Dewi (Indonesia)

Rapporteur: Anke Herold (Germany)

The BOG discussion focused on the issues to be included in the draft TOC based on the annotated list of issues (see Annex 3) prepared by TFI TSU. The annotated list includes the issues identified for a Methodology Report(s) at technical assessment meeting held in Geneva in 2015 and summarizes outcomes of the technical assessment meeting.

In addition to the issues included in the annotated list, the group also identified some new issues which need to be addressed in the Methodology Report(s) such as update of default data on waste composition and waste generation, elaboration of first order decay (FOD) method taken into account active aeration of landfills, elaboration of EFs from waste incineration related to new technologies and update of oxidation factors for open burning of MSW.

The draft TOC prepared by the group is presented at the final plenary session on Day 3 and the participants agreed to the draft TOC proposed by the BOG5. It was also agreed that further work is required to harmonize and integrate the outputs from each BOG as well as to reflect discussion at the final plenary. The harmonized final draft TOC for Waste sector is given below.

Draft TOC 5: Waste Sector

Chapter 1 Introduction - *No refinement*

Chapter 2 Waste Generation, Composition and Management Data

2.1 Introduction - *No refinement*

2.2 Waste generation and management data

Issue: Update default data on Municipal Solid Waste (MSW) generation and management

Location in 2006 IPCC Guidelines: Section 2.2.1, Table 2.1

Type of refinement: Update

Guidance to Authors: Waste generation rates are subject to change with waste policies implemented. Authors should compare the waste generation rates reported in countries' GHG inventories with default data and update Table 2.1, if this comparison indicates significant differences to the default data. In this exercise, authors should take care of whether the reported figures refer to MSW generation or MSW collection.

2.3 Waste composition

Issue 1: Update default data on MSW composition data

Location in 2006 IPCC Guidelines: Section 2.3.1, Table 2.3

Type of refinement: Update

Guidance to Authors: Waste composition is subject to change with waste policies implemented. Authors should compare the information reported in countries' GHG inventories with default composition data and update Table 2.1 if this comparison indicates significant differences to the default data.

Issue 2: Add information on nitrogen (N) content, Biochemical Oxygen Demand (BOD) or Chemical Oxygen Demand (COD) of sludge

Location in 2006 IPCC Guidelines: New guidance in Section 2.3.2

Type of refinement: New guidance

Guidance to Authors: Add information on N content, BOD or COD of sludge for sludge from domestic and industrial wastewater. If such information can be provided for sludge from industrial wastewater, the categories of industries with relevant N loads should be consistent with the wastewater chapter and this information could be referenced in the wastewater chapter. Highlight to agriculture experts.

Annex 2A.1 Waste Generation and Management Data - by country and regional averages

Issue: Update default data on MSW generation and management

Location in 2006 IPCC Guidelines: Table 2A.1

Type of refinement: Update

Guidance to Authors: Waste generation rates are subject to change with waste policies implemented. Authors should compare the waste generation rates reported in countries' GHG inventories with default data and update Table 2.1 if this comparison indicates significant differences to the default data. In this exercise, authors should take care of whether the reported figures refer to MSW generation or MSW collection. References: update with all new references used

Chapter 3 Solid Waste Disposal

3.1 Introduction - *No refinement*

3.2 Methodological issues

Issue 1: Elaborate on the First Order Decay (FOD) method taking into account active aeration of landfills

Location in 2006 IPCC Guidelines: New guidance in Section 3.2.1.1

Type of refinement: New guidance

Guidance to Authors: A number of countries use active aeration or aerobic stabilization of managed landfills at large scale as abatement measure (e.g. Germany and other European countries). Through aeration of landfills anaerobic decomposition of organic matter is replaced by fast aerobic decomposition which reduces Degradable Organic Carbon (DOC) available for anaerobic decomposition and intensive monitoring programmes have been conducted (e.g. Rettenberger et al. 2015). Active aeration has also been approved as method for Clean Development Mechanism (CDM) projects. A section should be added to the methodological

description of the FOD method for this specific technology that elaborates how the equations presented in Section 3.2.1.1 could be modified to take into account active aeration of landfills.

Issue 2: Elaborate on default DOC which decomposes (DOC_f) values for different waste components

Location in 2006 IPCC Guidelines: Section 3.2.3 (Fraction of degradable organic carbon which decomposes (DOC_f))

Type of refinement: Elaboration

Guidance to Authors: 2006 IPCC Guidelines state that higher tier methodologies (Tier 2 or 3) can also use separate DOC_f values defined for specific waste components. A number of countries use DOC_f values separated to waste components (e.g. Australia, Finland) and report on underlying research and more scientific research is available. Authors should develop a table with default values for DOC_f based on waste components as a further elaboration of Tier 1 FOD method for those countries that have waste composition data which are based on representative sampling and analyses. It is not the intention to replace the default DOC_f value of 0.5

3.3 Use of measurement in the estimation of CH_4 emissions from solid waste disposal site (SWDS) -

No refinement

3.4 Carbon stored in SWDS - *No refinement*

3.5 Completeness - *No refinement*

3.6 Developing a consistent time series - *No refinement*

3.7 Uncertainty assessment

Issue: Update uncertainty for DOC_f values

Location in 2006 IPCC Guidelines: Section 3.7.2

Type of refinement: Update

Guidance to Authors: In line with changes suggested related to DOC_f , authors should check and potentially update the information related to the uncertainty of the default DOC_f value of 0.5.

3.8 QA/QC, reporting and documentation - *No refinement*

Annex 3A.1 First Order Decay Model - *No refinement*

Chapter 4 Biological Treatment of Solid Waste - *No refinement*

Chapter 5 Incineration and Open Burning of Waste

5.1 Introduction - *No refinement*

5.2 Methodological issues - *No refinement*

5.3 Choice of activity data - *No refinement*

5.4 Choice of emission factors

Issue 1: Update oxidation factors for open burning of MSW

Location in 2006 IPCC Guidelines: Section 5.4.1, Table 5.2 (Oxidation factor for open burning of MSW)

Type of refinement: Update/Elaboration

Guidance to Authors: Recent inventory submissions in particular from development countries could be a source of data to update the oxidation factor for open burning of MSW. The current factor is based on expert judgement; thus it would be preferable if either scientific sources or sources from countries could be identified to check the expert judgement provided in 2006 IPCC Guidelines

Issue 2: Elaborate on EF for CH_4 from incineration related to new technologies gasification, pyrolysis, and plasma technology)

Location in 2006 IPCC Guidelines: Section 5.4.2, Table 5.3

Type of refinement: Elaboration

Guidance to Authors: New technologies (gasification, pyrolysis, and plasma technology) are available which are not represented in the current list of technologies in Table 5.3

Issue 3: Elaborate on EF for N_2O from incineration related to new technologies (e.g. gasification, pyrolysis, and plasma technology)

Location in 2006 IPCC Guidelines: Section, 5.4.3, Table 5.4

Type of refinement: Elaboration

Guidance to Authors: New technologies (gasification, pyrolysis, and plasma technology) are available which are not represented in the current list of technologies in Table 5.4

5.5 **Completeness** - *No refinement*

5.6 **Developing a consistent time series** - *No refinement*

5.7 **Uncertainty assessment** - *No refinement*

5.8 **QA/QC, reporting and documentation** - *No refinement*

Chapter 6 Wastewater Treatment and Discharge

6.1 Introduction

Issue 1: Update introduction language to reflect current understanding of CH₄ and N₂O emissions from wastewater treatment.

Location in 2006 IPCC Guidelines: Section 6.1

Type of refinement: Elaboration

Guidance to Authors: Discuss increased use of centralized systems with both aerobic and anaerobic zones, acknowledgement of methane generation in sewer systems, use of different types of septic systems, and evaluation of other updates (e.g., constructed wetlands supplement). Add sentence to discuss ability of systems to generate methane even if the average national temperature is below 15°C. Provide additional discussion of the variability of temperatures throughout the year, and the difference between ambient and system temperature (e.g., underground, heated).

Issue 2: Update Figure 6.1 and Table 6.1 to reflect additional types of treatment and disposal systems, such as aerobic/anaerobic treatment systems (e.g., anaerobic/anoxic/oxic (A2O), nitrification/denitrification, etc.) and constructed wetlands, as well as various types of septic systems (e.g., bottomless systems).

Location in 2006 IPCC Guidelines: Section 6.1

Type of refinement: Elaboration

Guidance to Authors: Update Figure 6.1 and Table 6.1 to reflect updates made in this methodology report (to be shaded) and also to note the relationship to Chapter 6 of the 2013 Wetlands Supplement.

Issue 3: Discuss updates/changes from 2006 IPCC Guidelines.

Location in 2006 IPCC Guidelines: Section 6.1.1

Guidance to Authors: Describe changes compared to 2006 IPCC Guidelines. Discuss use of this methodology report, in conjunction with the 2006 IPCC Guidelines and 2013 Wetlands Supplement. Discuss relation of this report to other sectors, as needed.

6.2 Methane emissions from wastewater

6.2.1 Methodological issues

6.2.2 Domestic wastewater

Issue 1: Update Section 6.2.2.1. Some inventory compilers are misinterpreting Equation 6.1 and combining zero emissions from aerobic systems with recovered methane from sludge digestion, but missing the step of calculating emissions from sludge digestion.

Location in 2006 IPCC Guidelines: Section 6.2.2.1

Type of refinement: Update

Guidance to Authors: Need to lay out the equation into multiple parts to better account for methane emissions from each type of wastewater treatment system and/or sludge management, including proper accounting of methane recovered. Suggest breakout of Equation 6.1 to be by type of treatment system, or at a minimum break out the equation for sludge treatment separately.

Issue 2: Develop new Methane Correction Factors (MCFs) to reflect treatment processes that may be a combination of aerobic and anaerobic or anoxic zones (e.g., anaerobic/anoxic/oxic (A2O), modified Ludzack-Ettinger (MLE), etc.).

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Update

Guidance to Authors: This is intended to apply to countries applying a Tier 2 or 3 methodology. Add discussion to 2nd paragraph of Section 6.2.2.2 to discuss that it is good practice to use process-specific MCFs for these types of systems.

Issue 3: Consider the development of new MCFs to reflect different types of septic system (e.g., bottomless) and also to consider the effect of temperature on the MCF.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Potential update

Guidance to Authors: At a minimum, re-evaluate the use of MCF=0.5 in Table 6.3 for “septic systems” because it already is accounting for sludge recovery. Should this MCF be higher and account for sludge separately as shown in Equation 6.1.

Issue 4: Elaborate guidance on what systems are classified as “not well managed”/overloaded for centralized aerobic treatment plants.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Elaboration

Guidance to Authors: Provide further discussion and guidance on how to evaluate whether a system should be classified as “not well managed” or “overloaded.” Are there specific characteristics that can be defined for “not well managed” and for “overloaded” systems, and to provide discussion on this topic?

Issue 5: Provide guidance on estimating emissions from septic systems that are connected to larger centralized treatment plants.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Elaboration

Guidance to Authors: Add some discussion to specify that emissions from septic system that are connected to large centralized treatment plants should be estimated separately and included in the emissions estimate.

Issue 6: Determine whether methane emissions from treated effluent should be included, particularly that discharged to stagnant water or overloaded receiving waters.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Update

Guidance to Authors: It is believed that main driver for methane emissions from treated effluent discharged would be the conditions of the receiving waters and whether there is likelihood of anaerobic conditions being present, or high organic loadings in the receiving waters. Table 6.3 could be amended to include a column reflecting the BOD removal by type of treatment system to assist inventory compilers in estimating BOD in the effluent.

Issue 7: Provide guidance on the origin of the (maximum CH₄ producing capacity) Bo values presented in the chapter.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Update

Guidance to Authors: Check original reference and describe how values were derived. Further information why Bo values should be checked are included in Geugen et al. 2016.

6.2.3 Industrial wastewater

Issue 1: Develop new MCFs to reflect treatment processes that may be a combination of aerobic and anaerobic or anoxic zones (e.g., anaerobic/anoxic/oxic (A2O), modified Ludzack-Ettinger (MLE), etc.).

Location in 2006 IPCC Guidelines: Section 6.2.3.2

Type of refinement: Update

Guidance to Authors: This is intended to apply to countries applying a Tier 2 or 3 methodology. Add discussion to 2nd paragraph of Section 6.2.3.2 to discuss that it is good practice to use process-specific MCFs for these types of systems

Issue 2: Elaborate guidance on what systems are classified as “not well managed”/overloaded for centralized aerobic treatment plants

Location in 2006 IPCC Guidelines: Section 6.2.3.2

Type of refinement: Elaboration

Guidance to Authors: Provide further discussion and guidance on how to evaluate whether a system should be classified as “not well managed” or “overloaded.” Are there specific characteristics that can be defined for “not well managed” and for “overloaded” systems, and to provide discussion on this topic?

Issue 3: Determine whether methane emissions from treated effluent should be included, particularly that discharged to stagnant water or overloaded receiving waters.

Location in 2006 IPCC Guidelines: Section 6.2.3.2

Type of refinement: Update

Guidance to Authors: It is believed that main driver for methane emissions from treated effluent discharged would be the conditions of the receiving waters and whether there is likelihood of anaerobic conditions being present, or high organic loadings in the receiving waters. Table 6.8 could be amended to include a column reflecting the BOD removal by type of treatment system to assist inventory compilers in estimating BOD in the effluent.

Issue 4: Update uncertainty tables to include new EFs and AD

Location in 2006 IPCC Guidelines: Section 6.2.3.5

Type of refinement: Update/Elaboration

Guidance to Authors: The uncertainty section should reflect any updates of emission factors and activity data suggested in the chapter.

6.3 Nitrous oxide emissions from wastewater

6.3.1 Methodological issues

Issue 1: Address “indirect” emissions and how this terminology interacts with Chapter 7.3, Volume 1 of the 2006 IPCC Guidelines.

Location in 2006 IPCC Guidelines: Section 6.3.1.1

Type of refinement: Elaboration

Guidance to Authors: Check and assess the consistency of the use of the term ‘indirect’ with the guidance provided on indirect emissions in the cross-cutting volume in Chapter 7.3, Volume 1 and discuss alternative terminology if not consistent.

Issue 2: Add discussion on the latest research related to how N₂O is formed and emitted in treatment system

Location in 2006 IPCC Guidelines: Section 6.3.1.1

Type of refinement: Elaboration

Guidance to Authors: Add discussion on the latest research related to how N₂O is formed and emitted in treatment system (see background document from Geneva meeting and related presentations), not just related to direct emissions from nitrification and denitrification systems and ensure consistency with Tables 6.1 and 6.3.

Issue 3: Consider introducing Tier 1 and Tier 2 methods, similar to the CH₄ section.

Location in 2006 IPCC Guidelines: Section 6.3.1.1

Type of refinement: Update

Guidance to Authors: Consider introducing Tier 1 and Tier 2 methods, similar to the CH₄ section, where Tier 1 uses the default values/calculations in the document (including addition of emissions from plants) and Tier 2 represents country-specific emissions estimates. Consider adding a decision tree.

Issue 4: Correct EF for nitrification/denitrification and develop N₂O emission factors for additional treatment system configurations (aerobic/anaerobic/anoxic systems) as well as activated sludge systems.

Location in 2006 IPCC Guidelines: Section 6.3.1.2

Type of refinement: Update/Elaboration

Guidance to Authors: The existing EF for nitrification/denitrification systems provided in Box 6.1 is based on measurements from a traditional activated sludge plant and does not represent nitrification/denitrification systems. Therefore, this EF should be removed from the guidance. Geneva assessment meeting discussed references that measure N₂O from various types of treatment systems, and therefore provides material that

forms a starting point for the development of EFs for additional treatment systems and activated sludge systems. Box 6.1 may be replaced by a table with EFs within Section 6.3.1.2

Issue 5: Add EF for septic systems.

Location in 2006 IPCC Guidelines: New guidance in Section 6.3.1.2

Type of refinement: New guidance

Guidance to Authors: Geneva assessment meeting provided material that allows the development of an EF for septic tanks

Issue 6: Update text regarding N (influent) to make consistent with Table 6.11.

Location in 2006 IPCC Guidelines: Section 6.3.1.3

Type of refinement: Elaboration

Guidance to Authors: Text should differentiate consistent with Table 6.11 between countries with and without garbage disposal and not between developed and developing countries

Issue 7: Clarify Food and Agriculture Organization (FAO) data in relation to protein supplied vs protein consumed

Location in 2006 IPCC Guidelines: Section 6.3.1.3

Type of refinement: Elaboration/Update

Guidance to Authors: Note that FAO data provides protein supplied and not protein consumed as required in the method. Develop additional guidance how FAO data on protein supplied could be adjusted to reflect protein consumption.

Issue 8: Addition of N₂O emission calculation for centralized plants and septic systems

Location in 2006 IPCC Guidelines: Sections 6.3.1.3/6.3.1.1

Type of refinement: Update

Guidance to Authors: Box 6.1 discussing N₂O from plants is located in this section, but consider whether it would be better placed in Section 6.3.1.1. In either case, suggest developing a new section to estimate N₂O from centralized plants and septic systems, with different N₂O EFs for different types of systems (see Section 6.3.1.2 for EFs).

Issue 9: Improve the calculation of Neffluent

Location in 2006 IPCC Guidelines: Section 6.3.1.3

Type of refinement: Update/Elaboration

Guidance to Authors: For calculation of Neffluent, need to fully address losses of N through the system prior to discharge (including air emissions and sludge). Suggest that a table of default N removal factors could be prepared for each type of wastewater treatment system to assist developers in estimating N effluent (where $\text{Neffluent} = \text{Ninfluent} * \% \text{removal N}$). Equation 6.8 should be refined to reflect these new factors. One potential way of improvement could be refining Equation 6.8 to calculate Ninfluent and Neffluent by type of system.

Issue 10: Addition of N₂O from industrial wastewater

Location in 2006 IPCC Guidelines: New guidance in Sections 6.3.1.1 and 6.3.1.3

Type of refinement: New guidance

Guidance to Authors: Consider adding estimation of N₂O emissions from industrial wastewater for those industrial wastewater sources that have high N loads. Suggest that a table of default values of N in different industrial wastewater could be developed to estimate N entering the treatment systems, and the N₂O emission factors developed for domestic water could be applied here. Information from Table 6.6 in 2013 Wetlands Supplement should be considered in this regard.

6.3.2 Time series consistency - No refinement

6.3.3 Uncertainties

Issue: Update uncertainty tables to include new EFs and AD

Location in 2006 IPCC Guidelines: Section 6.3.3

Type of refinement: Update/Elaboration

Guidance to Authors: The uncertainty section should reflect any updates of emission factors and activity data suggested in the chapter.

6.3.4 QA/QC, completeness, reporting and documentation - *No refinement*

3. Conclusions

The scoping meeting, was focused on production of the outline of a new methodology report(s) in accordance with the Appendix A to the Principles Governing IPCC Work which contains the procedures for the preparation, review, acceptance, adoption, approval and publication of IPCC reports. The background of this work is the technical assessment of the *2006 IPCC Guidelines* which was carried out by the IPCC TFI during 2014-2016 (based on around 1000 comments from more than 240 experts and 4 expert meetings with more than 230 participants). During the process of technical assessment, a list of issues which need refinement by means of production of a new methodology report(s) was identified.

As the 26th meeting of the IPCC TFB concluded, *the 2006 IPCC Guidelines provide a technically sound methodological basis of national greenhouse gas inventories and its fundamental revision is unnecessary*. The refinement work will not revise the 2006 IPCC Guidelines, but will update, supplement and/or elaborate the 2006 Guidelines. A new Methodology Report(s) will not replace the 2006 IPCC Guidelines, but will be used in conjunction with the 2006 IPCC Guidelines.

The scoping meeting concluded to recommend the following to the TFB which is also the recommendation to the IPCC Panel:

- The title of the Methodology Report should be “*2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*” (2019 Refinement).
- The format should be one single Methodology Report comprising an Overview Chapter and five volumes following the format of the *2006 IPCC Guidelines*:

Overview Chapter

Volume 1: General Guidance and Reporting

Volume 2: Energy

Volume 3: Industrial Processes and Product Use

Volume 4: Agriculture, Forestry and Other Land Use

Volume 5: Waste

- Draft outline or the draft TOC of *2019 Refinement* should be as presented in Annex 4 and the draft TOR including the Work plan and Instructions to Experts and Authors – as presented in Annex 2.

