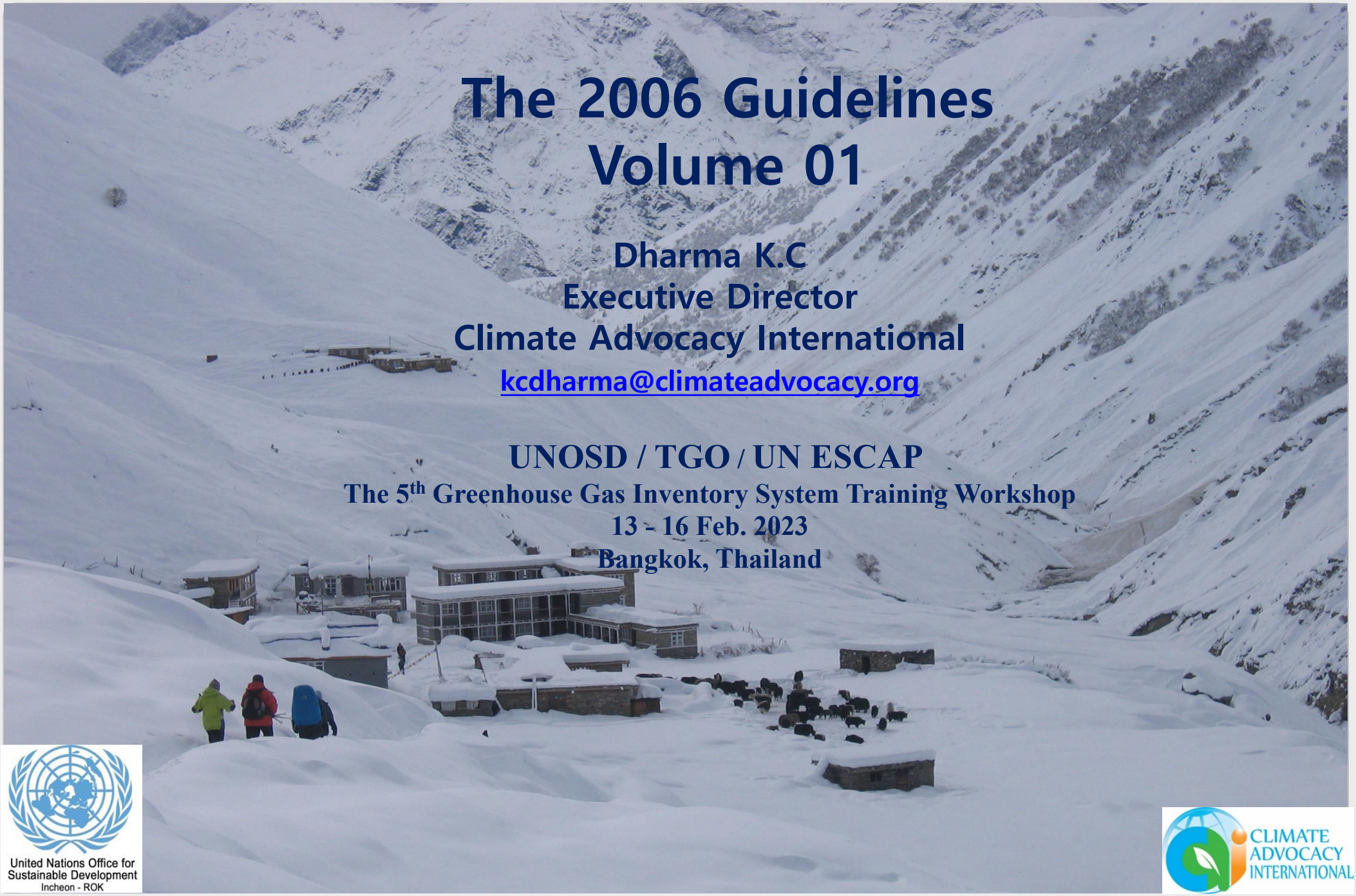

The 2006 Guidelines Volume 01

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Bangkok, Thailand

United Nations Office for Sustainable Development
Incheon - ROK

CLIMATE ADVOCACY INTERNATIONAL

1. Introduction

2. 2019 Refinement to the 2006 IPCC Guideline

3. Highlights of the Guideline

4. Chapter wise information

5. Examples – calculation

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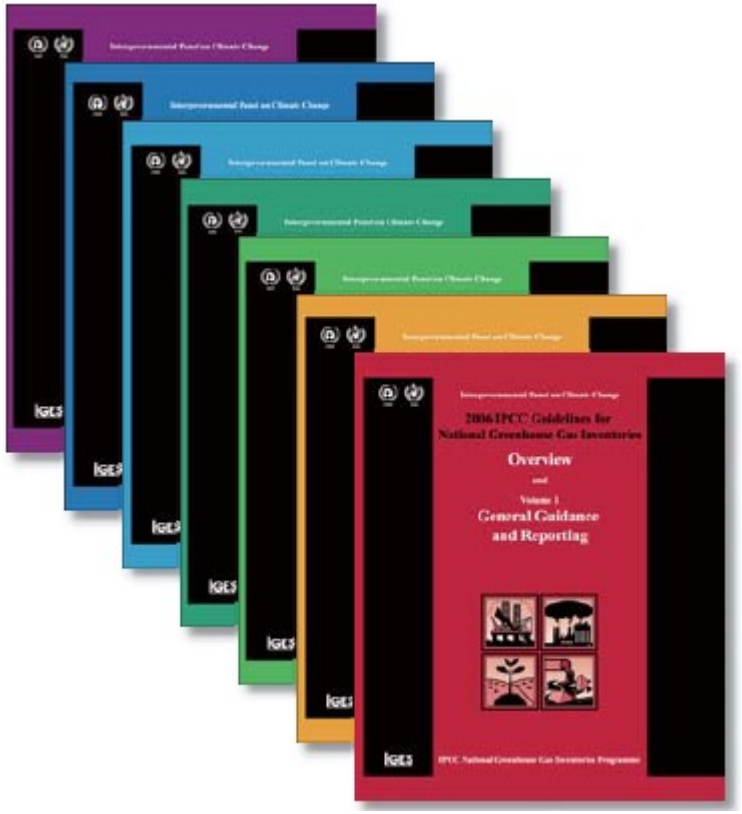
Background Information

1. The 2006 Guidelines are a significant step forward in the production of high quality national estimates of emissions and removals of GHGs.
2. It is a revised 1996 Guideline together with two volumes on inventory good practice.
3. More than 250 authors worked over 2 years and it has been extensively peer-reviewed.
4. 2019 Refinement to the 2006 IPCC Guidelines.



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The 2019 Refinement

1. 2006 IPCC Guidelines – 13 years ago !!
2. The 2019 refinement – updates, supplements and/or elaborates the 2006 IPCC Guidelines where gaps or out-of-date science have been identified but does not revise.
3. Prepared by the Task Force on National Greenhouse Gas Inventories (TFI) in accordance with the decision taken at the 44th Session of IPCC in Bangkok, Thailand, in October 2016, & adopted and accepted during the 49th Session of the IPCC in Kyoto Japan in May 2019.
4. More than 280 scientists and experts, authors from 47 countries, 5 refinements is composed of 5 volumes and an overview chapter and glossary.
5. Type of refinements: U – Update, NG – New Guidance, NR – No Refinement & R – Removed
6. The same structure as that of the 2006 IPCC Guidelines so as to make it easier for inventory compliers to use the 2019 Refinement with the 2006 IPCC Guidelines

Emission Inventories

Definition & importance:

1. National Greenhouse Gas Inventories are complete estimates of the anthropogenic annual emissions and removals of greenhouse gases from a country developed source-by source and sink-by-sink.
2. It is very important for policy makers as well
3. Assists on developing the scientific understanding of Climate Change.

Good knowledge of GHGs inventory;

- enables to develop cost effective reduction policies
- allows different policy options to be compared
- provides a simple monitoring mechanism to monitor implementation of these policies
- are a key input to scientific studies of many environmental issues

Good Practice Guidance

Good practice is 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.

Good practice inventories are:

