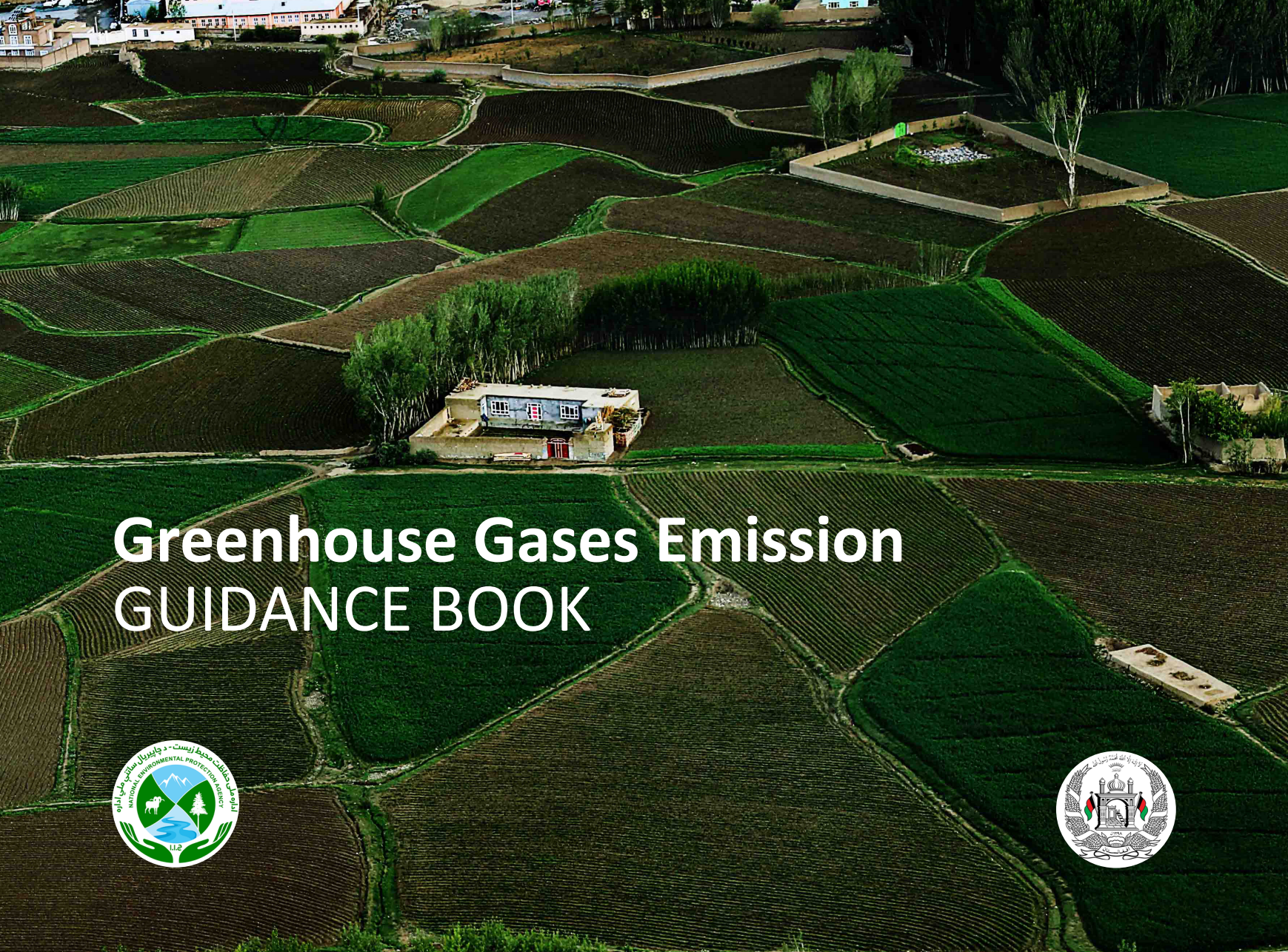


Greenhouse Gases Emission
GUIDANCE BOOK

GREENHOUSE GAS (GHG) EMISSIONS

CONTENT

WHAT ARE GREENHOUSE GASES (GHGs)?

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere.

The UNFCCC and its Kyoto Protocol deals with the carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). Water vapours because of its short life in the atmosphere and not directly attributed to human generated activities are not estimated in the national GHG inventories. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol.

Carbon dioxide (CO_2) from burning fossil fuels is by far the largest single source of greenhouse gas emissions from human activities. Extraction and distribution activities of fossil fuels also releases greenhouse gases. Globally, deforestation is the second largest source of CO_2 emissions. Raising of livestock animals, rice cultivation and fertilizer application as well as the treatment of waste and wastewater emit significant amounts of methane (CH_4) and nitrous oxide (N_2O). Producing lime to make cement is a significant industrial source, as well as the industrial production (and subsequent use in many areas of life) of many of the man-made gases, the so-called fluorinated gases (F-gases). The F-gases have a high global warming potential (GWP).

HOW DO HUMAN ACTIVITIES PRODUCE GREENHOUSE GASEs?

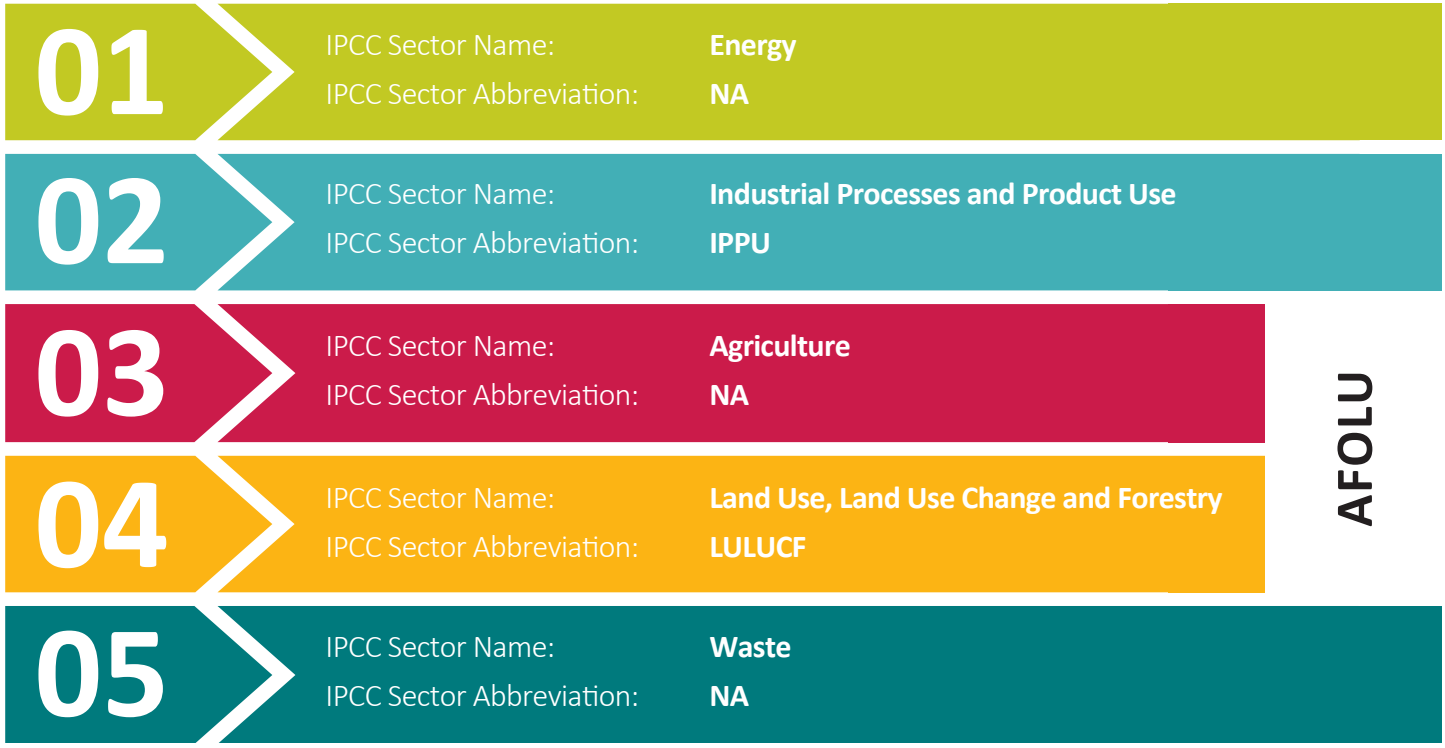
Greenhouse gases (GHGs) are gases in the atmosphere that trap energy from the sun as infrared radiation in form of heat. Some greenhouse gases occur in nature such as water vapour, carbon dioxide, methane, nitrous oxide and ozone, while others are man-made such as products or by-products of foam production, refrigeration, and air conditioning. Each greenhouse gas differs in its ability to absorb heat in the atmosphere which is expressed as Global Warming Potential (GWP). The man-made gases, the so-called fluorinated gases (F-gases), are the most heat absorbent, while carbon dioxide is the least absorbent. Concern about these gases comes from the fact that human actions are increasing their concentrations, creating the prospect of global climate change. According to the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR), today's CO_2 concentration has not been exceeded during the past 420,000 years and likely not during the past 20 million years. For further information, visit ww.IPCC.ch.