The draft TOC is focused on particular issues and covers only certain areas of the *2006 IPCC Guidelines*. For each issue a type of refinement is specified as well as a location in the *2006 IPCC Guidelines* (section, subsection, table, etc., where it is possible). However, the following two principles need to be noted:

- *Authors should develop modifications even for those Chapters/Sections/Subsections where No refinement is indicated in the draft table of contents, if deemed necessary to ensure consistency with the refinements made in the other Chapters/Sections/Subsections.*
- *Authors may conclude No refinement should be made even for the Chapters/Sections/Subsections where refinement is expected in the draft table of contents, after comprehensive review of available literature.*

The TOR is based on decisions of the IPCC-43 in Nairobi, Kenya, and TORs of the previous IPCC TFI Methodology Reports (*2006 IPCC Guidelines, 2013 Wetlands Supplement and 2013 KP Supplement*). The Work Plan also follows the decisions of the IPCC-43 and the Strategic Planning Schedule of IPCC AR6 cycle with the aim to produce a new Methodology Report in 2019.

These recommendations and documents will constitute the basis of the TFI proposal to the IPCC-44.

Annex 1: Agenda of the scoping meeting (agreed at the beginning of the meeting)

<p>Monday 29 August</p>	9:00 - 9:30	Registration
	9:30 - 10:00	<p>Welcome Address</p> <ol style="list-style-type: none"> 1. <i>Dr. Andrei Kovkhuto, the Minister of the Natural Resources and Environmental Protection of the Republic of Belarus</i> 2. <i>TFI Co-Chairs</i>
	10:00 – 10:30	<p>Photo session</p> <p>Coffee break for Press interview / informal dialogue among Co-chairs, the Government guests, Participants, Journalists</p>
	10:30 - 13:00	<p>Plenary session (Presentations followed by Q&A and discussion)</p> <ol style="list-style-type: none"> 1. <i>Introduction (background and objectives of the meeting)</i> 2. <i>Decisions taken at IPCC-43 and proposal for IPCC-44</i> 3. <i>Procedures for the preparation, review, acceptance, approval, adoption and publication of IPCC reports</i> 4. <i>Technical Assessment of IPCC Inventory Guidelines (survey, experts meetings and outcomes):</i> <ul style="list-style-type: none"> • <i>Cross-sectoral issues</i> • <i>Sectoral issues</i> 5. Expected outcome of the Scoping Meeting: <ul style="list-style-type: none"> – <i>Recommendation on the format of the Methodology Report(s)</i> – <i>Draft terms of reference (TOR)</i> – <i>Draft table of contents (TOC)</i> – <i>Draft work plan</i> – <i>Draft instructions to authors</i> – <i>Any other recommendations</i> <p>Discussions:</p> <ul style="list-style-type: none"> • <i>Format of the Methodology Report(s)</i> • <i>Key questions to be considered at this meeting (consistency across chapters, significant difference of EFs, etc.)</i>
	13:00 - 14:30	<i>Lunch break</i>
14:30 – 16:00	<p>Plenary session (continuation)</p> <ul style="list-style-type: none"> • <i>Formation of break-out groups (BOGs). The BOG formation provisionally suggested by TSU:</i> 	

		<p>BOG1: TOC for cross-sectoral issues (Volume . 1 of 2006 IPCC Guidelines)</p> <p>BOG2: TOC for issues on Energy Sector (Volume . 2 of 2006 IPCC Guidelines)</p> <p>BOG3: TOC for issues on IPPU Sector (Volume. 3 of 2006 IPCC Guidelines)</p> <p>BOG4: TOC for issues on AFOLU Sector (Volume . 4 of 2006 IPCC Guidelines)</p> <p>BOG5: TOC for issues on Waste Sector (Volume . 5 of 2006 IPCC Guidelines)</p> <p><i>(BOG formation depends on the result of discussion on the format of MR(s). Some BOGs may wish to split into sub-BOGs. Other BOG(s) may be considered necessary in addition to these 5 BOGs)</i></p>
	16:20 – 18:00	<p>Break-out Group (BOG) session</p> <p>Each BOG will consider draft TOC as well as the following:</p> <ul style="list-style-type: none"> • <i>Issues that need to be addressed in the draft TOR</i> • <i>Issues that need to be addressed in the draft instructions to authors</i> • <i>Any other issues for discussion at the plenary</i>
Tuesday 30 August	09:00 - 10:00	<p>Plenary session</p> <p>Discussion on cross-BOG issues that have arisen during the BOG session:</p> <ul style="list-style-type: none"> • <i>Issues that need to be addressed in the draft TOR</i> • <i>Issues that need to be addressed in the draft instructions to authors</i> • <i>Any other issues for discussion at the plenary</i>
	10:00 – 13:00	<p>BOG session (continuation from Day 1)</p> <p>Each BOG will consider draft TOC as well as the following:</p> <ul style="list-style-type: none"> • <i>Issues that need to be addressed in the draft TOR</i> • <i>Issues that need to be addressed in the draft instructions to authors</i> • <i>Any other issues for discussion at the plenary</i>
	13:00 - 14:30	<i>Lunch break</i>
	14:30 - 17:00	<p>BOG session (continuation)</p> <p>Each BOG will consider draft TOC as well as the following:</p> <ul style="list-style-type: none"> • <i>Issues that need to be addressed in the draft TOR</i> • <i>Issues that need to be addressed in the draft instructions to authors</i> • <i>Any other issues for discussion at the plenary</i> <p><i>A small group will revise the draft TOR and draft instructions to authors in parallel to this BOG session.</i></p>
	17:00 – 18:00	<p>Plenary session</p> <p>Discussion on cross-BOG issues that have arisen during the BOG session:</p> <ul style="list-style-type: none"> • <i>Issues that need to be addressed in the draft TOR</i> • <i>Issues that need to be addressed in the draft instructions to authors</i> • <i>Any other issues for discussion at the plenary</i>

		<i>If this plenary discussion is not considered necessary, BOG session will continue.</i>
Wednesday 31 August	09:00 - 13:00	<p>BOG session (continuation from Day 2)</p> <p>Each BOG will consider draft TOC as well as the following:</p> <ul style="list-style-type: none"> • <i>Issues that need to be addressed in the draft TOR</i> • <i>Issues that need to be addressed in the draft instructions to authors</i> • <i>Any other issues for discussion at the plenary</i> <p><i>A small group will revise the draft TOR and draft instructions to authors in parallel to this BOG session.</i></p>
	13:00 - 14:30	<i>Lunch break</i>
	14:30 – 17:30	<p>Plenary session (Discussion based on reports from BOGs & wrap-up)</p> <ul style="list-style-type: none"> • <i>Presentation of draft TOC from each BOG</i> • <i>Presentation of draft TOR, draft instructions to authors, and draft work plan</i> • <i>Discussion</i> • <i>Wrap-up discussion to agree on recommendations to Task Force Bureau</i> • <i>Closing remarks</i>

Coffee break: 11:00 – 11:20 and 16:00 – 16:20 every day

Annex 2: Draft Terms of Reference (TOR), including Work Plan and Instructions to Experts and Authors

Draft Terms of Reference

for the production of a Methodology Report to Refine the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Background

1. *The 26th Meeting of Task Force Bureau (TFB) (28 - 29 August 2014, Ottawa) concluded that:*
 - *The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines) provide a technically sound methodological basis of national greenhouse gas inventories, and therefore fundamental revision is unnecessary.*
 - *To maintain the scientific validity of the 2006 IPCC Guidelines, certain refinements may be required, taking into account scientific and other technical advances that have matured sufficiently since 2006.*
2. *Following these conclusions by the TFB and approval by the IPCC at its 40th Session, the Task Force on National Greenhouse Gas Inventories (TFI) started a technical assessment of IPCC Inventory Guidelines through an on-line questionnaire survey and four expert meetings in 2015 and 2016. The technical assessment revealed that there has been abundant new scientific and empirical knowledge published since 2006 which the IPCC should take into account, particularly with respect to data for emission factor development for some categories and gases. Consequently, the necessity and usefulness of refining the current methodological guidance (e.g. updating default emission factors) has been recognized by TFB.*
3. *A refinement of the 2006 IPCC Guidelines is required as early as possible in order to address the issues that were identified through the technical assessment referred to in paragraph 2 above. The refinement will help all UNFCCC Parties use good practice inventory methodologies based on up-to-date scientific knowledge.*

Scope

4. *The IPCC at its 43rd Session (11-13 April 2016, Nairobi) approved the proposal on "Refinement of 2006 IPCC Guidelines for National Greenhouse Gas Inventories, including production of a Methodology Report(s)" as contained in the Decision IPCC/XXIII-8 "Update of methodologies on National Greenhouse Gas Inventories", and decided to consider the draft Methodology Report(s) at a Plenary session of the IPCC in May 2019 as contained in the Decision IPCC/XXIII-7 "Sixth Assessment Report (AR6) Products. Strategic Planning".*
5. *The overall aim of the refinement of the 2006 IPCC Guidelines is to provide an updated and sound scientific basis for supporting the preparation and continuous improvement of national greenhouse gas inventories.*
6. *In order to achieve the overall aim, the Methodology Report will:*
 - *Provide supplementary methodologies for sources or sinks of greenhouse gases only where currently there are gaps or where new technologies and production processes have emerged requiring elaborated methodologies or for sources or sinks that are not well covered by the 2006 IPCC Guidelines;*

- Provide updated default values of emission factors and other parameters based on the latest available science only where significant differences from currently adopted factors are identified;
 - Provide additional or alternative up-to-date information and guidance, where possible, as clarification or elaboration of existing guidance in the 2006 IPCC Guidelines.
7. In line with paragraph 6 above, the Methodology Report will clearly indicate what type of refinement is provided in each section. The types of refinement are defined in **Annex 1**. These terms should be used consistently throughout the Methodology Report.
 8. For the purpose of elaborating on and clarifying the existing IPCC guidance, the Methodology Report should aim to address any important needs for clarification arising from GHG inventory reviews or the technical analysis of inventories as part of biennial update reports under the UNFCCC if such needs are identified in time during the elaboration of the report.
 9. The refinement work will not revise the 2006 IPCC Guidelines, but will update, supplement and/or elaborate the 2006 IPCC Guidelines where gaps or out-of-date science have been identified. The Methodology Report will not replace the 2006 IPCC Guidelines, but will be used in conjunction with the 2006 IPCC Guidelines.

Approach

10. The result of this work will be an IPCC Methodology Report "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories".
11. The authors will follow **Annex 2** "Instructions to Experts and Authors" to ensure a consistent and coherent approach across all the volumes or chapters, including the use of common terminology.
12. Literature will be considered up to a cut-off date at the start of the Government/Expert Review.
13. Table 1 provides the time table for this task.

Annex 2 Continued: Table 1: Work Plan

Date	Action	Comments
October 2016	IPCC-44	IPCC Plenary approves TOR, chapter outline, work plan and guidance to authors
November 2016	Call for Nomination of Authors and Review Editors	IPCC invites nominations from governments and international organizations
February 2017	TFB select Authors and Review Editors	Selection by TFB considering expertise and geographical coverage
June 2017	1 st Lead Author Meetings	LAM1a (non-AFOLU) and LAM1b (AFOLU) and LAM1c (General Guidance and Reporting). To develop zero order draft
September 2017	2 nd Lead Author Meeting	To develop first order draft for review
December 2017– January 2018	Expert Review	8 weeks review by experts
March 2018	Science Meeting	A small meeting of CLAs and some LAs to discuss specific issues that require intensive discussion to reinforce the writing process.
April 2018	3 rd Lead Author Meeting	To consider comments and produce second order draft for review
xxx 2018	Literature cut-off date	Only papers published before this date will be considered
July-August 2018	Government & Expert Review	8 weeks review by governments and experts
October 2018	4 th Lead Author Meeting	To consider comments and produce final draft
January 2019	Government Review	Distribute to governments for their consideration prior to approval (at least 4 weeks prior to the Panel)
May 2019	Adoption/acceptance by IPCC-49	Final draft submitted to IPCC Panel for adoption/acceptance
xxx 2019	Distribute Report	Distribute to governments and international organizations

Annex 2 Continued: Types of refinement

The following three refinement types should be indicated in the refined sections of the Methodology Report.

<p>1. Update</p>	<p>This is to update existing guidance (table, section, or an entire chapter) to address the needs explained in the first or second bullet under paragraph 6 in this TOR. New elements that do not change default approaches in the existing guidance is considered “update”. A typical example is to provide new default values for EFs contained in a table in the <i>2006 IPCC Guidelines</i>, and in this case it is considered “Update of Table X.X (on default EFs)”.</p> <p>Update of section or entire chapter is to rewrite an existing section or chapter including existing information and new information in the case it is difficult to provide only the new information without overlap with existing guidance.</p> <p>From the inventory compiler’s view point, “update” of existing guidance means that they are encouraged to use the table/section/chapter in the new Methodology Report <u>instead of</u> the corresponding table/section/chapter in the <i>2006 IPCC Guidelines</i>.</p>
<p>2. Elaboration</p>	<p>This is to elaborate existing guidance to address the needs explained in the first or third bullet under paragraph 6 in this TOR.</p> <p>New elements that may be added to default approaches in the existing guidance is considered “elaboration”. Also, additional or alternative up-to-date information and guidance provided to clarify existing guidance is considered “elaboration”. A typical example is to include the contents in FAQs in TFI website in the new Methodology Report(s).</p> <p>Elaboration of section or entire chapter is NOT to rewrite an existing section or chapter, but to provide a sub-section or section which contains additional or alternative up-to-date information without overlap with existing guidance.</p> <p>From the inventory compiler’s view point, “elaboration” of existing guidance means that they are encouraged to use the table/section/chapter in the new Methodology Report <u>in conjunction with</u> the corresponding table/section/chapter in the <i>2006 IPCC Guidelines</i>.</p>
<p>3. New guidance</p>	<p>This is to add completely new guidance on issues for which there is essentially no guidance in the <i>2006 IPCC Guidelines</i> to address the needs explained in the first bullet under paragraph 6 in this TOR.</p> <p>Creation of default approaches to issues that are not well covered in the 2006 IPCC Guidelines is considered “new guidance”.</p> <p>From the inventory compiler’s view point, “new guidance” means that they are encouraged to use the section/chapter in the new Methodology Report <u>without reference to</u> specific sections/chapters in the <i>2006 IPCC Guidelines</i>, recognizing that there is essentially no corresponding guidance in the <i>2006 IPCC Guidelines</i>.</p>

Besides, “No refinement” should indicate that no refinement has been made in that section.

Annex 2 continued: Instructions to Experts and Authors

1. Work on a Methodology Report to refine the *2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines)* will be guided by the IPCC procedures for the Preparation, Review, Acceptance, Adoption, Approval and Publication of the IPCC Reports (Appendix A to the Principles Governing the IPCC Work⁷). This document is consistent with the IPCC procedures, and applies to all experts engaged in the production of a new Methodology Report.
2. In this document the term “experts” covers Co-Chairs, members of the TFI Bureau (TFB), TSU Staff, Coordinating Lead Authors (CLAs), Lead Authors (LAs), and Review Editors (REs) as well as Contributing Authors (CAs) and Expert Reviewers.
3. These notes are intended as guidance to experts contributing to a new Methodology Report. They are intended to ensure a consistent and coherent approach across all the volumes or chapters and to promote common terms used.

Confidentiality

4. Authors meetings are closed meetings. Any discussions are confidential except for any published report of the meeting. This is to ensure that experts participating in the meetings can express themselves and discuss issues freely and openly.
5. The IPCC considers the drafts of a new Methodology Report, prior to acceptance, to be pre-decisional, provided in confidence to reviewers, and not for public distribution, quotation or citation.
6. The TSU will keep drafts of a new Methodology Report sent for the IPCC review, any comments received on them and the responses by authors. All written expert and government review comments will be made available to reviewers on request. These will be made available on the IPCC website as soon as possible after the acceptance by the Panel and the finalisation of the report.

Conflict of Interest

7. It is important that all experts involved in the IPCC activities avoid any conflict of interest or the direct and substantial appearance of a conflict of interest. It is recognised that many experts in Emission Inventories are employed by, or funded by, parties with some interest in the outcome (e.g. most inventory compilers are funded by national governments or industry). It is therefore important to be open and transparent about financial and other interests.
8. The IPCC implements a Conflict of Interest (COI) Policy^{8 9} that applies to all individuals directly involved in the preparation of IPCC reports, including senior IPCC leadership (IPCC Chair and Vice-Chairs), other Bureau and Task Force Bureau members, authors with responsibilities for report content (CLAs, LAs), Review Editors and staff of the Technical Support Units. The overall purpose of this policy is to protect the legitimacy, integrity, trust, and credibility of the IPCC and of those directly involved in the preparation of reports, and its activities.
9. Before an individual is appointed as a CLA, LA and RE for a new Methodology Report, the TFB will request the individual to complete a Conflict of Interest Disclosure Form (“the COI Form”) contained in Annex B to the COI Policy which will be submitted to the TFI TSU. The TFB will then evaluate the form to determine whether the individual has a conflict of interest that cannot be resolved.
10. All CLAs, LAs and REs will inform the TFI TSU annually of any changes in the information provided in their previously submitted COI Form. The TFB will evaluate the revised information.
11. All COI Forms and any records of the deliberations of the COI Expert Advisory Group, deliberations and/or decisions of the COI Committee in relation to conflict of interest issues in respect of specific individuals and any information disclosed by individuals for the purposes of the COI Policy will be transferred to the Secretariat after they have been reviewed and will be securely archived by the Secretariat and retained for a period of five years after the end of the assessment cycle during which the relevant individual contributed, after which the information will be destroyed. Subject to requirement to notify the existence of a conflict of interest to others, the information referred to above will be considered confidential and will not be used for any purpose other than consideration of conflict of interest issues under these Implementation Procedures without the express consent of the individual providing the information.

⁷ <http://www.ipcc.ch/pdf/ipcc-principles/ipcc-principles-appendix-a-final.pdf>

⁸ <http://www.ipcc.ch/pdf/ipcc-principles/ipcc-conflict-of-interest.pdf>

⁹ The IPCC COI Policy including the COI Form is currently being reviewed and may be revised at the 44th Session of the IPCC in Bangkok, Thailand, on 17-20 October 2016. If it is revised at that session of the IPCC, paragraphs 8-11 of this document will be revised accordingly.

Responsibilities of authors and other experts

12. The role of authors is to impartially assess ALL the available literature and to describe the best methodologies available. Experts should be impartial. Authors should review all literature available up to a cut-off date to be decided by the TFB as part of the agreed work plan.
13. After drafting the report authors will be asked to consider all comments received on the drafts and to adjust and revise the text accordingly. They should document their responses. If they do not accept a comment this should be explained. Review Editors should check whether the accepted changes were fully incorporated in the revised text.
14. Responsibilities and duties of authors and other experts are currently explained in more detail in the IPCC procedures for the Preparation, Review, Acceptance, Adoption, Approval and Publication of the IPCC Reports (Appendix A to the Principles Governing the IPCC Work).

Literature

15. The use of literature should be open and transparent. In the drafting process, emphasis is to be placed on the assurance of the quality of all cited literature. Priority should be given to peer-reviewed scientific, technical and socio-economic literature if available.
16. It is recognized that other sources provide crucial information for IPCC Reports. These sources may include reports from governments, industry, and research institutions, international and other organizations, or conference proceedings. Use of this literature brings with it an extra responsibility for the author teams to ensure the quality and validity of cited sources and information. In general, newspapers and magazines are not valid sources of scientific information. Blogs, social networking sites, and broadcast media are not acceptable sources of information for IPCC Reports. Personal communications of scientific results are also not acceptable sources.
17. For any sources written in a language other than English, an executive summary or abstract in English is required.
18. All sources will be integrated into a reference section of an IPCC Report.
19. For more details of the procedure on the use of literature in IPCC Reports, see Annex 2 to the IPCC procedures for the Preparation, Review, Acceptance, Adoption, Approval and Publication of the IPCC Reports (Appendix A to the Principles Governing the IPCC Work).