Transparent + Complete + Internally Consistent + Comparable between Countries + Accurate

"*Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*" and *"Good Practice Guidance for Land Use, Land-Use Change and Forestry"* are updated and merged into the 2006 Guidelines.

General Guidance and Reporting Objectives

❑ **To guide inventory complier of Energy, IPPU, AFOLU and Waste sectors on:**

- National GHG Inventory arrangements and manage tools
- Data collection and adapting for inventory use
- Uncertainty assessment
- Methodological choice and identification of key categories
- Ensuring a consistent time series
- QA/QC and verification of emission estimations
- Use and reporting of models
- Calculation of emission of precursors of GHGs and indirect emissions
- Reporting of emissions and removals

❑ **To provide reporting framework in standard tabular format:**

- Tables facilitate consistency between countries, categories, gases and years
- They are not intended to prescribe specific reporting formats under the UNFCCC

What has been included in 2006 Guideline

Vol. 1

- **General Guidance and Reporting**
- Gives general information on inventory compilation, QA/QC, uncertainty and guidance on the choice of methods

Vol. 2

- **Energy**
- Covers the use, production and transport of energy. Includes coverage of carbon dioxide capture and storage

Vol. 3

- **Industrial Processes and Product Use (IPPU)**
- covers industrial processes such as metal production, petrochemicals and other chemical production.
- also covers the use of products including fluorinated gases.

Vol. 4

- **Agriculture, Forestry and Other Land Use (AFOLU)**
- integrates agriculture with all other land uses and changes in land use. Covers agricultural sources such as livestock, manure management and fertilizer use as well as emissions and removals of greenhouse gases from differing land uses such as forestry, grasslands and settlements.

Vol. 5

- **Waste**
- covers the collection, treatment and disposal of wastes including solid wastes, landfills and waste water treatment.

Consistency

- It is not revision but Refinement to the 2006 guidelines,

- The approach adopted is consistent with the remainder of the 2006 guidelines,
  - in particular a fundamental principle that the inventory methods reflect the estimated actual emissions in the year in which they occur;
  - emissions are reported where they occur;
  - and in line with the approach used for the treatment of biogenic material.
- The methods in the 2006 Guidelines are compatible with the revised 1996 IPCC guidelines and subsequent good practice guidance.