THE GWP OF THE MAIN GHGs ARE PROVIDED IN THE TABLE BELOW:

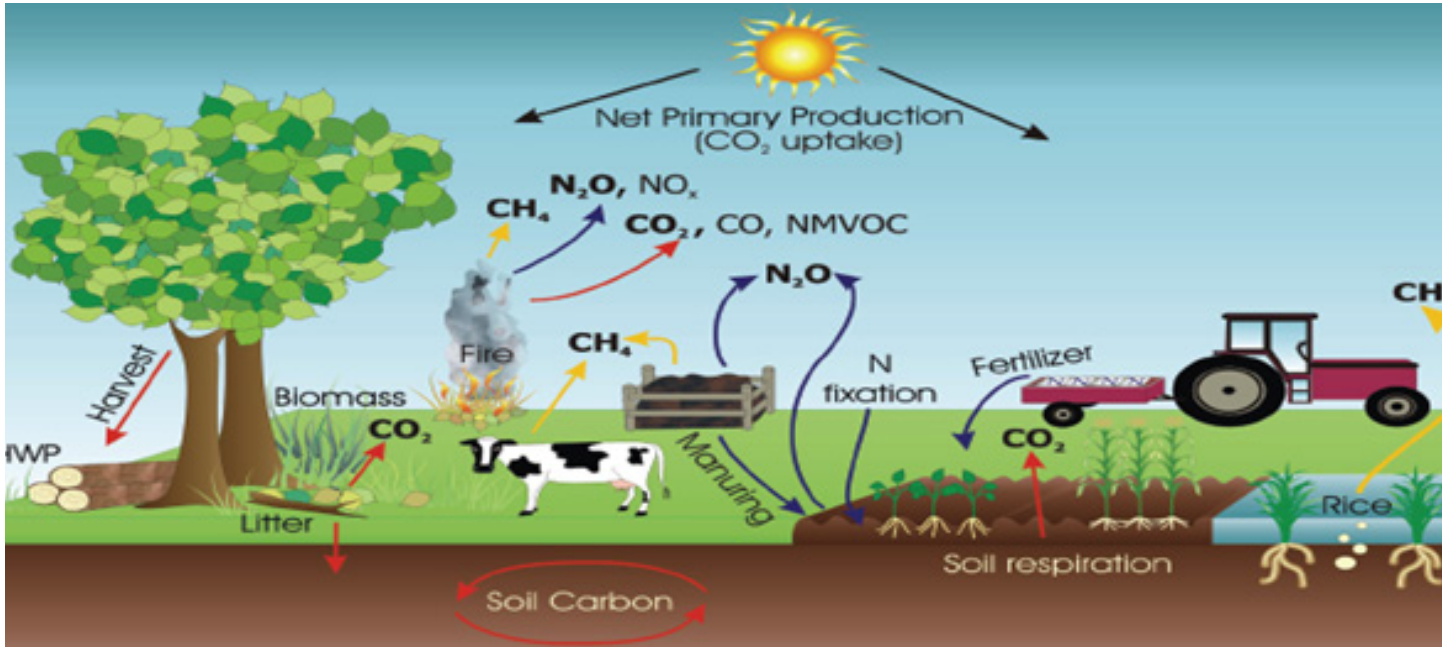
Type		Gas name	Chemical formula / Abbreviation	Global Warming Potential (GWP)(Time Horizon) based on the effects of GHGs over a 100-year time horizon
Common	Greenhouse gas	Carbon dioxide	CO_2	1
		Methane	CH_4	25
		Nitrous oxide	N_2O	298
Man-made		Sulphur hexafluoride	SF_6	23,800
		Hydrofluorocarbons	HFC	HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on the substances
		Perfluorocarbons	PFC	
		Nitrogen trifluoride	NFH_3	17,200
Source: IPCC Fourth Assessment Report (AR4)				

WHAT IS INCLUDED IN A NATIONAL GREENHOUSE GAS INVENTORY?

All countries compile national greenhouse gas inventories as part of their obligations under the inventory quantifies the greenhouse gases being released into, or sequestered from, the atmosphere as a result of a country's human activities, on a gas-by-gas basis. Under the UNFCCC, countries report their emissions and removals of greenhouse gases for five sectors:



WHAT IS THE MEANING OF EMISSIONS BY SOURCES AND REMOVALS BY SINKS?



Agriculture, Forestry and Other Land Use (AFOLU) activities generate greenhouse gas emissions by sources as well as removals by sinks, caused by the oxidation and fixation of organic matter via photosynthesis and complex microbial processes associated to human management and disturbance of ecosystems. They comprise:

- non-CO_2 emissions by sources from agriculture,
- CO_2 and non-CO_2 emissions by sources from Forestry and Other Land Use (FOLU), and CO_2 removals by FOLU sinks.

From the sectors Energy, Industrial Processes and Product Use (IPPU) and Waste only emissions occur.

For more information, visit www.ipcc-nggip.iges.or.jp

HOW ARE GHG EMISSIONS AND REMOVALS ESTIMATED?

Estimates are based on parameters associated with emission rates:

- CO_2 from fuel depends on carbon in fuel
- CO_2 proportional to amount of fuel burnt
- Changes on stocks of carbon in forests give emissions or removals of CO_2

In its most basic form, the method used to estimate an emission or removal from a specific source or sink is:

Emission (EMI) = Activity data (AD) • Emission Factor (EF)

With:

- **Emissions (EMI)** of greenhouse gases are expressed in Gg CO_2, Gg CH_4, Gg N_2O or Gg CO_2 equivalent (eq)
- **Activity data (AD)** describes the annual national magnitude of an activity
- **Emission factor (EF)** is the mass of greenhouse gas emitted per unit of activity

Example 1: AD: tonnes of diesel oil combusted nationally in a given year

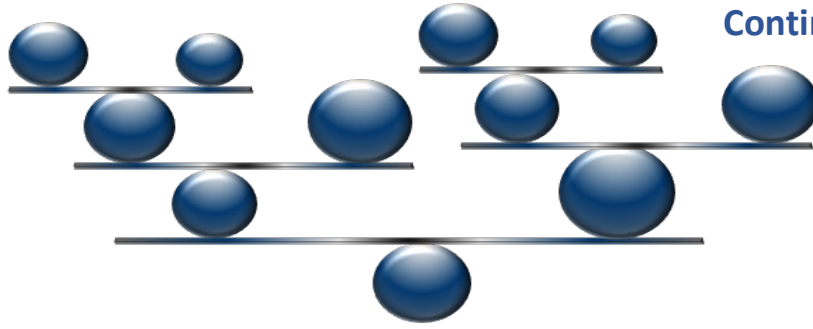
EF: Gg of CO_2 per GJ of diesel oil combusted

Example 2: AD: number of livestock per animal category

EF: Gg of CH_4 per animal per year (enteric fermentation)

WHAT ARE THE QUALITY OBJECTIVES OF A GREENHOUSE GAS INVENTORY?

Tranparency
Accuracy
consistency
Comparability
completeness



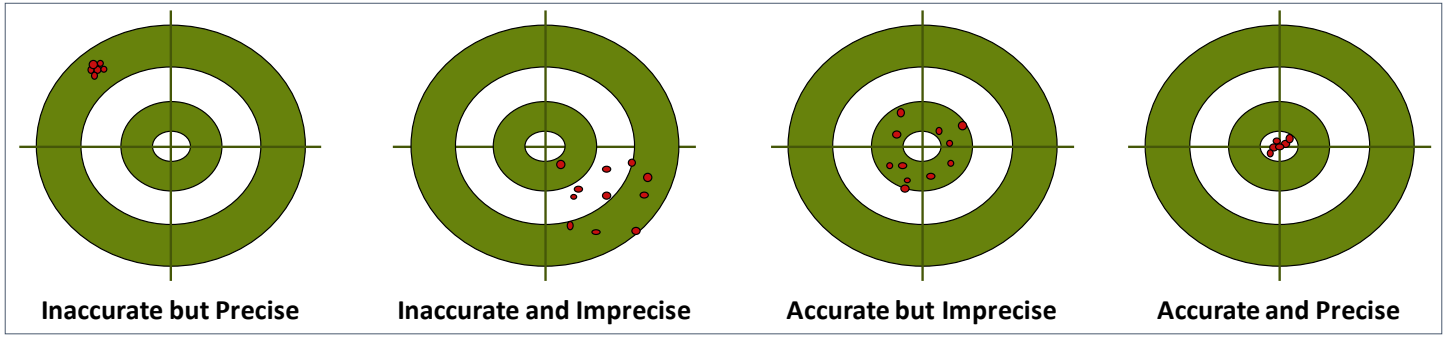
Continuous Improvement
Timeliness
Acceptability
Practicability
Cost-effectiveness

TRANSPARENCY

- Provision of sufficient and clear documentation
- Other persons than the inventory compilers can understand how the inventory was compiled
- Other persons can assure themselves it meets the good practice requirements

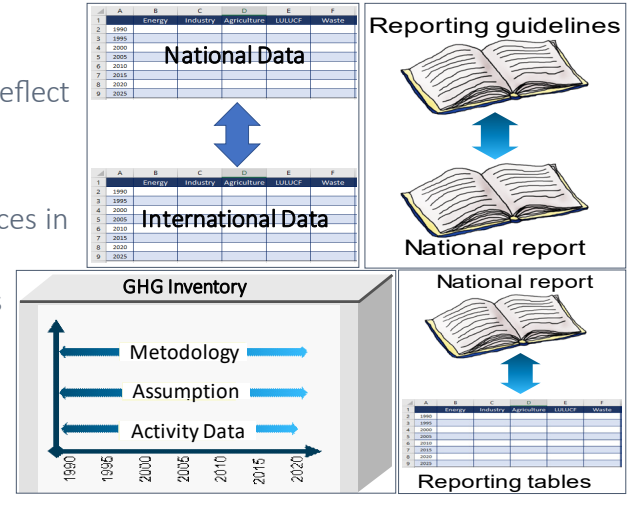
ACCURACY

- Contains neither over- nor under-estimates so far as can be judged
- Making all endeavours to remove bias from the inventory estimates