Principles of the new Methodology Report

20. Guidance in the new Methodology Report should be understandable and easy to implement. Lead authors should make efforts to balance the need to produce a comprehensive self-contained report with reasonable limits to the length and detail of the guidance. In particular:
 - a. The guidance should follow a cookbook approach by providing clear step by step instructions. It should not try to be a textbook. Detailed background information on emission processes, scientific studies, etc. is generally referenced rather than included.
 - b. Lead authors must consider all recent scientific developments and national methods used by countries in their inventories.
 - c. Significant changes from the *2006 IPCC Guidelines* will have significant implications for all countries. Parties to the UNFCCC use the IPCC Guidelines to prepare national inventories and national communications. Substantial changes should only be introduced if they can be justified on sound scientific and technical grounds.
 - d. Authors should bear in mind that the target audience is a diverse group of readers who are primarily concerned with the elaboration of national inventories. For this reason, the emphasis should be on ensuring clear communication of practical and understandable guidance.
21. This work aims to cover all IPCC inventory sectors but only those categories where the science is considered to have sufficiently advanced since the 2006 or where new or additional guidance is required, namely the categories that were selected through technical assessment carried out in 2015 and 2016 and the Scoping Meeting held in August 2016 using the significance and prioritization criteria as shown below. However, authors should also develop modifications for other parts of the *2006 IPCC Guidelines* if deemed necessary to achieve consistency with the refinements mandated by the IPCC Plenary. On the other hand, authors may conclude no refinement should be made even for the categories that were selected through the process mentioned above, after comprehensive review of available literature.

Significance and prioritization criteria

- *Significance of the source/sink and the gas within the sector on a global scale. Sources significant only for a limited number of particular countries, currently or in the foreseeable future, may not meet this criterion. The adequacy of the existing guidance for a particular category should be considered, as should the likelihood that new information would lead to a definite improvement in the IPCC Guidelines.*
- *Availability of relevant new scientific results.*
- *Sufficient data availability and maturity of scientific advances since 2006 to provide a basis for methodological development or refinement, including:*
 - *Ability to develop new or updated default emission/removal factors*
 - *Feasibility of obtaining the necessary data to implement the methods*
- *Emergence of new sources or gases meeting these criteria*

22. The new Methodology Report will cover the same greenhouse gases and precursors as included in the *2006 IPCC Guidelines*.
23. The general structure, approach and definitions used in the *2006 IPCC Guidelines*, such as tiered approach and decision trees will be followed. Annexes may be used where necessary to contain additional data to support the methodologies, although large numbers of annexes will probably not be necessary. Appendices are not ruled out where scientific knowledge is insufficient for countries to agree full methodologies, but please avoid as far as possible work on areas that have to be relegated to an appendix. Appendices should be sub-titled by “Basis for future methodological development”.

Reporting Tables and worksheets

24. Refinement of worksheets and reporting tables may be required. Worksheets reflect the application of tier 1 methods only, due to the varied implementation of higher tier methods by countries. Lead authors should stress the importance of documentation and archiving of particular types of information of relevance to each category, although advice may be given of what needs to be reported for transparency at higher Tiers.

Emission factors and methods

25. Authors should provide default emission factors. In doing this work, they should draw on the widest possible range of available literature, including the IPCC Emission Factor Database (EFDB), scientific articles and country reports.
26. All new default data should be evaluated for scientific and technical appropriateness, and their development should be clearly described and referenced. The attached form (Appendix 1) should be used as the means for documenting data and the derivation procedure which will also facilitate future integration of the EFDB and the archiving of the derivation. Lead authors should be familiar with the draft cross-cutting guidance on data collection in Volume 1 and the guidance on cross-cutting issues in this note on terms, data types, data demands of methods and stratification requirements. Default data should also meet the EFDB evaluation criteria – robustness, documentation, and applicability.
27. Authors should develop guidance to provide additional information on rationale, references and background information on parameters used for estimating of default values where such information is available (similar to Annex 3A.3 of Wetlands Supplement), with a view to enhancing the transparency and applicability of default values presented in the new Methodology Report.
28. Single IPCC default factors might not be ideal for any one country, but they can be recommended provided that regional factors are unavailable, and the defaults are representative of typical conditions as far as can be determined. It may be necessary or appropriate to provide a range of default factors along with clear guidance about how countries should select from within the range. Lead authors may also provide multiple default emission factors, disaggregated by region, technology, or another classification scheme (e.g., livestock type),
29. It is important to provide more default emission factors that reflect the unique conditions of developing countries. Default emission factors for Tier 1 should represent emissions without category-specific mitigation measures.
30. Users of the guidelines should be encouraged to develop and use country specific data. Emission factors for higher tiers need not be specified in the *2006 IPCC Guidelines*. 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.

31. The basic principle concerning national methods will continue to apply – countries are encouraged to use national data or methods so long as they are consistent with the IPCC Guidelines.

Decision trees

32. Consistent with the format and structure the *2006 IPCC Guidelines*, the new Methodology Report may contain a decision tree for some sub-categories to assist countries in selecting from the IPCC methods. These decision trees link the choice of IPCC methods to national circumstances via specific questions about data availability and status as a key source category¹⁰.

33. To ensure consistency in decision tree logic and format across categories, lead authors should adhere to the following requirements:

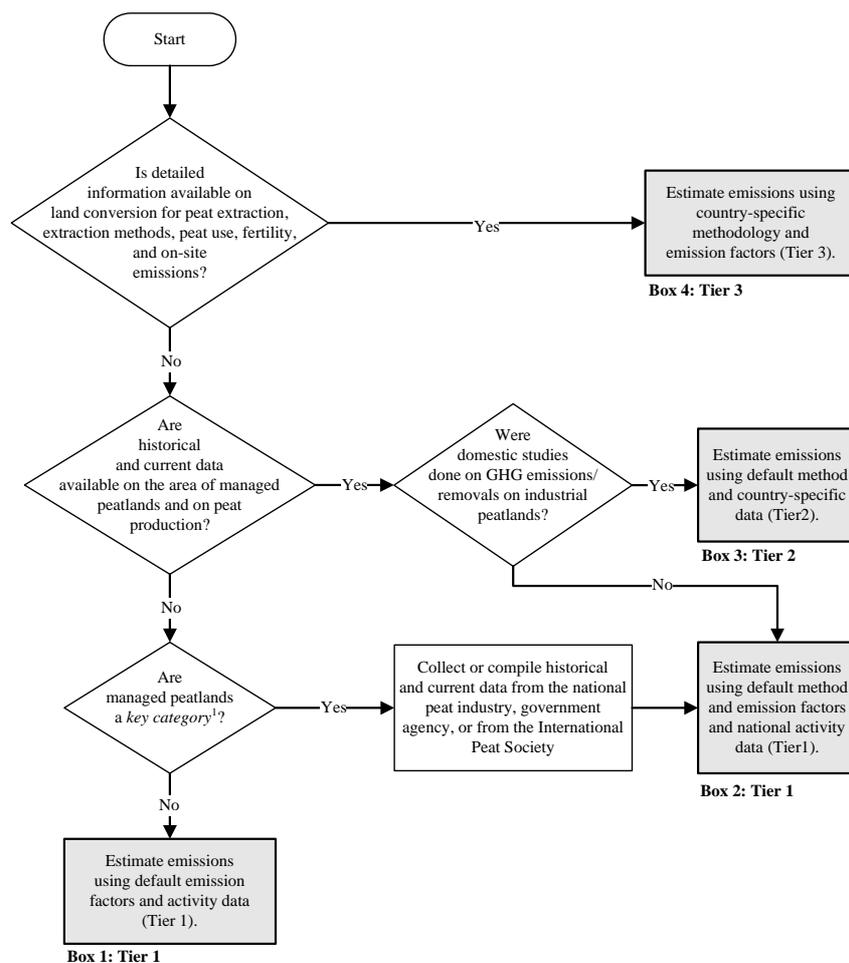
- a. The decision trees should be based on a series of questions with clear yes/no answers, and two subsequent branches along yes/no paths.
- b. The decision trees should start with assessing data availability for the highest tier method, and then direct countries step-wise towards lower tier methods if activity data, emission factors or other parameters are not available.
- c. The decision tree should indicate the lowest tier method that is judged to be appropriate for estimating emissions/removals from a key category.
- d. If data are not available for the method referred to in 3, the 'No' response should direct the reader to the question "Is this a key category?" If the answer to this is 'Yes', the decision tree should recommend that the country collect the necessary data to implement a higher tier method. If the answer is 'No', then the decision tree can recommend a lower tier method. There is no need to deal with the case for a key source where a country does not have the resources to gather additional data needed to implement higher Tier methods. This is dealt with in Volume 1 of the *2006 IPCC Guidelines*.
- e. The branches of the decision trees should end in 'out-boxes' that correspond to specific tiers identified in the guidance for that category and are labelled by Tier. Lead authors may also recommend out-boxes for hybrid tiers.
- f. Lead authors may develop separate decision trees for different sub-categories. Alternatively, they may include decision tree options for selecting different tiers for different sub-categories. This second option is appropriate if it is advantageous to recommend a higher tier method only for significant sub-categories rather than for the entire category. Decision trees that use the 'significance' criterion must include the "25-30% rule" (i.e., a significant sub-category is one that makes up more than 25-30% of emissions/removals from a category).

34. Additional Formatting Guidelines (see example):

- a. Decision trees should be drafted in separate Microsoft Word files. The TSU will integrate these files into the main text at a later date.
- b. Decision trees should NOT ask the question: "Does this source occur in the country?" This is because decision trees will only be used for sources which occur.
- c. There should be a "START" box.
- d. "Diamonds" should be used for questions/decisions.
- e. "Squares" should be used for all other information.
- f. The out-boxes should be individually numbered.
- g. The text font should be Times New Roman 10pt.
- h. Text should be centred within the boxes.

¹⁰ The most appropriate choice of estimation method (or tier) may also depend on national circumstances, including the availability of resources and advice on this will be given in the cross-cutting volume.

Decision tree to estimate CO₂-C and N₂O emissions from *Peatlands Remaining Peatlands*



Note:
1: See Volume 1 Chapter 4, "Methodological Choice and Identification of Key Categories" (noting Section 4.1.2 on limited resources), for discussion of *key categories* and use of decision trees.

IPCC Emission Factor Database (EFDB)

35. The EFDB is an important resource for this work, both as a source of emission factors for consideration by the LAs and as a repository of emission factors once agreed for use in the guidelines.
36. The new Methodology Report may contain Tier 1 methods and the corresponding default emission factors (once the guidelines are approved by the IPCC, the default emission factors cannot change). These defaults need to be recorded in to the EFDB, either because they are already there, or they will have to be entered as a result of the process of developing the Methodology Report. Preferably the EFDB should be populated with new emission factors as the Methodology Reports are drafted, but if this proves impossible the guideline emission factors should be entered in the EFDB with the underlying documentation information in the property fields as soon as possible, after guidelines completion.
37. The evolving information on peer reviewed emission factors in the EFDB will also be a useful source of information for countries to refer to in applying Tier 2 and 3 methods. In applying these methods (Tier 2 and/or 3) it will remain the country's responsibility to ensure that the choice of emission factors properly reflects national circumstances and is consistent with the requirements of the *2006 IPCC Guidelines*, and to document that this is the case.
38. It should be noted that Methodology Reports go through IPCC reviews, but the EFDB does not. The EFDB is a long(er)-term exercise. The TSU will provide technical advice/information to authors for their consideration.

Definitions

39. The following terms will be used throughout the new Methodology Report, and it is essential that all Lead Authors have a common understanding of their meaning and relevance:
40. **Tier A** Tier refers to a description of the overall complexity of a methodology and its data requirements. Higher tier methods are generally more complex and data-intensive than lower tier methods. The guidance for each category should contain at least a Tier 1 method, and in many cases there will be a Tier 2 and Tier 3. The general expectation is that Tier 2 and Tier 3 methods will both be consistent with good practice guidance for key sources, although in some cases Tier 3 will be preferred, for example with methane from coal mines where Tier 1 is a global default value, Tier 2 basin specific and Tier 3 mine specific.
41. **Tier 1** approaches are simple methods that can be applied by all countries in all circumstances. Default values for the emission factors and any other parameters needed must be supplied (see below for documentation needed).
42. **Tier 2** methods should in principle follow the same methodological approach as Tier 1, but allow for higher resolution country specific emissions factors and activity data. In some categories, this may not be the case. These methods should better replicate the parameters affecting the emissions. Country specific emission factors are needed and possibly more parameters will also be needed.
43. **Tier 3** methods give flexibility either for country specific methods including modelling or direct measurement approaches, or for a higher level of disaggregation, or both. This is a more complex method, often involving a model. This will replicate many features of nation emissions and require specific parameters for each country.
44. **Default information** is data that is appropriate for use where there is no better detailed, country specific information. If appropriate, authors may specify regional default data. Users of the guidelines should be encouraged to try to find better country specific data. Default data are appropriate for Tier 1 methods and the guidelines should contain all the default values needed. Emission factors for higher tiers need not be specified because it is a function of higher tier methods to find data reflecting national circumstances. Volume 1 of the *2006 IPCC Guidelines* suggests that the EFDB may help identify data reflecting national circumstances, but reference to the EFDB should in no case be used as a device for evading the necessity of finding data for default methods. 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.
45. **Decision Trees**. A decision tree is a graphical tool to assist countries in selecting from the IPCC methods.
46. **Sector** refers to the four sectors of the guidelines (Energy; Industrial Process and Product Use (IPPU); Agriculture, Forests and Other Land Use (AFOLU) and Waste) these are divided into source/sink categories and sub categories.
- a. Sector 1
 - b. Category 1.A
 - c. Sub-category 1st order 1.A.1
 - d. Sub-category 2nd order 1.A.1.a
 - e. Sub-category 3rd order, 1.A.1.a.i,
47. **Worksheets**. These will be printed versions of spreadsheet tables, that, when filled in, enable the user to perform the emission estimation. They should contain all the calculations and written text with any formulae. Additional worksheets may be required to compile the results of the worksheets into the reporting tables.
48. **Reporting Tables** are tables that present the calculated emission inventory and sufficient detail of other data used to prepare the inventories for others to understand the emission estimates.
49. Usage:
- a. **Good Practice**, is defined as a set of procedures intended to ensure that greenhouse gas inventories are accurate in the sense that they are systematically neither over nor underestimates so far as can be judged, and that uncertainties are reduced so far as possible. Inventories consistent with good practice are those which contain neither over- nor under-estimates so far as can be judged, and in which uncertainties are reduced as far as is practicable. To say that “It is Good Practice to do x” implies x is part of the good practice procedures.
 - b. **“Shall”** should not be used. Either say “Good Practice is...” or say what needs to be done or what should be done. These all indicate what needs to be done to comply with Good Practice.

- c. "Be encouraged to" indicates a step or activity that will lead to higher quality inventory, but are not required for ensuring consistency with the IPCC Guidelines.
- d. "Recommend" should not be used. In the GPG2000, the word "recommend" was avoided and "Suggested" was used instead.
- e. "Inventory agency" is the body responsible for actually compiling the inventory, perhaps from contributions from a number of other bodies while "inventory compiler" is the person actually compiling the inventory,

Units

- 50. SI units shall be used throughout: in text, equations, worksheets and tables. Emissions have to be expressed in mass units and units have to be used consistently within the each sector. When similar activity data is used for different sectors same units need to be used (CLAs have to take care about such harmonisation). Conversion factors have to be provided (for example to estimate N₂O from N). Where input data available may not be in SI units conversions should be provided.
- 51. Standard abbreviations for units and chemical compounds are given in Appendix 2. (See also a complete discussion available at <http://www.bipm.org/en/publications/si-brochure/>)
- 52. For the purpose of reporting, the sign convention is positive (+) for emissions, and negative (-) for removals (uptake). Where needed, for estimation of removals and carbon stock increases are counted positive, and the sign reversed for reporting purposes. This is consistent with the *2006 IPCC Guidelines* and other Methodology Reports on national GHG inventories in the past.

Appendix 1. Data Documentation

This form should be used to document all data used in the new Methodology Report. This gives the minimum information that should be considered by the authors.

Author ¹					
IPCC Source/Sink Category					
Fuel ² (applicable only in the Energy Sector):					
Gas ³ :	CO ₂	CH ₄	N ₂ O		
Value:					
Unit:					
Uncertainty (as +/-% or 2.5 and 97.5 percentiles) ⁴					
Applicability ⁵ – fill in as necessary if data not generally applicable. Describe appropriate Technologies, Practices, Abatement Technologies, Region, and/or Regional Conditions					
Source of data (chose one)	Measurement - Scientific Literature Other Measurement National Inventory Report Calculated Based on fuel quality Expert Judgement				
Method of derivation of the value (e.g., arithmetic mean, weighted mean, adjustment of a literature data by expert judgment etc.)					
Reference ⁶					

Note:

The author is the LA/CA/CLA who writes the relevant section and proposes the data.

Fuels as defined in the Energy volume

Add additional gases as required

As defined by cross-cutting volume

Only to be completed where it is necessary to specify the applicability of the data

As reference to document, report, calculation or if expert judgement to those involved (Names or group e.g. "Waste BOG on Solid Waste Disposal Sites")

Appendix 2 Units and Abbreviations

Abbreviations of, and how to Spell, Chemical Compounds

CH ₄	Methane
N ₂ O	Nitrous oxide ¹¹
CO ₂	Carbon dioxide
CO	Carbon monoxide
NO _x	Nitrogen oxides
NMVOCS	Non-methane volatile organic compounds
NH ₃	Ammonia
CFCs	Chlorofluorocarbons
HFCs	Hydrofluorocarbons
PFCs	Perfluorocarbons
SF ₆	Sulphur hexafluoride
CCl ₄	Carbon tetrachloride
C ₂ F ₆	Hexafluoroethane
CF ₄	Tetrafluoromethane
S	Sulphur

Units and abbreviations

cubic metre	m ³
Hectare	Ha
Gram	g
Gigagram	Gg
Tonne	T
Gigatonne	Gt
Joule	J
degree Celsius	°C
Calorie	Cal
Year	Yr
Capita	Cap
Gallon	Gal
dry matter	Dm

¹¹ In the IUPCA N₂O is officially named "Dinitrogen Oxide". However, "nitrous oxide" is widely used and understood in the emission inventory community and by the UNFCCC and so, to avoid confusion, will be used.

Prefixes and multiplication factors

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

Standard equivalents

1 tonne of oil equivalent (toe)	1 x 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 gigatonne	1 petagram
1 kilogram	2.2046 lbs
1 hectare	10 ⁴ m ²
1 calorie _{IT}	4.1868 joule
1 atmosphere	101.325 kPa

Annex 3: Annotated lists of issues for all sectors

Cross-sectoral (General Guidance and Reporting)

Refinement Options:

1. Update
2. Elaboration
3. New guidance

For details of these options, see the document on “Explanation of Refinement Options”.

Issue #1.

Chapter 1. Introduction

Clarification of the concept of “anthropogenic emissions and removals”

Wollongong Expert Meeting (2016) recommended guidelines be updated to reflect the following: for the AFOLU sector to extend circumstances under which the “Managed Land Proxy” should be supplemented with techniques to distinguish between anthropogenic and natural or background emissions (e.g. by drawing on Guidance contained in the 2013 KP Supplement chapter 2.3.4 and 2.3.5 and the 2013 Wetlands Supplement)

Suggested refinement option(s): [Update]

(Update of Section 1.1 Concepts, Chapter 1, and Volume 1 with Guidance contained in the 2013 KP Supplement chapter 2.3.4 and 2.3.5 and the 2013 Wetlands Supplement)

Issue #2.

Chapter 2: Approaches to Data Collection

Development of additional guidance to develop country-specific emission factors and design new surveys for activity data collection.

At Wollongong Expert Meeting (2016) this item was subdivided into 2 sub-issues: (a) development of additional guidance to develop country-specific emission factors and the other on (b) additional guidance on collection of activity data.

Background

2a) Additional guidance to develop country-specific emission factors

The technical survey indicated the necessity to expand a methodological work focusing on developing countries and their country-specific emission factors. In many cases developing countries cannot accommodate emission factors which are based on developed countries’ circumstances and are different in climate, technological and/or other conditions.

2b) Additional guidance to activity data collection

The technical survey also indicated, there is a capacity problem to gather and to manage national data which can be addressed by an additional guidance for collecting activity data, utilizing best practices, suggesting surveys and activities to develop suitable emission factors. National communications and BURs of developing countries can be potential sources of information

Suggested refinement option(s): [New Guidance]

New guidance to develop country-specific emission factors and additional guidance on activity data collection (See table of outcomes from Wollongong Expert meeting on means of refinement - last page of this paper)

Issue #3.