Gases included

① Carbon Dioxide CO_2

② Methane CH_4

③ Nitrous Oxide N_2O

④ Hydroflurocarbons (HFCs), including hydrofluoro-olefins (HFOs)

⑤ Perflurocarbons PFCs

⑥ Sulphur Hexaflouride SF_6

⑦ Nitrogen Trifluoride NF_3

⑧ Trifluoromethyl Sulphur Pentafluoride SF_5CF_3

⑨ Halogenated Ethers (e.g., $C_4F_9OC_2H_5$)

⑩ Other halocarbons not covered by the Montreal Protocol (e.g., CF_3I, $CHCL_3$)

Changes in 2006 Guideline: Additional Inclusion

① F gases

② Non-energy product uses of fossil fuels

③ All defaults and emission factors reviewed

④ Carbon capture and storage

⑤ Harvested wood products

⑥ Wetlands

New Sources

- ✓ Carbon Capture and Storage
- ✓ Closed Coal Mines
- ✓ Lead and zinc production,
- ✓ Titanium dioxide production,
- ✓ Various sources of SF_6 (Accelerators, etc),
- ✓ Liquid crystal display (LCD) manufacturing
- ✓ Settlements

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Categories added

Fuel Combustion
- CO_2 - Transport and Storage
- Urea-based Catalysts (Road Transport)

Fugitive Emissions from Fuels
- Abandoned Underground Mines

Mineral Industry
- Glass Production
- Ceramics
- Non Metallurgical Magnesia Production

Chemical Industry
- Caprolactam, Glyoxal & Glyoxylic Acid Production
- Titanium Dioxide Production
- Petrochemical and Carbon Black Production

Metal Industry
- Lead Production
- Zinc Production

Electronics Industries
- Integrated Circuit or Semiconductor
- TFT Flat Panel Display
- Photovoltaics
- Heat Transfer Fluid

Other Uses of Fluorinated Gases
- Electrical Equipment
- Military Applications
- Accelerators
- Medical Applications
- Propellant for Pressure and Aerosol Products