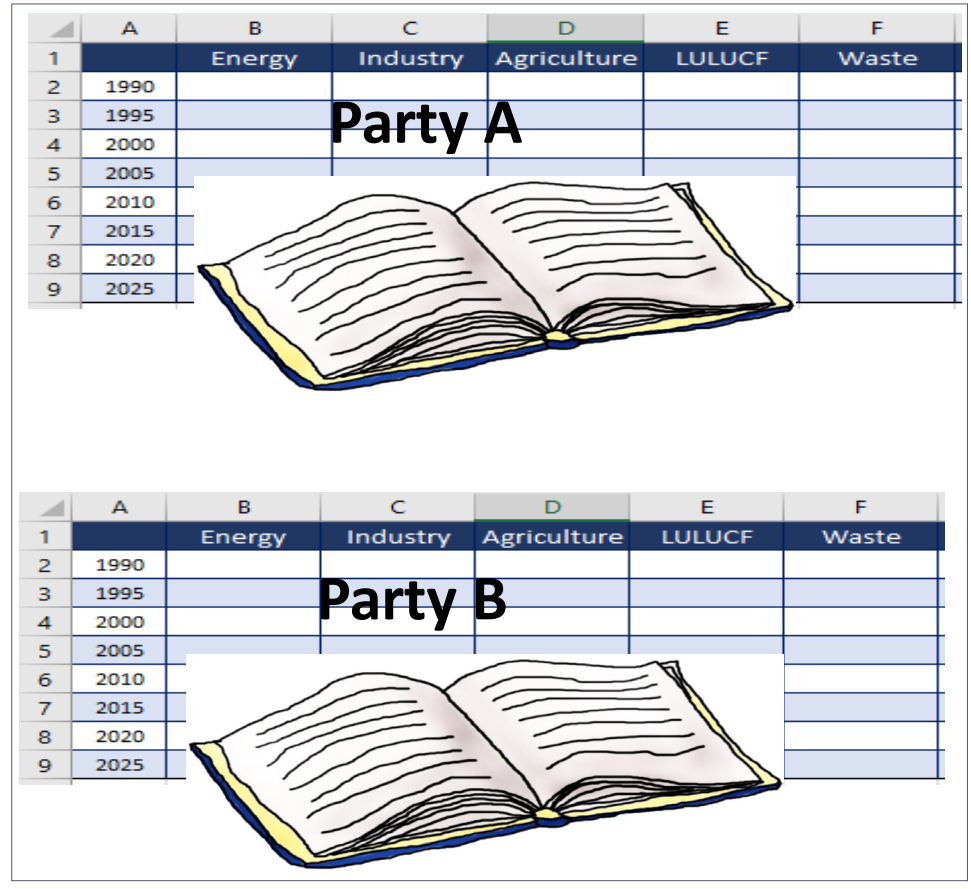
CONSISTENCY

- Differences in the results between years and categories reflect real differences in emissions.
- Inventory annual trends should:
  - be calculated using the same method and data sources in all years
  - aim to reflect the real annual fluctuations in emissions or removals



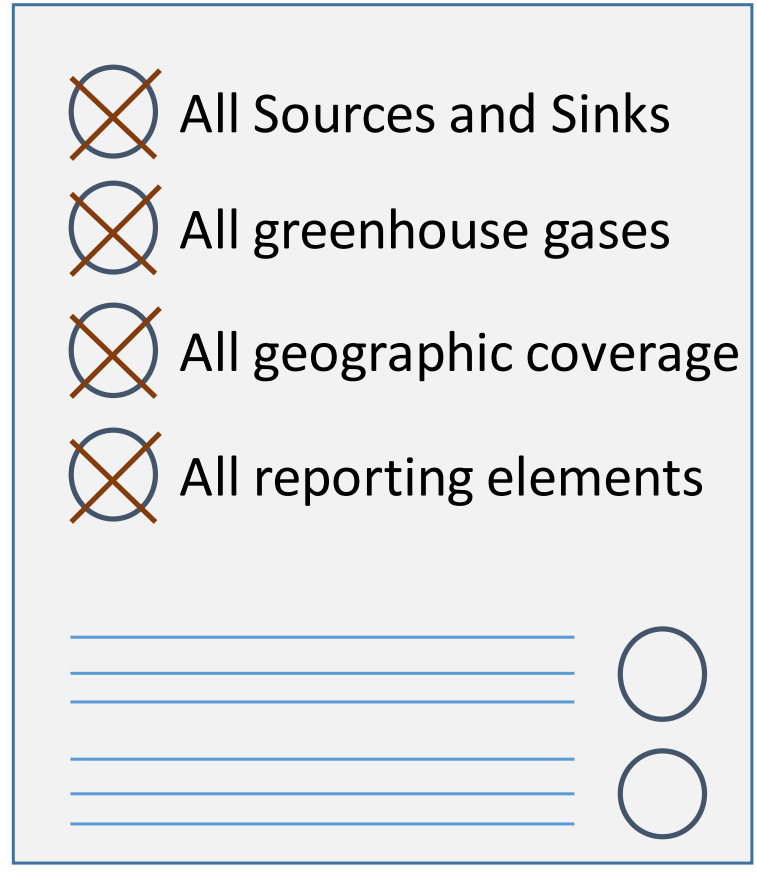
COMPARABILITY

- Inventory is reported in a way that allows it to be compared with national GHG inventories for other countries
- Comparability should be reflected in appropriate choice of key categories, and in the use of the reporting guidance and tables and use of the classification and definition of categories of emissions and removals



COMPLETENESS

- Estimates are reported for:
  - all relevant categories of sources and sinks
  - all gases
- Covering national territory / geographic area
- Where elements are missing their absence should be clearly documented together with a justification for exclusion.

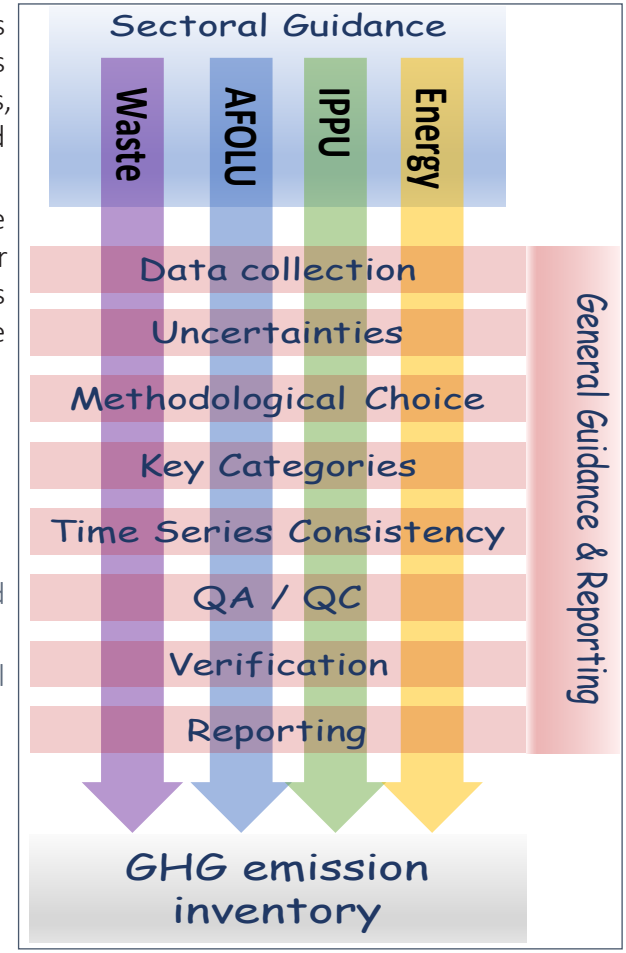


WHAT IS THE MEANING OF GOOD PRACTICE?

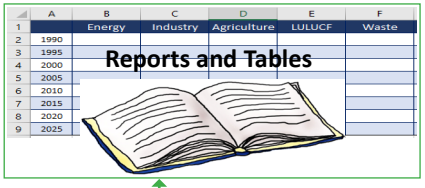
Good practice approach is a pragmatic means of building inventories that are TACCC - and maintaining them in a manner that improves inventory quality over time and quality control requirements, improved accuracy and reduced uncertainty need to be balanced against requirements for timeliness and cost effectiveness.