Chapter 2. Approaches to Data Collection

Development of guidance on the integration of GHG emissions reported from industrial facilities into national GHG inventories and development of guidance on use of models (including review and integration of outcome of 2010 Sydney meeting and 2011 Wellington meeting)

At Wollongong Expert Meeting (2016) this item was subdivided into 2 sub-issues (a) Guidance on the integration of GHG emissions reported from facilities into national GHG inventories and (b) Guidance on use and reporting of models

Background

3a) Guidance on the integration of GHG emissions reported from facilities into national GHG inventories

The 2006 IPCC Guidelines focus on providing guidance on lower level tiers, leaving nationally specific Tier 3 approaches to national inventory compilers to design and document. After the 2006 IPCC Guidelines were developed, many countries started obtaining GHG emission reports from industrial facilities within their jurisdiction (e.g. EU-ETS). Based on the experiences gained by such countries, new guidance may be developed to supplement the 2006 IPCC Guidelines on how the data reported from facilities can be used in national GHG inventories.

3b) Guidance on use and reporting of models

This subject was discussed at two IPCC Expert Meetings - the Expert Meeting on Use of Models and Measurements in GHG Inventories in Sydney, Australia (August 2010) and the Expert Meeting on the Use of Facility and Project Information in National GHG Inventories in Wellington, New Zealand (July 2011). The outcome of discussion at these meetings are summarized in the following publications:

- Report of the IPCC Expert Meeting on Use of Models and Measurements in GHG Inventories: http://www.ipcc-nggip.iges.or.jp/public/mtdocs/pdffiles/1008_Model_and_Facility_Level_Data_Report.pdf
- TFI Technical Bulletin 1: "Use of Facility-Specific Data in National Greenhouse Gas Inventories" http://www.ipcc-nggip.iges.or.jp/public/tb/TFI_Technical_Bulletin_1.pdf

Suggested refinement option(s): [New Guidance]

New Guidance on the integration of GHG emissions reported from industrial facilities into national GHG inventories and new guidance on use of models (See table of outcomes from Wollongong Expert meeting on means of refinement - last page of this paper)

Issue #4.

Chapter 3. Uncertainty.

Refinement of guidance on uncertainty based on the latest scientific knowledge and simplification of guidance by providing more default values, calculation examples and best practices

During the Wollongong expert meeting the following issues were identified for a further refinement and elaboration:

- i) incorporation of methodological development and/or case studies on issues, such as spatial variability, regional upscaling, correlation/autocorrelation, resampling techniques, addressing representativeness of data, trend analysis, population vs. mean variance
- ii) propagation of uncertainty applying Approach 1 for some sources and Approach 2 for others. Address large percentage uncertainties when using Equation 3.1 in Chapter 3, Volume 1 of the 2006 IPCC Guidelines.. Expand good practice for Monte Carlo simulations (more direction but not be overly prescriptive)
- iii) inclusion of guiding principles for conducting an uncertainty analysis. Provide additional simplified explanation of procedures with case studies and decision trees
- iv) discussion on how to use uncertainty as a way to improve the inventory development (focusing effort on large sources of uncertainty or reducing model complexity (e.g., simple decision tree)

Literature: over 50 relevant articles based on a brief search of the literature published since 2006, and over 10 years of reporting by parties to the UNFCCC. Literature may be useful for general guidance that can supplement the existing methods (however it should not be a scientific review of the methods).

It was noted that it might be a need to address specific issues on uncertainty analysis in the sectoral sections of a report, technical bulletin, etc.

The Wollongong expert meeting concluded that no major changes to the existing guidance are needed.

Suggested refinement option(s): [Update and/or Elaboration]

(Chapter 3, Volume 1)

Issue #5

Chapter 4: Methodological Choice and Identification of Key Categories (and other volumes)

Additional guidance on key category analysis to address treatment of disaggregation of categories, trend analysis, equations for trend analysis and the need for consistent definition of significant subcategories across the different volumes of the IPCC Guidelines

At Wollongong Expert Meeting (2016) this item was identified as high priority therefore for consideration at scoping meeting

Background

The technical analysis identified the need to review and update Chapter 4 of Volume 1 highlighting that contents for this chapter have already evolved from the original "contribution to uncertainty" basis to a more general identification of "important" categories. The general guidance is that key categories are those worth investing in to develop accurate estimation methods and under the UNFCCC guidelines the status of a category being key has many consequences. It is worth exploring if and how the technical guidance for the identification of key categories can be improved. The feedback from the use by the Parties of the methods can be a good input, in particular, *the issue of aggregation/disaggregation of categories is one that has not shown good results in the application of the analysis by many Parties therefore there is a need for improving the guidance on this subject.*

Suggested refinement option(s): [Elaboration]

Elaboration of Chapter 4, Volume 1 to add guidance on key category analysis to address treatment of disaggregation of categories, trend analysis, equations for trend analysis and the need for consistent definition of significant subcategories across the different volumes of the 2006 IPCC Guidelines (See table of outcomes from Wollongong Expert meeting on means of refinement - last page of this paper)

Issue #6

Chapter 5. Time series consistency

Review and refinement of guidance on time series consistency (*including discussion on the applicability of default EFs over time*)

At Wollongong Expert Meeting (2016) subdivided into 2 sub-issues (a) Guidance on time series consistency and (b) Guidance on applicability of EFs over time

Background

6a) Guidance on time series consistency

Usefulness of additional guidance on how to ensure time series consistency has been suggested by some members of Task Force Bureau.

It is often the case that data availability improves over time, therefore, the question is how we ensure time series consistency in estimation of GHG emissions/removals for the entire time series while using different data sets for different periods during the time series. Apparently countries have gained a lot of experiences in ensuring time series consistency in their national greenhouse gas inventories, and there has been a lot of discussion on this issue during the UNFCCC inventory review process. Additional practical guidance could be developed based on such experiences.

6b) Guidance on applicability of EFs over time

Another issue that deserves consideration is applicability of default emission factors over time. Emission factors and other parameters to be used in estimation of GHG emissions/removals need to reflect various conditions of the associated source/sink, such as technology used, etc. Where such conditions change over time, it is not appropriate to use the same default values of emission factors and other parameters for all years. This issue is taken into account to some extent in the existing guidance on some categories in the 2006 IPCC Guidelines (e.g., Section 3.10.1 on HFC-23 emission from HCFC-22 production where default emission factors are suggested as shown below). However, there is no explicit generic guidance on this issue in the 2006 IPCC Guidelines.

Suggested refinement option(s): [Elaboration]

Elaboration of Chapter 5, Volume 1 to add guidance on time series consistency and guidance on applicability of EFs over time. See table of outcomes from Wollongong Expert meeting on means of refinement - last page of this paper)

Issue #7

Chapter 6. QA/QC and verification. Section 6.10.2. Comparisons with atmospheric measurements. Development or improvement of guidance on the verification using other estimation results like FAOSTAT emissions database and GHG concentration in atmosphere by satellite observation (remote sensing data)

The experts at the Wollongong expert meeting pointed out that the verification section in the 2006 IPCC Guidelines is outdated. There is a need to discuss various ways to verify emission estimates in the context of the latest science with case examples: i) atmospheric concentration data; ii) independent monitoring of carbon stocks and fluxes; iii) other approaches. The refinement work should not be focused on developing detailed methods, but reference more detailed guidance material that has been published elsewhere.

Also, other uses of these data should be discussed, for example, direct emission measurements to prepare better emission factors and use of additional data to improve GHG inventories.

It was noted that it might be a need for some follow-up in the sectoral guidance about the use of atmospheric data and other data.

Suggested refinement option(s): [Update and/or Elaboration]
(Update and/or Elaboration of Section 6.10.2, Chapter 6, Volume 1)

Issue #8.

Chapter 7. Precursors and Indirect emissions. Clearer guidance for the calculation of indirect CO₂ emissions.

The expert's discussion during the Wollongong expert meeting suggested that there is a need to provide clarity about estimation of the indirect CO₂ emissions across sectors that are not otherwise counted, to elaborate the Box 7.2 "Calculating CO₂ inputs to the atmosphere from emissions of carbon-containing compounds" (CH₄, CO, NMVOC), to clarify if the adopted GWPs include the indirect CO₂ emissions, to clarify definition for "indirect" emissions in the guidelines (e.g., AFOLU vs. Waste) and also other terms such as "offsite emissions".

Suggested refinement option(s): [Update and/or Elaboration]
(Update and/or Elaboration Box 7.2, Chapter 7, Volume 1)

Table of Outcomes from Wollongong Expert Meeting (April 2016)

Chapter in Vol.1	Refinement	Suggested ways of refinement (to be further explored and decided in the scoping meeting)
Chapter 1: Introduction	1. Clarification of the concept of “anthropogenic emissions and removals”	For the AFOLU, to extend circumstances under which the “Managed Land Proxy” should be supplemented with techniques to distinguish between anthropogenic and natural or background emissions (e.g. by drawing on Guidance contained in the 2013 KP Supplement chapter 2.3.4 and 2.3.5 and the 2013 Wetlands Supplement)
Chapter 2: Approaches to Data Collection	2. Additional guidance to develop country-specific emission factors	<p>Indication of source categories that are more sensitive (significant) to country-specific EF (e.g. by using UNFCCC database and EFDB)</p> <p>Examples of sector specific approaches</p> <p>Addition of more rationale, references and background information on the default parameters used for the country-specific EF</p> <p>“Australia example”:</p> <ul style="list-style-type: none"> • “Decision tree approach” that can be applied on different source specific categories • “Systematic way to make consistent choices in the use of facility-specific data” <p>Use of CDM “database” and/or scientific papers for description of cases where country specific EF where developed (taking into consideration the need of consistency with IPCC methodologies)</p> <p>General:</p> <p>Links to capacity building opportunities and training materials (FAQ)</p>
Chapter 2: Approaches to Data Collection	3. Additional guidance to activity data collection	<p>Provide clarity on representative sample</p> <p>Confidential data:</p> <ul style="list-style-type: none"> • Example of agreement for disclosure confidential information • Provisions of examples for incorporating confidential data <p>Refinement of the “multi-year averaging” provision with additional exception listed for guidance for AFOLU tier 3</p>

		<p>approaches drawing on IPCC KP Supplement chapter 2.3.</p> <p>Update links to international database and more detailed description on data available and its potential use</p> <p>New tools/technologies for data collection (e.g. companies surveys) for completeness purposes</p> <p>General:</p> <p>Links to capacity building opportunities and training materials (FAQ)</p>
Chapter 2: Approaches to Data Collection	4. Guidance on the integration of GHG emissions reported from facilities into national GHG inventories	Use as a basis “TFI Technical Bulletin 1: “Use of Facility–Specific Data in National Greenhouse Gas Inventories”” and the “Report of the IPCC Expert Meeting on Use of Models and Measurements in GHG Inventories”
Chapter 2: Approaches to Data	5. Guidance on use and reporting of models	Use as a basis the “Report of the IPCC Expert Meeting on Use of Models and Measurements in GHG Inventories”
Chapter 4: Methodological Choice and Identification of Key Categories (and other volumes)	6. Additional guidance on key categories analysis	<p>In particular on:</p> <ul style="list-style-type: none"> • Disaggregation • Trend analysis in situations of large fluctuations in emissions • Equation for trend analysis (in the cases of small sources and net sources and net sinks) • Consistent definition of “significant subcategories” across different parts of the IPCC 2006 Guidelines (e.g. subcategories which make up 60% of the key category emissions according to their contribution in Volume 1 and 25-30% of the emissions of a key category in the AFOLU Volume)
Chapter 5: Time Series Consistency	7. Guidance on time series consistency	<p>Incorporate examples of country approaches (e.g. Canada “merging of data sets from different time periods”, Finland “ methods for F gases”, others)</p> <p>Explore if there are new methods available (e.g. elaboration based on the guidance for AFOLU tier 3 approaches drawing on 2013 KP Supplement chapter 2.3.)</p>

Chapter 5: Time Series Consistency	8. Applicability of EFs over time	Incorporate guidance to reflect that parameters to be used in estimation of GHG emissions/removals need to reflect various conditions of the associated source/sink, such as technology used, etc. Where such conditions change over time, it is not appropriate to use the same default/country specific values of emission factors and other parameters for all years
All volumes	9. Transparency and applicability of default EF	<p>For new emission factors to be updated or developed addition of more rationale, references and background information on the parameters used for estimating the default EF where information is available for new and existing ones (e.g. Annex 3A.3 of 2013 Wetlands Supplement)</p> <p>For the existing emission factors TSU to consider prioritization, eg., TSU could find commonly used but not well documented EF, where inventories area highly sensitive to the emission factor used.</p>

Energy Sector

Issue #1.

Category 1.A.1.c. Manufacture of solid fuels. Development of guidance for estimating GHG emissions from charcoal production

There is no guidance for estimating GHG emissions from charcoal production in the 2006 IPCC Guidelines, only clarification on definition of wood/wood waste which is provided in Table 1.1 Volume 2. However, the Revised 1996 IPCC Guidelines provide the default non-CO₂ emission factors for charcoal production (Reference Manual (Volume 3) Energy, p.1.46).

During the Geneva expert meeting it was suggested to develop a guidance for estimating GHG emissions from charcoal production taking into account a relationship between production and combustion, CO₂ and non-CO₂ emissions as well as a coordination with the AFOLU sector.

Suggested refinement option(s): [New Guidance]

Issue #2 and Issue #3 (abandoned facilities).

#2. Category 1.B.1. Fugitive emissions: Solid Fuels. Development of guidance for estimating GHG fugitive emissions from abandoned or decommissioned surface mines

#3. Category 1.B.2. Fugitive emissions: Oil and Natural Gas. Development of guidance for estimating GHG fugitive emissions from abandoned or decommissioned oil and gas wells

The Technical Assessment pointed out that "*after closure, abandoned or decommissioned surface mines may continue to emit methane as the gas leaks from the coal seams that were broken or damaged during mining. There are no methods at present for estimating emissions from this source. ...Methane emissions from non-producing oil and natural gas wells may be significant for oil- or gas-producing nations. These methane emissions may consist of surface casing vent flows, gas migration and other potential emissions. Such emissions are not covered in the 2006 IPCC Guidelines and this may lead to a potential source of under-estimation of oil and gas fugitive emissions in national inventories*".

The Geneva expert meeting concluded that a new guidance is needed for abandoned facilities:

- i) abandoned or decommissioned surface mines;
- ii) abandoned or decommissioned oil and gas wells.

It needs to be considered whether the robust data is available.

Suggested refinement option(s): [New Guidance]

Issue #4.

Category 1.B.2. Fugitive emissions: Oil and Natural Gas. Development of guidance for estimating GHG emissions from unconventional oil and gas production such as shale gas, shale oil, tight gas, tight oil and CBM

There is no clear guidance in the 2006 IPCC Guidelines on how to deal with the GHG emissions from unconventional oil and gas production such as shale gas, shale oil, tight gas and tight oil. Definition of what the 2006 IPCC Guidelines mean by conventional and unconventional production is needed as well. Refinement needs to consider development of Tier 1 EFs for unconventional oil and gas production and refinement of methodology, if necessary.

Also, the materials of the 2013 Washington expert meeting needs to be taken into account (IPCC Expert Meeting: Fugitive Emissions of Greenhouse Gases from Oil and Natural Gas Systems (including shale gas, coal bed methane, etc), August 2013, Washington, D.C., USA).

Suggested refinement option(s): [New Guidance]

Issue #5.

Category 1.B.2. Fugitive emissions: Oil and Natural Gas. Update or addition of default emission factors of fugitive emissions from oil and gas by reflecting current practices and the latest measurement data

The update of Tier 1 EFs for this category is necessary based on a new and representative facility-specific information, including a time-changing Tier 1 EFs (controlled EFs). The refinement needs to include new sub-categories more specific for natural gas production. Also, the materials of the 2013 Washington expert meeting needs to be taken into account.

Suggested refinement option(s): [Update and/or Elaboration]
(Update and/or Elaboration of Section 4.2.2.3 and Table 4.2.4, Chapter 4, Volume 2)

Issue #6.

Category 1.B.3. Fugitive emissions: Other emissions from Energy production. Provision of clearer guidance on fuel transformation considering linkages with the methodology on fugitive emissions under IPPU

This issue was raised during discussion at the Geneva expert meeting and initially it was about reporting of emissions of coal-coke transformation and also it is linked to the Issue #1. Emissions from Charcoal production. Some guidance on emissions allocation is presented in the Volume 3. IPPU, but more clear guidance is probably needed in the Volume 2. Energy.

Also, other fuel transformation (gas-to-liquid, solid-to-liquid, etc.) needs to be considered as well. During the Geneva expert meeting the two options to address this issue were proposed – FAQ or Methodology Report. It was decided to bring this issue to the Scoping meeting for a further consideration.

Suggested refinement option(s): [New Guidance]

IPPU Sector

Issue # 1.

Category 2.B. Chemical Industry (not specified). Hydrogen production. Development of guidance for estimating GHG emissions from hydrogen production

Hydrogen can be produced either in petrochemical industry (IPPU) or in refineries (Energy). In IPPU, the 2006 IPCC Guidelines do not provide specific guidance for hydrogen production, although Chapter 3.2 Ammonia production (Volume 3, p.3.11) and section on Methanol production (Volume 3, p. 3.58) refer to the steam reforming process (syngas technology). With the growing production of hydrogen, it was suggested during the Technical Assessment that Hydrogen Production should be recognized as a new category (*e.g., 2B8g Hydrogen Production 2B8 Petrochemical and Carbon Black Production*) and guidance should be provided noting that hydrogen can be used in the production of other chemicals. The production in Energy should be noted as well.

Suggested refinement option(s): [New Guidance]

Issue # 2.

Category 2.B.2. Nitric Acid Production. Addition of guidance on appropriate emission factors to use for dual pressure technologies for Nitric Acid Production

The 2006 IPCC Guidelines do not contain emission factors for dual pressure technologies for Nitric Acid Production (as current – low, high, medium). It was suggested to add a new default EF into the Table 3.3 Chapter 3 Volume 3 (p.3.23).

Suggested refinement option(s): [Update]
(Update of Section 3.3.2.2 and Table 3.3, Chapter 3, Volume 3)

Issue #3.

Category 2.B.9. Fluorochemical Production. Update of guidance and default Tier 1 emission factors for production of fluorinated compounds other than HCFC-22

During the Geneva expert meeting it was pointed out that the default EF of 0.5% is a factor of five to ten smaller than the uncontrolled EFs implied by information gathered during development of the US GHG Reporting Programme. Such an inappropriately low default EF may result in failure to identify source category as key. It was suggested to consider this issue at the Scoping meeting in order to update this EF with a support of the US information.

Suggested refinement option(s): [Update]
(Update of Section 3.10.2.2, Chapter 3, Volume 3)

Issue #4.

Category 2.C.1. Iron and Steel Production. Update of guidance and emission factors for Iron and Steel Production

The estimation of GHG emissions from Iron and Steel Production is difficult because of a diversity of processes, products flows, used materials and techniques. During the Technical Assessment it was suggested to produce more clear differentiation between the Energy and the IPPU sectors, to comprehensively include all processes with a clear indication of products flows including coke oven gas and blast furnace gases, to update default EFs based on existing scientific results developed by different countries and international organizations, e.g. the World Steel Association (WSA).

The Geneva expert meeting pointed out that countries' submissions according to the 2006 IPCC Guidelines (from 2015) can provide with information on implementation of Iron and Steel guidance. Country-specific EFs contained in the national submissions as well as information in reports and other studies are required to update default EFs.

Recently the EU updated the report on Iron and Steel - 2012-2013 Best Available Techniques Reference Document for Iron and Steel Production. The WSA reports are also available.

Suggested refinement option(s): [Update]
(Needs to specify - Update of Section XXX, Chapter 4, Volume 3)

Issue #5.

Category 2.C.3. Aluminium Production. Development of a new guidance and emissions factors on “non-anode effect” (“low-voltage anode effect”) PFCs emissions and its integration into the existing methodology on anode-effect (“high-voltage anode effect”). Update of the Tier 1 and Tier 2 defaults.