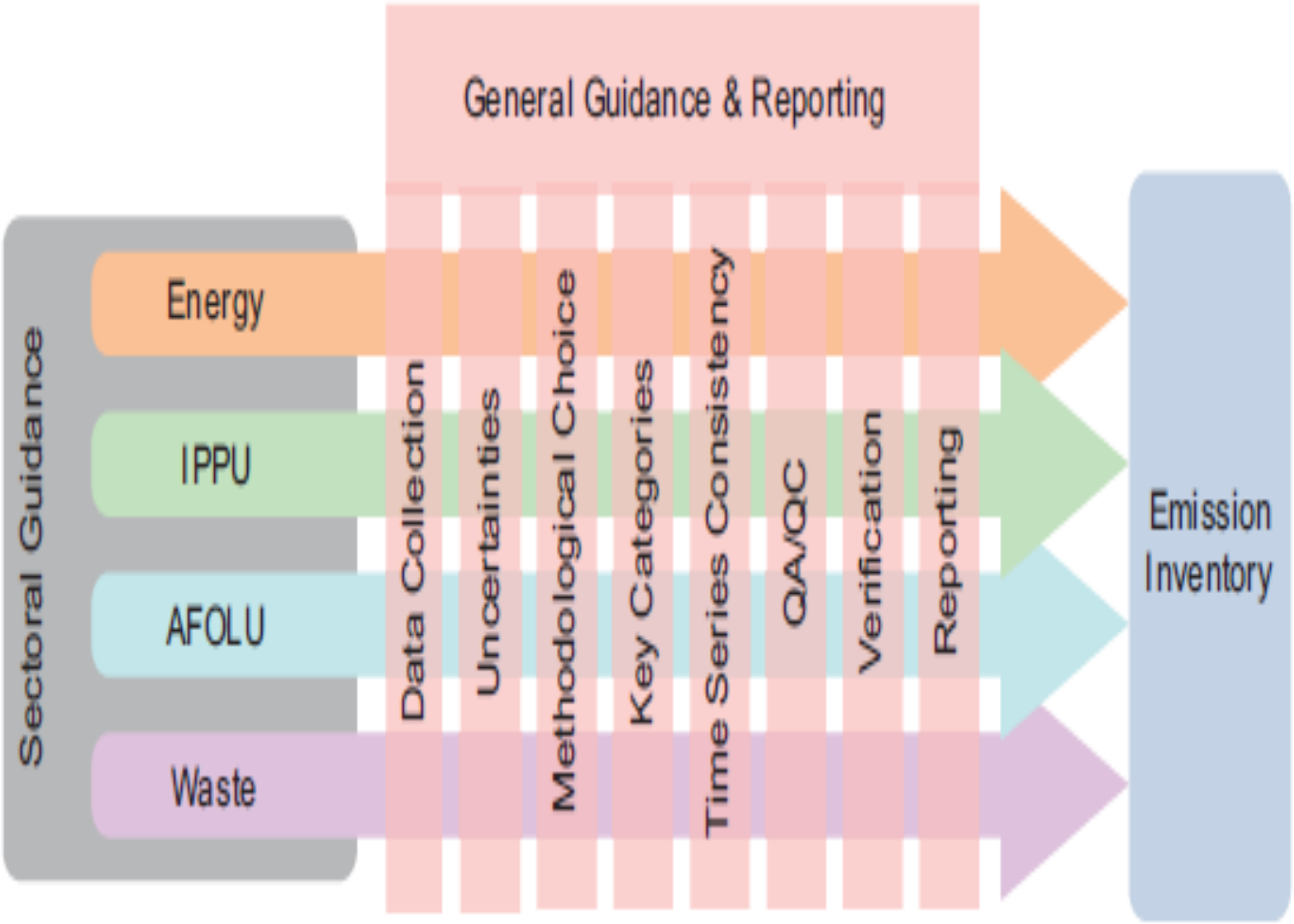
Ozone Depleting Substances Substitutes

Land Use
- Complete, consistent treatment of fires
- Liming
- Urea Application
- Indirect N_2O Emissions from Manure Management
- Harvested Wood Products (methods now provided)

Waste
- Biological Treatment of Solid Waste
- Open Burning of Waste

Other
- Indirect N_2O Emissions from the Atmospheric Deposition of NO_x and NH_3 (excluding agricultural sources)

Relationship – General and Sectoral Guidance



Chapters in Vol. 1

Chapter 1	Introduction to National GHG Inventory
Chapter 2	Approaches to Data Collection
Chapter 3	Uncertainties (And Addendum: IPCC tool for Approach 1 uncertainty analysis)
Chapter 4	Methodological Choice and Identification of Key Categories
Chapter 5	Time Series Consistency
Chapter 6	QA, QC & Verification
Chapter 7	Precursors and Indirect Emissions
Chapter 8	Reporting Guidance and Tables (Separate Annexes: Annex8A.1 & Annex8A.2
Annex 1	Mapping Tables

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Chapter 1: Introduction

Estimation Method:

Emissions = AD × EF

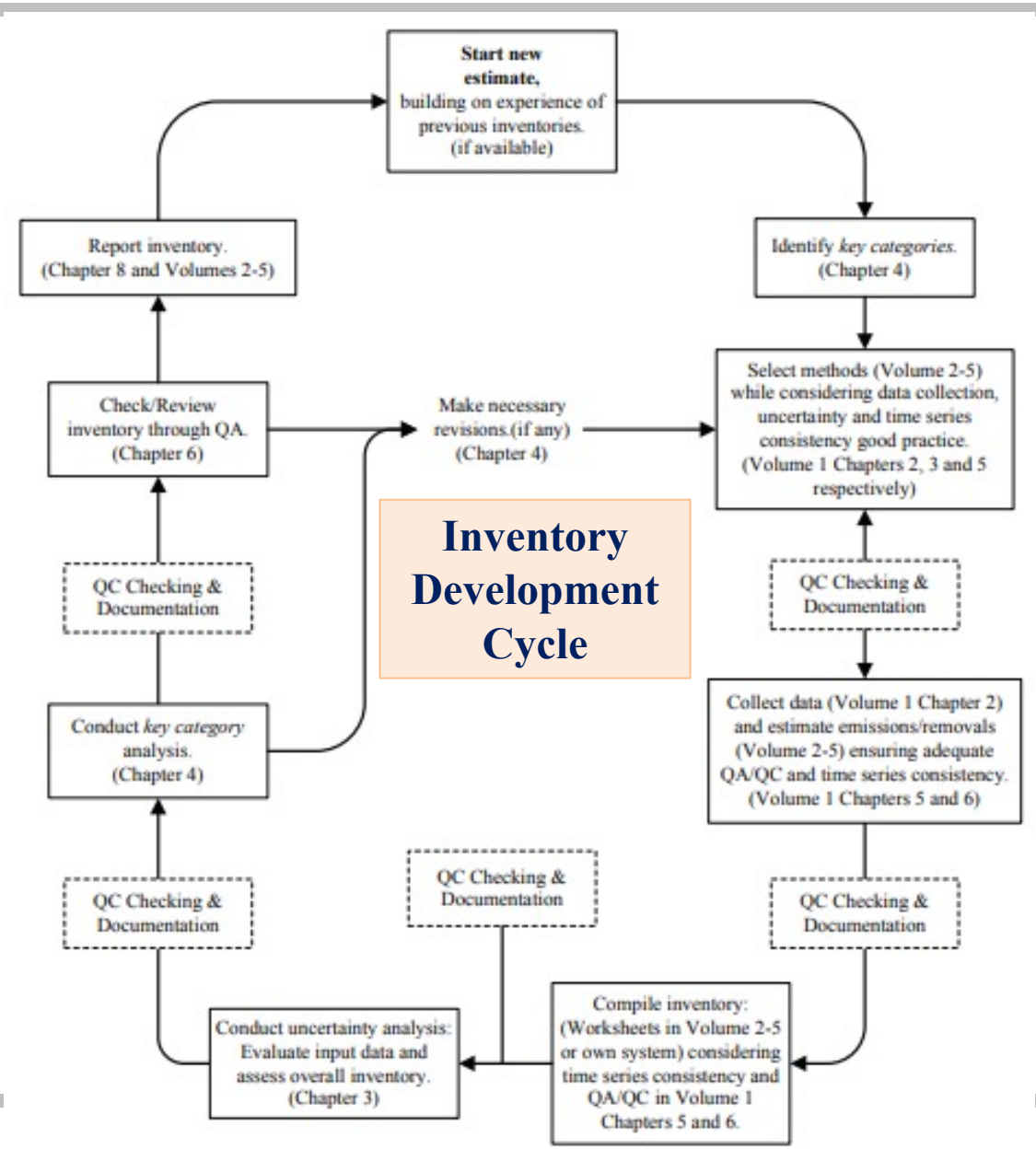
Concepts:

- Good Practice
- Tires
- Default data
- Key categories

Inventory quality:

- Transparency
- Completeness
- Consistency
- Comparability
- Accuracy

Chapter 1: Introduction



Chapter 1: Introduction

- New guidance on implementation of a national inventory management system, including:
  - Establishing arrangements to support the development, improvement and maintenance of national GHG inventories
  - Examples of institutional arrangements structuring, roles and capabilities of actors and stakeholders, data flows and suggested contents of Data Supply Agreements
  - Description of inventory management tools such as work plans, improvement plans, data management systems and quality systems with the illustrative examples

- Updated concept of "anthropogenic emissions and removals" related to new optional approach for disaggregation of emissions and removals by human and natural components in Chapter 2 of Volume 4

- Elaborated guidance on the treatment of CO_2, CH_4 and N_2O emissions from combustion of biomass or biomass-based products

Chapter 2: Approaches to Data Collection

Data and data processing

- Existing data
- New data
- Adapting data for inventory use
- EF and direct measurement of emissions
- Activity data

Data survey

- Energy surveys
- Industries surveys
- Agricultural surveys and censuses
- Forest surveys
- Waste surveys

National grid emission factor?

https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_2_Ch2_DataCollection.pdf

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Chapter 2: Approaches to Data Collection

- ❑ New guidance for the development of CS emission factors, including:
  - Examples of main EF sensitive parameters
  - Potential sources of Efs
  - Update on standard measurement methods

- ❑ New guidance for data collection, including:
  - Outline of data collection steps and decision
  - Treatment of confidential data with illustrative examples
  - Update on potential data sources

- ❑ New guidance on the integration of emissions reported from facilities into national GHG inventories, including:
  - Designing facility-reporting programmes for inventory use (e.g. quality goals and reporting requirements for facility data)
  - Facility-reported data integration options into national dataset with illustrative example
  - Use of facility data not originally designed for inventory use

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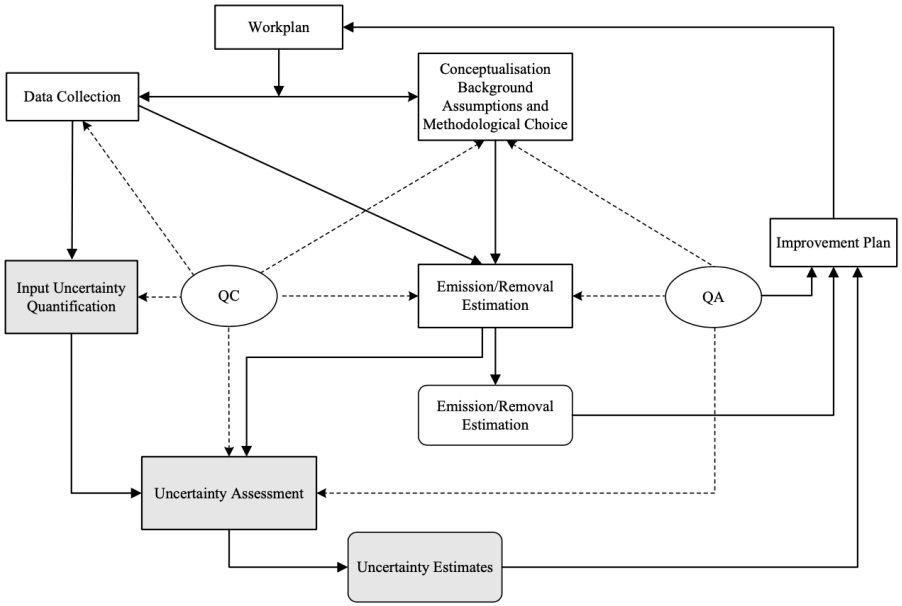
Chapter 3: Uncertainties



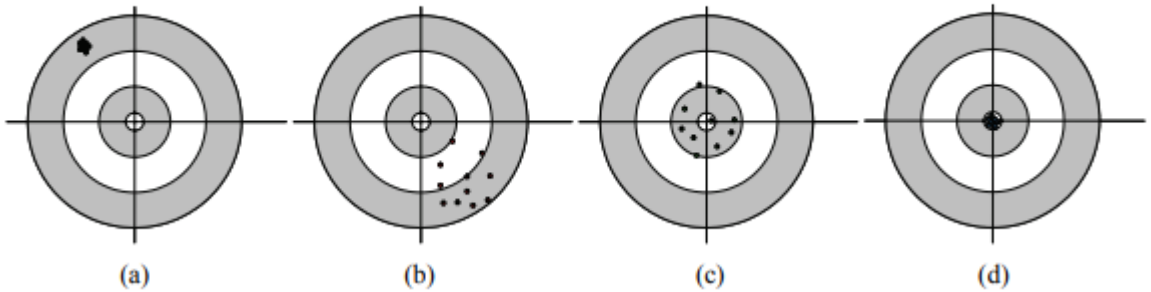
Generic uncertainty analysis

Uncertainty reduction

- Improving conceptualization
- Improving models
- Improving representativeness
- Using more precise measurement methods
- Collecting more measured data
- Eliminating known risks of bias
- Improving states of knowledge