Good Practice assists countries in producing inventories that are accurate in the sense of being "those that contain neither over- nor under-estimates so far as can be judged, and in which uncertainties are reduced as far as is practical". In addition, good practice has the following advantages:

- gives guidance on data collection
- gives a way to manage uncertainties
- gives guidance on choice of methodology
- identifies "KEY" categories to focus resources
- supports in preparation time series consistency and recalculations
- gives guidance on quality assurance and quality control (QA/QC) activities
- provides transparent documentation
- gives guidance on verification
- provides support in reporting and review



INVENTORY PREPARATION CYCLE



START NEW BUILDING ON OF PREVIOS

DOCUMENT AND ARCHIVE

REPORT INVENTORY

MAKE NECESSARY (IF

CHECK / REVIEW INVENTORY THROUGH QA

QC Checking (👀) & Documentation (✎)

CONDUCT KEY CATEGORY ANALYSIS (KCA)

QC Checking (👀) & Documentation (✎)

CONDUCT UNCERTAINTY ANALYSIS (UA): EVALUATE INPUT DATA AND ASSESS OVERALL INVENTORY

QC Checking (👀)

ESTIMATE, EXPERIENCE INVENTORIES

IDENTIFY KEY CATEGORIES

QC Checking (👓) & Documentation (✎)

SELECT METHODS
WHILE CONSIDERING DATA COLLECTION, UNCERTAINTY AND TIME SERIES CONSISTENCY **GOOD PRACTICE**

COLLECT DATA AND **ESTIMATE EMISSIONS/ REMOVALS** ENSURING ADEQUATE **QA/QC** AND **TIME SERIES CONSISTENCY**

QC Checking (👓) & Documentation (✎)

COMPILE INVENTORY:
(WORKSHEETS)
CONSIDERING **TIME SERIES CONSISTENCY** AND **QA/QC**

& Documentation (✎)

REVISIONS ANY)

GREENHOUSE GAS (GHG) INVENTORY OF AFGHANISTAN

All governments compile national greenhouse gas inventories as part of their obligations under the United Nation Framework Convention on Climate Change (UNFCCC); 197 countries have become parties to the convention. This international treaty sets general goals and rules for confronting climate change and preventing dangerous human interferences with the climate system. These Countries are obliged to report on periodic basis through the submission of a national communication (NC) as well as Biennial Update Report (BUR) or Biennial Report (BR). The cornerstone of these reports is the national greenhouse gas inventory. For information on GHG emissions and climate actions, visit www.UNFCCC.int.

> **COMMITMENT IS AN ACT, NOT A WORD.**
>
> Jean Paul Sartre

WHAT ARE THE REPORTING OBLIGATIONS OF AFGHANISTAN?

To achieve the objective of the Convention and any related legal instruments "to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" all Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:

(Develop, periodically update, publish and make available to the Conference of the Parties (COP), in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties (COP).

Based on the aforementioned obligation, Afghanistan has to prepare its national GHG inventories using the IPCC guidelines and good practices.Compiling an inventory requires a fairly lengthy and interconnected series of tasks, including collecting emission factors and activity data, selecting appropriate methods, estimating GHG emissions and removals, implementing uncertainty assessment and quality assurance/quality control procedures, reporting the results, and documenting and archiving all relevant data and procedures.

The work requires fundamental decisions about data and methods, the establishment of a network of contacts for accessing data and reviewing results, as well as the design of a system for data management, quality assurance, quality control, documentation and archiving. The inventory process should be planned, operated and managed to ensure optimal quality and efficiency, given available resources.

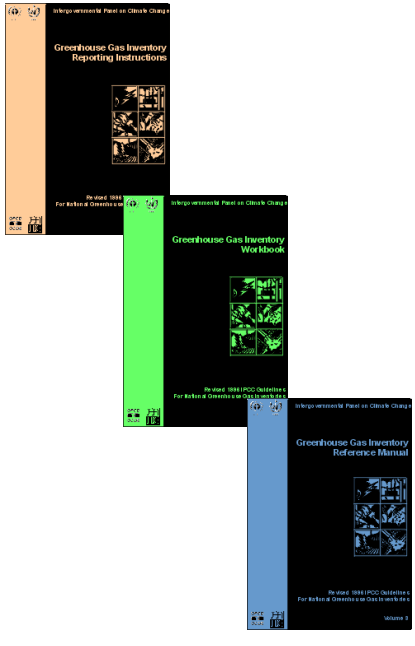
Because each new inventory builds on the information gathered during the previous inventory effort, a rigorous national inventory system should be established and maintained for reporting, documenting and archiving of data, data sources, methods, assumptions, uncertainties and results. Without such a system, inventory teams and the national inventory itself will not be able to benefit from its previous efforts.

Revision & Update of Guidelines by the Intergovernmental Panel on Climate Change (IPCC)

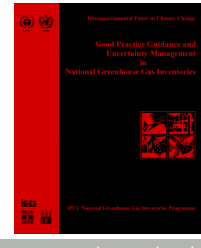
Afghanistan as Non-Annex I Parties:

- **should** use Revised 1996 IPCC Guidelines (Annex to Decision 17/CP.8)
- is **encouraged** to use GPGs.

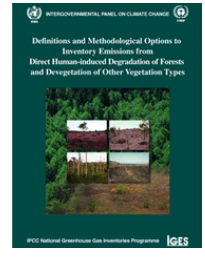
Revised 1996 IPCC Guidelines



IPCC Good Practice Guidance (GPG) 2000



Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types



Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG LULUCF) 2003

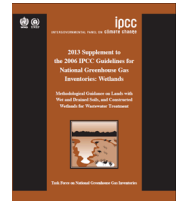
Non-Annex I Parties: Although not a formal request, the UNFCCC welcomes the use of the 2006 IPCC guidelines.

Annex I Parties shall use the 2006 IPCC Guidelines, from 2015 onwards.

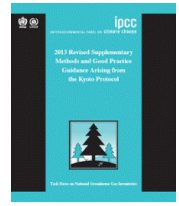
Annex I Parties and Non-Annex I Parties: no formal need to use the 2019 refinements

2006 IPCC Guidelines

2013 Supplement to the 2006 IPCC GL



2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol



2019 Refinements to the 2006 IPCC Guidelines

SUMMARY OF AFGHANISTAN'S NATIONAL GHG INVENTORY FOR 1990-2017 TIME SERIES

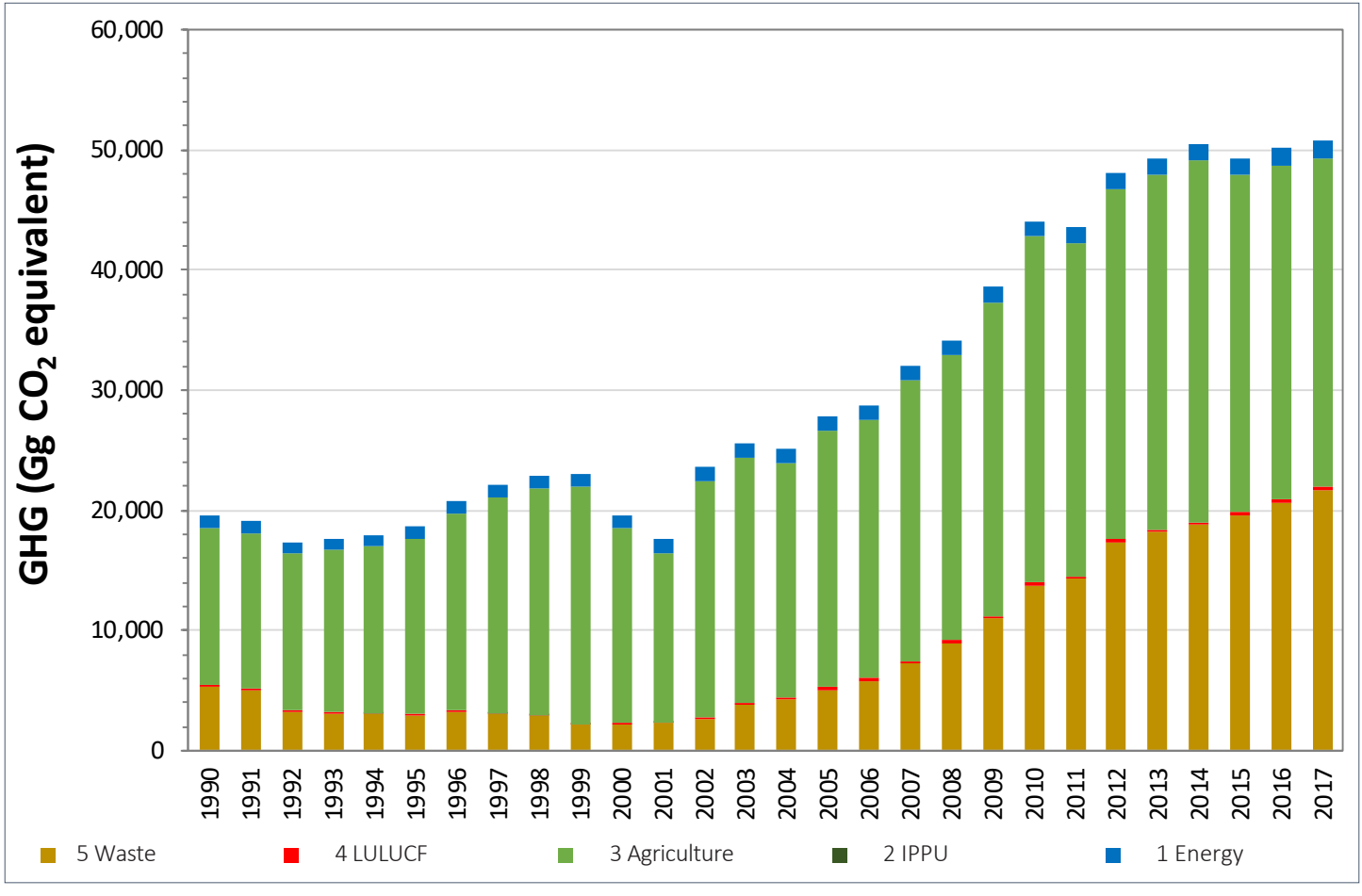
Afghanistan's total National greenhouse gas (GHG) emissions (without LULUCF) amounted in 2017 to 43,471.39 Gg CO_2 equivalents. Compared to 2005 the GHG emissions increased by 93.6 % and compared to 1990 the GHG emissions increased by 140.5 %. In 2005 the GHG emissions (without LULUCF) amounted to 22,453.86 Gg CO_2 equivalents and in 1990 the GHG emissions (without LULUCF) amounted to 18,076.57 Gg CO_2 equivalents.