During the Technical Assessment and the following Geneva and Wollongong expert meetings it was suggested *“to develop a method to estimate PFC emissions from Aluminium production that are NOT associated with anode effects. The methods in the 2006 IPCC Guidelines assume that PFC emissions from Aluminium production only occur when anode effects occur. If anode effects are not detected, PFC emissions are assumed to be zero. However, research over the last several years shows that PFCs can be emitted from Aluminium production in the absence of anode effects as those have historically been defined. In fact, for many new smelters using very large electrolytic cells, the PFC emissions that are NOT associated with anode effects account for the vast majority of PFC emissions, and the emission rate per ton of Aluminium for these smelters is more than 50% greater than the global average. Moreover, these new smelters account for over 50% of global production. Thus, “non-AE” emissions from Aluminium are significant at the global level, and they are likely to grow as the average size of electrolytic cells continues to grow world-wide”.*

The term “low- or high- voltage anode effect” should be used reflecting the nature of the process and a language of the published literature. Tier 1 and Tier 2 methods need to be updated accordingly.

Suggested refinement option(s): [New Guidance and/or Update]
(New Guidance and Update of Section 4.4.2.3 and 4.4.2.4, Chapter 4, Volume 3)

Issue #6.

Category 2.C.4. Magnesium Production. Update of guidance on fluorinated GHG emissions from Magnesium Production taking into account replacement of SF₆ by HFC-134a (*subject to literature availability*)

SF₆ is currently being replaced by HFC-134a (and to small part by HFC-125) as a cover gas in Magnesium Production. The 2006 IPCC Guidelines note that *“the industrial use of fluorinated compounds other than SF₆ for magnesium oxidation protection commenced in 2003-2004. As such, the industrial experience in using these compounds for magnesium protection purposes is yet very limited. Even individual plants will have little historic data, if any, on actual emissions of these other fluorinated compounds from their operations. While there is a general sense in industry that the volume use of these alternate gases will be less than SF₆, there are no data available at this time on which to base emission factors. Hence, it is not possible at this time to develop an emission factor-based approach (Tier 1 or 2) for reporting emissions”.* [Relevant Section 4.5.2.1 Volume 3, text on p. 4.65].

The Geneva expert meeting noted such a development, but the literature availability was questioned. The experts mentioned only one good study in this respect - Bartos, Scott C.: Characterization of Emissions and Occupational Exposure Associated with Five Cover Gas Technologies for Magnesium Die Casting, U.S. Environmental Protection Agency Climate Protection Partnership Division, [EPA 430-R-07-008] Washington DC August 2007 (http://www.epa.gov/magnesium-sf6/documents/lunt_measurement_study_full.pdf).

Some other publications exist as well, but their sufficiency to elaborate a new method/EFs is a subject for discussion.

Suggested refinement option(s): [Elaboration]
(Elaboration of Section 4.5.2.1, Chapter 4, Volume 3)

Issue #7.

Category 2.C. Metal Industry (not specified). Rare Earth elements. Development of a new guidance on GHG emissions (PFCs and CO₂) from production of Rare Earth elements

This missing and potentially significant category was identified during the Wollongong expert meeting during investigation of the observed gap in PFCs emissions. It was suggested that development of new guidance on PFCs is needed (taking into account CO₂ emissions as well). Current literature is limited; some laboratory studies exist. It is expected that more literature will be available within the next two years.

Suggested refinement option(s): [New Guidance]

Issue #8.

Category 2.E. Electronics Industry. Update of guidance and default Tier 1 and Tier 2 emission factors for Semiconductor Industry, improvement of the Tier 3 guidance and elaboration of guidance on generation of by-products from abatement technologies (CF₄ from NF₃)

The US GHG Reporting programme has brought a new information to support the update and addition of EFs in Semiconductor Industry. Update of the existing guidance for Tier 1 and 2 is needed as well as elaboration of Tier 3 guidance and the guidance on generation of by-products from abatement technologies (CF₄ from NF₃).

Suggested refinement option(s): [Update and/or Elaboration]

(Update of Section 6.2.2 and Elaboration of Section 6.2.1.1 Chapter 6, Volume 3)

Issue #9.

Category 2.F.1. Refrigeration and Air Conditioning (RAC). Update of guidance on sub-applications and default emission factors for ODS substitutes, particularly for RAC, for different equipment types, geographical regions and time periods

The range of estimates for charge, operation and end-of-life emissions is quite large. In view of a high uncertainty and a lack of uniformity in this sector, further refinement of the default EFs would be welcomed. Although the Geneva expert meeting pointed out the direction of refinement (more precise by further segregating equipment types, regions, and time periods), the absence of sufficient literature could be an impediment for refinement.

The verification studies in Australia and the UK (presented at the Wollongong expert meeting) showed that the current approach of a constant leakage rate needs an adjustment to better reflect the reality of RAC emissions. The concept of the “bank” accumulation is valid, specific EFs need to be better justified though it is a quite difficult task.

The Geneva meeting put this issue in a long-term methodology update when the literature and countries submissions can provide sufficient information for refinement.

Suggested refinement option(s): [Update]

(Needs to specify - Update of Section XXX, Chapter 7, Volume 3)

AFOLU (Categories 3.A & 3C)

Issue #1.

Enteric Fermentation (3.A.1)

Improve parameters based on different feeding strategies for ruminants

Outcomes of the Sao Paulo meeting

- *CH₄ from enteric fermentation is a significant source. Feeding strategies are changing and mitigation strategies are rising in importance.*
 - *Feed intake for cattle seems to be fine in the guidelines.*
- Methane conversion rates for dairy and other cattle:*

Refinement for CH₄ mitigation options by feed additives and feed quality. There is a lot of new literature available, including developed countries and Africa. The approach to be taken would be to relate CH₄ conversion rates to feed components, quantitatively define what low and high quality feed means (this choice is most critical!), derive a refined Tier 2 table for methane conversion rates and then check, and update if appropriate, the Tier 1 factors. The analysis has to be carefully consider the representativeness of feeding strategies for regional and global conditions. The main concern is that different models produce different methane conversion rates so that guidance on model applications is needed. Additional guidance is also needed how to derive a time series of methane conversion rates and corresponding activity data. Check whether scaling factors or time series of the defaults are feasible. It is important to add quantitative uncertainty estimates to the default factors

Methane conversion rates for sheep, buffalo, yaks...: Availability of new data is unclear

Suggested refinement option(s): [Update/elaboration]

(Update of Section 10.3, Chapter 10, Volume 4)

Issue #2.

Manure Management (3.A.2)

Refine parameters based on new science

Outcomes of the Sao Paulo meeting

- *Temperature dependence of CH₄ can be updated. Tier 1 should still use annual mean temperature ranges for the MCFs. Higher tiers may use seasonal temperatures rather than annual means, and typical temperatures in manure stores.*
- *Storage time is an important driver to be considered in MCFs.*
- *A good background documentation of the development of the new default MCFs is required to support countries in producing higher Tier values consistent with the defaults.*
- *The current guidance on C and N from bedding is inconsistent. The current emission factors could, however, already include the bedding. Additional guidance for higher tiers could be included suggesting to consider carbon from bedding in the VS estimate.*
- *The effect of natural crusts on CH₄ emissions from slurry storage may need to be re-evaluated based on new findings.*
- *Bo for cattle and swine seems to be different in global regions (feed characteristics!) and may be further stratified.*

Suggested refinement option(s): [Update/elaboration]

(Update of Section 10.4, Chapter 10, Volume 4)

Re-evaluate and update where appropriate all parameters and EFs, including further stratification for countries with better activity data.

Issue #3.

Manure Management (3.A.2)

Develop/update guidance on how to deal with avoided methane emissions due to biogas production

Outcomes of the Sao Paulo meeting

New data and methodological experience is available from several world regions, including the MCF

CH₄ from barn + farm prior to storage is missing.

Suggested refinement option(s): [Update/elaboration]

(Update of Section 10.4, Chapter 10, Volume 4)

Cross-cutting issue to develop, complete and update the equation (Table 10.17) and parameters, that is cross-cutting between energy, waste and agriculture for biogas, including all substrates (manure, waste, biomass).

Issue #4.

Manure Management (3.A.2)

Reconsider method of estimating nitrogen excretions, development of the MCF factors, N₂O estimation of N₂O from liquid manure storage based on surface area of manure storage

Outcomes of the Sao Paulo meeting

- *Re-evaluate and update, if appropriate, the default N excretion rates for applicability in world regions. Clarify the animal categories (e.g., rabbit values are for mother+children).*
- *Emission factors for N₂O: new data available. Table 10.21 contains a lot of expert judgement. EFs can be re-evaluated and updated, if appropriate, with new measured data, in particular for treatment systems.*
- *N₂O estimation from liquid manure storage based on surface area of manure storage: Surface area is inconsistent with the available activity data in most countries and does not suit for a lower tier method.*

Suggested refinement option(s): [Update/elaboration]

(Update of Section 10.5, Chapter 10, Volume 4)

- *Verification and plausibility checks for the default N excretion rates if possible.*
- *Re-evaluate and update Table 10.21 EFs, if appropriate.*

Note: The update should not result in new methodologies and animal categories but rather improve the existing tables.

Issue #5.

Direct N₂O Emissions from Managed Soils (3.C.4)

Evaluation of EF1 and options for stratification/disaggregation (e.g. climate zone)

Outcomes of the Sao Paulo meeting

- *There are a lot of new high-quality measurements available. Evaluate those whether the EF1 could be stratified by*

- *climate zone as an option for countries with data on fertilizer use by climate zone.*
- *New findings are available to be considered in higher Tiers, e.g. a non-linear N₂O response to fertilizers.*
- *There is not enough evidence yet to change the methodology for N₂O from N input by crop residues.*

Suggested refinement option(s): [Update/elaboration]

(Update of Section 11.2, Chapter 11, Volume 4)

Evaluate EF1 and include an option for stratification by climate, if appropriate, and the change would be significant.

Outcomes of the Wollongong meeting

Evidence is solid that there can be further disaggregation of these emission factors. At this point it is not possible to evaluate how far we can go in disaggregation and what factors could be considered. There is adequate evidence to take this to a Methodology Report.

The refinements recommended include the update of defaults with new data, and the elaboration of existing guidance, based on further disaggregation, specifically for climate factors. It is important to note that the current default non-disaggregated method would be retained. Further guidance and case examples could be included for movement to higher Tiers.

Suggested refinement option(s): [Update/elaboration]

(Update of Section 11.2, Chapter 11, Volume 4)

Issue #6.

Direct N₂O Emissions from Managed Soils (3.C.4)

Evaluate the EF3 as 2% of the N applied to soils, pasture, range and paddock by grazing animals

Outcomes of the Sao Paulo meeting

The preliminary data suggest that the current EF3 is too high. It would be more logical that the EF3 is similar to the EF1, which includes organic manure application. EF3 should be re-evaluated based on clear quality criteria for the studies. Care has to be taken that the measurements cover a long enough phase to allow for decomposition of the dung. The EF3 should still relate to the sum of urine and dung.

Suggested refinement option(s): [Update/elaboration]

(Update of Section 11.2, Chapter 11, Volume 4)

Encourage input of preliminary evidence to the EFDB. Methodology report to finally elaborate the new EF₃.

Issue #7.

Indirect N₂O Emissions from Managed Soils (3.C.5)

Derive new emissions factors for indirect N₂O, both the amount of leaching/runoff and volatilization, as well as the indirect emission factor

Outcomes of the Sao Paulo meeting

- *New evidence on N volatilization is captured in the link to EMEP/EEA Air Pollutant Emission Inventory Guidebook, EF is OK.*
- *Leaching/runoff: there is new scientific evidence to be considered in the guidelines.*
- *EFs have to be seen in combination with the leaching factor, FracLEACH. There is a major methodological issue that the N leached from the root zone is currently assumed to entirely enter the ground- and surface waters. This neglects significant N loss by denitrification along the N pathway.*
- *The methodology description is not transparent regarding the simplifications. Indirect N₂O also occurs in the waste sector (waste effluent). The approach has to be the consistent across sectors.*
- *N₂O hotspots may also occur in riparian zones, which are not included in the methodology.*
- *EFr: surface waters: new studies suggest higher EF for rivers with high N load, but the measurements are related to the N that finally reaches the rivers, not the N leached, which is used in the equation.*
- *EF5g: groundwaters: OK, supported by new studies*
- *EF5e: estuaries: no new studies*

Suggested refinement option(s): [Update/elaboration]

(Update of Section 11.2, Chapter 11, Volume 4)

The indirect N source is significant and would require some change in methodology and EF.

Scientific evaluation is needed. Science on N retention in ground- and surface waters has to be stimulated and matured. FAQ to better explain the concept of indirect N₂O leaching/runoff pathways.

Methodology report or appendix on methodological improvements accounting for N retention in the derivation of EFs or to reconcile the measurements in rivers with N leached from agricultural systems.

Issue #8.

Rice Cultivation (3.C.7)

Update emission factor (N₂O) based on country-specific publications

Outcomes of the Sao Paulo meeting

- *The source is significant. The current EF by N input does not consider management practices. New management strategies, in particular alternating wet-dry may clearly alter (increase) N₂O emissions.*
- *New data is available from many important rice producing countries to improve and refine and disaggregate the existing EF.*
- *Evaluate and update the EF based on new literature. Additional guidance on activity data is needed how to allocate fertilizer fractions to the different rice management regimes, consistent with the guidance on CH₄ from rice, including an aggregated EF if no further stratification by management regime is possible*

Suggested refinement option(s): [Update/elaboration]

(Update of Section 11.2, Chapter 11, Volume 4)

Forestry and Other Land Use (FOLU) - 3B

Category: Forest Land (3.B.1) Gas CO₂

Issue #1a:

Update default values for litter and *develop* default values for deadwood (Table 2.2, page. 2.27, 2006 IPCC Guidelines); that have been provided in the 2013 Wetlands Supplement and other parameters from scientific literature.

Background

Table 2.2 provides Tier 1 default values for litter but not for dead wood carbon pool these are broad-scale estimates with considerable uncertainty when applied at the country level therefore Table 2.2 is incomplete because of the paucity of published data for dead wood carbon pools. The technical survey identified limitations of the IPCC approach, the IPCC definitions of dead organic matter carbon stocks include litter and dead wood. The litter pool contains all litter plus fine woody debris up to a diameter limit of 10 cm (see Vol 4, Chapter 1, Table 1.1). Published litter data generally do not include the fine woody debris component, so the litter values in Table 2.2 are incomplete 2006 IPCC Guidelines page 2.26). Survey results indicated that there is a need to update values for litter and develop default values for deadwood, (2006 Guidelines, Table 2.2, page. 2.27).

Outcomes from Sao Paulo Expert Meeting July 2015

Update default values for litter and develop default values for deadwood (Table 2.2, page. 2.27, 2006 IPCC Guidelines); taking into account values provided in the 2013 Wetlands Supplement and other parameters from scientific literature. NOTE: Plus the development of equation for estimating DOM_{out} (equation 2.18 of the 2006 IPCC Guidelines) based on existing knowledge of decomposition rates in each land use

Suggested refinement option [Update]

[Update Section 2.3.2.1, Chapter 2, Volume 4, IPCC default values for litter and dead wood (Table 2.2, page. 2.27, 2006); IPCC Guidelines and development of equation 2.18 for estimating DOM_{out}]

Note: For litter and deadwood - Generic Methodologies Applicable to Multiple Land-Use Categories

Issue #1b:

Update values for BEF/BCEF (Box 4.2, page 4.13-4.14, 2006 IPCC Guidelines), harvest losses and root/shoot ratio, average biomass stocks and average biomass increments, emissions factors that have been provided in the 2013 Wetlands Supplement and other parameters from scientific literature.

Background

Box 4.2, 2006 IPCC Guidelines Vol 4, page 4.13-4.14 provides Biomass Conversion and Expansion Factors for assessing biomass and carbon in forests. Survey further highlighted that there is a need to update values for BEF/BCEF, harvest losses and root/shoot ratio, average biomass stocks and average biomass increments according to the current state of scientific knowledge and to reflect data from tropical countries. There were substantial developments since the publication of the 2006 IPCC Guidelines. Increasingly allometric equations are used. An international compilation of allometric equations was established available at: <http://www.globallometree.org/> Guidelines for developing allometric equations are now available. In addition, recent scientific compilations and/or studies on average biomass stocks and average biomass increments are available.

Outcomes from Sao Paulo Expert Meeting July 2015:

Update default values for BEF/BCEF (Box 4.2, page 4.13-4.14, 2006 IPCC Guidelines), harvest losses and root/shoot ratio, average biomass stocks and average biomass increments, emissions factors to reflect latest science and other parameters from scientific literature.

Suggested refinement option [Update]

[Update Section 4.2.1, Chapter 4, Volume 4, default values for BEF/BCEF (Box 4.2, page 4.13-4.14, 2006 IPCC Guidelines GL), harvest losses and root/shoot ratio, average biomass stocks and average biomass increments, emissions factors]

Note: For Harvest losses, IPCC Guidelines do not contain such data (they are activity data). May however need to add guidance on the use of international sources (e.g. FAO data) on harvesting and HWP.

Category AFOLU: Gas CO₂, CH₄ and N₂O

Issue #2:

Update guidance on activity data (including natural disturbances), for land representation to link land classification system with digital maps (Remote Sensing or GIS data) and also stratified by climate, soil and land use

Background

There is a lack of guidance in Chapter 3 on Land representation in the 2006 IPCC Guidelines on linking land classification system with the digital maps. There is a need to update or further develop guidance on activity data on land representation to link the land classification system and digital maps (remote sensing data or GIS data). This should allow for aggregation of relevant classes into the main six IPCC Land Use Categories defined in the 2006 IPCC Guidelines (Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land), also addressing the need to capture land use conversion while also stratifying by climate, soil and land use type

Section 3A.2.4 on “Tools for Data Collection” in Volume 4 of the 2006 IPCC Guidelines has a subsection on “Remote Sensing Techniques” which provides a simple outline of the type of RS data acquired by sensors (Optical, Radar or LIDAR) on board satellites or by cameras equipped with optical or infrared sensors operated on airborne platforms. Since the 2006 IPCC Guidelines were produced, RS technologies have further continued to develop and there is considerably more experience in their use. In addition, the need for reliable estimates of GHG emissions and removals from forests in developing countries has increased because of the GHG mitigation measures such as REDD+ incentives and the requirement to report information on GHG emissions/removals in their Biennial Update Reports (BURs) under the UNFCCC process.

Outcome from Sao Paulo Expert Meeting July 2015

- Recommend expert meeting for technical assessment of available information and consider updating guidance on how to assemble activity data to allow for aggregation of relevant classes into the main six IPCC Land Use/Conversion Categories defined in the 2006 IPCC Guidelines. Also stratified by climate, soil and land use type and capture other information such as natural disturbances.
- Recommend expert meeting to update references in Chapter 3 (including list of RS datasets - Annex 3A.2.4 in Volume 4 of the 2006 IPCC Guidelines). Update guidance, (including information on data organization, use of reference data, and integrating frameworks for a consistent land representation) referring to material elsewhere (FAO emissions database, GFOI, GOFI-GOLD, FFPRI REDD+ Cookbook).
- Recommend expert meeting to consider that in order to make this update relevant to the inventory compilers, this means that an assessment of land use change is required, measurement of land use change that is consistent over time and the need to clarify in guidelines distinction between land use and land cover. Specify, for example, how GFOI products can help inventory compilers with examples of land use transition/LUC of remote sensing data into LUC and land use.

Outcome from Wollongong Expert Meeting April 2016

Summary of discussions:

Due to advances in the last 10 years' progress IPCC good practice guidance on RS is outdated, several examples of the recent advances were presented. Remote sensing techniques (such as National Land Cover Database - NLCD) have already been used in representing IPCC land use categories, however, there are still remaining technical issues such as:

- Definition (can we live with remote-sensing-based definitions or develop guidelines on scientifically-acceptable conversion tables) and
- Standard for accuracy (should it be 80%, 85%, 90 %?) by specific classes.

Remote sensing tools such as FAO-Google Collect Earth can help inventory compilers in accessing remote sensing imagery and the use of sampling based approach to classify land for IPCC land representation. Use of different RS systems in different land categories for example Brazilian case study (up to now more focus was given to forest land with PRODES, DEGRAD and DETER), the use of different allometric equations produce different results, recognition that several maps of different biomes can be presented. Possibility of mixing techniques: including field data, statistics and remote imagery (e.g. LIDAR, optical, aircraft, satellite, and space station). Development of verification techniques and quantifying uncertainties associated with RS data. How to overcome difficulties to move from national land classification to IPCC classification. New Zealand example on clarifying land cover is not the same as land use, therefore mapping land cover requires additional information to get to land use data. Land-use change takes time to confirm and any new guidance should allow for that. Australia presented good example to allow for tracking of land use. Further, guidance on a consistent land representation, i.e. constant area across time, transition time within land use change categories would be needed to avoid frequent errors in GHG inventories..