(a) inaccurate but precise; (b) inaccurate and imprecise; (c) accurate but imprecise; and (d) precise and accurate

Data accuracy and precision



https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf

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Chapter 3: Uncertainties

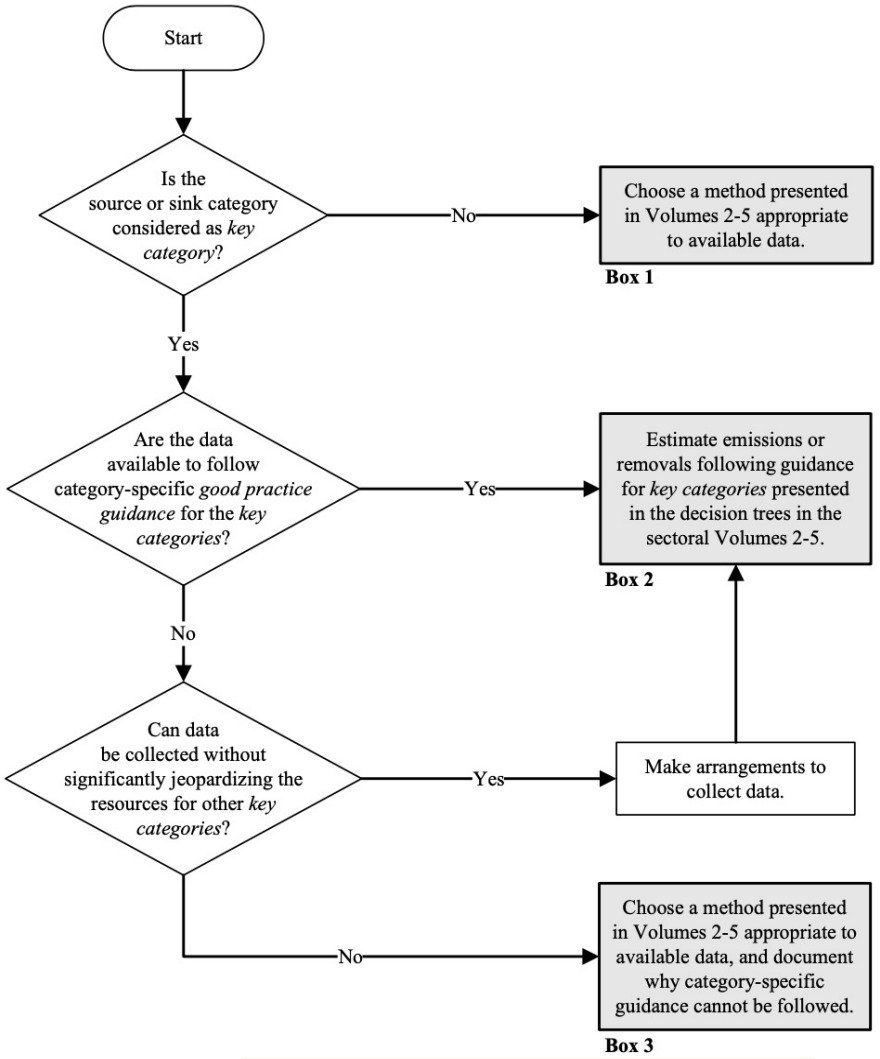
- Updated guidance on uncertainty by providing more default values, calculation examples and best practices, including:
  - Structure of uncertainty assessment process
  - AD uncertainty assessment based on complete and random samples (with examples)
  - Clarification on key requirements for use of Approach 1 for combining uncertainties
  - Application of Approach 1 in practice
  - Uncertainty assessment steps description
  - Stepwise example demonstrating the use of Approach 2 uncertainty assessment (Monte-Carlo analysis)

- Excel-based addendum to Chapter 3: Tier 1 Uncertainty calculation tool

Chapter 4: Methodological Choice and Identification of Key Categories

Key Category

It is the one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals. Includes both sources and sink categories.



Identifying key categories

https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_4_Ch4_MethodChoice.pdf

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Chapter 5: Time Series Consistency

Why it is important?
Because it provides information on historical emissions trends and tracks the effects of strategies to reduce emissions at the national level.

How to ensure time series consistency?

- Recalculations due to methodological changes and refinements
- Adding new categories
- Tracking increases and decreases due to technological change and other factors

Reporting and documentation of trend information

CATEGORY-SPECIFIC DOCUMENTATION OF RECALCULATIONS

Category/Gas	Emissions and Removals (Gg)										
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Previous Data (PD)											
Latest Data (LD)											
Difference in percent =100•[(LD–PD)/PD]											
Documentation (reason for recalculation):											

https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_5_Ch5_Timeseries.pdf

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Chapter 4 & Chapter 5

❑ Updated guidance on Key category analysis, including:

- Treatment of disaggregation of categories
- Treatment of particularly significant subcategories
- Simplification of equation on trend assessment (Approach 1)
- Introducing of key categories ranks

❑ Elaborated guidance on time series consistency, including:

- Information on how to ensure time series consistency when using facility level data and different data sources
- Case studies of overlap, linear and non-linear interpolation method
- Examples of surrogate data by sector

Chapter 6: QA, QC & Verification

Definition – Quality Control, Quality Assurance & Verification?