Greenhouse Gases	GHG (Gg CO_2 equivalent)				Trend	1990	2017
	1990	2005	2012	2017	1990 – 2017	Share [%]	
CO_2	5191.09	4774.85	16770.99	20934.98	303.8 %	28.7 %	48.2 %
CH_4	9559.16	12255.60	16109.71	16418.51	71.7 %	52.9 %	37.8 %
N_2O	333.00	5423.67	7043.92	6117.89	83.5 %	18.4 %	14.1 %
Total GHG	**18083.25**	**22453.86**	**39924.62**	**43471.39**	**140.4 %**	**100.0 %**	**100.0 %**

The most important GHG in Afghanistan is carbon dioxide (CO_2) with a share of 48.2% in 2017. The CO_2 emissions primarily result from fuel combustion activities; methane (CH_4), which mainly arises from livestock farming, contributes to 37.8% of the national total GHG emissions, and nitrous oxide (N_2O) with agricultural soils as the main source contributes to the remaining 14.1% in 2017. In 2005, the most important GHG was CH_4 with a share of 54.6%, followed by N_2O with 24.2%. CO_2 was at that time only responsible for 21.3% of the total GHG emissions.

In 1990 (as in 2005), CH_4 emissions from livestock farming had a share of 52.9% of total GHG emissions. CO_2 emissions mainly from fuel combustion contributed with 28.7%, and N_2O contributed with 18.4% total GHG emissions. These changes in the contribution of the specific GHGs to total emissions were driven by the War in Afghanistan, leading in earlier year to less power production from fossil fuels, and thereby to lower CO_2 emissions.

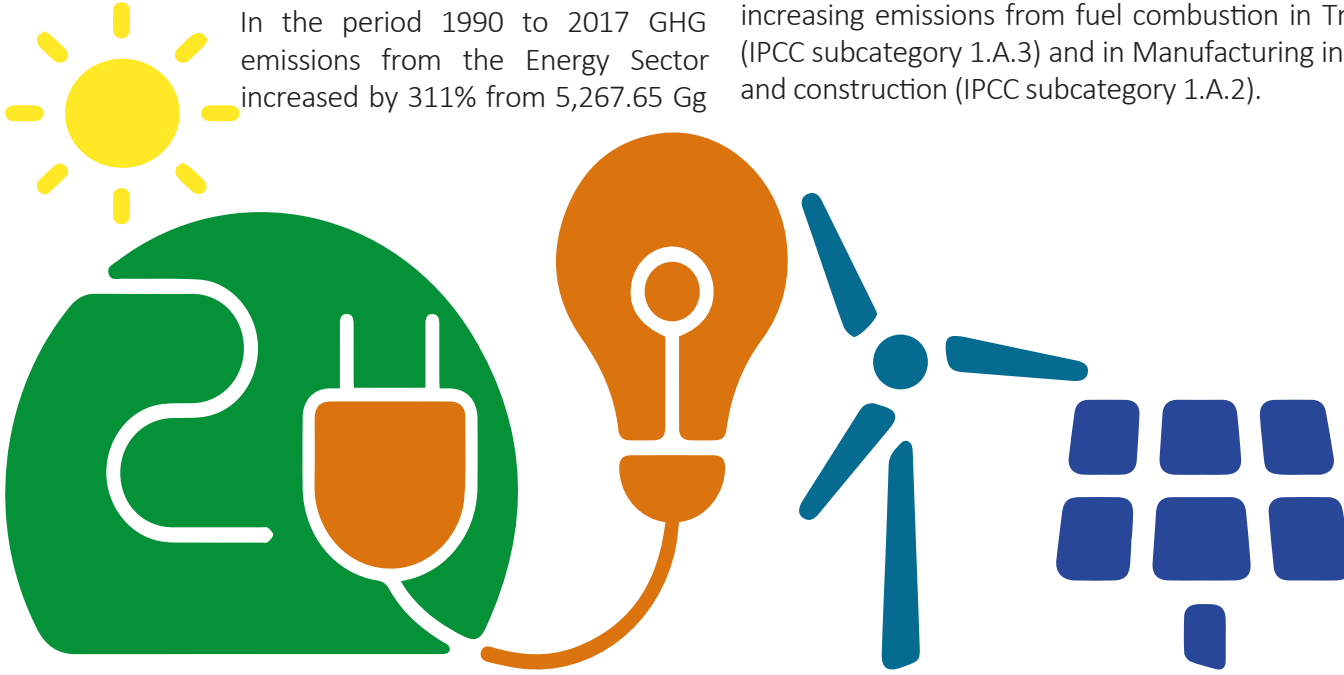
Total national GHG emissions by IPCC sector

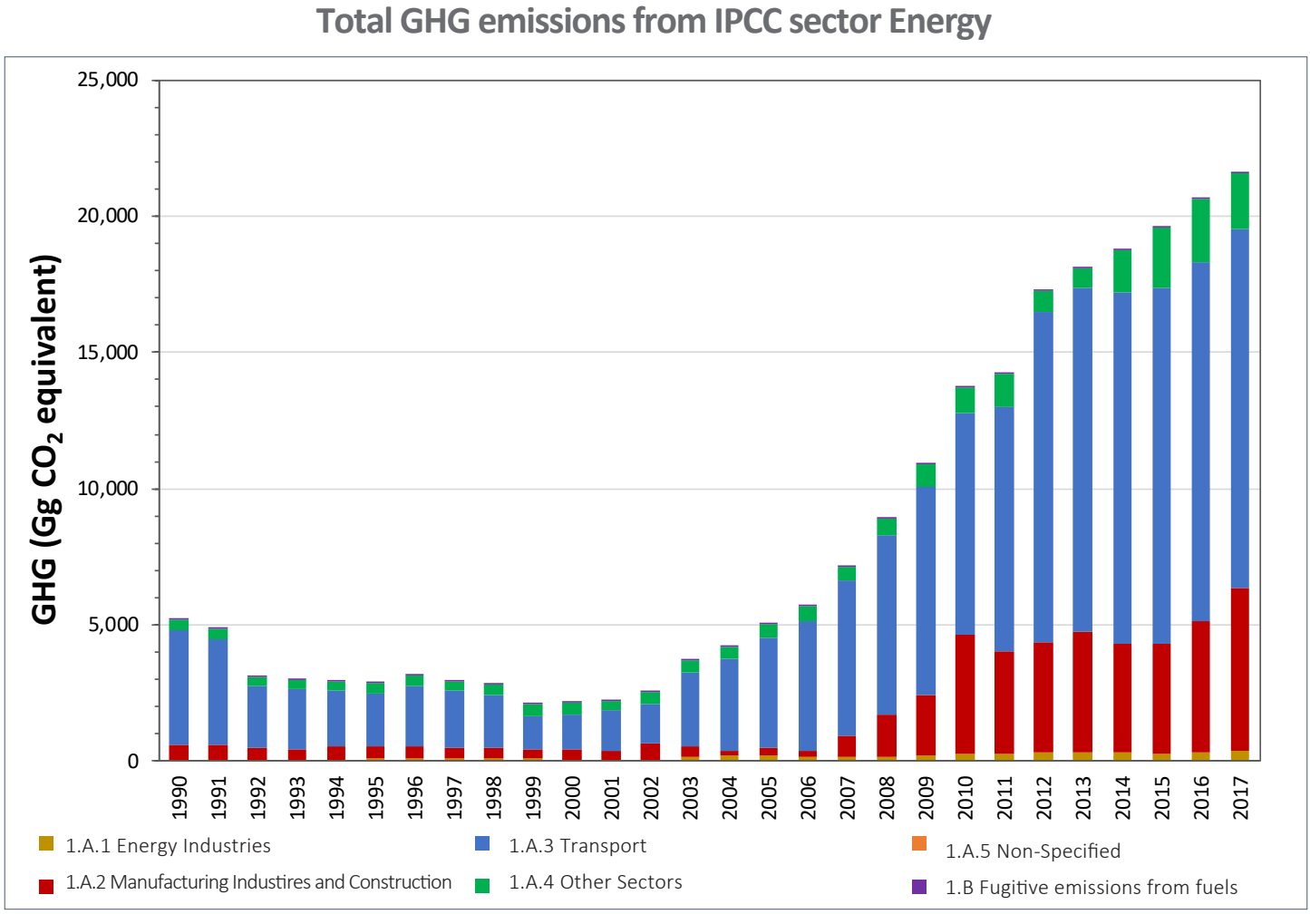


GREENHOUSE GAS EMISSION FROM ENERGY SECTOR

In the Energy Sector, emissions originating from fuel combustion activities in road traffic, in the energy and manufacturing industry and in the commercial, agricultural and residential sector (Category 1.A) as well as fugitive emissions from fuels (Category 1.B) are considered. However, fugitive emissions make up less than 1% of the total emissions from this sector.