Outcomes from Wollongong Meeting: Chapter 3, Volume 4 on Land Representation

Elaboration of existing guidance inter alia:

- i) How to decide when to use global data, products and tools for land use representation? Use of techniques (in conjunction and/or in complement with national data)
- ii) Guidance on activity data uncertainties
- iii) Extend IPCC Guidance on consistent use of time series data, including for tracking land use change
- iv) Integration of ground observation, ancillary and RS data
- v) Identification and tracking of disturbances in land representation
- vi) Guidance on how to better assess conversion to forest land and forest regrowth in the context of RS and ground data
- vii) How to relate national land classification to IPCC land categories, including sub-stratification
- viii) Guidance on how RS land cover data, ground based data and ancillary data can be used to derive land use
- ix) Guidance on how consistency between REDD+ and/or project activities and IPCC inventory guidelines can be demonstrated
- x) Guidance on how to use Tier 1 and 2 methods with Approach 3
- xi) Guidance on how to deal with seasonal nature of specific land categories

Table of Outcomes from Wollongong Meeting

i)	How to decide when to use global data, products and tools for land use representation? Use of techniques (in conjunction and/or in complement with national data)	Elaboration of existing guidance (i.e. Chapter 3) based on, inter alia: <ul style="list-style-type: none"> • MGD Module 2 and version 2 (currently in preparation);
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		<ul style="list-style-type: none"> • GOFC-GOLD/GFOI/ESA Workshop on global datasets; • FFPRI Cookbook; • FAO (currently in preparation)
ii)	Guidance on activity data uncertainties	<p>Elaboration of existing guidance (i.e. section 3.5) by inter alia:</p> <ul style="list-style-type: none"> - including material on statistical inference; - updating table 3.7 in IPCC guidelines; - using section 3.7 of MGD (Version 1); <p>etc.</p>
iii)	Extend IPCC Guidance on consistent use of time series data, including for tracking land use change	<p>Elaboration of existing guidance by, inter alia:</p> <p>Using examples from relevant countries (e.g. Canada, Australia, etc.);</p> <p>Using FAO sampling approach;</p> <p>Etc.</p>
iv)	Integration of ground observation, ancillary and RS data	<p>Elaboration of existing guidance by, inter alia:</p> <ul style="list-style-type: none"> - Correlation of different types of data; - Using MGD; - Using countries examples; - GOFC/GOLD; - ALU Software; <p>Etc.</p>
v)	Identification of disturbances in land representation	<p>Elaboration of existing guidance by, inter alia:</p> <ul style="list-style-type: none"> - Using KP supplement; <p>Etc.</p>
vi)	Guidance on how to better assess conversion to forest land and forest regrowth in the context of RS and ground data	<p>Elaboration of existing guidance by, inter alia:</p> <ul style="list-style-type: none"> - Adding use of time series, RS data and ancillary data; <p>Etc.</p>
vii)	How to relate national land classification to IPCC land categories, including sub-stratification	<p>Elaboration of existing guidance by, inter alia, using:</p> <ul style="list-style-type: none"> - Decision tree; - Ancillary data and management practices; - Examples of countries approaches; <p>Etc.</p>
viii)	Guidance on how RS land cover data, ground based data and ancillary data can be used to derive land use	<p>Elaboration of existing guidance by, inter alia, identifying the attribution of the change through the use of:</p> <ul style="list-style-type: none"> - Time series data; - Ancillary data; <p>Etc.</p>

ix)	Guidance on how consistency between REDD+ and/or project activities and IPCC inventory GL can be demonstrated	Elaboration of existing guidance by, inter alia: - Using MGD (in respect of REDD+); - GOFC/GOLD; - FFPRI Cookbook; Etc.
x)	Guidance on how to use Tier 1 and 2 methods with Approach 3	Elaboration of existing guidance by, inter alia: - Covering multiple transitions for estimating emissions; Etc.
xi)	Guidance on how to deal with seasonal nature of specific land categories	Elaboration of existing guidance by, inter alia: - Better categorization of land through use of thresholds to identify seasonality; Etc.

Suggested refinement option [Elaboration and Update]

[Elaboration of Chapter 3, Volume 4, update Table 3.7 using section 3.7 of MDG (Version 1) and update Annex 3A.2.4, see Table of outcomes from Wollongong Meeting April 2016 for mode of refinement]

Category: AFOLU, Gas CO₂, N₂O and CH₄

Issue #3:

Revise emission factor for flooded land (Wetlands) and to fully develop a methodology for estimating CH₄ emissions from flooded lands and possible refinement of methodology for estimating CO₂ taking into consideration issues such as the following: the quantity and type of flooded land; management activities prior to flooding and during reservoir management; inflow/outflow rates and drawdown area, water depth drawn off and timing/frequency; upstream watershed and erosional estuarine exchange- inputs of organic material and nutrients; and other new scientific literature.

Background

Methane emissions are covered in Appendix 3 in Volume 4 of the 2006 IPCC Guidelines, as “For Further Methodological Development”. The results from the survey highlighted a number of issues including the fact that both CO₂ and N₂O emissions can vary due to upstream watershed and erosional estuarine exchange. There is risks of double counting. Better guidance of watershed reporting/ protocols is necessary in order to clarify the need to account for N₂O or allochthonous CO₂.

Although much of the advice on derivation of emission factors in Appendices 2 and 3 is still applicable, research results published since 2006 indicate that there are other important factors which should be considered in order to obtain representative flux CO₂ values. These factors include: the quantity and type of carbon pool flooded (e.g. tropical forest biomass vs. boreal peatland soil), management activities prior to flooding (e.g. harvesting) and during reservoir management, inflow/outflow rates and drawdown area. The types of ecosystems flooded have been shown to influence the magnitude and spatial patterns of CO₂ emissions (Teodoru et al., 2010; Brothers et al., 2012b). The availability of numerous published articles from many countries, reporting emissions from both young and older reservoirs as well as various synthesis studies support the development of relevant methodologies for various tier levels and the derivation of both new and updated emission factors. Countries with new data include Finland, India, China and Russia. (See EDG for literature sources)

Outcome from Sao Paulo meeting July 2015

Sao Paulo meeting (2015) recommend expert meeting with a view to providing advice to the scoping meeting on the development of a methodology report to update and complete methods in the 2006 IPCC Guidelines to estimate emissions and removals from flooded lands.

Wollongong expert meeting (2016) considered what information exists to allow the development of more complete guidance for all gases and what management practices for which there is enough knowledge that could justify their inclusion in the guidelines. (See EDG for Scientific references)

Outcomes from Wollongong Meeting April 2016

The expert meeting considered the following for the scope of the definitions for flooded land:

- The definition used in this report agrees with common definitions used in the Ramsar Convention on Wetlands and the Convention on Biological Diversity (CBD).
- Flooded lands are defined as water bodies regulated by human activities for energy production, irrigation, navigation, recreation, etc. and where substantial changes in water area due to water regulation occur.
- Regulated lakes and rivers, where the main pre-flooded ecosystem was a natural lake or river, are not considered as flooded lands. Rice paddies are addressed in the Agriculture Chapter of the 2006 IPCC Guidelines and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG-2000).
- N₂O is considered elsewhere

The discussion also covered “natural” reservoirs (= regulated lakes) used for hydroelectricity generation that do not have substantial changes in water area in comparison with the pre-flooded ecosystem. They do not meet the definition of “Flooded Land” in the 2006 IPCC Guidelines although they can be significant sources of GHGs and the same methodology can be applied as reservoirs for hydroelectricity that meet the definition of “Flooded Land” in the 2006 IPCC Guidelines. How should we treat these reservoirs? Do we need to change the definition of “Flooded Land”?

Emerging issues to be considered at scoping meeting or by authors

- i) “Net emissions” approach was recommended by presenters (Anthropogenic emissions to be included in the inventory = Post-flood emissions – Pre-flood emissions.) However, this is not consistent with the Managed Land Proxy in the 2006 IPCC Guidelines (=all emissions from managed land should be included in the inventory).

In relation to the discussion about “Net emissions” approach, the following were noted.

- IPCC Inventory Guidelines provide methods to estimate and report national GHG emissions/removals, but do not deal with “accounting” (= relating to emission reduction commitment).
 - This issue may need to be considered also in the context of cross-sectoral issues such as time-series consistency and recalculation. (In the case natural wetlands were converted to Flooded Lands for hydroelectricity in 20XX, should we recalculate the inventory to include emissions from that areas for years before 20XX which were not included because they were considered as emissions from “unmanaged lands”?)
- ii) Definition of flooded land to include run of the river dams
 - iii) Several key emission pathways can be addressed at Tier 1 level
 - iv) Some emission pathways will require higher tier approach in countries where they are important
 - v) Cross cutting issues
- Consistency/overlap with some categories in the 2013 Wetlands Supplement
 - Avoidance of double counting/not accounting for carbon and nitrogen exported from terrestrial ecosystems and processed within flooded lands

Suggested refinement option [New Guidance and Update]

[Revision of emission factor for flooded land (Wetlands) and development of a methodology for estimating CH₄ emissions from flooded lands and possible refinement of methodology for estimating CO₂]

(Annotated list of Issues discussed in Agriculture BOGs in 2015 and 2016 Expert meetings)

Forestry and Other Land use

CROPLAND (3.B.2)

Issue #4:

Mineral soils under Cropland: Carbon stock change factors

Outcomes of the Sao Paulo meeting July 2015

Main difficulty is to find necessary activity data. Maybe it is useful to show alternative methods to get necessary data (consistent with 3.D) or to use them in a refined alternative methodology (gain-loss; C input minus C losses; Russia has experience, Stephen Ogle suggests equilibrium model runs). The methodology would somehow be less data-intensive than the current methodology (simpler). But methodologies have to be consistent across land-uses and in the time series.

Tillage: a lot of new research; no-till effect does not work everywhere, so the defaults may imply an impact which does not happen everywhere. Check how much information comes from tropics and regions where the default method is commonly used

Productivity: new data, in particular on cover crops. Highlight that residue etc. data is available from N input estimate in 3.D. Strive for internal consistency and highlight this here

Organic input: new data available, factor was very uncertain. Highlight that organic manure data is available from N input estimate in 3.D. Strive for internal consistency and highlight this here.

Suggested refinement option [Methodology Report]

If there is a methodology change in croplands, this has implications in all land-use categories.

Assess the potential other, simpler methodology for croplands for applicability in other land-use categories

Generic equations including equation 2.25, Chapter 2, Vol 4 and relevant parameters used in equations and default factors are given in respective chapter of (Cropland Chapter 5, Table 5.5) and Grassland (Chapter 6, Table 6.2) of Vol 4.

Outcomes of the Wollongong meeting April 2016

i. Assessment of feasibility of other potential simpler methodology

Alternative methodologies were presented and considered. Modified gains-loss or hybrid gains-loss approach. They were not simpler or less data intensive. However, they may fit better with certain national data availability and circumstances.

This would only be considered if default factors can be developed, activity data is available and the method is verified.

The current methodology would be retained and be an option for countries to use if it is more appropriate for their national circumstances.

Suggested refinement option [New Guidance]

Alternative methodologies should be explored in a methodology report.

This requires the development of new guidance. Development would be based on methods currently being used by countries or developed in the scientific literature.

Authors should consider the comparability of the existing Tier 1 method with any alternative Tier 1 methodology.

ii. Consideration of implications in all land-use categories if there is a methodology change, and applicability of the method in other land-use categories

Changes to carbon stock change factors will have implications on land-use change categories and also other land-use categories. Elaboration on the use of higher Tier methods is required and the application of different higher Tier methods among different land-use categories.

Suggested refinement option [New Guidance]

These changes will have implications for other land-use categories.

Updates and addition of default factors is required.

Factors that require exploration are the time of transition for carbon following land-use change in different ecosystems. The use of a two stage transition, as applied in the wetland supplement was discussed, and the use of different transition periods for different climates and different management practices.

Special emphasis should be placed on integrating information about tropical land-use changes.

Guidance should be developed to provide approaches to develop carbon stock change estimates for land-use transitions when using different Tier 1 or higher Tier methodologies for different land-use categories.

iii. Consideration of data availability to update default C stock change factors for mineral soils

Currently the current methodology is not being used widely due to the complexity of the current guidance. It is necessary to revise this guidance.

Suggested refinement option [New Guidance]

There is adequate evidence to take this to a methodology report.

There is evidence that default factors in the current guidance could be updated. In particular new defaults for tropical regions and tropical land-use change can be developed based on recent research. Other factors such as the tillage stock change factor also requires revision based on recent research. Other factors within the current guidance should be reviewed in light of new research.

The elaboration required to applying the present guidance would require clear instructions on applying increasing amounts of information (activity data) on soil carbon management in the present method. A guide to continuous improvement of the application of the Tier 1 methodology (prioritization of application of management factors). For example the compiler should use at least the land-use change effects, followed by addressing management and input factors.

This should include clear guidance, as well, on how and why it is important to move to higher Tier methods.

Links should be made between spatial representation approaches and the collection of information on soil management through mechanisms such as expert information surveys.

GRASSLAND (3.B.3)

Issue #5

Mineral soils under grassland: Carbon stock change factors

Outcomes of the Sao Paulo meeting July 2015

C stock change factors in 2006 IPCC Guidelines were made on a small data base; several more are available and could make a difference, which cannot be assessed by the expert group; defaults, e.g. linked to production, could be more robust. An update of the EF is probably not a big effort, since the overall information is relatively scarce. Would also help to improve burning estimates.

Suggested refinement option [Methodology report]

In line with changes in croplands.

Generic equations including equation 2.25, Chapter 2, Vol 4 and relevant parameters used in equations and default factors are given in respective chapter of (Cropland Chapter 5, Table 5.5) and Grassland (Chapter 6, Table 6.2) of Vol 4.

Outcomes of the Wollongong meeting

i. Assessment of feasibility of other potential simpler methodology

The same approach as proposed for cropland should be explored for grasslands.

Suggested refinement option [New Guidance]

This subject should be addressed in a methodology report.

This requires the development of new guidance. Development would be based on methods currently being used by countries or developed in the scientific literature.

ii. Consideration of implications in all land-use categories if there is a methodology change, and applicability of the method in other land-use categories

The same considerations would be considered for grassland as cropland.

Suggested refinement option [New Guidance]

See cropland

iii. Consideration of data availability to update default C stock change factors for mineral soils

Grassland methodology requires the same elaboration of guidance in its application as cropland C. The majority of evidence of changes in C stock changes factors is in the cropland category, but new research should be reviewed to evaluate if similar changes could be made to grassland factors.

Suggested refinement option: [New Guidance]

There is adequate evidence to take this to a methodology report.

Elaborate on guidance, a step-by-step guide to continuous improvement of methodology.

Review C-stock change factors, in light of recent research.

Waste Sector

Issue #1.

Domestic Wastewater Treatment and Discharge (4.D.1)

Development or update of methods and default emission factors for emission estimation for septic tanks

- Unclear of significance but used in almost every country
- Encouraged addition of data to EFDB to reflect different types of septic systems (e.g., bottomless, water sealed) and temperature
- Recommended expert meeting for technical assessment of ability to update/complement default parameters and clarify the methodology (e.g., when using multiple systems)

***Suggested refinement option(s):* [Update]**

(Update of Section 6.2, Chapter 6, Volume 5)

Issue #2.

Domestic Wastewater Treatment and Discharge (4.D.1)

Improvement of guidance and update or addition of default emission factors of N₂O emissions from nitrification and denitrification at wastewater treatment plants

- New studies confirm highly variable emissions dependent on type of treatment, but the current EF is considered too low for these types of systems and there may be need for an EF for other types of systems
- Encouraged addition of data to EFDB to evaluate the default factor and evaluate range of emissions
- Discuss/highlight potential source in FAQ
- Current guidance is outdated and does not respond to recent research
- Recommended expert meeting for technical assessment of method, EF, and activity data before further consideration for supplementary guidance related to N₂O emissions from wastewater treatment

Suggested refinement option(s): [Update]

(Update of Section 6.3, Chapter 6, Volume 5)

Issue #3.

Industrial Wastewater Treatment and Discharge (4.D.2)

Development of guidance on N₂O emissions from industrial wastewater treatment process

- Significance of this source is not clear
- Methodology used for domestic wastewater could be applied to industrial wastewater (both direct and indirect N₂O) for countries where this is a significant source and activity data are available
- Guidance could be provided on how to address industrial wastewater treatment emissions in FAQ
- Encouraged addition of data to EFDB to reflect industrial data and emissions
- Recommended expert meeting for technical assessment of activity data and method before further consideration for supplementary guidance related to N₂O emissions from wastewater treatment

Suggested refinement option(s): [New Guidance]

Overall summary of recommendations of the Geneva meeting:

- CH₄ emissions from septic systems
 - Flagged for focused scoping meeting
 - Most relevant topic globally
 - Need to update and refine emission factors (MCF) based on new data to address different types of tanks
- N₂O emissions from wastewater
 - Flagged for focused scoping meeting
 - Overall recommendation is to relook/rewrite N₂O section to address new data and need for better guidance
 - Improvement of N₂O emission factors from wastewater treatment plants (nitrification/denitrification processes and conventional treatment)
 - Inclusion of industrial wastewater (new source)
 - Mass balance approach (clarify how to address N lost through system)
 - FAO data on protein consumption vs protein supply
 - Need to keep methods simple, because it is a minor source but allow also for higher Tiers

Annex 4. Draft Integral Table of Contents (TOC)

2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Draft Table of Contents

Introductory Note

The *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* (2019 Refinement) will be a single Methodology Report comprising an Overview Chapter and five volumes following the format of the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (2006 IPCC Guidelines).

Overview Chapter

Volume 1: General Guidance and Reporting

Volume 2: Energy

Volume 3: Industrial Processes and Product Use

Volume 4: Agriculture, Forestry and Other Land Use

Volume 5: Waste

The draft table of contents is presented below for each volume. Its structure is the same as that of the *2006 IPCC Guidelines* so as to make it easier for inventory compilers to use this Methodology Report with the *2006 IPCC Guidelines*. For those Chapters/Sections/Subsections where refinement is expected, the following three elements are explained.

- *Issue* (which needs to be addressed)
- *Location in 2006 IPCC Guidelines* (location of relevant guidance in the 2006 IPCC Guidelines)
- *Type of refinement* (Update, Elaboration or New guidance, as explained in the draft Terms of Reference)

On the other hand, for those Chapters/Sections/Subsections where refinement is NOT expected, “No refinement” is indicated.

However, the following two principles need to be noted.

- *Authors should develop modifications even for those Chapters/Sections/Subsections where “No refinement” is indicated in this draft table of contents, if deemed necessary to ensure consistency with the refinements made in the other Chapters/Sections/Subsections.*
- *Authors may conclude no refinement should be made even for the Chapters/Sections/Subsections where refinement is expected in this draft table of contents, after comprehensive review of available literature.*

In addition, authors should develop modifications for Annexes (e.g. Worksheets) at the end of each volume as well, if deemed necessary to ensure consistency with the refinements made in Chapters/Sections/Subsections in the same volume, even though those Annexes are not explicitly included in this draft table of contents.

Overview Chapter

- *Background – Technical Assessment of IPCC Inventory Guidelines*
- *Fundamental principle (not revising, but refining)*
- *Relationship with the 2006 IPCC Guidelines*
- *Policy Relevance*

Volume 1: General Guidance and Reporting

Chapter 1 Introduction to the 2006 IPCC Guidelines

Issue 1: Provide a better description on how to implement a national inventory management system that manages all parts of Volume 1, implements continuous improvement and leads to the development of mature inventories.

Location in 2006 IPCC Guidelines: New Section in Chapter 1

Type of refinement: New guidance

Issue 2: Clarify the concept of “anthropogenic emissions and removals”.

Location in 2006 IPCC Guidelines: Section 1.1 Concepts, with Guidance contained in the 2013 KP Supplement Chapter 2.3.4 and 2.3.5 and the 2013 Wetlands Supplement

Type of refinement: Update

Chapter 2 Approaches to Data Collection

Issue 1: Add guidance for the development of country-specific emission factors, focusing on developing countries.

Location in 2006 IPCC Guidelines: New guidance in Chapter 2

Type of refinement: New guidance

Issue 2: Add guidance for activity data collection; technical survey indicated there is a capacity problem to gather and manage national data which can be addressed by an additional guidance.