Elements of QA/QC and Verification system

- Participation of an inventory compiler
- A QA/QC plan
- General QC procedures that apply to all inventory categories
- Category-specific QC procedures
- QA and review procedures
- QA/QC system interaction with uncertainty analyses
- Verification activities
- Reporting, documentation, and archiving procedures

https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_6_Ch6_QA_QC.pdf

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Chapter 6: QA, QC & Verification

- ❑ Elaborated definitions of QA/QC and verification, including:
  - Distinguishing of term "verification" defined in IPCC Guidelines from that used e.g. in carbon markets

- ❑ Updated guidance on comparisons with atmospheric measurements, including:
  - Advantages, limitations and prospects of using atmospheric measurements for verification of GHG emissions
  - Key steps in applying inverse modelling for verification of national inventory (with country examples)
  - Checklist to identify whether inverse model estimates are applicable for verification
  - Outline of inventory comparison to global/regional inverse modelling products and satellite observations

- ❑ New guidance on the use and reporting of models, including:
  - Identification of model suitability
  - Implementation and evaluation of model
  - Checklist for ensuring good practice in use of models

Chapter 7: Precursors and Indirect Emissions

Precursors emissions and indirect emissions & its importance in inventory

Inventory of precursors emissions in each sectors

https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf

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Chapter 7: Precursors and Indirect Emissions

- Elaborated Guidance on indirect CO_2 to the atmosphere from emissions from carbon-containing compounds, including;
  - Treatment of emissions of precursors from indirect CO2 from fossil fuels combustion, fugitive and biogenic sources in national inventories
  - Options to address indirect CO2 depending on metrics chosen (e.g. GWP for fossil methane)
  - Steps to estimate CO2 inputs to atmosphere from NMVOC emissions
  - Description of non-biogenic sources of indirect CO2 from oxidation of CH4, CO and NMVOC
  - Carbon content in NMVOC species from different source categories
  - Carbon content in solvent portion of various materials (NMVOC emissions)

Chapter 8: Reporting Guidance and Tables

Reporting Guidance

- Coverage
- Gases included
- Time frame of reporting
- Sectors and categories
- Notation keys and completeness information
- Unites and digits
- Time series
- Indirect N2O

Inventory reporting table

- Summary and short summary table
- Sectoral and background table
- Cross-sectoral table
- Emission trend table by gas
- Uncertainty and key categories table

Summary Table

Categories	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors[3]	Other halogenated gases without CO_2 equivalent conversion factors [4]	NO_x	CO	NMVOCs	SO_2
	(Gg)			CO_2 equivalents (Gg)				(Gg)	(Gg)			
Total National Emissions and Removals												
1 ENERGY												
1A Fuel Combustion Activities												
1A1 Energy Industries												
1A2 Manufacturing Industries and Construction												
1A3 Transport												
1A4 Other Sectors												
1A5 Non-Specified												
1B Fugitive Emissions from Fuels												
1B1 Solid Fuels												
1B2 Oil and Natural Gas												
1B3 Other Emissions from Energy Production												
1C Carbon Dioxide Transport and Storage												
1C1 Transport of CO_2												
1C2 Injection and Storage												

https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_8_Ch8_Reporting_Guidance.pdf

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Chapter 8: Reporting Guidance and Tables

- Updated to reflect refinements made in other Volumes (although it was not explicitly included in the original scope of refinements), including:
  - Reporting guidance
  - List of GHGs
  - List of IPCC categories and their definitions
  - Reporting Tables

- Chapter is not intended to prescribe reporting format to be used under the UNFCCC (e.g. GWP, gases, structure of categories etc.)

Example calculations

https://www.environment.gov.au/system/files/resources/5a169bfb-f417-4b00-9b70-6ba328ea8671/files/national-greenhouse-accounts-factors-july-2017.pdf

Fuel combustion emission factors - solid fuels and certain coal based products

Fuel combusted	Energy content factor GJ/t	Emission factor kg CO_2-e/GJ (relevant oxidation factors incorporated)		
		CO_2	CH_4	N_2O
Bituminous coal	27.0	90	0.03	0.2
Sub-bituminous coal	21.0	90	0.03	0.2
Anthracite	29.0	90	0.03	0.2
Brown coal	10.2	93.5	0.02	0.4
Coking coal	30.0	91.8	0.02	0.2
Coal briquettes	22.1	95	0.07	0.3
Coal coke	27.0	107	0.04	0.2
Coal tar	37.5	81.8	0.03	0.2
Solid fossil fuels other than those mentioned in the items above	22.1	95	0.07	0.3
Industrial materials and tyres that are derived from fossil fuels, if recycled and combusted to produce heat or electricity	26.3	81.6	0.02	0.2
Non-biomass municipal materials, if recycled and combusted to produce heat or electricity	10.5	87.1	0.7	1.1
Dry wood	16.2	0	0.1	1.2
Green and air dried wood	10.4	0	0.1	1.2
Sulphite lyes	12.4	0	0.07	0.6
Bagasse	9.6	0	0.2	1.2
Biomass municipal and industrial materials, if recycled and combusted to produce heat or electricity	12.2	0	0.7	1.1
Charcoal	31.1	0	4.8	1.1
Primary solid biomass fuels other than those mentioned in the items above	12.2	0	0.7	1.1