In the period 1990 to 2017 GHG emissions from the Energy Sector increased by 311% from 5,267.65 Gg CO_2 eq in 1990 to 21,649.43 Gg CO_2 eq in 2017. Emissions from the energy sector decreased by 3.8% from 5,267.65 Gg CO_2 equivalents in 1990 to 5,066.98 Gg CO_2 equivalents in 2005. In the period 2005 to 2017 GHG emissions from the energy sector increased by 327% from 5,066.98 Gg CO_2 equivalents in 2005 to 21,649.43 Gg CO_2 equivalents in 2017. The increase of emissions is mainly caused by increasing emissions from fuel combustion in Transport (IPCC subcategory 1.A.3) and in Manufacturing industries and construction (IPCC subcategory 1.A.2).



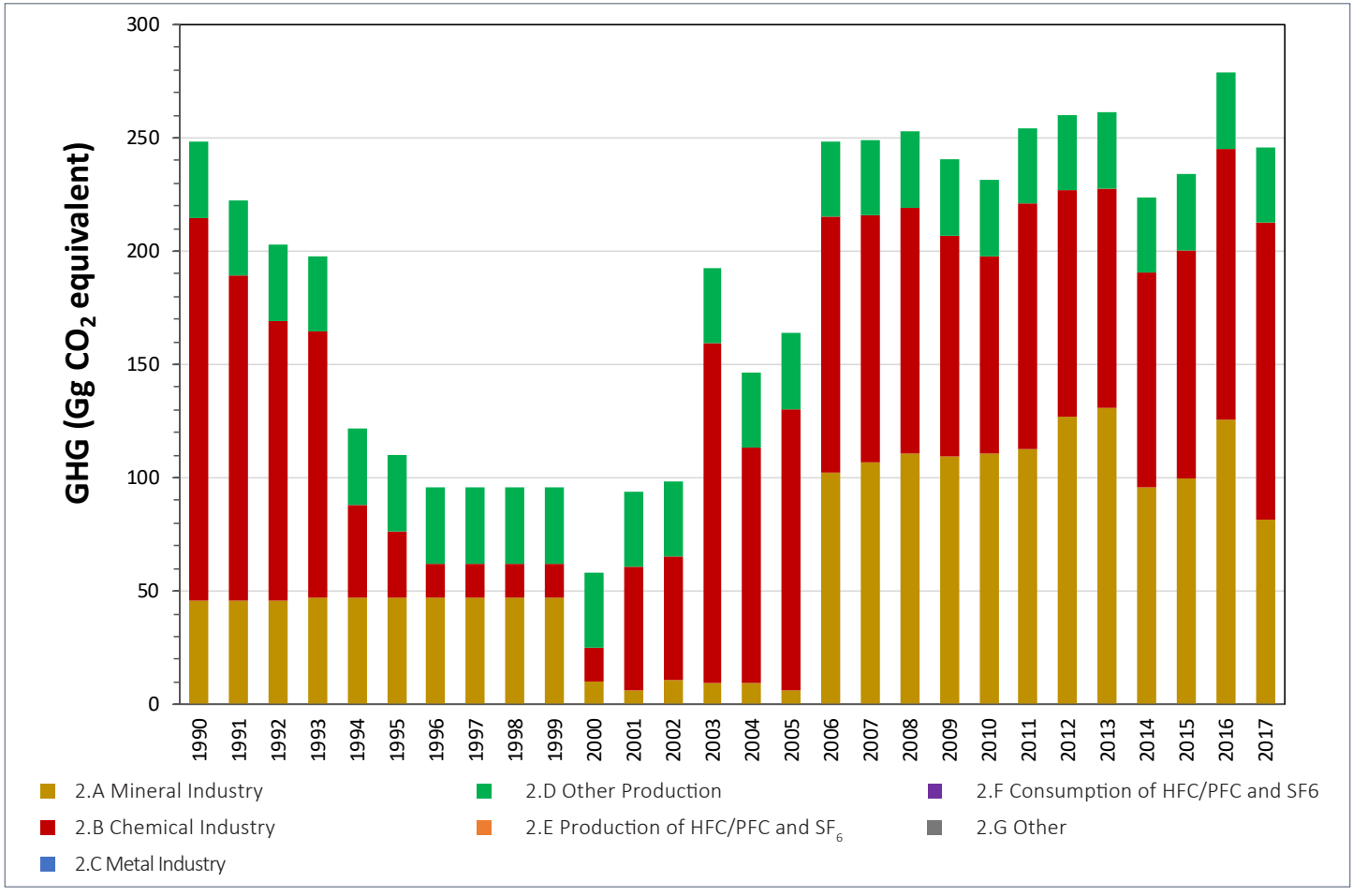

Total GHG emissions from IPCC sector Energy
GHG (Gg CO_2 equivalent)
25,000
20,000
15,000
10,000
5,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1.A.1 Energy Industries
1.A.2 Manufacturing Industires and Construction
1.A.3 Transport
1.A.4 Other Sectors
1.A.5 Non-Specified
1.B Fugitive emissions from fuels

GREENHOUSE GAS EMISSION FROM INDUSTRIAL PROCESSES AND PRODUCTS USE SECTOR

In the period, 1990 to 2017 GHG emissions from the IPCC Sector Industrial Processes and Product Use (IPPU) decreased slightly by 0.9% from 248.13 Gg CO_2 eq in 1990 to 245.78 Gg CO_2 eq in 2017. Emissions from the IPCC Sector Industrial Processes and Product Use (IPPU) decreased by 34% from 248.13 Gg CO_2 equivalents in 1990 to 163.84 Gg CO_2 equivalents in 2005. In the period, 2005 to 2017 GHG emissions from the IPCC Sector Industrial Processes and Product Use (IPPU) increased by 50% from 163.84 Gg CO_2 equivalents in 2005 to 245.78 Gg CO_2 equivalents in 2017.

The decrease of emissions is mainly caused by production reduction during the Afghan war. The increase of GHG emission are due to the increased production in the chemical industry also due to a significant increase of cement production in the Mineral industry.

Total GHG emissions from IPCC sector 2 Industrial Process and Product Use (IPPU)



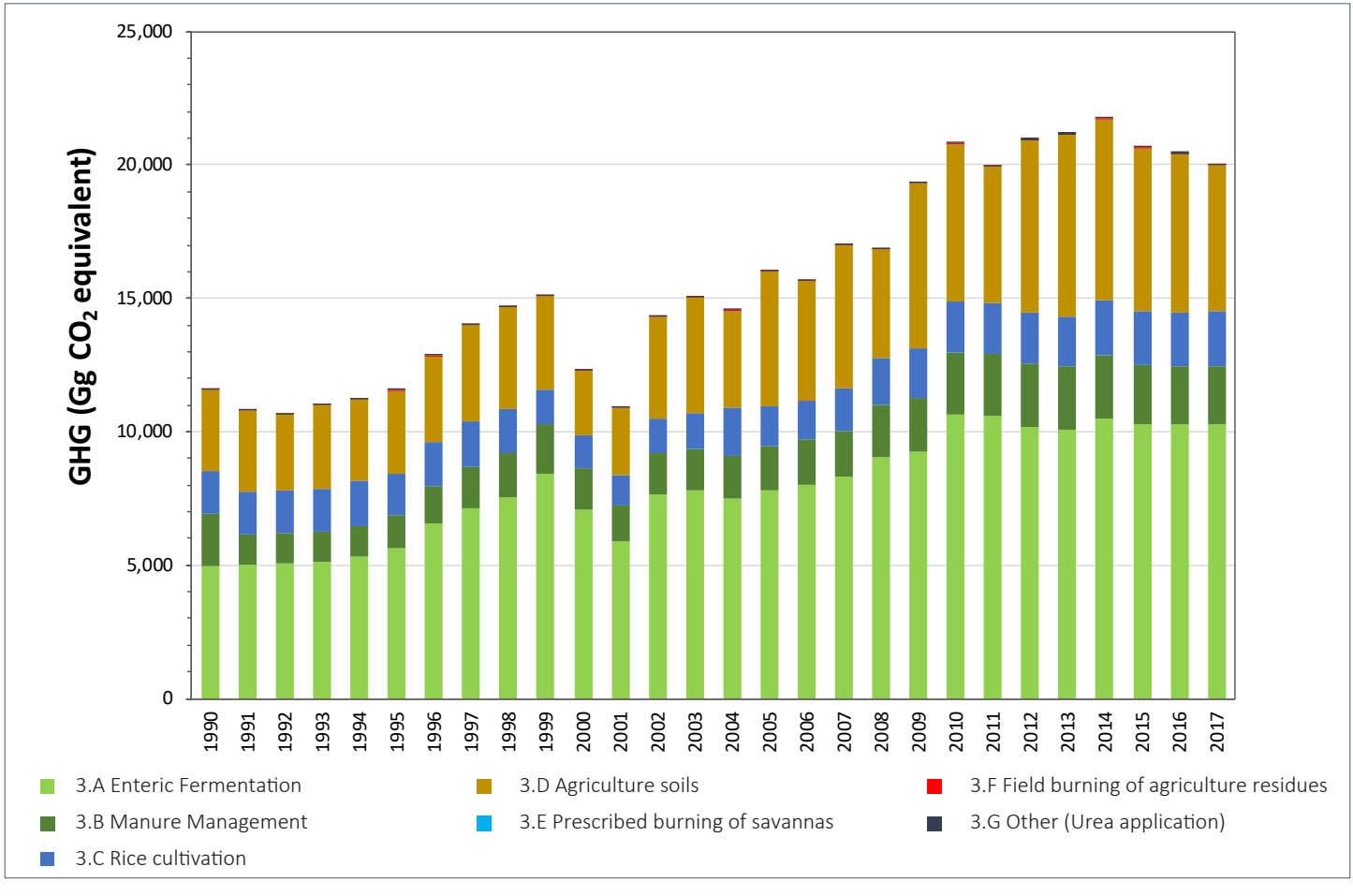
GREENHOUSE GAS EMISSION FROM AGRICULTURE SECTOR

In the period 1990 to 2017 GHG emissions from the Agriculture Sector increased by 73% from 11,623.10 Gg CO_2 eq in 1990 to 20,073.90 Gg CO_2 eq in 2017. Emissions from the Agriculture sector increased by 38% from 11,623.10 Gg CO_2 equivalents in 1990 to 16,036.89 Gg CO_2 equivalents in 2005. In the period 2005 to 2017 GHG emissions from the Agriculture sector increased by 25% from 16,036.89 Gg CO_2 equivalents in 2005 to 20,073.90 Gg CO_2 equivalents in 2017. The increase of emissions is mainly caused by increasing emissions from Enteric Fermentation and Manure Management (IPCC subcategory 3.A and 3.B) and Agricultural Soils (IPCC subcategory 3.D).