Location in 2006 IPCC Guidelines: New guidance in Chapter 2

Type of refinement: New guidance

Issue 3: Add guidance on the integration of GHG emissions reported from facilities into national GHG inventories

Location in 2006 IPCC Guidelines: New guidance in Chapter 2

Type of refinement: New guidance

Chapter 3 Uncertainties

Issue: Refine guidance on uncertainty based on the latest scientific knowledge and simplification of guidance by providing more default values, calculation examples and best practices.

Location in 2006 IPCC Guidelines: Chapter 3

Type of refinement: Update

Chapter 4 Methodological Choice and Identification of Key Categories

Issue: Add guidance on key category analysis to address treatment of disaggregation of categories, trend analysis, equations for trend analysis and the need for consistent definition of significant subcategories across the different volumes of the 2006 IPCC Guidelines.

Location in 2006 IPCC Guidelines: Chapter 4 (and relevant guidance in the other volumes)

Type of refinement: Elaboration

Chapter 5 Time Series Consistency

Issue: Provide practical guidance on how to apply existing guidance on time series consistency because this proved to be a problem for many countries.

Location in 2006 IPCC Guidelines: Chapter 5

Type of refinement: Elaboration

Chapter 6 Quality Assurance / Quality Control and Verification

Issue 1: Add guidance on the use and reporting of models

Location in 2006 IPCC Guidelines: New Section in Chapter 6

Type of refinement: New guidance

Issue 2: Elaborate user-friendly description of verification, validation, audit and QA/QC because users are unclear on their IPCC meanings compared to outer definitions, such as ISO as used by CDM.

Location in 2006 IPCC Guidelines: Section 6.1, Box 6.1

Type of refinement: Elaboration

Issue 3: Update/elaborate verification guidance because the existing guidance is outdated (especially the guidance on comparisons with atmospheric measurements and new datasets).

Location in 2006 IPCC Guidelines: Section 6.10

Type of refinement: Update/Elaboration

Chapter 7 Precursors and Indirect Emissions

Issue: Elaborate clearer guidance for the calculation of indirect CO₂ emissions.

Location in 2006 IPCC Guidelines: Section 7.2.1.5

Type of refinement: Elaboration

Chapter 8 Reporting Guidance and Tables

No refinement

Volume 2: Energy

Chapter 1 Introduction

No refinement

Chapter 2 Stationary Combustion

2.1 Overview

No refinement

2.2 Description of sources

No refinement

2.3 Methodological issues

Issue: Link to issue related to biomass combustion and methodologies for HWP

Location in 2006 IPCC Guidelines: Section 2.3.3.4

Type of refinement: Elaboration

2.4 Uncertainty assessment

No refinement

2.5 Inventory Quality Assurance/Quality Control QA/QC

No refinement

2.6 Worksheets

No refinement

Chapter 3 Mobile Combustion

No refinement

Chapter 4 Fugitive Emissions

4.1 Fugitive emissions from mining, processing, storage and transportation of coal

Issue1: Elaborate chapter to include guidance on emissions from exploration and CO₂ emissions (Underground coal mines, Surface coal mining)

Location in 2006 IPCC Guidelines: Sections 4.1.3 and 4.1.4 (Sections 4.1.1, 4.1.2 and 4.1.6 are relevant)

Type of refinement: Elaboration

Issue2: Include new section on abandoned surface coal mines

Location in 2006 IPCC Guidelines: Not applicable. (Next to Section 4.1.5. Sections 4.1.1, 4.1.2 and 4.1.6 are relevant)

Type of refinement: New guidance

4.2 Fugitive emissions from oil and natural gas systems

Issue: Update chapter including update/inclusion of EFs representative for current practice. Additional guidance for unconventional oil and gas production and abandoned wells.

Location in 2006 IPCC Guidelines: Sections 4.2

Type of refinement: Update

4.3 Fuel transformation [New]

Issue: Include new section on fuel transformation

Location in 2006 IPCC Guidelines: New Section in Chapter 4 (Next to Section 4.2)

Type of refinement: New guidance

Chapter 5 Carbon Dioxide Transport, Injection and Geological Storage

No refinement

Chapter 6 Reference Approach

No refinement

Volume 3: Industrial Processes and Product Use

Chapter 1 Introduction

No refinement

Chapter 2 Mineral Industry Emission

No refinement

Chapter 3 Chemical Industry Emissions

3.1 Introduction

No refinement

3.2 Ammonia production

No refinement

3.3 Nitric acid production

Issue: Update guidance on appropriate emission factors to use for dual pressure technologies for Nitric Acid Production

Location in 2006 IPCC Guidelines: Section 3.3.2.2 and Table 3.3

Type of refinement: Update

3.4 Adipic acid production

No refinement

3.5 Caprolactam, glyoxal and glyoxylic acid production

No refinement

3.6 Carbide production

No refinement

3.7 Titanium dioxide production

No refinement

3.8 Soda ash production

No refinement

3.9 Petrochemical and carbon black production

No refinement

3.10 Fluorochemical production

Issue: Update guidance and default Tier 1 emission factors for production of fluorinated compounds other than HCFC-22

Location in 2006 IPCC Guidelines: Section 3.10.2.2

Type of refinement: Update/Elaboration

3.11 Hydrogen production [New]

Issue: Develop guidance for estimating GHG emissions from hydrogen production

Location in 2006 IPCC Guidelines: New Section in Chapter 3 (Next to Section 3.10)

Type of refinement: New guidance

Chapter 4 Metal Industry Emissions

4.1 Introduction

No refinement

4.2 Iron & steel and metallurgical coke production

Issue: Update emission factors for Iron and Steel Production and elaborate methodological guidance.

Location in 2006 IPCC Guidelines: Section 4.2.2.3 and Table 4.1

Type of refinement: Update/Elaboration

4.3 Ferroalloy production

No refinement

4.4 Primary aluminium production

Issue: Elaborate guidance and emissions factors to incorporate “low-voltage anode effect” PFC emissions and integrate this guidance into the existing methodology on “high-voltage anode effect” PFC emissions. Update of the Tier 1 and Tier 2 defaults.

Location in 2006 IPCC Guidelines: Section 4.4

Type of refinement: Update/Elaboration

Issue: Develop a new methodology for the CO₂ emissions from the alumina production. Ensuring completeness and avoiding double counting

Location in 2006 IPCC Guidelines: New guidance in Section 4.4

Type of refinement: New guidance

4.5 Magnesium production

No refinement

4.6 Lead production

No refinement

4.7 Zinc production

No refinement

4.8 Rare Earth elements [New]

Issue: Develop a new guidance on GHG emissions (PFCs and CO₂) from production of Rare Earth elements

Location in 2006 IPCC Guidelines: New Section in Chapter 4 (Next to Section 4.7)

Type of refinement: New guidance

Chapter 5 Non-Energy Products from Fuels and Solvent use

No refinement

Chapter 6 Electronics Industry Emissions

Issue: Update guidance and default Tier 1 and Tier 2 emission factors for Semiconductor Industry, improvement of the Tier 3 guidance and elaboration of guidance on generation of by-products from abatement technologies (CF₄ from NF₃)

Location in 2006 IPCC Guidelines: Section 6.2.1 and 6.2.2, and 6.3.1 (uncertainty, to the extent necessary)

Type of refinement: Update/Elaboration/New guidance

Chapter 7 Emissions of Fluorinated Substitutes for Ozone Depleting Substances (ODS)

7.1 Introduction

No refinement

7.2 Solvents (non-aerosol)

No refinement

7.3 Aerosols (propellants and solvents)

No refinement

7.4 Foam blowing agents

No refinement

7.5 Refrigeration and air conditioning

Issue: Add examples (collection of activity data, distribution of ODS substitutes by application within countries). Elaborate by adding a box with “recipe-style” guidance on how to launch the ODS substitutes inventory. Elaborate the reference to Montreal Protocol. Update emission factors by further segregating equipment types, regions, and time periods where possible.

Location in 2006 IPCC Guidelines: Sections 7.5.2.1 - for the recipe, 7.5.2.2 - for emission factors, 7.5.2.3 - for activity data

Type of refinement: Update/Elaboration

7.6 Fire protection

No refinement

7.7 Other applications

No refinement

Chapter 8 Other Product Manufacture and Use

8.1 Introduction

No refinement

8.2 Emissions of SF₆ and PFCs from electrical equipment

No refinement

8.3 Use of SF₆ and PFCs in other products

Issue 1: Develop guidance for PFCs (GHG) emissions from Textile Industry.

Location in 2006 IPCC Guidelines: New guidance in Section 8.3

Type of refinement: New guidance

Issue 2: Develop guidance for PFCs (GHG) emissions from water-proofing electronic circuit boards

Location in 2006 IPCC Guidelines: New guidance in Section 8.3

Type of refinement: New guidance

8.4 N₂O from product uses

No refinement

Volume 4: Agriculture, Forestry and Other Land Use

Chapter 1 Introduction

No refinement

Chapter 2 Generic Methodologies Applicable to Multiple Land-use Categories

2.1 Introduction

No refinement

2.2 Inventory framework

No refinement

2.3 Generic methods for CO₂ emissions and removals

2.3.1 Change in biomass carbon stocks (above-ground biomass and below-ground biomass)

Issue 1: Develop guidance on the use of allometric equations for biomass estimation

Location in 2006 IPCC Guidelines: New Subsection in Section 2.3.1

Type of refinement: New guidance

Issue 2: Develop guidance on how to use biomass density (amount per unit area) maps generated from remote sensing data for biomass estimation

Location in 2006 IPCC Guidelines: New Subsection in Section 2.3.1

Type of refinement: New guidance

2.3.2 Change in carbon stocks in dead organic matter

Issue 1: Update default values for litter stocks and develop default values for deadwood stocks

Location in 2006 IPCC Guidelines: Section 2.3.2.1, IPCC default values for litter and dead wood (Table 2.2)

Type of refinement: Update/Elaboration

Issue 2: Develop equation 2.18 for estimating DOM_{out} and associated default values

Location in 2006 IPCC Guidelines: Section 2.3.2.1, IPCC default values for litter and dead wood (Table 2.2)

Type of refinement: Elaboration

2.3.3 Change in carbon stocks in soils

Issue 1: Update reference carbon stocks.

Location in 2006 IPCC Guidelines: Section 2.3.3.1, Table 2.3

Type of refinement: Update

Issue 2: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 2.3.3.1

Type of refinement: New guidance

Issue 3: Elaborate Tier 3 Methodologies with case study examples for soils.

Location in 2006 IPCC Guidelines: Tier 3 methods, Section 2.3.3.1,

Type of refinement: Elaboration

2.4 Non-CO₂ emissions

Issue: Replace defaults for cropland mass of fuel with crop residue estimation method in Chapter 11 for soil N₂O method to ensure consistency in the calculation of residues between the two categories, and provide a basis to estimate mass of fuel for all crops instead of just the 4 crops listed in Table 2.4.

Location in 2006 IPCC Guidelines: Section 2.4, Table 2.4

Type of refinement: Update

2.5 Additional generic guidance for Tier 3 methods

Issue 1: Provide guidance on how to address inter-annual variability

Location in 2006 IPCC Guidelines: Chapter 2.5

Type of refinement: Elaboration

Issue 2: Elaborate guidance on the use of Tier 3 methods

Location in 2006 IPCC Guidelines: Sections 2.5.1 and 2.5.2

Type of refinement: Elaboration

Chapter 3 Consistent Representation of Lands

3.1 Introduction

No refinement

3.2 Land-use categories

No refinement

3.3 Representing land-use areas

Issue: Develop guidance on how remotely sensed data, ground based data, and ancillary data can be integrated and used to derive consistent time series estimates of land use and land-use change

Location in 2006 IPCC Guidelines: Section 3.3 and Annex 3A.1 and 3A.2

Type of refinement: Update/Elaboration/New guidance

3.4 Matching land areas with factors for estimating greenhouse gas emissions and removals

Issue: Provide guidance on how to use methodologies within different methodological tiers in combination with different approaches for land representation

Location in 2006 IPCC Guidelines: New Subsection in Section 3.4

Type of refinement: New guidance

3.5 Uncertainties associated with the Approaches

No refinement

Annex 3A.1 Examples of International land cover datasets

(See the above issue under Section 3.3)

Annex 3A.2 Development of land-use databases

(See the above issue under Section 3.3)

Chapter 4 Forest Land

4.1 Introduction

No refinement

4.2 Forest Land Remaining Forest Land

4.2.1 Biomass

No refinement

4.2.2 Dead organic matter

No refinement

4.2.3 Soil carbon

Issue: Provide guidance and develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 4.2.3

Type of refinement: New guidance

4.2.4 Non-CO₂ greenhouse gas emissions from biomass burning

No refinement

4.3 Land Converted to Forest Land

(All issues for Section 4.2 above apply to this Section similarly.)

4.4 Completeness, time series, QA/QC, and reporting and documentation

Issue: Develop guidance on how to ensure methodological consistency of time series, such as through the use of age class structure data

Location in 2006 IPCC Guidelines: Section 4.4.2 on time series consistency

Type of refinement: Elaboration

4.5 Tables

Issue: Update values for BEF/BCEF and root/shoot ratio, average biomass stocks, and average biomass increments

Location in 2006 IPCC Guidelines: Tables 4.4, 4.5, 4.7, 4.8, 4.9, 4.10, 4.11A and 4.11B, 4.12

Type of refinement: Update/Elaboration

Chapter 5 Cropland

5.1 Introduction

No refinement

5.2 Cropland Remaining Cropland

5.2.1 Biomass

Issue: Update default biomass carbon parameters.

Location in 2006 IPCC Guidelines: Section 5.2.1.2, Tables 5.1, 5.2, 5.3

Type of refinement: Update

5.2.2 Dead organic matter

No refinement

5.2.3 Soil carbon

Issue 1: Update carbon stock change factors.

Location in 2006 IPCC Guidelines: Section 5.2.3.2, Table 5.5

Type of refinement: Update

Issue 2: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 5.2.3

Type of refinement: New guidance

5.2.4 Non-CO₂ greenhouse gas emissions from biomass burning

No refinement

5.3 Land Converted to Cropland

(All issues for Section 5.2 above apply to this Section similarly.)

5.4 Completeness, time series, QA/QC, and reporting

No refinement

5.5 Methane emissions from rice cultivation

Issue: Develop regionally specific default EFs

Location in 2006 IPCC Guidelines: Section 5.5.2, Tables 5.11 to 5.14,

Type of refinement: Update

Annex 5A.1 Estimation of default stock change factors for mineral soil C emissions/removals for cropland

(See the above issues under Section 5.2.3.)

Chapter 6 Grassland

6.1 Introduction

No refinement

6.2 Grassland Remaining Grassland

6.2.1 Biomass

Issue: Update default biomass carbon parameters.

Location in 2006 IPCC Guidelines: Section 6.2.1.2, Table 6.1

Type of refinement: Update

6.2.2 Dead organic matter

No refinement

6.2.3 Soil carbon

Issue 1: Update carbon stock change factors.

Location in 2006 IPCC Guidelines: Section 6.2.3.2, Table 6.2

Type of refinement: Update

Issue 2: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 6.2.3

Type of refinement: New guidance

6.2.4 Non-CO₂ greenhouse gas emissions from biomass burning

No refinement

6.3 Land Converted to Grassland

(All Issues for section 6.2 above apply to this Section similarly.)

6.4 Completeness, time series, QA/QC, and reporting

No refinement

Annex 6A.1 Estimation of default stock change factors for mineral soil C emissions/removals for grassland

(See the above issues under Section 6.2.3.)

Chapter 7 Wetlands

7.1 Introduction

No refinement

7.2 Managed peatlands

No refinement

7.3 Flooded Land

Issue: Update CO₂ emission factors for land converted to flooded land (Wetlands) and fully develop a consistent methodology for estimating CO₂ and CH₄ emissions from flooded lands (both land converted to flooded land and flooded land remaining flooded land).

Location in 2006 IPCC Guidelines: Section 7.3 and associated good practice guidance in Section 7.4, and Appendices 2 and 3; also relevant to Chapter 2, Section 2.3 (Generic Methodologies for CO₂ emissions and removals).

Type of refinement: New guidance/Update

7.4 Completeness, time series consistency, and QA/QC

No refinement

7.5 Future methodological development

Issue: Clarify that this section of the 2006 IPCC Guidelines is no longer relevant

Location in the 2006 Guidelines: Section 7.5

Type of refinement: Elaboration

7.X. Additional guidance on Tier 2 method for mineral soils [New]

Issue: Develop guidance to implement new Tier 2 method for mineral soils that requires less activity data than the current default method, taking into consideration Chapter 5 of the 2013 Wetlands Supplement to the 2006 IPCC Guidelines: Wetlands.

Location in 2006 IPCC Guidelines: New Section in Chapter 7 (Between Sections 7.3 and 7.4)

Type of refinement: New guidance

Chapter 8 Settlements

8.1 Introduction

No refinement

8.2 Settlements Remaining Settlements

8.2.1 Biomass

Issue: Update default biomass carbon parameters.

Location in 2006 IPCC Guidelines: Section 8.2.1.2,

Type of refinement: Update

8.2.2 Dead organic matter

No refinement

8.2.3 Soil carbon

Issue: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 8.2.3

Type of refinement: New guidance

8.3 Land Converted to Settlements

(All Issues for section 8.2 above apply to this Section similarly.)

8.4 Completeness, time series consistency, QA/QC and reporting

No refinement

8.5 Basis for future methodological development

Issue: Clarify the elements in this section of the 2006 IPCC Guidelines that are no longer relevant

Location in the 2006 Guidelines: Section 8.5

Type of refinement: Elaboration

Chapter 9 Other Land

9.1 Introduction

No refinement

9.2 Other Land Remaining Other Land

No refinement

9.3 Land Converted to Other Land

9.3.1 Biomass

No refinement

9.3.2 Dead organic matter

No refinement

9.3.3 Soil carbon

Issue: Develop new Tier 2 method for mineral soils that requires less activity data than the current default method

Location in 2006 IPCC Guidelines: New guidance in Section 9.3.3

Type of refinement: New guidance

9.4 Completeness, time series, QA/QC and reporting

No refinement

Chapter 10 Emissions from Livestock and Manure Management

10.1 Introduction

No refinement

10.2 Livestock population and feed characterisation

Issue 1: Update Section 10.2.2 to include guidance on improved description of feeding systems

Location in 2006 IPCC Guidelines: Section 10.2.2

Type of refinement: Update

Issue 2: Develop consistent system descriptions for manure management between source categories (regionally/climatically stratified) for basic and enhanced characterisation for livestock populations

Location in 2006 IPCC Guidelines: Section 10.2.2

Type of refinement: Update

10.3 Methane emissions from enteric fermentation

Issue: Improve parameters based on different feeding strategies for cattle and sheep.

Location in 2006 IPCC Guidelines: Section 10.3.2, Table 10.11 and Table 10.12

Type of refinement: Update

10.4 Methane emissions from manure management

Issue 1: Update methodology, temperature relationships, Tier 1 Emission Factors and Tier 2 parameters for different manure management systems

Location in 2006 IPCC Guidelines: Section 10.4.2

Type of refinement: Update

Issue 2: Update guidance on how to deal with non-CO₂ emissions due to biogas production.

Location in 2006 IPCC Guidelines: Section 10.4.2, Table 10.17

Type of refinement: Update

10.5 N₂O emissions from manure management

Issue 1: Update N excretion parameters for all livestock categories considering updated livestock characterization in Section 10.2.

Location in 2006 IPCC Guidelines: Section 10.5.2

Type of refinement: Update

Issue 2: Update emission factors for N₂O for manure management system descriptions.

Location in 2006 IPCC Guidelines: Section 10.5.2, Table 10.21

Type of refinement: Update

Issue 3: Update manure management volatilization and leaching factors with manure management systems identified in Section 10.2.

Location in 2006 IPCC Guidelines: Section 10.5.4, Tables 10.22 and 10.23,

Type of refinement: Update

Issue 4: Provide text on quality control procedures that use a mass balance approach to evaluate C and N flows through animal management systems.