Source: National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Schedule 1)

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Example calculations

Example: calculation of emissions from black coal consumption

A facility consumes 20,000 tonnes of bituminous coal for a purpose other than for the production of electricity or to produce coke.

Emissions of greenhouse gases (carbon dioxide, methane and nitrous oxide) in tonnes of CO_2-e are estimated as follows:

Emissions of carbon dioxide:

= (20,000 x 27.0 x 90)/1,000

= 48,600 t CO_2-e

Emissions of methane:

= (20,000 x 27.0 x 0.03)/1,000

= 16 t CO_2-e

Emissions of nitrous oxide:

= (20,000 x 27.0 x 0.2)/1,000

= 108 t CO_2-e

Total scope 1 GHG emissions = 48,600 + 16 + 108

= 48,724 t CO_2-e

Example: calculation of emissions from transport fuels consumed

A freight company consumes 10000 kL of automotive diesel for transport purposes. Emissions of greenhouse gases (carbon dioxide, methane and nitrous oxide) in tonnes of CO_2-e are estimated as follows;

Emissions of carbon dioxide:

= (10,000 x 38.6 x 69.9)/1,000

= 26,981 t CO_2-e

Emissions of methane:

= (10,000 x 38.6 x 0.1)/1,000

= 39 t CO_2-e

Emissions of nitrous oxide:

= (10,000 x 38.6 x 0.5)/1,000

= 193 t CO_2-e

Total scope 1 GHG emissions = 26981 + 39 + 193

= 27,213 t CO_2-e

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Example calculations

Indirect (scope 2) emission factors for consumption of purchased electricity or loss of electricity from the grid

State or Territory	Emission factor kg CO_2-e/kWh
New South Wales and Australian Capital Territory	0.83
Victoria	1.08
Queensland	0.79
South Australia	0.49
South West Interconnected System (SWIS) in Western Australia	0.70
North Western Interconnected System (NWIS) in Western Australia	0.62
Darwin Katherine Interconnected System (DKIS) in the Northern Territory	0.59
Tasmania	0.14
Northern Territory	0.64

Sources: National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Schedule 1) and Department of the Environment and Energy.

Example: calculation of emissions from electricity consumption

A company in New South Wales consumes 100,000 kWh of purchased electricity from the grid.

Emissions of greenhouse gases (scope 2) in tonnes of CO_2-e are estimated as follows:

= 100,000 x (0.83 /1000)

= 83 tonnes.

Total scope 2 GHG emissions = 83 tonnes CO_2-e

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Example calculations

Cement clinker production

$$E_{ij} = \left(EF_{ij} + EF_{toc,j}\right) \times \left(A_i + A_{ckd} \times F_{ckd}\right)$$

where:

E_{ij} is the emissions of CO_2 released from the production of cement clinker (CO_2 -e tonnes)

EF_{ij} is the emission factor for cement clinker (tonnes of CO_2 emissions per tonne of clinker produced). See Table 18.

A_i is the quantity of cement clinker produced (tonnes)

A_{ckd} is the quantity of cement kiln dust (CKD) produced (tonnes)

$EF_{toc,j}$ is the emission factor for carbon-bearing non-fuel raw material (tonnes of CO_2 emissions per tonne of clinker produced). See Table 18.

F_{ckd} is the degree of calcination of cement kiln dust (range from 0% to 100%). If the information is not available the degree is assumed to be 100%, that F_{ckd} =1

Clinker production emission factors

Source	Emission factor (tonnes CO_2-e per tonne)
	CO_2
EF_{ij}	0.534
$EF_{toc,j}$	0.010

Source: National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Se

Example: Calculation of emissions generated from cement clinker production

A company produces 20,000 tonnes of cement clinker and 300 tonnes of cement kiln dust per year. The degree of calcination of the cement dust is not known. The GHG emissions are calculated as follows:

= (0.534 + 0.01) x (20,000 + 300 x 1)

= 11,043 tonnes CO_2-e

Total scope 1 GHG emissions = 11,043 tonnes CO_2-e

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Courtesy and source of information

Sources of Information

- ✓ IPCC webpage
http://www.ipcc.ch/pdf/activity/2006gls-brochure.pdf
- ✓ Presentation by Yurii Pyrozhenko in SBSTA - IPCC Special Event on 2019 Refinement to the 2006 IPCC Guidelines
- ✓ Presentation by Simon Eggleston, IPCC, Technical Support Unit
- ✓ National Greenhouse Accounts Factors, Australian national greenhouse accounts Commonwealth of Australia 2017

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THANK YOU

P.C.: P. Pokhrel

United Nations Office for Sustainable Development
Incheon - ROK

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