In the period 2016 to 2017 GHG emissions from the Agriculture Sector decreased by 2.1% from 20,490.89 Gg CO_2 eq in 2016 to 20,073.90 Gg CO_2 eq in 2017, which is mainly caused by decreasing emissions from cultivation activities in Agricultural Soils (IPCC subcategory 3.D).

The most important sources of GHGs in the Agriculture Sector is Enteric Fermentation and Agricultural Soils. With regards to CH_4 emission, the source Enteric Fermentation was the primary source. With regards to N_2O emission, the source Agricultural Soils was the primary source.

Total GHG emissions from IPCC sector 3 Agriculture



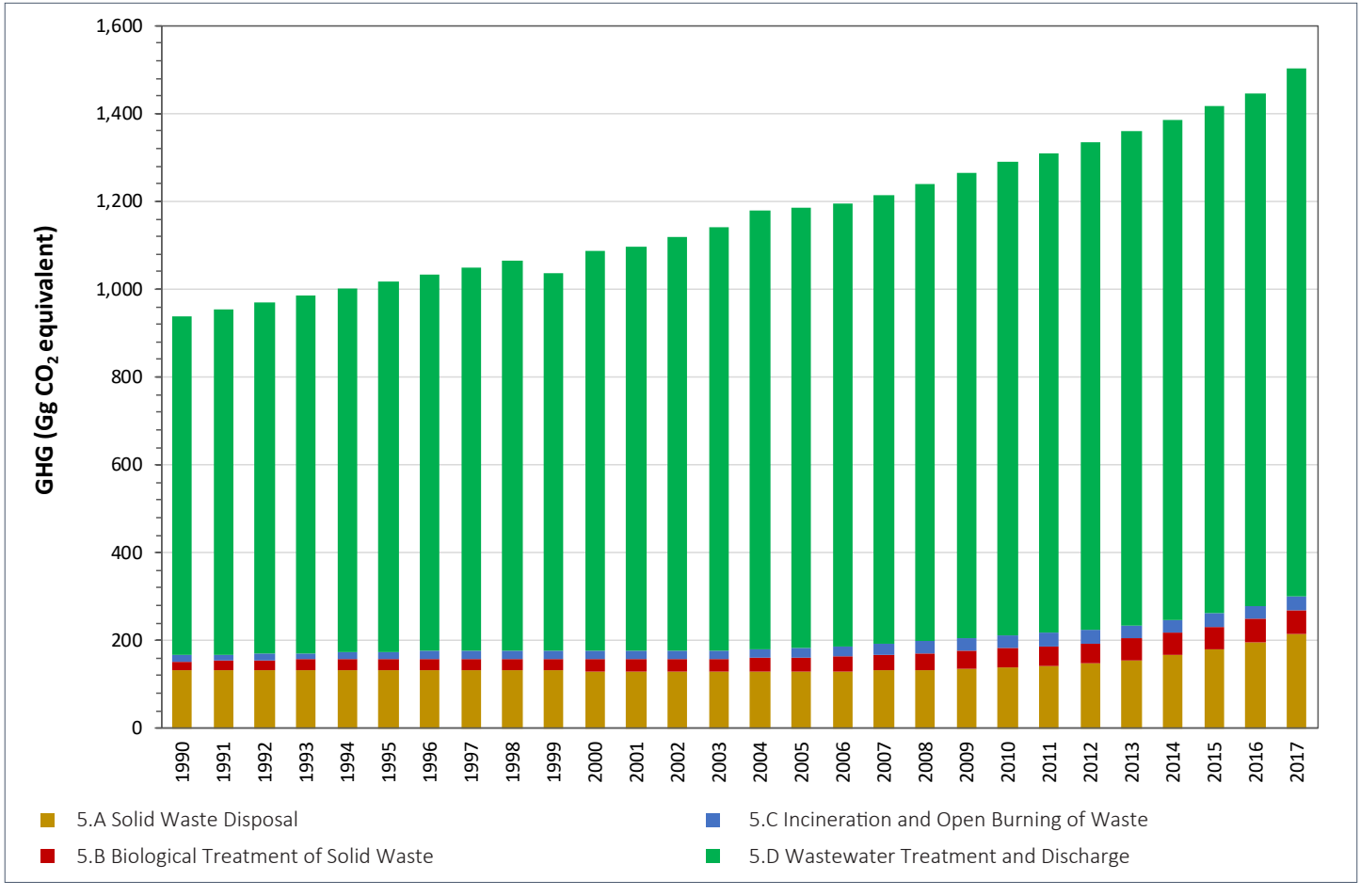
GREENHOUSE GAS EMISSION FROM WASTE SECTOR

In the period 1990 to 2017 GHG emissions from the Waste Sector increased by 60% from 937.70 Gg CO_2 eq in 1990 to 1,502.27 Gg CO_2 eq in 2017. Emissions from the Waste sector increased by 26% to 1,186.15 Gg CO_2 equivalents in 2005 compared to the level of 1990. In the period 2005 to 2017 GHG emissions from the Waste sector increased by 27%. The increase of emissions is mainly caused by increasing emissions from Solid waste Disposal (IPCC subcategory 5.A) and Incineration and Open Burning of Waste (IPCC subcategory 5.C).

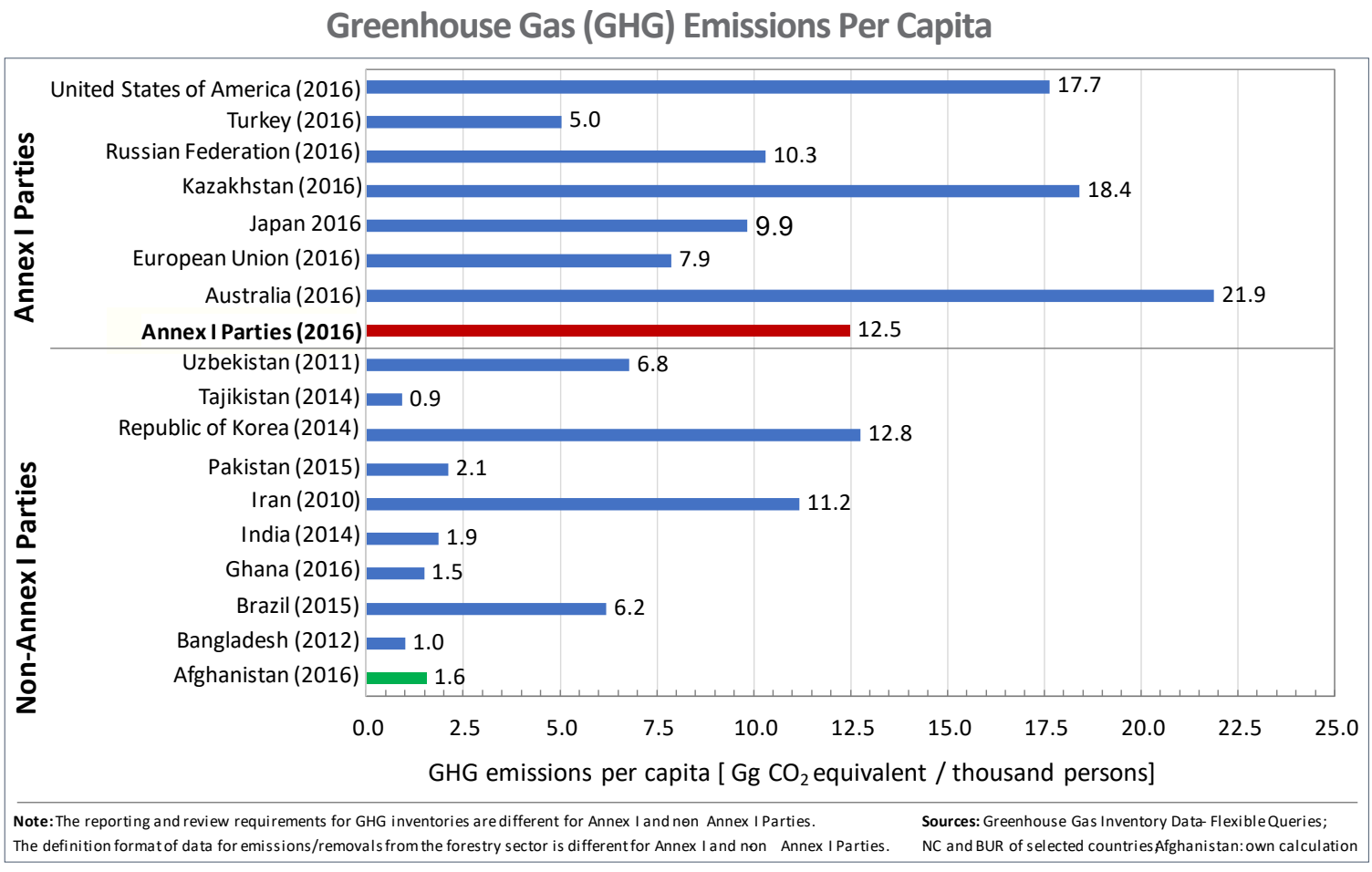
In the period 2016 to 2017 GHG emissions from the Waste Sector increased by 3.8% from 1,446.59 Gg CO_2 eq in 2016 to 1,502.27 Gg CO_2 eq in 2017, which is mainly caused by increasing emissions from Solid waste Disposal (IPCC subcategory 5.A).