Location in 2006 IPCC Guidelines: Section 10.5.6

Type of refinement: Elaboration

Chapter 11 N₂O Emissions from Managed Soils, and CO₂ Emissions from Lime and Urea Application

11.1 Introduction

No refinement

11.2 N₂O emissions from managed soils

11.2.1 Direct N₂O emissions

Issue 1: Update N₂O EF1, stratification by climate

Location in 2006 IPCC Guidelines: Section 11.2.1.2, Table 11.1

Type of refinement: Update

Issue 2: Update crop parameters for calculating residue quantity and N.

Location in 2006 IPCC Guidelines: Section 11.2.1.4, Table 11.2

Type of refinement: Update

Issue 3: Update the EF3 for N applied to soils, pasture, range and paddock by grazing animals.

Location in 2006 IPCC Guidelines: Section 11.2.1, Table 11.1

Type of refinement: Update

Issue 4: Update emission factor for rice production (N₂O)

Location in 2006 IPCC Guidelines: Section 11.2, Table 11.1

Type of refinement: Update

11.2.2 Indirect N₂O emissions

Issue: Evaluate emissions factors for indirect N₂O, both the amount of leaching/runoff and volatilization, as well as the indirect emission factor.

Location in 2006 IPCC Guidelines: Section 11.2.2, Table 11.3

Type of refinement: Update

11.2.3 Completeness, Time series, QA/QC

No refinement

11.3 CO₂ emissions from liming

No refinement

11.4 CO₂ emissions from urea fertilization

No refinement

Annex 11A.1 References for crop residue data in Table 11.2

No refinement

Chapter 12 Harvested Wood Products (HWP)

Issue 1: Update the relevant technical parameters, maintaining the existing approaches in the 2006 IPCC Guidelines

Location in 2006 IPCC Guidelines: Chapter 12

Type of refinement: Update

Volume 5: Waste

Chapter 1 Introduction

No refinement

Chapter 2 Waste Generation, Composition and Management Data

2.1 Introduction

No refinement

2.2 Waste generation and management data

Issue: Update default data on Municipal Solid Waste (MSW) generation and management

Location in 2006 IPCC Guidelines: Section 2.2.1, Table 2.1

Type of refinement: Update

2.3 Waste composition

Issue 1: Update default data on MSW composition data

Location in 2006 IPCC Guidelines: Section 2.3.1, Table 2.3

Type of refinement: Update

Issue 2: Add information on nitrogen (N) content, Biochemical Oxygen Demand (BOD) or Chemical Oxygen Demand (COD) of sludge

Location in 2006 IPCC Guidelines: New guidance in Section 2.3.2

Type of refinement: New guidance

Annex 2A.1 Waste Generation and Management Data - by country and regional averages

Issue: Update default data on MSW generation and management

Location in 2006 IPCC Guidelines: Table 2A.1

Type of refinement: Update

Chapter 3 Solid Waste Disposal

3.1 Introduction

3.2 Methodological issues

Issue 1: Elaborate on the First Order Decay (FOD) method taking into account active aeration of landfills

Location in 2006 IPCC Guidelines: New guidance in Section 3.2.1.1

Type of refinement: New guidance

Issue 2: Elaborate on default DOC which decomposes (DOC_i) values for different waste components

Location in 2006 IPCC Guidelines: Section 3.2.3 (Fraction of degradable organic carbon which decomposes (DOC_i))

Type of refinement: Elaboration

3.3 Use of measurement in the estimation of CH₄ emissions from solid waste disposal site (SWDS)

No refinement

3.4 Carbon stored in SWDS

No refinement

3.5 Completeness

No refinement

3.6 Developing a consistent time series

No refinement

3.7 Uncertainty assessment

Issue: Update uncertainty for DOC_r values

Location in 2006 IPCC Guidelines: Section 3.7.2

Type of refinement: Update

3.8 QA/QC, reporting and documentation

No refinement

Annex 3A.1 First Order Decay Model

No refinement

Chapter 4 Biological Treatment of Solid Waste

No refinement

Chapter 5 Incineration and Open Burning of Waste

5.1 Introduction

No refinement

5.2 Methodological issues

No refinement

5.3 Choice of activity data

No refinement

5.4 Choice of emission factors

Issue 1: Update oxidation factors for open burning of MSW

Location in 2006 IPCC Guidelines: Section 5.4.1, Table 5.2 (Oxidation factor for open burning of MSW)

Type of refinement: Update/Elaboration

Issue 2: Elaborate on EF for CH₄ from incineration related to new technologies (gasification, pyrolysis, and plasma technology)

Location in 2006 IPCC Guidelines: Section 5.4.2, Table 5.3

Type of refinement: Elaboration

Issue 3: Elaborate on EF for N₂O from incineration related to new technologies (e.g. gasification, pyrolysis, and plasma technology)

Location in 2006 IPCC Guidelines: Section, 5.4.3, Table 5.4

Type of refinement: Elaboration

5.5 Completeness

No refinement

5.6 Developing a consistent time series

No refinement

5.7 Uncertainty assessment

No refinement

5.8 QA/QC, reporting and documentation

No refinement

Chapter 6 Wastewater Treatment and Discharge

6.1 Introduction

Issue 1: Update introduction language to reflect current understanding of CH₄ and N₂O emissions from wastewater treatment.

Location in 2006 IPCC Guidelines: Section 6.1

Type of refinement: Elaboration

Issue 2: Update Figure 6.1 and Table 6.1 to reflect additional types of treatment and disposal systems, such as aerobic/anaerobic treatment systems (e.g., anaerobic/anoxic/oxic (A2O), nitrification/denitrification, etc.) and constructed wetlands, as well as various types of septic systems (e.g., bottomless systems).

Location in 2006 IPCC Guidelines: Section 6.1

Type of refinement: Elaboration

Issue 3: Discuss updates/changes from 2006 IPCC Guidelines.

Location in 2006 IPCC Guidelines: Section 6.1.1

Type of refinement: Elaboration

6.2 Methane emissions from wastewater

6.2.1 Methodological issues

6.2.2 Domestic wastewater

Issue 1: Update Section 6.2.2.1. Some inventory compilers are misinterpreting Equation 6.1 and combining zero emissions from aerobic systems with recovered methane from sludge digestion, but missing the step of calculating emissions from sludge digestion.

Location in 2006 IPCC Guidelines: Section 6.2.2.1

Type of refinement: Update

Issue 2: Develop new Methane Correction Factors (MCFs) to reflect treatment processes that may be a combination of aerobic and anaerobic or anoxic zones (e.g., anaerobic/anoxic/oxic (A2O), modified Ludzack-Ettinger (MLE), etc.).

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Update

Issue 3: Consider the development of new MCFs to reflect different types of septic system (e.g., bottomless) and also to consider the effect of temperature on the MCF.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Potential update

Issue 4: Elaborate guidance on what systems are classified as “not well managed”/overloaded for centralized aerobic treatment plants.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Elaboration

Issue 5: Provide guidance on estimating emissions from septic systems that are connected to larger centralized treatment plants.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Elaboration

Issue 6: Determine whether methane emissions from treated effluent should be included, particularly that discharged to stagnant water or overloaded receiving waters.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Update

Issue 7: Provide guidance on the origin of the (maximum CH₄ producing capacity) Bo values presented in the chapter.

Location in 2006 IPCC Guidelines: Section 6.2.2.2

Type of refinement: Update

6.2.3 Industrial wastewater

Issue 1: Develop new MCFs to reflect treatment processes that may be a combination of aerobic and anaerobic or anoxic zones (e.g., anaerobic/anoxic/oxic (A2O), modified Ludzack-Ettinger (MLE), etc.).

Location in 2006 IPCC Guidelines: Section 6.2.3.2

Type of refinement: Update

Issue 2: Elaborate guidance on what systems are classified as “not well managed”/overloaded for centralized aerobic treatment plants

Location in 2006 IPCC Guidelines: Section 6.2.3.2

Type of refinement: Elaboration

Issue 3: Determine whether methane emissions from treated effluent should be included, particularly that discharged to stagnant water or overloaded receiving waters.

Location in 2006 IPCC Guidelines: Section 6.2.3.2

Type of refinement: Update

Issue 4: Update uncertainty tables to include new EFs and AD

Location in 2006 IPCC Guidelines: Section 6.2.3.5

Type of refinement: Update/Elaboration

6.3 Nitrous oxide emissions from wastewater

6.3.1 Methodological issues

Issue 1: Address “indirect” emissions and how this terminology interacts with Chapter 7.3, Volume 1 of the 2006 IPCC Guidelines.

Location in 2006 IPCC Guidelines: Section 6.3.1.1

Type of refinement: Elaboration

Issue 2: Add discussion on the latest research related to how N₂O is formed and emitted in treatment system

Location in 2006 IPCC Guidelines: Section 6.3.1.1

Type of refinement: Elaboration

Issue 3: Consider introducing Tier 1 and Tier 2 methods, similar to the CH₄ section.

Location in 2006 IPCC Guidelines: Section 6.3.1.1

Type of refinement: Update

Issue 4: Correct EF for nitrification/denitrification and develop N₂O emission factors for additional treatment system configurations (aerobic/anaerobic/anoxic systems) as well as activated sludge systems.

Location in 2006 IPCC Guidelines: Section 6.3.1.2

Type of refinement: Update/Elaboration

Issue 5: Add EF for septic systems.

Location in 2006 IPCC Guidelines: New guidance in Section 6.3.1.2

Type of refinement: New guidance

Issue 6: Update text regarding N (influent) to make consistent with Table 6.11.

Location in 2006 IPCC Guidelines: Section 6.3.1.3

Type of refinement: Elaboration

Issue 7: Clarify Food and Agriculture Organization (FAO) data in relation to protein supplied vs protein consumed

Location in 2006 IPCC Guidelines: Section 6.3.1.3

Type of refinement: Elaboration/Update

Issue 8: Addition of N₂O emission calculation for centralized plants and septic systems

Location in 2006 IPCC Guidelines: Sections 6.3.1.3/6.3.1.1

Type of refinement: Update

Issue 9: Improve the calculation of Neffluent

Location in 2006 IPCC Guidelines: Section 6.3.1.3

Type of refinement: Update/Elaboration

Issue 10: Addition of N₂O from industrial wastewater

Location in 2006 IPCC Guidelines: New guidance in Sections 6.3.1.1 and 6.3.1.3

Type of refinement: New guidance

6.3.2 Time series consistency

No refinement

6.3.3 Uncertainties

Issue: Update uncertainty tables to include new EFs and AD

Location in 2006 IPCC Guidelines: Section 6.3.3

Type of refinement: Update/Elaboration

6.3.4 QA/QC, completeness, reporting and documentation

No refinement

Annex 5: Proposal for a technical note on reporting of carbon from HWP between importing and exporting countries

Table 1 shows the number of times emissions from HWP (including emissions from HWP-based energy production) will be reported if exports/imports of HWP are involved and depending on the choice of reporting approach selected by the country that exports wood and the country that imports that wood. Two of the four approaches (default and production approach) report the emissions associated with exported HWP as occurring in the country where the wood was harvested, while the two other approaches (stock change and atmospheric flow) report the emissions as occurring in the country that imported the wood (provided that HWP were not re-exported).

The table shows under which conditions emissions are under reported (0), over reported (2) or correctly reported (1).

For example, if the wood exporting country uses the stock change or the atmospheric flow approach but the wood importing country uses the Default or production approach, then neither will report the emissions originating from exported HWP (under reporting). Conversely, if the exporting country uses the Default or the Production Approach while the importing country uses the stock change or atmospheric flow approach the emissions will be double counted and over reported.

Table 1: The four approaches are IPCC Default (D), Production Approach (PA), Stock Change (S) and Atmospheric Flow Approach (AF).

importing country → exporting country ↓	D	PA	S	AF
D	1	1	2	2
PA	1	1	2	2
S	0	0	1	1
AF	0	0	1	1

Annex 6: List of Participants

David Buluku Adegu
Ministry of Environment & Natural Resources
Kenya

Andrea Vanina Afranchi
Energy Performance SRL
Argentina

Naikoa Aguilar-Amuchastegui
World Wide Fund for Nature (WWF)

Rehab Ahmed Hassan
Higher Council for Environment and Natural Resources
Sudan

Hiroko Akiyama
National Agriculture and Food Research Organization
Japan

Marta A. Alfaro
INIA
Chile

Jukka Alm
Natural Resources Institute Finland (Luke)
Finland

Joao Wagner Alves
CETESB
Brazil

Abe Yapo Eric-Michel Assamoi
Climate Change Direction, Ministry of Environment
Cote d'Ivoire

Carlos Humberto Bahamondez
Instituto Forestal
Chile

Nathan Barros
Federal University of Juiz de Fora
Institute of Biology Science
Brazil

Deborah Bartram
Eastern Research Group, Inc.
USA

Martial Bernoux
FAO

Kathrine Loe Bjønness
Statistics Norway
Norway

Andrea Brandon
Ministry for the Environment
New Zealand

Bofeng Cai
Chinese Academy for Environmental Planning
China

Edwin Castellanos
Center for Environmental Studies, Universidad del Valle
de Guatemala
Guatemala

Michael Roger Czerniak
Edwards Vacuum Limited
UK

Laura Elena Dawidowski
National Atomic Energy Commission
Argentina

Retno Gumilang Dewi
Institut Teknologi Bandung
Pusat Kebijakan Keenergian, ITB
Indonesia

I Wayan Susi Dharmawan
Forest Research and Development Center, Ministry of
Environment and Forestry
Indonesia

Grant Michael Domke
US Department of Agriculture, Forest Service
USA

Hongmin Dong
Institute of Environment and Sustainable Development
in Agriculture, Chinese Academy of Agricultural
Sciences
China

Yoshitaka Ebie
National Institute for Environmental Studies
Japan

Simon Eggleston
Global Climate Observing System (GCOS)

Takahiro Endo
Remote Sensing Technology Center of Japan
(RESTEC)
Japan

Sandro Federici
San Marino

Laura Finster
Instituto Nacional de Tecnología Agropecuaria (INTA)
Argentina

Jason Funk
Climate Action Network (CAN)

Amit Garg
Indian Institute of Management Ahmedabad
India

Michael W. Gillenwater
Greenhouse Gas Management Institute
USA

Mikhail Gitarskiy
Institute of Global Climate and Ecology
Russia

Carlos Gomez
Universidad Nacional Agraria La Molina
Peru

Kristina Gonchar
RUE "Bel SRC "Ecology" under the Ministry of Natural
Resources and Environmental Protection
Belarus

Justin William Lawton Goodwin
Aether
UK

Barbara Gschrey
Oeko-Recherche GmbH
Germany

Céline Gueguen
CITEPA
France

Steen Gyldenkærne
Department of Environmental Science,
Aarhus University
Denmark

Javier Marcelo Hanna Figueroa
UNFCCC

John Harrison
Washington State University
USA

Elsa Hatanaka
National Institute for Environmental Studies
Japan

Anke Herold
Oeko-Institut
Germany

Yasumasa Hirata
Forestry and Forest Products Research Institute
Japan

Edward Charles Huffman
Agriculture and Agri-Food Canada
Canada

Matthew R. Johnson
Energy & Emissions Research Lab., Mechanical &
Aerospace Engineering, Carleton University
Canada

Samuel Kainja
Total Landcare
Malawi

Joseph Katongo Kanyanga
Zambia Meteorological Department
Zambia

Jamidu Hizzam Yahaya Katima
University of Dar es Salaam
Tanzania

Ermias Kebreab
University of California, Davis
USA

Werner Alexander Kurz
Natural Resources Canada, Canadian Forest Service
Canada

Adrian Leip
European Commission (EC)

Magda Aparecida Lima
Embrapa Meio Ambiente
Brazil

James Douglas MacDonald
Environment and Climate Change Canada
Canada

Elsayed Mansour Nasr
Freelancer
Egypt

Brian McConkey
Ministry of Agriculture and Agri-Food, Government of
Canada
Canada

Dzmitry Melekh
RUE "Bel SRC "Ecology"
Belarus

Takashi Morimoto
Mitsubishi UFJ Research and Consulting Co., Ltd.
Japan

Michael Mugarura
Ministry of Water and Environment, Climate Change
Department
Uganda

Rodrigo Mussi Buzarquis
National University of Asunción
Paraguay

Aleksandr Nakhutin
Institute of Global Climate and Ecology
Russia

Frank Neitzert
Environment and Climate Change Canada
Canada

Ole-Kenneth Nielsen
Aarhus University
Denmark

Sini Maaria Niinistö
Statistics Finland
Finland

Stephen Michael Ogle
Natural Resource Ecology Laboratory, Colorado State
University
USA

Jean Pierre Ometto
National Institute for Space Research (INPE)
Brazil

Deborah Ottinger
Climate Change Division, U.S. Environmental Protection
Agency
USA

Xuebiao Pan
Department of Agrometeorology,
China Agricultural University
China

Yves Prairie
International Hydropower Association (IHA)

Ana Derly Pulido
Institute of Hydrology, Meteorology and Environmental
Studies of Colombia
Colombia

Klaus Radunsky
Umweltbundesamt
Austria

Nijavalli H. Ravindranath
Centre for Sustainable Technologies, Indian Institute of
Science
India

Shanti Reddy
Department of the Environment & Energy
Australia

Kristiina Regina
Natural Resources Institute Finland
Finland

Hector Ivan Restrepo Orozco
Warnell School of Forestry and Nat. Res.
at University of Georgia
USA

Daniela Romano
Institute for Environmental Protection and Research -
ISPRA
Italy

Kokou Sabi
Université de Lomé (UL), Faculté Des Sciences (FDS),
Laboratoire de Chimie Atmosphérique (LCA)
Togo

Sukarni Sallons-Mitro
Meteorological Service Suriname
Suriname

Estela Santalla
UNICEN, College of Engineering
(Universidad Nacional del Centro)
Argentina

María José Sanz Sánchez
Basque Centre for Climate Change (BC3)
Spain

Atsushi Sato
Mitsubishi UFJ Research & Consulting Co., Ltd.
Japan

Dingane Sithole
Business Council for Sustainable Development in
Zimbabwe
Zimbabwe

Zoltán Somogyi
NARIC Hungarian Forest Research Institute
Hungary

Alexey Spirin
International Aluminium Institute (IAI)

Michael Strogies
Federal Environment Agency
Germany

Samir Tantawi
United Nation Development Programme (UNDP)
Egypt

Marcelo Theoto Rocha
Fábrica Éthica Brasil
Brazil

Francesco Nicola Tubiello
USA

Jason Alan Tullis
University of Arkansas
USA

Gabriel Vazquez-Amabile
AACREA (Argentine Association of Regional
Consortiums for Agricultural Experimentation)
Argentina

John David Watterson
Ricardo Energy & Environment
UK

Melissa Weitz
U.S. Environmental Protection Agency
USA

Jongikhaya Witi
Department of Environmental Affairs
South Africa

Jung Hun Woo
Department of Advanced Technology Fusion (DATF),
Konkuk University
Republic of Korea

Jong Su Yim
National Institute of Forest Science
Republic of Korea

IPCC Task Force on National Greenhouse Gas Inventories (TFI)
Task Force Bureau (TFB)

Thomas Charles Wirth
US Environmental Protection Agency
USA

Fahmuddin Agus
Indonesia Soil Research Institute, Indonesian Agency for Agricultural Research and Development
Indonesia

Irina Yesserkepova
JSC "Zhasyl Damu", the Ministry of Energy, Almaty office
Kazakhstan

Dominique Blain
Environment and Climate Change Canada
Canada

IPCC TFI TSU
C/o Institute for Global Environmental Strategies (IGES)

Eduardo Calvo Buendia (TFI Co-chair)
Universidad Nacional Mayor de San Marcos (UNMSM)
Peru

Andrej Kranjc
Baasansuren Jamsranjav
Sekai Ngarize
Pavel Shermanau
Toru Matsumoto
Eriko Nakamura
Koh Mikuni

Fatma Betül Demirok
Turkish Statistical Institute (TurkStat)
Turkey

Dario Gomez
Atomic Energy Commission of Argentina
Argentina

G. H. Sabin Guendehou
Benin Centre for Scientific and Technical Research
Benin

Bundit Limmeechokchai
Sirindhorn International Institute of Technology,
Thammasat University
Thailand

Riitta Kristiina Pipatti
Statistics Finland
Finland

Yasna Rojas
Instituto Forestal (INFOR)
Chile

Batouli Said Abdallah
National Center of Documentation and Scientific Research (CNDRS)
Comoros

Rob Sturgiss
Department of the Environment & Energy
Australia

Kiyoto Tanabe (TFI Co-chair)
Institute for Global Environmental Strategies (IGES)
Japan