The most important sources of GHGs in the Waste Sector is Solid waste Disposal. With regards to CO_2 emission, the source Incineration and open burning of waste was the primary source. With regards to CH_4 emission and N_2O emission, the source Solid waste Disposal was the primary source.

Total GHG emissions from IPCC sector 3 Agriculture



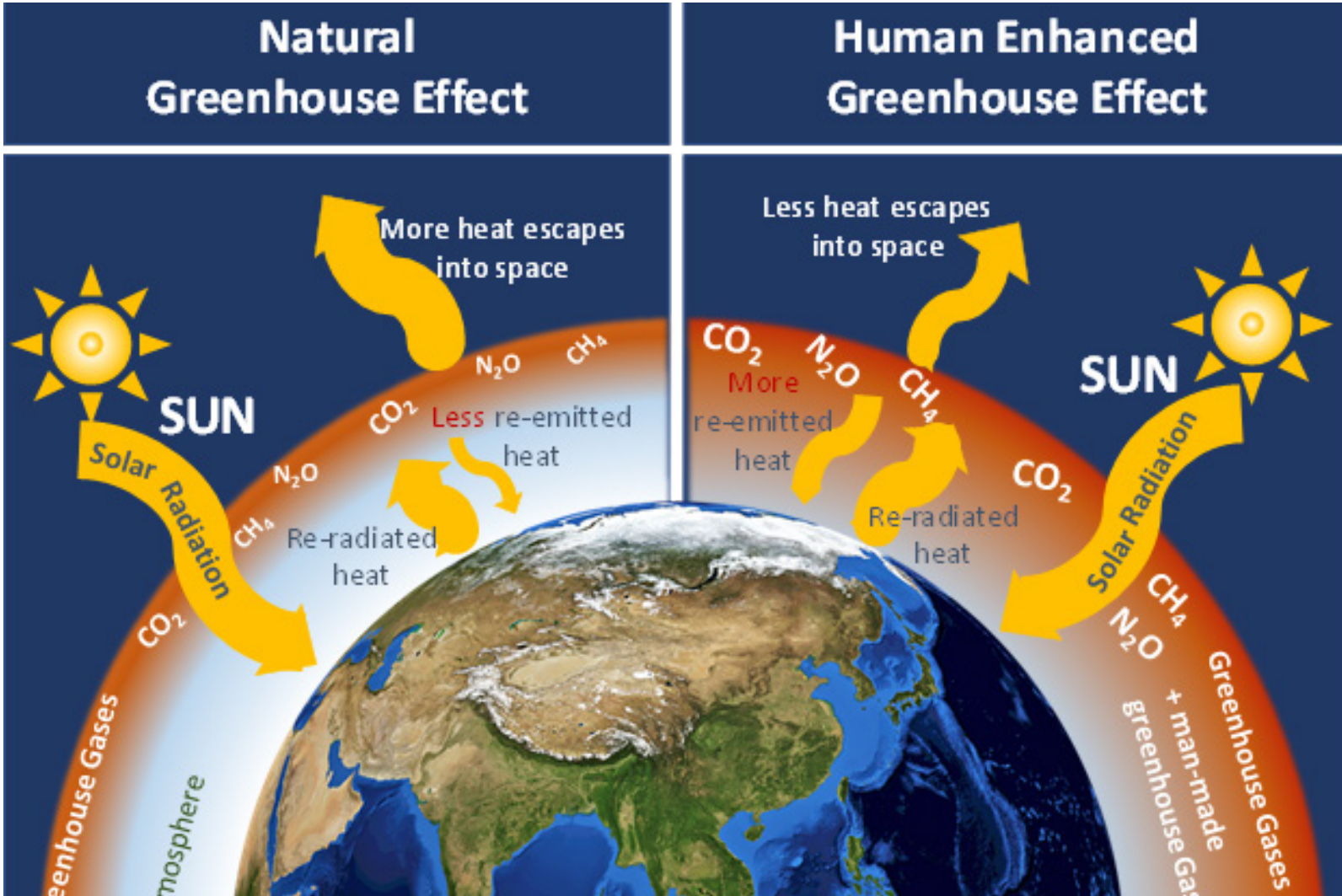
GREENHOUSE GAS (GHG) EMISSIONS PER CAPITA OF SELECTED COUNTRIES

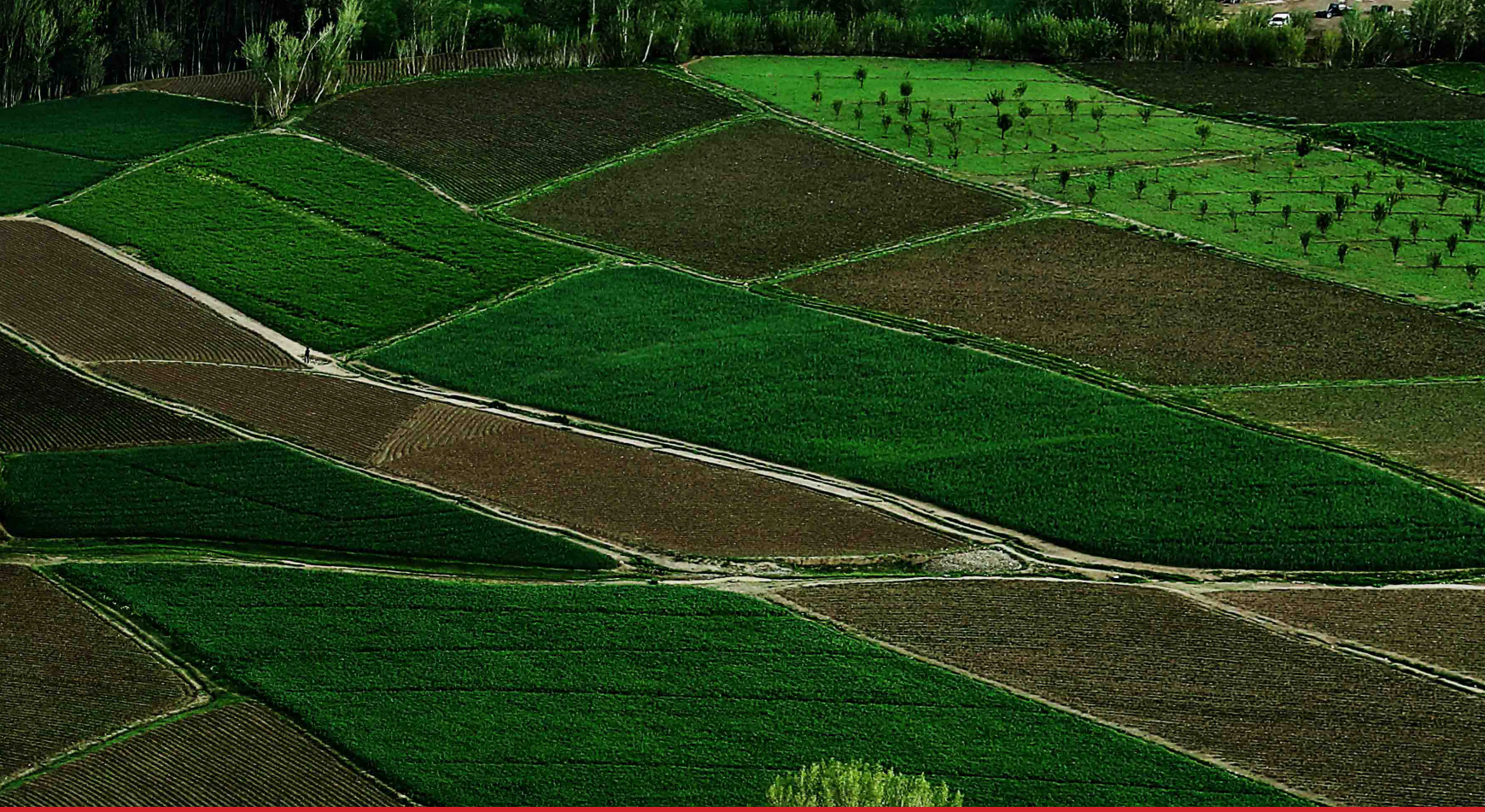


Note: The reporting and review requirements for GHG inventories are different for Annex I and non Annex I Parties. The definition format of data for emissions/removals from the forestry sector is different for Annex I and non Annex I Parties.

Sources: Greenhouse Gas Inventory Data- Flexible Queries; NC and BUR of selected countries; Afghanistan: own calculation

WHAT IS THE GREENHOUSE GAS EFFECT?





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This guidance chart is developed to enhance the capacity of the national experts involved in GHG emission calculation and to raise the public awareness on GHG emission sources and removal sinks.

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